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Flint River Assessment

Joseph M. Leonardi
and
William J. Gruhn

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MICHIGAN DEPARTMENT OF NATURAL RESOURCES
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EXECUTIVE SUMMARY

This is one of a series of river assessments to be prepared by Michigan Department of Natural Resources (MDNR), Fisheries Division, for Michigan rivers. This report describes characteristics of the Flint River and its biological communities.

River assessments are prepared to provide a comprehensive reference for citizens and agency personnel who desire information about a particular fisheries resource. These assessments will provide an approach to identifying opportunities and solving problems related to aquatic resources in watersheds. It is hoped that this river assessment will increase public awareness of the Flint River and its challenges and serve to promote a sense of public stewardship and advocacy for the resources of the watershed. The ultimate goal is to increase public involvement in the decision making process to benefit the river and resources.

This document consists of four parts: an introduction, a river assessment, management options, and public comments and responses. The river assessment is the nucleus of the report. The characteristics of the Flint River and its watershed are described in twelve sections: geography, history, geology and hydrology, soil and land use patterns, channel morphology, dams and barriers, special jurisdictions, water quality, biological communities, fishery management, recreational use, and citizen involvement.

The management options section of the report identifies a variety of challenges and opportunities. These management options are categorized and presented following the organization of the main sections of the river assessment. It must be stressed that the options listed are not necessarily recommended by MDNR, Fisheries Division. They are intended to provide groundwork for public discussion and comment.

The Flint River and its tributaries form a network draining approximately 1,332 square miles of southeast Michigan. The main river is approximately 142 miles in length and its basin contains portions of the following Michigan counties: Oakland, Lapeer, Tuscola, Sanilac, Genesee, Shiawassee, and Saginaw. The Flint River is a principal tributary of the Shiawassee River, which flows to the Saginaw River and Saginaw Bay of Lake Huron. Its major tributaries include the South and North Branch Flint rivers, and Kearsley, Thread, Swartz, and Misteguay creeks.

For purposes of discussion, the Flint River mainstem is divided into six sections called valley segments. Valley segments represent portions of a river that share common channel and landscape features. They were identified using major changes in hydrology, channel and valley shapes, land cover, and surficial geology. The upper South Branch Flint River segment extends from Horseshoe Lake to Winns Pond. It has moderate groundwater inflow keeping water temperature cool and water flow is moderately stable. The middle South Branch Flint River segment extends from Winns Pond to the Plum Creek confluence, north of Lapeer. Groundwater inflow is reduced, water temperature is warmer, and flow is less stable. The lower South Branch Flint River segment extends from the confluence of Plum Creek to the confluence of the South Branch Flint River with the North Branch Flint River and includes the North Branch Flint River tributary. In this segment, groundwater inflow is low, water temperature is warm, and flow is moderately unstable. The upper Flint River segment extends from the confluence of the North and South branches to the Swartz Creek confluence in Flint. Flow is greater in this segment but is regulated by a number of dams (Holloway, Mott, Utah, and Hamilton). Groundwater inflow is low and water temperature is warm. The middle Flint River segment extends from the confluence of Swartz Creek to the Saginaw County line north of Montrose. Groundwater inflow is low, water temperature is warm, and flow is unstable and event responsive. The lower Flint River segment extends from the Saginaw County line to the confluence of the Flint with the Shiawassee River. Groundwater inflow is low, water temperature is warm, and flow remains unstable and event responsive.

The hydrology of the Flint River is strongly influenced by glacial deposits and watershed development. Surficial geology is generally of two types: permeable sandy loam and gravel providing moderate groundwater inflow, and less permeable clay-rich loam providing little groundwater inflow and greater surface water runoff. Unstable and event responsive flow is found in the majority of the basin. Much of the Flint River basin has been channelized for drainage exacerbating unstable flow. Moderately stable flow is found in the upper South Branch Flint River and in the headwater reaches of some tributaries (i.e. Kearsley and Thread creeks).

The average gradient of the mainstem Flint River is 2.9 feet per mile with a range of 0-10 feet per mile. The highest gradient (> 5 feet per mile) is located in the upper South Branch Flint River and the middle Flint River in the Flushing area. The lowest gradient (< 1 foot per mile) occurs in the lower Flint River. Fish and other aquatic animals are typically most diverse and productive in river sections with higher gradient and well established riffle-pool sequences with good hydraulic diversity.

Land use in the Flint River watershed is dominated by agriculture (49%) followed by forested (16%), non-forested (15%), urban development (15%), wetland (3%), and water (1%). The loss of wetlands from channelization and tiling has decreased flow stability, increased erosion and sedimentation, and altered stream temperature regimes. Urban development along the river has had significant affects on water quality. Continued growth and development in the watershed is expected to exacerbate unstable flow and degraded water quality conditions.

The channel of the mainstem Flint River has been adversely altered. High gradient reaches in the upper Flint River have been impounded, inundating natural rock and gravel substrates, altering stream flow, reducing stream habitat continuity, and interrupting sediment and nutrient transport. Unstable flow has widened the mainstem channel by increased erosion resulting in gradual bank sloping. Erosion has reduced aquatic stream bank habitat and overhanging vegetative cover. Removal of riparian vegetation has reduced important habitat associated with large woody structure in the channel. Most tributaries have been straightened and continue to be dredged on a routine basis.

There are 93 dams and water-control structures in the Flint River basin registered with the Michigan Department of Environmental Quality (MDEQ). Four major dams are on the mainstem. Dams alter flow and fragment river systems turning high gradient river habitat into lentic habitat. These high-gradient riverine areas are essential spawning habitat for several species of fish. Dams impede fish movements to refuge habitats, isolate populations, and block spawning migrations. Hamilton Dam on the mainstem, in the city of Flint, is the first barrier blocking upstream movement of potamodromous fish. Dams also act as sediment, nutrient, and woody debris traps. Holloway Reservoir and Mott Impoundment have experienced increases in sediments and nutrients affecting their aquatic communities. Sediment-free water released from dams has high erosive power that can cause bank erosion and increase sediment transport downstream.

Despite their effects on natural river function, dams provide some human benefit. They provide water supply to municipalities, industries, and fire stations vital to the community. Impoundments created by Holloway and Mott dams provide valuable recreational uses to the Flint area where water-based recreational opportunities are lacking. Impoundments in the Lapeer State Game Area and upper Thread Creek provide valuable wildlife habitat and refuge.

Historically, the Flint River basin has suffered from poor water quality due to unregulated discharges by industries and municipalities and from channelization. Point source pollution has decreased over the past thirty years through restrictive discharge regulations and with improved technology and managerial practices. Pollution from point sources will continue to be reduced as municipal wastewater treatment plants upgrade their facilities, transport lines, and technology, and with tighter restrictions on industrial discharge permits.

Nonpoint source pollution is the greatest factor that degrades water quality in the Flint River watershed. This type of pollution consists of sediments, nutrients, bacteria, organic chemicals, and inorganic chemicals from agricultural fields, construction sites, parking lots, roads and road crossings, and septic seepage. Extensive channelization facilitates pollutant transport by eliminating the filtering capacity of wetlands. Reduced nonpoint source pollution can occur through implementation of best management practices. However, drainage ditches will continue to transport pollutants at an accelerated rate unless corrective and rehabilitative efforts to restore wetlands in the watershed are implemented.

Based on post-1950 records, the present fish community of the Flint River watershed is composed of 77 species. Seven fish species (brassy minnow, redfin shiner, silver redhorse, greater redhorse, tadpole madtom, coho salmon, pirate perch) have been recorded in the Flint River but their current status is unknown. Five indigenous species are believed extirpated: lake sturgeon, lake trout, lake herring, lake whitefish, and muskellunge. These extirpated fish species are associated with Lake Huron and historically used the Flint River for spawning. Thirteen species of the present fish community have been introduced or have colonized in the basin. No State or Federally threatened or endangered fish species occur in the Flint River watershed. Although the diversity of fish species present in the Flint River remains relatively high, certain species have declined in abundance. Affects of watershed development have favored tolerant species with broad habitat requirements. Silt-tolerant fish species have increased in the watershed, whereas fishes requiring clean gravel substrate or clean cooler water have declined. Degraded water quality, unstable flow, and stream habitat loss from channelization are the three principal factors that have resulted in significant changes in fish species composition in the Flint River basin. Also, dams and lake-level control structures have affected fish communities by fragmenting the river system, altering flow, increasing erosion, blocking fish movement, and changing lotic habitat to sediment laden and nutrient rich lentic habitat.

Fisheries management of the Flint River and its tributaries has been limited due to degraded water quality, unstable flow, and habitat loss. Future fisheries management depends on improvement of these limitations. The re-establishment of the Saginaw Bay walleye run in the Flint River is an example of how improved water quality teamed with fish stocking can result in fisheries rehabilitation and improvement. Other fisheries improvements may be made in localized areas with fish stocking and habitat rehabilitation. Identifying and protecting river reaches of good water quality and habitat, and rehabilitating degraded reaches is necessary to establish and maintain self-sustaining populations. Fish communities in isolated areas and in some inland lakes are now being enhanced with fish stocking. Creel census and an angler reporting system would provide valuable insight for future fisheries management.

Recreational use of the Flint River is high in areas where public access is available. Many people use the river and corridor for fishing, canoeing, swimming, picnicking, and hunting. However, recreational use suffers because of limited access and pollution (bacteria). To achieve recreation potential, new access areas throughout the watershed need to be purchased. Corrective actions on reducing bacterial contamination must also be taken to assure full body contact recreation is permissible in the river system.

Interest in the Flint River watershed is increasing and gaining public support. Several organizations work on various aspects of the river including fishing, hunting, and other recreational use. Interest from groups outside of the Flint River watershed stems from the role the Flint River plays as a component of the Saginaw Bay watershed. The Flint River Watershed Coalition has taken a lead role in watershed education. With decreases in governmental funding and personnel, public involvement through local and watershed organizations is important to ensure that habitat protection and enhancement of water quality and recreational opportunities continues to move forward in the Flint River basin.

INTRODUCTION

This river assessment is one of a series of documents being prepared by Michigan Department of Natural Resources, 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 aquatic ecosystem. Our approach is consistent with the mission of the Michigan Department of Natural Resources, Fisheries Division, namely to "protect and enhance the public trust in populations and habitat of fishes and other forms of aquatic life, and promote optimum use of these resources for benefit of the people of Michigan".

As stated in the Fisheries Division Strategic Plan, our aim is to develop a better understanding of the structure and functions of various aquatic ecosystems, to appreciate their history, and to understand changes to systems. Using this knowledge we will identify opportunities that provide and protect sustainable fishery 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 unable 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; the amount varies. Therefore each assessment focuses on ecosystem maintenance and rehabilitation. Maintenance involves either slowing or preventing losses of ecosystem structures and processes. Rehabilitation is putting back some structures or processes.

River assessments are based on ten guiding principles of Fisheries Division. 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 determine decisions. They also provide an organized reference for Fisheries Division personnel, other agencies, and citizens who need information about a particular aspect of the river system.

The nucleus of each assessment is a description of the river and its' watershed using a standard list of topics. 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. This section sets the scene.
>
> **History -** a description of the river as seen by early settlers and a history of human uses and modifications of the river and watershed.
>
> **Geology and 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, habitat characteristics, and perturbation frequency.

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

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

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

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

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

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

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

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

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

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

Copies of the draft assessment were distributed for public review beginning December 20, 2001. Three public meetings were held: February 26, 2001 in Flint (attendance = 23); March 6 in Lapeer (attendance = 53); and March 8 in Montrose (attendance = 2). Written comment were received through March 31, 2001. Comments were either incorporated into this assessment or responded to in this section.

A fisheries management plan will be written after completion of this assessment. This plan will identify options chosen by Fisheries Division, based on our analysis and comments received, that the Division is able to address. In general, a Fisheries Division management plan will focus on a shorter time period, include options within the authority of Fisheries Division, and be adaptive over time.

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

Michigan Department of Natural Resources
Fisheries Division
10650 Bennett Drive
Morrice, MI 48857-9792

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

RIVER ASSESSMENT

Geography

The Flint River basin (Figure 1) is in Southeast Michigan, in the area known as the "thumb". This is described as the Central Lowland Physiographic Province by the United States Department of Agriculture (1987). The mainstem is formed by the confluence of the North and South Branch Flint rivers (Figure 2). The South Branch Flint River originates at Horseshoe Lake in north central Oakland County and flows north. The North Branch Flint River is formed by the confluence of Elm and Cedar creeks near the town of North Branch and flows west, to join with South Branch Flint River to form the mainstem near Columbiaville. From Columbiaville, the Flint River flows west through the city of Flint then north to join the Shiawassee River. The Shiawassee, Tittabawassee, and Cass rivers merge to form the Saginaw River near Saginaw. The Saginaw River flows into Saginaw Bay, Lake Huron. From the origin of the South Branch Flint River, the Flint River is 142.2 miles and drains 1,332 square miles (Michigan Department of Natural Resources (MDNR) 1988).

The Flint River basin can be broken into six river valley segments using a landscape based ecological classification system (Seelbach et al. 1997) (Figure 3). Although each valley segment has common characteristics: land cover; hydrology; channel shape; valley shape; and surficial geology, these characteristics may not be representative of the tributaries within the valley segment.

Upper South Branch Flint River
This segment includes the upstream reach of the South Branch Flint River, from its origin at Horseshoe Lake, to Winns Pond Dam, 20.6 miles downstream. Wigville Creek is the principal tributary (Figure 2). The town of Thornville is located in this segment.

Middle South Branch Flint River
This segment extends from Winns Pond Dam down to the confluence of the South Branch Flint River with Plum Creek near Millville. This segment includes approximately 7.7 miles of mainstem plus Pine, Hunters, Mill, Farmers and Plum creeks and flows through the city of Lapeer (Figure 2).

Lower South Branch Flint River
This segment extends from the confluence of Plum Creek to the confluence of the South Branch Flint River with the North Branch Flint River near Columbiaville. It contains approximately 12.3 miles of mainstem plus the North Branch Flint River and its tributaries (Figure 2).

Upper Flint River
This segment extends from the confluence of the South and North Branch Flint rivers downstream to the confluence with Swartz Creek. It includes approximately 56.9 miles of mainstem including Holloway Reservoir, Mott Lake, and Hamilton Impoundment. Principal tributaries are Henry, Powers-Cullen, and Kimball drains and Hasler, Butternut, Kearsley, Duck, Black, Gilkey, Swartz, and Thread creeks (Figure 2). The city of Flint and the town of Columbiaville are the principal communities in this segment.

Middle Flint River
This middle segment extends from the confluence of Swartz Creek to the Saginaw County line, north of Montrose, where the Flint River descends downhill into the Saginaw Lake Plain. This segment is approximately 26.2 miles and collects Mud, Cole, Brent and Brent Run creeks (Figure 2).

Lower Flint River
This segment extends from the Saginaw County line to the confluence of the Flint River and Shiawassee River near the town of St. Charles. It is approximately 19.5 miles in length passing through the towns of Morseville and Fosters collecting Pine Run, Silver, and Misteguay creeks (Figure 2).

History

Michigan was fully covered by the Late Wisconsinan glacier, of the Pleistocene Epoch, 18,000 years ago (Farrand and Eschman 1974) (Figure 4). This great sheet of ice extended as far south as the Ohio River in western Ohio and eastern Indiana and extended westward into eastern Illinois. Major lobes followed the axes of Lakes Michigan, Huron, and Erie. Repeated advances and retreats of the Lake Huron lobe formed the Flint River basin as the glacier melted approximately 10,000 years ago.

Pre-settlement vegetation consisted of open forests and savannas of black and white oak on sandy moraines, beech-maple forests on loamy soils, and white pine and eastern hemlock scattered along the South Branch Flint River. Kettle lakes and swampy depressions on the outwash typically supported alder or conifer swamp; northern white-cedar, tamarack, black ash, white pine and eastern hemlock were the common species. In the upper and middle Flint River segments, beech-sugar maple forest (sugar maple, basswood, red oak, and white ash) occupied the upland and moraine areas, and oak-hickory forest (red oak, white oak, hickory) occupied the drier moraine ridges. Swamp forests dominated most of the depressions, but wet meadows were also present along streams. The flat, inland expanses of sand lake plain, of the lower mainstem, supported eastern hemlock, with white pine, black ash, American elm, and other hardwoods. On the better-drained portions of the clay plain, along the southern end of Saginaw Bay, beech and sugar maple forests dominated. Many of the upland forests on clay plain were probably fairly moist, as indicated by the abundance of American elm, basswood and black ash. Tamarack and northern white cedar were present in the swamps (Albert 1994). For a more detailed description of pre-settlement vegetation, see **Soils and Land Use Patterns** later.

The recorded history of Michigan dates back to the same time that pilgrims were settling Massachusetts (Fitting 1975). During that same period, the French, who came into the area to convert Native Americans to Christianity and to trade with them, were exploring the area around Sault Ste. Marie. The French established outposts at Sault Ste. Marie in 1668 and at St. Ignace in 1671.

Archaeological sites along the Flint River indicate Native Americans hunted mastodon, mammoths, caribou, and other now extinct animals on the plains and marshes along the Flint River during the Paleo-Indian Period, approximately 10,000 years ago (B. Mead, Department of State, Office of the State Archaeologist, personal communication) (Table 1). By 500 BC, during the Woodland Period, these early inhabitants were experimenting with raising crops and making ceramics.

When the first European explorers arrived in the Saginaw Valley, they found it populated by Chippewa and Ottawa Indians, with the Chippewas being more numerous (Ellis 1879). However, Chippewa history tells that when they came into the area the Sauks and Onottoways inhabited the valley. The Sauks lived along the Tittabawassee, Flint, and Shiawassee rivers and the Onottoways along the Onottoway-Sebewing, and Cass rivers. The Chippewas, being envious of the abundance of fish, game, furbearers, and fruits in the Saginaw Valley, formed a pact with the Ottawa's taking over the Saginaw Valley by nearly annihilating the Sauks and driving the Onottoways out of the region.

When early French fur traders moved into the Flint River Valley, they established an encampment at a natural river crossing used by Native Americans. The Indian name for this river was *Pewoni*g*owink* meaning "river of fire stone" or river of flint. The crossing was located on the "southern bend" of the

Flint River on the "Saginaw Trail" that ran between villages at the outlet of Lake St. Clair (Detroit) and encampments at the mouth of the Saginaw River. It was very near the mouth of Swartz Creek. This crossing became known as the "Grande Traverse" or great crossing place and was probably named by the French fur trader Bolieu (Crowe 1945). This trail later became a primary military route between Saginaw and Detroit. However, no permanent trading post was established here until Jacob Smith arrived in 1819 (Crowe 1945).

Initially, immigration into Michigan was slow because of its reputation for inhospitable soils and climate. Ten years after Jacob Smith, several families from New York moved into the area and a water power mill was built. The first settlers came from the Genesee Valley, New York and New England. When they organized the county, they named it Genesee County. The primary economic activity was trapping, but this eventually gave way to farming.

The settlement of Michigan progressed rapidly after the War of 1812 and the acquisition of several tracts of land from Native Americans by the first Territorial Governor, Lewis Cass. The City of Flint grew up at the site of the "Grand Traverse" and European settlers concentrated along the banks of the Flint River, taking up farming, lumbering, and manufacturing.

Although Michigan was primarily an agricultural state before the Civil War, and even though America's first mining boom occurred in its Upper Peninsula in the 1840s, lumbering became the principal economic activity in the new state during the second half of the 19th century (Fitting 1975). Muskegon, Menominee, and Saginaw were lumbering centers and "lumbering altered much of the landscape, as all of the timber of the northern lower peninsula and much of the upper peninsula was removed between 1860 and 1910" (Fitting 1975). Truman Fox (1858) described the Flint River…"Pine is found in abundance upon the banks of this stream…. Many rich bottomlands are also found along this river. The river also affords a number of excellent mill sites, and is already being applied to a variety of manufacturing purposes."

Flint was originally named the "City of Flint" in its 1855 charter. With a good supply of high quality lumber and a need to move supplies from town to lumbering camps, it is not surprising that Flint became a center for transportation producing horses, horse harnesses, horse-drawn vehicles, and ox carts. In 1870, there were half a dozen or more wagon and carriage builders in Flint and by 1900, Flint was building 150,000 vehicles per year, both wagons and carts. As the pine forests were exhausted, Flint's attention turned to other industries and the transition to automobile manufacturing was natural (Crowe 1945). In 1903, Buick Motor Company began production of the Buick automobile. By 1910, one of six cars on United States highways were Buicks. Future automobile manufacturers, Walter Chrysler, Louis Chevrolet, and C. W. Nash learned automobile manufacturing at Buick Motor Company. Under the business genius of Will Durant, formerly of Durant-Dort Carriage Company, Buick Motor Company convinced suppliers such as Champion Spark Plug Company, Weston-Mott (Axle) Company, and Fisher Body Company to relocate in Flint. In September 1908, Durant organized General Motors whose sole purpose was to consolidate Buick Motor Company and its affiliate companies to Flint. Flint became the birthplace of General Motors and the United Auto Workers (UAW) union. Even today, Flint is often referred to as Buick City, and its prosperity centered on the manufacture of automobiles.

Flint and Buick Motor Company made an important contribution to the war effort in World War II producing Pratt and Whitney aircraft engines and M-10 and M-18 tank destroyers. In addition, Buick Motors metallurgists developed the technology to make ammunition cartridge cases from steel when brass was in very short supply (Crowe 1945).

After World War II, prosperity fostered population increase and diversifying communities. Gasoline was inexpensive, new highways were built, vehicles were in demand, and General Motors, the UAW, and Flint flourished. Outlying communities of Lapeer, Davison, Grand Blanc, Flushing, Clio, and Montrose experienced growth and were desirable locations to live and work. Advancements in the gasoline engine allowed for increased agriculture and farming dominated watershed land use. However, economic woes in the 1970s had devastating affects on Flint. General Motors position in the global market resulted in closed auto plants, job loss, and the "deindustrialization" of Flint (Dandaneau 1996).

Presently, Flint is changing. A community, whose economic welfare traditionally was tied to the prosperity of General Motors, has had to seek economic stability through diversification. Although General Motors is vital to Flint's tax base, new businesses have become equally important and re-development of underused industrial properties to attract new business has become a challenge, particularly as urban sprawl becomes commonplace.

Geology and Hydrology

Geology

Geology is an important factor influencing the hydrology of a river system. Michigan's southern peninsula geology was strongly influenced by the Wisconsinan Glacier 18,000 to 10,000 years ago (Figure 4). Glacial moraines were formed in the Flint River basin by minor oscillations in the early retreat of the Saginaw Lobe. Glacial lake plains were left by the later rapid retreat of the Saginaw and Huron-Erie lobes from the Michigan Lobe (Farrand and Eschman 1974).

The Flint River basin lies within the Huron, Ionia, and Saginaw districts of the Southern Lower Michigan Regional Landscape Ecosystem (Albert 1994) (Figure 5). The Huron District contains the Sandusky and Lum subdistricts. The South Branch Flint River lies within the Lum Subdistrict. Coarse and medium textured moraines dominate the upper reach of the South Branch Flint River, lacustrine clay, and finely textured moraines are found in the middle reach, and lacustrine sand and medium textured moraines are found in the lower reach. Albert (1994) describes medium textured moraines as typically well drained and lacustrine clay and finely textured moraines as being well to poorly drained.

The Ionia District is made up of the Greenville and Lansing subdistricts (Figure 5). The upper and middle Flint River segments lie largely within the Lansing Subdistrict. Soils are characterized as medium textured moraines and lacustrine clay and silt. A narrow band of outwash sand and gravel occupies the main Flint River valley. Two geological features stand out in the upper Flint River segment: a bedrock outcrop that forms the "Grand Traverse" near the mouth of Swartz Creek and an outcropping near Flushing (Ellis 1879). Soils of the upper and middle Flint River segments vary from being well to poorly drained (Albert 1994).

The lower Flint River segment is located in the Saginaw District (Figure 5). Soils in this area are characterized as lacustrine clay, silt, and sand. Albert (1994) describes Saginaw District soils as "glacial lake plain and reworked till plain". Soils are fine textured, semi-impervious to water, and poorly drained.

Flint River basin groundwater and surface water patterns follow geological soil types. Darcy's Law describes the flow of groundwater through a medium, such as soil (Dunne and Leopold 1978). Groundwater flow is a product of soil permeability and hydraulic head pressure (groundwater elevation). Permeable soils with high groundwater elevation result in high groundwater inflow.

Many streams in southern Michigan (including the Flint River) lie in glacial outwash sand valleys and run across and through coarse and medium textured moraines resulting in groundwater inflow (P. Seelbach, MDNR, Fisheries Division, personal communication). High groundwater inflows insure stable stream flows throughout the year and cooler water temperatures during the summer. Groundwater inflow above the Michigan lower peninsula average can be found in the upper and lower reaches of the South Branch Flint River, the upper reach of the North Branch Flint River, the upper mainstem Flint River, and the upper reaches of Kearsley and Thread Creeks (Figure 6). Groundwater inflow in the middle and lower Flint River segments is below average resulting in decreased flow stability and warmer water temperatures (Figure 6).

Climate

Climatic factors influence biota and land use. Climate in the Lum Subdistrict (Figure 5), which includes the South Branch Flint River, is influenced by Lake Huron only 21 miles away. The average growing season is 130 to 140 days, average rainfall is 28 to 30 inches, and average snowfall is 40 inches. Extreme minimum temperatures in this subdistrict range from -24^{o}F to -28^{o}F (Albert 1994). Climate in the Lansing Subdistrict is more inland and influenced by Lake Michigan becoming wetter as one moves westward. These climatic conditions dominate the upper and middle Flint River segments. Average growing season is longer at 140 to 160 days, average annual precipitation ranges from 30 to 32 inches, and average snowfall is more variable ranging from 40 to 70 inches annually. Extreme minimum temperatures in the Lansing Subdistrict range from -24^{o}F to -38^{o}F, the lowest in the Flint River watershed. The lowest minimum temperatures occur in the northern part of the subdistrict (Albert 1994).

Climate in the Saginaw District is very similar to regions at the southern boundary of the State. The Saginaw District is nestled next to the southern tip of Saginaw Bay and contains the lower Flint River segment. Average growing season ranges from 150 to 160 days, average annual precipitation ranges from 28 to 40 inches, and average annual snowfall is 40 inches. Extreme annual minimum temperatures range from -24^{o}F to -28^{o}F (Albert 1994).

The mean annual temperature in the Flint River watershed is 47^{o}F and mean July temperature is 70^{o}F (Gooding 1995). Albert (1994) describes summers in the Flint River basin as “hot and humid, with high temperatures in the mid-90^{o}F range accompanied by humidity up to mid-90%, resulting in low evaporation”.

Annual Stream Flow

Stream flow can be considered the “master variable” that regulates ecological integrity of streams and limits distribution and abundance of aquatic species (Poff et al. 1997). Stream flows reflect watershed conditions and influence temperature regimes, habitat characteristics, and perturbation frequency. Changes in stream flows and flow regimes limit and sometimes eliminate many aquatic species within a stream system (Vannote et al. 1980; Poff and Ward 1989; Newman 1999). Flow stability is critical to support balanced diverse fish communities and is an important component of habitat suitability (Richards 1990; Hay-Chmielewski et. al. 1995). Analyzing stream flow, over time periods, is useful in characterizing stream flow patterns. Measurements of annual, monthly, and daily flow are often used to assure adequate dilution of municipal and industrial effluents.

Stream flow data in Michigan are recorded continuously at gauging stations operated by the United States Geological Survey (USGS). The USGS maintains three active gauges on the Flint River and two on tributaries (Figure 7). In addition, historic data are available from eleven retired USGS gauges on the Flint River and its tributaries (Figure 7). Data from these gauges have been collected for up to 69 years (period of record). All USGS gauge data discussed are for period of record (Table 2).

Stream discharge measurements provide data to determine mean annual flow at gauging locations in the Flint River basin (Table 2). Mean annual flow averaged 185 cfs at the South Branch Flint River USGS gauging station. Near Otisville, downstream of the North and South Branch confluences, mean annual flow for the mainstem averaged 344 cfs. Downstream of the Kearsley, Thread, and Swartz creeks confluence, mean annual flow at the Flint River near Flint was 643 cfs. At the retired gauging station near Fosters, approximately 12 miles upstream of the Flint and Shiawassee rivers confluence, mean annual discharge of the Flint River averaged 757 cfs.

Mean annual flows vary significantly from year to year depending on precipitation. High flow extreme for the South Branch Flint River gauging station, occurred in 1985 when mean annual flow was 295 cfs. Low flow extreme occurred in 1989 when mean annual flow was 126 cfs. For the Flint River near Otisville, high flow extreme occurred in 1985 when mean annual flow was 638 cfs. Low flow extreme occurred in 1969 when mean annual flow was 83 cfs. Flow extremes at the gauging station near Flint were recorded in 1985 when mean annual flow was 1,258 cfs and in 1964 when mean annual flow was 153 cfs. Wide variations in mean annual flow is characteristic of an unstable flow regime influenced by precipitation and surface water runoff.

Seasonal Water Flow

Mean monthly discharge shows seasonal variability within the Flint River system (Figure 8). Mean monthly discharge at the South Branch Flint River, near Columbiaville, ranged from a low of 70 cfs in August to a high of 354 cfs in March. Mean monthly discharge at the Otisville gauge on the mainstem ranged from 134 cfs in August to 807 cfs in March. Mean monthly discharge at the Flint gauge on the mainstem ranged from 236 cfs in August to 1,520 cfs in March and at the retired Fosters gauge ranged from 288 cfs in August to 1,854 cfs in March. High flow in the Flint River generally occurs in March and April and low flow in July and August.

Mean monthly discharges at the USGS gauges on Flint River tributaries show the same variability as the mainstem gauges (Figure 9). The tributaries and mainstem show a common response to snowmelt and precipitation with high flow generally occurring in March and April and low flow in July and August.

Flow stability can be viewed by examining flow duration curves constructed using percent exceedence data from USGS gauging stations. An exceedence value is discharge that can be expected to be exceeded for a given percentage of the time. For example, the 10% exceedence value is discharge that can be expected to be exceeded 10% of the time within a given water year (October-September). A 10% or less exceedence value represents relatively rare high flow events (e.g. snowmelt or extraordinary storm events). The 50% exceedence value represents median discharge for a particular station, as half of the time it is higher, and half of the time it is lower than this value. The 90% exceedence value is referred to as base flow and indicates steady contributions of groundwater to the stream, meaning that 90% of the time discharge is expected to be greater than this value.

When comparing exceedence values for stream of varying sizes, it is necessary to standardize values so direct comparison can be made. One method of standardization entails dividing exceedence values by median exceedence. The resulting number represents magnitude of discharge variance for median flow. For exceedence flow over 50%, the smaller the standardized value, the more stable the stream. For example, 5% exceedence divided by 50% exceedence equals standardized discharge at the 5% exceedence level. If this value is equal to 2, flood flow is two times greater than median flow. It is important to remember that flow duration curves are constructed from data collected at specific gauging stations. Gauging stations for Flint River tributaries are located near their confluence and may not represent flow patterns of headwater reaches where flow is typically more stable.

Standardized high flow duration curves for the South Branch Flint River and mainstem, at 5% intervals, is illustrated in Figure 10 in descending order (headwaters to mouth) based on gauge location. The most stable USGS station is the South Branch Flint River near Columbiaville, which has a standardized discharge at 5% exceedence (high flow) of 4.1 i.e., flood flow is 4.1 times greater than the median flow (Figure 10). Standardized discharge at 5% exceedence (high flow) at 3 gauging stations on the mainstem were almost identical at 6.7 i.e., flood flow is 6.7 times greater than the median value (Figure 10). This indicates a moderately unstable system regardless of watershed size. For comparison, the most stable streams in Michigan (e.g. Au Sable, Manistee, and Jordan rivers) have standardized 5% exceedence (high) flows that are slightly less than twice their median flows, whereas the flashy lower Rouge River in southeast Michigan shows a standardized 5% exceedence of 13.7 (Beam and Braunscheidel 1998).

Standardized high flow duration curves for Flint River tributaries show Farmers and Kearsley creeks are more stable than Butternut, Thread, and Swartz creek (Figure 11). However, standardized 5% exceedence values still indicates flow is moderately unstable in each tributary and is strongly influenced by precipitation and surface water runoff.

Flow stability can also be analyzed using low flow (base flow) patterns. In general, the higher the base flow relative to overland flow, the more stable the stream. The higher the ratio between each exceedence rate and the median discharge, the less variation in stream flow. Standardized low flow duration curves for the South Branch Flint River and mainstem are illustrated in Figure 12. Standardized discharge at 95% exceedence (low flow) ranged from 0.2 to 0.3 at the South Branch Flint River gauge and three mainstem gauges (Figure 12). This indicates low groundwater inflow into the Flint River at gauging station locations. For comparison, the groundwater fed South Branch Au Sable River near Luzerne, Michigan has a value of 0.6 (Wesley and Duffy 1999).

Standardized low flow duration curves for Farmers, Butternut, Kearsley, Swartz, and Thread creeks are similar to the mainstem (Figure 13). Standardized 95% exceedence (low flow) values range from 0.3 for Butternut Creek to 0.1 for Swartz and Thread creeks indicating low groundwater inflow. However, gauging station locations on Kearsley and Thread creeks are downstream from where groundwater inflow is above Michigan lower peninsula average (Figure 6) and may not reflect inflow contribution in their upstream reach.

Daily Water Flow

In natural streams, daily flow changes are generally gradual. Extensive alteration of the Flint River watershed has resulted in unstable daily flows that react quickly to rain and snowmelt events. Surface water runoff from impervious surfaces (buildings, parking lots, roads etc…) and tiled agricultural land direct water to the river with little retention time. Artificial drainage ditches, altered (channelized) tributaries, and storm water drains exacerbate surface water movement to the river. Dam and lake-level control structure operations can also affect daily discharge. Daily flow fluctuations can destabilize banks, create abnormally large moving sediment loads, disrupt habitat, and interfere with recreational uses of the river.

Hydrographs (graphs of daily discharge over time) are used to analyze daily flow. Since climate is relatively similar across the watershed, change in the shape of a hydrograph over time can be attributed to variations in geology, land use, water from storm drains, or human alteration by way of channelization and dam or lake-level operations. To illustrate Flint River response to a rain event, data for the gauging station near Flint was examined for the period September 6, 2000 to September 13, 2000 (Figure 14). From September 6 to September 9, daily flow ranged from 110 cfs to 122 cfs with no precipitation recorded. On September 10, Flint River flow increased to 958 cfs after a recorded rainfall of 1.33 inches in Flint. In 24 hours, flow decreased to 253 cfs, then increased to 605 cfs after 0.37 inches of recorded rain in Flint. By September 13, flow was decreasing toward pre-rain level.

Dams can have a major influence in stream flow patterns (see **Dams and Barriers**). Holloway Dam was built in 1953 for potable water supply and flow augmentation for the Flint Wastewater Treatment Plant effluent. The Otisville gauging station was not established below Holloway Dam until the year of dam construction, therefore, data from this gauge does not show before and after effects on Flint River flow. Data from the Flint gauge were reviewed but this gauge is located below Mott Dam and the river receives Kearsley, Swartz, Thread and Gilkey creeks above the gauge making it impossible to determine the effect of Holloway Dam on Flint River flow.

Consumptive Water Use, Irrigation

Bedell (1982) lists no municipal water withdrawals from the Flint River system. The Genesee County Water Service maintains an intake and withdrawal ability that uses Holloway Reservoir to augment flow. Now, potable water in the Flint basin is supplied by groundwater wells or from water lines connected to Saginaw Bay or Lake Huron near Port Huron, Michigan. The city of Flint purchases its water supply from Detroit, which owns the Port Huron transport line. “Large volumes of water are added to the drainage network by townships and municipalities that import drinking water from Lake Huron, Saginaw Bay, or groundwater supplies. The city of Flint, for example, adds an average of 44 cfs to the flow of the Flint River, from its wastewater treatment plant, by discharging water originally taken from Lake Huron. This addition represents 48% of the drought flow in the Flint River at its mouth” (MDNR 1988). Today, Flint’s addition to the flow of the Flint River below its wastewater treatment plant is 50 cfs representing roughly 55% of the rivers drought flow (M. Lesmez, Michigan Department of Environmental Quality (MDEQ), Land and Water Management Division (LWMD), personal communication).

Irrigation withdrawals are common in the Flint River basin. In 1979, approximately 2,826 acre-feet of water was withdrawn from the South Branch Flint River to irrigate 3,460 acres and 404 acre-feet from the mainstem to irrigate 1,495 acres (Bedell and Van Til 1979). These figures include irrigation of golf courses, lawns, and agricultural fields. Approximately 25% of the irrigation withdrawal from the Flint River basin is for golf courses (R. Van Til, MDEQ, Drinking Water and Radiological Protection Division, personal communication). In 1998, there were 27 golf courses in the Flint River basin irrigating 1,420 acres with 2.08 million gallons per day (mgd). A total of 1.21 mgd was withdrawn from inland surface sources and 0.87 mgd from groundwater sources. No withdrawals from the Great Lakes occurred. These figures are misleading because mgd calculations are based on continuous pumping 365 days per year and most withdrawals are made during the driest five months of the year when the river is at low flow. Withdrawals during this period have maximum negative effect on the river and its aquatic community (R. Van Til, MDEQ, Drinking Water and Radiological Protection Division, personal communication).

Flooding

The Flint River, as do most southern Michigan rivers, experiences flood events. Floods are part of the natural cycle of river systems and flood flows are important in sediment, nutrient, and woody structure transport. However, floods have potential to cause great economic damage, particularly where human development of the floodplains has occurred. In the Flint River basin, flooding has been minimized by an extensive drainage system. However, extraordinary flood events may still result in economic damage. Agricultural businesses are typically damaged most often because of their desire to farm fertile floodplain soils.

MDEQ, LWMD, Hydrologic Studies Unit has calculated 50 and 100 year flood discharges for gauging locations in the Flint River watershed (Table 3). A 50 year flood event is what might be expected every 50 years, but it has a 2% probability of occurring each year. A 100 year flood event might be expected every 100 years, but it has a 1% probability of occurring each year. Flooding in the Flint River basin nearing the 50 year event discharge occurred most recently in April, 1975 and September, 1985 (USGS 1998). The last occurrence of a 100-year flood event in the Flint River basin was in April 1947 (USGS 1998).

The United States Army Corps of Engineers, in partnership with the city of Flint, constructed a "flood control project" on the upper Flint River segment in downtown Flint in 1963. This project consists of concrete lining of the riverbed and banks from the mouth of Swartz Creek downstream approximately one mile. The objective of the project is to move water through this reach as efficiently as possible to eliminate flooding. However, the project resulted in loss of roughly one mile of natural river bed and stream bank habitat for aquatic species.

Soils and Land Use Patterns

In combination with climate, soils and land use patterns are important in determining stream hydrology and channel morphology (Dodge 1998). Soils of the Flint River basin reflect glacial influences. As ice melted, rock and soil material ranging in thickness from less than 20 feet to more than 250 feet was deposited over sedimentary bedrock (USDA 1987). Due to the erratic nature of glacial retreats, contrasting soil types can often be found in the same location. A complete review of Flint River soil types is not within the scope of this report, however, a brief review of soil data and its relation to stream hydrology and channel morphology is appropriate. Detailed soils maps are available from offices of the United States Department of Agriculture (USDA) and local Soil Conservation Services.

Soils

Soil texture and particle size determines soil permeability to water. For example, water will percolate at a higher rate through coarse textured sand and gravel than it will through fine textured clay and silt. Permeable soils, if associated with topographic relief (usually moraines), can have high ground water elevation resulting in ground water inflow to a stream. Streams with high ground water inflow are typically cooler and have more stable flow regimes. Less permeable soils, high in clay content, produce greater surface water runoff resulting in unstable stream flow. Because water seeks a path of least resistance, soil is an important component of channel morphology (see **Channel Morphology**).

Sandy loam soils or loams of varying clay, silt, sand, and organic matter content dominate the Flint River basin. Sand soils drain well but tend to be less fertile due to their inability to hold nutrients and moisture. Mixed loam soils have greater fertility and hold moisture for longer time periods. However, loam soils with high clay, silt, and organic content, saturate quickly during wet periods and drainage can be very poor.

Upper South Branch Flint River

Undulating moraines of medium textured sandy loam soil is most common to the upper South Branch Flint River segment. However, clay-rich loams with greater water-holding capacity can be found on moraine ridges. Soils are moderately well drained and fertile. Ground water inflow is above the Michigan lower peninsula mean (Figure 6) and South Branch Flint River flow is fairly stable. Wetlands, rich in organic matter, occupy depressions and surround many of the kettle lakes in this segment. Both marl and peat deposits were mined in the past in the headwater reaches of the South Branch Flint River (Albert 1994).

Pre-settlement vegetation consisted of open forests and savannas of black and white oak on the sandy loam moraines and beech-sugar maple forests with some white oak on the clay-rich soils (Albert 1994). Depressions supported alder and conifer swamps with white pine, white cedar, tamarack, black ash, and eastern hemlock. Today, much of the upland has been de-forested for farming and residential housing.

Middle South Branch Flint River

The middle South Branch Flint River segment has flatter topography than the upper South Branch Flint River. Soils are typically fertile loam with high clay content and are poorly drained. Pre-settlement vegetation followed the same patterns as the upper South Branch Flint River segment with beech-maple forests dominating the clay-rich soils and black and white oak forests dominating the sandy loam soils. Today, this segment is extensively farmed and supports residential housing and development by the city of Lapeer.

Lower South Branch Flint River

Undulating moraines of medium textured sandy loam soils are encountered in the lower South Branch Flint River segment. However, clay loam soils dominate the land surrounding the North Branch Flint River. The sandy loam soils are typically well drained and have ground water inflow that is above the Michigan lower peninsula average (Figure 6). Clay loam soils of the North Branch Flint River are fertile but poorly drained.

Pre-settlement vegetation consisted of open forests and savannas of black and white oak on sandy loam moraines and beech-maple forests on clay-rich loam soils (Albert 1994). Large amounts of white pine and eastern hemlock were also found. Wetland depressions, rich in organic material, supported swamp forests abundant with tamarack, white cedar, and eastern hemlock. Today, portions the lower South Branch Flint River segment remains forested because of State ownership but privately owned lands have been cleared for farming and residential housing.

Upper and Middle Flint River

Topography and soils of the upper and middle Flint river segments is described as gently rolling hills of sandy loam moraines with clay-rich loam between the ridges (Albert 1994). There is a rich band of gravel and sand following the Flint River valley that has been heavily mined. Pre-settlement vegetation consisted of beech-sugar maple forest on the upland moraine areas and oak-hickory forest, dominated by red and white oak, on the drier moraine ridges. Conifer and alder swamp forest was found in depressions, but wet meadows were also present along tributaries. Among the common tree species were silver maple, white pine, American elm, red ash, and red and white oaks. Tamarack was also present, especially in very poorly drained soils. Today, this area has been extensively developed with industry and housing by the city of Flint.

Lower Flint River

The lower Flint River segment is glacial lake plain that can best be described as flat with poorly drained clay and sand soils. Pre-settlement vegetation on the flat inland expanses of sand lake plain supported eastern hemlock, with some white pine, as well as black ash, elm, and other hardwoods. On better drained portions of the clay plain along the southern end of Saginaw Bay, beech and sugar maple dominated the forests. Many of the upland forests on clay plain were probably fairly moist, as indicated by the abundance of (American) elm, basswood, and black ash (Albert 1994). Tamarack and white cedar were present in the swamps.

Land Use

> "Following logging, drainage began for agricultural use of the clay plain. By 1900, the chemical industry was well developed. Most of the clay lands have been ditched and tiled, and they are among the most valued agricultural lands in the State. Parts of the sand plain were also ditched for agriculture, but the wettest areas remain, either as swamp forest, wet prairie, or marsh. Diking and pumping have allowed vast expanses of wet prairie and some areas of marsh to be farmed, especially along Saginaw Bay. Organic soils were burned to improve their suitability for agriculture. Wet and wet-mesic prairies were originally extensive, along with oak savannas or "openings," but these now remain only as small remnants, primarily on State-owned lands. Prairies and savannas on the lake plain are called lakeplain prairie or oak opening because of the distinctive flora and fauna. The white pine and hemlock forests of the lake plain have been virtually eliminated" (Albert 1994).

A review of survey note data from the pre-settlement surveys (*c.* 1800) show the Flint River watershed was 75.3% forested, 13.2% wetland, 9.9% barren savanna, 0.9% non-forested, and 0.7% water (B. Nelson, MDNR, Michigan Resource Inventory System, personal communication) (Table 4). Wetlands were described by early surveyors as black ash swamp, cedar swamp, mixed confer swamp, mixed hardwood swamp, muskeg-bog, and shrub swamp-emergent marsh. Barren savanna was described as black oak barren, mixed oak savanna, and oak-pine barren. Non-forested lands were described as grassland and wet prairie.

Data from 1978 aerial photographs show the Flint River watershed is now 48.7% agricultural, 16.4% forested, 15.4% urban, 14.8% non-forested, 3.3% wetland, 1.4% water, and less than 1% barren savanna (B. Nelson, MDNR, Michigan Resource Inventory System, personal communication) (Table 4). Losses in forested, wetland, and barren savanna cover type is attributed to increases in agricultural and urban cover types. Increases in non-forested cover type (grassland and wet prairie) represents abandoned agricultural lands and the near doubling of surface water area is the result of river damming and construction of many miles of drainage ditches. Today, 64% of the Flint River watershed is human-made cover types.

Agriculture

Roughly 50% of the Flint River basin is in cropland management (USDA 1987). Crops include seed and feed corn, wheat, oats, soybeans, dry edible beans, sugar beets (for which the Bay region is famous), and truck crops (vegetables, melons, and sweet corn). The Saginaw Bay basin is also a major producer of cattle, milk cows, hogs, sheep, horses, chickens, and hay (MDNR 1988). "Crop management has a significant affect on resource concerns such as erosion, soil depletion, drainage, flooding, sedimentation, water quality, and fish and wildlife habitat" (USDA 1987). The erosion process on land affects downstream water quality and related resources. The rate and amount of sediment delivered to a downstream point is a function of the quantity of solids available for transport and the capacity of the stream to transport soils. Sediment production rates will vary according to the characteristics of the watershed. Capacity to transport sediment is dependent on watershed relief, hydraulics, shape, and vegetative characteristics. Available solids are a product of soil erodibility, precipitation, cover, and other characteristics. It is estimated the annual yield of sediment from the upper Flint and South Branch Flint river segments is between 10,000 and 15,000 tons per 100 square miles and between 15,000 and 20,000 tons per 100 square miles from the middle and lower Flint River segments (USDA 1987). Thus, soil erosion is a major problem in the Flint River basin and it contributes significantly to Saginaw Bay sedimentation.

Urban Development

In 1990, the National Census estimated the Flint River basin population at 819,481 people, 32% of who lived in towns and villages and the rest in cities and urban areas. The city of Flint's population has declined since 1960 from 196,940 people to 124,943 people in 2000. Conversely, according to the 2000 census, Atlas and Goodrich Townships showed significant increases in population. Modern day trends indicate urban sprawl is progressing at an accelerated rate. If urban sprawl continues as predicted, it will result in further conversion of agricultural and idle land into suburban residences, malls, and hard surfaced roadways adding more nutrients, sediments, and pollutants to the Flint River system. This continued alteration of the watershed will result in additional stresses on the river.

Channel Morphology

Channel morphology describes stream form and structure. Channel morphology is determined by flow regime, geology, land surface form, soil, and human activities (Platts et al. 1983). River gradient and flow volumes are important components in determining how streams carve their course through soils and geological formations of the land. Natural channels typically provide better fish and invertebrate habitat than manipulated channels (Wesley and Duffy 1999). Steep gradients allow higher water velocities with accompanying changes in depth, width, channel meandering, and sediment transport (Knighton 1984). Rivers with unstable flow typically have an over-wide and shallow channel during average flow periods. Unstable flow erodes stream banks causing them to slope and become u-shaped. Abnormal sediment loads (either too much or too little) will modify habitat by causing deposition or erosion. Bridges, culverts, channel modifications, and armored substrates will also cause deviations from expected channel width.

Gradient

Stream gradient is the drop in elevation over distance commonly measured in feet per mile. Saginaw Bay basin is described in the Saginaw River and Bay Remedial Action Plan as low slope (MDNR 1988). The Flint River descends 412 feet in 142.2 miles from its origin at Horseshoe Lake to its confluence with the Shiawassee River (Figure 15). Gradient ranges from a high of 10.04 feet per mile below Flushing to a low of 0.46 feet per mile near Fosters (G. Whelan, MDNR, Fisheries Division, unpublished data) (Figure 16). Average gradient is 2.9 feet per mile. Predictions concerning fish communities, channel characteristics, and hydraulic diversity can be made from gradient information. Gradient classes and associated channel characteristics are listed below (G. Whelan, MDNR, Fisheries Division, personal communication).

Gradient class	Channel characteristics
0.0 – 2.9 ft/mi.	Mostly run habitat with low hydraulic diversity
3.0 – 4.9 ft/mi.	Some riffles with modest hydraulic diversity
5.0 – 9.9 ft/mi.	Riffle-pool sequences with good hydraulic diversity
10.0 – 69.9 ft/mi.	Well established, regular riffle-pool sequences with excellent hydraulic diversity
70.0 – 149.9 ft/mi.	Chute and pool habitats with only fair hydraulic diversity
> 150 ft/mi.	Falls and rapids with poor hydraulic diversity

Gradient in the upper South Branch Flint River segment is some of the steepest in the Flint River, averaging 8.3 feet per mile as it descends the terminal moraines left by the retreating Saginaw Lobe of the Wisconsinan Glacier. Most of this segment exhibits high hydraulic diversity and contains frequent riffle-pool-run sequences providing diverse fish habitat. However, the lower reach of this segment has been inundated by the impoundment created at Winns Pond Dam.

Gradient in the middle South Branch Flint River segment averages 3.92 feet per mile and 3.3 feet per mile in the lower South Branch Flint River segment. Reduced gradient in these two segments results in higher frequency of run habitat with some riffle-pool sequences.

Gradient in the upper Flint River segment ranges from a low of 0.6 feet per mile, under the Holloway Dam, to a high of 7.5 feet per mile through a short stretch just above the mouth of Swartz Creek, the site of the "Grand Traverse". The river in this stretch has been inundated by water impounded by Holloway, Mott, Utah, and Hamilton dams resulting in mostly run habitat.

Gradient in the middle Flint River segment ranges from 2.9 feet per mile at the mouth of Swartz Creek to high of 10 feet per mile through Flushing. Flushing is the second site of rock out crop in the watershed. Good riffle-pool-run sequences and modest hydraulic diversity provide diverse fish habitat throughout this segment.

The lower Flint River segment is located in the Saginaw Bay lake plain. Gradient averages 0.5 foot per mile providing mostly run habitat little hydraulic diversity.

Channel Cross Section

Channel cross section is another measurement of fish habitat quality. It describes bank vegetation, stream flow and bank stability, channel width, bottom substrates, sediment deposition, and stream sinuosity. Channel cross section data for the Flint River is limited. Observations made by Leonardi (1997) provide general information on substrates and channel cross sections (see **Biological Communities**) but quantitative data are necessary to complete an evaluation of channel form problems in the Flint River basin.

One quantitative measure of channel form compares channel width to calculated width (Leopold and Wolman 1957). Calculated width at 5% and 95% flow exceedences can be determined by the relation: log (width) = 0.741436 + 0.498473 log (mean daily discharge), where width is measured in feet and discharge is measure in cfs. Generally speaking, if measured width falls between calculated width at 5% and 95% flow exceedence, it is not considered overly narrow or wide (T. Zorn, MDNR, Fisheries Division, personal communication).

Expected width calculations for the Flint River and tributaries were done using 5% and 95% flow exceedences (Table 5). Channel widths at five sites (Farmers Creek near Lapeer, South Branch Flint River near Columbiaville, Flint River near Otisville and Fosters, and Kearsley Creek near Davison) fell within range of calculated widths indicating channel form was not over-wide or narrow. Channel widths at four sites (Flint River near Flint, Butternut, Swartz, and Thread creeks) were greater than the calculated width at 5% flow exceedence indicating an over-wide channel. Over-wide channels are often the result of greatly fluctuating flows or excessive sediment loading whereas excessively narrow channels are usually the result of armored stream banks or dredging.

Dams and Barriers

Dams were a vital component of early development of the Flint River watershed. They were built to harness water power for lumber and gristmills to promote settlement of the area. Most present day communities developed around these lumber and grist mills.

Dams are regulated under Michigan's Dam Safety, Part 315 of the Natural Resources and Environmental Protection Act (P.A. 451, 1994). MDEQ, LWMD, Dam Safety Unit, lists 93 dams and water-control structures in Flint River basin (Table 6). Dams and water-control structures serve multiple uses including private and public recreation, flood control, water storage, water supply, historic hydroelectric generation, and milling. Although LWMD inventory lists most of the dams as recreational, many, especially those built before the mid-1940s, were built for other purposes such as lumber and gristmilling and hydroelectric production. Now, there are no active lumber, gristmill, or hydroelectric dams in the Flint River system. Today, dams in the Flint River basin are principally used for recreational purposes or for municipal back-up and commercial water supply. Limited retention capacities prevent their use for effective flood control except on Misteguay Creek.

Dams, regardless of their intended use or origin, have major effects on river systems. They alter stream flow patterns. Increased evaporation from impoundments can significantly decrease downstream flow. Studies by Bain and Finn (1988) have shown that altering stream flows reduce habitat diversity, accelerate erosion, and reduce productivity. Dams are usually constructed in the downstream reach of highest stream gradient and the upstream areas are flooded. The inundation of high gradient reaches and loss of preferred spawning habitat has affected the survival and reproduction of some potamodromous fish species such as lake sturgeon and walleye. Sediment-free water released below dams is an erosive power that can cause increased bank erosion downstream. During high flow periods, this erosion increases downstream movement of sediments that cover important fish and aquatic organism habitat. Alexander and Hansen (1986) documented that an increase of 80 ppm of sand bedload had a profound effect on brook trout production in Hunt Creek, Michigan. The negative changes in the productivity of reservoirs has been, in part, attributed to increases in the amount of sedimentation and losses in habitat diversity caused by the filling of the impoundment (Kimmel and Groeger 1986).

Dams cause changes in water quality. They disrupt the natural flow of sediments and nutrients in a stream, trapping them in the impoundment. Sediments are deposited over original substrates and can have negative affects on biological communities (see **Biological Communities**). Nutrients accumulate in impoundments and can result in increased growth of algae and vascular aquatic plants. Increased surface acreage of impounded water allows sunlight to warm water temperatures. Surface water discharge over dams has a warming effect on downstream water temperatures. Impoundments become lentic, altering biological communities. Fish species that prefer the warm-water lentic environment, such as carp, channel catfish, and gizzard shad can be found in abundance in Flint River impoundments. Also, impoundments are attractive sites for human development, which results in further habitat alterations and increased nutrient loading.

Dams fragment habitat, blocking movements of fish and invertebrates. Many species of fish move upstream significant distances to spawn and their offspring disperse back downstream filling available habitat niches. Fish also move upstream to escape uncomfortably warm water temperatures for feeding, and to find protective cover. Many insects spawn upstream of larval rearing areas and eggs that are deposited upstream of dams drift downstream into impoundments, settle to the bottom, and suffocate. In addition, larvae that hatch upstream of dams may become trapped in impoundments while dispersing back downstream.

Henry van der Schalie (1948) recognized the effects of dams on aquatic systems and especially freshwater clams. As early is 1948, Dr. van der Schalie pointed out that the hydroelectric dams on the Grand River were negatively affecting the freshwater mussels due to significant flow variations during peaking operation. In addition, dams impede fish movement and most freshwater clams depend on migrating fish to disperse themselves upstream after drifting in the current during incubation.

Dams prevent downstream movement of natural vegetative structure (logs, stumps, limbs, sticks, and leaves). Although sediment deposition in many areas of the stream system is detrimental, sediment deposition in the stream mouth delta area is important. This deposition can form a rich and complex wetland system that provides habitat for a wide variety of plants, birds, mammals, reptiles, and amphibians. Vegetative structure trapped in impoundments is often removed and disposed of to upland sites. This material is an important habitat component for both fish and invertebrates and it contributes nutrients to the system. Many species of fish use woody structure for cover, foraging, and spawning. Many invertebrates feed directly on vegetative materials, using it for cover.

Dams can also interfere with navigation and recreational use on rivers. They are obstacles to canoers and kayakers and during high flow periods can be a hazard. Most portages around Flint River dams are poorly marked making them difficult to locate.

Despite their effects on natural river function, dams provide some human benefits. They provide necessary water supplies to municipalities and industries. In some areas, recreational use has been greatly enhanced by impounded water. Impoundments can provide valuable wildlife habitat and provide boating and swimming opportunities to areas where water-based recreational opportunities are lacking. These impoundments often provide recreational fisheries that are more accessible and usable to the public. Impoundments are sometimes used for fish rearing. Dams can also be a beneficial barrier in blocking upstream movement of undesirable exotic fish such as carp and lamprey.

Lake-level control structures are frequently operated in a manner that benefits lake riparians at the expense of the outlet stream. During high water, it is common practice to remove boards from the structure to allow water to exit the lake as quickly as possible and lower the lake level to what is considered normal. This practice results in the loss of shallow water spawning, feeding, and nursery habitat. If the drawdown is rapid enough, it can trap fish in very shallow pools, which may result in death. Less mobile species such as clams, snails, and insects are also lost during the de-watering of shallow areas. Conversely, when lake levels drop naturally during drought, water-impounding boards are placed in the water control structure to maintain the lake level artificially higher than it otherwise would be. This practice intensifies already low flow problems in outlet streams and sometimes dries the stream. Since most species are trapped below the dam they may not survive. Lake-level control structures also block fish migrations. Fish move up into a lake for a variety of reasons: for spawning, to feed, to escape intolerable conditions in the stream, to find cover, and for winter refuge. Lake-level controls are also used to lower a lake level in the winter to reduce ice damage to docks and the shoreline. All too often it is not raised back to the “normal level” early enough in the spring to flood the shallow shoreline marshes that provide important fish spawning habitat. This practice also damages habitat for a variety of aquatic and terrestrial species.

Dams and water control structures require maintenance. If maintenance is neglected, structural integrity is compromised posing a human and environmental hazard. MDEQ, Dams Safety Unit rates dams by hazard type: type 1- high hazard, dam failure expected to cause loss of life, type 2- significant hazard, dam failure would cause extensive property damage, type 3- low hazard, dam located in remote area or having very low head. In the Flint River basin, three dams are classified as type 1 (Heron Lake, Holloway, Hamilton) and twelve as type 2 (Minnawana, Metamora, White Sands, Long Lake, Bottom Creek, Atlas, Goodrich, Kearsley, Perrysville, Thread Lake, Crystal Lake, Mott) (Table 6). The remaining seventy-eight dams are low head dams classified as type 3.

Upper South Branch Flint River

Five dams and lake control structures are recorded for the upper South Branch Flint River segment. Winns Dam is the principal barrier affecting the river system (Figure 17). It is a 430 foot earthen dike with a concrete control structure regulating discharge. Winns Dam has a 15 foot head and impounds

25 acres of water. Originally a gristmill dam, Winns Pond is now used for private recreation. There are no means for effective fish passage. Negative affects of Winns Dam include flow alteration, habitat fragmentation, increased nutrient loading and sediment deposition in the impoundment, and altered (warmer) water temperatures affecting aquatic communities. Winns Dam benefits riparians by providing an impoundment allowing recreational use for boating and angling. Impounded water benefits some wildlife species, which provides additional aesthetic value to riparians. Winns Dam may also serve as an effective barrier preventing nuisance carp movement into the upper South Branch Flint River.

Middle South Branch Flint River

There are no major barriers on the main middle South Branch Flint River. Thirty-two dams and lake control structures are recorded on tributaries and lakes (Table 6). Mill and Farmers creeks have a number of small dams and control structures that create impoundments or enlarge existing water bodies. Much of the Plum Creek system, in the Lapeer State Game Area, has been dammed and diked for waterfowl refuge (Figure 17).

Lower South Branch Flint River

No major barriers exist on the main lower South Branch Flint River. Seven dams and lake control structures are recorded on tributaries and lakes (Table 6). Bottom Creek Dam, located on the lower reach of Bottom Creek, is a barrier to fish passage (Figure 17). Bottom Creek Dam is an earthen dike with a concrete control structure regulating discharge. The impoundment is 64 acres and the dam has an 18 foot head. The dam is privately owned and used for recreation and agricultural purposes. The upper reach of Bottom Creek has a cold water temperature regime which changes to warm water regime due in part to this dam but also due to landscape clearing and extensive channelization for drainage. Dam removal would be necessary to restore natural flow, gradient, and stream temperatures allowing for cool and cold water fish management.

Upper Flint River

This segment has 44 dams and water control structures recorded (Table 6). Dams on the mainstem include the Earl Holloway Dam, C.S. Mott Dam, Utah Dam, Hamilton Dam, and the inflatable Fiber Dam (Figure 17). Although these dams have severely fragmented the upper Flint River and have negative affects, Holloway, Mott, and Hamilton dams provide valuable recreational uses to the area.

Construction of the Earl Holloway Dam was completed in 1953 and full operation began in 1955. Holloway Dam impounds 1,973 acres of water and has a storage capacity of 17,500 acre-feet. Hydraulic retention time is unknown. The spillway of the dam consists of two 90 foot drum gates, three 20 foot tainter gates, and two rectangular tubes controlled by sluice gates. Holloway Dam is owned and operated by the city of Flint. The purpose of this dam is for water supply and sewage dilution for the city of Flint. However, since Flint purchases its potable water from Detroit, Holloway Reservoir only serves as emergency back-up water supply. Holloway Reservoir water levels are adjusted in accordance with Flint’s National Pollution Discharge Elimination System (NPDES) permit (see **Water Quality**). General operating procedures strive to achieve a spring elevation of 755 feet by May 1 of each year, maintain elevation through summer, then drawdown to winter elevation of 751 feet during the first two weeks of November to prevent structural damage to the dam from freezing. For flow augmentation and sewage dilution, the city tries to maintain a minimum discharge of 85 cubic feet per second (cfs) to the 752.7 foot elevation. Once at the elevation of 752.7 feet, run-of-river mode is maintained. Fish passage is restricted to movement through the sluice gate tubes or over the spillway.

Downstream of the Holloway Dam is the C.S. Mott Dam. Construction of Mott Dam was completed in 1972. It is part earthen dike and part concrete structure with control gates that spans approximately

1000 feet. The dam impounds 650 acres of water and has a storage capacity of 5,200 acre-feet. Hydraulic retention time is unknown. Mott Dam was built, and is solely used for recreation. It is owned and operated by Genesee County Parks and Recreation Commission. Water level is maintained at a fixed crest. Flow reduction resulting from increased evaporation occurs at an unknown rate. There is no means for fish passage.

Downstream of the Mott Dam structure is the Utah Dam. It is primarily a steel structure that spans 200 feet. The Utah dam, owned by the city of Flint, and built in 1928, has no storage capacity. It was primarily used to prevent oil from industrial discharges from entering the intakes of the Flint drinking water system. Now, the structure serves no use and its gates are locked in an open position. This dam is an example of a structure no longer serving a purpose and should be removed.

Downstream of the Utah Dam structure is Hamilton Dam. Hamilton Dam, a concrete structure spanning 200 feet, replaced the original dam constructed in the 1920s by the lumber industry. It has a storage capacity of approximately 100 acre-feet. Its present use is for water supply and recreation. A ladder design is available for fish passage but is ineffective for most warmwater fish species.

Downstream of the Hamilton Dam structure is the Fiber Dam. This inflatable dam was built in 1979 by the city of Flint for visual and recreational enhancement of the downtown area. It has virtually no storage capacity. Removal would allow fish passage and enhance navigability for canoers.

Kearsley Creek is severely fragmented by four dams (Figure 17). In the headwater reach, Lake Louise Dam was built in 1930 to enlarge Lake Louise for recreational purposes. It is an earthen dike with a water control structure using boards to manipulate water level. Now, it is under private ownership and is maintained at a fixed crest water level. Downstream from the Lake Louise Dam structure is the Goodrich Mill Pond Dam. The Goodrich Mill Pond Dam was built in 1930 for gristmill operation. It has a storage capacity of 200 acre-feet and is maintained at a fixed-crest water level with surface water discharge. Downstream of the Goodrich Mill Pond Dam is the Atlas Mill Pond Dam also having a storage capacity of 200 acre-feet. It is maintained at a fixed crest water level with a surface water discharge. Downstream of the Atlas Mill Pond, just upstream of the confluence, is Kearsley Dam. Kearsley Dam was built in 1928 for water and ice supply. It is a concrete structure with an 18 foot head and a storage capacity of 1,800 acre-feet. It is owned and maintained by the city of Flint and its present use is for recreation and occasional flow augmentation for sewage dilution in the mainstem. Water level controlled by Kearsley Dam is at a fixed-crest with a 2 foot winter drawdown. There are no means for fish passage on these dams. Removal of Lake Louise, Goodrich Mill Pond, and Atlas Mill Pond dams would be necessary to enhance cold and cool water fish management on the upper reach of Kearsley Creek.

Thread Dam is the principal barrier on Thread Creek (Figure 17). It is an earthen dam expanding 290 feet with a concrete control structure that impounds 80 acres of water. Located near the confluence, Thread Dam was constructed in 1928 for ice supply. Now, it serves for recreational use. Although true ownership of the dam is unclear, the city of Flint has maintained and operated the dam for the past several years. Water levels are maintained at a fixed crest and there is no means for fish passage.

The remaining dams in this segment are recorded on small tributaries. All serve for recreational use and are principally lake-level control structures.

Middle Flint River

One of the first dams built on the Flint River was located in Flushing (Ellis 1879). The shallow rocky rapids in this area made floating lumber downstream difficult and, in 1836, Thomas Brent built a rock dam for lumber and gristmilling. However, this dam was washed out and eventually replaced with the

Hart Dam. Ice making and recreation became important uses of the impoundment created by this dam. However, when industry expanded in Flint, oils being discharged into river made the Hart Impoundment unsuitable for ice and recreation and the dam was removed (Anonymous 1985). It is probable the dams in Flushing played a significant role in blocking upstream migration of potamodromous fish in the Flint River.

Now, no major barriers exist on the middle Flint River. Two small lake level control structures are recorded on tributaries in this segment (Table 6).

Lower Flint River

This segment has 7 dams and water control structures recorded (Table 6). The principal dams are found on Misteguay Creek and were constructed for flood control. Misteguay Creek dams 2A, 3A, and 4 are earthen with concrete control structures (Figure 17). Typically, normal flow is allowed through the barrier, however during high flow, earthen dikes act as retention areas and allow flooding in designated areas.

Bridges and Other Stream Crossings

The Flint River basin is typical of rivers in the southern half of the Lower Peninsula of Michigan; that is, it is crisscrossed with roads almost every mile. In addition to road crossings, there are also railroad crossings that have many of the same problems, as do road crossings. Bridges and culverts are typically hard surfaced, gravel, sand, or indigenous soil surfaced. Road and bridge crossings alter stream habitat and cumulative affects have significant effects on biological communities. Almost always, banks and side slopes around these structures are cleared of vegetation resulting in soil eroding directly into the stream. Poorly stabilized banks are also in jeopardy of being washed directly into a stream. With gravel, sand, and native soil road surfaces, surface soils are washed into the stream. These sediments destroy fish habitat, suffocate fish eggs and larvae, and kill less mobile aquatic organisms.

Many culverts are poorly placed resulting in bottom cutting at a culvert outlet. The result is a barrier to upstream movement of many aquatic species. These barriers, like dams, prevent upstream movements of fish for spawning, dispersal, and feeding. They also prevent the upstream dispersal of most freshwater clams, which depend on fish hosts for movement. Culverts can also create velocity barriers to upstream movement of fish under high flow events due to under-sized design.

Road crossings can also be a source of contaminants. Many hard surfaced road crossings have gutters that empty directly into the stream. Bridges, especially the longer ones, have storm drain discharging directly down through the road surface into the stream. These transport oils, antifreeze, and motor fuel combustion by-products directly into the waterway. They also transport any other contaminants finding their way onto the roadway into the stream.

Although bridges are the crossing type of choice, they are often sized too short to clearly span the floodway or they have pillar or pier supports in the stream. When bridges are too short to span the floodway, they cause an increase in velocity at high flows and collect debris. When piers and pillars are placed in the stream, they also collect debris. This collection of debris disrupts downstream movement of large woody structure, increases water velocity through the structure, causes erosion, destabilize the banks, prevents upstream movements of fish and the freshwater mussels that depend on fish for dispersal and interrupt recreational activities. In the most extreme cases these collections of debris can present a human safety hazard.

Minimizing negative effects of stream crossings can be accomplished with design improvements. Structures that preserve natural stream substrates are more beneficial to biological communities and should replace culverts. Sedimentation and contamination can be reduced when crossings direct surface water run off to retention areas where they can be filtered before entering the stream.

Special Jurisdictions

There are a variety of government units and agencies that have statutory jurisdiction over segments of the Flint River and the lands bordering it.

U. S. Army Corps of Engineers Section 404 Jurisdiction

One short segment of the lower Flint River falls under Section 404 of the Clean Water Act of 1972. The Flint River, from Curtis Road, Saginaw County, 2.7 miles downstream to its confluence is regulated for dredging, filling, and placement of dredge and fill materials in wetlands and waters of the United States.

Coastal Zone Management

None of the Flint River basin falls within the Federal Coastal Management Program boundary approved in 1978. However, it is included in the Coastal Nonpoint Source Program Management Area based on watersheds. This program was added to the Federal Coastal Zone Management Act in the 1990 re-authorization which established joint authority shared by the Environmental Protection Agency and the National Oceanic and Atmospheric Administration to protect water quality in the Saginaw Bay and Lake Huron. The Coastal Nonpoint Source components have not been officially incorporated into Michigan's federally approved Coastal Management Program, therefore, Michigan relies heavily on MDEQ, Surface Water Quality Division and the nonpoint source funding provided through the Clean Michigan Initiative (M. Houghton, MDEQ, LWMD, personal communication).

Navigability

One reach of the Flint River is considered navigable by law. The Flint River, from Curtis Road, Saginaw County, 2.7 miles downstream to its confluence is legally navigable under both Section 404 of the Clean Water Act of 1972 as amended and Section 10 of the Rivers and Harbors Act of 1899 regulating work within navigable waters of the United States.

There are also a number of judicial rulings declaring waters or parts of waters, within the Flint River basin, as navigable. These include:

1. Michigan Supreme Court, by either judicial notice or direct reference, in opinions rendered during the period of 1843 through 1930 , indicated the following streams and lakes as having floated logs on a commercial basis during the early lumbering (MDNR 1993):

    Flint River, Lapeer County, seasonably navigable (Volume 46, Michigan Laws, pg. 297);

    Flint River, Lapeer County, Columbiaville to the mouth (Volume 70, Michigan Laws, pg. 286); and

    Flint River, Genesee County, (Volume 185, Michigan Laws, pg. 454).

2. The Michigan Legislature, from 1837 through 1907 by local act of general statute authorizing dam locations, states streams are navigable from the dam site downstream (MDNR 1993). There is one such site on the Flint River system:

> Flint River, Lapeer County, section 17, T.8N., R.8E. (Michigan Laws, 1937).

Waters of the State are also "presumed navigable" if:

> flow exceeds 41 cubic feet per second, greater than 30 feet width and depth is greater than one (1) foot, or capable of floating loose logs, ties or similar products seasonally;
>
> used by fishing public for extended periods of time;
>
> stocked with fish by the State of Michigan; or
>
> waters susceptible to navigation by boats for commerce or travel (MDNR 1993). The Thread River (Thread Creek), Genesee County, is the only stream in the Flint River basin to be declared "non-navigable" by the Michigan Supreme Court (Volume 59, Michigan Laws, pg. 279).

Federal Energy Regulatory Commission (FERC)

Only those reaches of the Flint River that have been determined navigable by the Michigan Supreme Court by the test of floating logs (i.e. from the confluence of the South and North Branch Flint rivers downstream to its mouth at the Shiawassee River) are considered jurisdictional by FERC. As such, hydroelectric dams on this reach would be required to obtain a license under the Federal Power Act of 1935. There are currently no active hydroelectric projects on the Flint River System, however, Genesee County maintains intent to license its Holloway Dam with FERC to protect its rights in the licensing process should another operator submit a competing license application.

Natural and Scenic River Designation

No portion of the Flint River system has been designated a Federal or State Natural or Wild and Scenic River under the Natural Rivers Part 305 of Public Act 451 of 1994 (formerly Natural River Act, P.A. 231 of 1970) (D. Pearson, MDNR, Forest Management Division, personal communication).

County Drain Commissions

County Drain Commissioners have authority to establish designated county drains under the Drain Code (P.A. 40 of 1956). This allows for construction, maintenance, inspection, and improvement of all designated county drains. Further authority is granted for determination and assignment of drain assessments. Activities carried out under authority of the Drain Code do not require MDEQ approval, if applied to drains designated before 1972.

There are over 800 designated drains in the Flint River basin (Table 7). The complexity of this drain system depends upon the topography and soils in the area. The Flint River and its drainage system drains 95% of Genesee County (USDA 1987). Everything in the Flint River system in Genesee County is a designated county drain except: the mainstem Flint River, Kearsley Creek, all but one mile of Thread Creek in Atlas Township, and all of Gilkey Creek, except the 1,200 feet at its mouth (the old Mott farmstead) (J. Gerth, Genesee County Drain Commission, personal communication). Genesee County has not computerized its designated drain therefore the number of miles of drains is unknown but it maintains 663 distinct county drains (J. Gerth, Genesee County Drain Commission, personal communication). Four-hundred fourteen drains are tributaries to the upper Flint River, 159 drains are tributaries to the middle Flint River, and 90 drains are tributaries to the lower Flint River.

Seventy-two percent of Lapeer County is drained by the Flint River (USDA 1987). The Lapeer County Drain Commission maintains 325 miles of county drain comprised of 173 distinct county drains (Table 7) (J. Freeman, Lapeer County Drain Commission, personal communication). Thirty-one of these drains are tributaries to the upper South Branch Flint River, 63 are tributaries to the middle South Branch Flint River, and 89 are tributaries to the lower South Branch Flint River.

Sanilac County has one designated drain tributary to the lower South Branch Flint River. The Negus Inter-County Drain is 3.5 miles in length and maintenance is shared with Lapeer County. Only 4% of Sanilac County is within the Flint River drainage (USDA 1987).

Ten percent of Oakland County is drained by the Flint River (USDA 1987). The Oakland County Drain Commission maintains 26.9 miles of county drain composed of 14 individual county drains (Table 7) (J. Kozma, Oakland County Drain Commission, personal communication). All fourteen of Oakland County's drains are tributary to the upper Flint River, more specifically, to the headwater tributaries of Kearsley, Thread, and Swartz creeks.

Approximately 6% of Tuscola County is within the Flint River drainage (USDA 1987). The Tuscola County Drain Commission maintains seven designated county drains (75.4 miles) within the Flint River basin (S. Pistro, Tuscola County Drain Commission, personal communication). All are tributary to the lower South Branch Flint River (Table 7).

Approximately 15% of Saginaw County is within the Flint River drainage (USDA 1987). The Saginaw County Drain Commission maintains 57 designated drains (225 miles) within the Flint River basin (S. Honamarn, Saginaw County Drain Commission, personal communication). All drains are tributary to the lower Flint River (Table 7).

Approximately 12% of Shiawassee County is within the Flint River drainage (USDA 1987). The Shiawassee County Drain Commission maintains 58 designated drains (T. Fett, Shiawassee County Drain Commission, personal communication). All drains are tributary to the lower Flint River (Table 7).

River systems are viewed by drainage engineers as a means of getting water off land. Artificially constructed and maintained surface drain systems destroy natural flow sequences in a river system, alter discharge patterns, increase sediment loading, reduce or eliminate water storage, promote sedimentation and nutrient loading in the streams they are tributary to, and destroy important habitat features in the system. The Flint River is under great stress because of these types of controls.

Drain commissioners are also responsible for maintenance and operation of many lake-level control structures, particularly those set by Part 307 of the Natural Resources and Environmental Protection Act (P.A. 451 of 1994), formerly the Inland Lake Level Act (P.A. 146 of 1961). Methods of operation are at the discretion of each drain commissioner.

Federal Government

The U.S. Department of Interior, Fish and Wildlife Service operates the Shiawassee National Wildlife Refuge on the lower Flint River. This refuge was established in 1953 and occupies 9,100 acres including approximately 3 miles of the Flint River. Lands within the refuge are managed to minimize human disturbance to waterfowl during the breeding season and migration. All waters within it boundaries are open to normal water recreational activities including fishing and the uplands are open to deer hunting, bird watching, hiking and biking (D. Spencer, U.S. Fish and Wildlife Service, personal communication).

State Government

Several State of Michigan agencies have jurisdiction within the Flint River basin. MDEQ administers statutes to protect the aquatic resource (Tables 8a and 8b). Under Part 301 of the Natural Resources and Environmental Protection Act (P.A. 451 of 1994), MDEQ is the lead agency in regulating: dredging and filling lake or stream bottoms, bridge, dam, and seawall construction, culvert installation, beach sanding, draining and filling of wetlands, placement of permanent fishing and boating piers, and boat ramp construction.

MDNR operates State game areas and State recreation areas providing public recreational opportunities within the Flint River basin. These include the Shiawassee State Game Area in Saginaw County, the Seven Lakes State Park and Holly State Recreation Area in Oakland County, the Ortonville State Recreation Area in Oakland and Lapeer counties, and the Metamora-Hadley State Recreation Area and Lapeer State Game Area in Lapeer County.

MDNR, Fisheries Division has designated sections of six streams as trout streams. These are: Kearsley Creek from the Oakland County line upstream to its origin; Duck Creek, Oakland County, from Section 8, Township 5 North, Range 9 East upstream to its origin; Thread Creek, Genesee County, from Section 33, Township 7 North, Range 7 East upstream to Oakland County, Section 5, Township 5 North, Range 8 East; the South Branch Flint River from Section 15, Township 7 North, Range 10 East, upstream to the Oakland County line including its tributaries; Gravel Creek, Lapeer County, from Section 19, Township 9 North, Range 11 East upstream to its origin; and Bottoms Creek, Lapeer County, from Section 20, Township 9 North, Range 11 East upstream to its origin. This designation sets the water quality standards for that reach and governs fishing seasons and fishing gear that can be used.

Water Quality

Overview

Water quality for Michigan streams is protected by law for specific designated uses (MDEQ 1998a). The law protects for multiple use of a river system and the water resource. The protected designated uses for the Flint River are aquatic life and wildlife support; agricultural, industrial, and municipal water supply; navigation; partial body recreation; and total body contact recreation (MDEQ, 1997a). MDEQ, Surface Water Quality Division is the lead regulatory agency for water quality in Michigan. To protect water quality, Michigan has developed Water Quality Standards after the Natural Resources and Environmental Protection Act (P.A. 451 of 1994) (MDEQ 1997a).

Water quality affects aquatic life and is critical in determining the health of a watershed. Many water-degrading pollutants demand oxygen during their breakdown process. This can limit or even eliminate oxygen needed to support fish and other aquatic organisms. Nutrients can lead to excessive aquatic vegetation that can further deplete oxygen concentrations through decay and bacterial respiration. Metals, pesticides, and other toxic chemicals can accumulate in the aquatic food chain and may have harmful effects on fish and aquatic organisms. Sedimentation can inundate fish and macroinvertebrate habitat and can suffocate eggs affecting survival. Other pollutants may pose human health threats affecting use of a river system.

A complete review of Flint River water quality is not within the scope of this report, however, a brief discussion on historic and current water quality parameters is appropriate. Detailed accounts of Flint River water quality are available from MDEQ (2000), MDEQ (1994a), MDEQ (1994b), MDNR

(1988), Roycraft and Buda (1979), Beck (1977), Wuycheck (1977), and Michigan Water Resources Commission (MWRC) (1969).

Historical information on water quality upstream of Flint is limited. In general, water quality was considered fair to good depending on the location. High nutrient content, particularly with phosphate, has been a concern in the North and South Branch Flint rivers, Holloway Reservoir, and Mott Lake (Bryant 1992; D. Nelson, MDNR, Fisheries Division, personal communication). Accelerated nutrient loading has been attributed to nonpoint source runoff from agricultural land in some river reaches.

Historically, the Flint River downstream of Flint suffered from poor water quality due to unregulated discharges by industries and municipalities. Also, unstable flow resulting from watershed development and systematic land drainage exacerbated water quality problems. During high flow periods, pollutant transport is accelerated. During low flow periods, flow augmentation by the manipulation of upstream dams aids in discharge dilution. In 1969, Flint River water quality downstream of Flint was severely degraded (MWRC 1969). Degraded water quality, caused by treated and untreated waste discharge, persisted into the late 1970s (Roycraft and Buda 1979). Water degradation was attributed to the presence of fecal coliform bacteria, low dissolved oxygen, plant nutrients, oils, and toxic substances. By the mid-1980s, after municipal wastewater treatment plant renovations and implementation of more restrictive water quality standards, water quality showed some improvement with declines in total phosphorus, ammonia, biological oxygen demand, and suspended solids. However, water quality monitoring from 1991 to 1993 found the Flint River to have the most degraded water quality among the Saginaw River tributaries (MDEQ 1994a). Compared to other Saginaw River tributaries, the Flint River was ranked as a high priority of concern for total phosphorus, biological oxygen demand, and chlorophyll *a*. Also, the Flint River had the highest concentrations for all parameters except total suspended solids and nitrite-nitrate (MDEQ 1994a).

Point Source Pollution

Point source pollution is regulated by the Clean Water Act (P.A. of 1972). National Pollution Discharge Elimination System (NPDES) permits issued by MDEQ, Surface Water Quality Division (SWQD) regulate point source discharges. There are 201 permitted discharges in the Flint River watershed (Table 9). These include storm water discharge from industrial activities (141), individual permit discharge (40), waste water discharge from petroleum or gasoline clean up activities (8), waste water discharge from stabilization lagoons (7), non-contact cooling water discharge (3), waste water discharge from municipal potable water supply (1), waste water discharge from sand and gravel mining (1), and waste water discharge from hydrostatic pressure testing (1). There are no combined sewer overflows permitted in the Flint River basin. Major municipal dischargers in the Flint River basin include the Lapeer, Flint, Genesee County Ragnone, and Flushing wastewater treatment plants (MDEQ 1994b).

Flow augmentation for effluent dilution is a special condition of the Flint Waste Water Treatment Plant (WWTP) NPDES permit. Under the terms of the NPDES permit, during the period that waste water discharge is authorized, the city of Flint shall carry out the Holloway Reservoir Management Plan (HRMP) in order to maintain a 95% exceedence flow of approximately 85 cfs immediately above the Flint WWTP outfall. The HRMP further requires the city maintain a minimum outflow of 65 cfs until the level of the reservoir falls to an elevation of 752.7 feet. Once at an elevation of 752.7 feet, the city shall operate the dam such that outflow does not exceed the inflow. However, during drought periods, Holloway Reservoir outflow can drop below inflow due to evaporation of reservoir water.

MDEQ works with industrial and municipal dischargers to maintain compliance and not cause water quality degradation beyond that allowed by State Water Quality Standards. Regulated industrial sources are required to implement pollution prevention for storm water discharge. However, non-regulated storm water dischargers implement little or no pollution prevention and can have significant effects on water quality.

Nonpoint Source Pollution

Nonpoint source is a pollutant that does not originate at a specific point of discharge and enters surface water through either atmospheric deposition or water transport. Nonpoint pollution is made up of sediments, nutrients, bacteria, organic chemicals, and inorganic chemicals. They are diffuse, often intermittent, and are often difficult to identify or quantify. Airborne pollutants are carried by winds, and deposited in watercourses directly, or on land and are transported as surface water runoff. Other sources of water transported pollutants include septic systems, stream bank erosion, agricultural erosion, fertilizers, and pesticides, road crossing erosion, construction sites, animal wastes, urban runoff, forest erosion, residential fertilizers and pesticides, golf courses, irrigation, and mining.

Nonpoint source pollution is a significant contributor to Flint River water quality degradation. Wind and water erosion of agricultural land, resulting in sediment and nutrient loading, is the largest source of nonpoint pollution in the Saginaw River watershed (MDEQ 1994b). Storm water runoff from urban areas also contributes significantly to sediment and nutrient stream loading in the Flint River, and on a per unit area basis, exceeds agricultural contributions (MDEQ 1994b).

Nonpoint source pollution issues may be addressed through best management practices (BMPs) that have been developed and distributed by MDEQ, SWQD and the Natural Resources Conservation Service (Peterson et al. 1993). BMPs are structural, vegetative, or managerial practices used to prevent, treat, or reduce negative effects to water quality. Also, studies, plans, and practices continue to be developed and implemented by communities at the local level, using grant awards and incentive payments that target nonpoint source pollution prevention and remediation.

Sites of Environmental Contamination (Part 201 Sites)

MDEQ, Environmental Response Division (ERD), has identified 134 sites of environmental contamination within the Flint River watershed (Table 10). These sites are regulated under Part 201 of the Natural Resources and Environmental Protection Act (P.A. 451 of 1994). This act provides for identification, risk assessment, evaluation, and clean up of these sites. Pollutants from these sites have potential to enter a river through surface water runoff or by groundwater contamination and may adversely affect the environment, aquatic resources, or pose public health hazards. Typical sources of these sites include manufacturing, commercial and industrial facilities, mining and oil drilling, landfills, and agricultural lands with heavy pesticide and fertilizer use. The Metamora and Forest Waste Disposal landfills are also listed on the national priority list for remedial action under the Federal Comprehensive Environmental Response Compensation and Liability Act of 1980 (Superfund Program).

MDEQ, Storage Tank Division (STD), by authority of Part 213 of the Natural Resources and Environmental Protection Act (P.A. 451 of 1994), is the lead regulatory agency for under ground and above ground storage tanks. Leaking oil and gasoline tanks are a potential source of environmental contamination that may affect water quality. However, most leaking storage tank contamination in the Flint River watershed is contained to the soils at site locations and does not pose a significant threat to water quality (B. Muench, MDEQ, STD, personal communication). The clay soils, common to the watershed, retard movement of these pollutants into groundwater by acting as a barrier or by chemical bonding to the pollutant. Leaking storage tanks that threaten water quality are addressed by NPDES permits or Part 213 corrective action.

Water Parameters

Chemical and physical characteristics of water, such as temperature and oxygen, are important parts of fish habitats. Physiologically, fish communities are characterized as coldwater, coolwater, or warmwater types. Coldwater fish communities require mean water temperatures below 70 °F (21 °C) and are influenced by groundwater inflow and stream bank shading. Warmwater fish communities are found where mean water temperatures are greater than 70 °F (21 °C). Coolwater fish communities operate in the transitional area where cold mixes with warm water. Most of the Flint River is characterized by a warm water temperature regime. Cold or cool water temperature regimes are found in the upper reaches of the South Branch Flint River, Pine, Bottom, Gravel, Duck, Kearsley, and Thread creeks (Figure 18). These cold or cool water river reaches are associated with good groundwater inflows and unperturbed landscapes.

Dissolved oxygen (DO) is a critical water quality factor affecting aquatic communities (Hynes 1970). Water quality standards for dissolved oxygen have been established by law to protect fish and other aquatic organisms. For cold-water designated streams, the dissolved oxygen water quality standard is 7.0 ppm. For warm water streams, the dissolved oxygen water quality standard is 5.0 ppm. The South Branch Flint River, upstream of Winns Pond, and the upstream reaches of Kearsley and Thread creeks are designated for cold water DO protection (Figure 18). Fish and macroinvertebrate sampling conducted in 1997 and 1998 found good presence of intolerant species indicating the dissolved oxygen water quality standard is being attained. However, DO downstream of Flint fluctuates above and below the standard of 5.0 ppm, as a result of biological oxygen demand from the nutrient rich environment (MDEQ 1994a).

Chemical water quality parameters of the Flint River and select tributaries were monitored in 1998 (Appendix 1). Caution should be used in interpreting the results because sampling was conducted over an extended period of time and affects of storm events could result in wide variations of parameters measured. For parameters measured, water quality standards are generally being met throughout the Flint River basin. However, nutrient loading, particularly phosphorus and ortho-phosphate, remain a concern (M. Walterhouse, MDEQ, SWQD, personal communication). Also, exceptions to water quality standards often follow storm events when transport of pollutants is worsened, or during extreme low flow conditions when pollutants are concentrated.

Bacteria

Bacteria are important as potential health hazards to humans and animals. A high level of certain bacteria indicates the potential presence of untreated human waste and suggests the presence of other pathogenic microorganisms. The County Health Departments are the lead agencies for monitoring bacteria. Since it is too difficult to measure all harmful bacteria, an indicator species is usually selected for monitoring. *Escherichia coli* is the bacteria commonly used to indicate the presence of human and animal waste. The Water Quality Standard for *Escherichia coli* is a 30-day geometric mean of 130 counts/100 milliliters for total body contact recreation (MDEQ 1997a). The County Health Department will advise against body contact when daily *Escherichia coli* samples are greater than 1000 counts/100 milliliters.

Information on bacteria levels in the Flint River is limited. Routine monitoring has been limited to the swimming beaches of Holloway Reservoir and Mott Lake, where full body contact recreation occurs. Expanded monitoring in the Flint area by the Genesee County Health Department has happened after a severe sewage discharge into the river in 1999. An estimated 20 million gallons of undiluted sewage was discharged into the river in Flint when trenching equipment ruptured a sewer line. This expanded monitoring has indicated that daily *Escherichia coli* levels exceed 2400 counts/100 ml after precipitation at locations both upstream and downstream of the 1999 sewage discharge (D. Gonzales, Genesee County Public Health Department, personal communication). High bacteria levels are now believed to come from multiple sources including faulty and illegal sewer hook-ups, failing septic systems, animal wastes, and storm water runoff.

Sediment Parameters

Sediment quality is not regulated directly, but is considered a component of water quality, since contaminants in river waters can be deposited in the sediments (MDEQ 1998a). Sediment contaminants accumulate and can enter the aquatic food chain through ingestion, absorption, or can be re-suspended into water when roiled. Some sediment contaminants can have adverse affects on fish and other aquatic life, or pose significant risk to human life.

Sediment quality is typically evaluated by MDEQ through chemical comparisons of other Michigan rivers with similar ecoregion characteristics, guidelines established by the United States Environmental Protection Agency, and guidelines established by the Ontario Ministry of the Environment (MDEQ 1999; Persaud et al. 1992). These comparisons help identify normal background chemical parameters as well as areas of human induced contamination.

In 1988, sediment sampling of Saginaw Bay and Saginaw River tributaries found the mouth of the Flint River to have the highest concentrations of total phosphorus, ortho-phosphorus, Kjeldahl nitrogen, and ammonia nitrogen indicating excessive nutrient loading (MDEQ 1994a). Sediment chemistry of the Flint River and select tributaries were also monitored in 1998 (Appendix 2). Caution should be used in interpreting results because sampling represents a single sample and may not be entirely representative of the area. Values for parameters measured in 1998 vary between sites but most are comparable to other rivers in the Southern Michigan Northern Indiana Till Plain Ecoregion.

Fish Contaminants

Fish are a highly nutritious food to many anglers. However, fish can accumulate and store contaminants in their body tissue and, sometimes, concentrations can pose health risks to humans. The Michigan Fish Contaminant Monitoring Program (FCMP) is coordinated by MDEQ, SWQD, in cooperation with MDNR, Fisheries Division, Michigan Department of Community Health (MDCH), and the Michigan Department of Agriculture.

> "The goals of FCMP are to: (1) evaluate whether fish contamination problems exist in specific surface waters; (2) identify spatial differences and temporal trends in the quality of Michigan's surface waters with respect to persistent, bioaccumulative chemicals; (3) evaluate whether existing pollution prevention, regulatory, and remedial programs are effectively eliminating or reducing chemical contamination in the aquatic environment; and (4) support the establishment or removal of public health sport fish consumption advisories by the MDCH" (MDEQ 1998b).

Michigan FCMP collects fish samples from lakes and streams throughout Michigan. MDCH is responsible for establishing, modifying, and removing fish consumption advisories for Michigan's surface waters. Edible portions of fish are monitored for contaminants and compared to the fish consumption advisory trigger levels to determine the need for sport fish consumption advisories (Table 11). Whole fish are analyzed to track spatial and temporal trends and to determine the ecological risk to birds and mammals that feed on fish. Also, caged fish studies are used to determine spatial trends in contaminant concentrations.

Elevated mercury concentrations have been detected in fish from approximately two thirds of the monitored inland lakes and impoundments in Michigan. MDCH has issued a statewide fish consumption advisory covering all inland lakes and impoundments in Michigan due to elevated concentrations of mercury. Mercury occurs naturally in the environment or as an airborne pollutant released by burning wastes, coal, and other fossil fuels. Natural processes convert elemental mercury into a more toxic form called methyl mercury. Fish accumulate methyl mercury as they feed or absorb it when water passes over their gills. Methyl mercury accumulates in the flesh and special trimming and cooking methods do not remove it. Typically, only large fish accumulate methyl mercury at concentrations hazardous to wildlife and humans. No one should eat more than one meal a week of rock bass, yellow perch, or crappie over nine inches or bass, walleye, northern pike, or muskellunge of any size from inland lakes and impoundments (MDCH 2000). Women of child bearing age and children under 15 years of age should restrict their consumption of these fish to one meal per month (MDCH 2000).

Since 1980, fish contaminant sampling has occurred at five locations in the Flint River watershed (Table 12). Sampling resulted in fish consumption advisories for specific fish species at three locations based on elevated concentrations of polychlorinated biphenyl (PCB) (MDCH 2000). PCBs are synthetic organic compounds that were primarily used as insulating fluids in electrical equipment such as transformers and capacitors. They have also been used in sealant, rubber, paint, plastic, printing ink, and insecticide. Due to the health risks associated with PCBs, its production was banned in the United States in 1977. Women and children under 15 years of age should restrict their consumption of channel catfish from Holloway Reservoir to one meal per month. The general population should restrict their consumption of carp from Thread Lake to one meal per week. Women of child bearing age and children under 15 years of age should restrict their consumption of carp from Thread Lake, less than 14 inches, to one meal per month, restrict their consumption of carp between 14 and 22 inches to 6 meals per year, and not consume carp greater than 22 inches. For the Flint River downstream of Flint, no one should consume carp greater than 30 inches and women of child bearing age and children under 15 years of age should restrict their consumption of carp less than 30 inches to one meal per month. Additionally, women of child bearing age and children under the age of 15 should restrict their consumption of smallmouth bass to one meal per week.

In 1988, the FCMP conducted a caged fish study using channel catfish on the Saginaw, Flint, Tittabawassee, Shiawassee, and Cass rivers (Morse 1993). The Flint River showed net bioaccumulation of total chlordane, heptachlor epoxide (HPE), total dichloro-diphenyl-trichloroethane (DDT), total PCB, and hexachlorobenzene (HCB) indicating that these contaminants were present in the Flint River during the 28-day study period. Bioaccumulation of DDT, HCB, and total PCB in the Flint River was relatively low compared to the Saginaw, Tittabawassee, Shiawassee, and Cass rivers. However, although still relatively low, the HPE final net concentration was highest in the Flint River. DDT and chlordane are banned or cancelled pesticides that are frequently detected in fish at relatively low concentrations (R. Day, MDEQ, SWQD, personal communication). HCB was used as a fungicide and is a by-product of some industrial processes and combustion when certain precursors are in the waste stream. HPE is a breakdown product of the banned pesticide heptachlor and is also frequently detected in fish at low concentrations (R. Day, MDEQ, SWQD, personal communication).

Summary by valley segments

To ascertain whether Michigan's water quality standards are being met, MDEQ has developed a monitoring program that consists of eight interrelated monitoring elements: biological integrity, physical habitat, water chemistry, sediment chemistry, fish contaminants, stream flow, wildlife contaminants, and inland lake quality and eutrophication (MDEQ 1998a, MDEQ 1997b). Biological integrity and physical habitat are discussed in detail under the heading Biological Communities, and stream flow is discussed under the heading Geology and Hydrology. A brief summary by valley segment follows:

Upper South Branch Flint River

There are 5 NPDES permits and 3 sites of environmental contamination in this segment (Tables 9 and 10). Water quality standards for water and sediment chemistry, biological integrity, and physical habitat are being met (MDEQ 2000). The upper South Branch Flint River maintains good biological integrity with high fish and macroinvertebrate diversity. Water and sediment chemistry values fall within the range considered acceptable for the Southern Michigan Northern Indiana Till Plain Ecoregion (Appendices 1 and 2). Stream flow is stable with moderate groundwater inflow. No fish or wildlife contaminant sampling has been conducted in this segment.

Middle South Branch Flint River

There are 23 NPDES permits and 14 sites of environmental contamination in this segment (Tables 9 and 10). Most permits are for industrial and municipal facilities within the city of Lapeer. Water quality standards for water and sediment chemistry, biological integrity, and physical habitat are generally being met however, some drains and tributaries have been identified impaired. Biological integrity and physical habitat of lower Pine Creek has been compromised due to ditching resulting in the loss of a brook trout fishery, a reduction of intolerant macroinvertebrates, increased water temperatures, and physical habitat loss. Elevated bacteria levels and nutrient loading from suspected failing septic systems, sewage lagoon discharge, and other nonpoint sources are a concern in unidentified drains located in Metamora, Elba, Mayfield, and Lapeer townships in Lapeer County (MDEQ 2000). Upper Pine, upper Farmers, Mill, and Plum creeks were found to be meeting Water Quality Standards and designated use. Water and sediment chemistry values for the middle South Branch Flint River and its tributaries fall within the range considered acceptable for the Southern Michigan Northern Indiana Till Plain Ecoregion (Appendices 1 and 2). Fish contaminant sampling is limited to Lake Nepessing where the statewide advisory for mercury applies. No wildlife contaminant information is available.

Lower South Branch Flint River

There are 11 NPDES permits and 2 sites of environmental contamination in this segment (Tables 9 and 10). Historical and current land use practices have resulted in impaired biological communities and reduced biological integrity. Biological community impairment in the North Branch Flint River is attributed to heavy shifting sediment loads, high turbidity, and elevated nutrients. Sediment arsenic levels are elevated but believed to be of natural origin (M. Walterhouse, MDEQ, SWQD, personal communication). Reduced biological integrity of this segment is attributed to affects resulting from agricultural land use. Stream flow is less stable due to low groundwater inflow, wetland loss, and extensive ditching. No fish or wildlife contaminant sampling has been conducted.

Upper Flint River

There are 136 NPDES permits and 92 sites of environmental contamination in this segment (Tables 9 and 10). Most permits are for industrial and municipal facilities within the city of Flint. Biological community impairment is attributed to reduced biological integrity resulting from habitat loss. Water Quality Standards are not being attained due to PCB contamination in fish. Point source and nonpoint source pollution occurs at an accelerated rate due to land development. Biological integrity for most tributaries is reduced in downstream progression due to extensive ditching resulting in unstable flow, habitat loss, reduced species richness, and increased sediment loading. Water chemistry parameters indicate elevated nutrient levels. Sediment loading and eutrophication in Holloway Reservoir and

Mott Lake occurs at an accelerated rate. Contaminated sediments are in the mainstem at Flint and in Thread Lake (J. Innes, MDEQ, ERD, personal communication). Gilkey Creek is heavily affected by various urban land use practices and petroleum products are present in the sediment (MDEQ 2000). Fish contaminant advisories are in effect for Holloway Reservoir, Thread Lake, and the entire Flint River downstream of Hamilton Dam in Flint. Designated use for total body contact recreation is not being met due to elevated bacteria counts after any form of precipitation accompanied with storm water runoff. No wildlife contamination information is available.

Middle and Lower Flint River

There are 12 NPDES permits and 18 sites of environmental contamination in the middle Flint segment and 14 NPDES permits and 5 sites of environmental contamination in the lower Flint segment (Tables 9 and 10). Water quality in the middle and lower Flint are greatly affected by point and nonpoint source pollution occurring upstream. Biological community impairment is attributed to reduced biological integrity resulting from habitat loss. Biological integrity for most tributaries is reduced in downstream progression due to extensive ditching resulting in unstable flow, habitat loss, reduced species richness, and increased sediment loading. Water Quality Standards are not being attained due to PCB contamination in fish. Water chemistry parameters indicate elevated nutrient levels and with exceedence in the dissolved oxygen standard downstream of Flint. Nutrient loading has resulted in abundant plant growth in the mainstem downstream of Flint. Respiration processes associated with excessive plant growth oftentimes results in diurnal fluctuations in dissolved oxygen content of the water. Fish contaminant advisories are present for the entire Flint River downstream of Hamilton Dam in Flint. Total body contact recreation is not recommended after any form of precipitation due to elevated bacteria counts. No wildlife contamination information is available.

River Classification by Fisheries Division

In 1967, MDNR, Fisheries Division developed a Michigan Stream Classification system for the purpose of fisheries management. This classification system identified stream reaches of similar temperature regimes, water characteristics, and sport fish characteristics. Stream classifications were identified as: 1) top-quality cold water streams capable of supporting self-sustaining populations of trout; 2) second-quality cold water streams that contain significant trout populations maintained by stocking; 3) top-quality warm water streams that contain self-sustaining warm water (and cool water) sport fish; 4) second-quality warm water streams that have limited sport fish populations due to pollution, competition, inadequate reproduction, or lack of suitable habitat. Three classifications were identified in the Flint River basin (Figure 19). The upper reaches of Hunters and Kearsley creeks were identified as second-quality cold water streams. The mainstem, upstream of the confluence of Butternut Creek, and the North and South Branch Flint rivers were classified as top-quality warm water streams. The remaining basin and all of its tributaries were classified as second-quality warm water streams.

The Michigan Stream Classification system is largely based on the distribution and abundance of sport fish. The presence or absence of sport fish, however, limits application of this classification system. Non-sport fish such as mottled sculpin and longnose dace are indicative of good water quality and need be considered for protection. Also, other intrinsic habitat attributes such as flow, channel morphology, thermal regime, and energy sources are important for ecosystem management and protection. Seelbach et al. (1997) developed a landscape-based ecological classification system using valley segments to describe homogeneous portions of the river channel that share common features and flow through specific landscape units (see **Geography**). This classification system is based on the fact that rivers are strongly influenced by the configuration of the landscape and by regional climatic characteristics. This system also takes into account predictable changes in physical and biological characteristics with stream size. Yet, isolated variances may occur in landscape-based ecological classification. It is important these variances are identified for protection under MDEQ Water Quality Standards.

MDEQ water quality standards rely largely on thermal habitat attributes. Wehrly et al. (1999) has developed a classification system based on thermal habitat attributes and fish assemblages that allows for protection under current MDEQ, water quality standards. Data collected from the Flint River in 1997 and 1998 allows for current classification using thermal habitat attributes and fish and macroinvertebrate assemblage (Figure 18) (Leonardi 1997; Walterhouse 2001a; Walterhouse 2001b). Thermal habitats are classified as: 1) cold water designated supporting cold water biota; 2) cool water designated supporting cool water biota; 3) warm water designated supporting warm water biota. MDEQ, Water Quality Standard for dissolved oxygen concentration should be protected for 7 ppm for cold and cool water designation and 5 ppm for warm water designation.

Biological Communities

Original Fish Communities

The fish communities of the Great Lakes region are of recent origin. Melt water from the Wisconsinan glacier 10,000 - 14,000 years ago created aquatic environments for fish. Post-glacial fossil evidence suggests large volumes of water harboring fish existed around the peripheral ice-free refuges and heads of rivers. Original fish communities gained access through migration from connecting waterways including both the Mississippi and St. Lawrence river basins. Species distribution patterns suggest colonization of the Great Lakes by 122 species from the Mississippi drainage, 14 species from the Atlantic drainage, and 18 species from dual Mississippi and Atlantic drainage (Bailey and Smith 1981).

Bailey and Smith (1981) identified 112 fish species, 99 native and 13 colonized or introduced, present in Lake Huron tributaries. A description of the fish community in the Flint River watershed at the time of European settlement (early 1800s) is not available. However, anecdotal accounts relating to potamodromous fishes in the Saginaw and Shiawassee rivers infer movement into the Flint River was probable. Cleland (1966) mentions the following species historically present in the Saginaw Valley: lake sturgeon, longnose gar, bowfin, longnose sucker, white sucker, silver redhorse, golden redhorse, shorthead redhorse, yellow bullhead, brown bullhead, channel catfish, northern pike, lake trout, white bass, rock bass, smallmouth bass, largemouth bass, yellow perch, walleye, and freshwater drum. Early Native Americans would collect lake sturgeon on the lower Flint River and use their dried flesh for summer meat and barter (Wood 1916).

In 1858, the commercial value of the Saginaw basin fish trade was estimated at $40,000 (Mills 1918). Fox (1858) lists as part of the fishery: sturgeon, trout (probably lake trout), muskellunge, pickerel (walleye), mullet (sucker sp.), whitefish, perch, roach (sunfish sp.), black bass, bill fish (gar), and catfish. By the end of the 1860s, annual harvest of the fall and winter fishery on the Saginaw and Shiawassee rivers was averaging 68 metric tons of yellow perch, northern pike, black bass, and walleye (Fox 1868). Each spring, the area known as the Shiawassee meadows (confluence of the Flint and Shiawassee rivers) would be spawning grounds for large runs of walleye (Mills 1918).

Surveys on the Flint River and several tributaries in 1927 provide a reasonable account of additional indigenous fish species (MDNR, Fisheries Division). These surveys were by seining and probably omit certain fish species, particularly those associated with dense cover. Also, these surveys were post-logging era and loss of some indigenous species from watershed degradation may have occurred. Additionally, colonization and introductions of some non-indigenous species would have occurred before 1927. A composite of the original fish community is derived from historical accounts and records of the MDNR, MDEQ, United States Fish and Wildlife Service (USFWS), and University of Michigan. Seventy-seven species are believed indigenous to the Flint River watershed (Table 13). There are no fish species currently present in the Flint River basin classified as threatened or endangered by the State or Federal government.

The original fish habitat of the Flint River watershed has been greatly altered by human settlement. However, anecdotal accounts of the watershed, its fishery, and physiographic features allow for inferences of early fish habitat. Pre-settlement vegetation, providing streamside shade and bank stabilization, was characterized by large stands of white pine, wet hemlock, beech-sugar maple, and swamp forests (Albert et al. 1986). Inferably, downed trees and flood-wood were plentiful and provided an abundance of instream fish habitat. Stream banks were less eroded with abrupt vertical change offering undercut banks for fish cover. Abundant wetlands stabilized flow, recharged groundwater supply, filtered surface water runoff, and provided fish refuge, spawning grounds, and nurseries throughout the watershed.

Physiographic features of the watershed indicate diverse habitats existed. As the river carved its way through varying substrates, habitat was created by pool-riffle-run sequencing. Valley segments describe locations of homogeny allowing for ecological classification (Seelbach et al. 1997) and infer characteristics of original fish habitat. Physiographic features suggest the headwaters and tributaries had stable flow, cool temperatures, and clear water. Where the North and South Branch Flint rivers converge, a large glacial valley exists where rock and gravel substrate is common. The occurrence of pool-riffle-run sequencing in this glacial valley provides spawning habitat for potamodromous fish including lake sturgeon, walleye, and suckers. Anecdotal accounts verify river characteristics associated with this glacial valley before settlement and human perturbation. The location of Jacob Smith’s cabin was at the small rapids where the trail from Detroit to the Saginaw country crossed the Flint River (Catton 1976). In Flushing, the bed of river was covered by undulating and shattered gray sandstone up to 12 feet in thickness (Ellis 1879).

Features of the lower Flint River are associated with lake-plain geology common to the lower Shiawassee River and the Saginaw River valley. Low gradient and low groundwater inflow result in reduced pool-riffle-run sequencing with increased occurrence of run habitat and higher sediment deposition. The accumulation of drift materials at the mouth would impede flow creating a slack-water habitat used for refuge by immature fish. In 1831, the mouth of the Flint River was so completely filled with flood-wood, it was impossible to float a boat downstream (Anonymous 1881) and not until 1843, after the Saginaw lumbermen cleared 60 rods of flood-wood, was navigation possible (Dustin 1968). Although navigation was hindered, many fish species such as largemouth and smallmouth bass and muskellunge were in habitat created by woody structure.

Factors Affecting Fish Communities

Biodiversity of plant and animal life is important to the health of a watershed. Maintaining a balanced biotic hierarchy is dependent on the physical features, which determine habitat diversity. Fish and other aquatic organisms require several types of habitat throughout their life cycle. Stream fish often require diverse habitats for spawning, feeding, and refuge habitat. Equally important is freedom of movement between these habitats (Schlosser 1991). If any one area is lacking or the ability to migrate from one to another is restricted, the species may become locally extinct. The same holds true for mammals and other terrestrial organisms, all which are linked in the food chain and hierarchy of a watershed. Affects of flow stability, dams and barriers, agricultural and urban land uses, and point source discharges on the river system are discussed further in other sections of this report. However, a brief discussion on the affect of settlement is appropriate here.

European settlers and their descendents caused dramatic changes to the Flint River and its watershed, many which had significant affects on fish communities. Earliest settlers were not drawn to timber but rather, sensed the value of the land was in agriculture (Catton 1976). When a town was developed, one of the first buildings to be built, given an adequate water supply, was a sawmill to process lumber for housing. Sustenance required land to be cleared and drained for crops and livestock. However, it was the lumber era (1830-1880) that brought increased numbers of settlers to the Flint River watershed. Large stands of pines were cleared and floated down river to mills for processing. The systematic removal of large woody structure from the river and scouring of the channel by logging drives, resulted in soil erosion and increased sedimentation. Negative affects on fish communities resulted through loss of critical habitat and reduced water quality. Dams for sawmills were strategically located along many Flint River tributaries for processing lumber. Sawdust discharges into the river physically suffocated fish and fish eggs. Synthetic pollutants from mill machinery washed into the river and degraded water quality. Potamodromous runs of fish were blocked from spawning areas and river habitats were altered. Dams have degraded fish communities through the inundation of high gradient reaches and through their cumulative affects on water temperature and flow patterns (Hay-Chmielewski et al. 1995). These affects have been shown to alter fish communities favoring fewer species capable of tolerating harsh conditions (Cushman 1985). Furthermore, potamodromous runs of fish concentrated below dams were made more vulnerable to harvest (Trautman 1981).

The demise of the logging industry in 1880 made way for the agriculture era of the Flint River watershed. The clearing of land for timber gave rise to increased agriculture and the need for land drainage. Draining wetlands by channelizing streams and creating new drainage channels all served to decrease flow stability. Peak flow increased and base flow was reduced through diminished recharge into groundwater tables (Hay-Chmielewski et al. 1995). The altered flow regime resulted in warmer and more variable water temperatures favoring conditions for tolerant fish species. Channelization reduced habitat by eliminating the natural pool-riffle-run sequencing and meanders of the stream. Erosion and resulting stream sedimentation buried rock and cobble spawning substrates. By the late 1800s the culmination of effects on the river created by the logging industry and by agriculture is believed partly responsible for the extirpation of river spawning populations of lake trout, lake sturgeon, lake herring, lake whitefish, and muskellunge in the Saginaw river basin. In 1879, the walleye fishery in the Shiawassee and Saginaw rivers declined severely due to sawmill pollution (Schneider 1977).

The 1900s gave rise to the industrial era and the urbanization of the Flint River watershed. Flint's rise to the top of the automobile industry brought new inhabitants by the thousands. Cities and towns located on the river became more developed as their populations increased. Industrialization and urbanization accelerated watershed degradation. The discharge of human wastes and synthetic pollutants into the river degraded water quality to the extent that only the most tolerant fish species could survive. Sophisticated road systems and other impermeable surfaces accelerated surface water discharge into the river, resulting in less stable flow, warmer water temperatures, and increased nutrient loading. River engineering became necessary for human inhabitation. Dams were built for flood control, flow augmentation, and water supply to municipalities and industries. Impounded water from dams created artificial lakes supporting significantly different fish communities. Wetland drainage became increasingly necessary for community housing and growth. Groundwater supplies, tapped for human use, were returned as surface water subject to higher evaporation rates and warmer temperatures.

Riparian ownership emphasized the aesthetic and recreational value of the watershed. What were once cabins and cottages in the early 1900s, have been converted to permanent housing on many inland lakes and impoundments. Shoreline development resulted in the loss of critical spawning habitat for fish. Lake-level control structures were placed on many lakes in the upper portion of the watershed. These low-head dams disrupt fish movement and often prevent fish from reaching spawning habitat. Also, the manipulation of water levels oftentimes results in loss of wetland spawning areas that originally ringed a lake. Failing septic systems have become a nutrient source accelerating natural eutrophication processes.

Fish communities have been altered through intentional and inadvertent introduction of exotic species (Mills et al. 1993). Fish stockings by MDNR, Fisheries Division (Table 14) has focused on improving recreational fishing opportunities. In the early 1920s, many headwater tributaries were stocked with brook trout. Although brook trout are indigenous to Michigan, no evidence exists to suggest they were native to the Flint River. Chinook and coho salmon were introduced to the mainstem in 1977, but only small runs developed and stocking was discontinued in 1982. Brown trout stocking in Kearsley and Thread creeks continue as successful recreational fishery programs. For more details see Fisheries Management.

No other non-indigenous species introduction has altered or affected the Flint River watershed fish communities like the common carp. This exotic was first introduced into Michigan waters in 1885 and spread with great rapidity (Petersen and Drews 1957). Its origin in the Flint River most probably came from Saginaw Bay and Lake Huron, although many private plants throughout the state were occurring at the time. Early interest for food and sport quickly diminished and by 1911 carp achieved obnoxious status in the state. Accounts of a popular 1918 sport dip-net fishery below the Hart Dam in Flushing suggests significant numbers of carp in the Flint River (Anonymous 1985). Problems with carp have been recognized. Their diet is omnivorous consisting of aquatic vascular plants, invertebrates, fish eggs, and occasional small fish. Where abundant, a loss of aquatic vegetation often results. Their movements and feeding behavior often results in increased water turbidity and they are very prolific. Carp are tolerant of degraded water quality and their abundance in the Flint River by the 1970s was indicative of severe water quality problems. Fisheries Division attempts to eradicate carp from the upper watershed in 1971 and 1976 using the fish toxicant rotenone, met with little success. Even though the 1971 effort removed an estimated 420 tons of carp upstream of Holloway Dam, carp had re-populated the river in noxious numbers by 1975 (MDNR, Fisheries Division). In 1976, an estimated 18 tons of carp were eradicated upstream of Mott Dam (MDNR, Fisheries Division).

Several inadvertent introductions or colonization of non-indigenous species into the Flint River watershed have occurred. Goldfish have similar affects as carp but they do not inhabit the watershed in great abundance. Sea lamprey and alewife, which use the Flint River for spawning and juvenile development, have had significant affects on the Lake Huron fishery. Lake trout collapsed in Lake Huron during the 1940s due to a combination of over-fishing and sea lamprey predation (Johnson 1998). Of more recent origin, has been the discovery of white perch (1983) and round gobies (1998). White perch from Saginaw Bay use the lower river for spawning and are considered a competitive threat to native yellow perch. In 1998, round gobies were discovered in the section of river between Mott Lake and Holloway Reservoir. Their origin is suspected to have come from anglers using live bait from outside the Flint River watershed. By 1999, movement of gobies has expanded downstream into Mott Lake. Although affects of round gobies are not fully understood, there is concern they have potential to out-compete native darter species (Jude and Smith 1992).

Besides changes in fish communities resulting from human settlement and related activities, natural events have also had an effect. Devastating fires in 1771 and 1881, kindled by the logging industry, burned much of Lapeer County altering primary plant growth in the northeast part of the watershed. As a result, stream shading was lost affecting temperature regimes and more land became available for agriculture, further increasing nutrient loading. Watershed development has greatly reduced floodplain availability and annual or catastrophic flooding results in increased deposition of nutrients, sediments, and synthetic pollutants.

Cultural stresses on the Flint River and its watershed continued at a rapid pace until the implementation of the Federal Clean Water Act (P.A. 401) in 1972. Since the implementation of this legislation considerable strides have been made towards improving water quality within the watershed. The affects of these improvements have resulted in fish communities of greater biotic integrity (Karr et al. 1986) however, original fish communities have been so affected that some species may be lost forever and others remain in an altered state.

Present Fish Communities

Based on post-1950 records of MDNR, MDEQ, and USFWS, the present fish community of the Flint River watershed is composed of 77 species (Table 13). Five indigenous species are believed extirpated: lake sturgeon, lake trout, lake herring, lake whitefish, and muskellunge. Thirteen species of the present fish community have been introduced to, or have colonized in, the watershed (Table 13). The status of seven species of the original fish community is unknown (Table 13).

In 1997, fish community assessments of the Flint River drainage were made at 44 locations (Figure 20) (Leonardi 1997). Sixty-one fish species were caught. Present fish community species not collected in 1997 were: (1) species extirpated from the drainage, (2) peripheral species whose occurrence in the basin is based on few documented records, (3) species not easily collected with electrofishing gear, and (4) species reported from recent (post-1950) stream, lake, or impoundment surveys. Distribution of individual species varies from basin-wide to isolated locations within the watershed (Appendix 3).

Fish species distribution is influenced by the landscape by a stream as well as by localized physical stream parameters including network position, stream discharge, water velocity, groundwater inflow, water depth, temperature, bottom substrate, and habitat availability (Seelbach et al. 1997). Also, the extent of human perturbation also affects species distribution (Karr et al. 1986). Information collected from the 1997 assessments allow for fish community assemblages to be discussed according to river valley segments (Tables 15-19). A brief description of these segments, their habitats, and their fish communities follows:

Upper South Branch Flint River

This segment (Figure 2) includes the river reach from the origin, a small inlet to Horseshoe Lake, downstream to Winns Pond, a 25 acre impoundment southeast of the town of Lapeer. Whigville Creek is the principal tributary to this reach. Moderate groundwater inflow, moderate gradient, cool water temperature, and stable flow typify this segment. Habitat is available in the form of pool-riffle-run sequencing, rock substrate, and submerged woody structure. In 1997, collections from three sites found 29 fish species with hornyhead chub, common shiner, and creek chub being most common. Collectively, cyprinids and catostomids accounted for 78% of the catch (Table 15). The fish communities at each site were rated excellent (non-impaired) using Great Lakes and Environmental Assessment Section (GLEAS), Procedure 51 (Leonardi 1997, MDEQ 1997c). Shallow water depth and low base flow limits top predator species. Winns Pond supports a warm-water fish community of bluegill, pumpkinseed sunfish, largemouth bass, northern pike, and common carp.

Middle and Lower South Branch Flint River

This segment includes the river reach from Winns Pond dam downstream to the confluence of the South Branch Flint River with the mainstem. The principal tributaries are Pine, Hunters, Farmers, Mill, and Plum creeks and the North Branch. With the exception of Pine Creek, this segment differs from the upper South Branch Flint River as it has less groundwater inflow, less gradient, reduced flow stability, and warmer water temperatures. Human perturbation is also greater. All tributaries of the middle and lower South Branch Flint River have been altered to accommodate land drainage, resulting in reduced fish habitat and flow stability. Pool-riffle-run sequencing is less frequent and sand, loam, and clay are the prevalent stream substrates.

A self-sustaining brook trout fishery exists in the upper reach of Pine Creek. South of Interstate 69 the creek is less perturbed, maintaining a natural flow with dense bank cover. Moderate groundwater inflow results in a cold-water temperature regime and coldwater fish community. North of Interstate 69, the creek has been dredged and channelized resulting in increased water temperature and loss of fish cover. Water temperatures taken July 7, 1997, south of Interstate 69, averaged 55 °F but, north of Interstate 69, temperature averaged 63 °F (Leonardi 1997). Four sites were sampled in 1997. Thirteen fish species were found with creek chub, blacknose dace, central mudminnow, and brook trout accounting for 76% of the combined catch (Table 15). Pine Creek was the only tributary of the Flint River where longnose dace exist. No brook trout were found north of Interstate 69.

Alteration of the natural flow of Farmers Creek occurred through the installation of lake-level control structures. Control structures impound water at Metamora, Minnewanna, Lapeer, and Nepessing lakes. These structures have reduced stream gradient and have had a warming effect on the stream temperature regime. Fish communities observed at two locations were dominated by cyprinid species. Rainbow darter, johnny darter, blacknose dace, creek chub, and bluntnose minnow accounted for 84% of the combined 1997 catch (Table 15). GLEAS Procedure 51 rated the fish community of the upper reach of Farmers Creek as acceptable (slightly impaired) and the lower reach poor, indicative of impaired conditions (Leonardi 1997). Significant spawning runs of carp and an occasional run of northern pike are known to occur in Farmers Creek (Leonardi, personal observation).

Mill Creek is an inlet to Lapeer Lake in the Farmers Creek drainage. The creek has been channelized for drainage resulting in loss of meanders and instream fish cover. Low base flow further limits fish community composition. A single location surveyed in 1997 found a warmwater fish community dominated by cyprinid and centrarchid species. Bluntnose minnow, creek chub, and green sunfish accounted for 73% of the catch (Table 15). GLEAS Procedure 51 rated the fish community as acceptable (Leonardi 1997). Low base flow limits the presence of adult predator species, however, there is a spring spawning run of northern pike.

Hunters Creek, once a cool water stream, now has a warm-water temperature regime due to watershed development and human perturbation. Earthen dams with water control structures have impounded the creek to enlarge Misch and Whelock lakes. The upper reach of Hunters Creek meanders through unperturbed wetlands that aid in flow stability. Fish habitat includes overhanging brush and submerged woody structure. The lower reach of Hunters Creek has been dredged and channelized for drainage resulting in loss of meanders and instream fish habitat. In 1997, fish communities were inventoried at one site in the upper reach and one site in the lower reach. Association with lake environment was indicated by an increased presence of bluegill and young-of-the-year largemouth bass. Bluegill, largemouth bass, and johnny darter composed 72% of the 1997 catch at both sites (Table 15).

Plum Creek is the principal drainage for Fish Lake, Lake Pleasant, and Long Lake Impoundment. The creek has been extensively channeled for agricultural drainage and wildlife refuge. Unstable flow results in severe bank scouring and habitat loss. In 1997, centrarchid, catostomid, and cyprinid species dominated the fish community at two locations (Leonardi 1997). Green sunfish, white sucker, johnny darter, and central mudminnow composed 64% of the combined site catch (Table 15). GLEAS Procedure 51 rated the fish community at both sites as acceptable (slightly impaired) (Leonardi 1997).

The North Branch Flint River drains northeast Lapeer County. Its principal tributaries are Cedar, Elm, Crystal, Bottom, Gravel, Indian, and Squaw creeks, and Fitch, Fostoria, and Forest drains. Low groundwater inflow, low gradient, and an unstable flow regime are characteristic of this drainage.

Warm-water temperature regimes are present in the North Branch Flint River and its tributaries with the exception of Gravel and Bottom creeks. Gravel and Bottom creeks have cold-water temperature regimes in their upper reaches. The North Branch Flint River has been greatly affected by agricultural land use and extensive ditching of the tributaries for drainage. Habitat is available in the form of downed flood wood, which in some areas impedes flow and prohibits navigation. Unstable flow has resulted in severe bank erosion reducing additional instream fish cover and stream bank habitat. The fish community of the North Branch Flint River is comprised of warmwater fish species. Collections at two sites in 1997 were dominated by centrarchid and cyprinid species (Leonardi 1997). Green sunfish, spotfin shiner, blackside darter, and creek chub composed 67% of the combined catch (Table 16). Though not sampled in 1997, deeper portions of the North Branch Flint River are known to contain populations of northern pike, channel catfish, white sucker, and carp (Alexander 1997, Leonardi, personal observation).

In 1997, fisheries assessments were made on Cedar, Crystal, and Bottom creeks, and on the North Branch Flint River (Leonardi 1997). Fish communities of both Cedar and Crystal creeks were dominated by cyprinid species with bluntnose minnow, creek chub, and johnny darter being most common (Table 16). GLEAS Procedure 51 rated the fish community of Cedar Creek as acceptable (slightly impaired) in the upper reach and poor (impaired) in the lower reach (Leonardi 1997). A single site sampled on Crystal Creek was rated as acceptable (slightly impaired) (Leonardi 1997). Alexander (1997) rated the fish community of Elm Creek as poor (impaired) with creek chub, bluntnose minnow, johnny darter, and central stoneroller dominating the catch. Shallow water depths and low base flows limit predator species in each of these tributaries.

Bottom Creek is a cold water tributary that has been altered by channelization and by impounded water on the lower reach. The fish communities at two upper reach sites in 1997 were dominated by cyprinid species with blackside darter and central mudminnow comprising 73% of the combined catch (Leonardi 1997) (Table 16). Although brook trout have not been stocked since 1964, two specimens were collected in 1997 indicating natural reproduction. Habitat loss from channelization limits potential trout survival. Also, impounded water at the lower reach has reduced gradient and warmed the water temperature regime making it unsuitable for trout. Water temperatures recorded July 30, 1997 indicated average water temperature of the upper reach was 56 °F while below the impoundment, water temperature averaged 72 °F (Leonardi 1997).

Upper Flint River

This segment extends from the confluence of the South Branch Flint River with the mainstem downstream to the confluence of Swartz Creek. The principal tributaries in this segment are Hasler, Butternut, Kearsley, Black, Duck, Gilkey, and Swartz creeks, and Henry and Powers-Cullen drains. Four dams are located on the Upper Flint. Earl Holloway Dam forms Holloway Reservoir, the C. S. Mott Dam forms Mott Lake, and the Hamilton Dam forms Hamilton Impoundment. The Utah Dam, located between C.S. Mott and Hamilton dams, is kept open and does not impound water or impede fish movement.

Holloway Reservoir (1,973 surface acres) and Mott Lake (650 surface acres) are located at the upper reach of this mainstem segment. Both impoundments are described as being relatively shallow and very fertile (Bryant 1992, D. Nelson, MDNR, Fisheries Division, personal communication). Phytoplankton blooms and suspended silt particles from wave action and carp movements result in turbid water. Secchi disc readings are typically two feet. Fish habitat of submerged woody structure and aquatic vegetation is sparse. High turbidity restricts growth of aquatic vegetation. Severe erosion from waves occurs on the sandy shores further reducing fish bank habitat. Fish communities of both impoundments are similar consisting of warmwater species. Principal sport fish species are walleye, channel catfish, black crappie, smallmouth bass, and northern pike. In 1986, gizzard shad were first documented upstream of Holloway Dam. Gizzard shad and carp are now the principal non-sport fish species in both impoundments.

In the past ten years, the fish communities of Holloway Reservoir and Mott Lake have experienced shifts in dominant species (MDNR, Fisheries Division). Catch per unit effort (CPUE) indicates significant reductions in black crappie and bluegill abundance (Table 17). Conversely, CPUE for channel catfish has shown significant increases (Table 17). Healthy and self-sustaining walleye populations occur in both impoundments. Walleye population estimates for Holloway Reservoir indicate a density of six adult walleye per acre. Young-of-the-year walleye density was estimated at 4 per acre and yearling walleye density was estimated at 5 per acre (MDNR, Fisheries Division). Carp, gizzard shad, channel catfish, and walleye dominate total fish biomass in both impoundments (MDNR, Fisheries Division).

Hamilton Impoundment includes the reach of river between Hamilton Dam and C. S. Mott Dam. Its flow shows river characteristics more so than Holloway Reservoir and Mott Lake. Littoral zones are limited due to the deep valley through which this reach meanders. Water retention is less resulting in a less fertile environment. Fish community information is limited to net sampling in 1997 (Leonardi 1997). Principal fish species include channel catfish, walleye, smallmouth bass, northern pike, carp, and white sucker. Catch per unit effort indicates fish abundance is significantly less in Hamilton Impoundment than Holloway Reservoir and Mott Lake (Table 17).

Henry Drain, the principal drainage of McDowell, Pero, and West lakes, flows into Holloway Reservoir. Although habitat loss due to channelization has occurred, fish species diversity is high due to its association with the reservoir environment. In 1997, seventeen fish species were collected at two sites (Leonardi 1997). White sucker and blackside darter composed 50% of the two-site collection (Table 18). Fish species collected are associated with a reservoir environment: black and brown bullhead, bluegill, largemouth bass, and yellow perch. GLEAS Procedure 51 rated the fish community of Henry Drain as fair or poor (moderately impaired, impaired) (Leonardi 1997). Nuisance levels of carp resulted in the installation of an electrical barrier in 1983, however, the barrier was removed in 1987 due to inefficiency.

Hasler Creek, the principal drainage of Hasler Lake, flows into Holloway Reservoir. The creek is characterized as having a warm-water temperature regime, low groundwater inflow, low gradient, and has been greatly altered by channelization for drainage. GLEAS Procedure 51 rated the fish community as acceptable (slightly impaired) (Leonardi 1997). Dominant fish species consisted of bluntnose minnow, johnny darter, and creek chub (Table 18). Leonardi (1997) reports increased turbidity, fom carp movement and surface water runoff, as being more prevalent in the lower reach.

Powers-Cullen Drain and Butternut Creek are tributaries that flow into the Upper Flint upstream of Mott Lake. Both are characterized as having a warm-water temperature regime, low groundwater inflow, low gradient, and both have been altered by channelization for drainage. Fish communities of both tributaries are similar being dominated by cyprinid species with creek chub, johnny darter, and bluntnose minnow being most common (Table 18). GLEAS Procedure 51 rated their fish communities as acceptable (slightly impaired) (Leonardi 1997).

Kearsley Creek is a cool water tributary that flows into the upper Flint upstream of Hamilton Impoundment. Four dams (Lake Louise, Goodrich Mill Pond, Atlas Mill Pond, and Kearsley Reservoir) have fragmented the stream altering flow and changing the water temperature regime to warm water. Upstream of M-15, Kearsley Creek is characterized as having moderate gradient and moderate groundwater inflow resulting in cool water temperature and stable flow. Downstream of M-15, gradient is reduced, water temperature is warmer, and flow is less stable.

The upper reach of Kearsley Creek (upstream of M-15) supports a cool-water fishery and is stocked annually with yearling brown trout. Since 1976, fisheries assessments have documented yearling trout survival at several upstream locations. However, extent of survival has often fluctuated from year to year (MDNR, Fisheries Division). In 1997, the brown trout population at Kipp Road was estimated at 273 brown trout per acre (Leonardi 1997). In 1999, a population estimate at the same site, using the same technique, found less than 1 brown trout per acre (MDNR, Fisheries Division). Over-winter survival and natural reproduction occur at low levels.

In 1997, the fish community of upper Kearsley Creek at Kipp Road consisted of 14 fish species (Leonardi 1997). Mottled sculpin, brown trout, and central mudminnow composed 81% of the catch (Table 18). Upper Kearsley Creek drainage is the only area of the Flint River watershed where mottled sculpin are found. Fish habitat consisted of pool-riffle-run sequencing, overhanging brush, abrupt bank cutting, rock and gravel substrate, and submerged woody structure. Beaver dams are common to upper Kearsley Creek. Although beaver dams have created pool habitat, flow is disrupted and sediments are covering spawning substrate (Leonardi, personal observation).

Duck Creek is a small cold water tributary to upper Kearsley Creek. In 1989, fisheries assessments found wild brook and brown trout populations (MDNR, Fisheries Division). In 1993, fisheries assessments found significantly reduced numbers of trout (MDNR, Fisheries Division). Trout habitat in Duck Creek has been reduced by beaver dams and bank erosion. Mottled sculpin, white sucker, and creek chub dominate the present fish community.

The fish community of lower Kearsley Creek (downstream of M-15) is one of a warm-water temperature regime. In 1997, cyprinid, catostomid, and centrarchid species dominated a single site located between Atlas Mill Pond and Kearsley Impoundment. Northern hog sucker, blackside darter, creek and hornyhead chub, and bluntnose minnow composed 79% of the catch (Table 18). GLEAS Procedure 51 rated the fish community as acceptable (slightly impaired) (Leonardi 1997). However, loss of brown trout and mottled sculpin in this reach is indicative of altered stream conditions caused by the impoundments.

Goodrich and Atlas mill ponds, and Kearsley Reservoir have similar warmwater fish communities. Principal fish species include: bluegill, pumpkinseed sunfish, black crappie, largemouth bass, northern pike, brown and yellow bullhead, white sucker, and carp. In contrast, Kearsley Reservoir supports a self-sustaining channel catfish fishery that is not found in Goodrich and Atlas mill ponds.

Gilkey Creek is a small tributary of the upper Flint that receives extensive urban runoff. It is characterized as having low gradient, low groundwater inflow, and a warm-water temperature regime. A single site sampled in 1997 collected 5 fish species with creek chub and white sucker comprising 90% of the catch (Table 18). Bank scouring is common to Gilkey Creek indicating flashy flow. GLEAS Procedure 51 rated the fish community as poor (impaired) (Leonardi 1997).

Swartz Creek, a tributary to the upper Flint, is characterized as having low gradient and low groundwater inflow resulting in a warm-water temperature regime. The confluence with the mainstem is downstream of Hamilton Dam allowing for potamodromous movement. Swartz Creek has been greatly altered by channelization to accommodate drainage for urban development, including Bishop International Airport and extensive road development by the cities of Flint, Swartz Creek, and Grand Blanc. Accelerated surface water runoff from urban development results in an unstable flow regime. Fish community information is limited to a single sampling in 1997 (Leonardi 1997). Twenty-five fish species were caught. Cyprinids accounted for 67% of the catch with creek chub, rainbow and johnny darter, and emerald shiner being most common (Table 18). GLEAS Procedure 51 rated the fish community as acceptable (slightly impaired) (Leonardi 1997).

Thread Creek is the principal tributary to Swartz Creek. The upper reach of Thread Creek (upstream of Grand Blanc) is characterized as having moderate groundwater inflow resulting in cool water temperatures, moderate gradient, and stable flow. Downstream of Gland Blanc water temperature is warmer, gradient is reduced, and flow is less stable. Two impoundments are located on Thread Creek. MDNR, Wildlife Division has impounded the headwaters for waterfowl habitat and Thread Lake is just upstream of the confluence.

The upper reach of Thread Creek has been stocked annually with yearling brown trout. Since 1976, fisheries assessments have documented trout survival at several upstream locations (MDNR, Fisheries Division). However, trout survival has fluctuated from year to year and natural reproduction and over-winter survival has been negligible. Fish habitat consists of pool-riffle-run sequencing and submerged woody structure. A single site sampled in 1997 collected 16 fish species (Leonardi 1997). Creek chub, rainbow and johnny darter were most common comprising 70% of the catch (Table 18). Yearling brown trout composed less than 2% of the catch. Other coolwater or coldwater fish species were noticeably absent indicating a marginal suitability for trout. GLEAS Procedure 51 rated the fish community as acceptable (slightly impaired) (Leonardi 1997).

The fish community of lower Thread Creek is consistent with a warm-water temperature regime. Fish species diversity is also influenced by the presence of Thread Lake near the confluence. A single site sampled in 1997, upstream of Thread Lake, found seventeen fish species with largemouth bass, rock bass, creek chub, bluntnose minnow, and common shiner being most common (Leonardi 1997) (Table 18). The presence of juvenile northern pike and largemouth bass indicates upstream fish movement from Thread Lake. Gizzard shad and emerald shiner, common to Swartz Creek, were not present above Thread Lake dam demonstrating affects of barriers on fish movement. Fish habitat consisted of pool-riffle-run sequencing, however, bank habitat was lacking due to severe bank erosion from unstable flow. GLEAS Procedure 51 rated the fish community of lower Thread Creek as acceptable (slightly impaired) (Leonardi 1997).

Thread Lake is a 65-acre impoundment that supports a warmwater fish community. It is characteristically shallow with an average depth of two feet. Maximum depth is less than ten feet. Aquatic vegetation provides the dominant fish cover. Principal fish species found in Thread Lake include black crappie, bluegill, white sucker, northern pike, largemouth bass, channel catfish, and carp. Carp have been reported in high abundance (MDNR, Fisheries Division).

Middle Flint River

This segment extends from the confluence of Swartz Creek downstream to north of the town of Montrose. Principal tributaries are Mud, Cole, Brent, and Brent Run creeks. Low groundwater inflow, moderate gradient, and a warm-water temperature regime typify this reach. Flow is unstable due to surface water runoff from surrounding land development. Fish habitat in the upper reach has been removed and replaced with concrete for flood control. Fish habitat in the lower reach consists of pool-riffle-run sequencing, rock and gravel substrate, and submerged woody structure. This segment has been identified as a principal spawning location for Saginaw Bay walleye (Leonardi 1997). Also, the prevailing rock substrate and greater mean depth provide suitable habitat for good smallmouth bass populations. However, stream bank cover is reduced due to erosion caused by flow fluctuations.

Warmwater cyprinid, centrarchid, and catostomid species dominant the fish community of the Middle Flint. Leonardi (1997) found gizzard shad, emerald shiner, rock bass, johnny darter, and blackside darter in moderate abundance (Table 19). MDNR, Fisheries Division personnel and anglers report white sucker, carp, and smallmouth bass also in abundance.

Since the early 1980s, a potamodromous walleye run has re-developed in this river reach. Estimates suggest the magnitude of this run in the realm of 50,000 walleye (Leonardi, unpublished data).

Biological data collected from spawning walleye in the Flint River shows similarities in year class strength and growth with the Saginaw Bay walleye stock. Age distribution of Flint River run walleye indicates a weak 1993 year class (Figures 21 and 22). Fielder and Thomas (1998) also report a weak 1993 Saginaw Bay year class. Conversely, 1994 and 1995 Saginaw Bay walleye year classes are considered healthy and are supported by Flint River data (Johnson et al. 1996; Leonardi, unpublished data). Growth of Flint River run walleye is consistent with Saginaw Bay walleye and is well above state average having a mean growth index of +2.6 in 1998 and +2.5 in 1999 (Leonardi, unpublished data). Fast growth is characteristic of Saginaw Bay walleye and reflects healthy forage conditions. Post-spawn movement, based on angler tag recoveries, shows a tendency for walleye to remain in the inner Saginaw Bay (Figure 23). However, recoveries from Thunder Bay and the Port Austin area show walleye are capable of ranging considerable distances.

Homing tendencies, based on tag recoveries from spawning evaluations, indicate discreteness of the Flint River spawning run (Leonardi, unpublished data). In 1999, 7.1% of 3,244 walleye captured were tagged in the Flint River in 1998. In 2000, 10.3% of 4,185 captured were tagged in the Flint River in 1998 or 1999. Thirty-four walleye were recaptured in both 1999 and 2000. Recoveries from other Saginaw Bay tagging was less than 0.5% for 1998, 1999, and 2000. This homing tendency suggests the spawning run of Flint River walleye originated within the Flint River. It is unknown if the spawning run origin is the result of natural reproduction downstream of Hamilton Dam, from emigration from the upstream impoundments where reproduction occurs, or a combination of the two.

Each of the tributaries in this river reach (Mud, Cole, Brent, and Brent Run creeks) are characterized by low groundwater inflow, low gradient, and warm-water temperature regimes. Instream habitat is lacking in each due to erosion from unstable flow and channelization for drainage. Dominant fish communities found in each creek consisted of cyprinid species with johnny darter, creek chub, blacknose dace, and bluntnose minnow being most common (Table 19). GLEAS Procedure 51 rated the fish communities of each tributary as poor (severely impaired) (Leonardi 1997).

Lower Flint River

This segment extends from north of Montrose downstream to the confluence with the Shiawassee River. Principal tributaries are Pine Run, Silver and Misteguay creeks. In this segment, gradient and groundwater inflow is low. Stream substrate is dominated by sand and clay-loam mixes. Summer water temperatures are warm. In 1997, the upper reach of this segment was dominated by cyprinid and centrarchid fish species (Leonardi 1997). Bluntnose minnow, johnny and blackside darter, and rock bass composed 66% of the catch (Table 19). The fish community of the lower reach reflects its large size and its proximity to Lake Huron. Carp, white sucker, gizzard shad, and channel catfish are the principal species. Potamodromous runs of walleye and white sucker occurs each spring.

Pine Run and Misteguay creeks are characterized by low gradient, low groundwater inflow, unstable flow, and warm summer water temperatures. Fish habitat is lacking in both creeks due to stream bank erosion and channelization for drainage. The fish communities of both creeks are dominated by cyprinid species with creek chub, bluntnose minnow, johnny darter, and common shiner being most common (Table 19). GLEAS Procedure 51 rated the fish communities as acceptable (slightly impaired) (Leonardi 1997). No fish community data is available for Silver Creek.

Aquatic Invertebrates

Invertebrates are an important and diverse component of the aquatic environment. Organisms in this grouping include sponges, moss animals, worms, arthropods (scuds, sowbugs, spiders, and crayfish), insects, and mollusks. They are an important food source for fish and other animals including birds, mammals, reptiles, and amphibians. Diversity and abundance of aquatic invertebrates often reflects stream quality (MDEQ 1997c).

Comprehensive studies of Flint River aquatic invertebrates are not available. However, a number of biological surveys address phylogenic diversity to some degree (Beck 1977, Wuycheck 1977, Alexander 1997, Walterhouse 2001a, Walterhouse 2001b). No aquatic invertebrates of the Flint River basin are listed as threatened, endangered, or of special concern by the Michigan Natural Features Inventory (MNFI). Non-aquatic insects listed by MNFI are the Poweshiek skipperling (threatened) and the Huron River leafhopper, tamarack tree cricket, and blazing star borer (special concern).

In 1974, the aquatic invertebrate community of the upper, middle, and lower Flint River showed degraded water quality conditions as indicated by low diversity (Beck 1977). Exceptions were found in the upper reaches of Kearsley, Thread, and Swartz creeks, which showed high species diversity and good habitat conditions. However, diversity and high water quality indicator species declined in downstream progression in each of these tributaries (Wuycheck 1977).

Present day aquatic invertebrate communities are best summarized by biological surveys reported by Alexander (1997) and M. Walterhouse, (MDEQ, SWQD, unpublished data). Fifty-four locations were sampled (Figure 24). Protocol for these surveys is outlined in GLEAS Procedure 51, which uses standardized criteria to measure stream biotic integrity (MDEQ 1997c). Present day aquatic invertebrate communities are discussed below by valley segment.

Upper South Branch River

The invertebrate community of the upper South Branch Flint River was rated as excellent at three locations (Walterhouse 2001b). Presence of a diversity and moderate abundance of mayfly, stone fly, and caddis fly taxon indicates good water quality and habitat (Table 20).

Middle South Branch River

In 1998, the aquatic invertebrate community of the middle South Branch Flint River was rated acceptable at a single location (Walterhouse 2001b). Diversity was significantly reduced from the upper South Branch Flint River indicating slight impairment (Table 20). Intolerant stonefly species, found in the upper South Branch Flint River, were absent from the middle South Branch Flint River.

The invertebrate community of Pine Creek was rated as excellent in the unperturbed area of the upper reach and as acceptable in the channeled lower reach (Walterhouse 2001b). A diversity of mayfly, stonefly and caddis fly are present (Table 20). However, lower Pine Creek exhibits reduced dominance of high water quality indicator species indicating impairment. Impairment is attributed to agricultural land use and stream channelization.

Invertebrate communities in Hunters Creek were rated poor in the upper reach and acceptable in the lower reach (Walterhouse 2001b). The poor rating of the upper reach is attributed to the prevailing organic substrate that offers limited habitat for diverse invertebrate communities. As a whole, Hunters Creek shows a diverse invertebrate community though dominated by tolerant aquatic insects (Table 20).

The invertebrate community of upper Farmers Creek and its tributary Mill Creek were rated acceptable (Alexander 1997, Walterhouse 2001b) (Table 20). The invertebrate community of lower Farmers Creek was rated as poor (Walterhouse 2001b). Degree of impairment, indicated by invertebrate communities, intensifies in downstream progression and is attributed to affects of agricultural land use, stream channelization, and stream fragmentation by lake-level water control structures.

Invertebrate communities of Plum Creek were rated as acceptable at two locations (Walterhouse 2001b). Communities showed moderately high insect diversity however intolerant species were absent indicating slight stream impairment (Table 20).

Lower South Branch Flint River

Invertebrate communities of the lower South Branch Flint River were rated as excellent, exhibiting high taxon diversity and occurrences of intolerant species (M. Walterhouse 2001b) (Table 20). The improved rating in this segment is attributed to increased habitat of rock substrate and woody structure and improved water quality resulting from higher groundwater inflow.

Aquatic invertebrate communities of the North Branch Flint River and its principal tributaries, Cedar, Elm, Bottom, and Crystal creeks, were each rated as acceptable or poor (Alexander 1997, Walterhouse 2001b). Invertebrate community ratings for sites on the North Branch remained similar from 1993 to 1998 (Alexander 1997, Walterhouse 2001b). Species diversity was reduced from South Branch Flint River locations (Table 20). Intolerant species abundance was absent or low at all locations. Stream impairment is attributed to affects of agricultural land use, stream channelization, and sediment loading.

Upper Flint River

Aquatic invertebrate sampling in the upper Flint River was done in 1993 and in 1998 at two locations between Holloway Reservoir and Mott Lake. Community rating was acceptable in both years (Alexander 1997, Walterhouse 2001a). Zebra mussels, present in Holloway Reservoir and Mott Lake, have not been observed in high abundance at other river locations (Leonardi, personal observation).

Tributaries to the upper Flint River sampled for aquatic invertebrates either in 1993 or 1998 include Hasler, Butternut, Kearsley, Gilkey, Thread, Swartz creeks, and Henry and Powers-Cullen drains (Alexander 1997, Walterhouse 2001a). Hasler, Butternut, Gilkey, Thread, and Swartz creeks and Powers-Cullen Drain each received acceptable rating. Kearsley Creek was rated acceptable in the upper reach and excellent in the lower reach. However, the upper Kearsley Creek rating was in part due to the absence of intolerant stoneflies, which have been observed in recent fisheries surveys. Invertebrates in Henry Drain were rated excellent. Species diversity varied with each location (Table 21).

Middle Flint

Aquatic invertebrate sampling in the middle Flint River occurred in 1993 and 1998 at six locations. Prevailing rock substrate provides good invertebrate habitat. Five locations received acceptable invertebrate ratings and one location (Vienna Road) was rated excellent (Alexander 1997, Walterhouse 2001a). Species diversity is high but intolerant species are absent or in low abundance indicating slight stream impairment (Table 22). High leech abundance in this segment has been observed during walleye spawning run assessments (Leonardi, unpublished data). Infestation rates were 27% in 1998 and 15% in 1999. High leech abundance is indicative of degraded water quality. Urbanization and municipal water discharge affect water quality in this segment.

Tributaries sampled for invertebrates include Brent Run and Mud Creek. The invertebrate community of Brent Run Creek was rated acceptable and poor in Mud Creek (Walterhouse 2001a). Diversity in both tributaries was dominated by tolerant species (Table 22).

Lower Flint River

Aquatic invertebrate communities at three locations of the lower Flint River were rated acceptable. Species diversity was similar to the middle Flint segment (Table 22). Intolerant species are low in abundance indicating slight stream impairment. Tributaries sampled for invertebrates include Pine Run, Silver, and Misteguay creeks. Invertebrate communities found in Pine Run and Misteguay creeks were acceptable (Walterhouse 2001a). The invertebrate community of Silver Creek was poor (Walterhouse 2001a). Diversity in each tributary was dominated by tolerant species (Table 22).

Amphibians and Reptiles

Many amphibians and reptiles rely on the aquatic environment for habitat, reproduction, and food. Marsh areas of lakes and rivers are homes to many frogs and turtles. Vernal ponds in both woodland and open grasslands are important breeding places for other species of anurans and salamanders (Harding 1997). Amphibians and reptiles are an integral component of the watershed. They are valued consumers of a variety of plant and animal materials and they are an important food source for other species including fish, mammals, and birds.

The degradation, fragmentation, and destruction of natural habitats due to watershed development are undoubtedly the greatest threats to amphibian and reptile populations (Harding 1997). Populations have become restricted to smaller habitats making them more vulnerable to mortality and exploitation. Affects of watershed development have favored adaptable species with broad habitat tolerances.

Forty-four species of amphibians and reptiles are believed to inhabit the Flint River watershed (Table 23). Two species (spotted turtle and eastern fox snake) are listed by MNFI as being threatened and two species (Blanchard’s cricket frog and eastern massasauga rattlesnake) are listed of “special concern” (Table 24).

Mammals

The Flint River basin is home to a diverse assemblage of mammals. Many species are highly valued by humans for aesthetics, hunting, and food. Habitat created by watershed plant communities provides essential cover for reproduction and survival. Aquatic environments are important sources of food and water. Watershed development has altered natural habitat, reducing, fragmenting, and degrading it, requiring mammals to adapt to coexistence with humans. Management of game species is necessary to avoid conflicts with humans and maintain balanced assemblages in limited habitat.

Comprehensive studies of Flint River watershed mammals are not available. However, Burt (1957) and Evers (1994) indicate 48 species to range or have ranged the watershed (Table 25). Extirpated Flint River basin species include: river otter, gray wolf, cougar, bobcat, lynx, marten, black bear, woodland caribou, and eastern elk. The marten is a threatened species and eastern elk are extinct in North America.

Other non-indigenous mammals in the watershed are either domesticated or are of special interest to owners. These animals are typically raised in some form of captivity. Many bovine, canine, feline, and equine species are of agricultural and recreational value.

Birds

A variety of birds are found in the Flint River watershed. Successional stages of plant communities provide diverse habitats throughout the watershed. Unique habitats such as bogs, fens, prairies, and forests are important for species diversity and survival. Birds are an integral component of the biodiversity of a watershed. They are important consumers and are a food source for other animal life. Many recreational birders appreciate the aesthetics of their sight and sound. Other bird species have provided hunting opportunities and table fare for humans since early settlement.

Many bird species are directly associated with aquatic environments; other species have an indirect association with them. The Flint River watershed is part of the Mississippi Flyway and is used by migratory waterfowl for nesting, feeding, and resting. The mouth of the Flint River is located in the Shiawassee National Wildlife Refuge, which harbors a diversity of bird species dependent on the aquatic environment. Also, MDNR, Wildlife Division, manages refuges near the South Branch Flint River in the Lapeer State Game Area and Thread Creek in the Holly Recreational Area.

The most comprehensive survey of Michigan breeding birds, the "Atlas Survey", was conducted from 1983 to 1988 (Brewer et al. 1991). Hundreds of birders, professional and volunteer, strategically mapped breeding birds throughout Michigan. The survey listed 233 breeding species for Michigan. A total of 146 breeding bird species were observed in the Flint River watershed (Table 26). Historically, common loon, osprey, bald eagle, king rail, long-eared owl, and passenger pigeon also bred in the watershed but were not observed in the Atlas Survey (Evers 1994). Many non-breeding species also occur. The Genesee Audubon Society lists 116 additional non-breeding bird species observed in the Flint River watershed. (Table 27) (Genesee Audubon Society, unpublished data; Boettner et al. 1983).

Endangered watershed species include short-eared owl, barn owl, piping plover, prairie warbler, loggerhead shrike, and peregrine falcon. Threatened species include common loon, least bittern, bald eagle, osprey, red-shouldered hawk, merlin, common tern, Caspian tern, long-eared owl, and Henslow's sparrow (Tables 24, 26, and 27). The passenger pigeon is extinct.

Other non-indigenous bird species in the watershed are domesticated or are of special interest to owners. These species are typically raised in some form of captivity. A variety of poultry species are of agricultural value. Exotic ducks, rheas, and peacocks are a few types that can be observed throughout the watershed.

Other Natural Features of Concern

The Michigan Natural Features Inventory maintains a list of endangered, threatened, or otherwise significant plant and animal species, plant communities, and other natural features (Table 24). Many of the vascular plants listed are associated with floodplains and the river corridor. Plant communities and geographic features are of concern as watershed development threatens their existence. Features such as bogs, prairie fens, and kames provide unique habitat for many forms of animal life.

Pest Species

Pest species are defined as those species that have been intentionally or accidentally introduced that pose a threat to native species or are exceptionally damaging to economic values. Most species do not pose any threat unless present in high densities.

Pest fish species in the Flint River basin include: sea lamprey, goldfish, round goby, common carp, and white perch. Sea lamprey, goldfish, and round goby are not present in pestilent densities. However, the recent introduction (1998) of round goby into the Flint River basin between Mott and Holloway dams is of concern. Should round goby achieve high density, they have potential to be a competitive threat to native darters (Jude and Smith 1992). Common carp are known for their undesirable affects on aquatic plant and fish communities (see **Factors Affecting Fish Communities**). Nuisance levels of carp are found throughout the Flint River basin. Carp mortalities are often the source of odor complaints after natural or human induced fish kills. White perch use the Lower Flint for spawning and are considered a competitive threat to native yellow perch.

A pest species of mollusk, the zebra mussel, has been documented in both Holloway Reservoir and Mott Lake and has recently been reported in Lake Pleasant, Lapeer County. Zebra mussels spread primarily in their veliger stage, being transported from one body of water to another by boaters with water in their outboard engines or in the boats themselves (Rozich 1998). Zebra mussels attach to any hard surface and can clog water intake pipes. They can become a nuisance on docks and piers and may compete with resident aquatic species that filter algae and zooplankton for food. Zebra mussels also kill native mussel species through suffocation and starvation. The success of zebra mussels is partly attributable to their high fecundity, rapid dispersal, and their lack of competitor and predator species (Rautio 1995). Increased water clarity and macrophyte densities often occur in the presence of high densities of zebra mussels.

There are three principal pest plant species in the Flint River basin: Eurasian milfoil, curly leaf pondweed, and purple loosestrife. Eurasian milfoil and curly leaf pondweed are non-native submergent aquatic plants that have become widespread in many inland lakes. These species can grow in dense canopies that crowd out native plant species, interfere with recreational activities, and reduce habitat quality for other aquatic organisms (Beam and Braunscheidel 1998). Predator fish species become less effective in densely vegetated lakes resulting in an overabundance of small, slow-growing bluegill and low proportions of largemouth bass (Schneider 1993). Purple loosestrife is a non-indigenous plant that has become widespread in Flint River basin wetlands. Humans have valued its ornamental flower for landscaping and gardening. Seed dispersal by wind, flowing water, and animals has resulted in its spread. Purple loosestrife, which is of lesser value to wildlife, will out-compete native plants for space.

Other pest species in the Flint River watershed include gypsy moth, spruce budworm, forest tent caterpillar, mosquitoes, horse and deer flies, and sometimes mute swan, Canada geese, deer, beaver, muskrat, raccoon, skunk, Norway rat, and mouse and mole species.

Fisheries Management

MDNR, Fisheries Division management of the Flint River basin dates back to the 1920s. Management to improve the recreational fishery have been vigorous at times, generally concentrating on isolated areas or tributaries. The entire watershed is subject to fishing regulations, as contained in law. Laws and regulations are forms of fisheries management aimed at protecting, preserving, and enhancing a fishery resource. Below is discussed, historical and current fisheries management of the watershed using valley segment boundaries identified in this report. Emphasis is placed on historical and current fisheries management, fisheries management limitations, and potential fisheries enhancement.

Upper South Branch Flint River

Fisheries management of the upper South Branch Flint River concentrated on establishing and maintaining a recreational trout fishery from 1921 to 1990, by maintenance stocking. From 1921 to 1971, there was periodic stocking of brown, rainbow, and brook trout. In 1971, the upper South Branch Flint River was included in a fisheries rehabilitation project to eradicate dominant carp populations upstream of Holloway Reservoir. This project used the fish piscicide rotenone to eradicate all fish species from the upper Flint and was followed with stockings of brown trout, rainbow trout, and smallmouth bass. In the mid-1970s, management direction shifted to brown trout-only. Stream parameters were inadequate for trout reproduction and the fishery was entirely dependent on stocking. The South Branch Flint River, upstream of Winns Pond, was classified as a designated trout stream and annual stocking continued until 1990.

In 1991, brown trout stocking was discontinued in the South Branch Flint River due to marginal survival and restricted public access to the fishery. Predator and competing fish species had become more abundant negatively affecting trout survival. Also, private landowners were increasingly restrictive toward allowing public access to the river (see **Special Jurisdictions, Navigability**). There has been no fisheries management on the upper South Branch Flint River since 1990. It maintains high species richness, but sizeable sport fish are not abundant due to the small size and shallow depth of the stream. Angling opportunities exist for sucker species, rock bass, and occasionally northern pike, however, angling pressure is light. Winns Pond (impoundment) supports a warmwater fish community with good opportunities for largemouth bass, bluegill, and northern pike.

Horseshoe Lake is the principal inland water body in this segment with public access. This 15-acre lake was stocked with rainbow trout during the 1950s and 1960s but has since been converted to a warmwater fishery with a good angling reputation for bluegill and largemouth bass. State owned land, available on the west shore, is undeveloped wetland and only accessible to walk-in anglers. No fisheries management has occurred on Horseshoe Lake since the mid-1960s.

Fisheries enhancement is not necessary in this segment. Stream suitability for trout management is marginal and public access remains restricted. Water quality is good and fish species richness is high. Continued development of the watershed will probably impose negative affects on the river and its fishery. Measures to preserve existing conditions rely on fundamental land use practices that minimize stream degradation.

Middle South Branch Flint River

Fisheries management of the middle South Branch Flint River and Farmers Creek included fish reclamation eradicating dominant carp populations with rotenone treatments in 1971 and 1976. After the 1976 eradication, brown trout were stocked annually until 1979 to provide an interim fishery. No fish stocking or fisheries management has occurred since 1979.

Hunters, Kintz, and Pine creeks, tributaries to the middle South Branch Flint River were stocked and managed for brook trout from the mid-1920s until the late 1960s. A remnant self-sustaining brook trout population exists in the upper reach of Pine Creek. No fisheries management has been done on tributaries to the middle South Branch Flint River since 1982.

Active fisheries management occurs on several inland lakes in this segment having public access. Lake Nepessing, Long Lake Impoundment, and Twin, Cedar, Watts, Duperow, and Fish lakes support warmwater fisheries with bluegill and largemouth bass as the principal sport fish. Lake Nepessing is managed for walleye. In 1986, the fishery of Long Lake Impoundment was reclaimed using rotenone. An estimated 22.3 tons of carps were removed. Post-reclamation fish stocking included channel catfish, largemouth bass, pumpkinseed sunfish, black crappie, and northern muskellunge. Natural reproduction of northern muskellunge did not occur and their management was discontinued. Redear sunfish have recently been introduced to Twin, Cedar, Watts, and Duperow lakes to enhance the recreational fishery (Table 14).

Fisheries management of the middle South Branch Flint River and its tributaries is limited by low base flow, unstable flow, insufficient water depth to support adult fish, habitat loss resulting from dredging and channelization, reduced water quality from nutrient and sediment loading, and restricted public access. Without fundamental changes in land uses in the watershed and improved public access, potential fisheries enhancement is limited. Land development should be discouraged or controlled to preserve the integrity of upper Pine Creek and other headwater tributaries.

Lower South Branch Flint River

Fisheries management of the lower South Branch and North Branch Flint rivers included fish reclamation by eradicating dominant carp populations with rotenone treatments in 1971 and 1976. After the 1976 eradication, smallmouth bass, walleye, and channel catfish were stocked. No fish stocking or fisheries management has occurred since 1982. Presently, some angling opportunities exist for white sucker, northern pike, and channel catfish. Carp are abundant.

Fisheries management of the lower South Branch Flint River and its tributaries is limited by unstable flow, habitat loss from dredging, channelization, bank scouring, and reduced water quality from nutrient and sediment loading. Many logjams impede flow and prevent boat navigation further reducing angling opportunities. Enhancement of the present fishery could be accomplished by the strategic removal of logjams allowing navigation but yet preserving fish cover. Management to eradicate an abundant carp population would be costly and would only have short-term benefits. Other potential fishery enhancement relies on fundamental changes in land use practices that minimize stream degradation.

Upper Flint River

The most aggressive fish management of the entire river system has occurred in Holloway Reservoir and Mott Lake (impoundment). No fisheries management has occurred on Hamilton Impoundment. In 1971, a fish reclamation project using rotenone removed an estimated 420 tons of carp upstream from Holloway Dam (MDNR, Fisheries Division). By 1976, carp had re-established themselves to a noxious level and another fish reclamation project using rotenone removed an estimated 18 tons of carp upstream of Mott Dam (MDNR, Fisheries Division). Post-reclamation stocking included largemouth bass, bluegill, black crappie, channel catfish, northern pike, walleye, tiger muskellunge, pumpkinseed sunfish, and fathead minnow.

Recent fisheries management of Holloway Reservoir and Mott Lake has focused on maintaining diverse warmwater fish communities with walleye, smallmouth bass, channel catfish, and black crappie as principal sport fish. Channel catfish stocking was discontinued in 1979 when natural reproduction appeared sufficient to maintain the fishery. Tiger muskellunge stocking was discontinued in 1991 when hatchery production ceased and no other source was available. Walleye stocking was discontinued in 1992 when natural reproduction was providing a self-sustaining fishery.

In 1986, a fish habitat improvement project submerged over fifty pallet-sized brush shelters off the north shore of Goose Point in Holloway Reservoir. Anglers have reported increased black crappie harvest around these shelters (Leonardi, MDNR, Fisheries Division, personal communication).

Active fisheries management on Holloway Reservoir is limited to evaluating affects of catch-release bass fishing before season closure. There is no active fisheries management on Mott Lake or Hamilton Impoundment. Recent assessments have found healthy and self-sustaining walleye and channel catfish fisheries in Holloway Reservoir and Mott Lake (MDNR, Fisheries Division). Smallmouth bass and northern pike occur in lesser abundance but still offer good recreational fishing opportunities. For reasons unclear, declining panfish communities are being observed in both water bodies (see **Biological Communities, Present Fish Communities**). Hamilton Impoundment offers good angling opportunities for smallmouth bass, channel catfish, rock bass, white sucker, and black crappie.

Fisheries enhancement of Holloway Reservoir must consider the needs and concerns of the city of Flint and the Genesee County Parks and Recreation Commission. Each party, including the State, has vested interest in the reservoir. The city of Flint owns and operates Holloway Dam, which controls reservoir water levels. Reservoir water levels are adjusted in accordance with the city of Flint's NPDES permit for flow augmentation, a four-foot winter drawdown, and for maintenance needs. The Genesee County Parks and Recreation Commission leases land from the city of Flint for recreational use. The fishery is of public domain and is entrusted to MDNR, Fisheries Division for preservation and enhancement. Presently, management of Holloway Reservoir is outlined in the Holloway Reservoir Management Plan developed by the city of Flint and the Genesee County Parks and Recreation Commission. However, this plan fails to address fisheries management concerns. Rehabilitation of the panfish fishery requires further investigation to determine causes of its decline. Erosion control using riprap has potential for fishery enhancement, particularly with the smallmouth bass fishery. Enhancement of the northern pike fishery is possible through rehabilitative stocking and spring water level adjustment to increase spawning area in the reservoir.

Fisheries enhancement of Mott Lake involves addressing the same concerns as Holloway Reservoir. The State, city of Flint, and Genesee County Parks and Recreation Commission each have interests. Mott Dam is operated by the Genesee County Parks and Recreation Committee and is kept at fixed elevation. The proximity of Mott Lake to Holloway Reservoir is such that management of Holloway Reservoir has influence on Mott Lake. Rehabilitation of the panfish community requires further investigation. Erosion control measures could also serve to benefit the smallmouth bass fishery.

River reaches between Holloway Reservoir, Mott Lake, and Hamilton Impoundment offer fair angling opportunities for smallmouth bass, white sucker, channel catfish, and northern pike. Fisheries enhancement will result from improved water quality and flow stabilization. Improvement in water quality and flow stabilization relies on fundamental changes in land use practices that minimize stream degradation.

Kearsley and Thread creeks are the principal tributaries in this segment with a history of fisheries management. Stream fragmentation created by dams on both creeks results in different fisheries management strategies for different areas. The upper reaches of both creeks are managed for coldwater fish species. The lower reaches, and the impoundments created by dams, are managed for warmwater fish species.

Fisheries management on upper Kearsley Creek has concentrated on establishing and maintaining a trout fishery since 1948. Periodic stocking of rainbow and brown trout occurred until the 1960s when management shifted to brown trout-only. In 1978, a fish reclamation project using rotenone was conducted and annual yearling brown trout stocking continued. In 1994, trout stocking downstream of M-15 was discontinued due to poor survival. Now, trout waters of Kearsley Creek are located upstream of Goodrich Mill Pond to the dam on Lake Louise. In 1999, the number of yearling brown trout stocked was reduced 40%, however, average size of stocked fish was increased one inch (Table 14). Evaluation of stocking reduced trout numbers at a larger size is in progress.

Fisheries management of lower Kearsley Creek has occurred on Kearsley Reservoir. Management has concentrated on maintaining a warmwater fish community. In 1978, a fish reclamation project using rotenone was conducted. Post-reclamation stocking included largemouth bass, tiger muskellunge, walleye, northern pike, bluegill, smallmouth bass, and channel catfish. No fish stocking or management has occurred since 1982. In 1999, Kearsley Reservoir was inadvertently lowered to original stream level. Fishery rehabilitation and enhancement are currently being investigated (J. Leonardi, MDNR, Fisheries Division, personal communication).

Lake Louise, Goodrich Mill Pond, and Atlas Mill Pond (impoundments of Kearsley Creek) each support warmwater fish communities. Principal sport fish include bluegill, black crappie, northern pike, and largemouth bass. No fisheries management has occurred on these impoundments.

The upper reach of Thread Creek has been managed for brown trout since 1961. In 1977, a fish reclamation project using rotenone was conducted, followed by annual stocking of brown trout. Trout waters of Thread Creek are located upstream of Bristol Road. Annual trout stocking is prescribed until 2001. An evaluation of the trout fishery will determine future fisheries management.

Fisheries management of lower Thread Creek has occurred on Thread Lake (impoundment). In 1977, a fish reclamation project using rotenone was conducted. Thread Lake was lowered and an estimated 3.4 tons of carp were removed from the stream. Post-reclamation fish stocking included channel catfish, largemouth bass, black crappie, bluegill, and brown trout. Brown trout were stocked to provide an interim fishery. No fish stocking or management has occurred since 1981. The most recent fisheries assessment of Thread Lake (1988) indicates abundant carp and satisfactory black crappie, largemouth bass, northern pike, and channel catfish fisheries (MDNR, Fisheries Division).

Trout management in upper Kearsley and upper Thread creeks is limited due to marginal stream suitability for coldwater species. Low base flow, a marginal water temperature regime, and insufficient habitat in the form of runs, pools, and spawning substrate require stocking to maintain a fishery. Trout survival in Kearsley Creek has consistently been higher than in Thread Creek, however, yearly fluctuations in trout abundance are experienced in both creeks (MDNR, Fisheries Division). Restricted public access also limits trout management (see **Special Jurisdictions, Navigability**).

Unstable flow, plus nutrient and sediment loading limit fisheries enhancement of lower Kearsley and lower Thread creeks. Abundant carp populations contribute to water turbidity and reduce aquatic vegetation, which provides critical fish habitat. Fisheries enhancement relies on fundamental changes in land use practices that minimize stream degradation.

Other tributaries in this valley segment do not have fisheries management histories. Low base flow limits presence of adult sport fish. However, spawning fish often ascend these tributaries and offer some angling opportunities.

Middle and Lower Flint River

Historical fisheries management of the middle and lower Flint River is limited to an attempt at establishing potamodromous runs of chinook and coho salmon. Chinook and coho salmon were stocked annually from 1979 to 1982. Salmon stocking was discontinued due to marginal success at establishing a fishery. Fisheries assessments in the late 1980s and early 1990s began examining a building walleye fishery. In 1998, a three-year tagging study was implemented to determine walleye status in the middle and lower Flint River. This study has revealed the middle and lower Flint River support a significant potamodromous run of walleye from Saginaw Bay (see **Biological Communities, Present Fish Communities**). This run of walleye now supports an important recreational fishery before season closure.

Good riverine fishing for suckers and smallmouth bass can be found throughout the middle and lower Flint River. Northern pike and rock bass fisheries also offer angling opportunities. Walleye are still an integral part of the fishery. However, the abundance of walleye that inhabit the river year round is significantly less than the potamodromous run (Leonardi, personal observation). Occasional catches of Lake Huron origin brown trout, steelhead, and chinook salmon occur. Carp are abundant. No information on the fishery at the mouth of the Flint River is available. No fisheries management occurs on tributaries.

Low base flow, unstable flow, reduced water quality, stream habitat loss, and restricted public access limit fisheries management of the middle and lower Flint. Fisheries enhancement relies on changes in fundamental land use practices that minimize stream degradation and improve access.

Recreational Uses

The Flint River watershed offers a variety of water-based recreational uses. Opportunities for hunting, fishing, swimming, camping, picnicking, boating, and wildlife viewing exist at various locations. However, limited public access, unstable flow, and public conscience of polluted water hinder potential recreational use of the Flint River.

From 1929 to 1964, conservation officers recorded catch and effort data from anglers at several locations in the watershed (Appendix 4). Records indicate preferred fish species sought by anglers. However, access to the river and its tributaries was probably greater than what exists today. Stocked brook trout in Pine and Hunters creeks provided opportunities for cold water species. Northern pike, black crappie, bluegill, and sucker species were commonly sought after in the warm water thermal habitats throughout the watershed.

Most land within the watershed is under private or corporate ownership. Large tracts of land protected for public recreational use include the Ortonville Recreation Area, Metamora-Hadley Recreation Area, Holly Recreation Area, Seven Lakes State Park, Lapeer State Game Area, Holloway Reservoir Regional Park, Genesee Recreation Area, Flushing County Park, and the Shiawassee National Wildlife Refuge (Figure 25). Also, a number of small parks and nature areas are maintained by local government units offering recreational use. Outdoor educational facilities within the watershed include the Seven Ponds Nature Center and For-Mar Nature Preserve and Arboretum (Figure 25).

Recreational navigation on the Flint River is affected by flow. Hydrological characteristics of the Flint River indicate low base flow and a flashy flow regime (see **Hydrology**). Average water depths, at base flow, are typically too shallow for large watercraft navigation. High flow currents add difficulty to navigation and maneuverings of smaller watercraft. High flow currents can also pose safety risks for activities on or near the river.

Public conscience of historical water quality problems in the Flint River further inhibits recreational use. Although water quality has improved since the 1970s, there remains a public mistrust of the river's safety. Human health risks of the river need to be continually monitored and conveyed to the public to satisfy this mistrust.

Boating and Canoeing

There are 19 public boat launches in the Flint River watershed (Figure 26.). Boating activities that require launches with enough water depths for safe operation are limited to inland lakes and the three principal impoundments of the river; Holloway Reservoir, Mott Lake, and Hamilton Impoundment. Barrier free launch facilities are provided at Lake Nepessing, Big Fish, Heron, Big Seven, and Dickinson lakes, and at Holloway Reservoir, Mott Lake, and Hamilton Impoundment.

The Flint River is canoeable from Lapeer downstream. However, the South and North branches are subject to low flow, insufficient water depth, logjams, and noxious insects during certain times of the year. A number of access sites are available for canoeing downstream of Columbiaville (Figure 27). A complete canoe guide from Holloway Dam downstream to Flushing is available on the Internet (Carter et al. 1997).

Recreational fishing by valley segment

Upper South Branch River

This segment receives light angler pressure due to limited access and low abundance of sport fish. State owned land on Horseshoe Lake is undeveloped and offers walk-in only access. No public access to the river proper exists. Trout management in this segment was discontinued, due in part, to illegal trespass by anglers. If landowner permission is granted, this segment provides some angling opportunities for sucker species, rock bass, creek chubs, and an occasional northern pike.

Middle South Branch River

Angler pressure is light in this segment due to limited public access and low abundance of sport fish. River access is limited to a few multi-use parks in Lapeer that do not offer sport fish opportunities. Most angling is on Lake Minnewana in the Metamora-Hadley Recreation Area or on Lake Nepessing. Lake Minnewana, Big Fish and Davidson lakes, and Lake Nepessing provide good angling for warmwater sport fish including bluegill, pumpkinseed sunfish, black crappie, largemouth bass, and northern pike. Also, walleye are stocked in Lake Nepessing and contribute to the sport fishery. Recreational boating on Lake Nepessing can conflict with angler use.

Lower South Branch River

Angler pressure increases slightly in this segment due to increased public access. However, navigation on the lower reaches of the North and South Branch Flint rivers is prevented by logjams reducing angling opportunity from small watercraft. Sport fish are not in abundance in the river proper, but opportunities for rock bass, channel catfish, and an occasional northern pike or smallmouth bass exist.

Most angler pressure is on the inland lakes of the Lapeer State Game Area. Long Lake, the largest of the lakes, is protected for wildlife refuge and is open to the public beginning the weekend before July 4 until Labor Day; closed Labor Day to January 1; and open from January 1 to ice out. Gas powered watercraft are prohibited on Long Lake. Angling on Long Lake concentrates on largemouth bass, northern pike, bluegill, black crappie, and channel catfish fisheries. Duperow, Cedar, Watts, Fish, and Twin lakes have small boat access and offer angling opportunities for largemouth bass, redear sunfish, bluegill, and pumpkinseed sunfish.

Upper Flint River

Angler pressure increases significantly in this segment. Holloway Reservoir, Mott Lake, and Hamilton Impoundment have paved boat launches that allow for moderate sized watercraft and each have several locations allowing for shore fishing (Figure 25 and 27). Each of these water bodies offers angling opportunities for walleye, channel catfish, black crappie, northern pike, smallmouth bass, and sucker species.

The cool water designated reaches of Kearsley and Thread creeks are stocked annually with brown trout by MDNR, Fisheries Division (Figure 18). The trout fisheries in these reaches are considered marginal for trout and survival often fluctuates from good to poor. Anglers typically wade the creeks or fish from shore. Public access on both creeks is limited restricting angling to those who receive land owner permission. Narrin Park provides legal access to Kearsley Creek however trout habitat is poor in the immediate vicinity (Figure 25).

Although boat access in not available, anglers often fish Kearsley Reservoir and Thread Lake from shore. These two water bodies have similar fish communities and offer angling opportunities for northern pike, largemouth bass, black crappie, channel catfish, and sucker species.

Most angling opportunities on inland lakes are in the Holly Recreation Area and Seven Lakes State Park (Figure 25). Wildwood, Valley, Heron, Crotched, Big Seven, and Dickinson lakes offer angling opportunities for a variety of warmwater sport fish. Also, walleye are stocked in Heron Lake and redear sunfish have been stocked in Crotched and Dickinson lakes contributing to the sport fishery.

Middle and Lower Flint River

Most angler pressure in this segment is directed at walleye, smallmouth bass, and sucker species. Public access here is limited however, the river is canoeable (Figure 25 and 27). During spring, angling targets spawning runs of walleye, northern pike, and sucker species. During summer, most angling is directed at the smallmouth bass and sucker fisheries. During fall, walleye again ascend the river and provide angling opportunity. There are no inland lakes with public access.

Citizen Involvement

The Flint River Watershed Coalition (FRWC) was formed in 1997 and is a collaboration between: University of Michigan-Flint, Kettering University, and Michigan State University, the city of Flint, Genesee County Government, General Motors, MDEQ, MDNR, concerned citizens, local businesses, and environmental groups who feel strongly that the Flint River and its tributaries are a vital resource needing protection from pollution. The coalition promotes the appropriate use of the watershed through education, research, technical assistance, and coordination.

The goals of the FWRC are to educate the public about water quality and ecosystem protection; promote involvement of citizens, governments, organizations and businesses to protect land and water resources of the watershed; collect scientific data on the river and develop key information to further protect area streams, lakes, wetlands, groundwater, and the river.

Using grant monies, the FWRC has held conferences discussing watershed issues, funded volunteer monitoring of benthic macroinvertebrates, conducted river cleanup events, provided trash containers to commonly frequented areas, and has posted signs identifying the watershed throughout Genesee and Lapeer counties. Now, the FRWC has identified the Swartz Creek sub-watershed for intensified monitoring. The FRWC printed its first newsletter, “Flint River Focus”, in 1999 and maintains an internet web site (<http:www.flintriver.org>).

The Saginaw Bay Watershed Initiative Network (WIN), formed in 1996, is a collaborative effort of communities, conservationists, farmers, foundations, and businesses to establish a partnership to enhance the Saginaw Bay watershed. Saginaw Bay WIN is active in identifying issues, prioritizing, and implementing projects which promote sustainable communities; balancing economic, environmental, and social priorities to enhance the quality of life for current and future generations.

The Flint River Valley Steelheaders, Greater Flint Muddler Minnows, Lake Nepessing Bass Club, and Michigan B.A.S.S. Chapter Federation are organizations that promote and educate citizens on recreational angling in the watershed. These organizations actively teach the value of recreational angling to youth groups. Also, each group is active with many local charities and community events.

Several other organizations work on aspects of the Flint River (Table 28). These organizations are largely associated with fishing, hunting, and recreation. There is significant interest from outside the Flint River watershed from groups who recognize the role the Flint River plays as a component of the Saginaw Bay watershed. Also, most local units of government have parks and recreation units, councils, and Chambers of Commerce, which are involved in promoting the river resource.

MANAGEMENT OPTIONS

The Flint River system is an "impacted river system". Human development and manipulation has had significant effects on how the system functions, on water quality, and on the aquatic community. This interference dates back to when European settlers moved into the area and before Michigan received statehood. The management options recommended below follow the recommendations of Dewberry (1992) and Alexander et al. (1995). These authors stress protection and restoration of headwater areas, riparian areas, and flood plains. River systems must be viewed as a whole as many important elements of aquatic habitat are determined by the functioning of the system in its entirety.

The options listed below are consistent with the Mission Statement of MDNR, Fisheries Division, i.e. to protect and enhance the public trust in populations and habitat of fishes and other forms of aquatic life, and promote optimum use of these resources for the benefit of the people of Michigan and future generations. Fisheries Division seeks to: protect and maintain healthy aquatic environments and fish communities and rehabilitate those now degraded; provide diverse public fishing opportunities to maximize the value to anglers; and foster and contribute to public and scientific understanding of fish, fishing, and fishery management. The management options listed below are organized according to the sections in this assessment. The options listed are not necessarily recommended by MDNR, Fisheries Division. They are intended to provide groundwork for public discussion and comment.

Geology and Hydrology

The Flint River system is characterized as being relatively stable in the upper two South Branch Flint River segments and unstable and event responsive in the mainstem segments. These extreme differences are due to topography, soils, and watershed development. Accomplishment of options in this section will have significant affects on the functioning of this system and the quality of aquatic habitat.

Option: Protect stable cold and cool water streams from land use practices (channelization, damming, wetland draining, and converting natural soil surfaces to impervious surfaces) that will destroy these qualities.

Option: Protect remaining wetlands from draining and conversion to other uses such as agricultural, residential, industrial, and golf courses. Work with agriculture agencies and groups to implement best management practices to protect wetlands.

Option: Rehabilitate destroyed wetlands by plugging tiled and open drains on marginal agriculture land and allow re-establishment of natural vegetation.

Option: Protect existing undeveloped floodplains from channelization, development, and damming thus allowing them to continue to function naturally.

Option: Rehabilitate floodplains by removing buildings, dams, and road crossings that interfere with their natural function. Explore alternatives to channelization to allow streams to re-establish a natural streambed and water course. Work toward zoning requirements that prevent development in floodplains.

Option: Protect natural lakes and lake outlets from artificial regulation with lake-level control structures. This will protect the natural lake level cycles, protect the contiguous wetlands, and insure natural flows in outlet streams.

Option: Operate lake-level control structures as fixed crest with bottom draw discharge to restore natural lake level cycles, minimize temperature alteration of downstream waters, and rehabilitate contiguous wetlands.

Option: Restore flow stability by working with drain commissioners to include flow patterns in drain design and require dams to be operated in run-of-river mode with fixed crests.

Soils and Land Use Patterns

Many land use practices result in loss of important riparian features that cause degradation of a river resource. Loss of wetlands, converting permeable soil surfaces to impervious surfaces, constructing land drainage systems, converting agricultural lands to urban and industrial uses, and destroying the naturally forested areas along the river corridor all negatively effect a resource.

Option: Protect natural areas by working with local governments and planners, zoning boards, agricultural agencies, and groups to implement best management practices.

Option: Protect remaining wetlands, especially the small "unregulated" wetlands, by working with local governments and planners, zoning boards, agricultural agencies, and groups.

Option: Seek legislation on land use to control urban sprawl and "industrial development" on rural lands to preserve the functionality of the watershed.

Option: Support enforcement of soil sedimentation and erosion laws to protect productivity of land and prevent siltation of instream aquatic habitat.

Option: Purchase flooding rights within the flood plain to allow the river system to function naturally.

Option: Protect and rehabilitate forested river corridors to retain critical habitats and natural sources of woody structure to the river.

Channel Morphology

Changes in channel morphology are the direct result of human activities such as draining, damming, road and road crossing construction, interruption of woody structure transport, interruption of sediment and nutrient transport, and removal of natural vegetation. The following recommendations will help to protect and rehabilitate instream channel morphology:

Option: Work with drain commissioners to discontinue the practice of ditching and directing unwanted surface water directly into the waterway. Encourage water diversion into natural wetlands and retention areas to facilitate groundwater recharge.

Option: Work with drain commissioners and others to retain large woody structure in the stream channel and provide incentives to land owners to retain, protect, and rehabilitate forested riparian areas.

Option: Restore critical high gradient stream areas by working with local government agencies and dam owners to remove unwanted, unprofitable, and high liability dams. Support State and Federal funds for dam removals.

Option: Promote and support implementation of best management practices by the agricultural and urban communities to reduce inflows of nutrients and sediment to the river. Develop green belts along all waterways.

Option: Survey enough reaches within each valley segment to provide the necessary data to develop channel morphology standards to restore high quality instream habitat.

Dams and Barriers

Dams and barriers fragment a river system by blocking migrations of fish and aquatic organisms, cause erosion at the dam sites, trap downstream movement of sediment and nutrients, impede downstream transport of woody structure, inundate critical high gradient habitat, inundate riparian wetlands, eliminate stream habitat at lake outlets, and alter flow and temperature regimes within the system. They interfere with recreational activities, and may create a dangerous hazard.

Option: Reconnect fragmented river reaches and rehabilitate high gradient reaches by working with government units and dam owners to remove deteriorating dams, high risk dams, and those no longer serving their original purpose and are no longer profitable. Specifically, support removal of Winns Pond, Bottom Creek, Lake Louise, Goodrich Mill Pond, Atlas Mill Pond, Thread Lake, Utah, Hamilton, and Fiber dams.

Option: Protect re-established floodplains created by dam removal from development. Re-establish natural vegetation in these areas by seeding and by allowing natural processes to occur.

Option: Update and use the MDEQ, Dams Safety Unit inventory to identify and target potential dam and lake-level control structure removal. Make use of global positioning and global information systems to map dams and water control structure locations in the watershed.

Option: Seek legislation requiring dam owners to establish funds to finance removal of dams when it becomes appropriate.

Option: Work with lake owner groups to remove lake-level control structures to allow lakes to function naturally. If the control structure cannot be removed, operate the control structures at a fixed crest to allow natural stream flow and fluctuation. Use bottom draw engineering on dams and control structures to minimize temperature alterations downstream.

Option: Actively oppose development of hydroelectric facilities within the Flint River basin, especially on the existing Mott and Holloway dams. If hydroelectric development cannot be avoided the Department should forcefully pursue mitigation of all project effects on the resource.

Bridges and Other Crossings

The numerous bridges and other crossings in the Flint River basin have many of the same effects as dams. They block upstream movements of fish and aquatic organisms, cause erosion, destroy high gradient areas, impede woody structure transport, and deposit large quantities of sediment in the stream. They interfere with recreational activities and degrade sport fish habitat.

Option: Reconnect fragmented riverine habitat by working with road commissions to replace perched culverts that block movement of fish and aquatic organisms, woody structure, and sediment with structures that allow preservation of the natural stream bottom.

Option: Work with MDEQ and citizen groups to conduct stream crossing surveys to identify sources of pollutants in the watershed. Specifically, eliminate road crossing discharges in Kearsley Creek in the Brandon area.

Option: Work with county road commissioners to install bridges that span the entire flood way without placing supporting structures in the floodway.

Option: Work with county road commissioners to prevent erosion by stabilizing road surfaces and embankments and by diverting surface water runoff to retention areas for sediment and contaminant deposition. Maintain retention areas by cleaning and transporting undesirable sediments and nutrients to appropriate locations away from the floodplain.

Option: Increase groundwater recharge by directing roadway run-off into wetlands and retention areas.

Special Jurisdictions

County drain commissions have authority over designated county drains and many lake-level control structures. Township and city officials control zoning and ordinances. MDEQ, Land and Water Management Division regulates construction of stream crossings, dredging and filling, and re-routing of streams. Public ownership and management of land in the Flint River watershed is minimal.

Option: Continue to advocate and work toward legislative adoption of the recreational definition of navigability (a stream is legally navigable if it can be navigated by canoe or small boat).

Option: Protect and rehabilitate the river system by supporting cooperative planning and decision making among all involved levels of government.

Option: Rehabilitate designated county drains to natural stream status where designation as a drain is no longer appropriate. Encourage drain commissioners to use stream management practices that protect and rehabilitate natural processes rather than traditional practices of straightening, deepening, widening, and enclosing natural streams. Accelerated land drainage has negative effects on the aquatic resource and is no longer environmentally acceptable.

Option: Protect the quality of wetlands, streams, and lakes through rigorous enforcement of Parts 31, 91, 301, and 303 of the NREPA Act of 1994.

Option: Survey and identify river reaches for natural rivers designation. The upper South Branch Flint River and upper Kearsley Creek should be considered for designation.

Water Quality

Flint River water quality has improved since the 1970s after years of neglect and abuse. Future improvements are hampered due to unstable flow, which exacerbates pollution transport via surface water runoff. However, several options are available to protect and rehabilitate Flint River water quality minimizing the effects caused by humans.

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

Option: Recommend MDNR and MDEQ develop a strategic plan, using public involvement, for future inventory and monitoring of Water Quality Standards in the Flint River watershed.

Option: Identify and map point source discharges in the watershed using advanced technology including global positioning systems and global information systems.

Option: Protect and rehabilitate water quality by effective use of regulatory tools (enforcement) available to MDNR and MDEQ.

Option: Support funding and programs directed at upgrading water quality improvements of municipal waste water treatment facilities.

Option: Continue to develop regulatory rules requiring reporting of accidental spills or discharges in the watershed.

Option: Produce and distribute an annual report of unintentional pollution discharge occurrences in the watershed.

Option: Protect and rehabilitate water quality by continuing to improve pollution prevention for storm water discharge of regulated industrial sources.

Option: Protect and rehabilitate water quality by identifying non-regulated sources of storm water discharge and implement regulatory controls on discharges.

Option: Encourage communities to implement street cleaning practices to reduce contributions of refuse, sediment, and pollutants to the river.

Option: Develop a strategic plan to identify sources of bacterial contamination in the watershed. Implement corrective actions to minimize bacterial contamination.

Option: Support legislative actions and State and Federal funding to require inspections of municipal sewer transport lines to assure they are supporting their function.

Option: Identify illegal sewer connections and failing septic fields in the watershed and implement corrective actions. Potential funding available from Clean Michigan Incentive program.

Option: Protect water quality by conservation of existing wetlands and riparian corridors, rehabilitating former wetlands, and maximizing use of constructed wetlands for water storage and as natural filters of sediment, phosphorus, and nitrogen.

Biological Communities

The biological communities of the Flint River have improved significantly since the 1970s with water quality improvements. Continued efforts to improve water quality will most probably result in greater biological integrity throughout the watershed. Although 77 species of fish remain present, at least 4 fish species that once used the Flint River for spawning (lake sturgeon, muskellunge, lake trout, lake herring, lake whitefish) are believed extirpated from the river. The status of 8 other fish species remains unknown (Table 14). Present day biological communities must adapt to human alteration of the watershed. The geological and hydrological characteristics of the watershed and the development of an extensive drainage system result in unstable flow and reduced habitat and only biological communities that can adapt will persist. A number of management options are available to minimize stream degradation and preserve biological integrity in the watershed.

Option: Develop and coordinate a strategic plan for future monitoring of biological communities in key locations with MDEQ Water Quality Standards monitoring program. Include inland lake sampling in the strategic plan.

Option: Identify and map biological community distributions in the watershed using advanced technology including global position and global information systems.

Option: Survey to determine status of unknown fish species with historical occurrence in the watershed.

Option: Preserve remaining stream margin habitats, including floodplains and wetlands, by encouraging vegetation buffer strips in zoning regulations. Control development in the stream corridor by acquiring additional greenbelts through agricultural set aside programs, conservation easements, or direct purchases from private landowners.

Option: Protect and rehabilitate cold and cool water thermal habitat areas and their unique biological communities including the upper South Branch, Gravel, Bottom, Duck, and upper Kearsley and Thread creeks.

Option: Seek legislative changes in the Drain Code that will allow restoration and rehabilitation of aquatic habitat lost from channelization.

Option: Survey distribution and status of species of concern and develop protection and recovery strategies for those species and explore options to protect critical habitat.

Option: Identify geological formations in the watershed with good groundwater inflow and their related biological communities, as “of special concern” with Natural Features Inventory.

Option: Identify longnose dace, mottled sculpin, and brook trout as fish species "of special concern" in the watershed.

Option: In cooperation with the city of Flint and the Genesee County Parks and Recreation Commission, develop resource management plans for Holloway Reservoir, Mott Lake, and Hamilton Impoundment.

Option: Identify spawning locations of Holloway Reservoir, Mott Lake, and Hamilton Impoundment walleye. Protect and rehabilitate these areas.

Option: Survey walleye emigration from Holloway Reservoir, Mott Lake, and Hamilton Impoundment and its contributions to the spring walleye run from Saginaw Bay.

Option: Survey smallmouth bass abundance and recruitment downstream of Flint.

Option: Preserve the integrity of natural rock-gravel habitat downstream of Hamilton Dam to Montrose which has been identified as a principal spawning area for Saginaw Bay walleye and other Flint River fish species.

Option: Determine the magnitude of natural reproduction of walleye in the mainstem downstream of Hamilton Dam.

Option: Survey biological communities in waters lacking data (e.g., lower Flint River, Swartz and Misteguay creeks, and other small headwater tributaries).

Option: Survey distribution and status of mussel populations and develop strategies for protection and recovery of these species.

Option: Survey distribution and status of reptiles and amphibians and develop strategies for protection.

Option: Survey and monitor distribution of exotic species in the watershed and affects caused by them.

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

Fisheries Management

Fisheries management of the Flint River basin is limited by its relatively small size, unstable flow regime, large number of designated drains, degraded water quality, fish contaminants, few cold or cool water thermal habitats, restricted public access, and insufficient staffing of trained personnel to address management options.

The Flint River watershed is relatively small compared to others in Michigan. Most of the Flint River is inaccessible to large watercraft limiting public angling to smaller vessels, shore fishing, or wadable stream reaches. Most inland lakes in the watershed are under private ownership restricting public access and MDNR, Fisheries Division management.

The unstable flow regime of the Flint River limits the ability of fish managers to enhance sport fish populations. Erosion caused by unstable flow has greatly reduced sport fish habitat by scouring stream banks and increasing sedimentation in the river. During low flow periods, fish habitat is reduced due to low base flow further limiting sport fish enhancement. Unstable flow is worsened by extensive drainage systems created by humans for watershed land development. Critical fish habitat has been lost to channelization of the Flint River and tributaries.

Biological communities and sport fish populations will improve with water quality improvements. Controlling point source and nonpoint source pollution is critical to improvements in the sport fish populations and their habitat. Improved water quality will allow for greater and safer public use of the aquatic resource.

Few cold or cool water thermal habitats exist in the watershed limiting fisheries management for cold or cool water sport fish (Figure 26). Protection and rehabilitation of these habitats is essential for future cold or cool water fisheries management. Most thermal habitat of the Flint River is warm water and fisheries management is for warmwater sport fish.

Limited public access to the river affects fisheries management. To effectively manage a water body for sport fish, MDNR, Fisheries Division requires access for management purposes including inventorying and habitat rehabilitation. Now, much of the watershed is under private or corporate ownership and access is not readily available. Land acquisition for public access will ensure more effective fisheries management of the sport fish communities.

Staffing of MDNR, Fisheries Division professional and technical personnel is greatly reduced from the past. This limits the availability of trained personnel to conduct surveys and implement fisheries management options for the watershed. Fisheries Division must rely on increased public stewardship and involvement for future fisheries management.

Future fisheries management should account for human alterations as well as the physiographic features of the watershed. Fisheries management should encourage habitat continuity through the removal of unnecessary dams and the rehabilitation of original water courses however, accept these alterations and manage fish in their presence.

Upper South Branch Flint River

Fisheries management of the upper South Branch Flint River should concentrate on maintaining and protecting existing coolwater fish communities. Should public access be acquired, potential for a brown trout sport fishery may exist.

Option: Increase public access through land acquisition where possible.

Option: Support removal of Winns Pond dam and restore stream habitat continuity.

Option: Protect and rehabilitate fish habitat for cool water fish species.

Option: Obtain temperature data to assist with future cool water fisheries management.

Middle and Lower South Branch Flint River

Fisheries management of the middle and lower South Branch Flint River should concentrate on maintaining healthy warmwater fish communities with the exception of the Pine, Bottom, and Gravel creeks, which should be managed for cold or coolwater fish communities.

Option: Increase public access through land acquisition where possible.

Option: Protect cold water thermal habitat and self-sustaining brook trout fishery of upper Pine Creek by seeking alternatives to land development or by encouraging sensible development that will protect stream temperature and the fishery.

Option: Restore cold-water thermal habitat of lower Pine Creek by encouraging landowners to create a vegetative buffer strip to produce stream shading. Encourage Lapeer County Drain Office to minimize ditching of this unique and sensitive water body. Restore meanders where channelization has occurred.

Option: Support removing unnecessary water control structures in the Lapeer State Game Area and restore stream habitat continuity.

Option: Rehabilitate and improve fish habitat at road crossings by minimizing erosion and sediment loading.

Option: Restore continuous flow and navigation of the lower South Branch and North Branch Flint rivers through removal of logjams. Develop a strategic plan and organize a team of professionals and volunteers to use removal techniques that protect and improve existing fish habitat. Use video equipment for training on similar habitat improvement projects.

Option: Inventory use of the lower South Branch Flint River by spawning fish originating from Holloway Reservoir.

Option: Inventory Gravel Creek for fish, macroinvertebrates, temperature, and habitat.

Option: Restore cold-water thermal habitat of Bottom and Gravel creeks by encouraging landowners to create vegetative buffer strips to produce stream shading. Encourage Lapeer County Drain Office to minimize ditching of these unique and sensitive water bodies.

Option: Support removing the dam on lower Bottom Creek to restore stream habitat continuity.

Upper Flint River

Fisheries management of the upper Flint River should concentrate on maintaining healthy warmwater fish communities with the exception of upper Kearsley and Thread creeks, which should be managed for coolwater fish communities.

Option: Increase public access through land acquisition where possible.

Option: Coordinate fisheries management activities on Holloway Reservoir, Mott Lake, and Hamilton Impoundment with dam owners and their dam maintenance schedules. Develop strategic plans for fisheries management and rehabilitation for anticipated de-watering of impoundments.

Option: Update the Holloway Reservoir Management Plan to better address fisheries management concerns. Implement a strategy to achieve summer pool elevation before May 1 to enhance northern pike spawning habitat.

Option: Develop a strategy to vegetate exposed substrate of Holloway Reservoir during winter drawdown.

Option: Rehabilitate panfish communities in Holloway Reservoir and Mott Lake by stocking bluegill and black crappie and implementing habitat improvements.

Option: Enhance smallmouth bass and northern pike fisheries of Holloway Reservoir, Mott Lake, and Hamilton Impoundment by stocking and implementing habitat improvements.

Option: Tag walleyes in Holloway Reservoir, Mott Lake, and Hamilton Impoundment and track harvest and movement with angler tag returns.

Option: Determine the recreational fishing value of Holloway Reservoir, Mott Lake, and Hamilton Impoundment by conducting creel surveys.

Option Develop an angler diary program to track effort and harvest of sport fish populations.

Option: Monitor affects of zebra mussels and round goby on native fish populations.

Option: Support removal or modification of Hamilton Dam to more effectively pass potamodromous fish and restore stream habitat continuity.

Option: Support the removal of Utah Dam to restore stream habitat continuity.

Option: Evaluate the success of stocking larger sized brown trout at reduced numbers in upper Kearsley Creek.

Option: Seek landowner approval to enhance trout populations of Kearsley Creek by improving stream habitat.

Option: Evaluate affect of beavers on trout populations of Kearsley Creek.

Option: Support removal of dams on Lake Louise, Goodrich Mill Pond, and Atlas Mill Pond to restore stream habitat continuity to Kearsley Creek.

Option: Survey water temperatures, trout survival, and angler use of upper Thread Creek to determine if trout stocking is prudent.

Option: Support removal of dams on upper Thread Creek and Thread Lake to restore stream habitat continuity.

Middle and Lower Flint River

Fisheries management of the middle and lower Flint River should concentrate on maintaining and enhancing warmwater fish communities and potamodromous runs of fish from Saginaw Bay. Management should continue to promote recreational fishing opportunities and provide additional access.

Option: Obtain public access through land acquisition.

Option: Continue to monitor the Saginaw Bay spawning walleye run in the Flint River.

Option: Support genetic testing of Flint River walleye to determine discreetness.

Option: Estimate angler use and harvest of sport fish with a creel survey.

Option: Survey fish population and inventory habitat in waters lacking data (e.g., Misteguay and Pine Run creeks).

Option: Survey habitat for rehabilitation of lake sturgeon spawning runs.

Option: Continue to monitor sea lamprey reproduction in the lower Flint. Implement control measures if necessary.

Recreational Use

The watershed provides extensive recreational opportunities in large public-owned areas. Impoundments of Holloway Reservoir and Mott Lake provide excellent sport fish angling opportunities as well as recreational boating, camping, hiking, and picnicking. However, portions of the river not in public ownership have little public access. Recreational uses could be enhanced by increased public access. Navigation is impeded in some areas by downed trees and dams with inadequate portages.

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

Option: Improve public access through land acquisition by all levels of government (i.e. State, County, and Township) and other private organizations.

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

Option: Develop and support programs, similar to MDNR, Wildlife Division's Hunter Access Program, that offer financial incentives for private landowners to permit public access.

Option: Develop a stream public right-of-way, by purchasing easements for angler access from private landowners.

Option: Restore navigation of stretches of river impeded by downed trees (i.e., North and South Branch Flint rivers and Thread Creek).

Option: Identify, develop, and mark adequate portages around barriers that impede navigation.

Option: Survey and quantify recreational user groups within the river system and identify programs to enhance compatible use.

Option: Develop a program with Genesee County Parks and Recreation Commission to improve recreational use of gravel pits in the Timber Wolf Campground area of Holloway Reservoir Regional Park.

Option: Make more efficient use of media outlets and publications identifying recreational areas and uses in the watershed.

Option: Support funding for fishing piers, river walkways, and other facilities to provide recreational use of the river. Allow Inland Fisheries Grant monies for maintenance needs.

Citizen Involvement

Citizen involvement in the watershed is increasing. The Flint River Watershed Coalition has taken a lead role in promoting issues of concern in the watershed. However, other groups remain active pursuing more specialized interests. It is important that all interest groups communicate with each other as well as with other groups around the state to develop educated and effective management strategies toward watershed improvements.

Option: Support communication between interest groups in the Flint River watershed.

Option: Assure MDNR, Fisheries Division involvement with special interest groups by attending meetings, reviewing project proposals, and providing information on watershed issues.

PUBLIC COMMENT AND RESPONSE

Comments were received on the draft assessment from December 20, 2001, through March 31, 2001. Two hundred and sixteen copies were distributed to State and Federal agencies, local units of government (city, village, township, and county), special interest organizations, educational facilities (colleges and libraries), and citizens of the Flint River watershed.

Three public meetings were held: February 26, 2001 in Flint (attendance = 23), March 6 in Lapeer (attendance = 53), and March 8 in Montrose (attendance = 2). Public meetings were advertised using local media outlets. In addition, on February 16, an informal presentation was given to 35 members of the Flint River Watershed Coalition. Comments from these meetings and from letters received were considered. The suggested change was either incorporated into the assessment or listed with the reason it was not included.

Introduction

Comment: "Thanks for compiling a great educational tool! This information will be used to better inform citizen groups on the state of the watershed." Thank you for the assessment. The assessment will be a terrific resource. "Excellent job".

> Response: Thank you. We are glad this document will be useful to many people.

Comment: Will there be a final report that people can get?

> Response: Yes. Copies will be available at the MDNR, Shiawassee Office and also on the MDNR, Fisheries Division library internet site at: <www.dnr.state.mi.us/www/ifr/ifrlibra/ifrlibra/htm>.

Comment: What was the reason for writing the Flint River Assessment.

> Response: To provide a comprehensive reference for citizens and agency personnel who desire information about a particular fisheries resource (see **Executive Summary** and **Introduction**).

Comment: Will other organizations write river assessments like ours?

> Response: Anyone can write a river assessment. MDNR, Fisheries Division is continuing to write assessments for major watersheds in the State.

Geology and Hydrology

Comment: How long would it take to return an impoundment to the thread of the stream?

> Response: It varies by impoundment and is determined by an engineer. Time of year is important because of precipitation and water temperature affects. The stability of impoundment substrate is also a concern. Dams are usually drawn down slowly to minimize sedimentation and downstream affects.

Comment: Will cleaning up the river raise the price of water to be sold (diverted) from the Great Lakes?

> Response: Currently the selling of Great Lakes water is under discussion. One would speculate that the less polluted the water is the more desirable it would be.

Dams and Barriers

Comment: Several people objected to the option of removing Thread, Goodrich, Atlas, and Winns Pond dams.

> Response: From an ecosystem point of view, we feel dam removal is an option that would be of benefit. We recognize it is unappealing to some. Our point in including the removal option is because we are focusing on the ecosystem, its resources, and restoring integrity and function of the river system. The only way to accomplish all these goals is through dam removal. Partial attainment of goals can be met by modifying some the existing dams.

Comment: Are you intending to destroy the Winns Pond Dam and drain the lake? Will the Lake Minnewana dam be removed? Will Thread Lake Dam be removed?

> Response: No. The owner of the dam must decide dam removal. We present a dam removal option to be considered for benefit of the ecosystem.

Comment: The specifics in the report do not support problems in fish management, water quality, and other categories. The recommendation for removal of Winns Pond dam seems at odds with the data. The Upper South Branch is stated to be one of the finest areas in the Flint River system. It couldn't get that way if Winns Pond Dam is as big of problem as its made out to be.

> Response: We disagree. The negative affects of dams are discussed in the Dams and Barriers section. Winns Pond Dam inundates a high gradient reach of the South Branch Flint River and has negative affects downstream. Dam removal would restore this valuable habitat and river integrity and function. However, it is unlikely Winns Pond Dam will be removed as long as the dam owners and the community support its presence.

Comment: "On page 33 it is stated that 'there is no means for fish passage'. It may be true fish are unable to pass upstream, but it is possible to pass downstream over Winns Dam as I have observed, or through the bottom draw feature of Winns Dam".

> Response: We have modified the paragraph. However, Winns Pond Dam is still a barrier impeding daily and seasonal fish movement.

Comment: "I believe most citizens are concerned about the environment. However, few of us would be willing to give up our homes to increase the number of trout or recreational opportunities. In the case of Winns Pond Dam, these reasons do not justify the removal of such a dam." Improving sewage systems would have a bigger potential to improve water quality than removing dams. You need to focus on sewer systems first.

Response: This report does not suggest anyone give up their homes to increase trout or recreational opportunities. The Winns Pond dam removal option only indicates there could be significant benefits to the river system (see **Dams and Barriers**). We believe property values along pristine streams can be equally as valuable as property adjacent to impoundments. Improvements in water quality rely on addressing many issues outlined in this report.

Comment: Thread Lake is a natural lake and should be kept up.

Response: Thread Lake is not natural, it is a human-made impoundment with water levels controlled by a dam.

Comment: If you took out Goodrich Dam, what would happen downstream. What effect would dam removal have on flooding in downstream areas. You haven't done any statistical modeling to should that any of the improvements you promise will occur.

Response: When it is decided to remove a dam the first step is to have an engineering analysis done. This will determine drawdown rates, flood potential, contaminant problems, sediment release, and any stabilization if needed. We do not believe "statistical modeling" is necessary at this point. A number of documents and case studies have been referenced which demonstrate the benefits of dam removal.

Comment: These dams are for flood control, how can you take them out.

Response: Only the dams on Misteguay Creek serve for flood control (see **Dams and Barriers**). Water retention behind other dams is inefficient to serve for flood control. We are not taking out the dams, only proposing dam removal is considered as an option for the benefit of the ecosystem. Dam removal will only occur if it has the support of the dam owner.

Comment: On page 73 you include Winns Pond Dam under high risk. Elsewhere it is classified as not being a high risk dam.

Response: We have reworded page 73 to indicate Winns Pond Dam is not classified as high risk.

Comment: Don't all the dams have to be removed to benefit the fish?

Response: No. Fragmented stream portions can be re-connected by single or multiple dam removals benefiting the river ecosystem and its biological communities (see **Biological Communities**).

Comment: Are there other options to allow fish passage and still keep a dam?

Response: Yes. A number of engineering designs exist to facilitate fish passage around or over dams. A bypass channel with fish ladder is one option. Oftentimes, engineering designs for fish passage are tailored to a specific dam.

Special Jurisdictions

Comment: What rights do riparians have regarding when their trees fall into the river?

> Response: As owner of the tree, you have the right to remove it. If you are not the tree owner, then MDEQ, LWMD should be consulted to see if permits are involved. If the stream is a designated drain, the drain commission has authority to remove.

Comment: Logjams prevent canoe navigation of the river, how can we remove them? What should be done with the logs removed from the river?

> Response: Projects to remove logjams in a stream need careful planning. The first step is securing MDEQ permits and landowner permissions. Sometimes logs can be anchored to stream banks to reduce erosion and improve fish and macroinvertebrate habitat. If a tree is still rooted, we recommend leaving the tree base and root system intact to minimize bank erosion. If complete removal is necessary, we suggest having the logs chipped and hauled out to minimize damage within the floodplain.

Comment: Is there a right to portage around a dam?

> Response: On a navigable stream, a wader or boater has right of passage around an obstacle within the defined banks of the stream. If a dam does not have a marked portage, the public may seek a "reasonable" route around the obstacle (MDNR 1993).

Comment: We should uncover Brent Run Creek.

> Response: We agree, however, Brent Run is a designated drain and falls under County Drain Commission authority.

Water Quality

Comment: Additional water quality information is available from the Flint Waste Water Treatment Plant.

> Response: It is not feasible to include all water quality data available in this document, so we have chosen representative data. We acknowledge other data exists and thank you.

Comment: Flint sewers leak into the Flint River. Isn't sewage management the problem in the watershed?

> Response: Sewage discharges are a problem in the watershed. Municipalities are faced with aging systems being pushed to their limits, especially during heavy rains or snowmelt. Also, illegal connections discharging into county drains and failing septic fields continue to be discovered. Improvements in sewage management are going to require large-scale efforts from government agencies and responsible authorities. Homeowners must also do their part in assuring proper waste disposal.

Comment: Who has jurisdiction over pollution problems? I think there should be a statewide 800 number for reporting pollution.

Response: MDEQ is the lead agency for pollution concerns in the State. MDEQ maintains a toll free statewide Pollution Emergency Alert System (PEAS) phone number for reporting pollution. The phone number is 1-800-292-4706.

Comment: "I saw pipes dumping water in the river in July, who would know what they are?"

Response: If the pipes are a permitted discharge, MDEQ, Surface Water Quality Division would have record. However, these pipes may be tiles off an agricultural field or possibly a storm water discharge from a nearby landowner, and would have to be traced to their origin in order to determine their purpose.

Comment: Are there rules regulating sump and wash water drainage from riparian homes? Do people have to get their septic tanks cleaned regularly?

Response: Yes. Under the regulations of P. A. 451, Part 31, it is illegal to discharge sump and wash water directly to a water body. Sump water discharge should be directed to dry wells and wash water to a septic field or sewer system. Septic tank maintenance is the home owner's responsibility. Depending upon the size of the septic tank and number of occupants in the household, it is generally recommended to clean a septic tank every 3-5 years.

Comment: "What's the effect of the chlorine discharge at Beecher Road?"

Response: The Flint WWTP chlorine discharge at Beecher Road is regulated by MDEQ and a NPDES permit. Permitted levels of chlorine discharge are set to minimize environmental damage. Chlorine is toxic to fish and if harmful levels were being discharged fish kills would probably result. There have not been any reports of fish kills resulting from chlorine at this location indicating the discharge requirements are adequate.

Comment: Who is responsible regulating soil erosion in the Flint River?

Response: MDEQ, Land and Water Management Division is the lead agency for regulating soil erosion. Local units of government may also have construction site regulations.

Comment: What plants would help prevent erosion of the stream banks?

Response: The types of plants may vary with soil type and climatic conditions. We recommend contacting the Michigan State University Extension Office or the Natural Resource Conservation Service for assistance. Pertinent information is also available at the internet site: <http://wawater.wsu.edu>.

Comment: It would help to re-vegetate the river corridor.

Response: We agree and have listed this as a management option.

Comment: Are there any known sources of pollution upstream of Winns Pond?

Response: There are 5 NPDES permits and 3 sites of contamination in the Upper South Branch Flint River (Tables 9 and 10).

Comment: Would it be a good idea to dredge the sediment out of Winns Pond?

Response: Not unless there is a specific reason to have it dredged. If contamination is a concern, we would recommend having a sediment analysis conducted before attempting any dredging.

Biological Communities

Comment: Why is there so little cover for fish in the Flint River?

Response: Many reasons for fish habit loss are discussed throughout this document. Probably the two most significant reasons relate to flow and the channelization of tributaries for drainage. An unstable flow regime results in increased bank erosion and bank sloping eliminating fish habitat. Many tributaries of the Flint River are designated drains and dredging and channelization have eliminated fish habitat.

Comment: What can a property owner do to improve habitat along a drain?

Response: Maintaining a buffer strip and providing streamside shade are the two best things a riparian can do improve habitat along a drain. However, your County Drain Office should be consulted for permission before any actions are taken. Any plantings placed in a drain right-of-way without the County Drain Commission permission could result in their removal at the riparian owner’s expense.

Comment: What's being done about zebra mussels?

Response: Although research continues on zebra mussel control, there has been little progress in finding an effective means to eradicate them from a natural water body. It is certain their presence will continue to expand to inland water bodies throughout Michigan and in the Flint River watershed. We recommend you contact the Michigan Sea Grant, Zebra Mussel and Aquatic Nuisance Species Office for the most current information on control and distribution of zebra mussels in Michigan.

Comment: "I moved out here and haven't seen a snake, where are they?"

Response: Snakes are found in a wide variety of environments. Harding (1997) should be consulted for a description of snake species and habitat.

Comment: Bowfins are often caught at the mouth of the Flint River.

Response: We believe it possible for bowfin to be in this location and have expanded the distribution map to include the mouth of the Flint River.

Comment: I have caught flathead catfish in Holloway Reservoir.

Response: MDNR, Fisheries Division has been very active in monitoring the fish community of Holloway Reservoir and no flathead catfish have been observed. Channel catfish are very abundant in Holloway Reservoir. Flathead catfish would be new fish species to the Flint River watershed and before we include it in this document, we ask a specimen be positively identified by a MDNR fisheries biologist.

Fisheries Management

Comment: Does MDNR stock any part of the Flint River with fish?

Response: MDNR fish stockings are provided in Table 14 of this document.

Comment: Why is the South Branch Flint River a designated trout stream if the MDNR does stock it?

Response: Trout designation does not necessarily mean a stream gets stocked with fish. MDNR discontinued trout stocking in the South Branch Flint River in 1990 (see **Fisheries Management**). We have maintained trout designation on the South Branch Flint River because some small tributaries have naturally reproduced trout that may emigrate. The South Branch Flint River has Type 4 regulations that are most liberal and allow for fishing other species year round.

Recreational Use

Comment: There are windfalls that impede canoeing on the North and South Branch Flint rivers, and Thread Creek.

Response: MDNR, Fisheries Division is aware of the windfalls on the North and South Branch Flint rivers and they undoubtedly are in other areas as well. This document supports restoring navigation in these areas for recreational use (see **Management Options**). However, these efforts are labor intensive, require careful planning, MDEQ permits, and landowner permissions. MDNR, Fisheries Division relies on volunteer assistance in order to undertake these labor intense projects.

Comment: Klam Road in Lapeer County should be made a MDNR access site. Help Genesee County fix the drive at the M15 access site.

Response: The property at Klam Road and the M15 access site is owned by Genesee County Parks and Recreation Commission and not within MDNR jurisdiction. MDNR, Fisheries Division supports and would be willing to assist in improving these sites, but Genesee County Parks and Recreation must assume the lead role.

Comment: There is a need for better boat access in Columbiaville.

Response: We agree the small boat access in Columbiaville could use improvement. However, the town of Columbiaville is the landowner and MDNR does not have jurisdiction.

MDNR, Fisheries Division supports and would be willing to assist in site improvement, but the town of Columbiaville must assume the lead role.

Comment: User conflicts are occurring on Holloway Reservoir.

Response: User conflicts occur because there are limited locations for boating, sailing, jet skiing, and angling in the watershed. MDNR, Law Enforcement Division and local authorities patrol Holloway Reservoir to assure safety, but conflicts will undoubtedly continue. To alleviate user conflicts on Holloway Reservoir, Genesee County Parks and Recreation Commission has placed no wake restrictions on nearby Mott Lake impoundment.

Citizen Involvement

Comment: I agree with you that all groups with interest in the Flint River must communicate better.

Response: We believe unified efforts will have the greatest affect on watershed improvements. There are many different interest groups in the watershed and communication is vital to addressing the needs of each.

Comment: What little bit can we do as individual citizens?

Response: A number of actions are outlined in the Management Options section. Educating yourself and others about the watershed is a good first step. Becoming active in the Flint River Watershed Coalition is encouraged. We also encourage you to make the environment an issue during government elections.

Management Options

Comment: Why isn't there a prioritized list of things to do to improve the river?

Response: We deliberately did not prioritize management options. When a prioritized list is given, many times there is a mistaken belief that until the first item on the list is completed, no other action can be attempted. We believe no single option should prevent another from being attempted or accomplished.

GLOSSARY

anuran - a frog or toad

base flow - groundwater discharge to a stream system

basin - a complete drainage including both land and water from which water flows to a central collector such as a stream or lake at a lower level elevation, synonymous with watershed

bedrock outcrop - emergence of early geologic rock at the soils surface

benthic - plants and animals living on, or associated with, the bottom of a water body

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

biological integrity - biotic communities able to withstand and survive natural and human perturbations

biota - animal and plant life

biotic hierarchy - trophic assemblage of plant and animal life in an area

BMPs - best management practices

cfs - cubic feet per second

catostomid - species of fish in the Catostomidae family, generally suckers and redhorse suckers

centrarchid - species of fish in the Centrarchidae family, generally the sunfishes, crappies, and basses

channelization - a process of altering natural stream channels by straightening, widening, and deepening to improve water movement

channel morphology - the study of the structure and form of stream and river channels including width, depth, and bottom type

CPUE - catch per unit effort

confluence - the joining or convergence of two streams

contiguous - bordering or in contact with

cobble - naturally rounded stones larger than pebbles and smaller than boulders arbitrarily limited to a size of two to ten inches in diameter

cyprinids - species of fish in the Cyprinidae family, generally carp, goldfish, and minnow species

DDT - dichloro-diphenyl-trichloroethane

drought flow - water flow during a prolonged period of dry weather

drum gate - a type of gate used in dams that uses drums to control water level

ecological - the relations between living organisms and their environment

ecosystem - a biological community considered together with the non-living factors of its environment as a unit

effluent - the outflow of a sewer, septic tank, municipality, industry etc.

ERD - Environmental Response Division

erosion - the process of moving soil particles by wind or rain

eutrophication - a process of becoming increasingly rich in nutrients either as a natural phase in the maturation of a body of water or artificially enhanced by human use such as agriculture run-off or waste disposal

event responsive - reacting to water run-off the land during rain or snow melt

exacerbate - to make more intense, aggravate

exceedence curves - the probability of a discharge exceeding a given value

extirpation - to make extinct by removing

FCMP - Fish Contaminant Monitoring Program

FERC - Federal Energy Regulatory Commission

fixed crest - a dam that is fixed at an elevation and has no ability to change from that elevation

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

FRWC - Flint River Watershed Coalition

forage stocking - fish stocking for the purpose of providing food for piscivorous fish

glacial moraine - a mass of rocks, gravel, sand, clay, etc. 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

GLEAS - Great Lakes and Environmental Assessment Section

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

gristmill - a mill for grinding grain

groundwater - water that is beneath the surface of the ground and is the source of a spring or well water

HCB - hexachlorobenzene

HPE - heptachlor epoxide

HRMP - Holloway Reservoir Management Plan

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

hydrology - the science of water

impermeable - will not permit fluids to pass through

indigenous - a species that is native to particular area

inundate - to flood or cover with water

kettle lakes - a round lake that is formed in depressions caused by melting ice

Kjeldahl nitrogen - the total combination of nitrogen and ammonia

lacustrine - pertaining to lakes

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

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

lentic - pertaining to or living in still water

littoral zone - of, on, or along a shore of a lake or pond

loam - a soil consisting of an easily crumbled mixture containing from 7 to 27% clay, 28 to 50 % silt, and less than 52% sand

lotic - pertaining to or living in flowing water

LWMD - Land and Water Management Division

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

mainstem - mainstream

maintenance stocking - fish stocking to maintain a species population when natural reproduction is insufficient to maintain a desired abundance

management stocking - fish stocking with specific fisheries management objectives

MDCH - Michigan Department of Community Health

MDEQ - Michigan Department of Environmental Quality

MDNR - Michigan Department of Natural Resources

MGD - million gallons per day

meander - a winding, curving stream segment

MNFI - Michigan Natural Features Inventory

moraine - a mass of rocks, gravel, sand, clay, etc. carried and deposited directly by a glacier

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

moss animals – taxa belonging to the Bryozoa phylum

MWRC - Michigan Water Resources Commission

NPDES - National Pollution Discharge Elimination System

P.A. - Public Act

PCB - polychlorinated biphenyl

perched culvert - an improperly placed culvert that fragments habitat by creating a significant drop between the culvert outlet and stream surface

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

permeable - soils with coarse particles that allow passage of water

phloem - tissue that transports food in a plant

phylogenic diversity - the assemblage of animals and plants of distinct origin and evolution

ppm - parts per million

private stocking - fish stocking by private individuals under permit by Michigan Department of Natural Resources, Fisheries Division

piscicide - a chemical designed to kill fish

potable - fit to drink

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

riffle - a shallow area extending across the bed of a stream where water flows swiftly so that the surface is broken in waves

riparian - adjacent to or living on the bank of a river; also refers to the owner of stream or lakefront property

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

Saginaw Bay WIN - Saginaw Bay Watershed Initiative Network

savanna - a treeless plain or grassland with scattered trees

sedimentation - a process of depositing silt, sand, and gravel on a stream or river bed

sinuosity - the degree of bending, winding, and curving of a river system

sluice - an artificial channel

sluice gate - a type of gate used in dams that controls discharge from a sluice

sport fish - fish valued by anglers

STD - Storage Tank Division

SWQD - Surface Water Quality Division

tainter gate - a type of gate used in dams, typically submerged under water, that controls discharge from the impoundment

tile - an underground enclosed drainage system generally installed for draining farmland

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

tributary - a smaller stream feeding into a larger stream, river, or lake

USDA - United States Department of Agriculture

USFWS - United States Fish and Wildlife Service

USGS - United States Geological Survey

vascular - plants having a xylem and phloem

vernal - relating to, or occurring in, the spring

watershed - the drainage area of basin, both land and water, from where water flows toward a central collector such as a stream, river, or lake at a lower elevation; synonymous with basin

wastewater treatment - the treatment of sewage

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

WWTP - Waste Water Treatment Plant

xylem - woody tissue of a plant

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TABLES

Table 1.–Number of archeological sites in the Flint River basin, listed by valley segment and congressional township. Asterisk (*) denotes township containing a site listed on the National Historical Register. Data from B. Mead, Office of the State Archaeologist, personal communication.

Segment and county	Township	Range	Number of sites
Upper South Branch			
Oakland	T5N	R7E	3
Oakland	T5N	R8E	5
Oakland	T5N	R9E	4
Oakland	T5N	R10E	2
Oakland	T5N	R11E	4
Lapeer	T6N	R9E	1
Lapeer	T7N	R9E	4
Lapeer	T7N	R10E	4
Lapeer	T7N	R11E	4
Middle South Branch			
Lapeer	T8N	R9E	7
Lapeer	T8N	R10E	5
Lower South Branch			
Lapeer	T8N	R11E	6
Lapeer	T8N	R12E	30*
Lapeer	T9N	R10E	1
Lapeer	T9N	R11E	17
Lapeer	T9N	R12E	30
Lapeer	T10N	R11E	2
Tuscola	T10N	R9E	1
Upper Flint			
Genesee	T5N	R6E	2
Genesee	T6N	R7E	4
Genesee	T6N	R8E	3
Genesee	T7N	R8E	3
Genesee	T8N	R7E	2
Genesee	T8N	R8E	4
Genesee	T9N	R8E	2
Lapeer	T9N	R9E	11
Middle Flint			
Genesee	T6N	R5E	4
Genesee	T6N	R6E	3
Genesee	T7N	R7E	7
Genesee	T8N	R5E	9
Genesee	T8N	R6E	1
Genesee	T7N	R6E	9
Genesee	T9N	R5E	19
Genesee	T9N	R6E	1

Table 1.–Continued.

Segment and county	Township	Range	Number of sites
Lower Flint			
Saginaw	T9N	R4E	3
Saginaw	T10N	R4E	39
Saginaw	T10N	R5E	96*
Saginaw	T10N	R6E	15
Saginaw	T11N	R3E	2
Saginaw	T11N	R4E	19
Saginaw	T11N	R5E	1

Table 2.–Period of record mean annual discharge at United States Geological Survey gauging stations on the Flint River. Blanks indicate no data available. Data from United States Geological Survey.

Gauge Site	Gauge number	Period of record	Drainage area (mi^2)	Mean annual discharge (cfs)
Farmers Creek, Lapeer	04146000	1933-97	55	33
South Branch Flint River, Columbiaville	04146063	1980-97	221	185
Flint River, Columbiaville	04146500	1932-33 1948-52	470	
Holloway Reservoir, Otisville	04147000	1954-91	526	
Flint River, Otisville	04147500	1953-97	530	344
Butternutt Creek, Genesee	04147990	1970-84	35	22
Flint River, Genesee	04148000	1931-52	593	
Kearsley Creek, Davison	04148140	1966-97	99	76
Gilkey Creek, Flint	04148160	1970-84	6	5
Thread Creek, Flint	04148440	1970-84	54	37
Swartz Creek, Holly	04148200	1956-75	12	8
Swartz Creek, Flint	04148300	1970-84	115	79
Flint River, Flint	04148500	1932-97	956	643
Brent Run, Montrose	04147200	1970-84	21	15
Flint River, Fosters	04149000	1940-84 1988-92	1,118	757
Flint River, Alicia	04149500	1949-84		

Table 3.–Calculated flood discharges for nine United States Geological Survey gauges on the Flint River and tributaries. Data from United States Geological Survey and Michigan Department of Environment Quality, Land and Water Management Division, Hydrological Studies Unit, for period of record (Table 2).

Gauge site	Calculated 100 year flood discharge (cfs)	Calculated 50 year flood discharge (cfs)
S. Br. Flint River, Columbiaville	4,300	3,800
Flint River, Otisville	8,600	7,400
Flint River, Flint	14,400	13,000
Flint River, Fosters	19,500	17,000
Farmers Creek, Lapeer	1,420	1,190
Butternut Creek, Genesee	1,100	980
Kearsley Creek, Davison	2,300	2,000
Swartz Creek, Flint	6,500	5,700
Thread Creek, Flint	1,500	1,300

Table 4.–Cover type in the Flint River watershed in acres. Data from Michigan Department of Natural Resources, Michigan Resource Inventory System (MIRIS).

Cover Type	Presettlement (*c.* 1800)	Current (1978)	Percent change
Agricultural	0	414,839	+48.7
Forested	640,551	139,046	-58.9
Urban and built up	0	130,984	+15.4
Non-forested*	7,835	125,840	+13.9
Wetlands	112,333	28,267	-12.9
Water	6,177	12,010	+0.7
Barren/Savanna	84,048	15	-9.9
Total	850,944	851,001	

* Non-forested includes grassland and wet prairie.

Table 5.–Measured width of Flint River at nine sites compared to the expected width at 95% and 5% flow exceedence. Data from United State Geological Survey gauging stations.

Site	Measured width (feet)	Calculated widths (feet)	
		95% Exceedence	5% Exceedence
South Branch Flint River, Columbiaville	55	44	82
Flint River, Otisville	61	53	101
Flint River, Flint	221	72	142
Flint River, Fosters	120	77	153
Farmers Creek, Lapeer	27	18	30
Butternut Creek, Genesee	23	13	20
Kearsley Creek, Davison	39	27	47
Swartz Creek, Flint	43	23	40
Thread Creek, Flint	40	17	29

Table 6.–Dams and water control structures in the Flint River basin. Data from Department of Environmental Quality, Land and Water Management Division, Dams Safety Unit. Data codes: P=private, S=state, LG=local government. Hazard type: 1=high, 2=significant, 3=low. High hazard – loss of life would occur; significant hazard – large amounts of property damage would occur. Blank indicates no data available.

Segment and dam name	Stream	Year built	Owner	Type	Height (feet)	Surface acreage	Storage capacity (acre-feet)	Use	Hazard type
Upper South Branch									
Straith Dam	Whigville Creek		P		0	2	0		3
Beaver Lake Dam	Beaver Creek	1960	P	Earth	24	160	2000	Recreation	3
Beattie Dam	South Branch tributary	1967	P	Earth	9	24	180	Recreation	3
Lockwood Lake Dam	South Branch tributary	1964	P	Earth	20	24	200	Recreation	3
Thompson Dam	South Branch tributary	1940	P	Earth	12	9	70	Recreation	3
Winns Pond Dam	South Branch	1971	P	Earth/concrete	12	25	250	Recreation	3
Middle South Branch									
Derderian Dam	Kintz Creek tributary		P		0	2	0		3
McGlashen Dam	Kintz Creek tributary	1950	P	Earth	6	1	20	Recreation	3
Lower Reed Lake Dam	Kintz Creek		P		5	3	8		3
Upper Reed Lake Dam	Kintz Creek	1950	P	Earth	11	9	220	Recreation	3
Trout Lake Dam	Hunters Creek tributary	1963	P	Earth	6	23	40	Recreation	3
Misch Lake Dam	Hunters Creek	1950	P	Earth	10	50	380	Recreation	3
Peppermill Dam	Hunters Creek	1964	P	Earth	3	2	5	Recreation	3
Caley Dam	Caley Lake outlet	1926	P	Earth	8	10	30	Recreation	3
Emery Dam	Mill Creek tributary	1964	P	Earth	0	0	15	Recreation	3
Rolland Dam	Mill Creek tributary		P		6	10	0		3
Snoblen Dam	Mill Creek tributary	1950	P	Earth	13	13	100	Recreation	3
Tody Lake Dam	Mill Creek tributary		P		6	12	0		3
Johnson Dam	Farmers Creek tributary	1964	P	Earth	6	10	15	Recreation	3
Lake Nepessing Dam	Farmers Creek tributary	1966	P	Earth/steel	7	354	730	Recreation	3
Minnawana Dam	Farmers Creek tributary	1963	S	Earth/concrete	33	44	900	Recreation	2
Renshaw Dam	Farmers Creek tributary	1955	P	Earth	20	4	30	Recreation	3
Farmers Creek USGS	Farmers Creek	1938	P		2	1	0	Flow data	3
McGinnis Lake Dam	Farmers Creek		P		0	3	0	Recreation	3
Merritt Lake Dam	Farmers Creek	1953	P		13	25	130	Recreation	3
Metamora Dam	Farmers Creek	1974	P	Earth	21	56	599	Recreation	2
Webster Dam	Farmers Creek	1957	S	Earth	7	10	16	Recreation	3
White Sands Dam	Farmers Creek	1969	P	Earth	29	297	5365	Recreation	2
Jasmond Lake Dam	Spring Bank Creek tributary	1950	S	Earth	5	5	20	Recreation	3
Fish Lake Dam	Plum Creek tributary	1966	S	Earth	3	18	140	Recreation	3
Lapeer Game Area #27	Plum Creek tributary	1987	S	Earth	8	50	159	Recreation	3

Table 6.–Continued.

Segment and dam name	Stream	Year built	Owner	Type	Height (feet)	Surface acreage	Storage capacity (acre-feet)	Use	Hazard type
Middle South Br.-continued									
Lapeer Game Area #30	Plum Creek tributary	1966	S	Earth	9	25	110	Recreation	3
Twin Lake Dam	Plum Creek tributary	1963	S	Earth	14	14	51	Recreation	3
Lapeer Game Area #13	Fish Lake Drain tributary	1987	S	Earth	6	20	36	Recreation	3
Watts Lake Dam	Watts Lake outlet	1965	S	Earth	4	23	2	Recreation	3
Long Lake Dam	Plum Creek	1965	S	Earth	11	202	750	Recreation	2
Lower South Branch									
Baggerly Dam	Cedar Creek tributary		P	Earth	6	4	0		3
Thorn Dam	Cedar Creek tributary		P	Earth	6	1	0		3
Bottom Creek Dam	Bottom Creek	1972	P	Earth	20	64	1050	Recreation	2
Barnes Lake Dam	Barnes Lake outlet	1935	LG	Earth	7	110	184	Recreation	3
Sawdell Lake Dam	South Branch tributary	1949	S	Earth	8	46	160	Recreation	3
Upper Flint									
McDowell Lake Dam	Hasler Creek tributary	1963	P	Earth	6	11	9	Recreation	3
Tody Dam	Hasler Creek tributary	1954	P	Earth	0	2	15	Recreation	3
Harrow Dam	Butternut Creek tributary	1966	P	Earth	5	2	15	Recreation	3
Ross Dam	Butternut Creek	1960	P	Earth	4	0	40	Recreation	3
Sherwood Dam	Powers-Cullen Drain	1964	P	Earth	8	2	30	Recreation	3
McCormick Lake Dam	Coe Drain	1965	LG	Earth	6	5	20	Recreation	3
Hemmingway Lake Dam	Whipple Drain	1912	P	Earth	10	65	875	Recreation	3
Tau Beta Dam	Whipple Drain	1927	P	Earth/concrete	13	10	60	Recreation	3
Potters Lake Dam	Black Creek tributary	1947	P	Earth/concrete	8	130	1000	Recreation	3
Algoe Lake #1 Dam	Duck Creek tributary	1923	S	Earth	3	50	70	Recreation	3
Spain-Lindsey Dam	Duck Creek tributary	1915	P	Earth	12	3	65	Recreation	3
Renchik Dam	Duck Creek	1957	P	Earth	13	29	120	Recreation	3
Algoe Lake #2 Dam	Kearsley Creek tributary		S	Earth	8	2	5	Recreation	3
Cummings Dam	Kearsley Creek tributary	1956	P	Earth	10	7	25	Recreation	3
Shinanguag Lake Dam	Kearsley Creek tributary	1958	P	Earth	6	190	500	Recreation	3
Lake Louise Dam	Kearsley Creek	1925	P	Earth	12	103	860	Recreation	3
Atlas Millpond Dam	Kearsley Creek	1835	LG	Earth/concrete	24	43	1000	Mill/recreation	2
Goodrich Dam	Kearsley Creek	1913	LG	Earth/concrete	18	24	650	Mill/recreation	2
Kearsley Dam	Kearsley Creek	1929	LG	Earth/concrete	33	250	3250	Water supply/recreation	2
Warwick Dam	Bush Creek	1950	P	Earth	5	40	96	Recreation	3
McGinnis Lake Dam	Thread Creek tributary	1953	S		19	8	61	Recreation	3
Phipps Lake Dam	Thread Creek tributary	1930	P	Earth	10	54	75	Recreation	3

Table 6.–Continued.

Segment and dam name	Stream	Year built	Owner	Type	Height (feet)	Surface acreage	Storage capacity (acre-feet)	Use	Hazard type
Upper Flint-continued									
Smith Dam	Thread Creek tributary	1938	P	Earth	7	16	0	Recreation	3
Thread Ck. Imp. Dam	Thread Creek tributary	1969	S	Earth	7	40	96	Recreation	3
Waterfowlers Dam	Thread Creek tributary	1985	S	Earth	7	10	28	Recreation	3
Heron Lake Dam	Thread Creek	1969	S	Earth	23	123	1600	Recreation	1
Wildwood Lake Dam	Thread Creek	1961	S	Earth	21	47	775	Recreation	3
Perrysville Dam	Thread Creek	1890	P	Earth	13	10	110	Recreation	2
Stewart Lake Dam	Thread Creek			Earth/rockfill	6	40	32	Recreation	3
Thread Lake Dam	Thread Creek	1928	LG	Earth/concrete	9	80	1250	Recreation/ice	2
Case Lake Dam	Indian Creek	1964	P	Earth	14	27	280	Recreation	3
Big Seven Lake Dam	Swartz Creek	1967	S	Earth	18	180	1150	Recreation	3
Crystal Lake Dam	Swartz Creek	1924	S	Earth	15	12	120	Recreation	2
Mill Pond Dam	Swartz Creek			Earth	6	5	0		3
Seven Lakes Dam	Swartz Creek	1970	S	Earth	26	19	290	Recreation	3
Spring Lake Dam	Swartz Creek	1938	P	Earth	8	19	340	Recreation	3
Crossroads Gristmill Dam	Flint River tributary		LG	Earth	8	3	2	Recreation	3
Lake Highland Dam	Flint River tributary	1953	LG	Earth	12	100	560	Recreation	3
Earl Holloway Dam	Flint River	1973	LG	Earth/concrete	30	1973	17500	Water supply	1
C.S. Mott Dam	Flint River	1971	LG	Earth/concrete	19	684	6887	Recreation	2
Utah Dam	Flint River	1928	LG	Concrete/steel	6	8	5	Flood control/industry	3
Hamilton Dam	Flint River	1920	LG	Concrete	24	7	180	Water supply/recreation	1
Fiber Dam	Flint River	1979	LG	Fiber		0	0	Water supply/recreation	3
Middle Flint									
Nellis Dam	Flint River tributary	1956	P	Earth	6	6	20	Recreation	3
Unsel Dam	Flint River tributary	1963	P	Earth	8	1	30	Recreation	3
Lower Flint									
Birchmeier Dam	Flint River tributary		P		6	1	0		3
Lewis Drain Dam	Lewis Drain	1969	P	Earth	15	14	120	Recreation	3
Gross Dam	Misteguay Creek	1966	P	Earth	13	1	0	Recreation	3
Misteguay Creek 2A	Misteguay Creek	1966	LG	Earth	29	0	3517	Flood control	3
Misteguay Creek 3A	Misteguay Creek	1966	LG	Earth	26	0	4037	Flood control	3
Misteguay Creek 4	Misteguay Creek	1967	LG	Earth	39	0	7450	Flood control	3
Wendling Dam	Misteguay Creek tributary	1966	P	Earth	18	3	19	Recreation	3

Table 7.–Designated drains in the Flint River watershed, by confluence location in valley segment. Information provided by each county drain office.

Upper South Branch

Lapeer County

- *Dryden Township*
  - Albrecht
  - Albrecht Branch
  - Sanborn
- *Elba Township*
  - Black Creek
  - Burdick
  - Burdick, Elba Branch
  - Elba & Oregon
  - Elba Tile
  - Hammond & Misner
  - Lassen-Cummings Swamp Branch
  - Threadway & Powelson
- *Elba Township – continued*
  - Washington
- *Lapeer Township*
  - Ruby Peters
  - Branch Ruby Peters
- *Marathon Township*
  - Clute
  - Collens Demode
  - Hemmingway & Whipple
  - Langley
  - Langley, West Branch
- *Metamora Township*
  - Long Swamp
- *Oregon Township*
  - Cummings Swamp
  - Henry
  - Henry Branch 1 of B
  - Henry Branch B
  - Henry, Branch A
  - Henry, Branch A of A
  - Lassen-Cummings Swamp
  - Mc Donald Lake
  - Shoemaker
  - Shoemaker Branch #1
  - Shoemaker Branch #2

Middle South Branch

Lapeer County

- *Arcadia Township*
  - Bryant
  - Bryant, East Road Branch
  - Bryant, Fisher Branch
  - Bryant, Wixon Branch
  - Hartman
  - Palmer Branch
- *Attica Township*
  - Bishop
  - Earl branch
  - Geer & Williams
  - Green
  - Hubbard
  - Pleasant lake
  - Sickles
- *Elba Township*
  - Geesey
  - Howe
  - May & White
  - May & White Branch
  - Popular Creek
- *Hadley Township*
  - Farmers Creek
  - Farmers Creek, Branch #1
- *Hadley Township – continued*
  - Farmers Creek, Branch #2
  - Farmers Creek, Branch #3
  - Farmers Creek, Branch #3A
  - Hadley
  - Pratt
  - Riley Outlet
- *Lapeer Township*
  - Alvard
  - Alvard Branch
  - Ballard
  - Mirror Lake
  - Pine Creek
  - Unity
- *Mayfield Township*
  - Abbott
  - Bryant
  - Bryant, East Branch
  - Cuttin Branch
  - Cutting
  - Fish Lake
  - Hamilton
  - Hewison lange
  - Keen
  - King
- *Mayfield Township – continued*
  - Kudner
  - Lee & Thomas
  - Mayfield & Oregon
  - Merlin Lake
  - Miller
  - Peasley
  - Plumb Creek
  - Reed
  - Reed, Branch #1
  - Roods Lake & Evans
  - Rucker
  - Sandhill
  - Townline
  - White
  - Wilder
- *Metamora Township*
  - Andress
  - Metamora
- *Oregon Township*
  - Davenport
  - Davenport Branch
  - Gibbons
  - Nelson
  - Nelson Branch

Table 7.–Continued.

Lower South Branch

Tuscola County

- *Dayton Township*
  - Drake North Branch
  - Lynch Branch
  - Squaw Creek Branch #2
- *Koylton Township*
  - Adams
  - Ball
- *Watertown Township*
  - Goodrich Mill Creek
  - Monroe
  - Robinet
  - Rumph Tile Extension

Lapeer County

- *Burlington Township*
  - Adams
  - Alams
  - Arnold
  - Burlington
  - Galbraith
  - Indian Creek
  - McKillop
  - McKillop, Darcy Branch
  - Morrison
  - Moyer
  - Moyer, East Branch
  - Moyer, South Branch
  - Negus Inter-County, Sanilac Co.
  - Negus, West Branch
  - North Branch Hobson A
  - North Branch Hobson B
  - North Branch Hobson C
  - North Branch Hobson D
  - North Clifford
- *Burlington Township – continued*
  - Rutledge & Edwards
  - Slattery
  - South Clifford
  - Stiver
  - Stover-Bently
  - Taft
- *Deerfield Township*
  - Avis
  - Burch
  - Crystal Creek
  - Degrow
  - Degrow, Branch #2
  - Fitch
  - Maxwell
  - Maybury
  - Oliver
  - Sheridan
  - Squaw Creek
- *Marathon Township*
  - Forest
  - Joslin & Coe
  - Kester
  - Martin

Sanilac County

- *Marlette Township*
  - Negus Inter-County, Lapeer Co.

Lapeer County

- *North Branch Township*
  - Bottom Creek
  - Elm Creek
  - Fishell
  - Gravel Bottom & Parsons
  - Lees Lake
- *North Branch Township – continued*
  - North Branch & Burlington
  - Rockwell
  - Wilson Hodge & Slattery
- *Oregon Township*
  - Bradford
  - Mc Keen Lake
- *Rich Township*
  - Adison
  - Bass-Cheeney
  - Batchelor
  - Cable
  - Cable, Branch #1
  - Clink Branch
  - Deerlick
  - Dillon Branch
  - Drake
  - Fostoria
  - High
  - Indian Creek
  - Kinney
  - Lyons
  - Lyons Branch
  - North County
  - North County, South Branch
  - Number 5
  - Number 5, Branch A
  - Number 5, Branch B
  - Rich
  - Rumph
  - Silver Creek
  - Squaw Creek, Branch #1
  - Squaw Creek, Branch #2
  - Sutler & Eightline

Upper Flint

Oakland County

- *Brandon Township*
  - A.J. Taylor
  - Bald Eagle Lake
  - County Line Inter-County, Lapeer Co.
  - Craft
  - Kent
  - Rhome Inter-county, Lapeer Co.
  - Woolman-Wells
- *Groveland Township*
  - Field
  - Paddison Inter-County, Genesee Co.
  - Slack Lake Inter-County, Genesee Co.
- *Holly Township*
  - Brace Inter-County, Genesee Co.
  - Sir Inter-County, Genesee Co.
  - Swartz Creek
  - Tiffany & Smith

Genesee County

- *Atlas Township*
  - Atlas Road Branch Hurd-Campbell
  - Cartwright and Extension Branch 1
  - Cartwright and Extension Branch 2
  - Cartwright and Extension Branch 3
  - Cummings
  - Davison Extension
- *Atlas Township – continued*
  - Hurd-Campell Extension
  - Jordan
  - Kipp
  - La Salle
  - Liscombe and Staton
  - Liscombe and Staton Branch
  - Liscombe and Staton Branch 1
  - Mc Neil
  - Mc Neil Branch
  - Medbury
  - Paddison
  - Perry Road Branch Thread Creek

Table 7.–Continued.

Upper Flint, *Genesee County* – continued

- *Atlas Township – continued*
  - Raynor
  - Raynor Branch
  - Ries
  - Schuman
  - Slack
  - Stein
  - Thread Creek Cleanout
  - York
  - York Branch 1
  - Zimmerman Branch Thread Creek
- *Burton Township*
  - Ala Street Extension
  - Alcona Drive Branch
  - Amy Street Branch Gilkey Creek
  - Belsey Road Branch Gilkey Creek
  - Branch 1 Robinson
  - Branch 2 Robinson
  - Branch Curtis
  - Branch No.1 Ives Avenue
  - Branch of Coates Ext. Gilkey Creek
  - Branch Phillips
  - Branch Schram
  - Brier
  - Brookwood
  - Brown Branch Gilkey Creek
  - Burton
  - Calvin Street Branch Richards
  - Cashin
  - Cast Branch Richards
  - Center & Bristol Rd. Br. Thread Ck.
  - Clark Street Branch Gilkey Creek
  - Coates Extension Gilkey Creek
  - Cochran
  - Coleman Branch 4 Brier
  - Curtis
  - Donovan Street Branch Schram
  - Drexel Park Branch Robinson & Curtis
  - East Branch Phillips
  - East Extension Richards
  - Eugene Street Branch Phillips
  - Extension East Branch Gilkey Creek
  - Extension Gibson
  - Extension Ives Avenue
  - Extension No.1 Robinson & Curtis
  - Fenton & Judd Road
  - Forest Avenue
  - Friel Street Extension Gibson
  - Genesee Road Branch Gilkey Creek
  - Gilkey Creek
- *Burton Township – continued*
  - Graham Branch Term Street
  - Granger
  - Graves Branch Thread Creek
  - Hemphill Road
  - Howe Road Branch Thread Creek
  - Iron Street
  - Ives Avenue
  - Judd Road Extension Gibson
  - Judd Road Extension Schram
  - Kehoe
  - Ketsler Branch Gilkey Creek
  - Kettering Street Branch Gilkey Creek
  - Kidd Branch
  - Kra-Nur Farms
  - Laduke Branch Gilkey Creek
  - Lapeer and Howe Road
  - Lapeer Road Branch Gilkey Creek
  - Meadows Branch Curtis
  - Morrish Street Branch Robinson
  - Nelson Street Branch Gilkey Creek
  - Pear Street Extension Richards
  - Pierson Branch Thread Creek
  - Quinn
  - Randau Branch East Ext. Richards
  - Raymond Branch Gilkey Creek
  - Raymond Street Branch Richards
  - Richards
  - Rinn Street Branch Gilkey Creek
  - Risedroph Extension
  - Robinson
  - Rumph 2
  - Schram & Extension
  - Shubert Street Branch
  - Sloan Extension Springfield
  - Springfield
  - Statler
  - Surrey Lane Extension Richards
  - Term Street
  - Tower
  - Walsh Extension
  - Washtenaw Extension Richards
  - Wright Branch Schram
- *Clayton Township*
  - Castor
  - Castor Wilson
  - Castor-Willis
  - Conlin
  - Conlin Branch 1
- *Davison Township*
  - Barden Street Branch Phillips
  - Big Swamp
  - Branch 1 Cummings
  - Branch Big Swamp
  - Branch Hathaway
  - Branch Hock & Walterhouse
  - Brier Creek
  - Bristol Road Branch Phillips
  - Clapsaddler
  - Clapsaddler Extension
  - Cummings Branch Black Creek
  - Dixon Rd. Br. Bristol Rd. Br. Phillips
  - Dumanois
  - Fromwiller Branch Long Lake
  - Hasler Creek
  - Hasler Inlet
  - Hathaway
  - Heal Branch Big Swamp
  - Hock & Walterhouse
  - Hoyle
  - Hoyle Branch 1
  - Kessling Street Branch Phillips
  - Kingsley Branch Long Lake
  - Lamos
  - Long Lake
  - Montaque
  - Morey Branch Big Swamp
  - Phillips
  - Powell Extension Big Swamp
  - State Road Branch Kearsley Creek
  - Stiles Branch Phillips
  - Vassar & Atherton Rd. Br. Phillips
  - Vassar Park Branch Phillips
  - Velat
  - White
- *Fenton Township*
  - Branch 1 Indian Creek
  - Branch 1 Kimball
  - Branch 2 Indian Creek
  - Branch 3 Indian Creek
  - Jennings Branch Petry Br.Indian Ck.
  - Parker Branch Dawe
- *Flint Township*
  - Baker
  - Bronx
  - Bronx Extension
  - Call & Extension
  - Carman Creek
  - Chevrolet Outlet

Table 7.–Continued.

Upper Flint, *Genesee County* – continued

- *Flint Township – continued*

Colonial Village No. 2 Extension Baker
Darby Extension Baker
Extension Baker
Extension Gibson
Fenton & Judd Road
Franklin
Franklin Extension
Friel Street Extension Gibson
Genesee Valley Br. W Br. Swartz Cr.
Gerard Station Extension Baker
Haven Baker
Hewlet
Howland
Judd Road Extension Gibson
Ketzler
Lizard Valley
Miller Road Branch Swartz Creek
Parkwood
Pinkwich #2 Extension Sherwood
Pinkwich #3 Extension Sherwood
Pinkwick Extension Sherwood
Piper Extension Call
Radcliff Street
Romayne Hts. & Extension
Sherwood
Swartz Creek
Tupper Branch Swartz Creek
Van Campen Street
Warner
West Branch Swartz Creek
White Extension Swartz Creek

- *Forest Township*

Averill
Barden Br. Butternut Creek
Branch 1 Misner
Branch 2 Misner
Branch Coe
Branch No. 1 Parker and Scotham
Coe
Crawford Lake
Extension Coe
Extension Coe Branch
Garnsey
Jackson Branch of Butternut Creek
Johnson
Lateral A Parker and Scotham
Lateral Branch Coe
Misner
Parker Extension Coe

- *Forest Township – continued*

Simmons Br. Butternut Creek
Walker Lake

- *Gaines Township*

Alger Creek
Alger Creek and Lum
Bloss Branch Alger Creek
Branch 1 Lum
Branch 1 Vincent
Branch No. 1 Alger Creek
Branch Spillane
Covey
Crapo & Extension
Crapo & Extension
Daniels
Dart
First Street Branch Swartz Creek
Houghton
Lum and Extension
Maple & Crapo Street
Miller Road
Morrish Road Extension Lum
North Branch Swartz Creek
Penny Branch Alger Creek
School Street
Sewer
Slocum
Spillane
Steele
Vincent

- *Genesee Township*

Abbott Extension Richfield Road
Bear Swamp Ditch
Becker Extension Throop
Berneda Road Extension Hill
Branch Crampton
Branch Kehoe
Bray & Mt Morris Road
Brown
Butternut Creek
Callahan
Calumen Manor Branch Crampton
Carpenter
Cashin Branch Richfield Road
Catheart
Centerwood Extension Callahan
Coggins
Cornwell
Crampton
Dow Dall Branch Hill

- *Genesee Township – continued*

Dot Avenue Branch Hill
Extension Callahan
Extension Genesee Rd. Br. Crampton
Extension No.1 Dow Dall Branch Hill
Frances Road Branch Wager
Gehring Extension Kehoe
Genesee
Genesee Road Branch Crampton
Hammond Extension Callahan
Hardy
Hill
Hill Extension
Hillier
Kearsley Branch Carpenter
Kehoe
Knapp Street Branch Kearsley Creek
Kurtz
Lanning Extension Callahan
Lepard
Mall Branch Crampton
Marilyn Branch Hill
McCanness Branch Crampton
McCorkle Extension
Moss
Pear St. Branch Lanning Ext.Callahan
Peteron Branch Crampton
Potter Road Branch Kearsley Creek
Richfield Road
Riskin
Roberts Extension Crampton
Saxton
Sinkhole
Throop
Throop Extension
Throop No. 2
Vassar Road Branch Sinkhole

- *Grand Blanc Township*

Baldwin Road Branch Groat
Bare
Br.1 Eggleston Ave. Ext. Sherwood
Branch 1 Crosby Branch Layman
Branch 1 Gibson
Branch 2 Crosby Branch Layman
Branch 3 Crosby Branch Layman
Branch Gilkey Creek
Branch Layman
Branch No. 1 Meyers
Branch No. 1 Slack Lake
Branch Seaver

Table 7.–Continued.

Upper Flint, *Genesee County* – continued

- *Grand Blanc Township – continued*

Brookview
Burgess Branch Sherwood
Bush
Chapin Street
Coolidge Extension
Crosby Branch Layman
Cross Branch Gibson
Day
Dort Hwy. Improvement
Eames
Gibson
Grand Blanc & Extension
Groat
Helman
Hickory Hill Br. Crosby Br. Layman
Hill Road Extension Meyers
Holly Spring Extension Seaver
Layman
Little Extension Hill Rd. Br. Sherwood
Lizotte Branch Seaver
Londrigan Embury Branch Layman
Mancour
Marson Branch Layman
Martin
Marvin
Massey Br. Embury Rd. Ext. Layman
McGregor Street Branch Layman
Meyers & Extension
Miller Branch
Oak Hills Extension Branch Seaver
Ottawa Hill Branch Sherwood
Page Branch Thread Creek
Perry
Pierson Branch Sherwood
Ransom St. Br. Hill Rd. Br. Sherwood
Raven Road Branch Thread Creek
Reid Road Branch Gibson

- *Grand Blanc Township – continued*

Reid Road Branch Sherwood
Russell Street Extension
Sherwood
Sir
Slack Lake
Valley Lake Branch Gibson
Welch
Wells

- *Mundy Township*

Baker
Baldwin Road Branch Indian Creek
Bigelow
Bloss & Extension
Branch No.1 Brewer
Brewer
Britton Acres Branch Brewer
Castor
Dawe
Decker Branch Call
Extension Hill Rd. Br. Sherwood
Extension Maple Rd. Br. Sherwood
Glass
Grand Blanc Rd. Br. Bigelow
Hill Road Branch Sherwood
Hungerford
Indian Creek & Extension
Johnson Branch Swartz
Kimball
Linden & Cook Rd. Br. Howland
McCullough
Petry Branch Indian
Seaver
Selarno Extension Sherwood
Selden
Thorn Branch Howland
Torrey
Torrey Branch Dawe

- *Mundy Township – continued*

Wendt
White

- *Richfield Township*

Arcadia Branch Sinkhole
Austin
Bird
Black Creek & Big Swamp
Black Lake & Big Swamp
Branch 1 Austin
Branch 2 Austin
Branch 3 Austin
Burkett Extension Blight
Comrad
Cullen-Powers
Davis & Mill
Fellows
Hotchkiss
Hubbard
Perkins
Prowent
Prowent Branch 1
Prowent Branch 2
Simmons
Wood & Cullen

- *Thetford Township*

Branch 1 Wilbur
Buell
Buell Extension
Buell Extension Branch 1
Buell Extension Branch 2
Drudge
Extension Geiger
Extension Wilbur
Farr
Jobson
Maxwell
Wager
Wilbur

Middle Flint

Genesee County

- *Clayton Township*

Bendle
Branch Bendle
Craney
Gilbank
Goyer
Long Road Branch Cole Creek
McVay Extension Bendle

- *Clayton Township – continued*

Messmore and Cronk
Seymour (non-county drain)

- *Flint Township*

Ballenger Highway
Beane Extension Burroughs
Beecher Road
Branch 1 Randall Extension Ryant
Branch 2 Extension Ryant

- *Flint Township – continued*

Branch Hunters Ridge Extension Case
Branch Ryant
Brobeck Extension Branch Ryant
Brockway Branch Ryant
Burroughs
Carmonwood
Case
Case Hts. Branch Case

Table 7.–Continued.

Middle Flint, *Genesee County* – continued

- *Flint Township – continued*
  Chapman
  Chapman Extension
  Clio & Flushing Roads
  Cullen Extension
  Dayton Street
  Eberly Street Branch Burroughs
  Eggleston
  Elk Street Branch Ryant
  Extension 1 Hialer Gard Branch Ryant
  Extension Ryant
  Gilbert Street Branch Chapman
  Hartman
  Hartshorn
  Hollingsworth & Extension
  Hollingsworth Extension 1
  Hollingsworth Extension 2
  Hunters Ridge Extension Case
  Kelly Branch Eggleston
  La Vall Road
  Lask
  Linden & Flushing Road
  Linden Road Branch Hartshorn
  Mansour Branch Ryant
  Maxson Street
  Metson
  Mill Road
  Mill Road Yards
  Natherly Burnell Walton Street
  Phame
  Potbury Branch Ryant
  Potbury Extension
  Ryant
  Stratford Street Extension
  Vogelsburg
  Vosburg
  W. Court St. Br. Messmore-Cronk
  Walnut Street Branch Extension Ryant
  Watson Branch Ryant
  Whitney Street Extension Chapman
- *Flushing Township*
  Boman
  Branch 1 Freeman
  Branch 1 Hertrich Branch Freeman
  Branch 2 Rowe
  Brent Creek
  Brentwood Farms
  Cattail Swamp
- *Flushing Township – continued*
  Cheney
  Cole Creek
  Cottrell
  Crooked Creek
  Duffield Branch Freeman
  Elms Road Branch French
  Extension Messmore & Cronk
  Fieman Branch Boman
  Flushing School
  Freeman
  French
  Glenn Jones
  Hertrich Branch Freeman
  Kelland
  McKinley & Coldwater Road
  Moore Estension Freeman
  Partridge
  Reed Outlet Cole Creek
  Root
  Rowe
  Seymour Road Branch Flint River
  Shillman
- *Montrose Township*
  Brent Run
  Clements
  Cross
  Fairchilds
  Huggins
  Kilpatrick
  Liba
  Marshall Road Outlet
  McAffee
  McKinley & Frances Road
  Morrish & Frances Road
  Reed
  Wilcox
- *Mt. Morris Township*
  Angola Avenue Extension
  Blackmore
  Branch 1 Craven & Benson
  Branch 1 French
  Branch Carpenter
  Branch Central
  Branch Lake
  Branch No.1 Collins
  Branch No.1 Hartshorn
  Carpenter No.1
- *Mt. Morris Township – continued*
  Central
  Clio & Frances Road
  Craven & Benson
  Dalton Extension Minard
  Daly
  Delaney
  Delaney Branch 1
  Delaney Branch 2
  Dubzinski Branch
  Elmorest Extension Craven & Benson
  Extension Branch Lake
  Extension No.1 Carpenter
  Extension No.1 Northgate Br. Hughes
  Florine Avenue Branch Lake
  Gaut Extension Branch Lake
  Hannan
  Hannan Relife
  Hawkshaw
  Hawkshaw Branch 1
  Huges
  Keith Branch Craven & Benson
  Kimberly Woods Extension Central
  Kimberly Woods Extension Stadler
  Lake
  Lateral A Hartshorn
  Lateral B Hartshorn
  Lewis
  Linden Road Extension Cattail
  Lucy Branch Hartshorn
  McAlpine Branch Hughes
  McClosky
  Minard
  Monroe Branch Root
  Neff Road Branch Hannan
  Neff Road Branch Mason
  Northgate Branch Lake
  Payne Branch Hartshorn
  Pierson Road Branch Hartshorn
  Schoolpark Branch Hughes
  Spens Extension No.1 Carpenter
  Stadler
  Woodland Extension Branch Root
  Woolfitt
  Wright Branch Root
  Zimmerman
- *Vienna Township*
  Forest Pines Branch Liba

Table 7.–Continued.

Lower Flint

Shiawassee County

- *Caladonia Township*
  - Galloway West Branch
- *Hazelton Township*
  - Bailey
  - Bailey Joint
  - Barrett
  - Beamish
  - Butler
  - Caledonia & Venice
  - Compton
  - Coon
  - Cronk
  - Fuller
  - Galloway
  - Garrison
  - Horton & Holmes
  - Jacobs
  - Morrison
  - North Creek – Orser
  - Onion Creek
  - Parkinson
  - Pettie Swamp
  - Porter Creek
  - Puffer
  - Ransom
  - Rush Creek
  - Sherman
  - Shippey
  - Smith-Lyons
  - Van Zant
  - White
- *New Haven Township*
  - Aymour
  - Butcher
  - Christian
  - Murray
  - Richardson
  - Riley
  - Seward
  - Smith
  - Totems
- *Venice Township*
  - Augsbury
  - Augsbury #2
  - Baker #2
  - Calkins
  - Carlin
  - Crawford
- *Venice Township – continued*
  - Ganssley
  - Gidley
  - Johnson #2
  - Koan
  - Lawcock
  - Limbarg
  - Long
  - Quay
  - Rush Creek Branch 1
  - Saxon
  - Smith-Lyons Inter-Co., Genesee Co.
  - Thompson
  - White #2
  - Whitely Inter-County, Genesee Co.

Saginaw County

- *Albee Township*
  - Becker
  - Bortle
  - Denslow
  - Dundee
  - Ivey
  - Ivey Branch #1
  - Ivey Branch #2
  - Koepke
  - Milks
  - Misteguay Creek
  - Mitchell Creek
  - Munson
  - Oaks
  - Peart
  - Savage
  - Verns
- *Birch Run Township*
  - Birch Run South West
  - Bogart
  - Briggs
  - Briggs Branch #2
  - Higal
  - Page Tile
  - Runnel Branch
  - Runnels
  - Silver Creek Extension
  - Trinklein
- *Maple Grove Township*
  - Andres
  - Bouck
  - Bouck Branch #2
  - Bouck Branch #3
- *Maple Grove Township – continued*
  - Branch
  - Deyoung
  - Eickholt
  - Misteguay Creek Estates
  - Mitchell Creek Branch #1
  - Mitchell Creek Branch #3
  - Mitchell Creek Branch #5
  - Northwood Creek
  - Sigmund
  - Special #12
  - Special #7
  - Spencer
  - Tupper
  - Yaklin
- *Taymouth Township*
  - Alexander
  - Atwell
  - Coon
  - Hutchinson & Young
  - Mc Nally Ditch
  - Mc Namara
  - Moore
  - Morse
  - Nichols Branch
  - Pine Run
  - Silver Creek
  - Springbrook
  - West Branch Springbrook
  - Woodward

Genesee County

- *Argentine Township*
  - Pettit
- *Clayton Township*
  - Branch Harrison
  - Branch Ottaway
  - Bristol Road Extension Harrison
  - Cozodd
  - East Lewis Branch Sprague
  - Goodwin
  - Harding
  - Harrison
  - Hudson
  - Lennon
  - Lennon Road Branch Harrison
  - Lewis Branch Sprague
  - Lyons
  - Miller Road and Extension
  - Miller Road Extension Smith

Table 7.–Continued.

Lower Flint, *Genesee County* – continued

- *Clayton Township – continued*
  Mistegaic
  Moore
  Ottaway
  Ottaway Branch
  Penoyer
  Post Extension
  Slack
  Slack Extension
  Smith
  Smith Branch 1
  Smith-Lyons
  Southeast Branch Lennon
  Sprague
  Syemour Road Branch Sprague
  Tice
  Traynor
- *Genesee Township*
  Adams Extension Walter Street Branch
  Alexandrine Branch Mason
  Branch No.2 Hughes
  Brock Branch
  Brock Branch Extension
  Coldwater Road Extension Hughes
  East Henshaw Branch Mason
  Elizabeth Street Branch Mason
  Extension Hughes
  Hughes & Extension
- *Genesee Township – continued*
  Rae Branch Mason
  Rockwell Branch
  Selby Street Branch Mason
  Walter Street Branch Mason
- *Montrose Township*
  Branch Montrose
  Branch No.1 Montrose
  Clayton Branch Pine Run
  Elms & Vienna (Pitch Creek)
  Feller
  Gibson
  Guinan
  Herman
  Leach
  Montrose
  Pine Run
  Watterman
- *Mt. Morris Township*
  Roberts Branch Mason
  Tillte Branch Hatshorn
- *Thetford Township*
  Powers
- *Vienna Township*
  Mason
  Alpine & McAllistser
  Alpine and Blackmore
- *Vienna Township – continued*
  Barnes Extension Langdon
  Birch Run Southwest
  Boutell
  Branch No.1 Clark
  Branch Silver Creek Extension
  Branch Wisner
  Clio Rd. Improvement Extension
  Collins
  Cooper Branch Silver Creek
  DeLong Br. Alpine and Blackmore
  Farrandville Br. Alpine & Blackmore
  Haven & Dexter Street
  Hurd
  Krampe
  Langdon
  Lewis
  Neelands
  Nesbitt Branch Collins
  Pine Run & Tryone
  Runnels
  S. Clio Hieghts Br. Langdon
  Vienna Road Branch Pine Run
  Wardle Br. Pine Run & Tryone
  Wilson & Linden
  Wing
  Wisner

Table 8a.–State statutes administered by Michigan Department of Environmental Quality, Land and Water Management Division, that protect the aquatic resource. N.R.E.P. Act = Natural Resource Environmental Protection Act. Data from: Beam and Braunscheidel 1996.

State of Michigan Acts	Previous Statute
Public Health Code (1978 PA 386, as amended)	Amendments to Aquatic Nuisance Control Act (PA 86, 1977)
Part 13 N.R.E.P. Act (1994 PA 451)	Floodplain Regulatory Authority (PA 167, 1968)
Part 91 N.R.E.P. Act (1994 PA 451)	Soil Erosion & Sedimentation Control Act (Pa 347, 1972)
Part 301 N.R.E.P. Act (1994 PA 451)	Inland Lakes and Streams Act (PA 346, 1972)
Part 303 N.R.E.P. Act (1994 PA 451)	Wetland Protection Act (PA 202, 1979)
Part 307 N.R.E.P. Act (1994 PA 451)	Inland Lake Level Act (PA 146, 1961)
Part 309 N.R.E.P. Act (1994 PA 451)	Inland Improvement Act (PA 300, 1989)
Part 315 N.R.E.P. Act (1994 PA 451)	Dam Safety Act (PA 300, 1989)
Part 323 N.R.E.P. Act (1994 PA 451)	Shoreland Protection & Management Act (PA 245, 1970)
Part 341 N.R.E.P. Act (1994 PA 451)	Irrigation District Act (PA 205, 1967)

Table 8b.–Federal statutes administered by Michigan Department of Environmental Quality, Land and Water Management Division, that protect the aquatic resource. Data from: Beam and Braunscheidel 1996.

U.S. Federal Acts
Federal Water Pollution Control Act, Section 314 (PL 92-55)
Coastal Zone Management Act (PL 92-583,1972)
Clean Water Act, Section 404 (PL 95-217)
River and Harbor Act, Section 10 (1899)
Coastal Energy Impact Program (PL 92-538)
Water Resources Development Act (PL 93-251)

Table 9.–National Pollution Discharge Elimination System permits issued in the Flint River watershed by Michigan Department of Environmental Quality, Surface Water Quality Division.

Location	Receiving water	Designated name	Permit type
Upper South Branch			
Oxford	South Branch Flint	AAM-Oxford	Individual permit
Oxford	South Branch Flint	Barroncast Inc.	Individual permit
Oxford	Unnamed trib.of S. Branch	Brazeway Inc.	Individual permit
Oxford	South Branch Flint	MSP Industries Corp.	Storm water from industrial activities
Oxford	South Branch Flint	MSP Industries-Plexus Dr.	Storm water from industrial activities
Middle South Branch			
Lapeer	Farmers Creek	Krutz Gravel Co.	Storm water from industrial activities
Lapeer	Farmers Creek	Carlisle Engineered Products	Storm water from industrial activities
Lapeer	Farmers Creek	Mich ARNG-Lapeer Armory	Storm water from industrial activities
Lapeer	Farmers Creek	Lapeer Industries Inc.	Storm water from industrial activities
Lapeer	Farmers Creek	Lapeer Auto & Truck Salvage	Storm water from industrial activities
Elba	Farmers Creek	Elba Twp-Lake Nepessing WWSL	Waste water stabilization lagoon discharge
Lapeer	Hunters Creek	Foamseal-Lapeer	Non-contact cooling water discharge
Lapeer	Hunters Creek	Byrnes Tool Co.	Storm water from industrial activities
Lapeer	Hunters Creek	Albar Industries Inc.	Storm water from industrial activities
Lapeer	Hunters Creek	Camtron Coatings Co.	Storm water from industrial activities
Lapeer	Hunters Creek	Peninsular Slate Co.	Storm water from industrial activities
Lapeer	Hunters Creek	Foamseal	Storm water from industrial activities
Metamora	Kintz Creek	Metamora WWSL	Waste water stabilization lagoon discharge
Lapeer	Miller Drain	Kamax-GB Dupont LP	Storm water from industrial activities
Lapeer	Pine Creek	Pine Lakes MHP	Individual permit
Lapeer	Plum Creek	Lapeer Manufacturing Co.	Storm water from industrial activities
Lapeer	Plum Creek Drain	Durakon Industries Inc.	Individual permit
Lapeer	Roods Lake & Evans Drain	Mayfield-Dupont Lapeer Airport	Storm water from industrial activities
Lapeer	South Branch Flint	Lapeer WWTP	Individual permit
Lapeer	South Branch Flint	Cambridge Industries Inc.	Storm water from industrial activities
Lapeer	South Branch Flint	Precision Machining Co.	Storm water from industrial activities
Lapeer	South Branch Flint	River Ridge Mfg. Home Comm.	Waste water stabilization lagoon discharge
Lapeer	South Branch Flint	MDEQ-ERD-Oregon Twp.	Waste water cleanup, contaminated petroleum/gas products
Lower South Branch			
Fostoria	Burch Drain	Bobs Auto Parts	Storm water from industrial activities
Lapeer	Crystal Creek	Total Petroleum Inc.	Individual permit
North Branch	Crystal Creek	Deerfield Pines WWSL	Individual permit
North Branch	Fitch Ditch	M K Chambers Co.	Storm water from industrial activities
Clifford	Indian Creek	Lablancs Auto Salvage Inc.	Storm water from industrial activities
Clifford	Indian Creek	Clifford WWSL	Waste water stabilization lagoon discharge
North Branch	North Branch Drain	North Branch WWSL No 2	Individual permit
Marlette	North Branch Flint	Eugene Welding Supply	Storm water from industrial activities
North Branch	North Branch Flint River	North Branch WWSL	Waste water stabilization lagoon discharge
Columbiaville	South Branch Flint	Wolverine Christ Service Camp	Individual permit
Mayville	Squaw Creek	Mayville WWSL	Individual permit

Table 9.–Continued.

Location	Receiving water	Designated name	Permit type
Upper Flint River			
Flint	Sherwood Drain	BFI	Storm water from industrial activities
Grand Blanc	Bare Drain	First Inertia Switch	Storm ater from industrial activities
Grand Blanc	Bare Drain	L & L Machine Tool Inc.	Storm water from industrial activities
Holly	Bare Drain	United Dominion-TM Inc.	Storm water from industrial activities
Grand Blanc	Bare Drain	Venture Ind-Vemco Inc.	Storm water from industrial activities
Davison	Black Creek	Fernco Inc.	Storm water from industrial activities
Lapeer	Black Creek	Lapeer CDC-Potters Lake	Waste water stabilization lagoon discharge
Davison	Black Creek	Davison PS	Waste water cleanup, contaminated petroleum/gas products
Burton	Burton Drain	Burton Auto Parts	Storm water from industrial activities
Burton	Burton Drain	Schmald Tool & Die Inc.	Storm water from industrial activities
Flint	Call Drain	GM-Flint Metal Center	Individual permit
Flint	Call Drain	Premiere Packaging Inc.	Individual permit
Flint	Call Drain	Fabricating Engineers Inc.	Storm water from industrial activities
Flint	Call Drain	Yellow Freight System	Storm water from industrial activities
Flint	Call Drain	GM-MFD-Flint Metal Center	Storm water from industrial activities
Flint	Call Drain	Grand Trunk WRR	Storm water from industrial activities
Flint	Carman Creek	GM-Flint V8	Individual permit
Flint	Carman Creek	ABF Freight System	Storm water from industrial activities
Flint	Carman Creek	GM-Flint V8	Storm water from industrial activities
Flint	Carmen Creek	GM-PTG-Flint Engine South	Storm water from industrial activities
Flint	Carmen Creek	Corrigan Moving Systems	Storm water from industrial activities
Otisville	Coe Drain	Otisville WWTP	Individual permit
Otisville	Coe Drain	Orchard Cove MHP WWTP	Individual permit
Flint	Cornwell Drain	Genesee Power Station	Storm water from industrial activities
Clio	Drudge Drain	Robert Eastman-Quick Sav #2	WW cleanup, contaminated petroleum/gas products
Flint	Flint River	GM-Truck & Bus-Flint Assembly	Individual permit
Flint	Flint River	GM-NAO	Individual permit
Flint	Flint River	GM-Service Parts Oprtns	Individual permit
Flushing	Flint River	Flushing WWTP	Individual permit
Flint	Flint River	Flint WWTP	Individual permit
Flint	Flint River	Mobil Oil Corp-Flint Terminal	Individual permit
Flint	Flint River	Total Petro Inc-Flint #2695	Individual permit
Flint	Flint River	MDOT-Flint MS4	Individual permit
Flint	Flint River	PPG Industries Inc.	Individual permit
Flint	Flint River	Spooner Sales-Dort Hwy.	Storm water from industrial activities
Flint	Flint River	ACCI-Flint-West Bristol	Storm water from industrial activities
Flint	Flint River	Flint Enterprises Inc.	Storm water from industrial activities
Flint	Flint River	Doyles Auto Salvage	Storm water from industrial activities
Flint	Flint River	Myers Cut Rate Auto Parts	Storm water from industrial activities
Flint	Flint River	Genesee Auto Salvage	Storm water from industrial activities
Flint	Flint River	Marko Metal Ltd.	Storm water from industrial activities
Flint	Flint River	Henry H Stevens Inc.	Storm water from industrial activities
Flint	Flint River	MAST Services LLC	Storm water from industrial activities
Flint	Flint River	United Plastics Inc.	Storm water from industrial activities
Flint	Flint River	B-B Paint Corp.	Storm water from industrial activities
Flint	Flint River	Consolidated Freightways-FLT	Storm water from industrial activities
Flint	Flint River	Flint WWTP	Storm water from industrial activities

Table 9.–Continued.

Location	Receiving water	Designated name	Permit type
Upper Flint River (continued)			
Flint	Flint River	SLC-Genesee Recycling	Storm water from industrial activities
Flint	Flint River	Industrial Iron & Metal	Storm water from industrial activities
Flint	Flint River	Kasper Industries Inc.	Storm water from industrial activities
Flint	Flint River	Lockhart Chem Co.	Storm water from industrial activities
Flint	Flint River	Country Fresh-McDonald Dairy	Storm water from industrial activities
Flint	Flint River	Reno Auto Parts	Storm water from industrial activities
Flint	Flint River	Resource Recovery of Flint	Storm water from industrial activities
Flint	Flint River	USPS	Storm water from industrial activities
Flint	Flint River	GM-Truck & Bus-Flint Assembly	Storm water from industrial activities
Flint	Flint River	Spooner Auto Parts	Storm water from industrial activities
Flint	Flint River	Spooner Sales Inc.	Storm water from industrial activities
Flint	Flint River	Flint WTP	WW discharge from municipal potable water supply
Flint	Franklin Drain	Koegel Meats Inc.	Non-contact cooling water discharge
Mount Morris	Geiger Drain	CPCO-Thetford Generating	Storm water from industrial activities
Grand Blanc	Gibson Drain	Metokote Corp.-Reid Road	Storm water from industrial activities
Burton	Gilkey Creek	United Cleaners Inc.	Individual permit
Flint	Gilkey Creek	Delphi E-Flint East	Storm water from industrial activities
Flint	Gilkey Creek	Barrett Paving-Flint Plant 114	Storm water from industrial activities
Flint	Gilkey Creek	Coca-Cola Company	Storm water from industrial activities
Flint	Gilkey Creek	Genesee Packaging Inc.	Storm water from industrial activities
Flint	Gilkey Creek	Mid-State Plating Co.	Storm water from industrial activities
Flint	Gilkey Creek	Mich ARNG-Flint Armory-OMS 3	Storm water from industrial activities
Flint	Gilkey Creek	Plastics Research Corp.	Storm water from industrial activities
Flint	Gilkey Creek	Stokes Steel Treating Co.	Storm water from industrial activities
Columbiaville	Holloway Reservoir	Columbiaville WWSL	Individual permit
Flint	Kearsley Creek	Complete Auto-Foreign Car	Storm water from industrial activities
Flint	Kearsley Creek	Complete Auto & Truck Parts	Storm water from industrial activities
Flint	Kearsley Creek	Complete Recycling Inc.	Storm water from industrial activities
Goodrich	Kearsley Creek	GCRC-Atlas Maint. Garage	Storm water from industrial activities
Goodrich	Kearsley Creek	Kens Redi-Mix Inc.	Storm water from industrial activities
Flint	Kearsley Creek	Lorbec Metals USA LTD	Storm water from industrial activities
Flint	Kearsley Creek	Genesee Lube Express Inc.	WW cleanup, contaminated petroleum/gas products
Burton	Kearsley Reservoir	Carl Schultz-Burton-Richfield	Individual permit
Flint	Kearsley Reservoir	Richfield Iron Works Inc.	Storm water from industrial activities
Flint	Kearsley Reservoir	Corsair Engineering Inc.	Storm water from industrial activities
Fenton	Lake Fenton	Charter House-Carpenter Ent.	Storm water from industrial activities
Flint	Moon & Gilkey Creek	Mass Trans Authority	Storm water from industrial activities
Mount Morris	Mott Lake	Marathon Ashland-Mott Lake	Hydrostatic pressure test water discharge
Mount Morris	Mott Lake	Marathon Oil Co.	Individual permit
Davison	Parker Scothan Drain	Clean-Up-Richfield Landfill	Storm water from industrial activities
Lapeer	Pero Lake & Henry Drain	Lapeer Co. Parks & Rec. Comm.	Individual permit
Davison	Powers Cullen Drain	Carl Schultz Inc.	Individual permit
Davison	Reigle Drain	Ferguson Block Co. Inc.	Storm water from industrial activities
Flint	Riskin Drain	CSX Transportation	Storm water from industrial activities
Otisville	Sand Lake & Coe Drain	GCRC-Otisville Maint. Garage	Storm water from industrial activities
Burton	Schram Drain	Genesee Polymers Corp	Non-contact cooling water discharge
Burton	Schram Drain	Bituminous Pavers Inc.	Storm water from industrial activities

Table 9.–Continued.

Location	Receiving water	Designated name	Permit type
Upper Flint River (continued)			
Burton	Schram Drain	Genesee Polymers Corp.	Storm water from industrial activities
Flint	Sherwood Drain	Stone Transport-Flint Stone	Storm water from industrial activities
Flint	Swartz Creek	Austin-Flint Twp.-Miller Rd	Individual permit
Holly	Swartz Creek	Beasley Foreign Parts	Storm water from industrial activities
Flint	Swartz Creek	Central Transport Inc.	Storm water from industrial activities
Flint	Swartz Creek	Allied Systems Ltd.	Storm water from industrial activities
Flint	Swartz Creek	Bishop International Airport	Storm water from industrial activities
Grand Blanc	Swartz Creek	Citizens Disposal	Storm water from industrial activities
Flint	Swartz Creek	Penkse Transportation	Storm water from industrial activities
Holly	Swartz Creek	RST-Grand Blanc Processing	Storm water from industrial activities
Holly	Swartz Creek	RST-Holly Distribution Center	Storm water from industrial activities
Holly	Swartz Creek	RST-Semco Fastener	Storm water from industrial activities
Holly	Swartz Creek	RST-Titan Fastener	Storm water from industrial activities
Flint	Swartz Creek	UPS	Storm water from industrial activities
Flint	Swartz Creek	Westside Welding & Fabrication	Storm water from industrial activities
Flint	Swartz Creek	GM-MFD-Flint Tool & Die	Storm water from industrial activities
Grand Blanc	Thread Creek	GM-MFD-Grand Blanc Plant	Individual permit
Burton	Thread Creek	Bristol Steel & Conveyor Corp	Storm water from industrial activities
Burton	Thread Creek	Southend Auto Savage	Storm water from industrial activities
Burton	Thread Creek	Laidlaw/USPCI-Muni Scvs Corp	Storm water from industrial activities
Burton	Thread Creek	Ace Asphalt & Paving-Plant 3	Storm water from industrial activities
Burton	Thread Creek	BLD-McGuane Industries	Storm water from industrial activities
Flint	Thread Creek	Mikes Auto Inc.-3220 Dort Hwy	Storm water from industrial activities
Flint	Thread Creek	Mikes Auto Inc.-3560 Dort Hwy	Storm water from industrial activities
Burton	Thread Creek	Delta Cont-Flint Boxmakers	Storm water from industrial activities
Burton	Thread Creek	Flint Manufacturing Company	Storm water from industrial activities
Flint	Thread Creek	GCRC-Flint Maint Garage	Storm water from industrial activities
Grand Blanc	Thread Creek	Grand Blanc Cement Products	Storm water from industrial activities
Flint	Thread Creek	Inter-City Auto Parts	Storm water from industrial activities
Flint	Thread Creek	J & S Auto Salvage	Storm water from industrial activities
Burton	Thread Creek	Londons Dairy-Ice Cream Plant	Storm water from industrial activities
Burton	Thread Creek	M J Manufacturing	Storm water from industrial activities
Grand Blanc	Thread Creek	Metokote Corp.-Plt 8	Storm water from industrial activities
Burton	Thread Creek	Metro Fabricators Inc.	Storm water from industrial activities
Burton	Thread Creek	Tiger Auto Salvage	Storm water from industrial activities
Flint	Thread Creek	Wolf Iron & Metal Co.	Storm water from industrial activities
Grand Blanc	Thread Creek	GM-MFD-Grand Blanc Plant	Storm water from industrial activities
Burton	Thread Creek	Waste Mgt.-Flint Hauling	Storm water from industrial activities
Burton	Thread Creek	Waste Mgt.-Flint Hauling/Trans	Storm water from industrial activities
Burton	Thread Creek	Con-Way Central Express	Storm water from industrial activities
Flint	Unnamed trib.of Mott Lk.	Kurtz Gravel Co.	Storm water from industrial activities
Grand Blanc	Seaver Drain	First Technology PLC-AVC Inc.	Storm water from industrial activities
Middle Flint River			
Flint	Brent Run Creek	Knickerbocker Inc.	Individual permit
Mount Morris	Brent Run Creek	Phil-Flint Oil Co.	Individual permit
Montrose	Flint River	Genesee Co.-Ragnone WWTP	Individual permit
Flint	Flint River	Modern Concrete	Storm water from industrial activities
Flint	Flint River	Delphi E-Flint West	Storm water from industrial activities

Table 9.–Continued.

Location	Receiving water	Designated name	Permit type
Middle Flint River (continued)			
Montrose	Flint River	GCRC-Montrose Maint. Garage	Storm water from industrial activities
Flint	Flint River	Central Concrete Products Inc.	Storm water from industrial activities
Flint	Flint River	Sun Co-Flint #0354-5753	WW cleanup, contaminated petroleum/gas products
Flint	Flint River	Sun Oil Co.	WW cleanup, contaminated petroleum/gas products
Flint	Flint River	Sun Co.-Flint #0354-5837	WW cleanup, contaminated petroleum/gas products
Flint	Hartshorn Drain	Mobil Oil	Individual permit
Flint	Hughes Drain	Peregrine Inc.	Storm water from industrial activities
Lower Flint River			
Montrose	Brent Run Creek	Brent Run Landfill	Storm water from industrial activities
Burt	Flint River	Oakridge MHP	Individual permit
Saginaw	Flint River	Hausbeck Pickle Co. Inc.	Storm water from industrial activities
Freeland	Flint River	Burns Sand Pit	Storm water from industrial activities
New Lothrop	Misteguay Creek	New Lothrop WWSL	Wastewater stabilization lagoon discharge
Clio	Pine Run Creek	Christensen Pond	Sand and gravel mining wastewater
Clio	Pine Run Creek	Blue Lakes Charters & Tours	Storm water from industrial activities
Clio	Pine Run Creek	BP Oil Co.	WW cleanup, contaminated petroleum/gas products
Birch Run	Runnels Drain	USF Holland Inc.	Storm water from industrial activities
Lennon	Rush Creek Drain	Waste Mgt.-Venice Park Facility	Storm water from industrial activities
Birch Run	Silver Creek	Birch Run WWSL	Individual permit
Birch Run	Silver Creek	Republic Waste Industries	Storm water from industrial activities
Birch Run	Silver Creek	Peoples Landfill Inc.	Storm water from industrial activities
Swartz Creek	Smith Drain	GCRC-Swartz Creek Maint. Gar.	Storm water from industrial activities

Table 10.–Contamination sites in the Flint River watershed, by valley segment. Data from Michigan Department of Environmental Quality, Environmental Response Division. Acronyms: T.=township, R.=range, Sec.=section, As=arsenic, Ba=barium, BEHP=bis-2-ethyl hexyl phthalate, BTEX=benzene, toluene, ethylbenzene, and xylene, Cd=cadmium, Cr=chromium, Cu=copper, DCA=dichloroethane, 1,1 DCA=isomer of dichloroethane, 1,2 DCA=isomer of dichloroethane, DCE=dichloroethylene, 1,2 DCE=isomer of dichloroethylene, cis-1,2-DCE=isomer of dichloroethylene, trans-1,2-DCE=isomer of dichloroethylene, Fe=iron, MEK=methyl ethyl ketone, Mg=magnesium, MIBK=methyl isobutyl ketone, Na=sodium, Ni=nickel, Pb=lead, PBB=polybrominated biphenyl, PCB=polychlorinated biphenyl, PCE or PERC=perchloroethylene, PNA=polynuclear aromatic hydrocarbon, Se=selenium, 1,1,1 TCA=isomer of trichloroethane, 1,2,3 TCB=trichlorobenzene, TCE=trichloroethylene, Tl=thallium, TPH=total petroleum hydrocarbons, VOC=volatile organic compound, Zn=zinc.

Site Location	T.	R.	Sec.	Pollutant
Upper South Branch				
Oakland County				
MSP Brazeway	05N	10E	9	TCE
Lapeer County				
Thornville Road Dump	06N	10E	13	PCBs, BTEX, TCE, metals,
Metamora Landfill	06N	10E	10	As, ethylbenzene, xylene
Middle South Branch				
Lapeer County				
Thread Forms	07N	10E	5	Pb, ethylbenzene, xylene, naphthalene
378 County Center Road	07N	10E	5	Cr, Cu, Zn
498 S. Main St.	07N	10E	5	Napthalene, phenanthrene, trimethylbenzene
24.7 A., Genesee St/W Lapeer	07N	10E	5	As, Pb, Zn
Lapeer Cleaners (former)	07N	10E	5	PERC, TCE
Lapeer Manufacturing	08N	10E	20	Fuel oil
Klein Shop Plaza	07N	10E	6	Pb, Se, PERC, TCE, PCBs
Amtrak/Grand Trunk Western RR	07N	10E	5	TPH, heating oil
Harris Property (Furniture Hospital)	07N	10E	3	Pb, PERC, methylene chloride
Greater Michigan Investments	06N	10E	29	Paint wastes
US Post Office, Lapeer	07N	10E	5	Gasoline
Thumb Radiator Service	07N	10E	4	Pb, As, Cr, Cu, Mg, Na, copper sodium
Star Oil Company, Lapeer	07N	10E	5	Gasoline
Lapeer Foundry and Machine Inc.	07N	10E	5	Pb, As, BTEX
Lower South Branch				
Lapeer County				
Leki 4	09N	09E	18	Condensate-BTEX, crude oil, brine/chloride
Lapeer Co. Road Comm., Mayfield	09N	11E	4	Salt
Upper Flint				
Lapeer County				
Perdue and Litwin 1-21	09N	09E	21	Condensate-BTEX, crude oil, brine/chloride
Odishooe and Broughman 2-21	09N	09E	21	Condensate-BTEX, crude oil, brine/chloride

Table 10.–Continued.

Site Location	T.	R.	Sec.	Pollutant
Upper Flint (continued)				
Spaven, Walter 1	09N	09E	16	Condensate-BTEX, crude oil, brine/chloride
Kader McComb Unit 1	09N	09E	18	Condensate-BTEX, crude oil, brine/chloride
Weaver 2-17	09N	09E	17	Condensate-BTEX, crude oil, brine/chloride
Elliott Comm. 1	09N	09E	18	Condensate-BTEX, crude oil, brine/chloride
Marathon, Otter Lake Field	09N	09E	17	Condensate-BTEX, crude oil, brine/chloride
Ross and Aurand Unit 1	09N	09E	17	Condensate-BTEX, crude oil, brine/chloride
Kern, Yvonne (Brynn Blain Farm) 1	09N	09E	16	Condensate-BTEX, crude oil, brine/chloride
Viers, Chester 1	09N	09E	16	Condensate-BTEX, crude oil, brine/chloride
Ulrich, Ralph and wife 1	09N	09E	17	Condensate-BTEX, crude oil, brine/chloride
Spaven, W 2	09N	09E	16	Condensate-BTEX, crude oil, brine/chloride
Richardson, Aurand 1-17	09N	09E	17	Condensate-BTEX, crude oil, brine/chloride
Richardson, James and Doris 1	09N	09E	17	Condensate-BTEX, crude oil, brine/chloride
Newsome, J 1	09N	09E	16	Condensate-BTEX, crude oil, brine/chloride
Newcombe, Clare and Marjorie 2	09N	09E	17	Condensate-BTEX, crude oil, brine/chloride
Newcombe, R K K-1	09N	09E	16	Condensate-BTEX, crude oil, brine/chloride
Kern 2-16	09N	09E	16	Condensate-BTEX, crude oil, brine/chloride
Kern 1-15	09N	09E	15	Condensate-BTEX, crude oil, brine/chloride
Hill, E 3	09N	09E	17	Condensate-BTEX, crude oil, brine/chloride
Fuller, Harold and Pauline 1	09N	09E	16	Condensate-BTEX, crude oil, brine/chloride
Flynn 1-17	09N	09E	17	Condensate-BTEX, crude oil, brine/chloride
Clark 3-16	09N	09E	16	Condensate-BTEX, crude oil, brine/chloride
Broughman 1-15	09N	09E	15	Condensate-BTEX, crude oil, brine/chloride
Otter Lake Marathon Field	09N	09E	18	Hydrogen sulfide
Oregon Township Dump	08N	09E	24	BTEX, vinyl chloride
Genesee County				
Windiate Park/Dixieland Subdivision	07N	07E	29	As, Pb, Ba
GM Truck and Bus Garage	07N	07E	26	As, Pb, BEHP
GM Hemphill Landfill	07N	07E	29	As, Pb, PCB
GM Atherton Landfill	07N	07E	19	Pb
1742 W. Court Street	07N	07E	7	Pb
Woodlawn Park, Lapeer Road	07N	07E	17	Pb
2601-2603 Richfield Road	07N	07E	32	Pb, As, Zn
1419 N. Dort Highway	07N	07E	4	TPH, phenanthrene
4315 S. Dort Highway	07N	07E	33	As, Cd, Cr
2603 Lapeer Road, Parcel B	07N	07E	17	Pb, Cr
Vanderhorst Property	06N	07E	5	BTEX
King-of-All Manufacturing, Inc.	07N	07E	5	1,4 dichlorobenzene, 1,2,4 TCB
High Tech Motors	07N	07E	15	TCE, benzene, Pb, PERC
Oil Chem Inc.	07N	07E	17	Petroleum products, BTEX
Tatrow Merton & Hopper, Aubrey J	09N	08E	11	Condensate-BTEX, crude oil, brine/chloride
Woodrow, Dewey 1-B	09N	08E	12	Condensate-BTEX, crude oil, brine/chloride

Table 10.–Continued.

Site Location	T.	R.	Sec.	Pollutant
Upper Flint (continued)				
Woodrow, Dewey 1-A	09N	08E	12	Condensate-BTEX, crude oil, brine/chloride
Wint, Arlie 1	09N	08E	12	Condensate-BTEX, crude oil, brine/chloride
Elliott & Sammons Unit 1	09N	08E	12	Condensate-BTEX, crude oil, brine/chloride
Handy, John L. 1-B	09N	08E	12	Condensate-BTEX, crude oil, brine/chloride
Handy, John L. 1	09N	08E	12	Condensate-BTEX, crude oil, brine/chloride
Reeves 2	09N	08E	12	Condensate-BTEX, crude oil, brine/chloride
Reeves, A W 1	09N	08E	12	Condensate-BTEX, crude oil, brine/chloride
Ulrich, S R & M M 1	09N	08E	12	Condensate-BTEX, crude oil, brine/chloride
Sammons & Elliott Unit 1	09N	08E	12	Condensate-BTEX, crude oil, brine/chloride
Sammons, Leo P 4	09N	08E	11	Condensate-BTEX, crude oil, brine/chloride
Sammons, Leo 3	09N	08E	11	Condensate-BTEX, crude oil, brine/chloride
Sammons, Leo 2	09N	08E	11	Condensate-BTEX, crude oil, brine/chloride
Sammons, Leo 1	09N	08E	11	Condensate-BTEX, crude oil, brine/chloride
Coe, Dalton 1	09N	08E	11	Condensate-BTEX, crude oil, brine/chloride
Chadwell et al. 2-13	09N	08E	13	Condensate-BTEX, crude oil, brine/chloride
Schafer Warehouse	07N	07E	16	Pb, Ba, Zn
Burnash Wrecking	07N	07E	9	Naphthalene, phenanthrene
Cons. Power, Flint Ser. Center #3	07N	07E	9	PCB, PNA's, BTEX, Pb, Ba, coal tar, oil, gas
Davison Shopping Center	07N	08E	10	PERC, TCE, vinyl chloride, cis-1,2 DCE
Zack Co/demo dump (former)	08N	07E	32	Pb, PERC, PCBs, benzo(a)pyrene
U of M Flint (former Cons. Power)	07N	07E	7	Benzene, cyanide, benzo(a)pyrene
Michigan Vinyl Window & Glass	07N	07E	32	PCE, Pb, Cr,
Stephenson Tree Surgeon	06N	07E	5	Methoxychlor, diazinon, lindane, organophosphate
Bray Road Dump	08N	07E	21	Cd, Zn, Cr, landfill
B & B Paint	07N	07E	5	BTEX, DCE, MIBK, MEK, vinyl chloride
Pro Met Plating	08N	07E	31	Cyanide, As, Cu, Ni, Pb, Cr, Zn
Vassar Road Farm	06N	07E	24	Cyanide, Pb, As, Cd, Cr, Ni, Tl, Ba
Kenyon Specialties	08N	07E	9	As
Mt. Morris Dumpsite	08N	07E	7	PCBs, Zn
Richfield Rd. Area-GW contamination	08N	07E	33	BTEX, PERC, 1,1,1 TCA, 1,2 DCA
Corsair Engineering	08N	07E	32	TCE, vinyl chloride, heavy manufacturing
Amoco Station #5099	07N	07E	19	BTEX
Stop-n-Go Food Store, Grand Blanc	06N	07E	16	BTEX
GMC BOC Flint Body Plant (former)	07N	07E	20	Benzene, toluene, TCA, Pb, ethylbenzene
McDonalds Corp., Mt. Morris	08N	07E	7	BTEX
Grand Blanc Disposal Area	06N	06E	23	Pb, As
Berlin and Farro	06N	05E	23	Hexachlorobenzene, PCE, BTEX
Thrall Oil Site (former)	07N	07E	17	As, Ba, Zn
Richfield Hambicki Landfill	08N	08E	2	Landfill
Phil Flint Oil Co.	07N	07E	8	Fuel oil

Table 10.–Continued.

Site Location	T.	R.	Sec.	Pollutant
Upper Flint (continued)				
Nevilles Waste Collection	06N	08E	4	Cd, Cr, Fe
Lockhart Chemical-Warehouse	07N	07E	7	Benzene, toluene, DCA, naphthalene
Lockhart Chemical-Plant Site	08N	07E	31	Benzene, TCE, 1,1 DCA
GMC Fisher Guide, Coldwater Rd.	08N	07E	18	Pb, Cr, Ni, chlorides, sulfates, cyanide
Genesee Co. Jail Project	07N	07E	18	Gasoline, oil
Forest Waste Products	09N	08E	8	PBB, Cr, VOC
Auto Brite Collision Inc.	07N	07E	28	Metals, PNA, toluene, PCB
Als Junk	07N	07E	9	PCB, PNA's
Action Auto No. 2	07N	07E	15	BTEX
A C Spark Plug	07N	07E	9	BTEX, naphthalene, hexane, cyclohexane
Middle Flint				
Genesee County				
NW Corner Pierson/Elm Road	08N	05E	25	As, Cr, Zn
SE Corner Stewart/J.P. Col.	08N	06E	31	As, Pb, benzene
300 W. Main Street	08N	05E	27	Benzo(a)pyrene, benzene, naphthalene
1080 N. Ballanger Highway	07N	06E	10	Trichloroethylene, cis-1,2-DCE, 1,1-DCE
5406 Clio Road	08N	06E	26	Cd, trimethylbenzene, benzene, xylene
300 W. Main	08N	05E	27	Benzo(a) pyrene, benzene, dibenzo(a,h)anthracene
Southern End of Holiday Drive	07N	06E	35	As, Se
Genesee Valley Mall Maint. Shed	07N	06E	28	BTEX
Parcel H-323 Torrey Road	07N	06E	26	As, benzo(a)pyrene, toluene
Flint, City of, Flint Park Allot	08N	06E	36	Naphthalene, pyrene
Al's Furniture	08N	05E	26	BTEX, PCE, TCE, Pb, methylene, chloride
Amoco Station #5450	08N	06E	26	BTEX
Stop-n-Go, Pierson Road	08N	06E	26	BTEX
McKinley/M57 Dump Site NE	09N	05E	15	Cr, Pb, phenols
Linden Road Landfill	07N	06E	17	trans-1,2-DCE, Pb, Ni
GM Fisher Guide, Flint	07N	06E	13	Benzene, toluene, ethybenzene, xylene
Dye Road Dump	07N	06E	17	Domestic community, heavy manufacturing
Container Specialties	07N	06E	10	TCE, PCE
Lower Flint				
Genesee County				
General Pavement Marking Co.	07N	05E	19	Styrene, toluene, xylene, ethylbenzene
Clio Johnson St. Plating	09N	06E	22	Cyanide, Pb, As, Cr
Kish Landfill	09N	05E	9	Chlorides, Pb, Cd, landfill
Saginaw County				
Dixie and Maple Roads, Resident	10N	06E	8	PCB, Cd, Cr, Ni, Pb, Zn
Birch Run Gasoline Contamination	10N	06E	29	Gasoline

Table 11.–Trigger levels for nine chemical used by the Michigan Department of Community Health in establishment of fish consumption advisories (ppm = parts per million; ppt = parts per trillion). Data from Michigan Department of Environmental Quality, Surface Water Quality Division (1998b).

Chemical	Advisory triggers
Total chlordane	0.3 ppm
Total DDT	5.0 ppm
Dieldrin	0.3 ppm
Toxic dioxin equivalents	10.0 ppt
Heptachlor + heptachor epoxide	0.3 ppm
Mercury	
Restrict consumption	0.5 ppm
No consumption	1.5 ppm
Mirex	0.1 ppm
Total PCB	
General population	2.0 ppm
Women of child bearing age and children under 15 years	
1 meal per week	0.05 ppm
1 meal per month	0.2 ppm
6 meals per year	1.9 ppm
No consumption	5.0 ppm
Toxaphene	5.0 ppm

Table 12.–Fish contaminant sampling (median values) in the Flint River watershed. Data from Michigan Department of Environmental Quality. Data codes: Fs = skin off fillet, F = skin on fillet, W = whole fish, ppm = parts per million, DDT = dichlorodiphenyl trichloroethane, PCB = polychlorinated biphenyls, K = concentration below the level of quantification shown, bold indicates a percentage of the sample exceeded trigger level warranting MDCH advisory.

Water body/ species	Total chlordane (ppm)	Total DDT (ppm)	Dieldrin (ppm)	Heptachlor (ppm)	Heptaclor epoxide (ppm)	Mercury (ppm)	Mirex (ppm)	Total PCB (ppm)	Toxaphene (ppm)	Number of fish sampled
Lake Nepessing (1997)										
Largemouth bass (F)	<0.003	0.036	<0.005	<0.005	<0.003	0.340	<0.005	0.025	0.050	10
Holloway Reservoir (1989)										
Largemouth bass (F)	<0.003	0.008	<0.005	<0.005	<0.003	0.070	<0.005	<0.025	<0.050	1
Black crappie (F)	<0.003	0.006	<0.005	<0.005	<0.003	0.130	<0.005	<0.025	<0.050	10
Channel catfish (Fs)	0.022	0.112	<0.005	<0.005	<0.003	0.120	<0.005	**<0.025**	<0.050	10
Smallmouth bass (F)	<0.003	0.017	<0.005	<0.005	<0.003	0.135	<0.005	<0.025	<0.050	6
Mott Lake (1996)										
Carp (Fs)	<0.003	0.023	<0.005	<0.005	<0.003	0.190	<0.005	<0.025	<0.050	6
Walleye(F)	<0.003	0.023	<0.005	<0.005	<0.003	0.190	<0.005	<0.025	<0.050	10
Thread Creek (1993)										
Carp(f)	<0.003	0.80	0.009	<0.005	<0.003	0.070	<0.005	**0.535**	<0.050	10
Northern pike(Fs)	<0.003	0.010	<0.005	<0.005	<0.003	0.150	<0.005	0.025	0.050	1
Flint River, below Flint (1993)										
Carp(Fs)	0.041	0.203	0.005	<0.005	<0.003	0.170	<0.005	**0.541**	<0.050	9
Flint River, below Flint (1998)										
Carp(Fs)	0.027	0.162	<0.005	<0.005	<0.003	0.185	<0.005	**0.797**	<0.050	10
Smallmouth bass(F)	<0.003	0.025	0.008	<0.005	<0.003	0.120	<0.005	**0.121**	<0.050	10

Table 13.–List of fishes in the Flint River watershed. Origin: N = native, C = colonized, I = introduced. Status: O = extirpated, P = recent observations, U = historic record-current status unknown. Data from: University of Michigan records; Michigan Department of Natural Resources, Fisheries Division records; Michigan Department of Environmental Quality, Surface Water Quality Division records; and United States Fish and Wildlife Service records.

Common name	Scientific name	Origin	Status
Lampreys			
Northern brook lamprey	*Ichthyomyzon fossor*	N	P
American brook lamprey	*Lampetra appendix*	N	P
Sea lamprey	*Petromyzon marinus*	C	P
Sturgeons			
Lake sturgeon **(threatened)**	*Acipenser fulvescens*	N	O
Gars			
Longnose gar	*Lepisosteus osseus*	N	P
Bowfins			
Bowfin	*Amia calva*	N	P
Herrings			
Alewife	*Alosa pseudoharengus*	C	P
Gizzard shad	*Dorosoma cepedianum*	N	P
Carps and minnows			
Central stoneroller	*Campostoma anomalum*	N	P
Goldfish	*Carassius auratus*	I	P
Spotfin shiner	*Cyprinella spiloptera*	N	P
Common carp	*Cyprinus carpio*	I	P
Brassy minnow	*Hybognathus hankinsoni*	N	U
Common shiner	*Luxilus cornutus*	N	P
Redfin shiner	*Lythrurus umbratilis*	N	U
Hornyhead chub	*Nocomis biguttatus*	N	P
River chub	*Nocomis micropogon*	N	P
Golden shiner	*Notemigonus crysoleucas*	N	P
Emerald shiner	*Notropis atherinoides*	N	P
Blackchin shiner	*Notropis heterodon*	N	P
Blacknose shiner	*Notropis heterolepis*	N	P
Spottail shiner	*Notropis hudsonius*	N	P
Rosyface shiner	*Notropis rubellus*	N	P
Sand shiner	*Notropis stramineus*	N	P
Mimic shiner	*Notropis volucellus*	N	P
Northern redbelly dace	*Phoxinus eos*	N	P
Bluntnose minnow	*Pimephales notatus*	N	P
Fathead minnow	*Pimephales promelas*	N	P
Blacknose dace	*Rhinichthys atratulus*	N	P
Longnose dace	*Rhinichthys cataractae*	N	P
Creek chub	*Semotilus atromaculatus*	N	P
Suckers			
Quillback	*Carpiodes cyprinus*	N	P
Longnose sucker	*Catostomus catostomus*	N	P

Table 13.–Continued.

Common name	Scientific name	Origin	Status
White sucker	*Catostomus commersoni*	N	P
Lake chubsucker	*Erimyzon sucetta*	N	P
Northern hog sucker	*Hypentelium nigricans*	N	P
Silver redhorse	*Moxostoma anisurum*	N	U
Golden redhorse	*Moxostoma erythrurum*	N	P
Shorthead redhorse	*Moxostoma macrolepidotum*	N	P
Greater redhorse	*Moxostoma valenciennesi*	N	U
Bullhead catfishes			
Black bullhead	*Ameiurus melas*	N	P
Yellow bullhead	*Ameiurus natalis*	N	P
Brown bullhead	*Ameiurus nebulosus*	N	P
Channel catfish	*Ictalurus punctatus*	N	P
Stonecat	*Noturus flavus*	N	P
Tadpole madtom	*Noturus gyrinus*	N	U
Pikes			
Grass pickerel	*Esox americanus vermiculatus*	N	P
Northern pike	*Esox lucius*	N	P
Muskellunge	*Esox masquinongy*	N	O
Tiger muskellunge	*E. lucius x Esox masquinongy*	I	P
Mudminnows			
Central mudminnow	*Umbra limi*	N	P
Trouts			
Lake herring **(threatened)**	*Coregonus artedi*	N	O
Lake whitefish	*Coregonus clupeaformis*	N	O
Rainbow trout	*Oncorhynchus mykiss*	I	P
Coho salmon	*Oncorhynchus kisutch*	I	U
Chinook salmon	*Oncorhynchus tshawytscha*	I	P
Brown trout	*Salmo trutta*	I	P
Brook trout	*Salvelinus fontinalis*	I	P
Lake trout	*Salvelinus namaycush*	N	O
Trout-perches			
Trout-perch	*Percopsis omiscomaycus*	N	P
Pirate perches			
Pirate perch	*Aphredoderus sayanus*	N	U
Killifishes			
Banded killifish	*Fundulus diaphanus*	N	P
Silversides			
Brook silverside	*Labidesthes sicculus*	N	P
Sticklebacks			
Brook stickleback	*Culaea inconstans*	N	P
Sculpin			
Mottled sculpin	*Cottus bairdi*	N	P

Table 13.–Continued.

Common name	Scientific name	Origin	Status
Temperate basses			
White perch	*Morone americana*	C	P
White bass	*Morone chrysops*	N	P
Sunfishes			
Rock bass	*Ambloplites rupestris*	N	P
Green sunfish	*Lepomis cyanellus*	N	P
Pumpkinseed	*Lepomis gibbosus*	N	P
Warmouth	*Lepomis gulosus*	N	P
Bluegill	*Lepomis macrochirus*	N	P
Longear sunfish	*Lepomis megalotis*	N	P
Redear sunfish	*Lepomis microlophus*	I	P
Smallmouth bass	*Micropterus dolomieu*	N	P
Largemouth bass	*Micropterus salmoides*	N	P
White crappie	*Pomoxis annularis*	N	P
Black crappie	*Pomoxis nigromaculatus*	N	P
Perches			
Greenside darter	*Etheostoma blennioides*	N	P
Rainbow darter	*Etheostoma caeruleum*	N	P
Iowa darter	*Etheostoma exile*	N	P
Least darter	*Etheostoma microperca*	N	P
Fantail darter	*Etheostoma flabellare*	N	P
Johnny darter	*Etheostoma nigrum*	N	P
Yellow perch	*Perca flavescens*	N	P
Logperch	*Percina caprodes*	N	P
Blackside darter	*Percina maculata*	N	P
Walleye	*Stizostedion vitreum*	N	P
Drums			
Freshwater drum	*Aplodinotus grunniens*	N	P
Gobies			
Round goby	*Neogobius melanostomus*	I	P

Table 14.–Fish stocking in the Flint River watershed, 1989-99. Data from Michigan Department of Natural Resources, Fisheries Division.

Common name	Stocking location	Years	Numbers	Comments
Bluegill	Twin Lake	97	103	management stocking
Bluntnose minnow	Twin Lake	97	2,000	forage stocking
Brown trout	Algoe Lake	89	500	discontinued 1989
	Big Fish Lake	89-93	12,790	discontinued 1993
	Kearsley Creek	89-99	93,990	on-going management
	S. Br. Flint	89,90	9,099	discontinued 1990
	Thread Creek	89-99	55,556	on-going management
Channel catfish	Cedar Lake	99	27	management stocking
	Lake Lapeer	93	200	private stocking
	Twin Lake	96-98	1,534	management stocking
Fathead minnow	Twin Lake	97-99	355,692	forage stocking
Golden shiner	Twin Lake	97	4,000	forage stocking
Hybrid sunfish	Lake Lapeer	94	900	private stocking
Largemouth bass	Cedar lake	99	28	management stocking
	Duperow Lake	89,92	764	maintenance stocking
	Long Lake	97,99	1,764	surplus stocking
	Watts Lake	89,92	500	maintenance stocking
Northern pike	Lake Lapeer	93,99	400	private stocking
Tiger muskellunge	Holloway Reservoir	90	5,400	discontinued 1990
	Lake Nepessing	89	1,600	discontinued 1989
	Mott Lake	91	2,600	discontinued 1991
Rainbow trout	Twin Lake	89,90	1,890	discontinued 1990
Redear sunfish	Cedar Lake	99	200	management stocking
	Dickinson Lake	96,97	10,769	management stocking
	Duperow Lake	98,99	2,728	management stocking
	Watts Lake	98,99	926	management stocking
Walleye	Big Seven Lake	97,98	43,364	management stocking
	Buell Lake	98	869	management stocking
	Heron Lake	96-98	53,433	management stocking
	Holloway Reservoir	92,92	71,100	self-sustaining since 1992
	Mott Lake	90-92	32,750	self-sustaining since 1992
	Lake Nepessing	90,92,93,96-99	266,494	on-going management
Yellow perch	Lake Lapeer	95,96	2,000	private stocking

Table 15.–Relative abundance of fish species (percent of total) found in the upper and middle South Branch Flint River and select tributaries. Dash (–) indicates species not collected. Data from Leonardi 1997.

	Site					
Fish species	Upper South Branch (3 sites)	Pine Creek (4 sites)	Farmers Creek (2 sites)	Mill Creek (1 site)	Hunters Creek (2 sites)	Plum Creek (2 sites)
Northern brook lamprey	0.8	–	–	0.9	–	–
Bowfin	–	–	–	–	–	0.7
Gizzard shad	–	–	–	–	–	–
Central stoneroller	1.7	0.2	–	–	–	–
Spotfin shiner	–	–	–	–	–	–
Common carp	–	–	2.9	–	0.8	3.3
Common shiner	14.7	–	–	–	0.8	0.7
Hornyhead chub	18.9	–	–	–	–	–
Rosyface shiner	2.4	–	–	–	–	–
Bluntnose minnow	3.5	–	11.4	38.1	–	9.3
Fathead minnow	–	–	–	–	–	–
Blacknose dace	0.6	17.9	14.3	–	–	0.7
Longnose dace	–	2.9	–	–	–	–
Creek chub	11.1	28.3	13.6	22.9	0.8	2.7
White sucker	4.5	3.3	4.3	5.1	3.1	10.6
Lake chubsucker	1.5	–	–	–	–	–
Northern hog sucker	8.1	0.7	–	–	8.5	–
Shorthead redhorse	1.8	–	–	–	–	–
Black bullhead	0.7	–	–	–	1.5	0.7
Yellow bullhead	0.1	–	–	–	–	–
Channel catfish	–	–	–	–	–	2.0
Stonecat	1.5	–	–	2.5	4.6	0.7
Grass pickerel	0.4	0.4	–	–	–	–
Northern pike	0.4	–	–	–	0.8	1.3
Central mudminnow	0.3	16.8	–	1.7	–	9.9
Brook trout	–	12.8	–	–	–	–
Brook stickleback	–	2.2	–	–	–	1.3
Rock bass	6.5	–	–	–	0.8	–
Green sunfish	7.1	3.1	1.4	11.9	5.4	30.5
Pumpkinseed	0.7	–	–	5.9	0.8	2.0
Bluegill	3.7	–	5.0	–	23.8	1.3
Longear sunfish	0.1	–	–	–	–	–
Largemouth bass	0.7	–	2.1	5.1	24.6	4.0
Black crappie	–	–	–	–	–	–
Rainbow darter	4.4	–	33.6	–	–	–
Iowa darter	–	0.2	–	–	–	–
Fantail darter	0.8	–	–	–	–	–
Johnny darter	2.1	11.3	11.4	5.9	23.9	12.6
Yellow perch	0.3	–	–	–	–	0.7
Blackside darter	0.8	–	–	–	–	5.3
Total number of fish caught	1191	452	140	118	130	151

Table 16.–Relative abundance of fish species (percent of total) found in the lower South Branch Flint River and select tributaries. Dash (–) indicates species not collected. Data from Leonardi 1997.

	Site				
Species	Lower South Branch (1 site)	North Branch (2 sites)	Crystal Creek (1 site)	Cedar Creek (2 sites)	Bottom Creek (2 sites)
Bowfin	–	–	0.7	–	–
Gizzard shad	5.0	–	–	–	–
Central stoneroller	0.3	–	–	–	–
Spotfin shiner	2.5	11.9	–	0.6	–
Common carp	1.0	1.5	–	4.9	–
Common shiner	–	1.5	–	–	–
Bluntnose minnow	10.8	4.5	8.8	18.5	–
Blacknose dace	0.5	–	0.7	–	6.0
Creek chub	–	10.5	35.0	11.7	–
White sucker	4.0	6.0	0.7	0.6	1.2
Northern hog sucker	19.4	–	–	–	–
Shorthead redhorse	2.5	–	–	–	–
Channel catfish	0.3	–	–	–	–
Stonecat	1.3	–	0.4	–	–
Grass pickerel	0.3	–	–	0.6	–
Northern pike	0.5	1.5	1.8	–	–
Central mudminnow	0.3	3.0	9.1	6.8	27.4
Brook trout	–	–	–	–	2.4
Brook stickleback	–	–	–	–	8.3
Rock bass	1.4	1.5	–	2.5	–
Green sunfish	4.0	34.3	2.6	4.3	2.8
Pumpkinseed	1.0	–	0.7	–	–
Bluegill	1.3	6.0	–	4.9	2.4
Longear sunfish	–	1.5	–	–	–
Largemouth bass	5.5	1.5	2.9	1.2	4.8
Black crappie	0.3	–	–	–	–
Rainbow darter	3.5	–	1.1	–	–
Johnny darter	12.3	4.5	33.2	43.2	–
Yellow perch	6.8	–	–	–	–
Blackside darter	13.9	10.5	2.2	–	45.2
Total number of fish caught	397	67	274	162	84

Table 17.–Catch per unit effort (number/lift) of fish species from trapnet surveys of Holloway Reservoir, Mott Lake, and Hamilton Impoundment, Flint River, Michigan. Data from MDNR, Fisheries Division.

	Site				
	Holloway Reservoir		Mott Lake		Hamilton Impoundment
Common Name	1989	1999	1988	1995	1997
Bowfin	0.1	–	0.3	–	–
Gizzard shad	–	22.3	11.3	–	–
Common carp	10.8	11.9	3.4	5.2	1.1
Golden shiner	–	–	0.2	–	–
White sucker	1.5	1.4	2.6	0.8	1.1
Bullhead species	0.6	0.1	0.2	0.3	0.1
Channel catfish	6.4	57.6	8.3	27.2	4.3
Northern pike	0.7	1.0	0.2	0.1	0.4
Tiger muskellunge	0.1	–	–	–	–
Rock bass	–	0.1	0.1	0.2	1.2
Pumpkinseed	–	0.1	1.3	–	0.2
Warmouth	–	–	–	–	0.2
Bluegill	41.1	4.0	40.7	0.3	1.0
Smallmouth bass	3.8	2.4	–	–	1.0
Largemouth bass	0.1	0.1	0.3	–	0.1
Black crappie	200.6	6.7	112.9	2.9	1.4
Yellow perch	0.3	0.2	7.0	2.0	0.3
Walleye	4.9	0.9	2.0	2.1	1.2

Table 18.–Relative abundance of fish species (percent of total) found in the upper Flint River and select tributaries. Dash (–) indicates species not collected. Data from Leonardi 1997.

	Site										
Species	Upper Flint (1 site)	Henry Drain (2 sites)	Hasler Creek (1 site)	Powers-Cullen Drain (1 site)	Butternut Creek (1 site)	Upper Kearsley Creek (1 site)	Lower Kearsley Creek (1 site)	Gilkey Creek (1 site)	Swartz Creek (1 site)	Upper Thread Creek (1 site)	Lower Thread Creek (1 site)
American brook lamprey	–	–	–	–	–	1.1	–	–	–	–	–
Gizzard shad	0.2	–	–	–	–	–	–	–	0.2	–	–
Central stoneroller	–	–	4.4	2.1	–	–	–	–	2.1	–	–
Spotfin shiner	1.2	–	–	–	–	–	–	–	0.4	–	–
Common carp	6.1	–	–	–	–	–	–	7.6	1.7	–	–
Common shiner	–	0.4	–	–	2.5	–	9.2	–	1.0	4.3	11.3
Hornyhead chub	–	–	–	–	–	0.3	9.2	–	–	1.7	3.6
River chub	–	–	–	–	–	–	1.9	–	–	–	–
Golden shiner	–	–	–	–	–	–	–	–	0.2	–	0.5
Emerald shiner	–	–	–	–	–	–	–	–	10.0	1.0	–
Sand shiner	0.2	–	–	1.4	–	–	–	–	7.3	–	–
Northern redbelly dace	–	8.5	–	–	–	–	–	–	–	–	–
Bluntnose minnow	2.0	8.5	38.2	13.2	12.4	–	13.5	–	5.7	0.3	15.3
Blacknose dace	–	–	–	5.1	1.2	–	–	1.0	1.3	2.3	–
Creek chub	4.1	5.2	19.1	32.3	21.0	5.0	11.8	75.8	12.3	44.0	13.5
White sucker	1.8	25.8	–	3.0	9.9	2.8	3.6	14.9	6.9	7.3	6.8
Northern hog sucker	1.2	0.4	–	–	–	–	25.3	–	4.2	–	–
Golden redhorse	0.4	–	–	–	–	–	–	–	–	–	–
Black bullhead	0.2	1.6	–	–	–	–	–	–	–	–	–
Yellow bullhead	7.3	–	–	–	–	–	–	–	–	–	0.9
Brown bullhead	–	0.8	–	–	–	–	–	–	–	–	–
Channel catfish	2.8	–	–	–	–	–	–	–	–	–	–
Stonecat	1.8	–	–	–	1.2	–	–	–	1.3	1.3	–
Grass pickerel	–	–	–	–	1.2	0.6	–	–	–	–	–
Northern pike	–	–	–	–	–	0.3	0.6	–	0.4	–	4.5
Central mudminnow	16.2	0.8	–	–	9.9	19.2	–	–	2.3	1.3	0.5
Brown trout	–	–	–	–	–	17.5	–	–	–	1.7	–
Mottled sculpin	–	–	–	–	–	44.4	–	–	–	–	–
Brook stickleback	0.2	–	2.9	2.6	2.5	–	–	0.7	–	–	–
Rock bass	9.3	–	1.5	–	–	–	3.0	–	3.1	–	10.4
Green sunfish	8.5	5.2	59.9	–	8.6	3.9	0.9	–	10.8	4.0	2.7
Pumpkinseed	0.6	–	–	–	–	0.6	1.5	–	4.4	0.3	–
Bluegill	2.0	5.2	–	–	–	–	0.6	–	–	–	2.7
Hybrid sunfish	1.0	–	–	–	–	–	0.6	–	0.2	–	0.5
Smallmouth bass	2.4	–	–	–	–	0.3	–	–	0.2	–	–
Largemouth bass	3.2	6.5	5.9	–	1.2	1.9	7.9	–	1.5	1.7	14.9
Black crappie	1.8	–	–	–	–	–	0.2	–	–	–	0.5
Greenside darter	0.4	0.4	–	–	–	–	–	–	–	–	–
Rainbow darter	–	–	–	–	–	–	–	–	14.0	12.0	3.2
Iowa darter	–	2.0	–	–	–	–	–	–	–	–	–
Fantail darter	–	–	–	–	–	–	–	–	–	2.3	–
Johnny darter	0.8	2.0	22.1	33.2	22.2	2.2	10.1	–	6.0	14.3	8.6
Yellow perch	5.1	2.4	–	–	–	–	–	–	–	–	–
Blackside darter	19.3	24.2	–	2.1	6.2	–	–	–	2.7	–	–
Walleye	0.2	–	–	–	–	–	–	–	–	–	–
Total number of fish caught	507	248	68	431	81	360	467	289	480	300	222

Table 19.–Relative abundance of fish species (percent of total) found in the middle and lower Flint River and select tributaries. Dash (–) indicates species not collected. Data from Leonardi 1997.

	Site							
Species	Middle Flint (1 site)	Lower Flint (1 site)	Mud Creek (1 site)	Cole Creek (1 site)	Brent Creek (1 site)	Brent Run Creek (1 site)	Pine Run Creek (1 site)	Misteguay Creek (1 site)
Gizzard shad	27.1	–	5.1	–	–	–	–	–
Central stoneroller	0.3	1.8	8.0	1.2	0.5	–	1.4	7.0
Spotfin shiner	1.0	–	–	–	–	–	–	–
Common carp	2.2	1.2	–	–	–	–	–	1.8
Common shiner	–	–	8.0	4.3	–	7.1	6.0	11.2
Hornyhead chub	0.3	–	–	–	–	–	–	–
Emerald shiner	24.4	3.7	–	–	–	–	–	–
Sand shiner	–	1.2	0.4	–	–	–	–	–
Bluntnose minnow	10.9	23.8	10.7	–	9.2	5.4	12.2	18.3
Blacknose dace	–	–	–	17.2	11.2	–	4.1	6.7
Creek chub	1.5	6.1	13.1	38.3	12.3	16.1	41.3	23.5
White sucker	1.9	0.6	5.1	3.9	0.6	7.1	5.1	1.4
Golden redhorse	0.8	0.6	–	–	–	–	–	–
Shorthead redhorse	0.5	–	–	–	–	–	–	–
Yellow bullhead	0.2	1.2	–	–	–	1.8	–	0.4
Channel catfish	0.2	–	–	–	–	–	–	–
Stonecat	2.9	–	–	–	–	–	–	–
Northern pike	–	–	–	–	–	–	–	0.4
Central mudminnow	–	–	–	–	–	–	0.2	0.4
Brook stickleback	–	–	–	5.5	–	–	–	–
Rock bass	12.5	17.7	–	0.5	0.2	–	–	4.9
Green sunfish	–	9.2	1.5	–	0.2	10.7	2.1	4.9
Pumpkinseed	–	0.6	–	–	–	–	1.8	–
Bluegill	0.8	–	–	–	–	1.8	–	–
Longear sunfish	–	–	–	–	–	–	–	1.1
Hybrid sunfish	0.2	–	–	–	–	–	–	–
Smallmouth bass	3.0	0.6	–	–	–	–	–	–
Largemouth bass	1.4	2.4	–	–	–	–	1.4	–
Black crappie	–	–	–	–	–	–	0.2	–
Greenside darter	–	0.6	–	–	–	–	–	–
Rainbow darter	3.7	3.0	–	–	–	–	–	–
Fantail darter	0.2	–	–	–	–	–	0.2	–
Johnny darter	0.7	14.0	48.2	29.7	65.9	50.0	19.7	16.5
Logperch	0.7	–	–	–	–	–	–	–
Blackside darter	1.9	10.4	–	–	–	–	5.7	1.8
Walleye	0.3	0.6	–	–	–	–	–	–
Total number of fish caught	594	164	475	475	651	56	436	285

Table 20.–Aquatic invertebrates of the South Branch Flint River and select tributaries. Phylogenetic order names in bold. Data code: X = present, dash (–) indicates not collected. Data from Alexander (1997) and Walterhouse (2001b).

Taxa	Sites												
	Upper South Branch	Middle South Branch	Lower South Branch	Pine Creek	Farmers Creek	Mill Creek	Hunters Creek	Plum Creek	North Branch	Crystal Creek	Cedar Creek	Elm Creek	Bottom Creek
Porifera (sponges)	–	–	–	–	X	–	–	–	X	X	X	–	X
Bryozoa (moss animals)	X	X	X	–	X	–	–	X	X	X	–	–	–
Platyhelminthes (flatworms)													
Turbellaria	X	–	X	–	X	–	X	–	–	–	–	–	X
Annelida (segmented worms)													
Hirudinea (leeches)	X	–	–	X	X	–	X	X	X	X	X	X	–
Oligochaeta (worms)	X	–	–	X	X	X	–	–	X	X	–	–	–
Arthropoda													
Crustacea													
Amphipoda (scuds)	X	X	X	X	X	–	X	X	X	–	X	X	X
Decapoda (crayfish)	X	X	X	X	X	X	X	X	X	X	X	X	X
Isopoda (sowbugs)	–	–	–	X	X	–	–	–	–	X	X	X	–
Arachnoidea													
Hydracarina (mites)	X	–	X	X	–	–	–	X	–	–	–	–	–
Insecta													
Ephemeroptera (mayflies)													
Baetidae	X	X	X	X	X	X	X	X	X	–	X	X	X
Caenidae	–	–	–	–	X	–	–	–	–	–	X	–	X
Ephemerellidae	X	X	X	X	–	–	X	–	–	–	X	–	–
Ephemeridae	X	–	–	–	–	–	–	–	–	–	–	–	–
Heptageniidae	X	X	X	X	X	–	X	X	X	X	X	–	X
Isonychiidae	X	–	–	–	–	–	–	–	–	–	–	–	–
Tricorythidae	X	–	–	X	–	–	X	–	–	–	–	–	–
Odonata													
Anisoptera (dragonflies)													
Aeshnidae	X	X	X	X	X	–	X	X	X	X	X	–	X
Corduliidae	–	–	–	X	–	–	–	–	–	–	–	–	–
Gomphidae	X	–	–	–	–	X	X	–	X	–	–	–	–
Zygoptera (damselflies)													
Calopterygidae	X	X	–	X	X	X	X	X	X	X	X	X	X
Coenagrionidae	X	X	–	–	X	–	X	X	X	–	–	–	–
Lestidae	–	–	–	–	X	–	–	–	X	–	X	X	X
Plecoptera (stone flies)													
Perlidae	X	–	X	X	–	–	–	–	–	–	–	–	–
Perlodidae	X	–	–	X	–	–	–	–	–	–	–	–	–
Hemiptera (true bugs)													
Belastomatidae	–	–	–	X	–	–	–	–	X	–	–	–	–
Corixidae	X	X	X	X	X	X	X	X	X	X	X	X	X
Gerridae	X	X	X	X	X	X	X	X	X	X	X	X	X
Mesoveliidae	X	X	–	–	X	X	X	X	–	–	X	–	–
Notonectidae	–	X	–	–	–	–	–	X	–	–	–	–	–
Veliidae	–	X	X	–	–	–	–	–	–	–	–	–	–
Pleidae	–	–	–	–	X	–	X	X	–	–	–	–	–

Table 20.–Continued.

Taxa	Sites												
	Upper South Branch	Middle South Branch	Lower South Branch	Pine Creek	Farmers Creek	Mill Creek	Hunters Creek	Plum Creek	North Branch	Crystal Creek	Cedar Creek	Elm Creek	Bottom Creek
Megaloptera													
Corydalidae (dobson flies)	X	–	–	X	X	–	–	–	–	X	–	–	–
Sialidae (alder flies)	X	X	–	X	X	–	X	–	–	–	–	–	X
Trichoptera (caddisflies)													
Brachycentridae	–	X	X	–	–	–	–	X	–	–	–	–	X
Glossosmatidae	X	–	–	X	–	–	–	–	–	–	–	–	–
Helicopsychidae	X	–	–	X	–	–	X	–	–	–	–	–	–
Hydropsychidae	X	X	X	X	X	X	X	X	X	X	X	X	X
Lepidostomatidae	–	–	–	–	–	–	–	–	X	–	–	–	–
Leptoceridae	X	X	X	X	–	–	X	–	–	–	–	–	–
Limnephilidae	X	–	X	X	X	X	X	X	X	X	X	–	X
Molannidae											X	–	–
Philopotamidae	X	X	X	X	X	–	X	–	–	X	–	–	X
Phryganeidae	X	X	–	X	X	–	X	X	–	–	–	–	–
Polycentropodidae	X	X	–	X	X	–	–	–	X	–	–	–	–
Uenoidae	X	X	X	X	X	–	X	X	–	X	–	–	X
Coleoptera (beetles)													
Dryopidae	–	–	–	–	–	X	–	–	–	–	–	–	–
Dyticsidae	–	–	–	–	X	–	–	X	X	X	–	–	X
Elmidae	X	X	X	X	X	X	X	X	X	X	X	X	X
Gyrinidae	–	X	X	X	X	–	–	–	X	–	X	X	–
Haliplidae	–	–	–	–	–	–	X	X	–	–	X	X	–
Hydrophilidae	–	X	X		X	X		X		X	X	X	X
Psephenidae	X	–	X	–	–	–	–	–	–	–	–	–	–
Ptilodactylidae	–	X	–	–	–	–	–	–	–	–	–	–	–
Diptera (flies)													
Athericidae	–	X	X	–	–	–	–	X	X	–	–	–	–
Ceratopogonidae	–	–	X	–	–	–	–	–	–	–	–	–	–
Chironomidae	X	X	X	X	X	X	X	X	X	X	X	X	X
Culicidae	–	–	–	–	X	–	X	X	–	–	X	–	X
Sciomyzidae	–	–	–	X	–	–	X	–	–	–	–	–	–
Dixidae	–	–	–	–	X	–	–	–	–	–	–	–	–
Empididae	–	–	X	–	–	–	–	–	–	–	–	–	–
Simuliidae	X	X	X	–	X	X	–	X	–	X	X	X	X
Tabanidae	X	–	X	–	–	–	X	X	–	X	–	–	X
Tipulidae	X	–	X	X	–	–	–	X	–	–	–	–	–
Mollusca													
Gastropoda (snails and limpets)	–	X	–	–	–	–	–	–	–	–	–	–	–
Ancylidae	–	–	–	X	–	–	–	X	–	–	X	–	–
Physidae	X	X	X	X	X	X	X	X	–	X	X	X	X
Planorbidae	X	–	–	–	–	–	–	X	–	–	–	–	–
Vivaparidae	X	–	–	–	–	–	–	–	–	–	–	–	–
Pelecypoda (bivalves)													
Sphaeriidae	X	X	X	X	–	–	X	X	X	X	X	X	X
Unionidae	X	–	–	–	–	–	–	–	–	–	–	–	–

Table 21.–Aquatic invertebrates of the upper Flint River and select tributaries. Phylogenetic order names in bold. Data code: X = present, dash (–) indicates not collected. Data from Alexander (1997) and Walterhouse (2001a).

	Site										
Taxa	Upper Flint	Henry Drain	Hasler Creek	Powers-Cullen Drian	Butternut Creek	Upper Kearsley Creek	Lower Kearsley Creek	Gilkey Creek	Swartz Creek	Upper Thread Creek	Lower Thread Creek
Porifera (sponges)	X	–	–	–	–	–	–	–	–	–	–
Bryozoa (moss animals)	–	–	–	–	–	X	–	–	–	X	–
Platyhelminthes (flatworms)											
Turbellaria	X	X	X	X	X	–	–	X	–	–	–
Nematomorpha (roundworms)	X	–	–	–	–	–	–	X	–	–	–
Annelida (segmented worms)											
Hirudinea (leeches)	X	X	X	X	X	–	–	X	–	–	–
Oligochaeta (worms)	X	–	–	–	X	–	–	–	X	–	–
Arthropoda											
Crustacea											
Amphipoda (scuds)	X	X	X	–	X	X	X	X	X	X	X
Decapoda (crayfish)	X	X	–	X	X	X	X	X	X	X	X
Isopoda (sowbugs)	–	–	X	X	–	–	–	–	X	–	–
Arachnoidea											
Hydracarina (mites)	X	–	X	–	–	X	X	–	–	–	–
Insecta											
Ephemeroptera (mayflies)											
Baetidae	X	X	X	X	X	X	X	X	X	X	X
Caenidae		X	X	X	X	–	–	–	–	–	–
Ephemerellidae	X	X	–	–	–	–	–	–	–	–	–
Heptageniidae	X	X		X	X	X	X		X	X	X
Isonychiidae	–	–	–	–	–	–	X	–	–	–	–
Tricorythidae	–	X	–	–	–	–	–	–	–	–	–
Odonata											
Anisoptera (dragonflies)											
Aeshnidae	X	X	X	X	X	X	X	X	X	X	–
Gomphidae	–	–	–	–	–	X	X	–	–	X	–
Libelluidae	–	–	–	–	–	–	–	X	–	–	–
Zygoptera (damselflies)											
Calopterygidae	X	X	X	X	X	X	–	X	X	X	X
Coenagrionidae	X	X	X	X	X	X	–	–	X	–	X
Lestidae	X	–	–	–	–	–	–	–	–	–	–
Plecoptera (stone flies)											
Perlidae	–	–	–	–	–	–	X	–	–	X	–
Perlodidae	–	–	–	–	–	–	X	–	–	–	–
Hemiptera (true bugs)											
Belastomatidae	–	–	–	X	–	–	X	–	–	–	X
Corixidae	X	X	X	X	X	X	X	X	X	X	X
Gerridae	X	X	X	X	X	X	X	–	–	X	X
Mesoveliidae	X	–	–	–	–	X	–	–	X	–	X
Naucoridae	X	X	X	–	–	–	–	–		–	–
Notonectidae	–	–	–	–	–	–	–	–	X	–	–
Saldidae	–	X	X	–	–	–	–	–		–	–

Table 21.–Continued.

Taxa	Site										
	Upper Flint	Henry Drain	Hasler Creek	Powers-Cullen Drian	Butternut Creek	Upper Kearsley Creek	Lower Kearsley Creek	Gilkey Creek	Swartz Creek	Upper Thread Creek	Lower Thread Creek
Megaloptera											
Corydalidae (dobson flies)	–	X	–	–	–	–	X	–	–	X	–
Sialidae (alder flies)	X	–	–	–	X	–	–	–	X	X	X
Trichoptera (caddisflies)											
Brachycentridae	–	–	–	–	–	X	X	–	–	–	–
Glossosmatidae	–	X	–	–	X	X	X	–	–	–	–
Helicopsychidae	–	X	–	–	X	X	X	–	–	–	–
Hydropsychidae	X	X	X	–	X	X	X	X	X	X	X
Hydroptilidae	–	X	–	–	–	X	–	–	–	–	–
Leptoceridae	X	–	–	–	–	X	X	–	–	–	–
Limnephilidae	X	X	X	X	X	X	X	–	–	X	–
Philopotamidae	X	–	–	–	X	–	–	–	–	–	–
Phryganeidae	–	–	–	X	–	–	X	–	–	–	–
Polycentropodidae	X	–	–	–	–	–	X	–	X	X	–
Psychomyiidae	–	–	–	–	–	–	X	–	–	–	–
Uenoidae	X	X	–	–	X	X	X	–	X	X	–
Lepidoptera (moths)											
Pyralidae	–	–	–	–	–	–	–	–	X	–	–
Coleoptera (beetles)											
Dryopidae	–	–	X	–	–	–	–	–	–	–	–
Dyticsidae	–	X	X	–	X	X	–	–	–	–	–
Elmidae	X	X	–	X	X	X	X	–	X	X	–
Gyrinidae	X	–	–	–	X	–	X	–	–	–	X
Haliplidae	–	X	–	X	X	–	–	X	–	–	X
Hydrophilidae	–	X	–	X	–	–	–	–	X	–	–
Psephenidae	–	–	–	–	–	–	X	–	X	X	–
Diptera (flies)											
Athericidae	–	–	–	–	X						
Chironomidae	X	X	X	X	X	X	X	X	X	X	X
Culicidae	X	X	X	–	–	–	–	–	–	–	–
Dixidae	–	–	X	–	–	–	–	–	–	–	–
Simuliidae	X	X	–	–	–	X	X	–	–	–	–
Stratiomyidae	–	–	–	–	–	–	X	X	–	–	–
Tabanidae	–	X	–	–	X	X	–	–	–	X	–
Tipulidae	X	X	–	–	X	–	–	X	–	–	–
Mollusca											
Gastropoda (snails and limpets)											
Ancylidae	–	–	–	X	X	–	–	–	–	–	–
Physidae	–	X	X	X	X	X	X	–	X	X	X
Planorbidae	–	–	–	–	–	–	–	X	–	X	X
Pleuroceridae	–	X	–	–	–	–	X	–	–	–	–
Pelecypoda (bivalves)											
Dreissenidae	X	–	–	–	X	–	–	–	–	–	–
Sphaeriidae	X	X	–	X	–	X	X	–	X	X	X
Unionidae	X	X	–	X	X	X	X	–	X	–	–

Table 22.–Aquatic invertebrates of the middle and lower Flint River and select tributaries. Phylogenetic order names in bold. Data code: X = present, dash (–) indicates species not collected. Data from Alexander (1997) and Walterhouse (2001a, unpublished data).

	Site						
Taxa	Middle Flint	Lower Flint	Mud Creek	Brent Run Creek	Pine Run Creek	Silver Creek	Mistiguay Creek
Porifera (sponges)	–	–	–	–	X	–	–
Bryozoa (moss animals)	X	X	X	–	–	–	–
Platyhelminthes (flatworms)							
Turbellaria	X	X	–	–	–	X	–
Annelida (segmented worms)							
Hirudinea (leeches)	X	X	–	–	X	X	X
Oligochaeta (worms)	X	X	–	X	–	–	–
Arthropoda							
Crustacea							
Amphipoda (scuds)	X	X	X	X	X	X	X
Decapoda (crayfish)	X	X	X	X	X	–	X
Isopoda (sowbugs)	X	–	X	–	X	X	–
Arachnoidea							
Hydracarina (mites)	X	–	–	–	–	–	–
Insecta							
Ephemeroptera (mayflies)							
Baetidae	X	X	–	X	X	–	X
Caenidae	–	–	–	–	X	–	X
Ephemerellidae	X	X	–	–	–	–	–
Ephemeridae	X	–	–	–	–	–	–
Heptageniidae	X	X	X	X	X	X	X
Isonychiidae	–	X	–	–	–	–	–
Potamanthidae	X	X	–	–	–	–	–
Tricorythidae	X	X	–	–	–	–	–
Odonata							
Anisoptera (dragonflies)							
Aeshnidae	X	X	X	–	X	–	X
Gomphidae	X	X	–	–	–	–	–
Libelluidae	–	–	–	X	–	–	–
Zygoptera (damselflies)							
Calopterygidae	X	–	X	–	–	–	X
Coenagrionidae	X	X	X	X	X	X	–
Lestidae	X	–	–	–	–	–	–
Plecoptera (stone flies)							
Perlodidae	X	–	–	–	–	–	–
Hemiptera (true bugs)							
Corixidae	X	X	X	X	X	X	X
Gerridae	X	X	X	X	X	X	X
Mesoveliidae	X	X	–	X	X	–	X
Veliidae	X	–	–	–	–	–	–

Table 22.–Continued.

Taxa	Site: Middle Flint	Lower Flint	Mud Creek	Brent Run Creek	Pine Run Creek	Silver Creek	Mistiguay Creek
Trichoptera (caddisflies)							
Glossosmatidae	X	–	–	–	–	–	–
Helicopsychidae	X	–	–	–	–	–	X
Hydropsychidae	X	X	–	X	X	X	X
Hydroptilidae	X	–	–	–	–	–	–
Leptoceridae	–	X	–	–	–	–	–
Limnephilidae	–	X	–	X	X	–	X
Philopotamidae	X	–	–	X	–	–	–
Uenoidae	–	–	–	–	–	–	X
Lepidoptera (moths)							
Pyralidae	–	X	–	–	–	–	–
Coleoptera (beetles)							
Dyticsidae	–	–	–	X	–	X	–
Elmidae	X	X	–	X	X	–	X
Gyrinidae	–	X	–	–	–	–	–
Haliplidae	X	–	–	X	–	X	X
Hydrophilidae	X	–	–	X	–	–	–
Psephenidae	X	–	–	–	–	–	–
Diptera (flies)							
Chironomidae	X	X	X	X	X	X	X
Culicidae	X	–	–	X	–	–	–
Simuliidae	X	–	–	X	–	–	–
Tabanidae	–	–	–	–	X	X	X
Tipulidae	X	–	–	–	X	–	–
Mollusca							
Gastropoda (snails and limpets)							
Ancylidae	X	X	–	–	X	–	–
Limnaeidae	–	–	–	–	–	X	–
Physidae	X	X	X	X	–	X	X
Planorbidae	X	–	–	–	–	–	–
Pleuroceridae	–	–	X	–	–	–	–
Pelecypoda (bivalves)							
Pisidiidae	–	–	–	X	–	–	–
Sphaeriidae	X	X	–	–	X	X	X
Unionidae	–	X	–	–	X	X	X

Table 23.–Amphibians and reptiles in the Flint River watershed. Data from Harding (1997) and Michigan Department of Natural Resources, Fisheries Division.

Common name	Scientific name
Salamanders	
Mudpuppy	*Necturus maculosus maculosus*
Eastern newt	*Notophthalmus viridescens*
Spotted salamander	*Ambystoma maculatum*
Blue-spotted salamander	*Ambystoma laterale*
Eastern tiger salamander	*Ambystoma tigrinum tigrinum*
Red-backed salamander	*Plethodon cinereus*
Four-toed salamander	*Hemidactylium scutatum*
Frogs and toads	
Eastern American toad	*Bufo americanus americanus*
Blanchard’s cricket frog	*Acris crepitans blanchardi*
Striped chorus frog	*Pseudacris triseriata*
Northern spring peeper	*Pseudacris crucifer crucifer*
Eastern gray tree frog	*Hyla versicolor*
Cope’s gray tree frog	*Hyla chrysoscelis*
Bullfrog	*Rana catesbeiana*
Green frog	*Rana clamitans melanota*
Wood frog	*Rana sylvatica*
Northern leopard frog	*Rana pipiens*
Pickerel frog	*Rana palustris*
Turtles and lizards	
Common snapping turtle	*Chelydra serpentina serpentina*
Common musk turtle	*Sternotherus odoratus*
Spotted turtle	*Clemmys guttata*
Eastern box turtle	*Terrapene carolina carolina*
Blanding’s turtle	*Emydoidea blandingii*
Common map turtle	*Graptemys geographica*
Painted turtle	*Chrysemys picta*
Red-eared slider	*Trachemys scripta elegans*
Eastern spiny softshell turtle	*Apalone spinifera spinifera*
Five-lined skink	*Eumeces fasciatus*
Six-lined racerunner	*Cnemidophorus sexlineatus viridis*
Snakes	
Northern water snake	*Nerodia sipedon*
Queen snake	*Regina septemvittata*
Common garter snake	*Thamnophis sirtalis*
Butler’s garter snake	*Thamnophis butleri*
Northern ribbon snake	*Thamnophis sauritus septentrionalis*
Brown snake	*Storeria dekayi*
Northern red-bellied snake	*Storeria occipitomaculata*
Smooth green snake	*Liochlorophis vernalis*
Blue racer	*Coluber constrictor foxi*
Black rat snake	*Elaphe obsoleta obsoleta*
Eastern fox snake	*Elaphe gloydi*
Eastern milk snake	*Lampropeltis triangulum triangulum*
Northern ring-necked snake	*Diadophis punctatus edwardsi*
Eastern hog-nosed snake	*Heterodon platirhinos*
Eastern massasauga	*Sistrurus catenatus catenatus*

Table 24.–Natural features of the Flint River watershed. Data from the Michigan Department of Natural Resources, Wildlife Division, Natural Features Inventory, September, 1999.

Common name	Scientific name	State status
Vertebrates		
Blanchard's cricket frog	*Acris crepitans blanchardi*	Special Concern
Spotted turtle	*Clemmys guttata*	Threatened
Eastern fox snake	*Elaphe vulpina gloydi*	Threatened
Eastern massasauga	*Sistrurus catenatus catenatus*	Special Concern
Barn owl	*Tyto alba*	Endangered
Invertebratse		
Huron River leafhopper	*Flexamia huroni*	Special Concern
Tamarack tree cricket	*Oecanthus laricis*	Special Concern
Poweshiek skipperling	*Oarisma poweshiek*	Threatened
Blazing star borer	*Papaipema beeriana*	Special Concern
Plants		
Cooper's milk-vetch	*Astragalus neglectus*	Special Concern
Swamp metalmark	*Calephelis mutica*	Special Concern
False hop sedge	*Carex lupuliformis*	Threatened
Hairy-fruited sedge	*Carex trichocarpa*	Special Concern
White lady-slipper	*Cypripedium candidum*	Threatened
Purple prairie-clover	*Dalea purpurea*	Extirpated
Beak grass	*Diarrhena americana*	Threatened
Showy orchids	*Galearis spectabilis*	Threatened
White gentian	*Gentiana flavida*	Endangered
Whiskered sunflower	*Helianthus hirsutus*	Special Concern
Whorled pogonia	*Isotria verticillata*	Threatened
Twinleaf	*Jeffersonia diphylla*	Special Concern
Furrowed flax	*Linum sulcatum*	Special Concern
Seedbox	*Ludwigia alternifolia*	Special Concern
Ginseng	*Panax quinquefolius*	Threatened
Small-fruited panic-grass	*Panicum microcrpon*	Special Concern
Prairie fringed orchid	*Platanthera leucophaea*	Endangered
Jacob's ladder	*Polemonium reptans*	Threatened
Showy coneflower	*Rudeckia fulgida var sullivantii*	Special Concern
Torrey's bulrush	*Scirpus torreyi*	Special Concern
Plant Community		
Bog		
Dry-mesic southern forest		
Prairie fen		
Southern wet meadow		
Geographic feature		
Kame		
Pennsylvanian earth history		
Other features		
Great blue heron rookery		

Table 25.–Mammals of the Flint River watershed. * denotes extirpated from the Flint River watershed. ** denotes extinct species. Data from Burt (1957) and Evers (1994).

Common name	Scientific name
Opossum	*Didelphis marsupialis*
Eastern mole	*Scalopus aquaticus*
Starnose mole	*Condylura cristata*
Masked shrew	*Sorex cinereus*
Shorttail shrew	*Blarina brevicauda*
Little brown myotis	*Myotis lucifugus*
Keen myotis	*Myotis keeni*
Silver-haired bat	*Lasionycteris noctivagans*
Big brown bat	*Eptesicus fuscus*
Red bat	*Lasiurus borealis*
Hoary bat	*Lasiurus cinereus*
Raccoon	*Procyon lotor*
Longtail weasel	*Mustela frenata*
Least weasel	*Mustela rixosa*
Mink	*Mustela vison*
Badger	*Taxidea taxus*
Striped skunk	*Mephitis mephitis*
Red fox	*Vulpes fulva*
Gray fox	*Urocyon cinereoargenteus*
Coyote	*Canis latrans*
Woodchuck	*Marmota monax*
Thirteen-lined ground squirrel	*Citellus tridecemlineatus*
Eastern chipmunk	*Tamias striatus*
Red squirrel	*Tamiasciurus hudsonicus*
Eastern gray squirrel	*Sciurus carolinensis*
Eastern fox squirrel	*Sciurus niger*
Southern flying squirrel	*Glaucomys volans*
Beaver	*Castor canadensis*
Deer mouse	*Peromyscus maniculatus*
White-footed mouse	*Peromyscus leucopus*
Southern bog lemming	*Synaptomys cooperi*
Meadow vole	*Microtus pennsylvanicus*
Pine vole	*Pitymys pinetorum*
Muskrat	*Ondatra zibethica*
Norway rat	*Rattus norvegicus*
House mouse	*Mus musculus*
Meadow jumping mouse	*Zapus hudsonius*
Eastern cottontail	*Sylvilagus floridanus*
Whitetail deer	*Odocoileus virginianus*
River otter*	*Lutra canadensis*
Gray wolf *	*Canis lupas*
Cougar*	*Felis concolor*
Bobcat*	*Felis rufus*
Lynx*	*Felis lynx*
Marten*	*Martes americana*
Black bear*	*Ursus americanus*
Woodland caribou*	*Rangifer tarandus caribou*
Eastern elk**	*Cervus elaphus canadensis*

Table 26.–Breeding bird observations in the Flint River watershed. Status codes in parentheses and bold. Data from Brewer et al. 1991.

Common name	Scientific name
Pied-billed grebe	*Podilymbus podiceps*
American bittern	*Botaurus lentiginosus*
Least bittern (**threatened**)	*Ixobrychus exilis*
Great blue heron	*Ardea herodias*
Green-backed heron	*Butorides striatus*
Mute swan	*Cygnus olor*
Canada goose	*Branta canadensis*
Wood duck	*Aix sponsa*
American black duck	*Anas rubripes*
Mallard	*Anas platyrhynchos*
Blue winged teal	*Anas discors*
Hooded merganser	*Lophodytes cucullatus*
Turkey vulture	*Cathartes aura*
Northern harrier	*Circus cyaneus*
Sharp-shinned hawk	*Accipiter striatus*
Cooper’s hawk	*Accipiter cooperii*
Northern goshawk	*Accipiter gentilis*
Red-shouldered hawk (**threatened**)	*Buteo lineatus*
Broad-winged hawk	*Buteo platypterus*
Red-tailed hawk	*Buteo jamaicensis*
American kestrel	*Falco sparverius*
Ring-necked pheasant	*Phasianus colchicus*
Ruffed grouse	*Bonasa umbellus*
Wild turkey	*Meleagris gallopavo*
Northern bobwhite	*Colinus virginianus*
Virginia rail	*Rallus limicola*
Sora	*Porzana carolina*
Common moorhen	*Gallinula chloropus*
American coot	*Fulica americana*
Sandhill crane	*Grus canadensis*
Killdeer	*Charadrius vociferus*
Spotted sandpiper	*Actitis macularia*
Upland sandpiper	*Bartramia longicauda*
Common snipe	*Gallinago gallinago*
American woodcock	*Scolopax minor*
Rock dove	*Columba livia*
Mourning dove	*Zenaida macroura*
Black-billed cuckoo	*Coccyzus erythropthalmus*
Yellow-billed cuckoo	*Coccyzus americanus*
Eastern screech-owl	*Otus asio*
Great horned owl	*Bubo virginianus*
Barred owl	*Strix varia*
Short-eared owl (**endangered**)	*Asio flammeus*
Common nighthawk	*Chordeiles minor*
Whip-poor-will	*Caprimulgus vociferus*
Chimney swift	*Chaetura pelagica*
Ruby-throated hummingbird	*Archilochus colubris*
Belted kingfisher	*Ceryle alcyon*

Table 26.–Continued.

Common name	Scientific name
Red-headed woodpecker	*Melanerpes erythrocephalus*
Red-bellied woodpecker	*Melanerpes carolinus*
Downy woodpecker	*Picoides pubescens*
Hairy woodpecker	*Picoides villosus*
Northern flicker	*Colaptes auratus*
Pileated woodpecker	*Dryocopus pileatus*
Eastern wood-pewee	*Contopus virens*
Acadian flycatcher	*Empidonax virescens*
Alder flycatcher	*Empidonax alnorum*
Willow flycatcher	*Empidonax traillii*
Least flycatcher	*Empidonax minimus*
Eastern phoebe	*Sayornis phoebe*
Great crested flycatcher	*Myiarchus crinitus*
Eastern kingbird	*Tyrannus tyrannus*
Horned lark	*Eremophila alpestris*
Purple martin	*Progne subis*
Tree swallow	*Tachycineta bicolor*
Northern rough-winged swallow	*Stelgidopteryx serripennis*
Bank swallow	*Riparia riparia*
Cliff swallow	*Hirundo pyrrhonota*
Barn swallow	*Hirundo rustica*
Blue jay	*Cyanocitta cristata*
American crow	*Corvus brachyrhynchos*
Black-capped chickadee	*Parus atricapillus*
Tuffed titmouse	*Parus bicolor*
Red-breasted nuthatch	*Sitta canadensis*
White-breasted nuthatch	*Sitta carolinensis*
Brown creeper	*Certhia americana*
House wren	*Troglodytes aedon*
Winter wren	*Troglodytes troglodytes*
Sedge wren	*Cistothorus platensis*
Marsh wren	*Cistothorus palustris*
Golden-crowned kinglet	*Regulus satrapa*
Blue-gray gnatcatcher	*Polioptila caerulea*
Eastern bluebird	*Sialia sialis*
Veery	*Catharus fuscescens*
Wood thrush	*Hylocichla mustelina*
American robin	*Turdus migratorius*
Gray catbird	*Dumetella carolinensis*
Northern mockingbird	*Minnus polyglottos*
Brown thrasher	*Toxostoma rufum*
Cedar waxwing	*Bombycilla cedrorum*
European starling	*Sturnus vulgaris*
Solitary vireo	*Vireo solitarius*
Yellow-throated vireo	*Vireo flavifrons*
Warbling vireo	*Vireo gilvus*
Red-eyed vireo	*Vireo olivaceus*
Blue-winged warbler	*Vermivora pinus*
Golden-winged warbler	*Vermivora chrysoptera*

Table 26.–Continued.

Common name	Scientific name
Nashville warbler	*Vermivora ruficapilla*
Yellow warbler	*Dendroica petechia*
Chestnut-sided warbler	*Dendroica pensylvanica*
Black-throated blue warbler	*Dendroica caerulescens*
Black-throated green warbler	*Dendroica virens*
Blackburnian warbler	*Dendroica fusca*
Pine warbler	*Dendroica pinus*
Prairie warbler (**endangered**)	*Dendroica discolor*
Cerulean warbler	*Dendroica cerulea*
Black-and-white warbler	*Mniotilta varia*
American redstart	*Setophaga ruticilla*
Ovenbird	*Seiurus aurocapillus*
Northern waterthrush	*Seiurus noveboracensis*
Louisiana waterthrush	*Seiurus motacilla*
Mourning warbler	*Oporornis philadelphia*
Common yellowthroat	*Geothlypis trichas*
Hooded warbler	*Wilsonia citrina*
Canada warbler	*Wilsonia canadensis*
Yellow-breasted chat	*Icteria virens*
Scarlet tanager	*Piranga olivacea*
Northern cardinal	*Cardinalis cardinalis*
Rose-breasted grosbeak	*Pheucticus ludovicianus*
Indigo bunting	*Passerina cyanea*
Dickcissel	*Spiza americana*
Rufous-sided towhee	*Pipilo erythrophthalmus*
Chipping sparrow	*Spizella passerina*
Clay-colored sparrow	*Spizella pallida*
Field sparrow	*Spizella pusilla*
Vesper sparrow	*Pooecetes gramineus*
Savannah sparrow	*Passerculus sandwichensis*
Grasshopper sparrow	*Ammodramus savannarum*
Henslow's sparrow (**threatened**)	*Ammodramus henslowii*
Song sparrow	*Melospiza melodia*
Swamp sparrow	*Melospiza georgiana*
Bobolink	*Dolichonyx oryzivorus*
Red-winged blackbird	*Agelaius phoeniceus*
Eastern meadowlark	*Sturnella magna*
Western meadowlark	*Sturnella neglecta*
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*
Brewer's blackbird	*Euphagus cyanocephalus*
Common grackle	*Quiscalus quiscula*
Brown-headed cowbird	*Molothrus ater*
Orchard oriole	*Icterus spurius*
Northern oriole	*Icterus galbula*
Purple finch	*Carpodacus purpureus*
House finch	*Carpodacus mexicanus*
Pine siskin	*Carduelis pinus*
American goldfinch	*Carduelis tristis*
House sparrow	*Passer domesticus*

Table 27.–Non-breeding birds observed in the Flint River watershed. Data from Genesee Audubon Society and Boettner et al. (1983). Common name status codes in parentheses and bold.

Common name	Scientific name	Abundance status
Common loon (**threatened**)	*Gavia immer*	Fairly common
Horned grebe	*Podiceps auritus*	Fairly common
Red-necked grebe	*Podiceps grisegena*	Fairly common
American white pelican	*Pelecanus erythrorhynchos*	Extremely rare
Double-breasted cormorant	*Phalacrocorax auritus*	Fairly common
Great egret	*Casmerodius albus*	Rare
Cattle egret	*Bubulcus ibis*	Extremely rare
Black-crowned night heron	*Nycticorax nycticorax*	Rare
Tundra swan	*Cygnus columbianus*	Fairly common
Snow goose	*Chen hyperborea*	Rare
Gadwall	*Anas strepera*	Occasional observation
Northern pintail	*Anas acuta*	Rare
Green-winged teal	*Anas crecca*	Uncommon
Northern shoveler	*Anas clypeata*	Rare
American widgeon	*Anas americana*	Occasional observation
Redhead	*Aythya americana*	Uncommon
Ringed-necked duck	*Aythya collaris*	Fairly common
Canvasback	*Aythya valisineria*	Occasional observation
Greater scaup	*Aythya marila*	Uncommon
Lesser scaup	*Aythya affinis*	Uncommon
Common goldeneye	*Bucephala clangula*	Fairly common
Bufflehead	*Bucephala albeola*	Fairly common
Oldsquaw	*Clangula hyemalis*	Rare
Surf scoter	*Melanitta perspicillata*	Rare
White-winged scoter	*Melanitta deglandi*	Rare
Ruddy duck	*Oxyura jamaicensis*	Fairly common
Common merganser	*Mergus merganser*	Abundant
Red-breasted merganser	*Mergus serrator*	Uncommon
Rough-legged hawk	*Buteo lagopus*	Rare
Merlin (**threatened**)	*Falco columbarius*	Rare
Peregrine falcon (**endangered**)	*Falco peregrinus*	Rare
Bald eagle (**threatened**)	*Haliaeetus leucocephalus*	Uncommon
Marsh hawk	*Circus cyaneus*	Uncommon
Osprey (**threatened**)	*Pandion haliaetus*	Uncommon
Purple gallinule	*Gallinula martinica*	Extremely rare
Black-bellied plover	*Squatarola squatarola*	Extremely rare
Lesser golden plover	*Pluvialis dominica*	Rare
Semipalmated plover	*Charadrius semipalmatus*	Extremely rare
Piping plover (**endangered**)	*Charadrius melodus*	Extremely rare
Greater yellowlegs	*Totanus melanoleucus*	Uncommon
Lesser yellowlegs	*Totanus flavipes*	Uncommon
Whimbrel	*Numenius phaeopus*	Rare
Solitary sandpiper	*Tringa solitaria*	Uncommon
Least sandpiper	*Erolia minutilla*	Uncommon
Semipalmated sandpiper	*Ereunetes pusillus*	Rare

Table 27.–Continued.

Common name	Scientific name	Abundance status
Pectoral sandpiper	*Erolia melanotos*	Rare
Upland sandpiper	*Bartramia longicauda*	Extremely rare
Dunlin	*Erolia alpina*	Rare
Buff-breasted sandpiper	*Tryngites subruficollis*	Extremely rare
Wilson's phalarope	*Steganopus tricolor*	Extremely rare
Franklin's gull	*Larus pipixcan*	Rare
Glaucous-winged gull	*Larus glaucescens*	Extremely rare
Glaucous gull	*Larus hyperboreus*	Occasional observation
Herring gull	*Larus argentatus*	Abundant
Ring-billed gull	*Larus delawarensis*	Abundant
Bonaparte's gull	*Larus philadephia*	Uncommon
Iceland gull	*Larus glaucoides*	Rare
Thayer's gull	*Larus thayeri*	Rare
Great black-backed gull	*Larus marinus*	Occasional observation
Lesser black-backed gull	*Larus fuscus*	Rare
Black-legged kittiwake	*Rissa tridactyla*	Extremely rare
Caspian tern (**threatened**)	*Sterna caspia*	Rare
Common tern (**threatened**)	*Sterna hirundo*	Rare
Black tern	*Chlidonias niger*	Rare
Snowy owl	*Nyctea scandiaca*	Rare
Long-eared owl (**threatened**)	*Asio otus*	Rare
Northern saw-whet owl	*Aegolius acadicus*	Rare
Rufous hummingbird	*Selasphorus rufus*	Extremely rare
Yellow-bellied sapsucker	*Sphyrapicus varius*	Uncommon
Yellow-bellied flycatcher	*Empidonax flaviventris*	Rare
Willow flycatcher	*Empidonax traillii*	Rare
Olive-sided flycatcher	*Contopus borealis*	Rare
Western kingbird	*Tyrannus verticalis*	Extremely rare
Boreal chickadee	*Parus hudsonicus*	Extremely rare
Carolina wren	*Thryothorus ludovicianus*	Rare
Bewick's wren	*Thryomanes bewickii*	Extremely rare
Hermit thrush	*Catharus guttatus*	Fairly common
Swainson's thrush	*Catharus ustulatus*	Fairly common
Gray-cheeked thrush	*Catharus minimus*	Rare
Ruby-crowned kinglet	*Regulus calendula*	Common
Varied thrush	*Ixoreus naevius*	Extremely rare
American pipit	*Anthus spinoletta*	Occasional observation
Bohemian waxwing	*Bombycilla garrulus*	Extremely rare
Northern shrike	*Lanius excubitor*	Rare
Loggerhead shrike (**endangered**)	*Lanius ludovicianus*	Extremely rare
White-eyed vireo	*Vireo griseus*	Rare
Philadelphia vireo	*Vireo philadelphicus*	Uncommon
Prothonotary warbler	*Limnothlypis swainsonii*	Rare
Tennessee warbler	*Vermivora peregrina*	Common
Oranged-crowned warbler	*Vermivora celata*	Occasional observation
Northern parula warbler	*Parula americana*	Uncommon
Magnolia warbler	*Dendroica magnolia*	Fairly common
Cape May warbler	*Dendroica tigrina*	Fairly common

Table 27.–Continued.

Common name	Scientific name	Abundance status
Yellow-rumped warbler	*Dendroica coronata*	Abundant
Bay-breasted warbler	*Dendroica castanea*	Fairly common
Blackpoll warbler	*Dendroica striata*	Fairly common
Palm warbler	*Dendroica palmarum*	Fairly common
Wilson's warbler	*Wilsonia pusilla*	Uncommon
Connecticut warbler	*Oporornis agilis*	Rare
Rusty blackbird	*Euphagus carolinus*	Uncommon
Evening grosbeak	*Coccothraustes vespertinus*	Rare
Pine grosbeak	*Pinicola enucleator*	Rare
Hoary redpoll	*Acanthis hornemanni*	Rare
Common redpoll	*Acanthis flammea*	Occasional observation
Red crossbill	*Loxia curvirostra*	Rare
White-winged crossbill	*Loxia leucoptera*	Rare
Dark-eyed junco	*Junco hyemalis*	Fairly common
American tree sparrow	*Spizella arborea*	Fairly common
Lark sparrow	*Chondestes grammacus*	Extremely rare
White-crowned sparrow	*Zonotrichia leucophrys*	Fairly common
White-throated sparrow	*Zonotrichia albicollis*	Common
Harris' sparrow	*Zonotrichia querula*	Extremely rare
Fox sparrow	*Passerella iliaca*	Uncommon
Lincoln's sparrow	*Melospiza lincolnii*	Rare
Lapland longspur	*Calcarius lapponicus*	Rare
Snow bunting	*Plectrophenax nivalis*	Rare

Table 28.–Organizations with interests in the Flint River watershed.

Organization name
Ducks Unlimited
Flint Area League of Women Voters
Flint River Valley Bass Masters
Flint River Valley Steelheaders
Flint River Watershed Coalition
For-Mar Nature Preserve and Arboretum
Genesee County Audubon Society
Genesee County Conservation District
Greater Flint Muddler Minnows
Izaak Walton League
Lake Nepessing Bass Club
Lapeer Conservation District
Michigan B.A.S.S. Chapter Federation
Michigan Chapter of American Fisheries Society
Michigan Duck Hunters Association
Michigan Trappers Association
Michigan United Conservation Club District # 7
Michigan United Conservation Club District # 9
Michigan United Conservation Club District # 10
Michigan State University Extension Service, Genesee County
Natural Resource Conservation Service
Nature Conservancy
Pheasants Forever
Pikemasters
Saginaw Bay Walleye Club
Saginaw Bay Watershed Initiative Network
Seven Ponds Nature Center
Sierra Club
Trout Unlimited
Vietnam Veterans of America

FIGURES

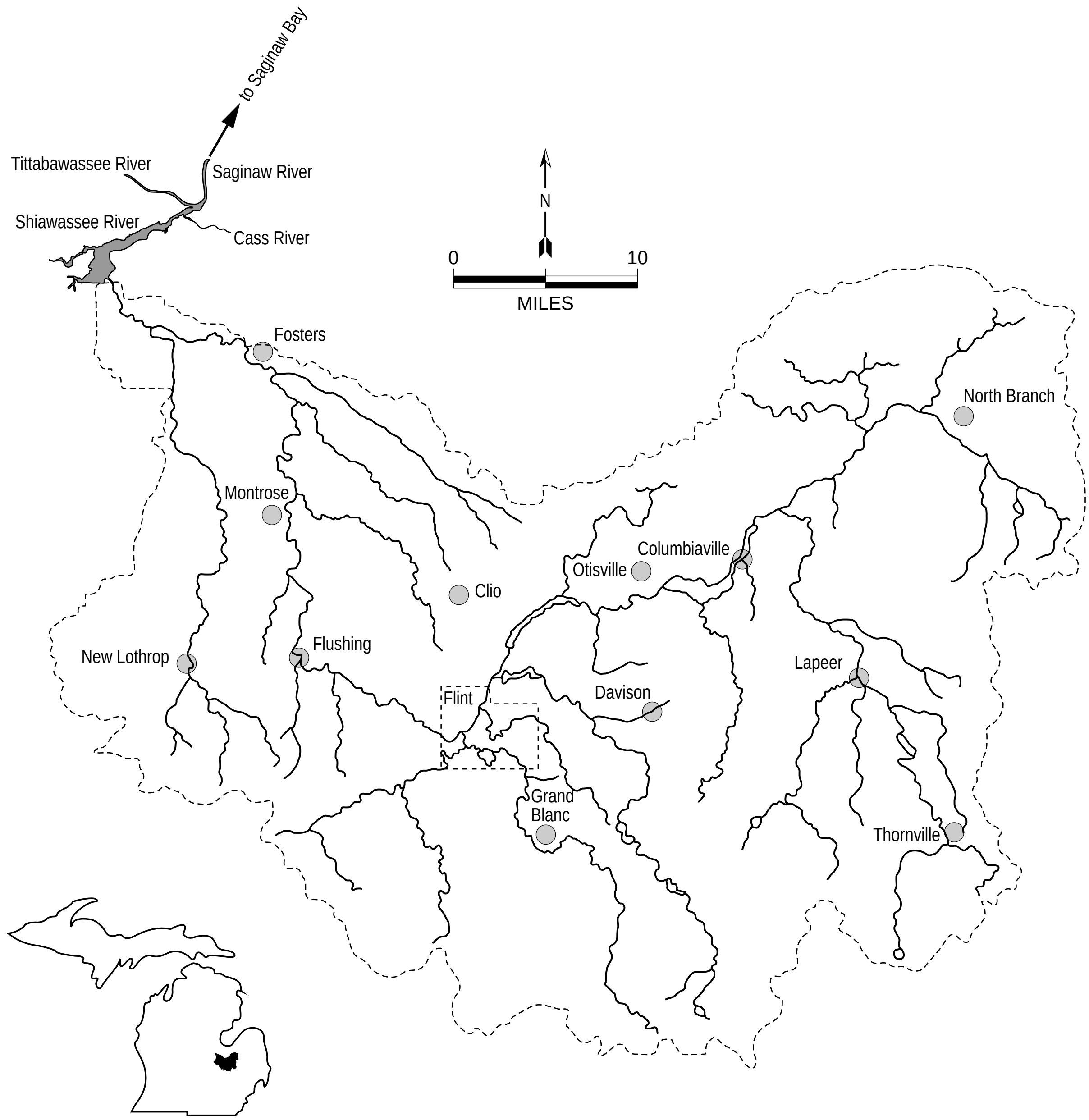


Figure 1.–Flint River watershed drainage.

Upper South Branch
1. Horseshoe Lake
2. South Branch
3. Whigville Creek
4. Winns Pond

Middle South Branch
5. Pine Creek
6. Hunters Creek
7. Mill Creek
8. Lapeer Lake
9. South Branch Farmers Creek
10. Farmers Creek
11. Plum Creek

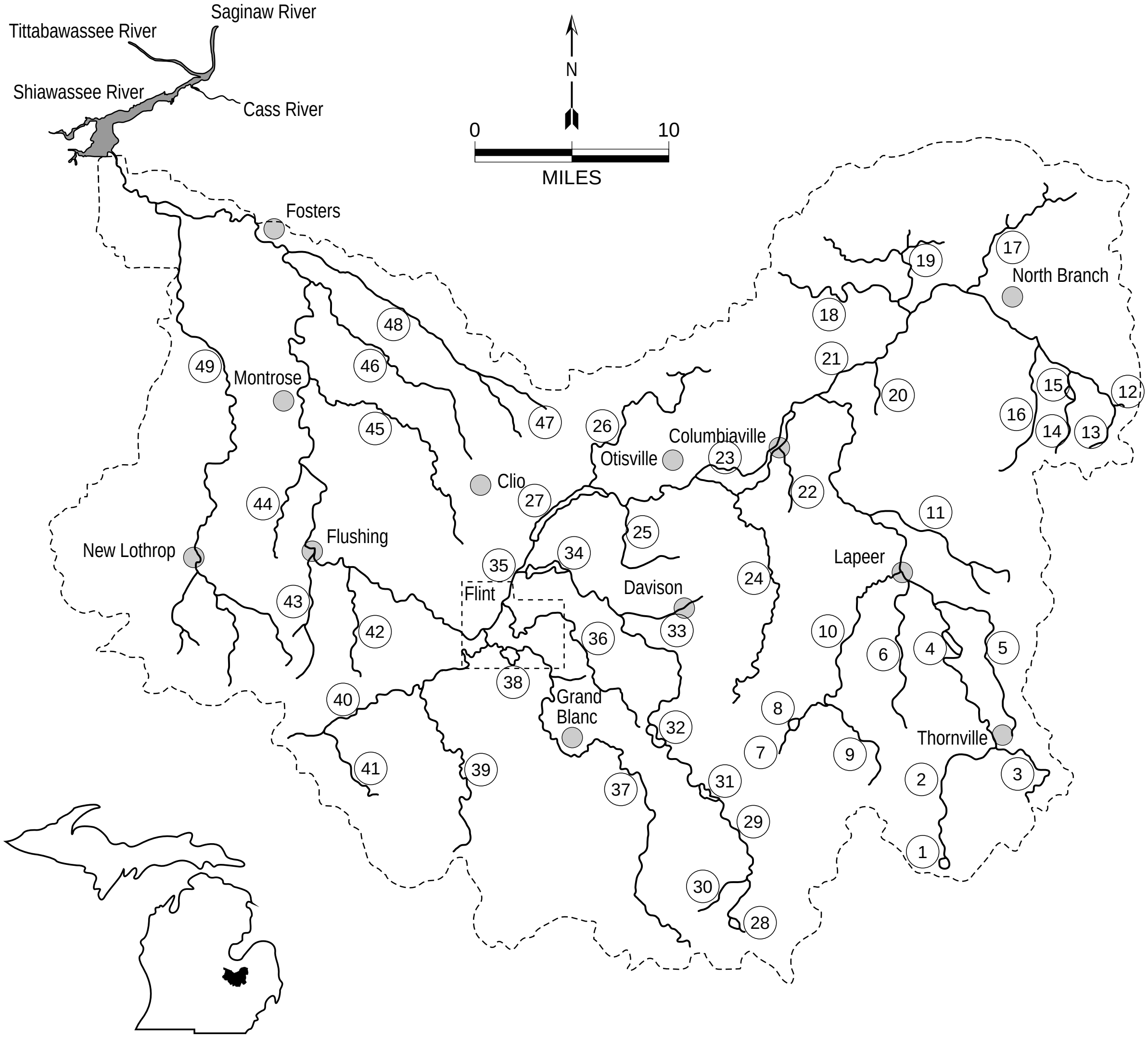
Lower South Branch
12. Elm Creek
13. Cedar Creek
14. Bottom Creek
15. Bottom Creek Impoundment
16. Gravel Creek
17. Indian Creek
18. Fostoria Drain
19. Squaw Creek
20. Crystal Creek
21. North Branch

Upper Flint
22. Henry Drain
23. Holloway Reservoir
24. Hasler Creek
25. Powers-Cullen Drain
26. Butternut Creek
27. C. S. Mott Lake
28. Lake Louise
29. Kearsley Creek
30. Duck Creek
31. Goodrich Mill Pond
32. Atlas Mill Pond
33. Black Creek
34. Kearsley Reservoir
35. Hamilton Impoundment
36. Gilkey Creek
37. Thread Creek
38. Thread Lake
39. Swartz Creek
40. West Branch Swartz Creek
41. Kimball Drain

Middle Flint
42. Mud Creek
43. Cole Creek
44. Brent Creek
45. Brent Run Creek

Lower Flint
46. Pine Run Creek
47. Runnels Drain
48. Silver Creek
49. Misteguay Creek

Figure 2.–Major tributaries and landmarks in the Flint River watershed.



Saginaw River
Tittabawassee River
Shiawassee River
Cass River
N
0
10
MILES
Fosters
19
17
North Branch
18
48
21
49
46
Montrose
15
12
20
16
14
13
47
45
26
Columbiaville
Otisville
23
Clio
22
27
44
11
Flushing
25
New Lothrop
34
Lapeer
35
Davison
24
Flint
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Figure 2.

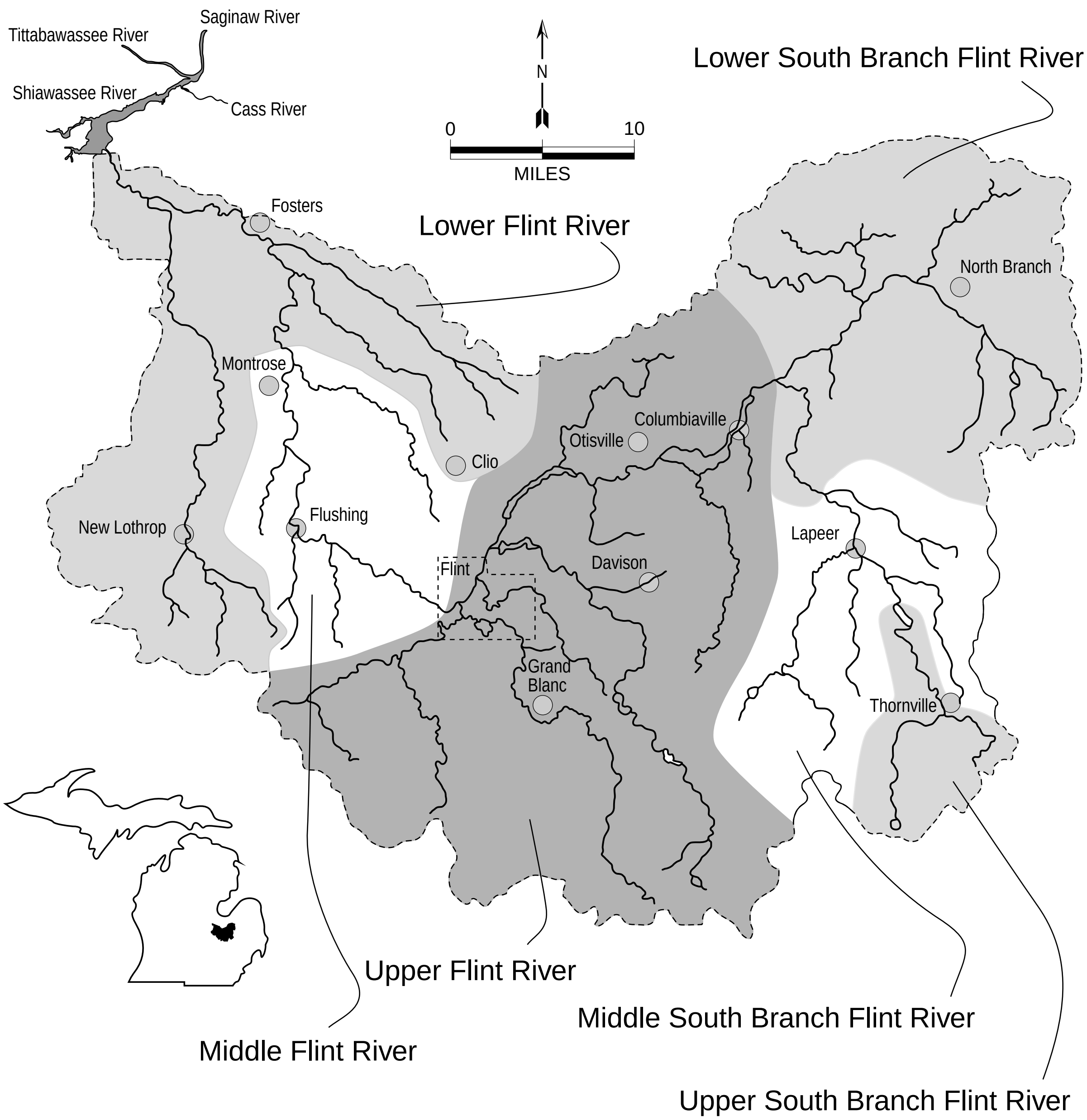


Figure 3.–Flint River basin valley segments.

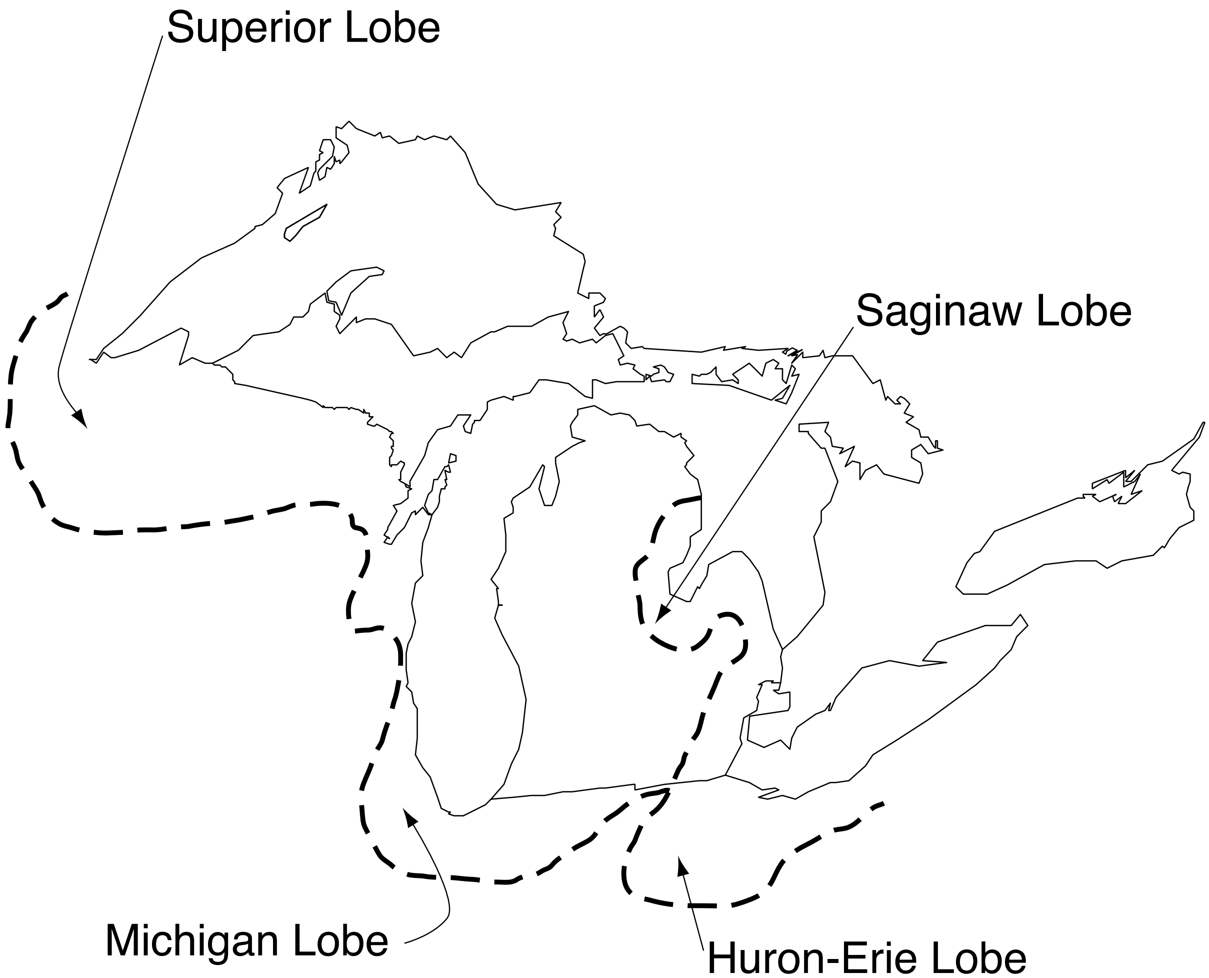


Figure 4.–Diagram of Wisconsinan Glacier with major lobes. Information from Farrand, 1988.

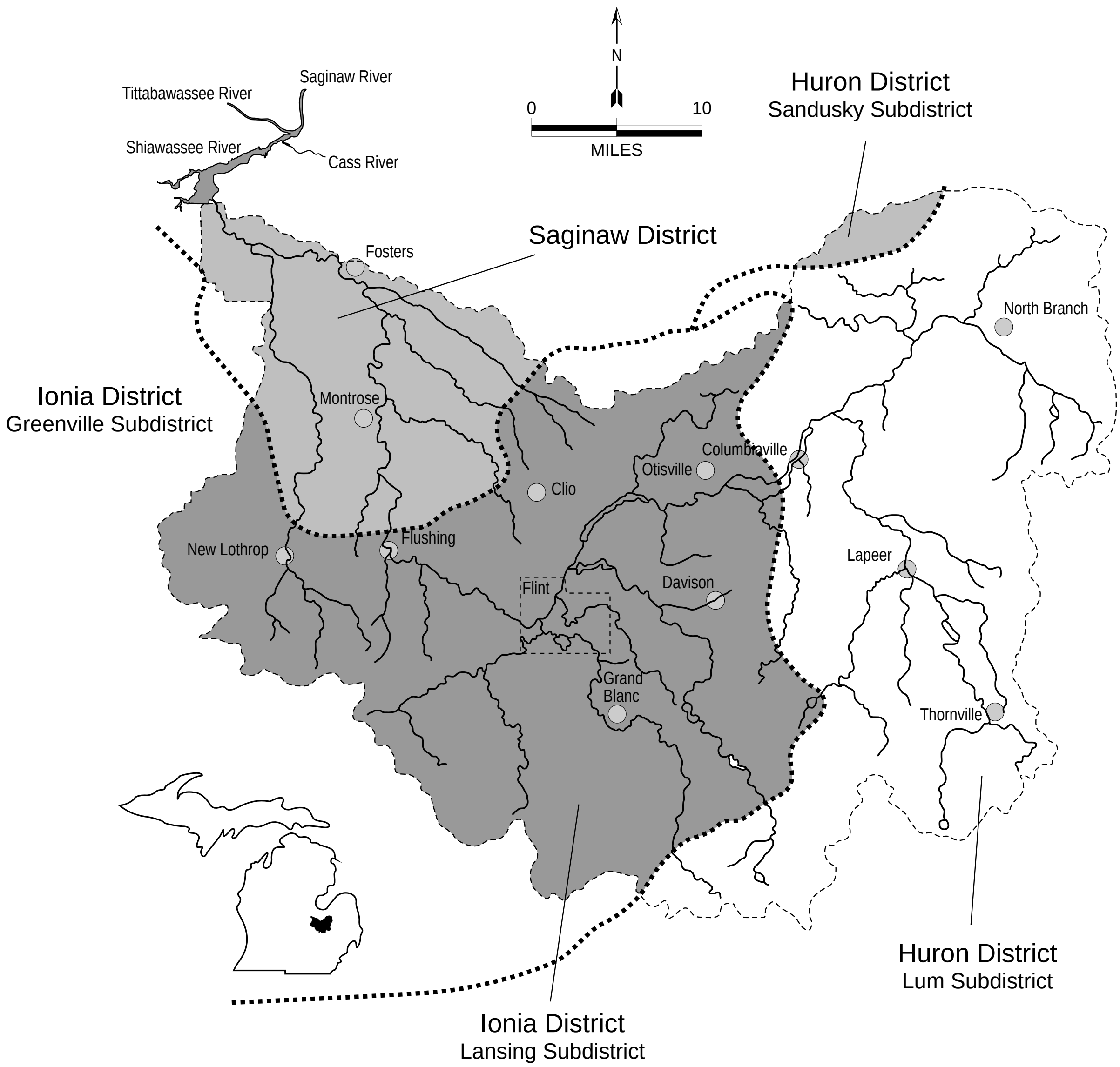


Figure 5.–Regional Landscape Ecosystem boundaries of the Flint River basin. Data from Albert 1994.

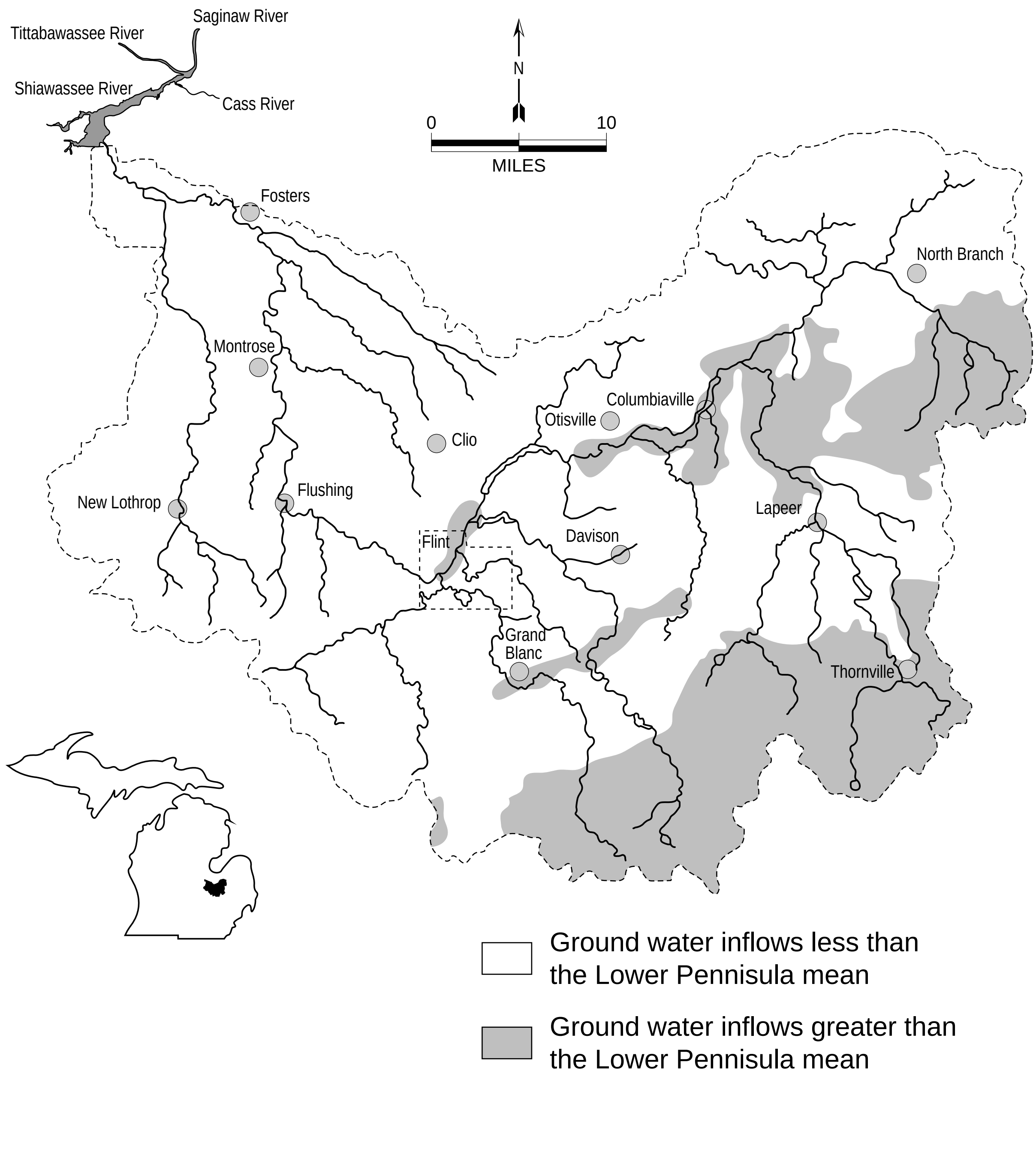
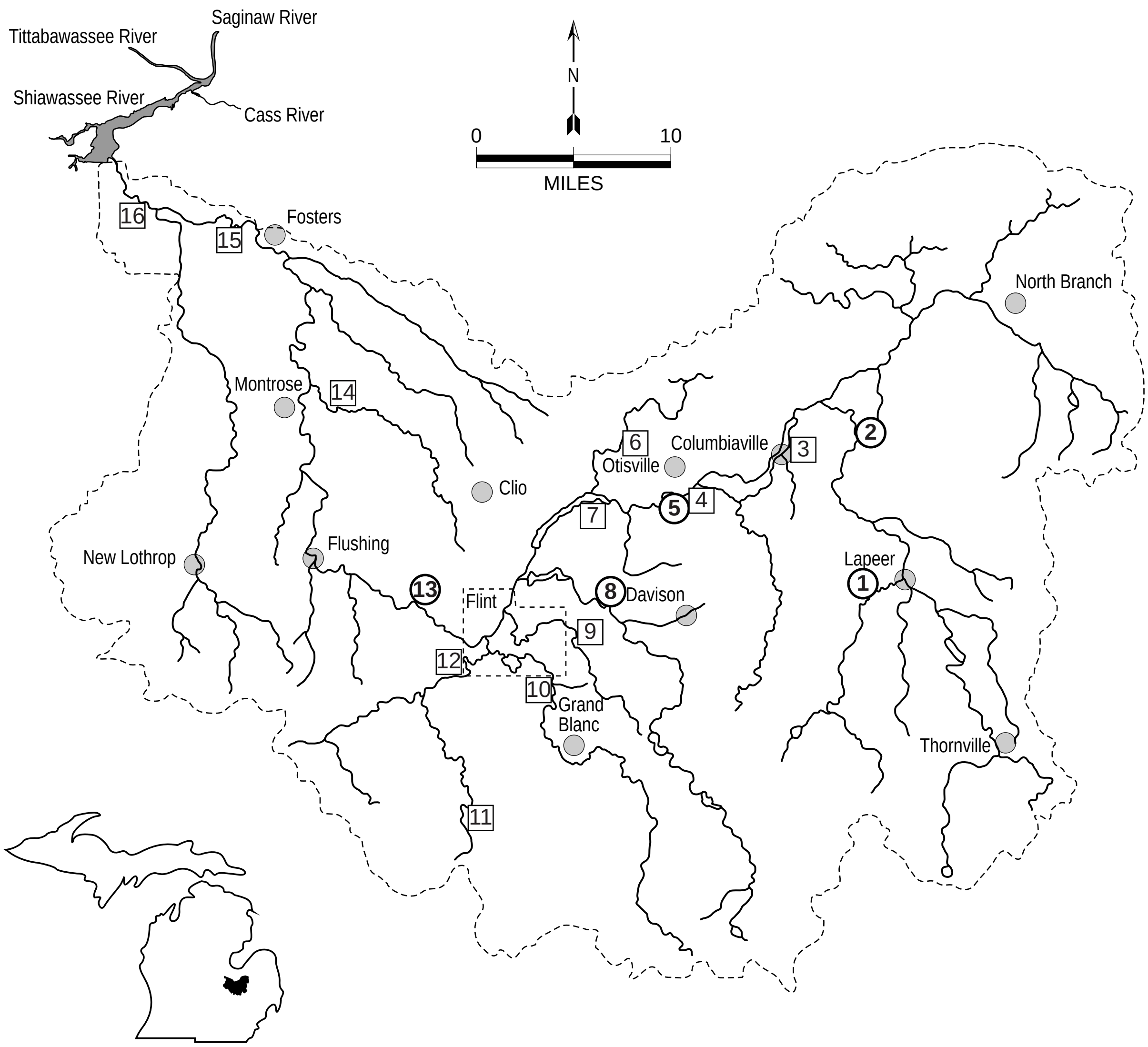


Figure 6.–Flint River basin groundwater inflow.



1. **Farmers Creek (04146000)**
2. **South Branch Flint River (04146063)**
3. Flint River (04146500)
4. Holloway Reservoir (04147000)
5. **Flint River (04147500)**
6. Butternutt Creek (04147990)
7. Flint River (04148000)
8. **Kearsley Creek (04148140)**
9. Gilkey Creek (04148160)
10. Thread Creek (04148440)
11. Swartz Creek (04148200)
12. Swartz Creek (04148300)
13. **Flint River (04148500)**
14. Brent Run (04147200)
15. Flint River (04149000)
16. Flint River (04149500)

Figure 7.–Approximate locations of Flint River basin United States Geological Survey (USGS) gauging stations. USGS identification number in parentheses. Bold circle indicates active gauging station, all others are retired stations.

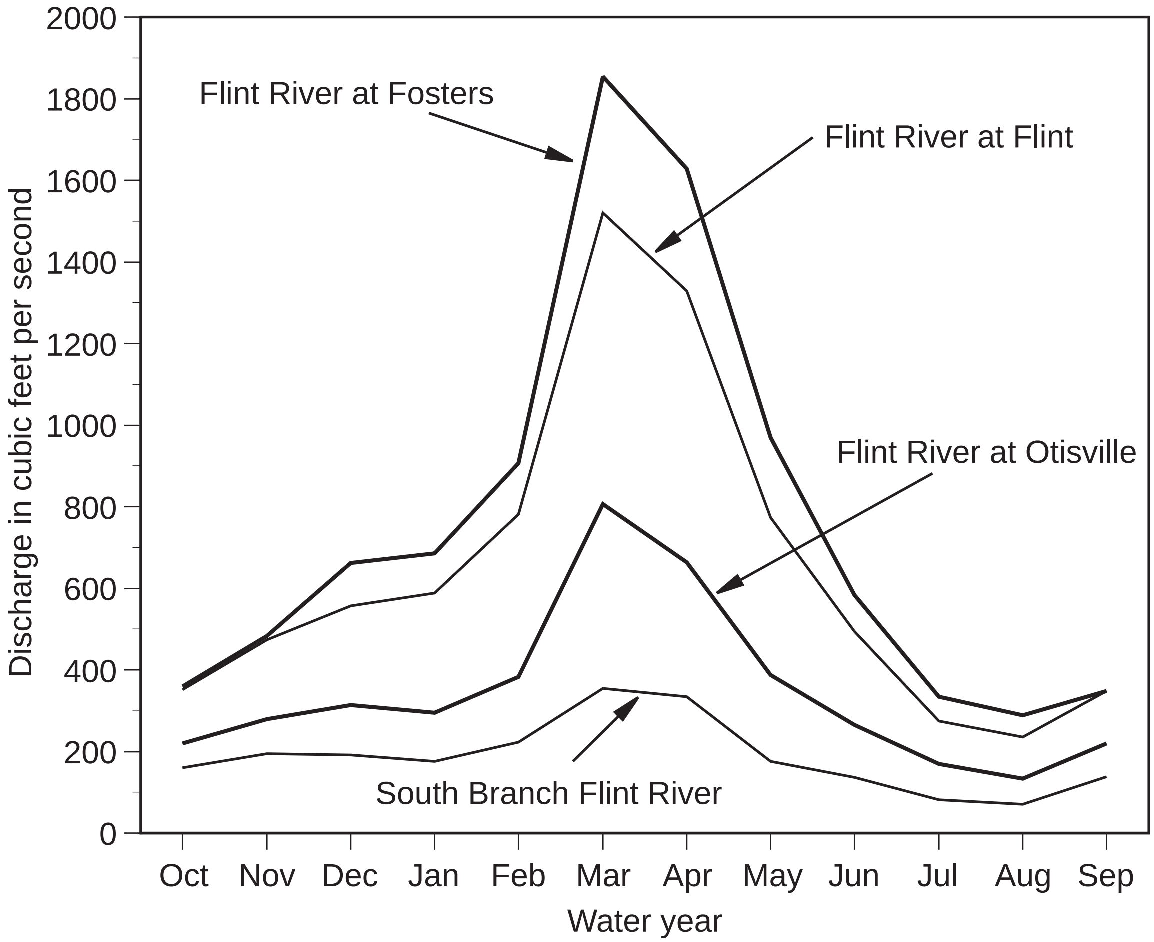


Figure 8.–Mean monthly discharge at four locations on the Flint River. Data source United States Geological Survey gauges for period of record (Table 2).

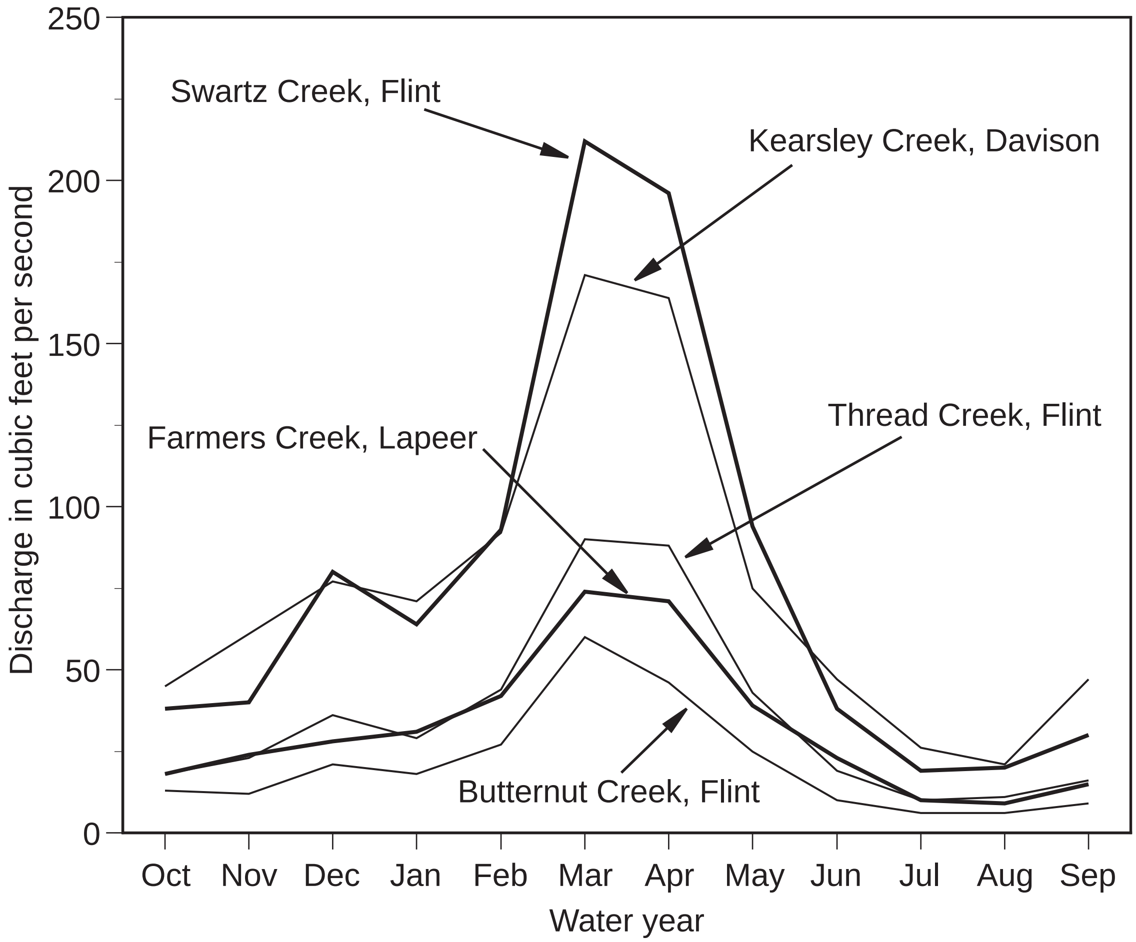


Figure 9.–Mean monthly discharge for Flint River tributaries. Data from United States Geological Survey for period of record (Table 2).

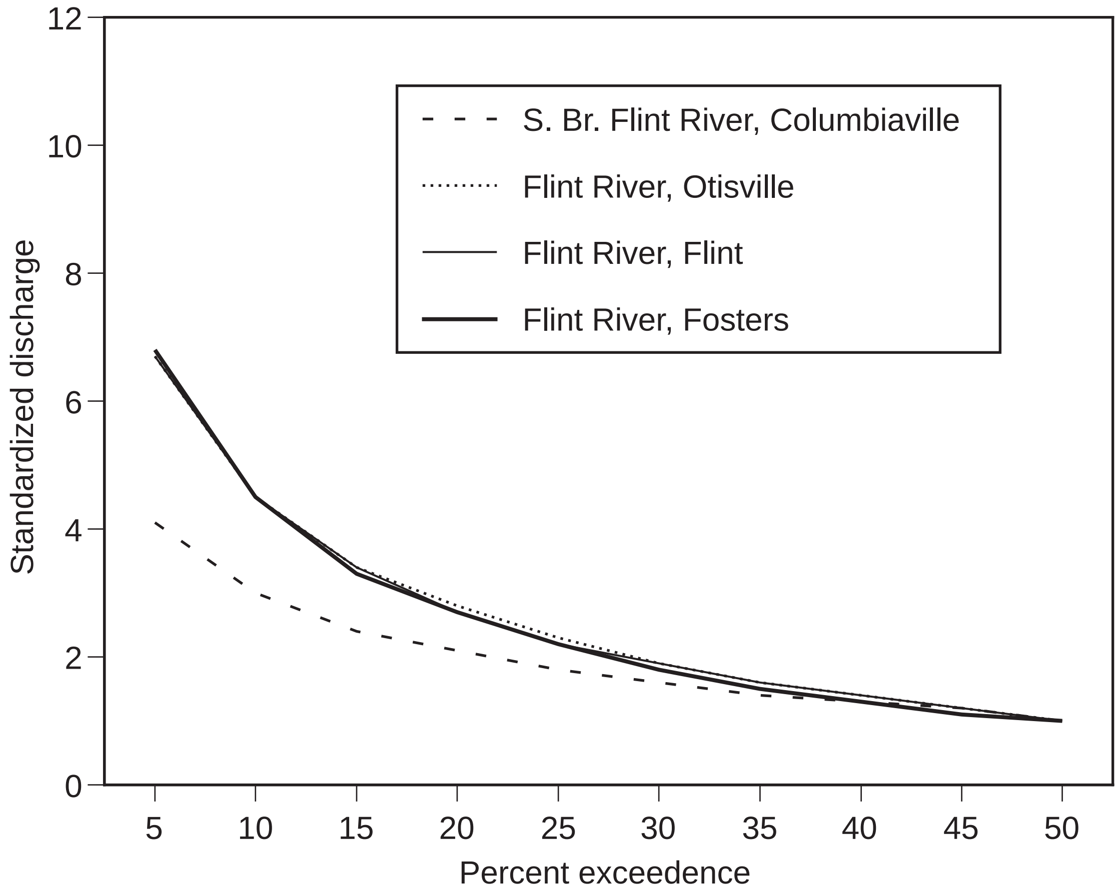


Figure 10.–Standardized high flow exceedence curves for the South Branch and mainstem Flint rivers. (Standardized discharge = discharge (Q)/median discharge(50% Q)). Exceedence curves represent the probability of a discharge exceeding a given value. Data from United States Geological Survey gauges for period of record (Table 2).

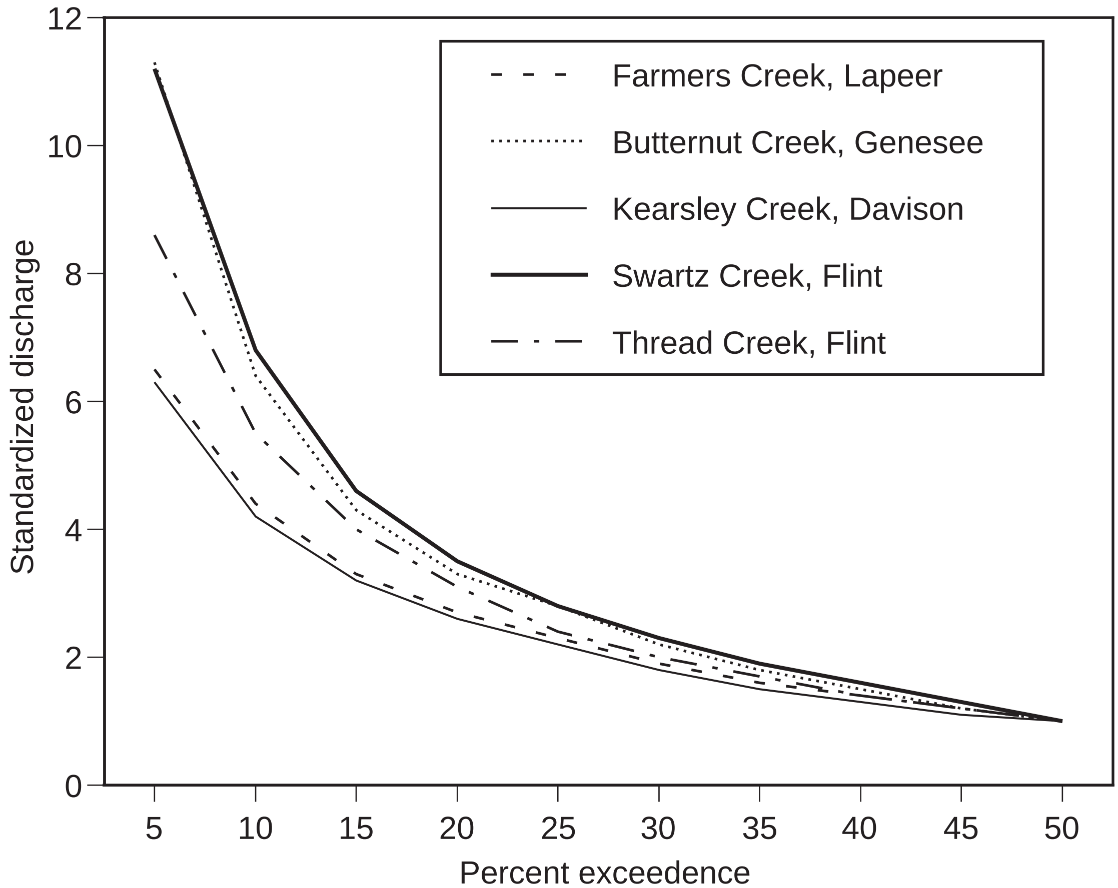


Figure 11.–Standardized high flow exceedence curves for Flint River tributaries. (Standardized discharge = discharge (Q)/median discharge(50% Q)). Exceedence curves represent the probability of a discharge exceeding a given value. Data from United States Geological Survey gauges for period of record (Table 2).

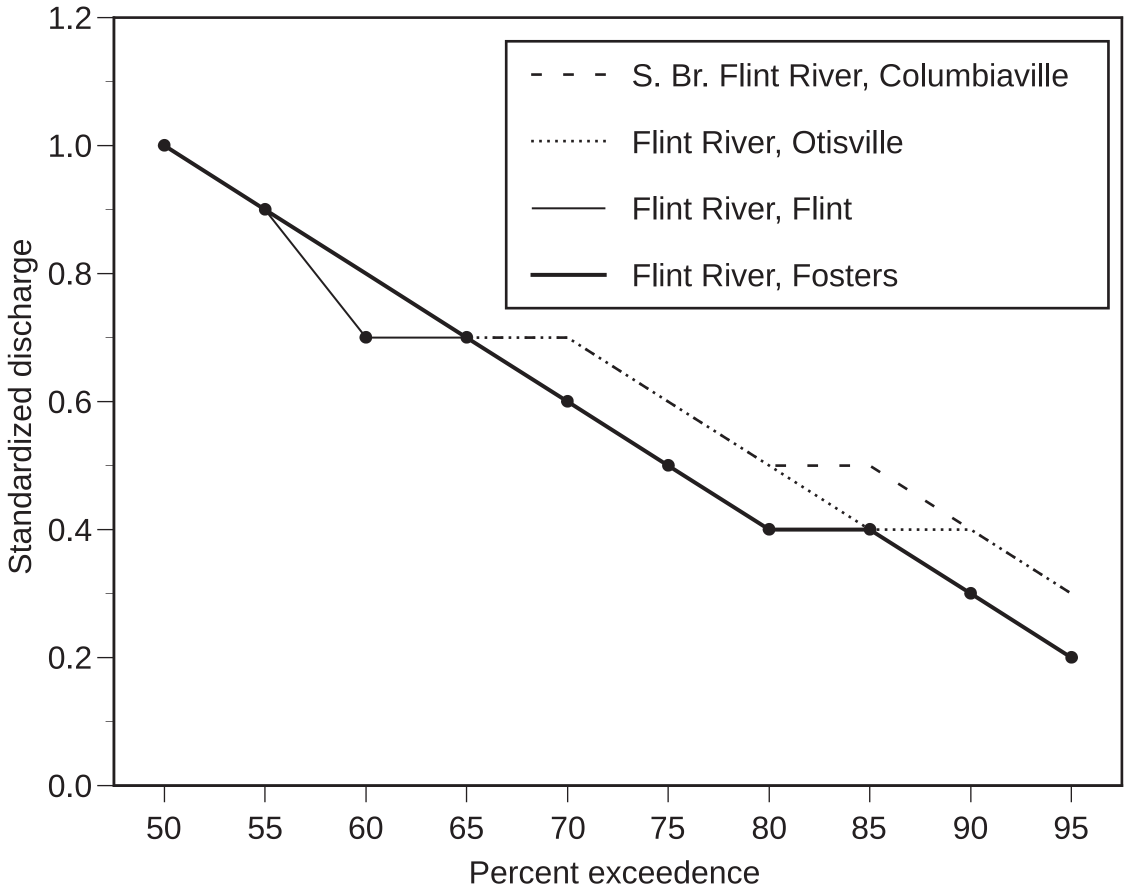


Figure 12.–Standardized low flow exceedence curves for the South Branch and mainstem Flint rivers. Standardized discharge is the discharge (Q)/median (50% Q) discharge. Exceedence curves represent the probability of a discharge exceeding a given value. Data from United States Geological Survey gauges for period of record (Table 2).

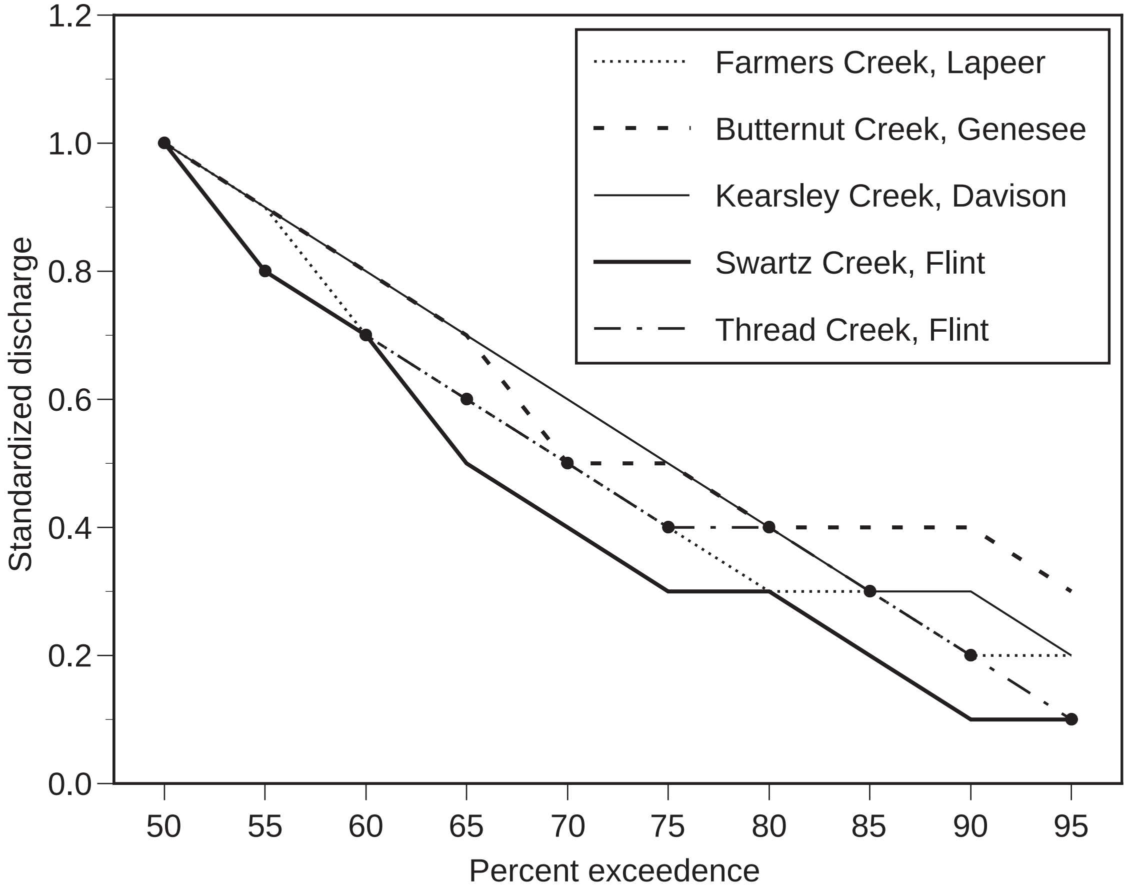


Figure 13.–Standardized low flow exceedence curves for Flint River tributaries. Standardized discharge is the discharge (Q)/median (50% Q) discharge. Exceedence curves represent the probability of a discharge exceeding a given value. Data from United States Geological Survey gauges for period of record (Table 2).

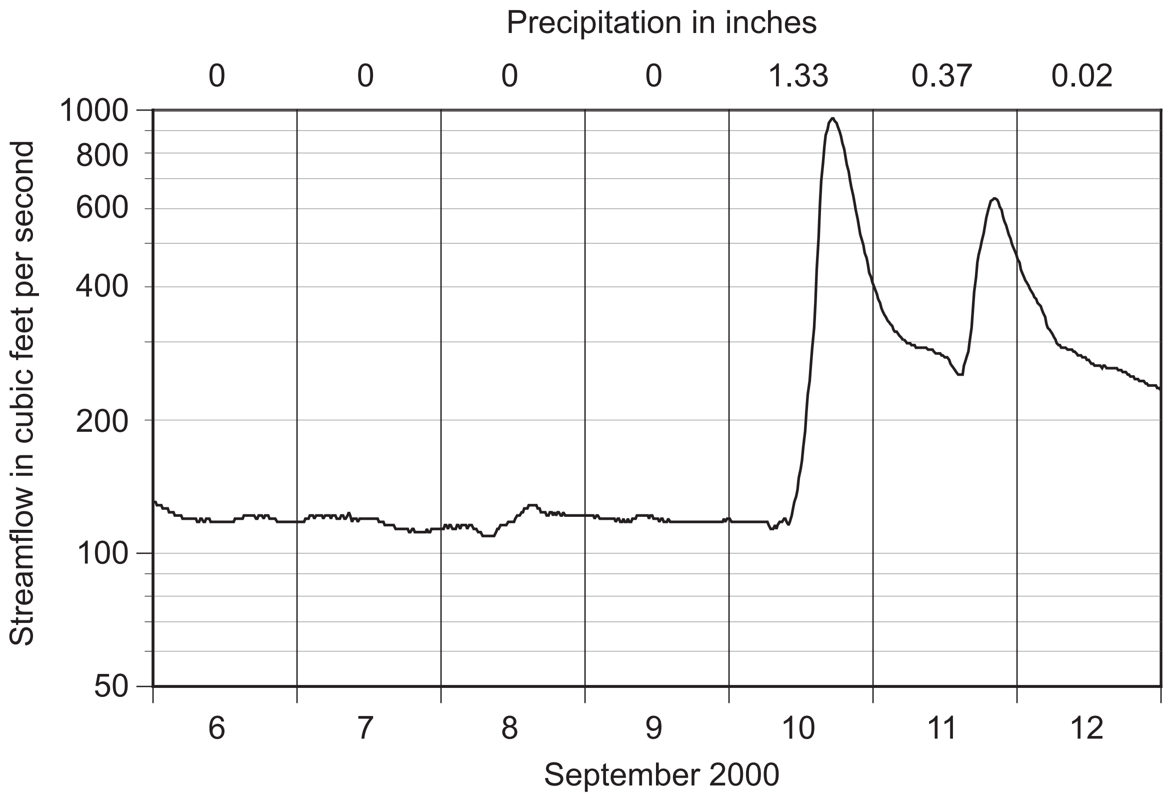


Figure 14.–Flint River daily flow at the Flint gauging station before and after a rain event. Data from United States Geological Survey.

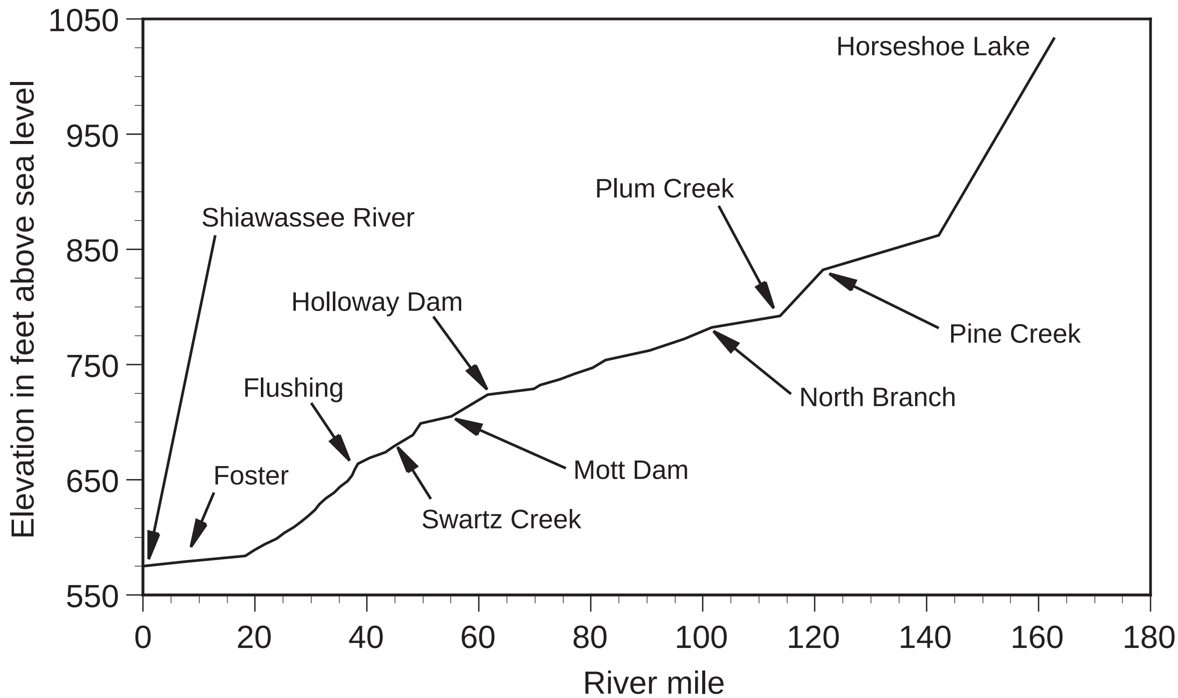


Figure 15.–Flint River stream elevation.

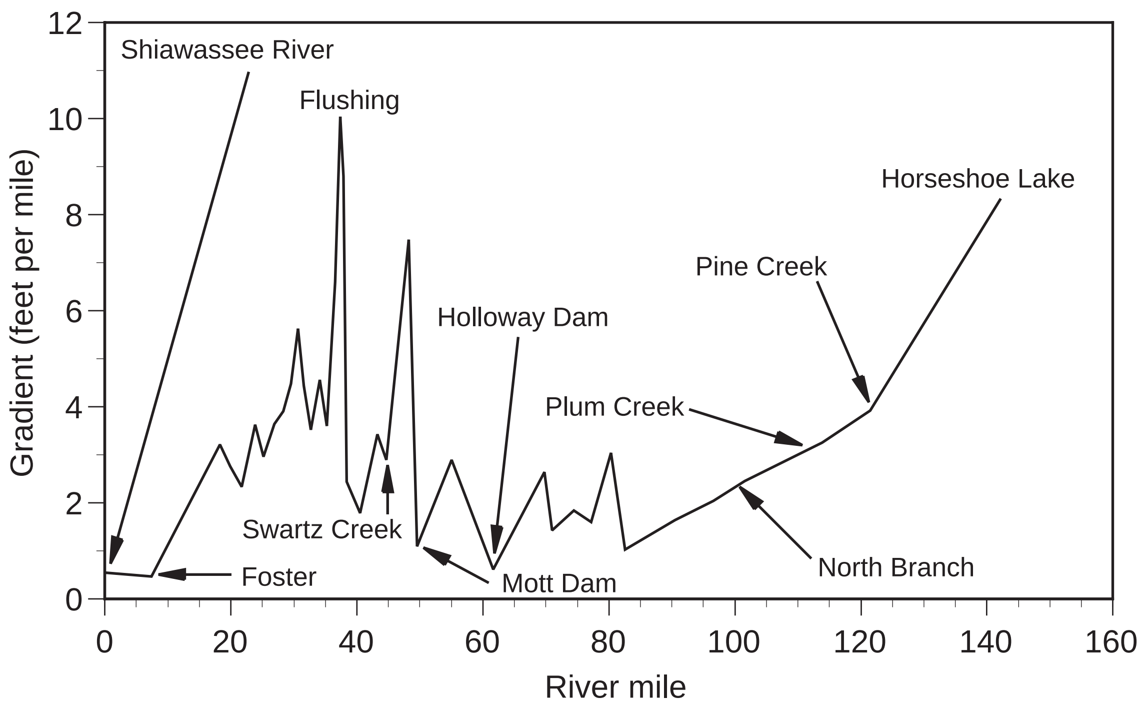
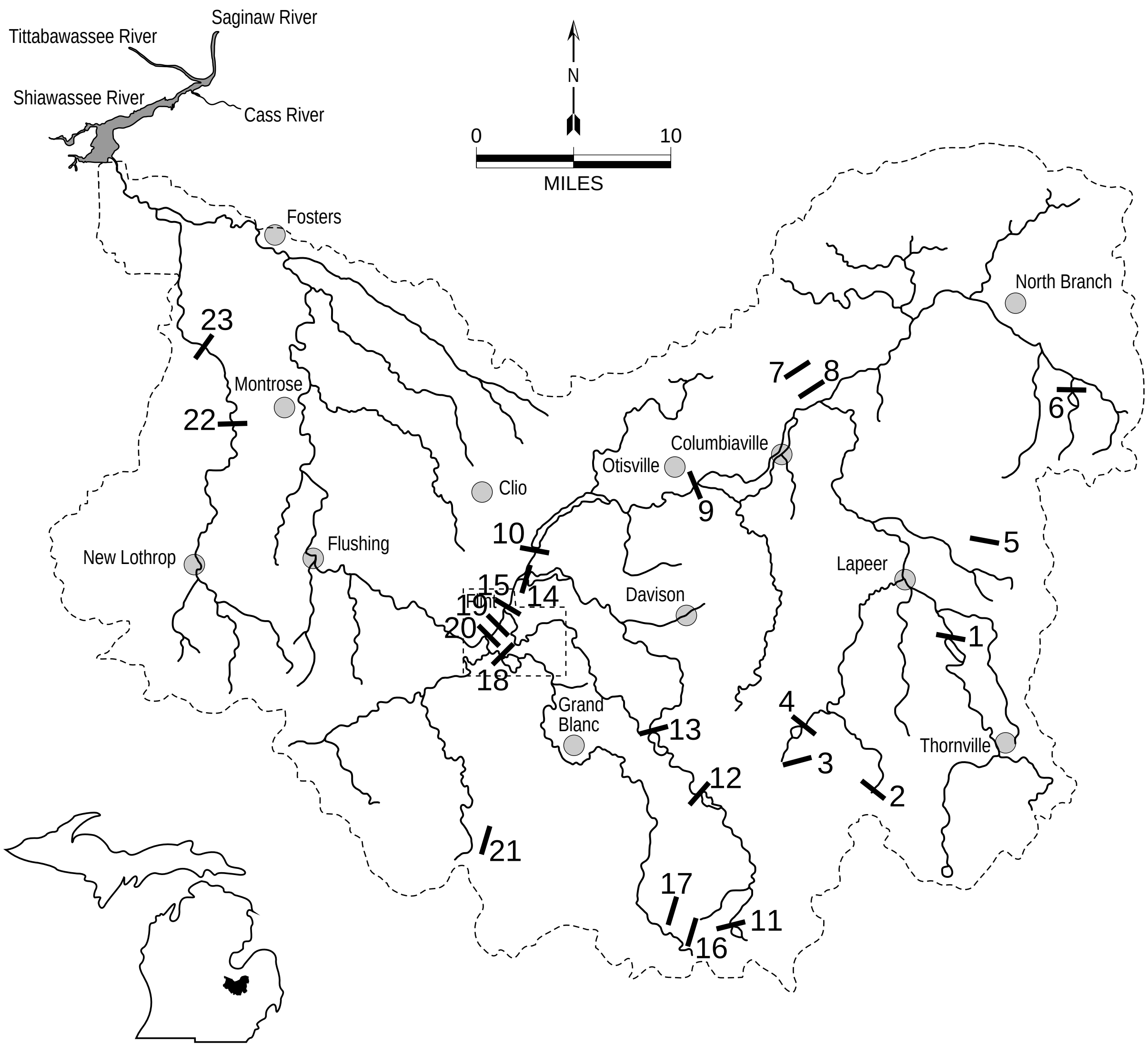


Figure 16.–Flint River gradient.



1. Winns Pond Dam
2. Metamora Dam
3. Minnawana Dam
4. White Sands Dam
5. Long Lake Dam
6. Bottom Creek Dam
7. Hemmingway Lake Dam
8. Tau Beta Dam
9. Earl Holloway Dam
10. C. S. Mott Dam
11. Lake Louise Dam
12. Goodrich Dam
13. Atlas Dam
14. Kearsley Dam
15. Utah Dam
16. Heron Lake Dam
17. Perrysville Dam
18. Thread Lake Dam
19. Hamilton Dam
20. Fiber Dam
21. Crystal Lake Dam
22. Mistequay Creek 2A Dam
23. Mistequay Creek 3A Dam

Figure 17.–Approximate location of principal dams in the Flint River watershed.

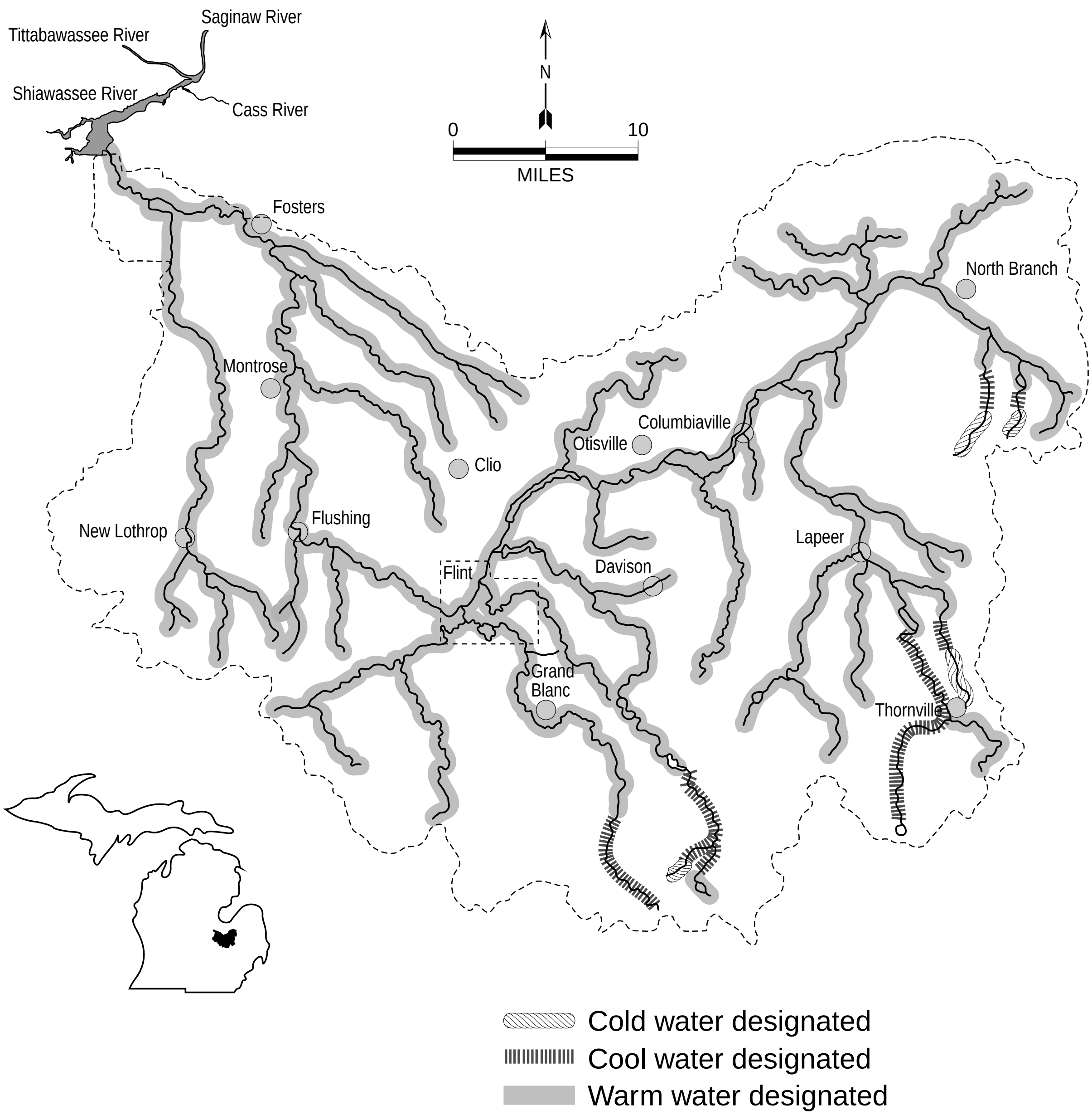


Figure 18.–Flint River basin thermal habitat classification.

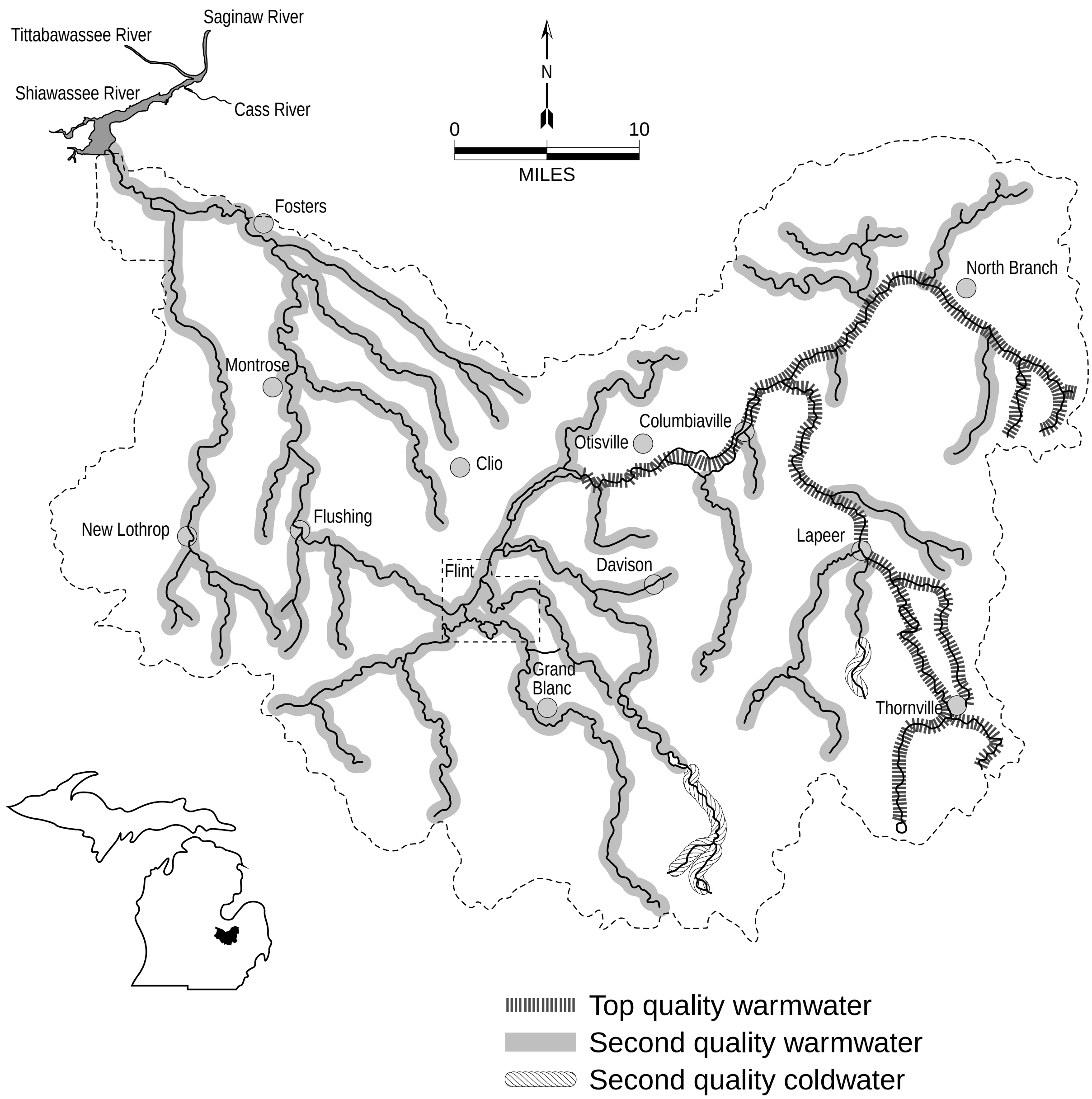
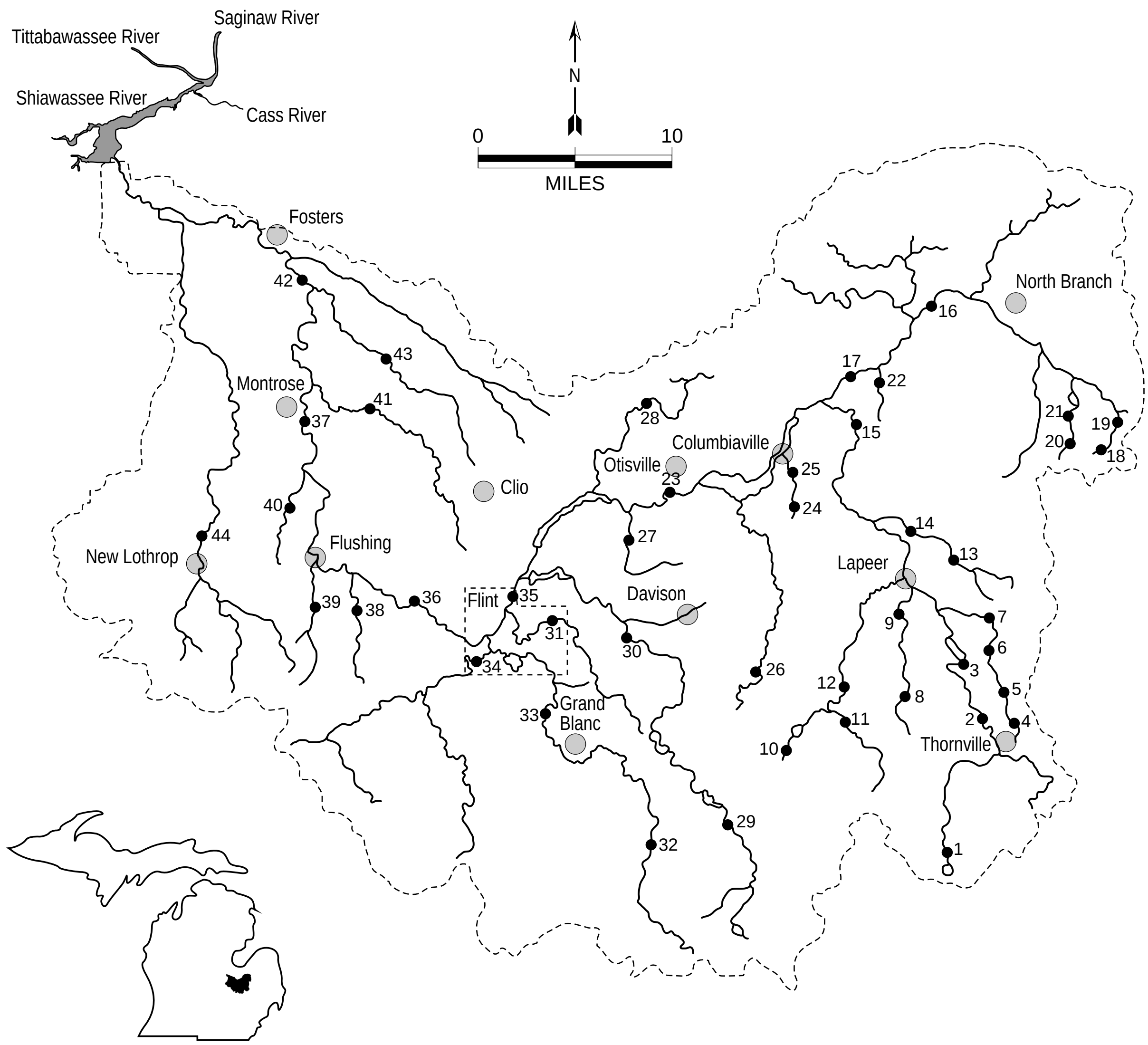


Figure 19.–Michigan stream classification, 1967. Data from Michigan Department of Natural resources, Fisheries Division.

	Water	Site Location	County	T	R	Sec.
1.	South Branch	Oakwood Road	Oakland	05N	10E	10
2.	South Branch	Wilder Road	Lapeer	06N	10E	01,02
3.	South Branch	Greenwood Road	Lapeer	07N	10E	14,23
4.	Pine Creek	Hunters Creek Road	Lapeer	07N	11E	31
5.	Pine Creek	Five Lakes Road	Lapeer	07N	11E	30
6.	Pine Creek	Newark Road	Lapeer	07N	10E	25
7.	Pine Creek	Peppermill Road	Lapeer	07N	10E	13
8.	Hunters Creek	Newark Road	Lapeer	07N	10E	28
9.	Hunters Creek	Terrill Road	Lapeer	07N	10E	17
10.	Mill Creek	Pratt Road	Lapeer	06N	09E	10
11.	Farmers Creek	Baldwin Road	Lapeer	06N	10E	18
12.	Farmers Creek	Merwin Road	Lapeer	07N	09E	26
13.	Plum Creek	Fish Lake Road	Lapeer	08N	10E	25
14.	Plum Creek	Valentine Road	Lapeer	08N	10E	19
15.	South Branch	Norway Lake Road	Lapeer	08N	09E	01
16.	North Branch	Castle Road	Lapeer	10N	10E	34
17.	North Branch	Barnes Road	Lapeer	09N	10E	13
18.	Cedar Creek	Willis Road	Lapeer	09N	12E	31
19.	Cedar Creek	Cedar Creek Road	Lapeer	09N	11E	23
20.	Bottom Creek	Jefferson Road	Lapeer	09N	11E	33
21.	Bottom Creek	Gravel Creek Road	Lapeer	09N	11E	20
22.	Crystal Creek	Barnes Lake Road	Lapeer	09N	10E	20
23.	Flint River	M-15	Genesee	08N	08E	10
24.	Henry Drain	Mt. Morris Road	Lapeer	08N	09E	04
25.	Henry Drain	Stanley Road	Lapeer	08N	09E	09
26.	Hasler Creek	Lippincott Road	Lapeer	07N	09E	20
27.	Powers-Cullen Drain	Carpenter Road	Genesee	08N	08E	30
28.	Butternut Creek	Irish Road	Genesee	09N	08E	19,20
29.	Kearsley Creek	Kipp Road	Genesee	06N	08E	26,35
30.	Kearsley Creek	Atherton Road	Genesee	07N	08E	22,27
31.	Gilkey Creek	East Court Street	Genesee	07N	07E	07
32.	Thread Creek	Baldwin Road	Genesee	06N	08E	29,32
33.	Thread Creek	Bristol Road	Genesee	07N	07E	28,33
34.	Swartz Creek	Miller Road	Genesee	07N	06E	27
35.	Flint River	Hamilton Impoundment	Genesee	06N	06E	many
36.	Flint River	Grand Traverse to Flushing	Genesee	07N	5,6E	many
37.	Flint River	M-57	Genesee	09N	05E	15,22
38.	Mud Creek	Potter Road	Genesee	07N	05E	01,36
39.	Cole Creek	Potter Road	Genesee	07N	05E	02,35
40.	Brent Creek	Stanley Road	Genesee	08N	05E	08,17
41.	Brent Run Creek	Wilson Road	Genesee	09N	06E	29
42.	Flint River	Morseville Road	Saginaw	10N	05E	22
43.	Pine Run Creek	Webster Road	Genesee	09N	06E	08
44.	Misteguay Creek	Byron Road	Shiawassee	09N	04E	36

Figure 20.–Flint River basin 1997 fish sampling locations. Data from Leonardi (1997).


Saginaw River
Tittabawassee River
Shiawassee River
Cass River
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Fosters
North Branch
Montrose
Columbiaville
Otisville
Clio
New Lothrop
Flushing
Lapeer
Davison
Flint
Grand Blanc
Thornville
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Figure 20.

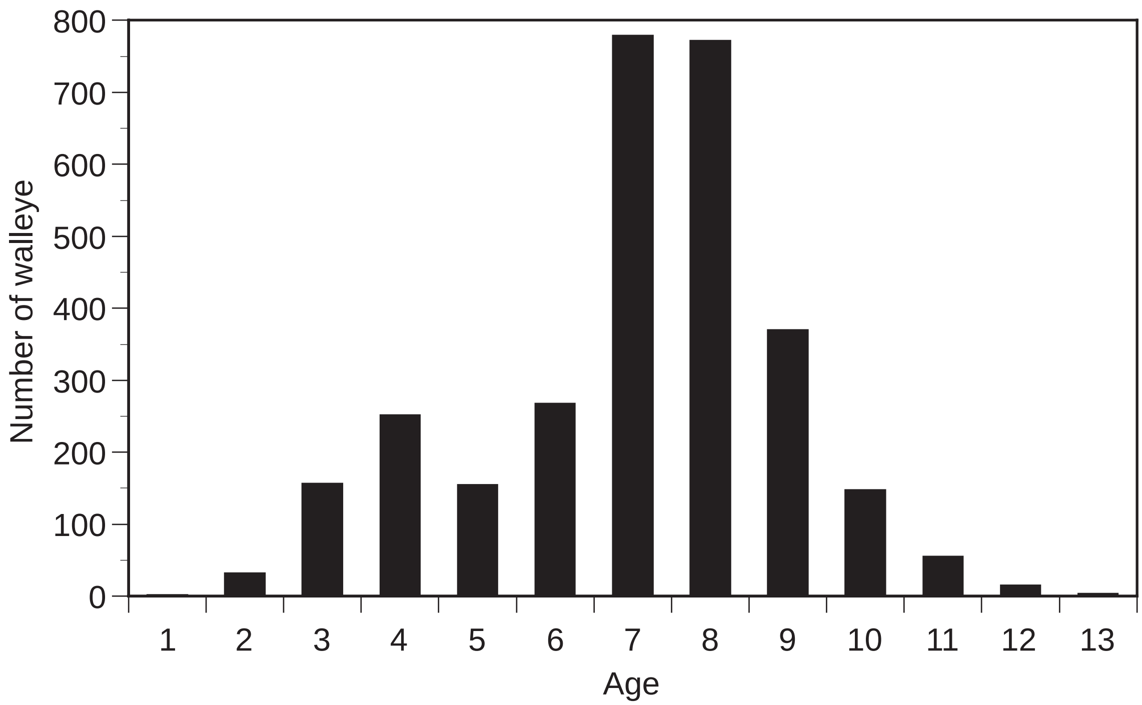


Figure 21.–Age distribution of Flint River spawning walleye, March 1998. Data from Leonardi (unpublished).

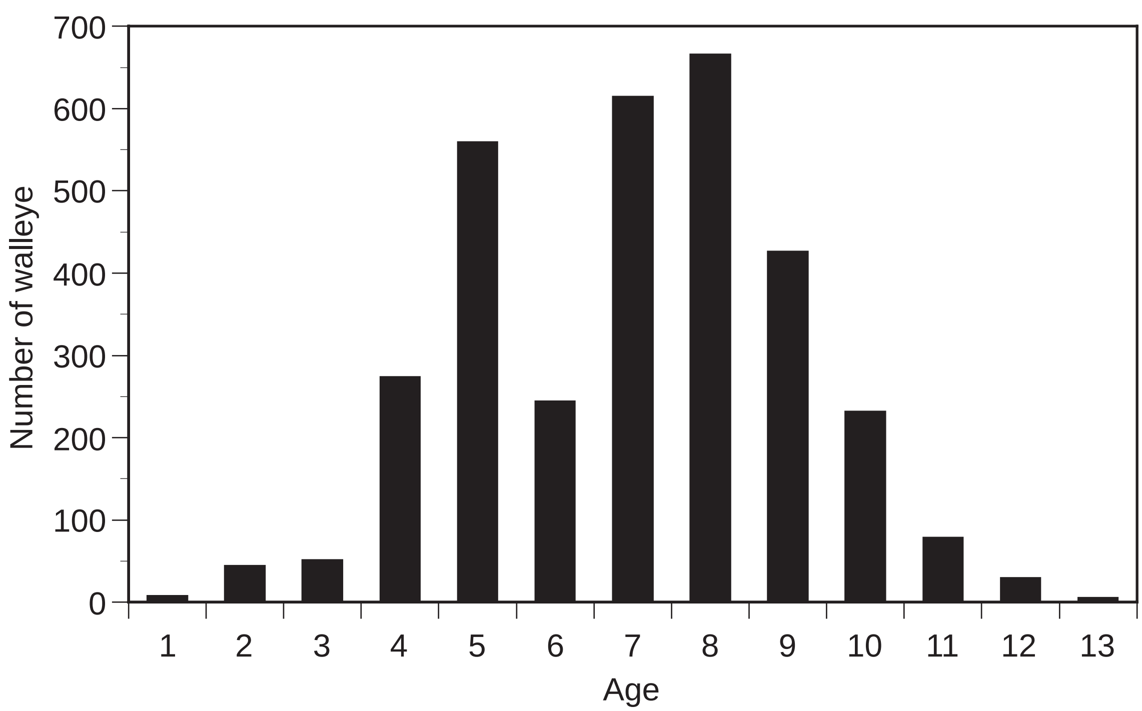


Figure 22.–Age distribution of Flint River spawning walleye, March 1999. Data from Leonardi (unpublished).

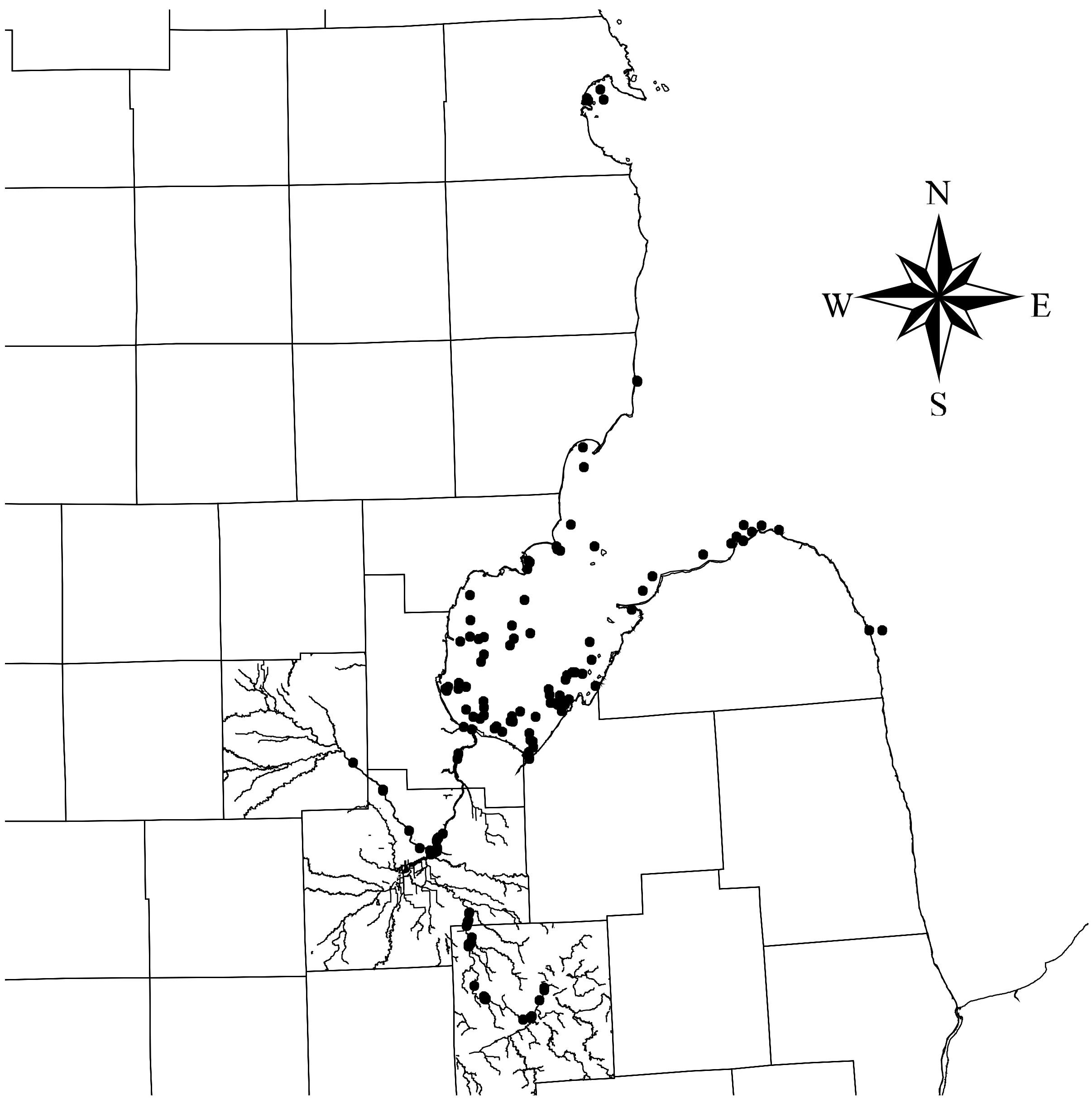
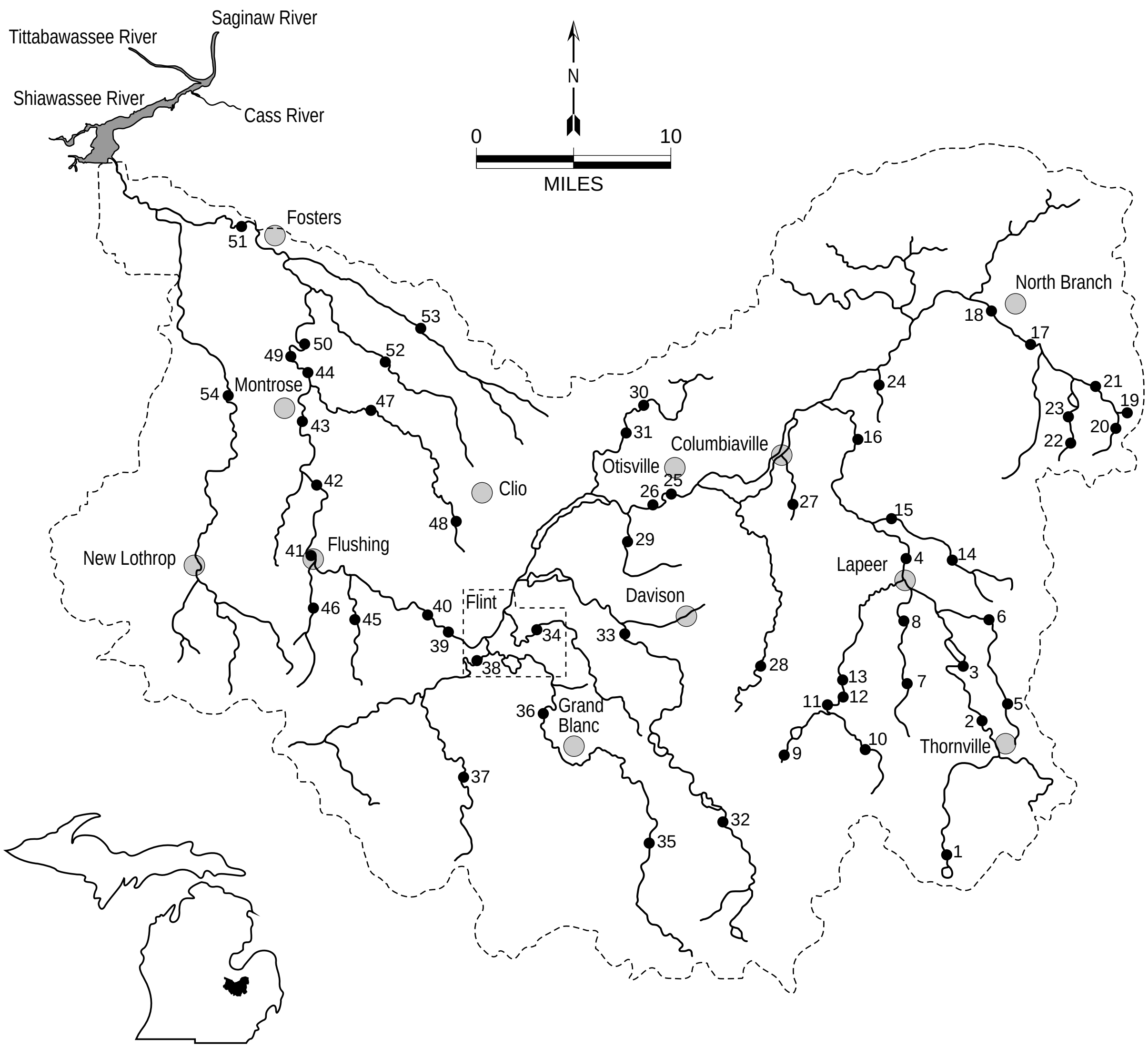


Figure 23.-Angler tag recoveries from Flint River tagged walleye, March 15, 1998 to January, 26, 2000. Data from Robert Haas, Michigan Department of Natural Resources, Fisheries Division.

	Water	Site Location	County	T	R	Sec.
1	South Branch	Oakwood Road	Oakland	05N	10E	10
2	South Branch	Wilder Road	Lapeer	06N	10E	01
3	South Branch	Greenwood Road	Lapeer	07N	10E	23
4	South Branch	Mayfield Road	Lapeer	08N	10E	29
5	Pine Creek	Hunters Creek Road	Lapeer	07N	11E	31
6	Pine Creek	Peppermill Road	Lapeer	07N	10E	13
7	Hunters Creek	Newark Road	Lapeer	07N	10E	28
8	Hunters Creek	Turrill Road	Lapeer	07N	10E	17
9	Mill Creek	Pratt Road	Lapeer	06N	09E	10
10	Farmers Creek	Baldwin Road	Lapeer	06N	10E	18
11	Farmers Creek	Mitchell Road	Lapeer	07N	09E	35
12	Farmers Creek	Merwin Road	Lapeer	07N	09E	26
13	Farmers Creek	Lippincott Road	Lapeer	07N	09E	24
14	Plum Creek	Fish Lake Road	Lapeer	08N	10E	25
15	Plum Creek	Valentine Road	Lapeer	08N	10E	20
16	South Branch	Norway Lake Road	Lapeer	08N	09E	01
17	North Branch	M-90	Lapeer	09N	11E	06
18	North Branch	Castle Road	Lapeer	10N	10E	34
19	Elm Creek	Patrick Road	Lapeer	09N	11E	01
20	Cedar Creek	Willis Road	Lapeer	09N	12E	31
21	Cedar Creek	Cedar Creek Road	Lapeer	09N	11E	23
22	Bottom Creek	Jefferson Road	Lapeer	09N	11E	33
23	Bottom Creek	Gravel Creek Road	Lapeer	09N	11E	20
24	Crystal Creek	Barnes Lake Road	Lapeer	09N	10E	20
25	Flint River	M-15	Genesee	08N	08E	10
26	Flint River	Gale Road	Genesee	08N	08E	16
27	Henry Drain	Mt. Morris Road	Lapeer	08N	09E	09
28	Hasler Creek	Lippincott Road	Lapeer	07N	09E	19
29	Powers-Cullen Drain	Carpenter Road	Genesee	08N	08E	30
30	Butternut Creek	Irish Road	Genesee	09N	08E	20
31	Butternut Creek	Vassar Road	Genesee	09N	07E	36
32	Kearsley Creek	Kipp Road	Genesee	06N	08E	35
33	Kearsley Creek	Atherton Road	Genesee	07N	08E	27
34	Gilkey Creek	East Court Street	Genesee	07N	07E	08
35	Thread Creek	Baldwin Road	Genesee	06N	08E	32
36	Thread Creek	Bristol Road	Genesee	07N	07E	33
37	Swartz Creek	Grand Blanc Road	Genesee	06N	06E	23
38	Swartz Creek	Miller Road & US 23	Genesee	07N	06E	27
39	Flint River	Mill Road	Genesee	07N	06E	04
40	Flint River	Linden/Flushing Roads	Genesee	07N	06E	05
41	Flint River	Riverview Park, Flushing	Genesee	08N	05E	27
42	Flint River	Mt. Morris Road	Genesee	08N	05E	03
43	Flint River	Vienna Road	Genesee	09N	05E	21
44	Flint River	Ragnone WWTP Outfall	Genesee	09N	05E	15
45	Mud Creek	Potter Road	Genesee	07N	05E	01
46	Cole Creek	McKinley Road	Genesee	08N	05E	35
47	Brent Run Creek	Stanley Road	Genesee	08N	06E	14
48	Brent Run Creek	Webster Road	Genesee	09N	06E	29
49	Flint River	E. Burt Road	Saginaw	10N	05E	27
50	Flint River	Morseville Road	Saginaw	10N	05E	21
51	Flint River	Sheridan Road	Saginaw	10N	04E	01
52	Pine Run Creek	Webster Road	Genesee	09N	06E	08
53	Silver Creek	Moorish Road	Saginaw	10N	05E	13
54	Misteguay Creek	Johnstone Road	Shiawassee	09N	04E	36

Figure 24.–Flint River basin aquatic invertebrate sample locations. Data from Alexander (1997) and M. Walterhouse (MDEQ, SWQD, unpublished data).


Saginaw River
Tittabawassee River
Shiawassee River
Cass River
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MILES
Fosters
North Branch
Montrose
Clio
Columbiaville
Otisville
Flushing
New Lothrop
Lapeer
Davison
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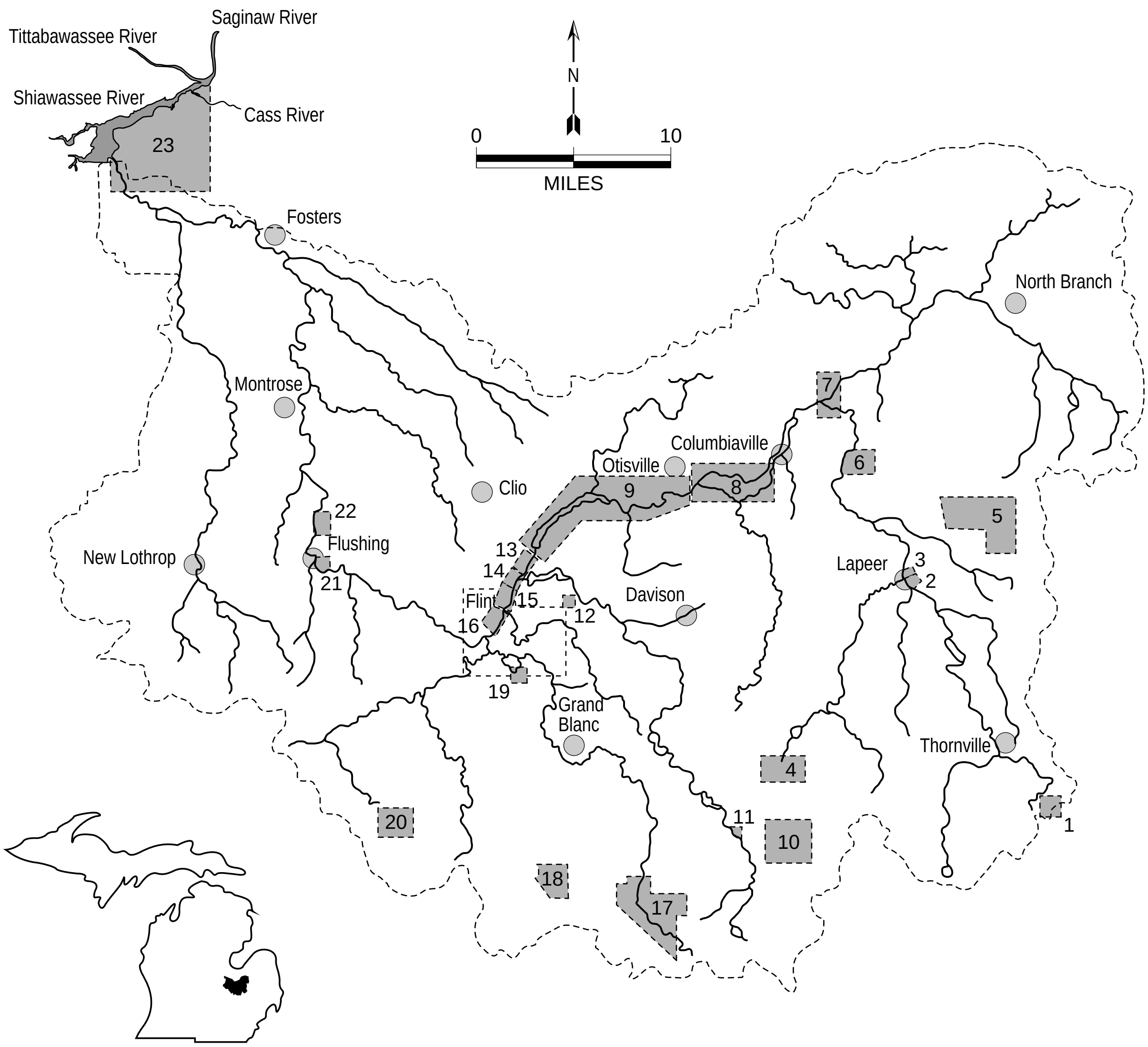
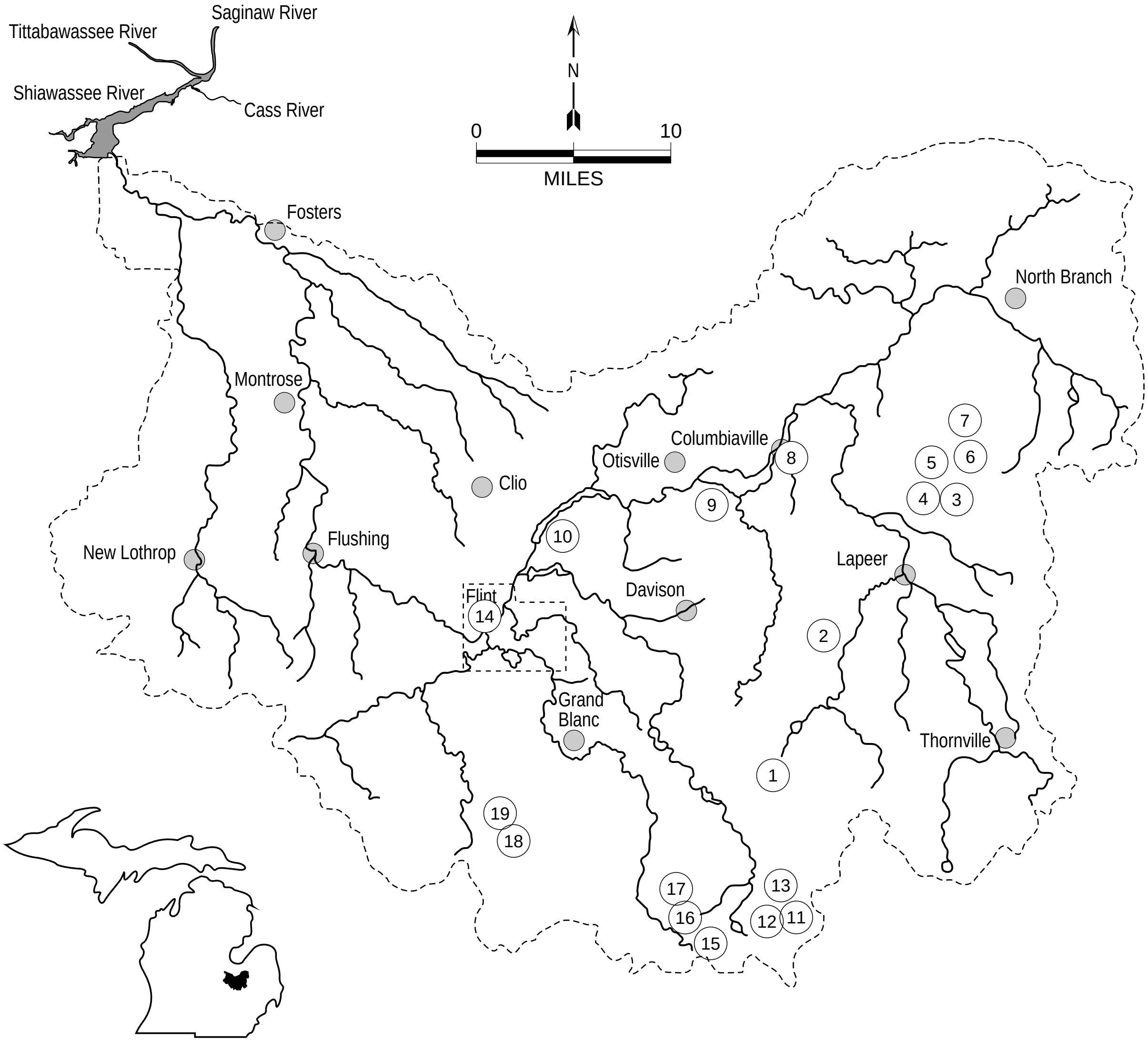
Figure 24.



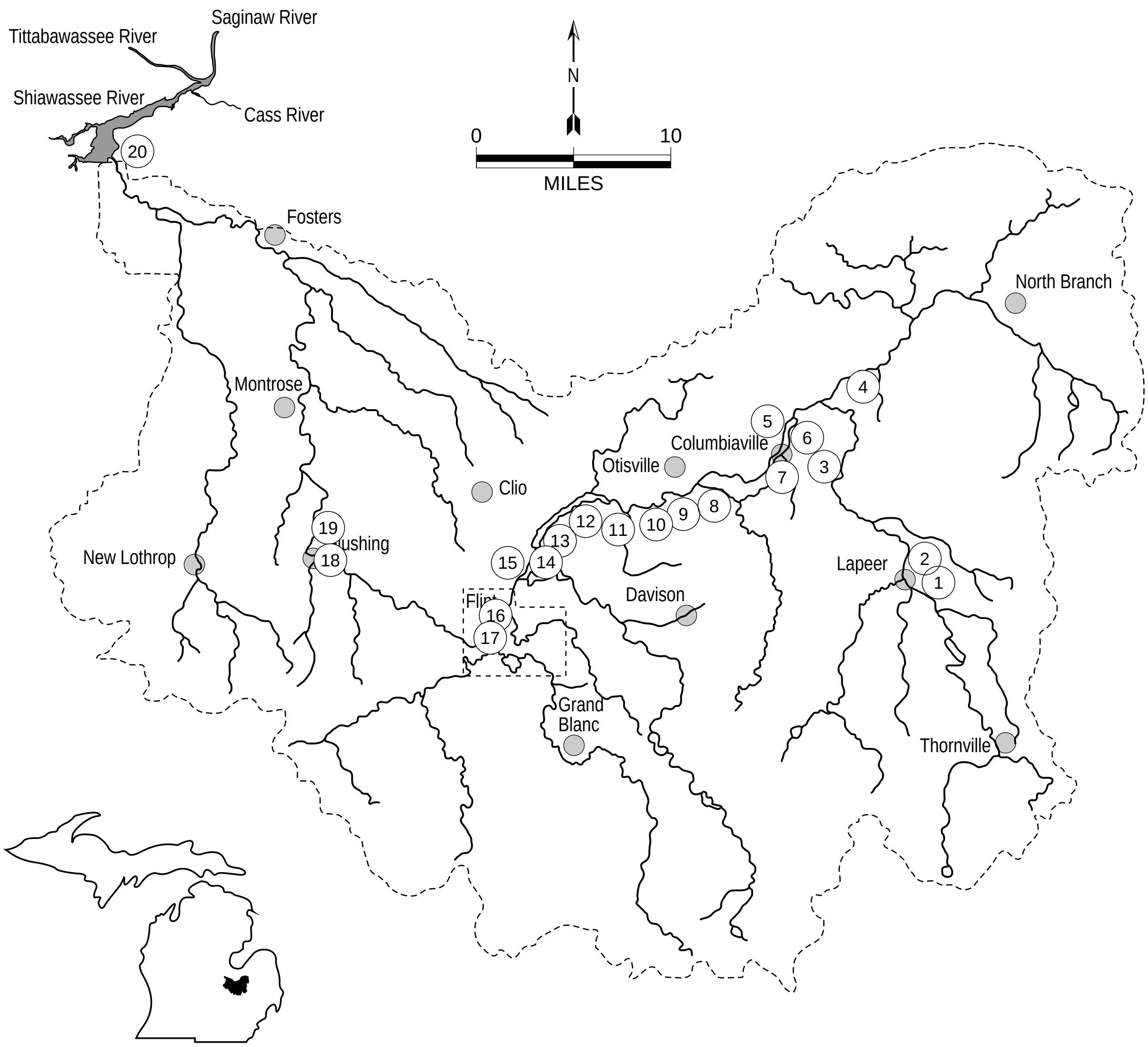
1. Seven Ponds Nature Center
2. Annrook Park
3. Rotary Park
4. Metamora-Hadley Recreation Area
5. Lapeer State Game Area, Parcel 1
6. Lapeer State Game Area, Parcel 2
7. Lapeer State Game Area, Parcel 3
8. Holloway Reservoir Regional Park
9. Genesee Recreation Area
10. Ortonville Recreation Area
11. Narrin Park
12. For-Mar Nature Preserve and Arboretum
13. Riverside Park
14. Whaley Park
15. Vietnam Veterans Park
16. Riverbank Park
17. Holly Recreation Area, Parcel 1
18. Holly Recreation Area, Parcel 2
19. McKinley Park
20. Seven Lakes State Park
21. Riverview Park
22. Flushing County Park
23. Shiawassee National Wildlife Refuge

Figure 25.–Areas of recreational access and use in the Flint River basin.



Name	Launch Code	Barrier Free	Ownership
1. Lake Minnewana	3	No	State
2. Lake Nepessing	2	Yes	State
3. Long Lake	3	No	State
4. Fish Lake	4	No	State
5. Watts Lake	3	No	State
6. Cedar Lake	3	No	State
7. Twin Lake	3	No	State
8. Columbiaville Park	3	No	Township
9. Holloway Reservoir Walleye Pike Boat Launch	1	Yes	County
10. Mott Lake Bluegill Boat Launch	1	Yes	County
11. Davidson Lake	3	No	State
12. Big Fish Lake	1	Yes	State
13. Algoe Lake	3	No	State
14. Vietnam Veteran's Park, Cussans Landing	1	Yes	City of Flint
15. Wildwood Lake	3	No	State
16. Heron Lake	2	Yes	State
17. Crotched Lake	3	No	State
18. Big Seven Lake	1	Yes	State
19. Dickinson Lake	1	Yes	State

Figure 26.–Public boat launches in the Flint River watershed. Launch code: 1 = hard surface ramp, good for most trailerable boats, 2 = hard surface ramp, limited water depth for large boats, 3 = gravel surface ramp, good for small boats, 4 = carry down access for small boats.



1. South Branch at East Annrook Park
2. South Branch at Rotary Park
3. South Branch at Norway Lake Road
4. North Branch at Barnes Lake Road
5. Mt. Morris Road Fishing Site
6. Stanley Road Fishing Site
7. Columbiaville Park
8. Holloway Reservoir Walleye Pike Boat Launch
9. Holloway Dam Canoe Launch Site
10. Flint River at M-15
11. Flint River at Irish Road
12. Mott Lake at Genesee Road
13. Mott Lake Bluegill Boat Launch
14. Stepping Stone Falls
15. Flint River at Bray Road
16. Vietnam Veteran's Park
17. Riverbank Park
18. Riverview Park
19. Flushing County Park
20. Shiawassee National Wildlife Refuge

Figure 27.–Canoe access sites on the Flint River.

Michigan DNR

STATE OF MICHIGAN
DEPARTMENT OF NATURAL RESOURCES

Number 27 July 2001

Flint River Assessment Appendix

Joseph M. Leonardi
and
William J. Gruhn

www.dnr.state.mi.us

FISHERIES DIVISION
SPECIAL REPORT

MICHIGAN DEPARTMENT OF NATURAL RESOURCES
FISHERIES DIVISION

July, 2001

Flint River Assessment
Appendix

Joseph M. Leonardi
and
William J. Gruhn

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Appendix 1

Water Quality Sampling Data

Water quality sampling results for sites on the Flint River and select tributaries. Data from Alexander (1997), Walterhouse (unpublished data), and MDEQ (1994). Blank indicates no data. Data codes: k = actual value is less than value given, if present is below detection limit, HT = recommended laboratory holding time exceeded for sample, A = mean value of two or more samples, DL = sample analyzed using dilution.

Appendix 1.

	SMNITP Ecoregion Mean	Pine Creek Hunter Ck Rd.	Pine Creek Peppermill Rd.	Hunter Creek Newark Rd.	Hunter Creek Turill Rd.	Farmers Creek Baldwin Rd.	Farmers Creek Mitchell Rd.	Farmers Creek Merwin Rd.	Farmers Creek Lippincott Rd.	Plum Creek Fish Lake Rd.	Plum Creek Velentine Rd.
Ortho phosphate (mg P/l)		0.006	0.005	0.026	0.007	0.025	0.008	0.017	0.032	0.009	0.009
Total phosphorus (mg P/l)	0.058	0.031	0.022	0.051	0.088	0.051	0.046	0.077	0.116	0.055	0.062
Suspended solids (mg/l)	15	59	5	k4.0	39	6	11	44	42	24	24A
Total dissolved solids (mg/l)		440	460	440	420	340	260	300	320	280	360
Nitrite (mg NO_2/l)		0.005	0.006	0.006	0.003	0.007	0.002	0.013	0.016	0.007	0.011
Nitrate + nitrite (mg N/l)		1.23HT	0.42HT	0.26HT	0.002HT	0.23	0.014	0.126	0.36	0.15	0.24
Ammonia (mg N/l)	0.042	0.02HT	0.21HT	0.036HT	0.016HT	0.024	0.065	0.101	0.138	0.037	0.053
Kjeldahl nitrogen (mg N/l)		0.37	0.38	0.59	1.15	0.41	0.7	0.75	0.92	0.66	0.8
Silver (ug/l)	k0.5							k0.5	k0.5		
Alkalinity (mg $CaCO_3$/l)	222							238	261		
Carbonate alkalininty (mg $CaCO_3$/l)								k5.0	k5.0		
Bicarbonate alkalinity (mg $CaCO_3$/l)								238	261		
Arsenic (ug/l)	1.2							8.9	8.2		
Barium (ug/l)								76	87		
Calcium (ug/l)	65							57	55.7		
Cadmium (ug/l)	k0.2							k0.2	k0.2		
Chloride (mg/l)	41							29	29		
Hex chromium (ug/l)								k5.0	k5.0		
Chromium (ug/l)	k1.0							k1.0	1.3		
Copper (ug/l)	1.4							k1.0	1.1		
Hardness (mg/l)	246							255	245		
Mercury (mg/l)	k0.2							k0.2	k0.2		
Magnesium (mg/l)	20							27.4	25.1		
Nickel (ug/l)	k2.0										
Lead (ug/l)	k1.0							1.1	1.1		
Selenium (ug/l)	k1.0							k1.0	k1.0		
Sulfate (mg/l)								14	16		
Zinc (ug/l)	10							6	7		
COD (mg/l)											
TOC (mg/l)											
BOD 5 day carb (mg/l)											
BOD 5 day total (mg/l)											

Appendix 1.–Continued.

	S. Branch Flint Oakwood Rd.	S. Branch Flint Wilder Rd.	S. Branch Flint Greenwood Rd	S. Branch Flint Mayfield Rd.	S. Branch Flint Norway Lk. Rd.	Cedar Creek Willis Rd.	Cedar Creek Cedar Ck. Rd.	North Branch Jefferson Rd.	Bottom Creek Jefferson Rd.	Bottom Creek Gravel Ck. Rd.	N. Branch Flint M 90
Ortho phosphate (mg P/l)	0.002HT	0.02	0.014	0.072	0.035	0.038HT	0.008HT		0.004HT	0.005HT	0.006HT
Total phosphorus (mg P/l)	0.017	0.04	0.041	0.153	0.091	0.072	0.051	0.06	0.015	0.013	0.048
Suspended solids (mg/l)	k4.0	4	6	50	34	k4.0	9		5	k4.0	19
Total dissolved solids (mg/l)	450	420	440	360	340	310	360		410	470	460
Nitrite (mg NO_2/l)	0.002	0.004	0.004	0.01	0.005	0.012HT	0.003HT		0.004HT	0.005HT	0.006HT
Ammonia (mg N/l)	0.072HT	0.175HT	0.23HT	0.43	0.33	0.13HT	0.021	0.24	0.44HT	0.9HT	0.163
Nitrate + nitrite (mg N/l)	0.013	0.017HT	0.028HT	0.044	0.042	0.059HT	0.017HT	0.084	0.019HT	0.011HT	0.053
Kjeldahl nitrogen (mg N/l)	0.28	0.37	0.43	0.69	0.62	0.55	0.61	0.78	0.2	0.17	0.48
Silver (ug/l)				k0.5							
Alkalinity (mg $CaCO_3$/l)				228							
Carbonate alkalininty (mg $CaCO_3$/l)				k5.0							
Bicarbonate alkalinity (mg $CaCO_3$/l)				228							
Arsenic (ug/l)				6							
Barium (ug/l)				79							
Calcium (ug/l)				66.5							
Cadmium (ug/l)				k0.2							
Chloride (mg/l)				44							
Hex chromium (ug/l)				k5.0							
Chromium (ug/l)				1							
Copper (ug/l)				1.5							
Hardness (mg/l)				290							
Mercury (mg/l)				k0.2							
Magnesium (mg/l)				30							
Nickel (ug/l)											
Lead (ug/l)				1.9							
Selenium (ug/l)				k1.0							
Sulfate (mg/l)				39							
Zinc (ug/l)				12							
COD (mg/l)								18			
TOC (mg/l)								8.0			
BOD 5 day carb (mg/l)											
BOD 5 day total (mg/l)											

Appendix 1.–Continued.

	Crystal Creek Barnes Lk. Rd.	N. Branch Flint Castle Rd.	Henry Drain Mt. Morris Rd.	Hasler Creek Lippincott Rd.	Flint River M 15	Powers-Cullen Drn. Carpenter Rd.	Butternut Creek Irish Rd.	Butternut Creek Vassar Rd.	Kearsley Creek Kipp Rd.	Kearsley Creek Atherton Rd.	Gilkey Creek East Court St.
Ortho phosphate	0.038HT	0.029HT	0.002HT	0.031HT	0.005HT	0.005HT	0.034HT		0.013 HT	0.009 HT	0.028HT
Total phosphorus (mg P/l)	0.1	0.09	0.092	0.089	0.075	0.033	0.135	0.08	0.029	0.034	0.09
Suspended solids (mg/l)	13	27	42	47	9	6	48		k4.0	10	11
Total dissolved solids (mg/l)	410	490	440	460	340	480	280		470	380	184
Nitrite (mg NO_2/l)	0.003HT	0.009HT	0.016HT	0.016HT	0.006HT	0.01	0.025HT		0.004HT	0.002HT	0.043HT
Nitrate + nitrite (mg N/l)	0.008HT	0.23	2.6	0.125	0.043	0.28	0.39	1.4	0.30HT	0.019HT	0.83
Ammonia (mg N/l)	0.104	0.05	0.019	0.088	0.07	0.025	0.091	0.07	0.012HT	0.018 HT	0.07
Kjeldahl nitrogen (mg N/l)	0.72	0.52	1.03	0.82	0.88	0.5	1.01	0.67	0.39	0.53	0.67
Silver (ug/l)											
Alkalinity(mg $CaCO_3$/l)											
Carbonate alkalininty (mg $CaCO_3$/l)											
Bicarbonate alkalinity (mg $CaCO_3$/l)											
Arsenic (ug/l)											
Barium (ug/l)											
Calcium (ug/l)											
Cadmium (ug/l)											
Chloride (mg/l)											
Hex chromium (ug/l)											
Chromium (ug/l)											
Copper (ug/l)											
Hardness (mg/l)											
Mercury (mg/l)											
Magnesium (mg/l)											
Nickel (ug/l)											
Lead (ug/l)											
Selenium (ug/l)											
Sulfate (mg/l)											
Zinc (ug/l)											
COD (mg/l)								18			
TOC (mg/l)								6.8			
BOD 5 day carb (mg/l)											
BOD 5 day total (mg/l)											

Appendix 1.–Continued.

	Thread Creek Baldwin Rd.	Thread Creek Bristol Rd.	Swartz Creek Cook Rd.	Swartz Creek Fenton Rd.	Swartz Creek Grand Blanc Rd.	Swartz Creek Miller Rd. & US 23	Flint River Mill Rd.	Mud Creek Potter Rd.	Flint River Flushing/Linden Rd.	Flint river Riverview park	Flint River Mt. Morris Rd.
Ortho phosphate	0.012	0.016	0.01	0.01	0.015	0.019	0.008	0.024	0.1	0.04	
Total phosphorus (mg P/l)	0.031HT	0.041HT	0.045HT	0.039HT	0.052HT	0.082HT	0.113HT	0.048HT		0.23HT	0.01
Suspended solids (mg/l)	4	4	5	16	19	36	37	12	11	60	
Total dissolved solids (mg/l)	370	480	340	330	320	390	380	380	420	400	
Nitrite (mg NO_2/l)	0.003	0.004	0.002	0.004	0.01	0.014	0.003	0.007	0.02	0.006	
Nitrate + nitrite (mg N/l)	0.052HT	0.094HT	0.009HT	0.017HT	0.099HT	0.2HT	0.005 HT	0.36 HT		0.9HT	1.6
Ammonia (mg N/l)	0.018HT	0.027HT	0.6HT	0.022HT	0.041HT	0.088HT	0.013HT	0.019HT		0.019HT	0.03
Kjeldahl nitrogen (mg N/l)	0.51HT	0.64HT	0.9HT	0.7HT	0.79HT	0.88HT	1.06HT	0.58HT		1.39HT	0.15
Silver (ug/l)			k0.5	k0.5	k0.5						
Alkalinity(mg $CaCO_3$/l)			276	186	169						
Carbonate alkalininty (mg $CaCO_3$/l)			k5.0	k5.0	k5.0						
Bicarbonate alkalinity (mg $CaCO_3$/l)			276	186	169						
Arsenic (ug/l)			14.1	3	3.1						
Barium (ug/l)			215	51	62						
Calcium (ug/l)			49.7	48.9	44.4						
Cadmium (ug/l)			k0.2	k0.2	k0.2						
Chloride (mg/l)			41	43	49						
Hex chromium (ug/l)			k5.0	k5.0	k5.0						
Chromium (ug/l)			k1.0	k1.0	k1.0						
Copper (ug/l)			k1.0	k1.0	1.3						
Hardness (mg/l)			245	215	195						
Mercury (mg/l)			k0.2	k0.2	k0.2						
Magnesium (mg/l)			29.2	23.2	20.4						
Nickel (ug/l)											
Lead (ug/l)			k1.0	1.3	1.2						
Selenium (ug/l)			k1.0	k1.0	k1.0						
Sulfate (mg/l)			INT	6	11						
Zinc (ug/l)			k4.0	k4.0	k4.0						
COD (mg/l)											<5
TOC (mg/l)											2
BOD 5 day carb (mg/l)									2		
BOD 5 day total (mg/l)									3		

Appendix 1.–Continued.

	Flint River Vienna Rd.	Flint River Ragnone WWTP Outfall	Flint River E. Burt Rd.	Brent Run Creek Stanley Rd.	Brent Run Creek Webster Rd.	Flint River Moorseville Rd.	Pine Run Creek Webster Rd.	Runnels Drain Dixie Highway	Silver Creek Moorish Rd.	Flint River Sheridan Rd.	Mistguay Creek Johnstone Rd.
Ortho phosphate	0.064	0.23	0.04	0.077	0.04	0.077	0.041	0.019	0.071	0.094	0.023
Total phosphorus (mg P/l)	0.179HT	0.53DLHT	0.15	0.114	0.069	0.138HT	0.07	0.088	0.124	0.17HT	0.061HT
Suspended solids (mg/l)	22	7	25	k4.0	6	13	10	27	7	14	11
Total dissolved solids (mg/l)	380	760	460	320	380	440	380	1830HT	410	480	440
Nitrite (mg NO_2/l)	0.012	0.16	0.02	0.007	0.023	0.015	0.022	0.007	0.022	0.027	0.002
Nitrate + nitrite (mg N/l)	1.76HT	15.0HT	1.6	0.032HT	0.47HT	2.5HT	0.31HT	0.013HT	0.34HT	3.2HT	0.017HT
Ammonia (mg N/l)	0.021HT	0.4HT	0.04	0.046HT	0.072HT	0.022HT	0.113HT	0.074HT	0.091HT	0.02HT	0.017HT
Kjeldahl nitrogen (mg N/l)	1.15HT	2.3HT	1.3	0.53	0.45	0.95HT	0.45	1.45	0.95	1.19HT	0.83HT
Silver (ug/l)	k0.5	k0.5				k0.5		k0.5	k0.5	k0.5	
Alkalinity (mg $CaCO_3$/l)	158	174				161		168	115	179	
Carbonate alkalininty (mg $CaCO_3$/l)	40	k5.0				k5.0		k5.0	k5.0	28	
Bicarbonate alkalinity (mg $CaCO_3$/l)	118	174				161		168	115	179	
Arsenic (ug/l)	4.2	3				3.9		2.3	2.5	4	
Barium (ug/l)	50	27				44		140	38	47	
Calcium (ug/l)	48.2	56.8				47		261	38.9	51.7	
Cadmium (ug/l)	k0.2	k0.2				k0.2		k0.2	k0.2	k0.2	
Chloride (mg/l)	58	206				80		280	113	79	
Hex chromium (ug/l)	k5.0	k5.0				k5.0		k5.0	k5.0	k5.0	
Chromium (ug/l)	k1.0	k1.0				k1.0		k1.0	k1.0	k1.0	
Copper (ug/l)	1.7	2				1.4		2.5	1.8	1.5	
Hardness (mg/l)	215	225				205		885	139	230	
Mercury (mg/l)	k0.2	k0.2				k0.2		k0.2	k0.2	k0.2	
Magnesium (mg/l)	22.7	19.9				21.3		57	10.1	24.1	
Nickel (ug/l)								2.2	2		
Lead (ug/l)	2.2	k1.0				k1.0		1	k1.0	2.1	
Selenium (ug/l)	k1.0	k1.0				k1.0		k1.0	k1.0	k1.0	
Sulfate (mg/l)	24	41				32		635	38	32	
Zinc (ug/l)	10	15				50		k4.0	k4.0	50	
COD (mg/l)			28								
TOC (mg/l)			8.9								
BOD 5 day carb (mg/l)			2								
BOD 5 day total (mg/l)			3								

Appendix 2.

Sediment Sampling Data

Sediment sampling from the Flint River and select tributaries. Blanks indicate no data measurement. Data from Alexander (1997), M. Walterhouse (unpublished), and MDEQ (1999). Data codes: nd = not detected, k = actual value less than value given, if present is below detection limit.

Appendix 2.

	SMNITP Ecoregion Mean value	Farmers Creek Merwin Rd.	Farmers Creek Lippincott Rd.	South Branch Mayfield Road	North Branch Castle Rd.	Flint River M15	Swartz Creek Cook Rd.	Swartz Creek Grand Blanc Rd.	Swartz Creek Fenton Rd.	Flint River Mill Rd.	Flint River Linden Rd.	Flint River Riverview Park	Flint River Mt. Morris Rd	Flint River Burt Rd.	Silver Creek Moorish Rd.	Runnels Drain Dixie Highway
Silver mg/kg (dry)	0.14	k0.25	k0.25	k0.25		k0.25	k0.25	0.3	k0.25	k0.25		0.4			k0.25	k0.25
Aluminum mg/kg (dry)	2600	3460	2530	2430		2900	4800	10800	7350	1700		2290			3560	6900
Arsenic mg/kg (dry)	5.5	12	8.4	4.9	27	20	42	13	13	2.9	4.2	4.2	7.8	6	3.6	6
Barium mg/kg (dry)	40	28	24	20		59	119	91	65	22		29			37	82
Beryllium mg/kg (dry)	0.14	k0.20	k0.20	k0.20		k0.20	0.26	0.57	0.39	k0.20		k0.20			0.2	0.4
Calcium mg/kg (dry)	34000	11400	10900	14500		17500	135000	3110	26700	15300		17500			11900	37100
Cadmium mg/kg (dry)	1.05	k2.0	k2.0	k2.0	<2	k2.0	k2.0	k2.0	k2.0		<2	k2.0	<2	<2	k2.0	k2.0
Cobalt mg/kg (dry)	3.9	5	k5.0	k5.0		k5.0	11	12	8.5	k5.0		k5.0			5.5	9
Chromium mg/kg (dry)	6.7	7	5	6	15	6	9	18	14	8	11	11	26	16	7	13
Copper mg/kg (dry)	5.7	5.5	4	5	15	4.5	13	21	14	9.5	14	11	27	20	8	18
Iron mg/kg (dry)	8100	8700	7330	6350		8000	17500	21300	15400	4700		6750			8650	15700
Mercury mg/kg (dry)	nd	k0.1	k0.1	k0.05	<0.1	k0.05	k0.05	k0.20	k0.15	k0.05	<0.1	k0.05	<0.1	<0.1	k0.05	k0.1
Potassium mg/kg (dry)	280	390	240	310		350	915	1590	1050	181		310			450	865
Lithium mg/kg (dry)	3.3	5.5	3.5	3.5		4.5	8.5	17	13	3		4			6	11
Magnesium mg/kg (dry)	6300	5350	3600	6050		4600	13100	14900	10100	4700		5250			5150	10900
Manganese mg/kg (dry)	370	170	180	190		955	380	705	605	110		220			280	505
Molybdenum mg/kg (dry)	nd	k5.0	k5.0	k5.0		k5.0	k5.0	k5.0	k5.0	k5.0		k5.0			k5.0	k5.0
Sodium mg/kg (dry)	110	130	90	90		110	170	190	170	150		130			140	280
Nickel mg/kg (dry)	5.4	7.5	6.4	6.5	16	8	21	23	17	7.5	7.9	11	15	10	10	19
Lead mg/kg (dry)	11	10	8.4	13	7.8	11	27	27	19	29	37	26	59	52	17	29
Selenium mg/kg (dry)	0.31	k0.5	k0.5	k0.5	<0.5	k0.5	k0.5	k0.5	k0.5	k0.5	<0.5	k0.5	<0.5	<0.5	k0.5	0.73
Strontium mg/kg (dry)	35	19	13	15		20	112	44	54	19		24			37	82
Titanium mg/kg (dry)	80	123	71	119		78	64	94	73	104		83			50	62
Thallium mg/kg (dry)	nd	k1.0	k1.0	k1.0		k1.0	k1.0	k1.0	k1.0	k1.0		k1.0			k1.0	k1.0
Total solids, inorganic %TS	50.4	47.0	47.7	68.5	30	61.2	54.3	23.8	30.8	69.2	58	66.9	43	59	54	42.3
Vanadium mg/kg (dry)	7.7	9	7	8		10	14	73	17	6		8			11	18
Zinc mg/kg (dry)	34	24	20	27	69	31	45	95	75	57	62	82.5	150	99	45	82.5

Appendix 3

Distribution Maps of Fish Species

This appendix contains maps of past and known present fish distributions within the Flint River watershed. The distributions of fish species were compiled from records located at the University of Michigan, Museums Fisheries Library, Michigan Department of Natural Resources, Institute for Fisheries Research, Michigan Department of Natural Resources offices in Perry and Bay City, and Michigan Department of Environmental Quality. Specific locations were plotted and extrapolated by the authors. Scientific names and phylogenic order follow Robins et al. (1991). For species that are listed under Michigan's Endangered Species Act (Part 365, Endangered Species Protection, of the Natural Resource and Environmental Protection Act, Act 451 of the Public Acts of 1994), their status follow their scientific name. Categories are declining, rare, threatened, endangered, extinct, and locally extinct.

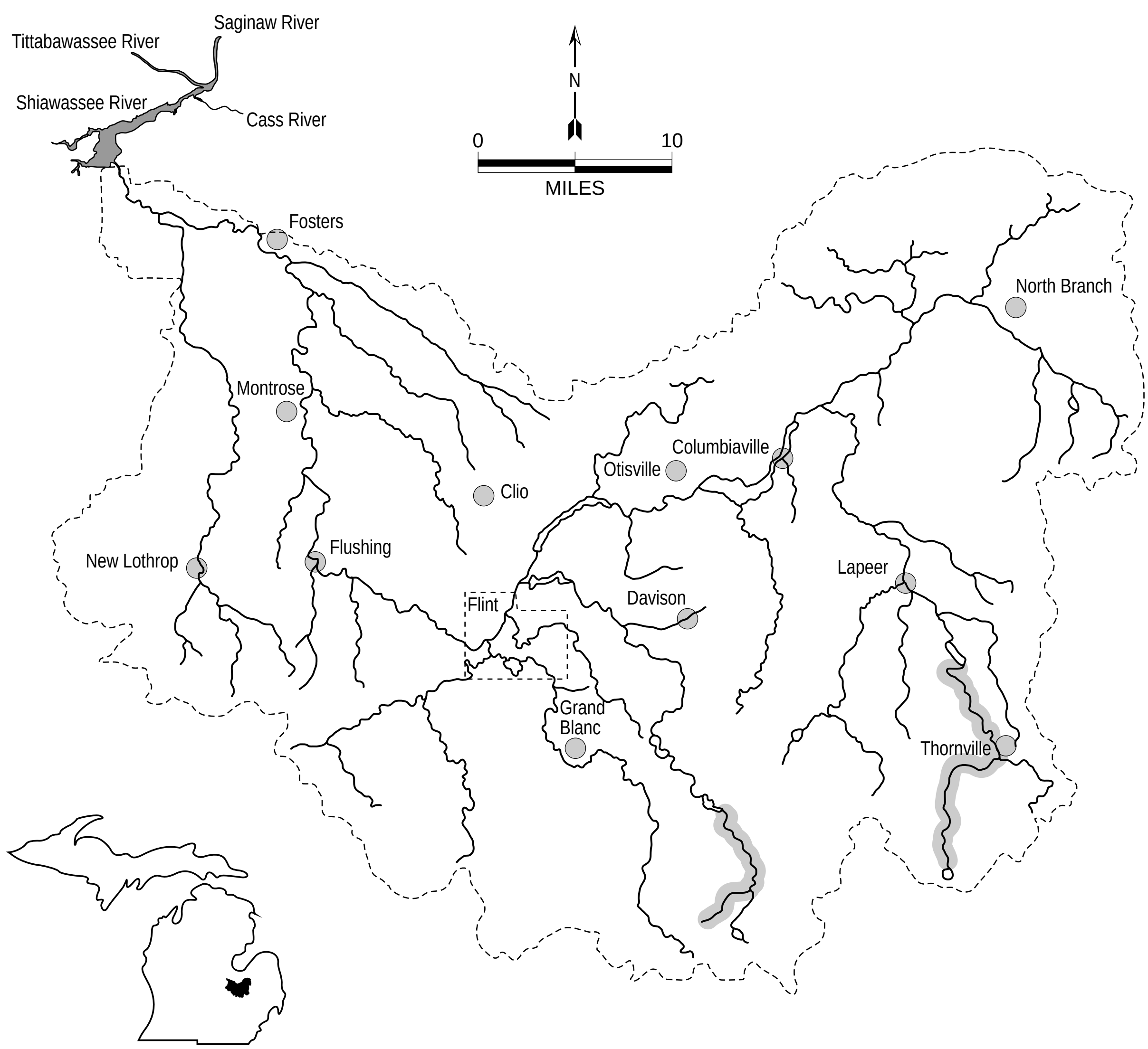
Habitat descriptions were compiled from the Fishes of Ohio (Trautman 1981), Freshwater Fishes of Canada (Scott and Crossman 1973), Fishes of Wisconsin (Becker 1983), Fishes of Missouri (Pflieger 1975) and fishes of the Great Lakes Region (Hubbs and Lagler 1947).

Northern brook lamprey (*Ichthyomyzon fossor*)

Habitat:

feeding - young: low gradient, substrate with bars and beds of mixed sand and organic debris
- moderately warm water

spawning - clear, high gradient streams (<15 feet wide)
- riffles with sand or gravel substrate



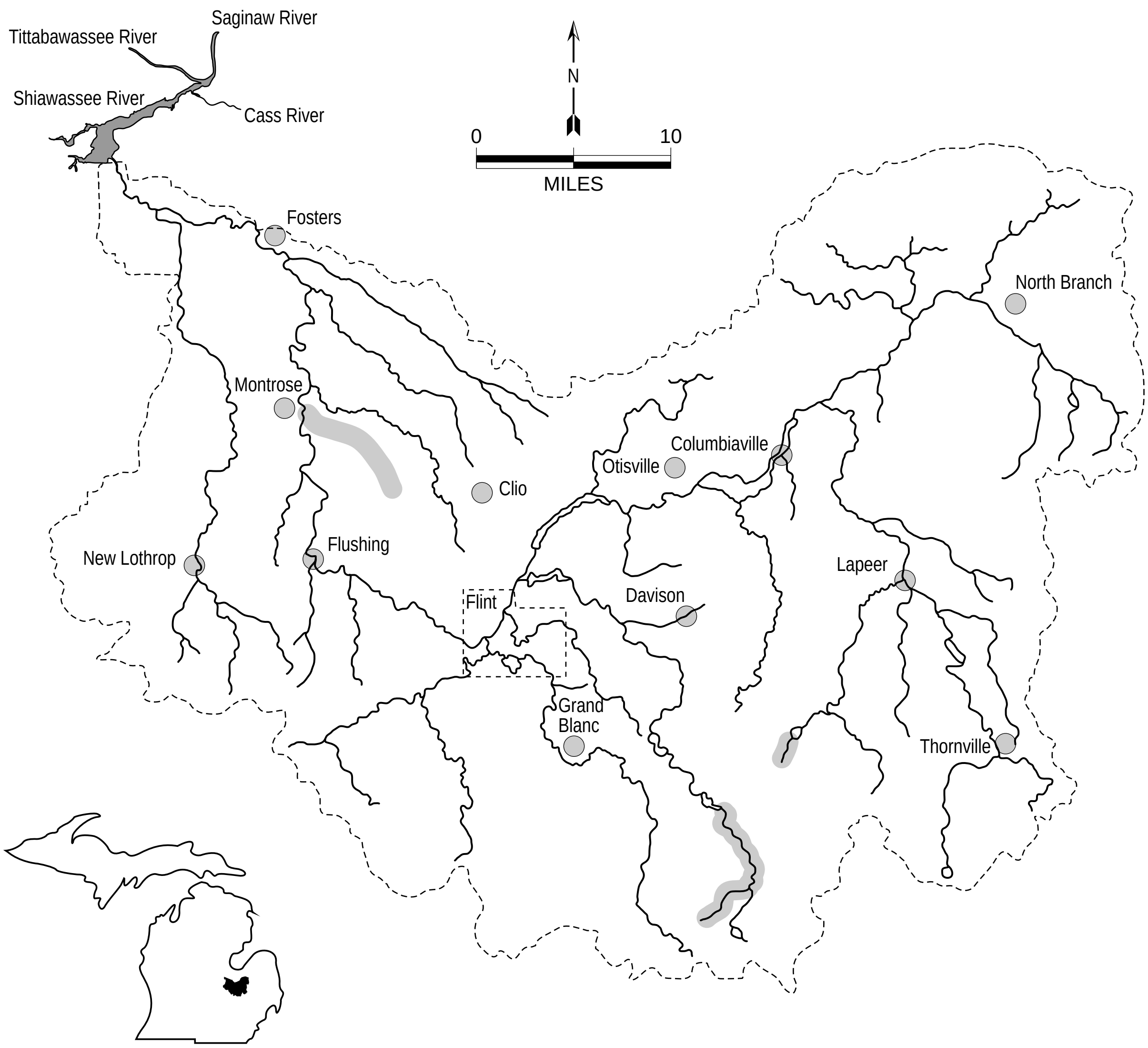
American brook lamprey (*Lampetra appendix*)

Habitat:

feeding - young: low gradient, substrate with bars and beds of mixed sand and organic debris
- clear cool stream water, sensitive to turbidity

spawning - clear, high gradient streams (>15 feet wide)
- cold water
- gravel substrate

winter refuge - sand or silt substrate for amnocetes

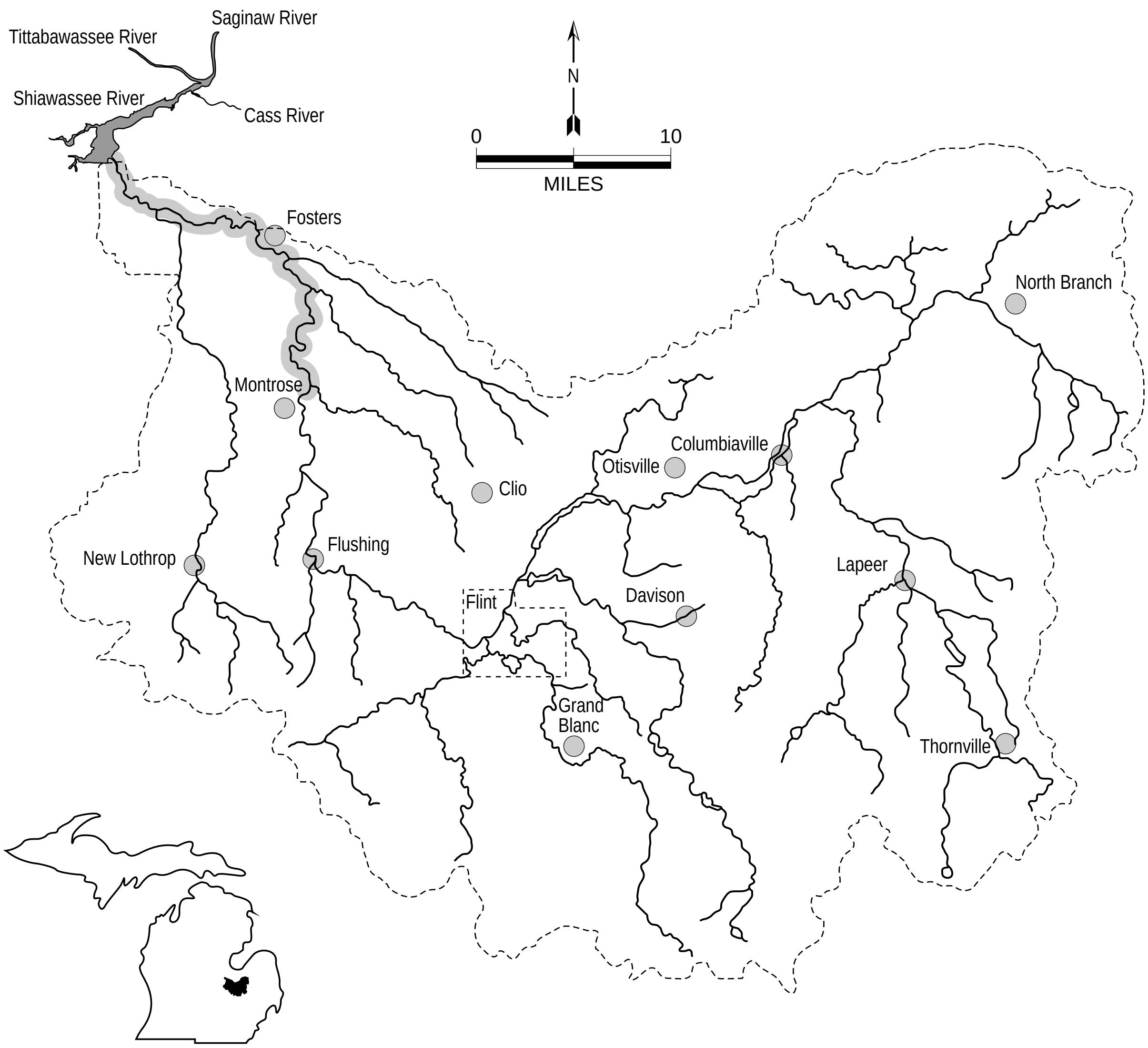


Sea lamprey (*Petromyzon marinus*)

Habitat:

feeding
- young: substrate with beds of sand mixed with organic debris
- cannot tolerate silt
- adults: clear cool water of Lake Huron

spawning
- no dams
- riffles with sand and gravel substrates

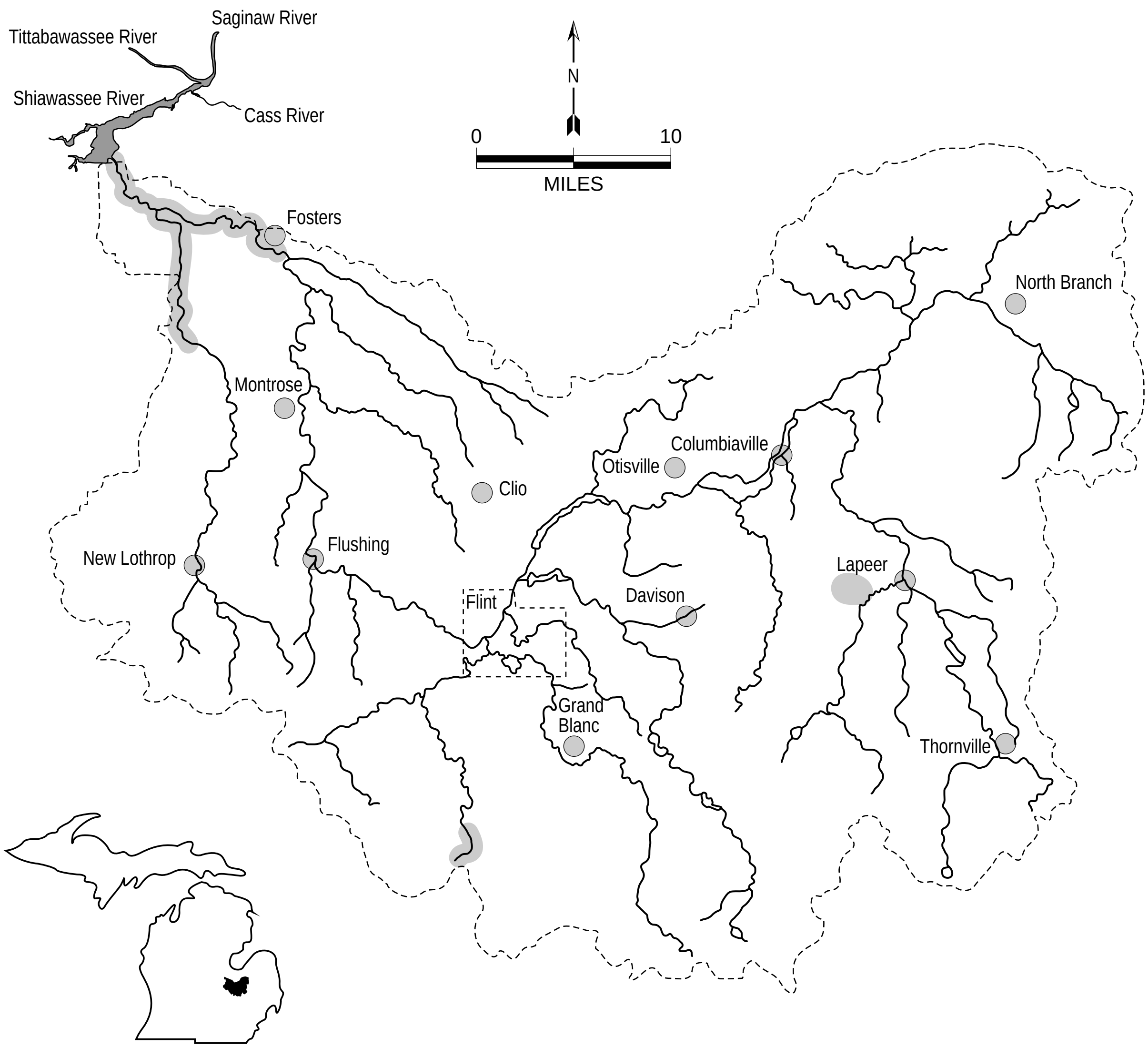


Longnose gar (*Lepisosteus osseus*)

Habitat:

feeding - adults: in deeper water
- young: in shallows
- clear water, low-gradient streams, lakes, and impoundments
- will feed in moderate current
- aquatic vegetation preferred, but not necessary
- open water fish

spawning - warm shallow water of lakes or streams over vegetation



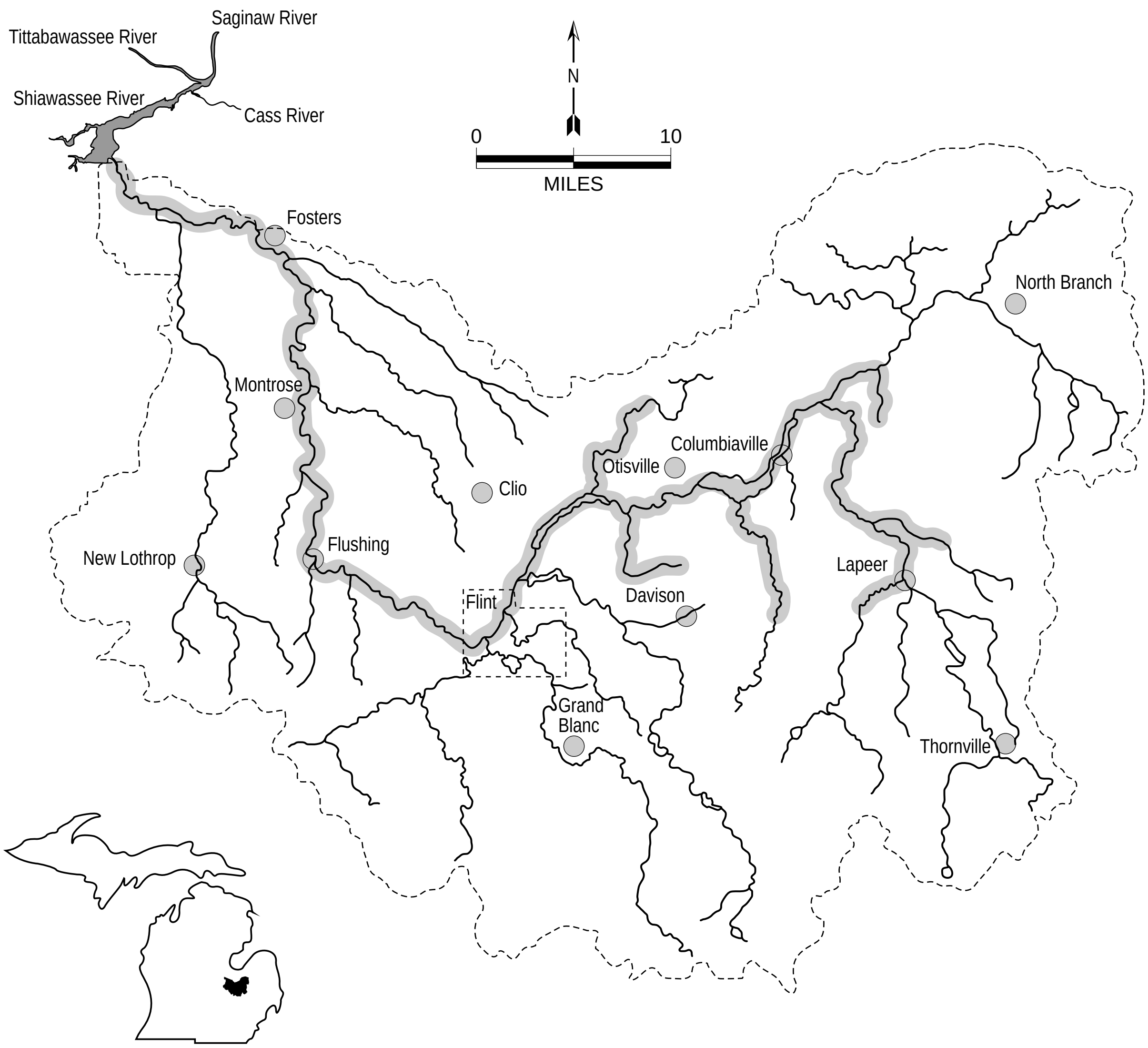
Bowfin (*Amia calva*)

Habitat:

feeding
- clear water
- abundant rooted aquatic vegetation
- low gradient streams, lakes, and impoundments
- tolerate only small amount of silt

spawning
- need vegetated water, 1 to 2 feet deep
- can spawn under logs, stumps, or bushes

winter refuge
- gravelly pockets among aquatic vegetation



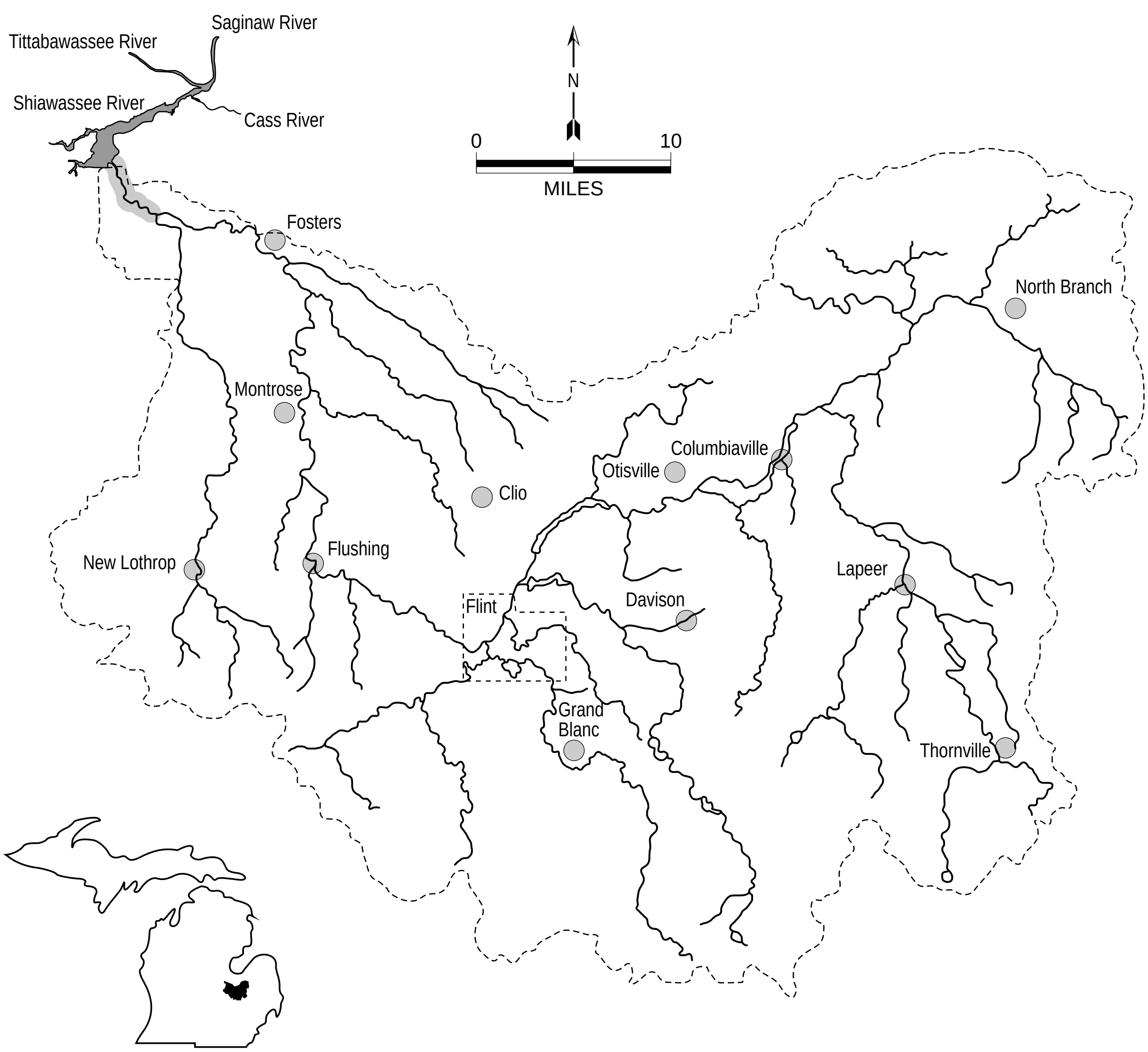
Alewife (*Alosa pseudoharengus*)

Habitat:

feeding - adults: deep water of Lake Huron
- young: shallow water of Lake Huron
- prefers warmer waters

spawning - streams or shallow beaches of lake
- sand or gravelly substrate

winter refuge - deep water

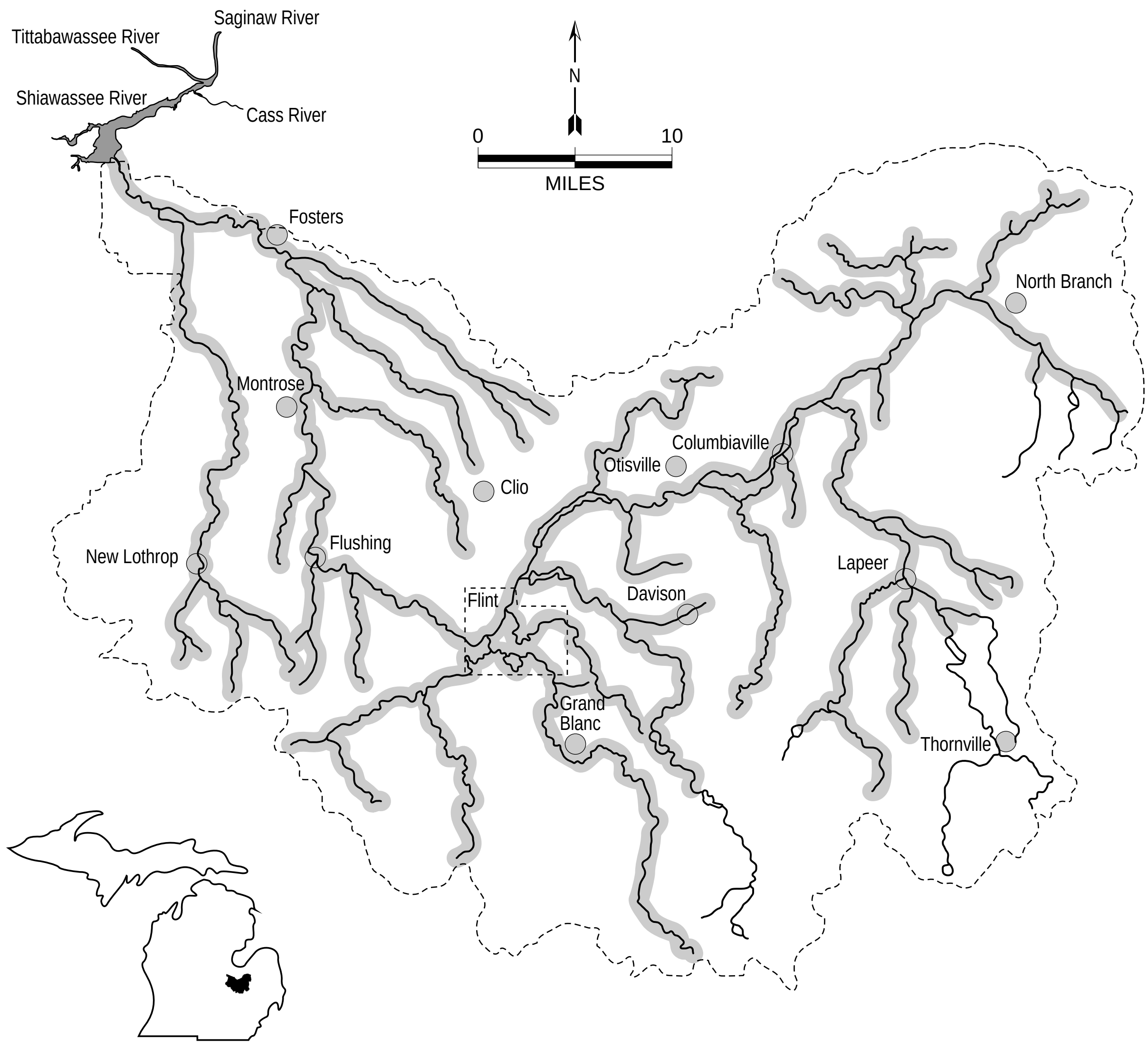


Gizzard shad (*Dorosoma cepedianum*)

Habitat:

feeding - large streams with low gradient, impoundments, and Lake Huron
- tolerant of clear and turbid water

spawning - shallow areas of ponds, lakes, and large rivers
- low gradient

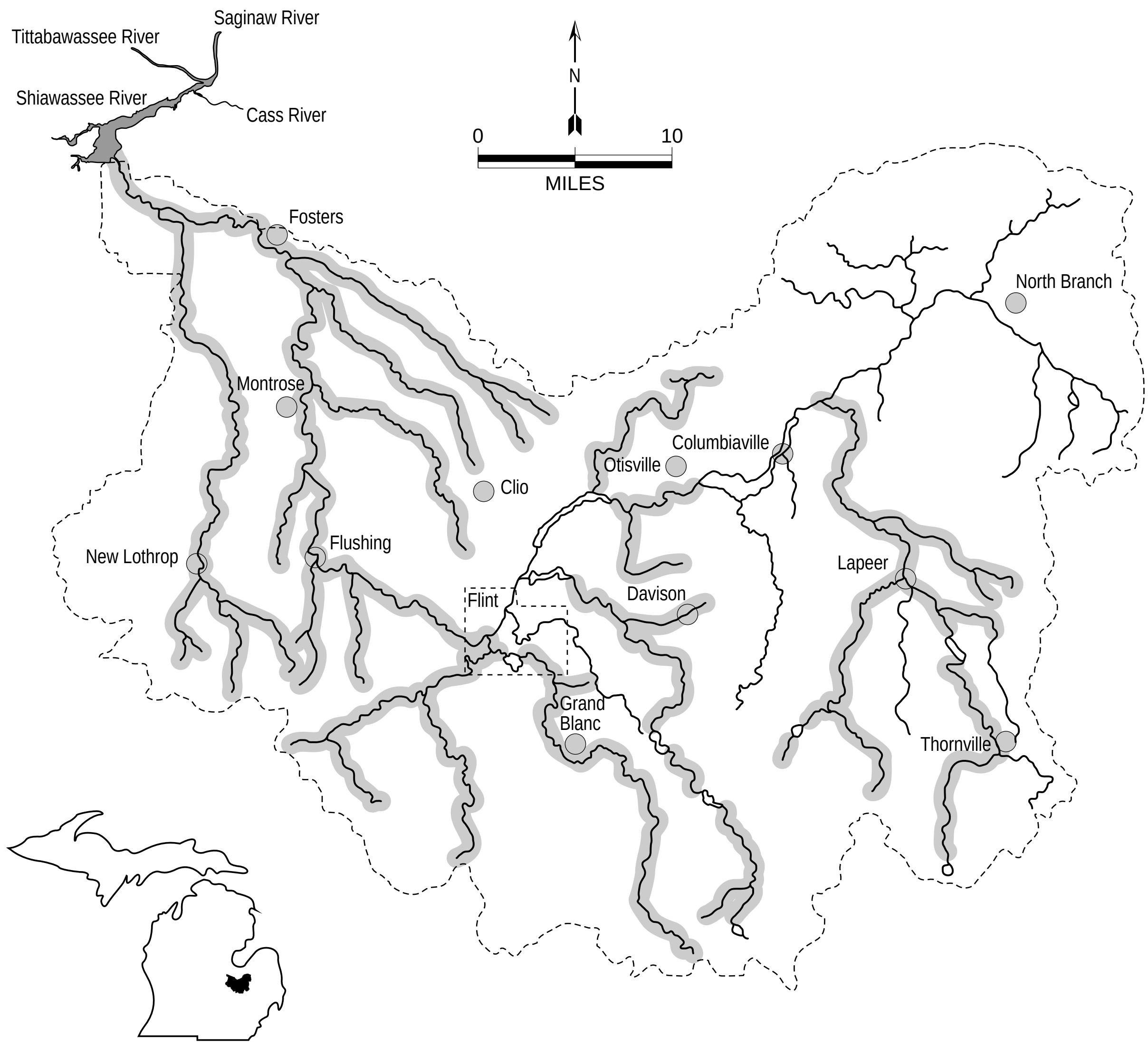


Central stoneroller (*Campostoma anomalum*)

Habitat:

feeding - moderate to high gradients
- rocky riffles
- somewhat tolerant of turbidity
- riffles and adjacent pools of warm, clear, shallow streams
- gravel or cobble substrate

spawning - riffles

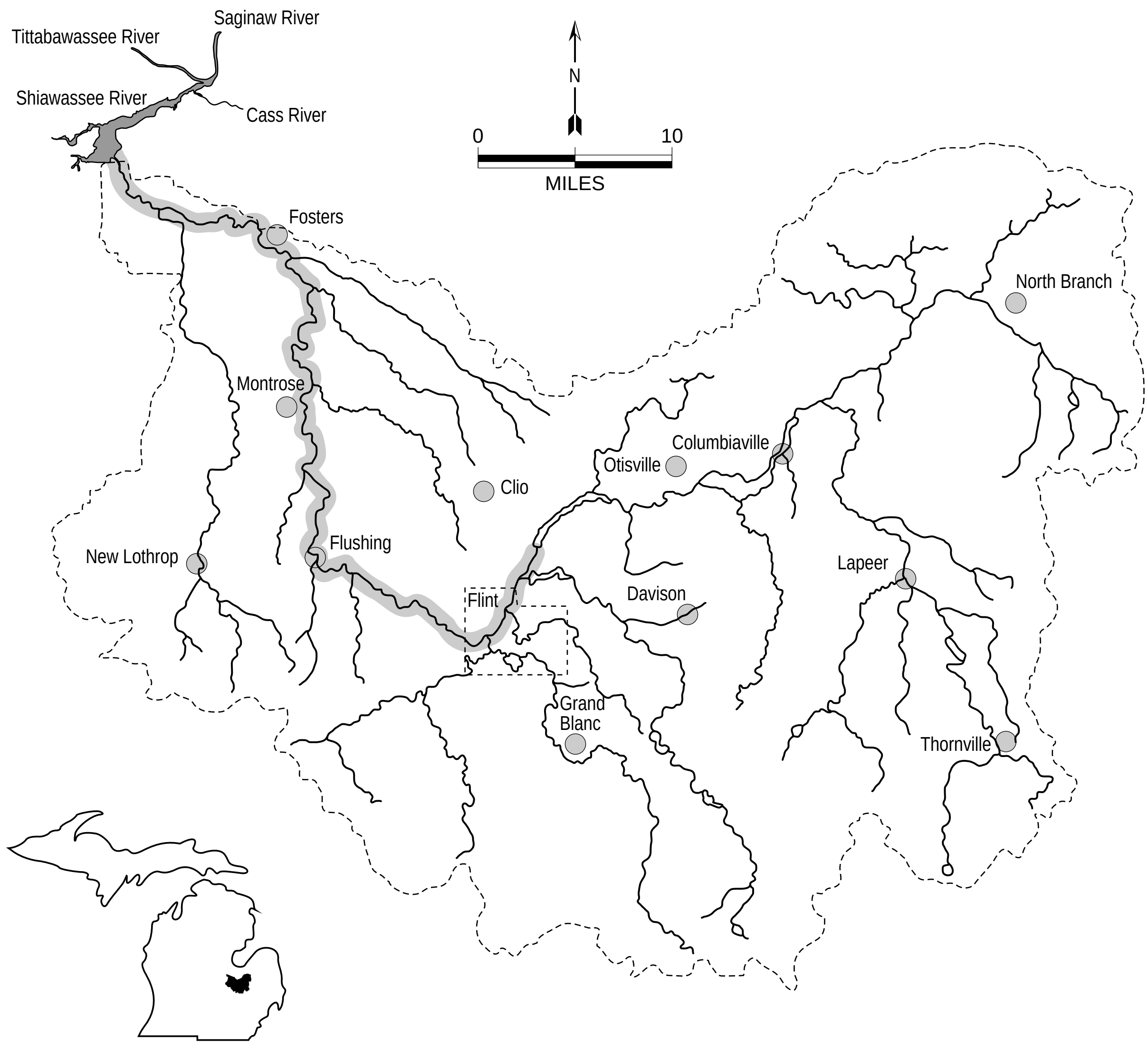


Goldfish (*Carassius auratus*)

Habitat:

feeding - vegetation
- low gradient, shallow, warm water streams, rivers, lakes, and impoundments
- tolerates some turbidity and siltation

spawning - warm, weedy shallows

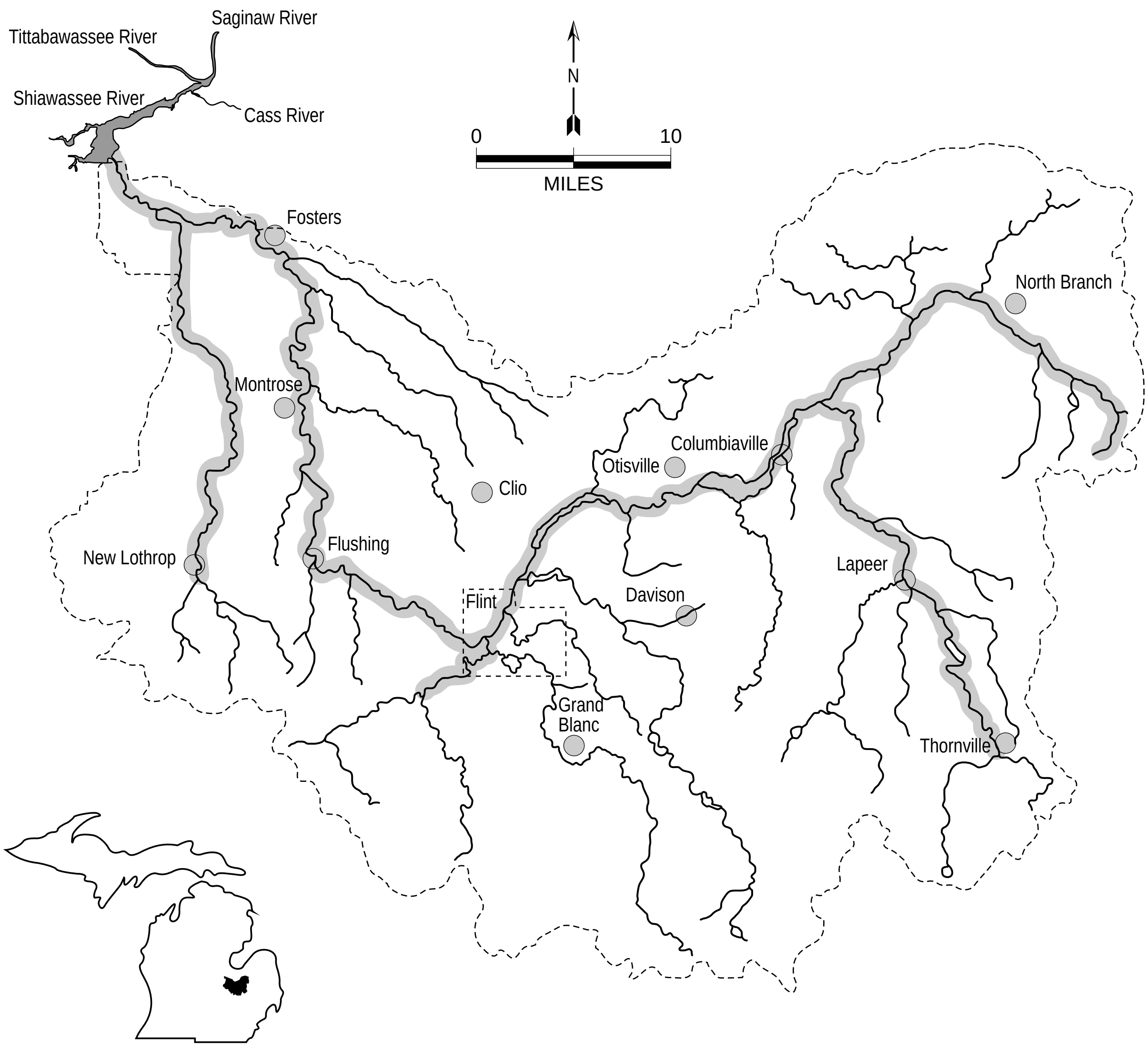


Spotfin shiner (*Cyprinella spiloptera*)

Habitat:

feeding
- clear water tolerant of turbidity and siltation
- some current
- shallow depths
- medium sized streams, lakes, and impoundments
- clear sand or gravel substrate

spawning
- swift current
- crevice spawner or on underside of submerged logs and roots

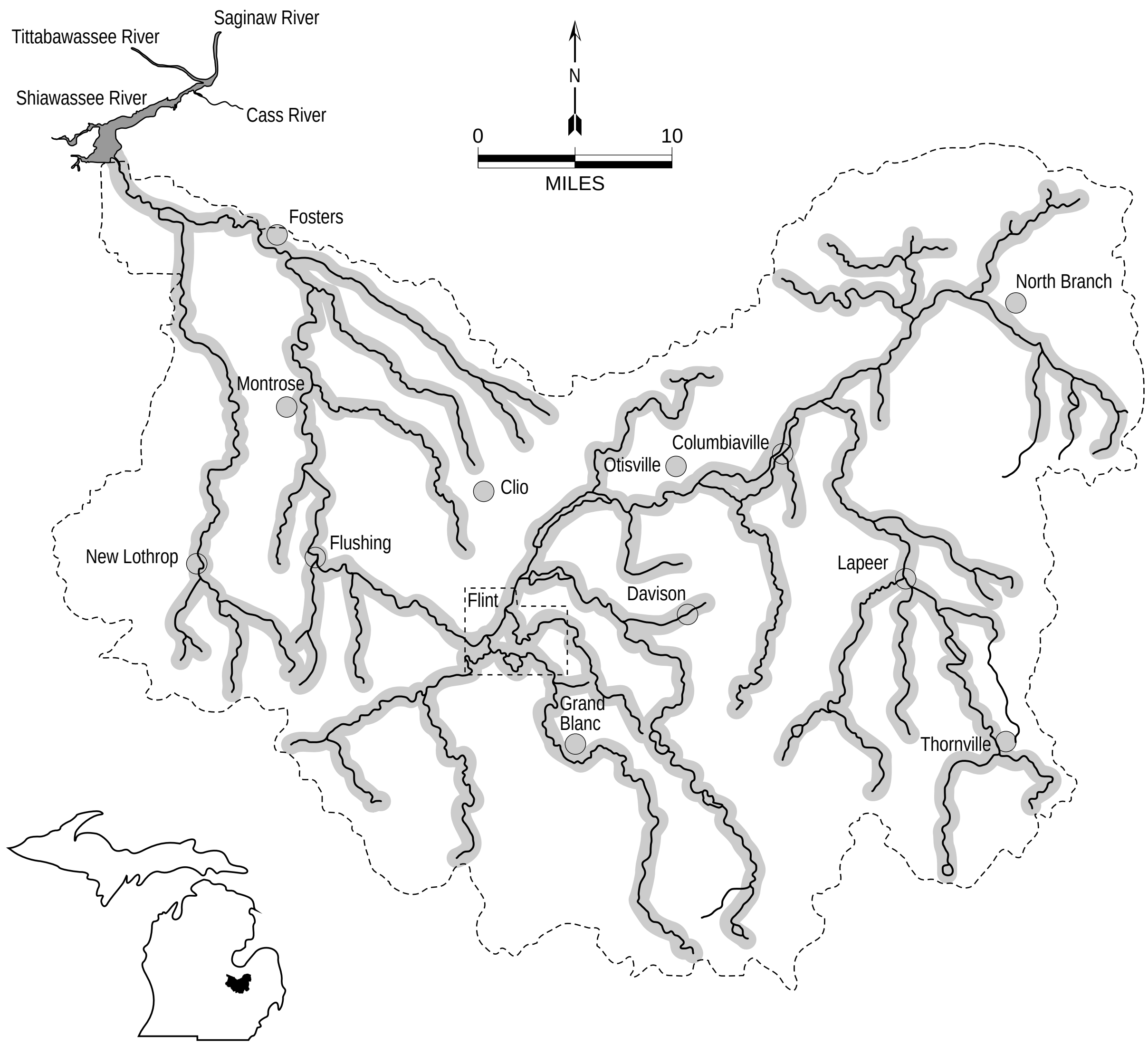


Common carp (*Cyprinus carpio*)

Habitat:

feeding - low gradient fertile streams, rivers, lakes, and impoundments
- abundance of aquatic vegetation or organic matter
- tolerant of all substrates and clear to turbid water

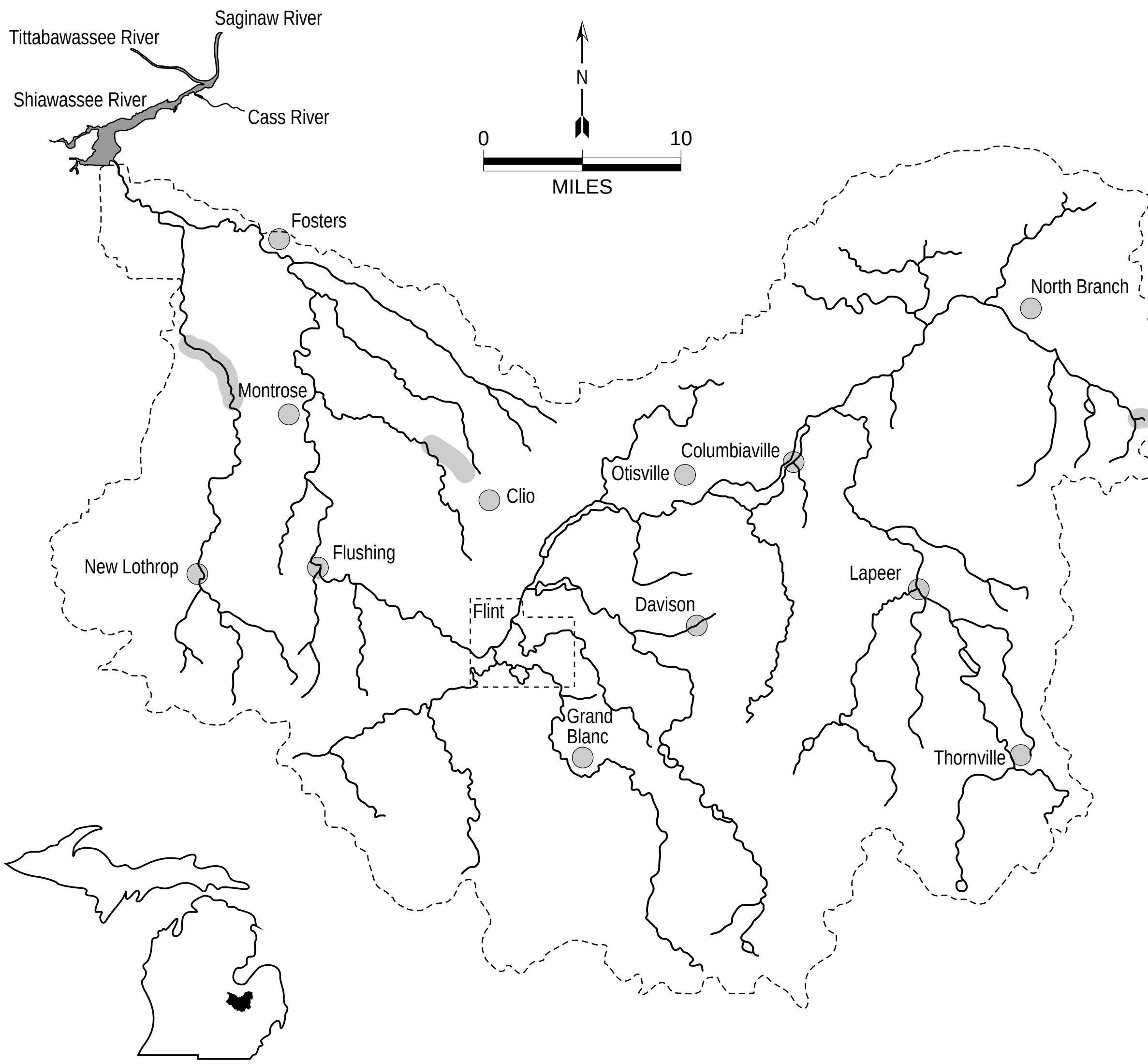
spawning - weedy or grassy shallows



Brassy minnow (*Hybognathus hankinsoni*)

Habitat:

feeding - cool acidic streams
- slow to moderate current
- sand or gravel substrate

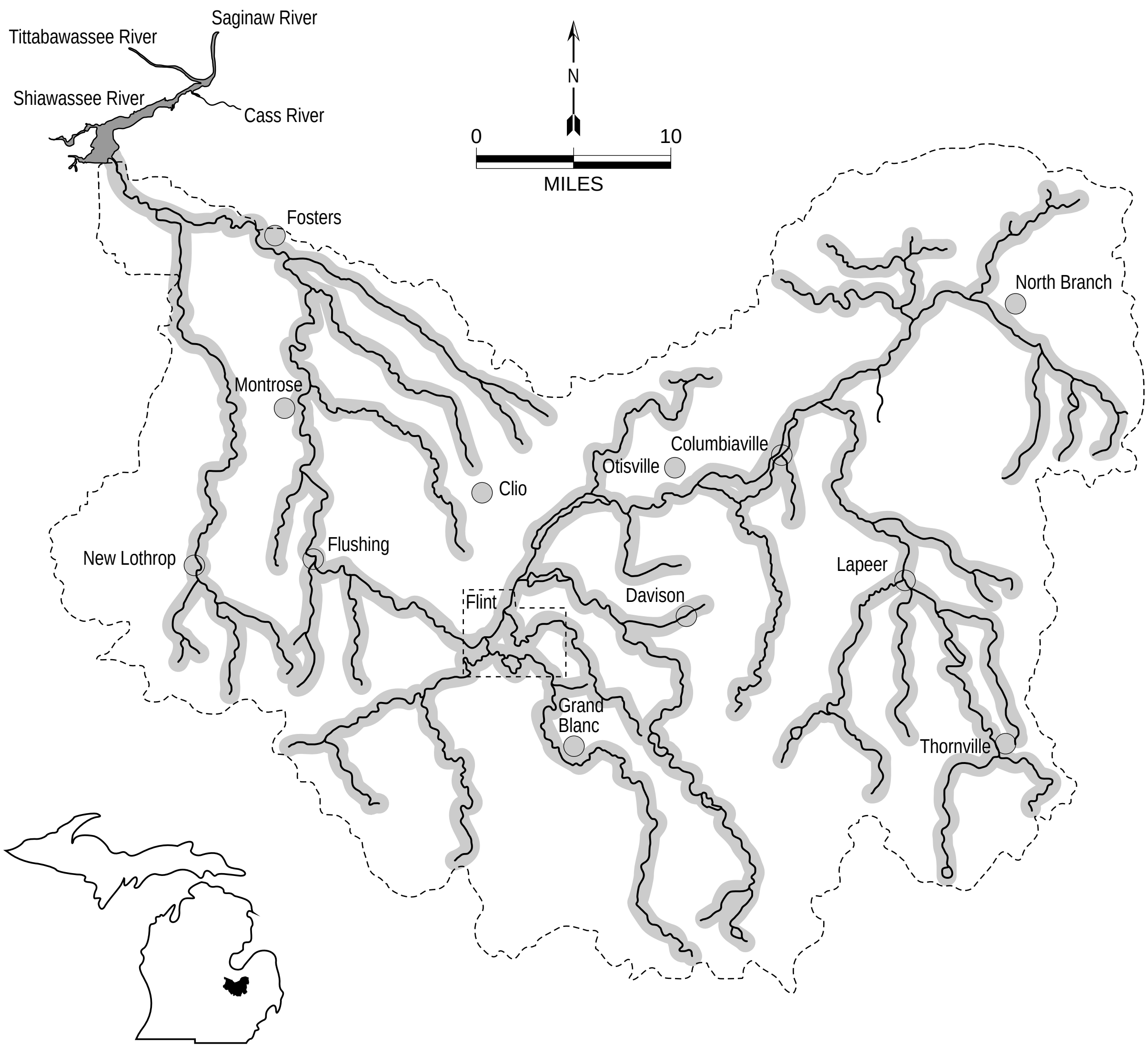


Common shiner (*Luxilus cornutus*)

Habitat:

feeding
- small, clear, high-gradient streams and rivers, or shores of clear water lakes and impoundments
- gravel substrate
- can tolerate some submerged aquatic vegetation
- not very tolerant of turbidity or silted waters

spawning
- gravel nests of other fish, especially those at the head of a riffle

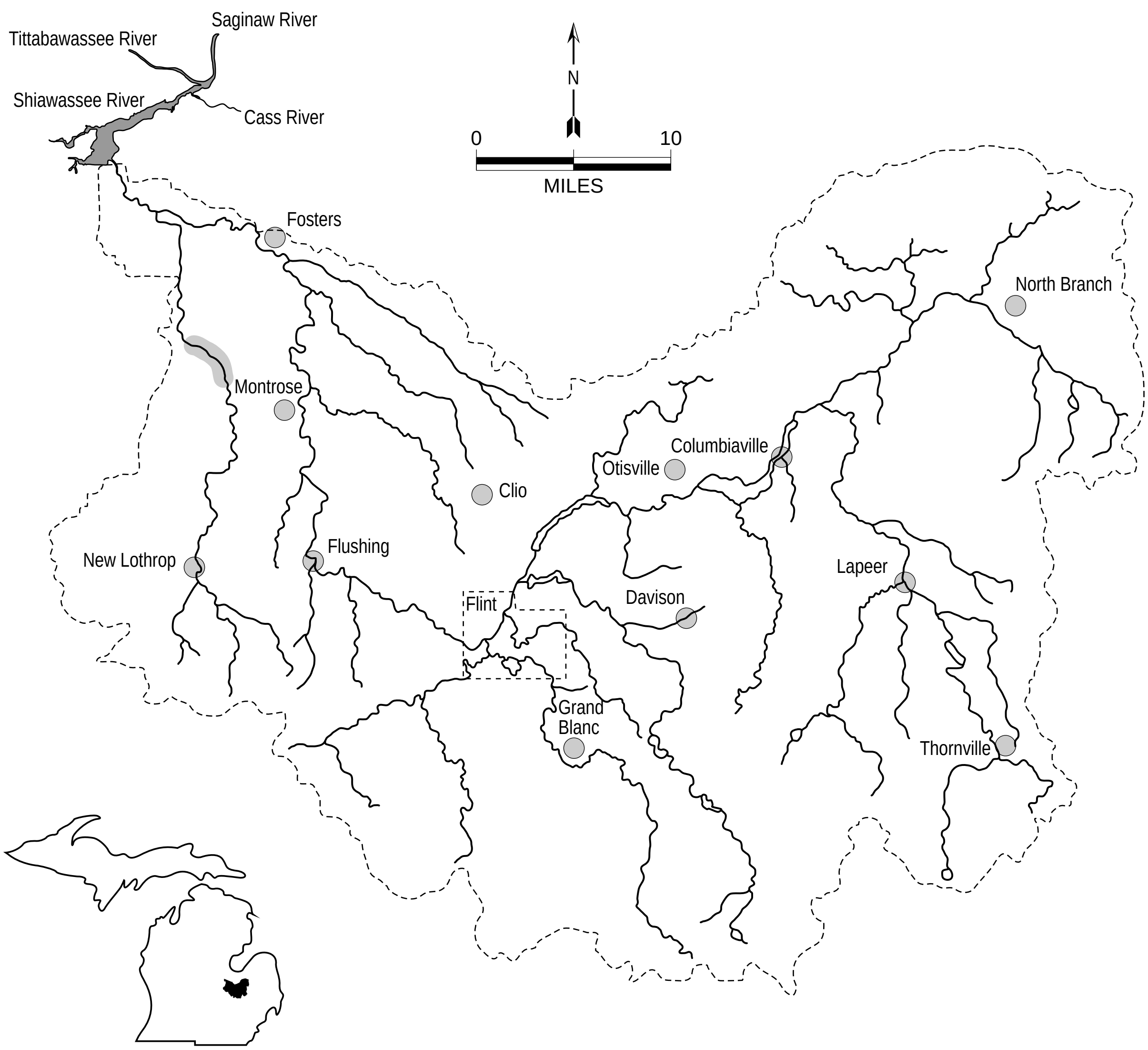


Redfin shiner (*Lythrurus umbratilis*)

Habitat:

feeding - clear, quiet warm rivers in weedy pools
- little to no current
- abundant submerged and emergent vegetation

spawning - over sand and gravel substrate in slow moving sections of streams

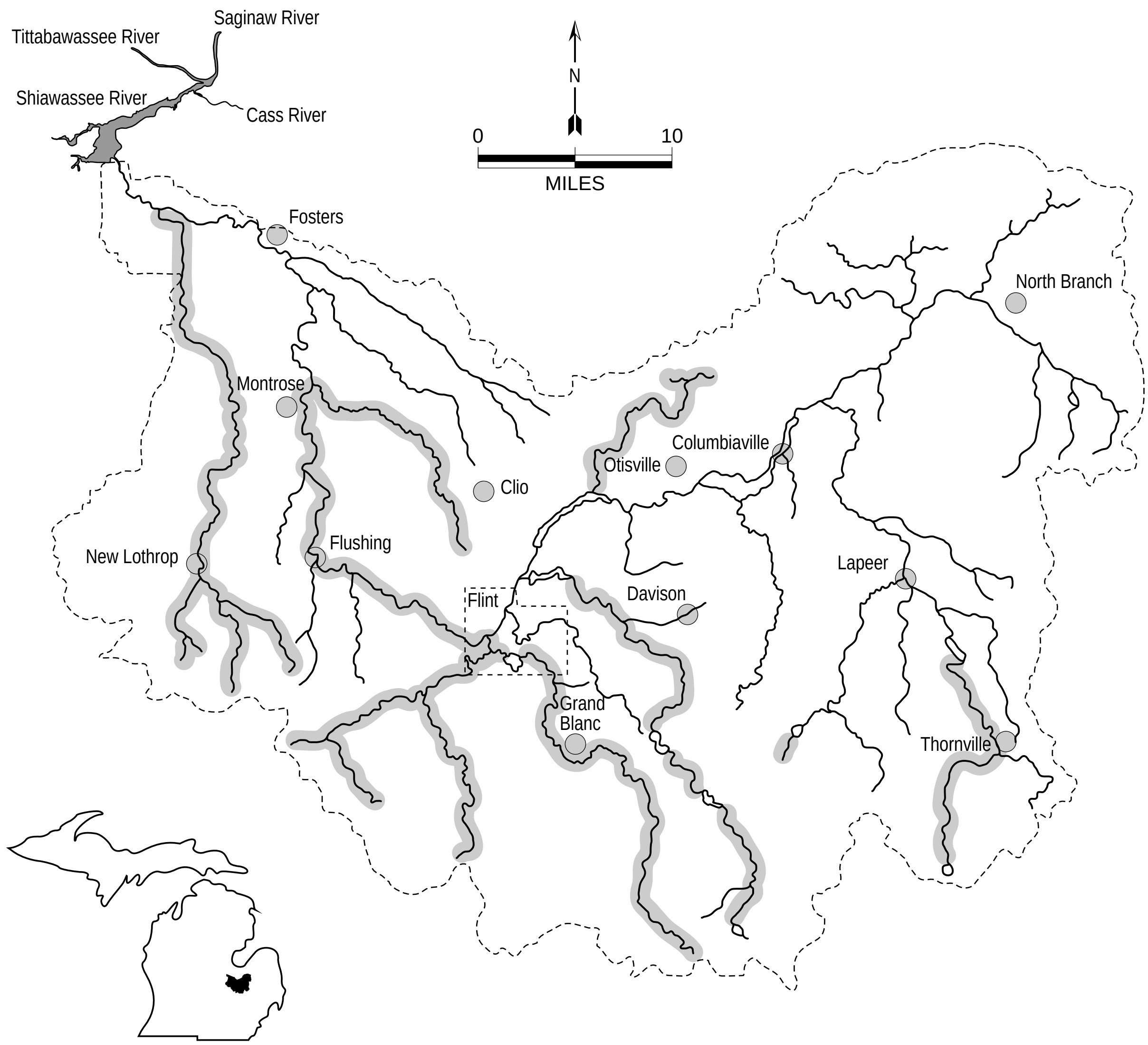


Hornyhead chub (*Nocomis biguttatus*)

Habitat:

feeding
- adults: near riffles
- young: near vegetation
- clear water, does not tolerate turbidity
- gravel substrate
- low gradient streams that are tributaries to large streams

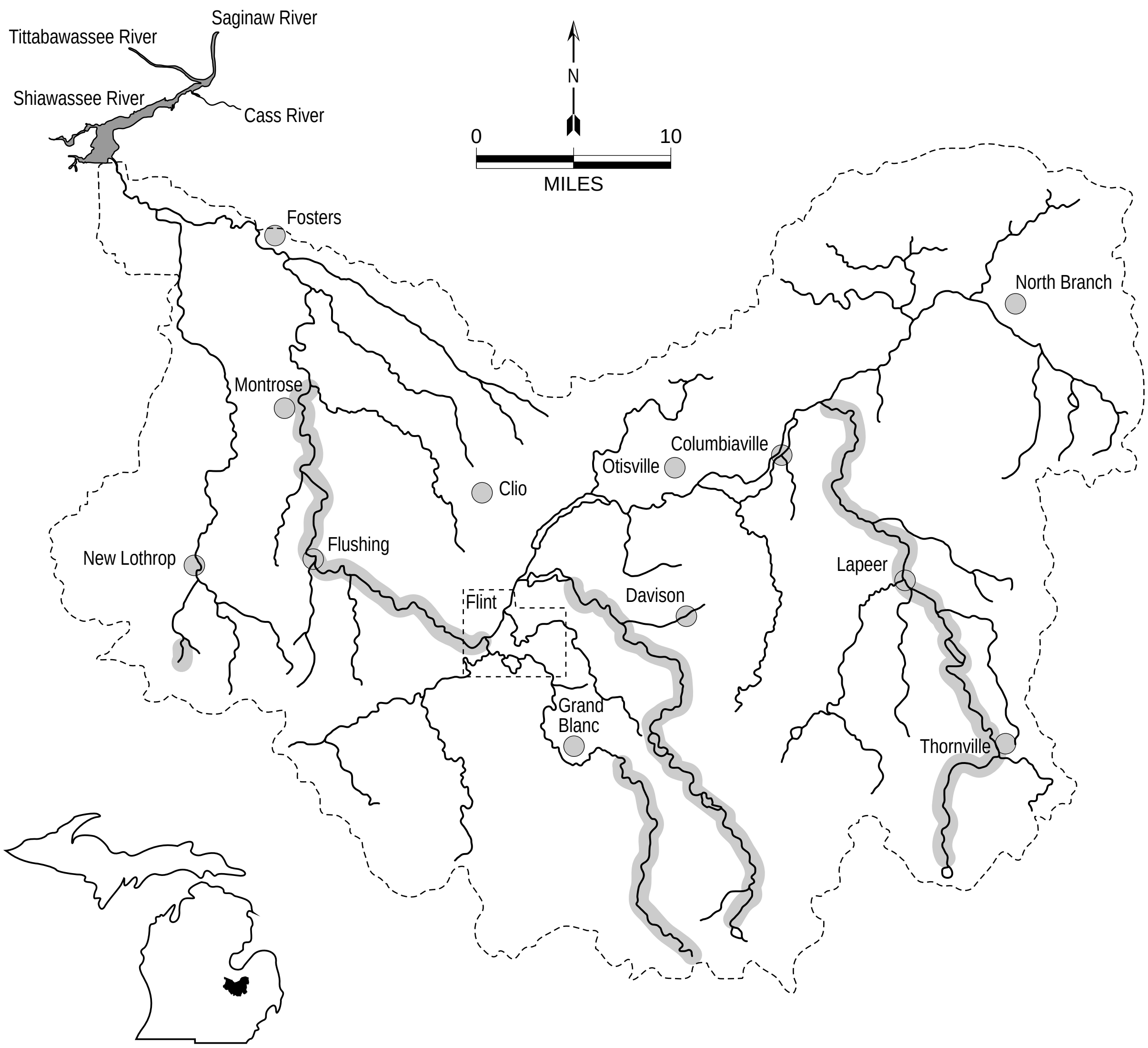
spawning
- large stones and pebbles present
- often below a riffle in shallow water
- gravel substrate



River chub (*Nocomis micropogon*)

Habitat:

feeding
- moderate to large streams
- moderate to high gradient
- gravel, boulder, or bedrock substrate
- little to no aquatic vegetation
- cannot tolerate turbidity or siltation

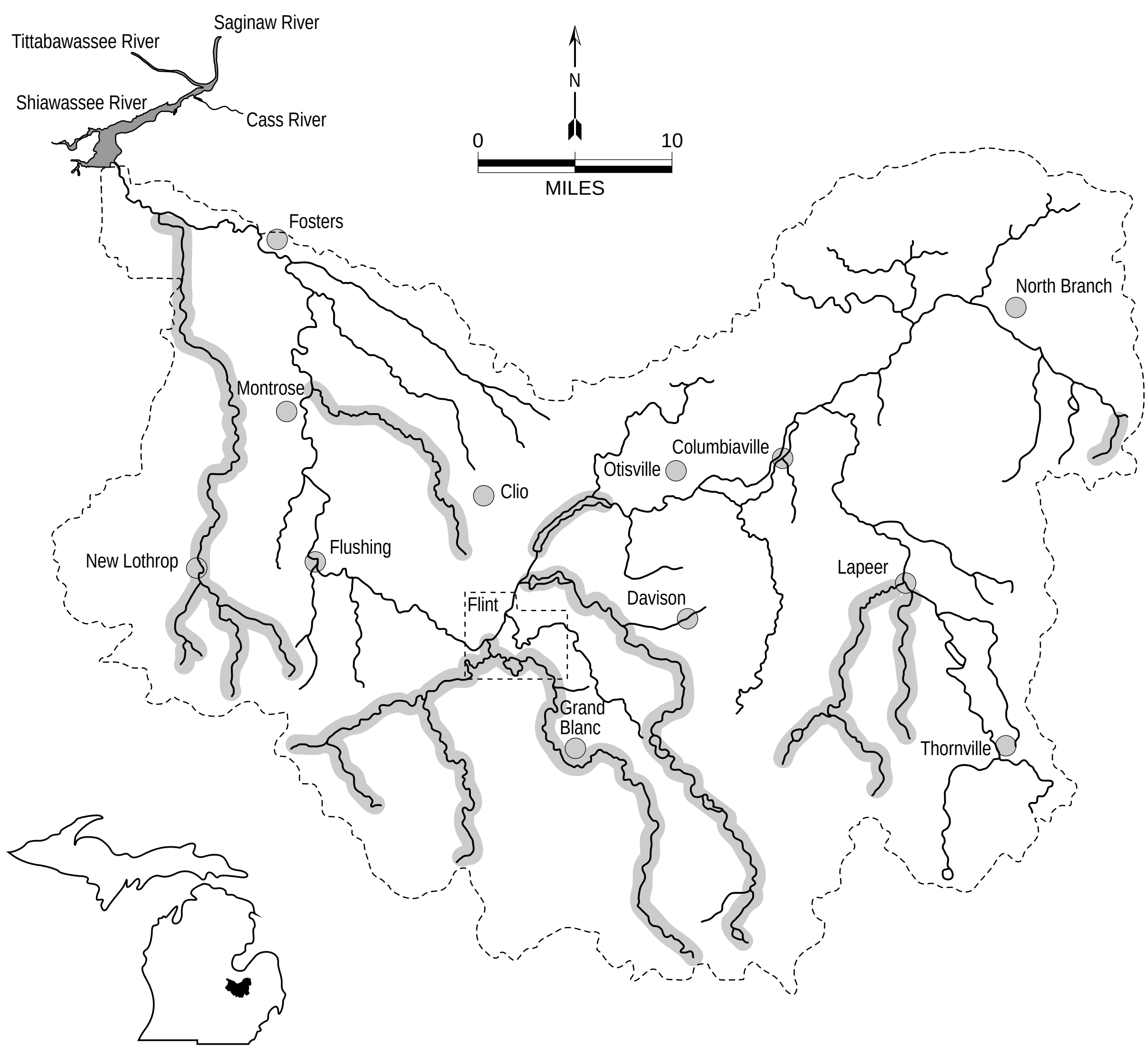


Golden shiner (*Notemigonus crysoleucas*)

Habitat:

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

spawning - vegetation

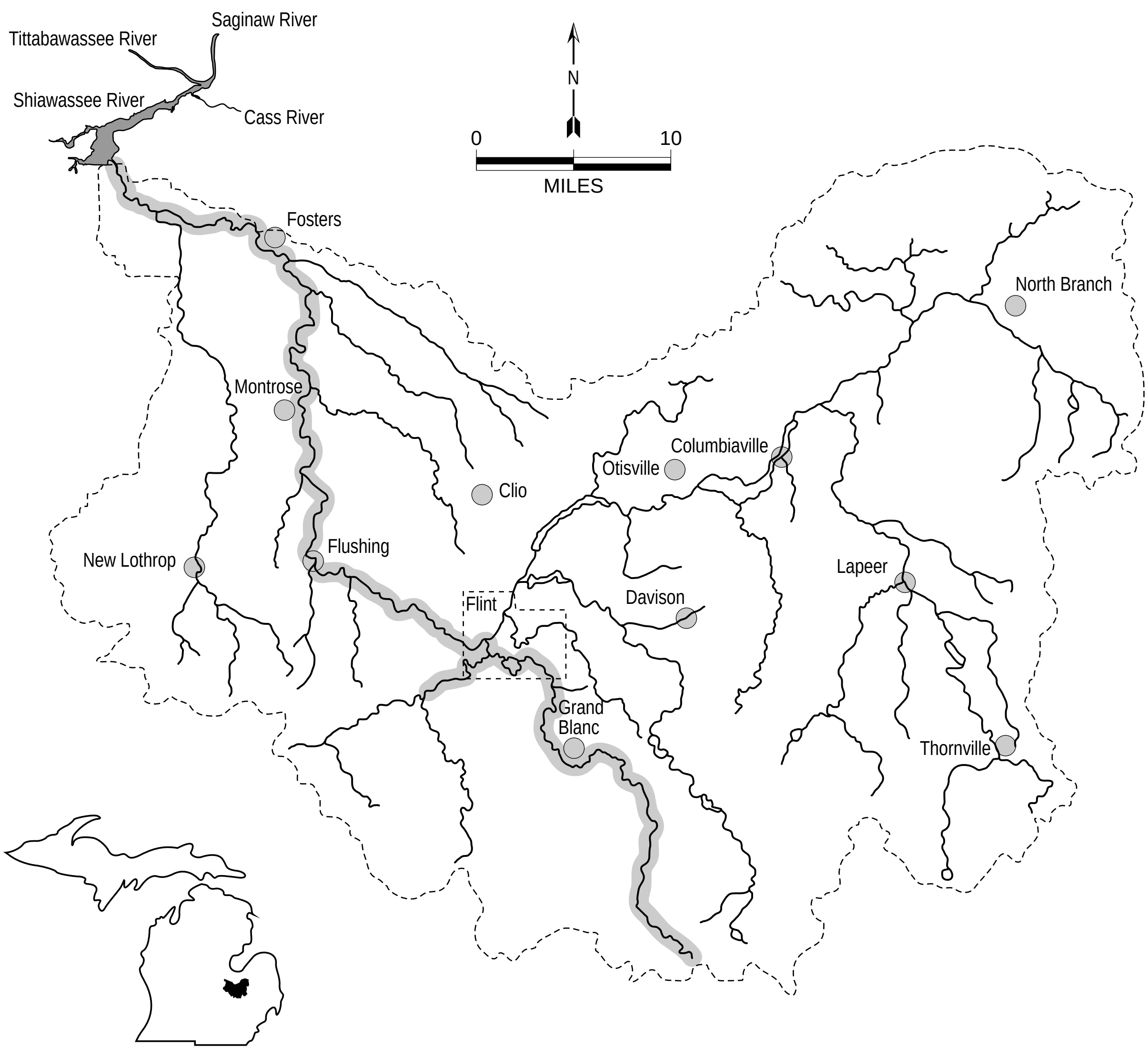


Emerald shiner (*Notropis atherinoides*)

Habitat:

feeding
- open-large stream channels and lake
- low to moderate gradient
- range of turbidities and bottom types
- midwater or surface preferred, substrate of little importance
- avoids rooted vegetation

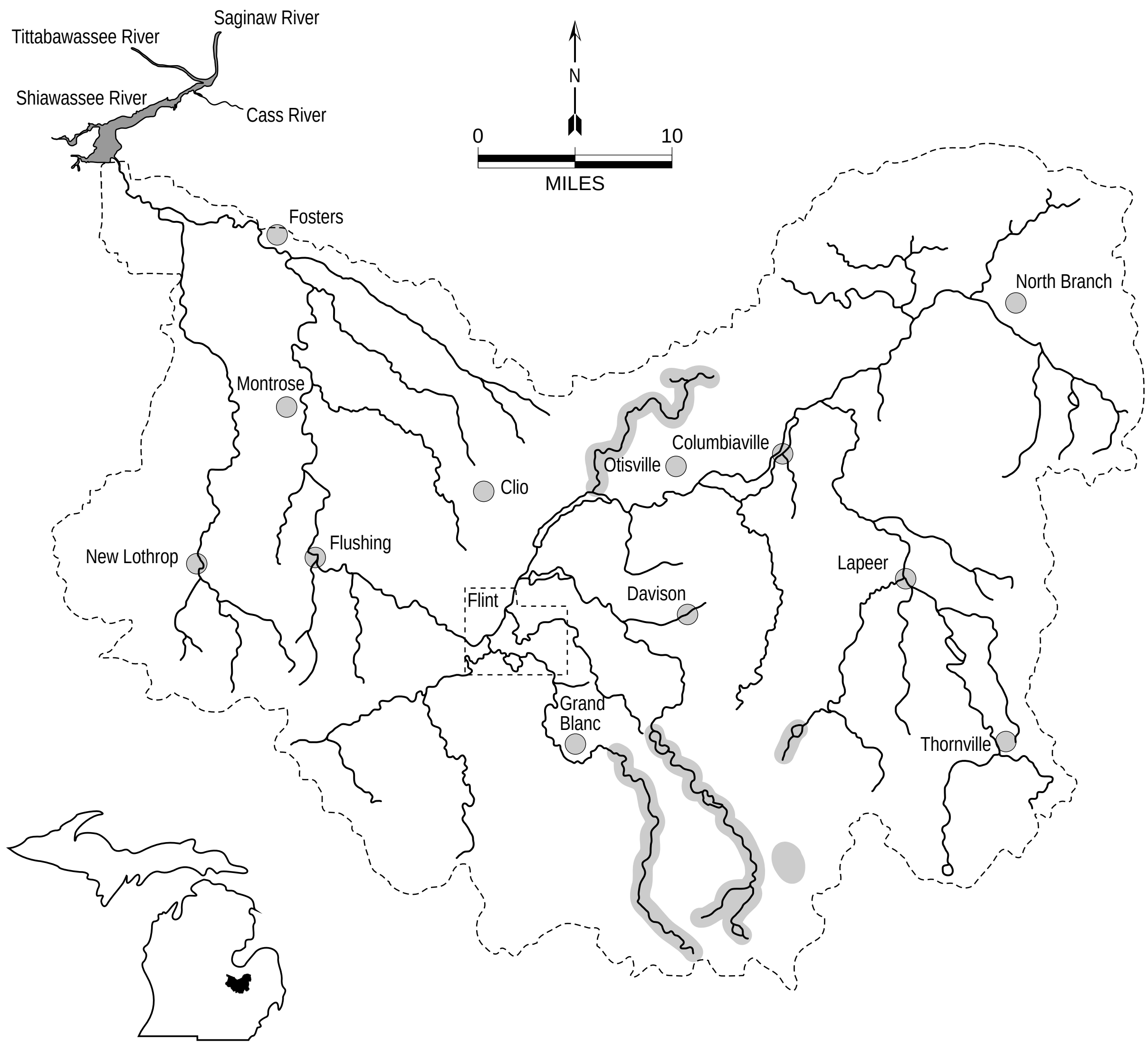
spawning
- sand or firm mud substrate or gravel shoals



Blackchin shiner (*Notropis heterodon*)

Habitat:

feeding
- lakes, impoundments, and quiet pools in streams and rivers
- clear water
- clean sand, gravel, or organic debris substrate
- dense beds of submerged aquatic vegetation
- cannot tolerate turbidity, silt, or loss of aquatic vegetation

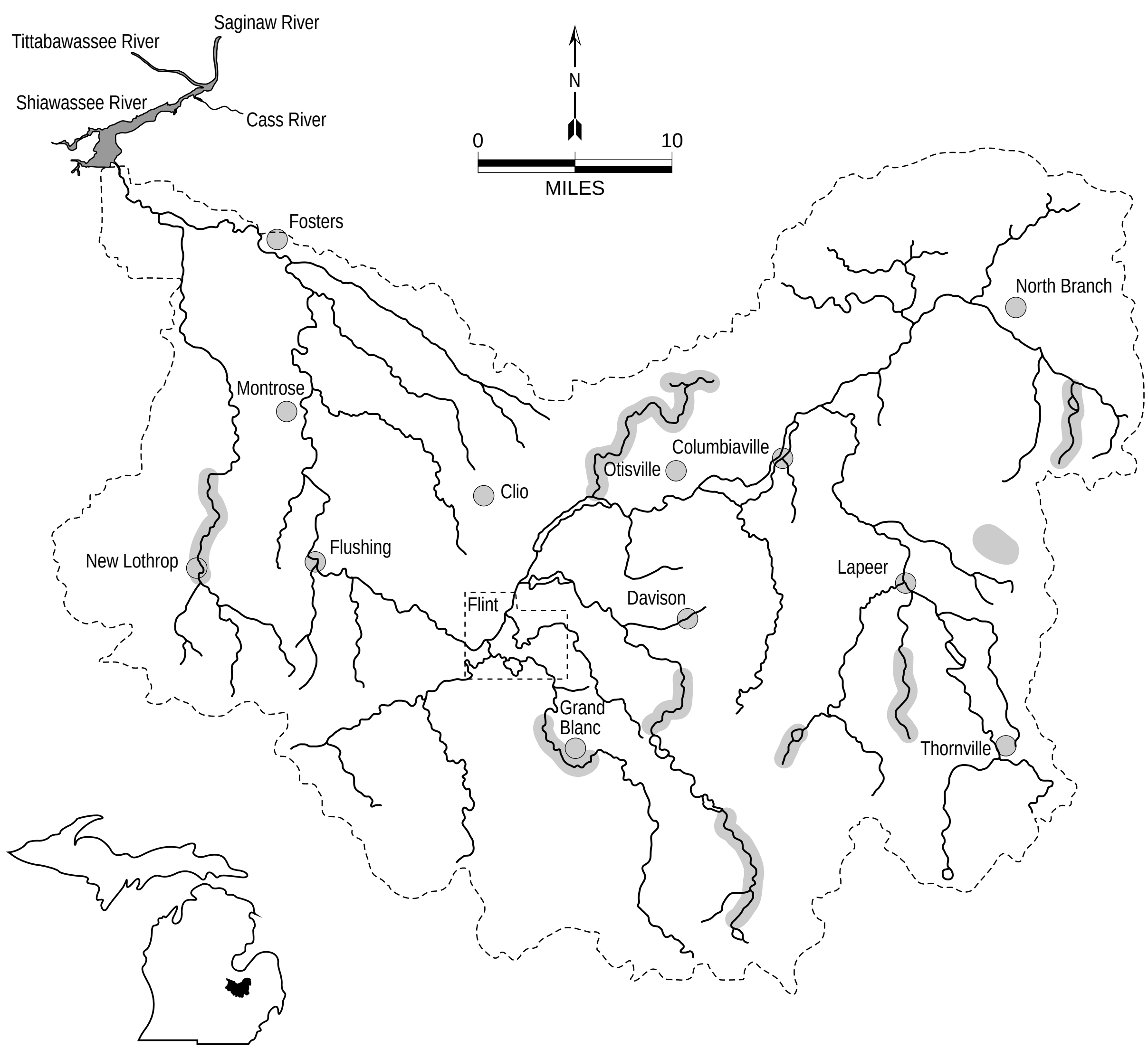


Blacknose shiner (*Notropis heterolepis*)

Habitat:

feeding
- clear lakes, impoundments, and pools of small, clear, low-gradient streams
- aquatic vegetation
- clean sand, gravel, marl, muck, peat, or organic debris substrate
- cannot tolerate much turbidity, much siltation, or loss of aquatic vegetation

spawning
- sandy substrate

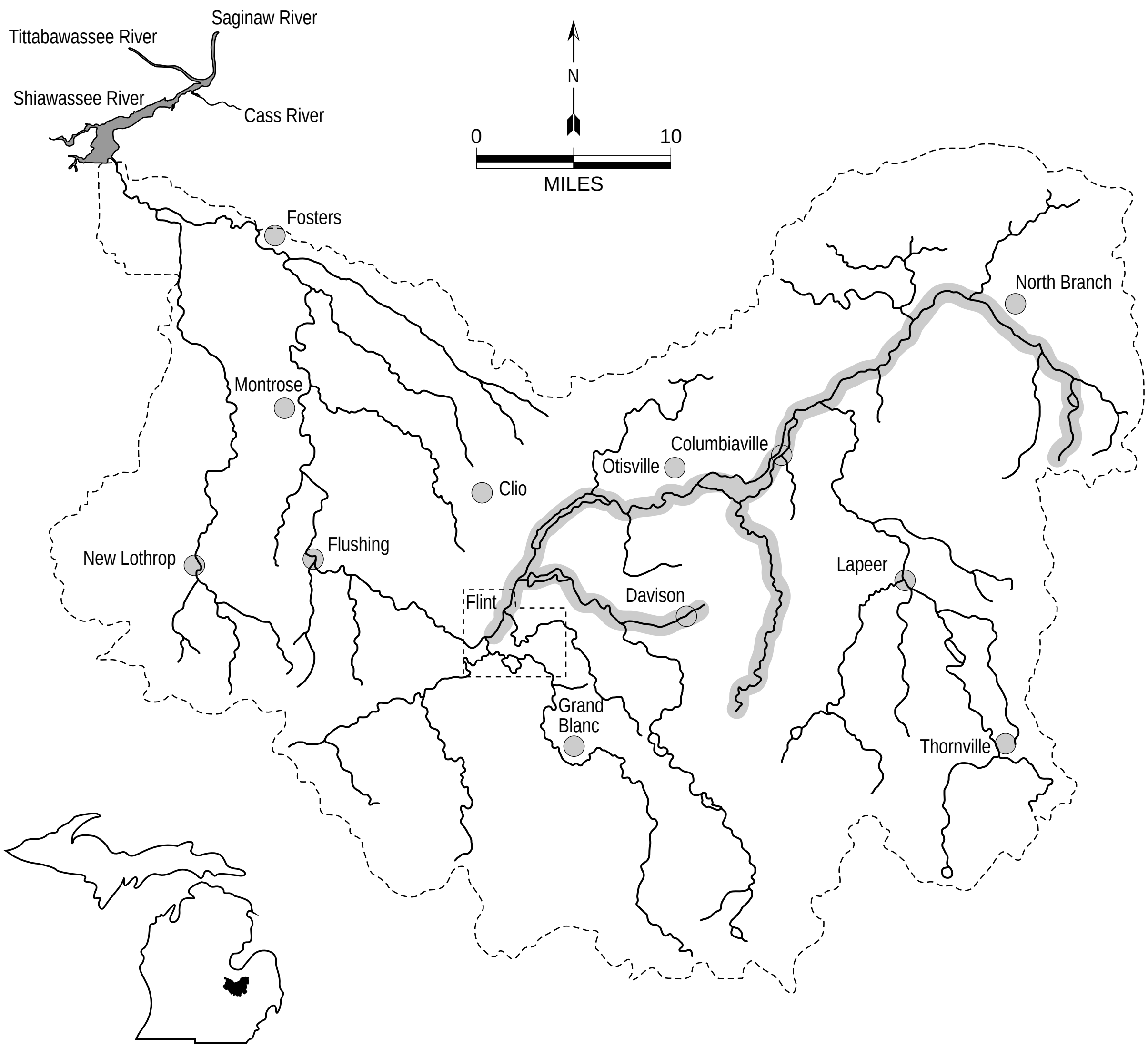


Spottail shiner (*Notropis hudsonius*)

Habitat:

feeding
- large rivers, lakes, and impoundments
- firm sand and gravel substrate
- low current
- sparse to moderate vegetation
- avoids turbidity

spawning
- over sandy shoals or gravelly riffles
- near the mouths of small streams

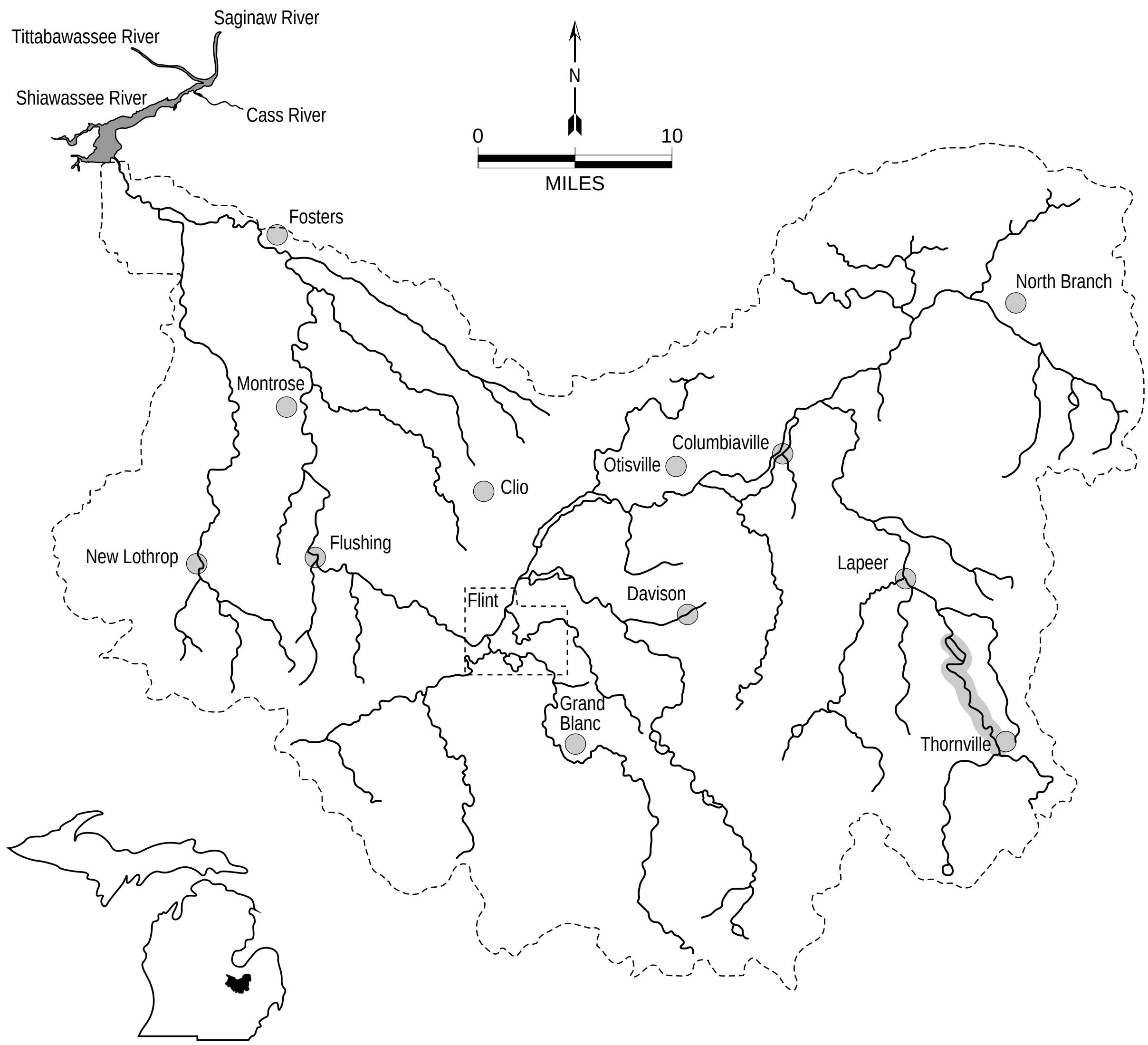


Rosyface shiner (*Notropis rubellus*)

Habitat:

feeding
- moderate sized streams
- moderate to high gradient
- gravel or sand substrate; intolerant of silt substrate
- clear water; intolerant of turbidity

spawning
- on nests of horneyhead chub, chesnut lamprey, and redhorses
- sandy-gravel, gravel or bedrock substrate
- shallow high gradient water

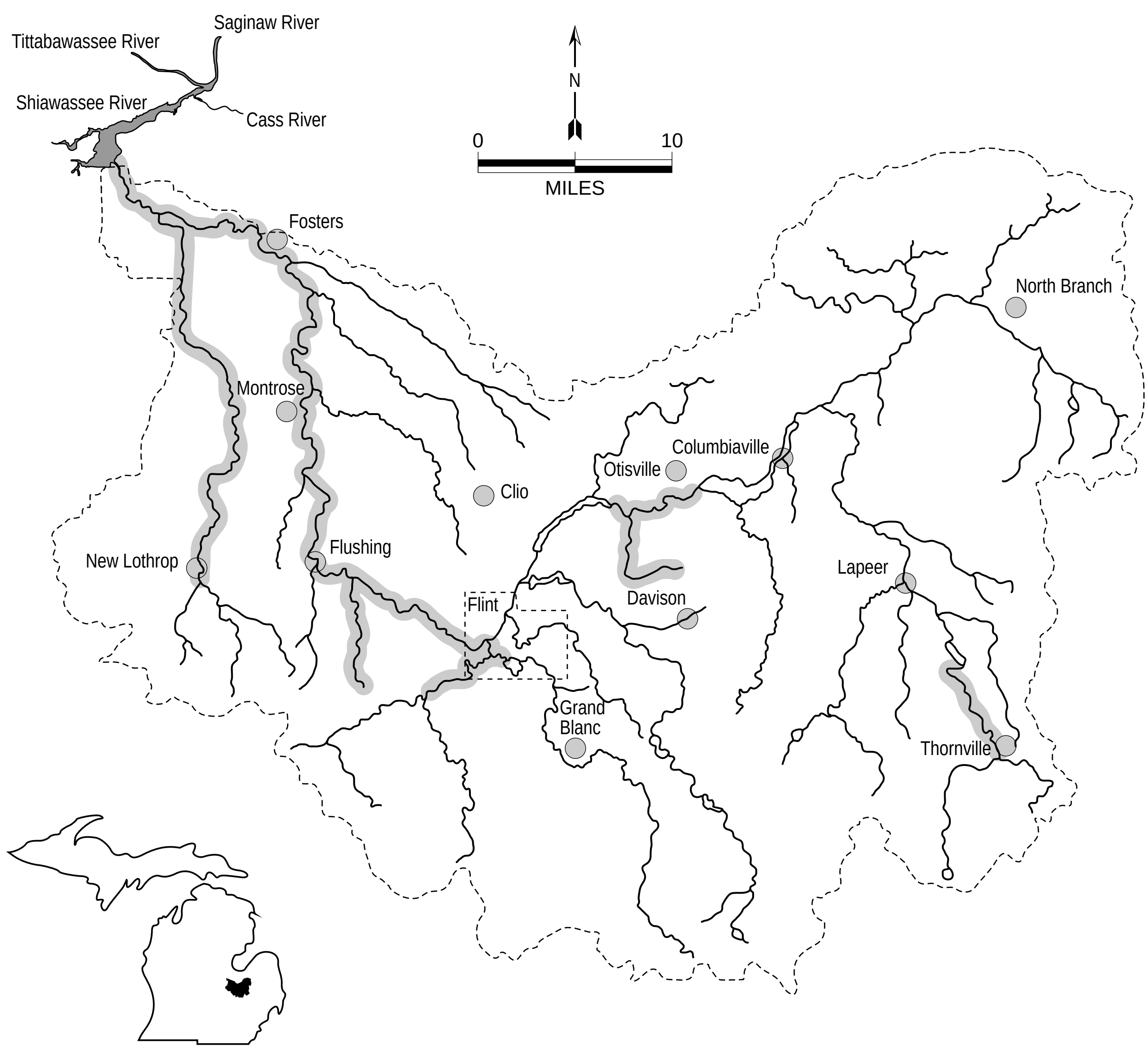


Sand shiner (*Notropis stramineus*)

Habitat:

feeding
- sand and gravel substrate
- shallow pools in medium size streams, lakes, and impoundments
- clear water and low gradient
- rooted aquatic vegetation preferred
- tolerant of some inorganic pollutants provided substrate is not covered

spawning
- clean gravel or sand substrate

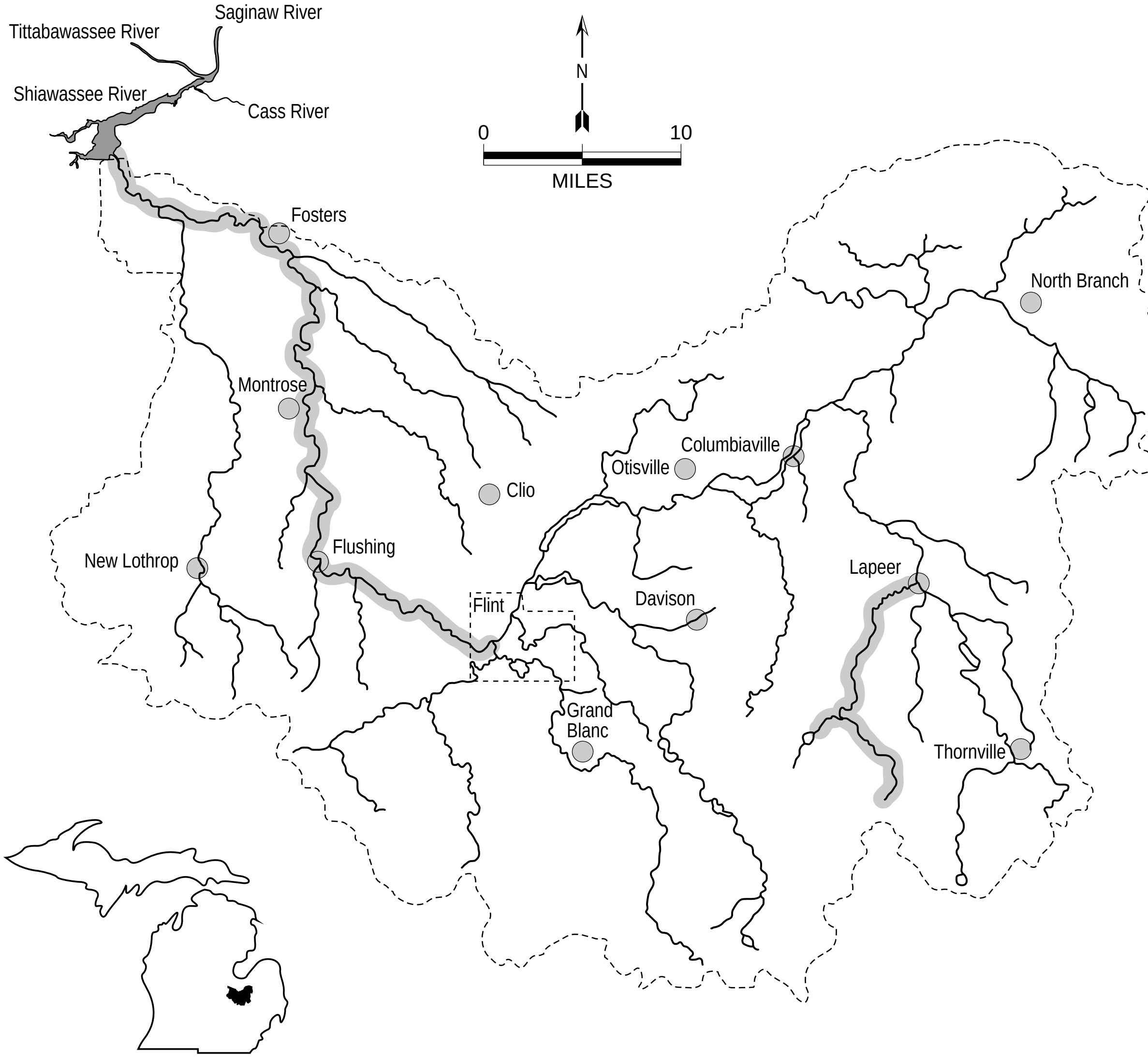


Mimic shiner (*Notropis volucellus*)

Habitat:

feeding - pools and backwater of streams, moderately weedy lakes and impoundments
- quiet or still water
- clear shallow water

spawning - aquatic vegetation necessary

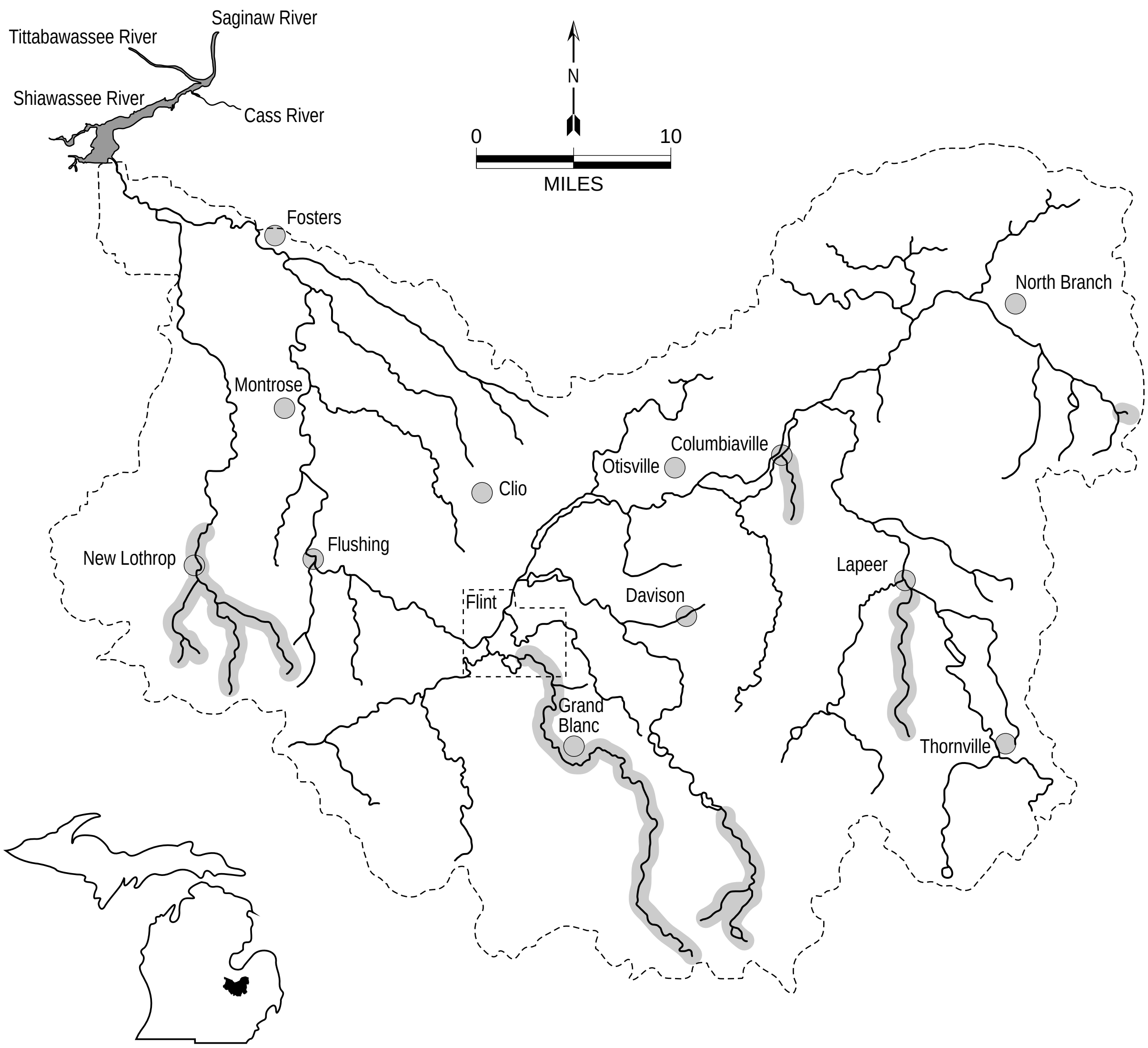


Northern redbelly dace (*Phoxinus eos*)

Habitat:

feeding - slow current
- in boggy lakes and streams
- detritus or silt substrate
- clear to slightly turbid water

spawning - filamentous algae needed for egg deposition

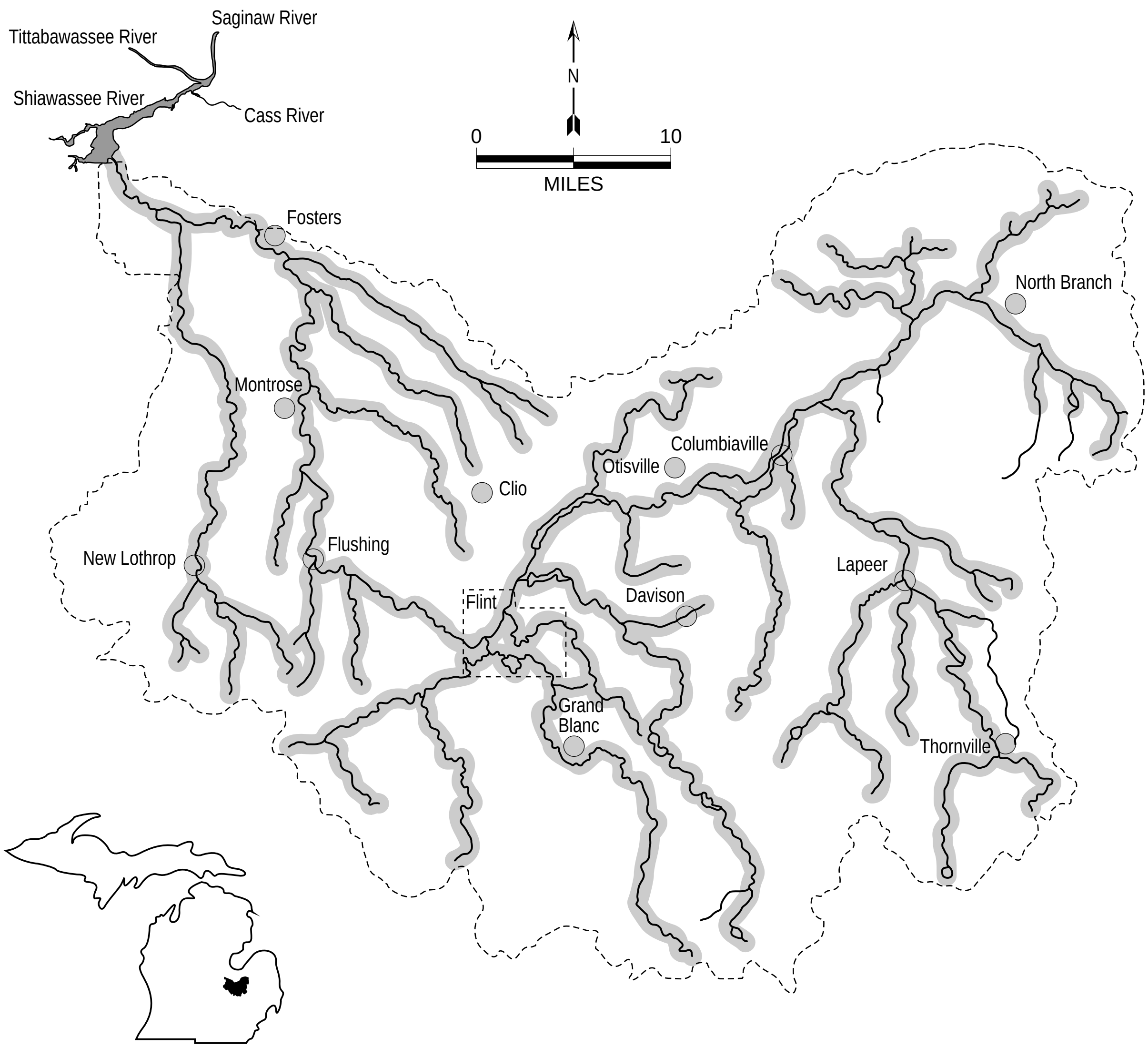


Bluntnose minnow (*Pimephales notatus*)

Habitat:

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

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

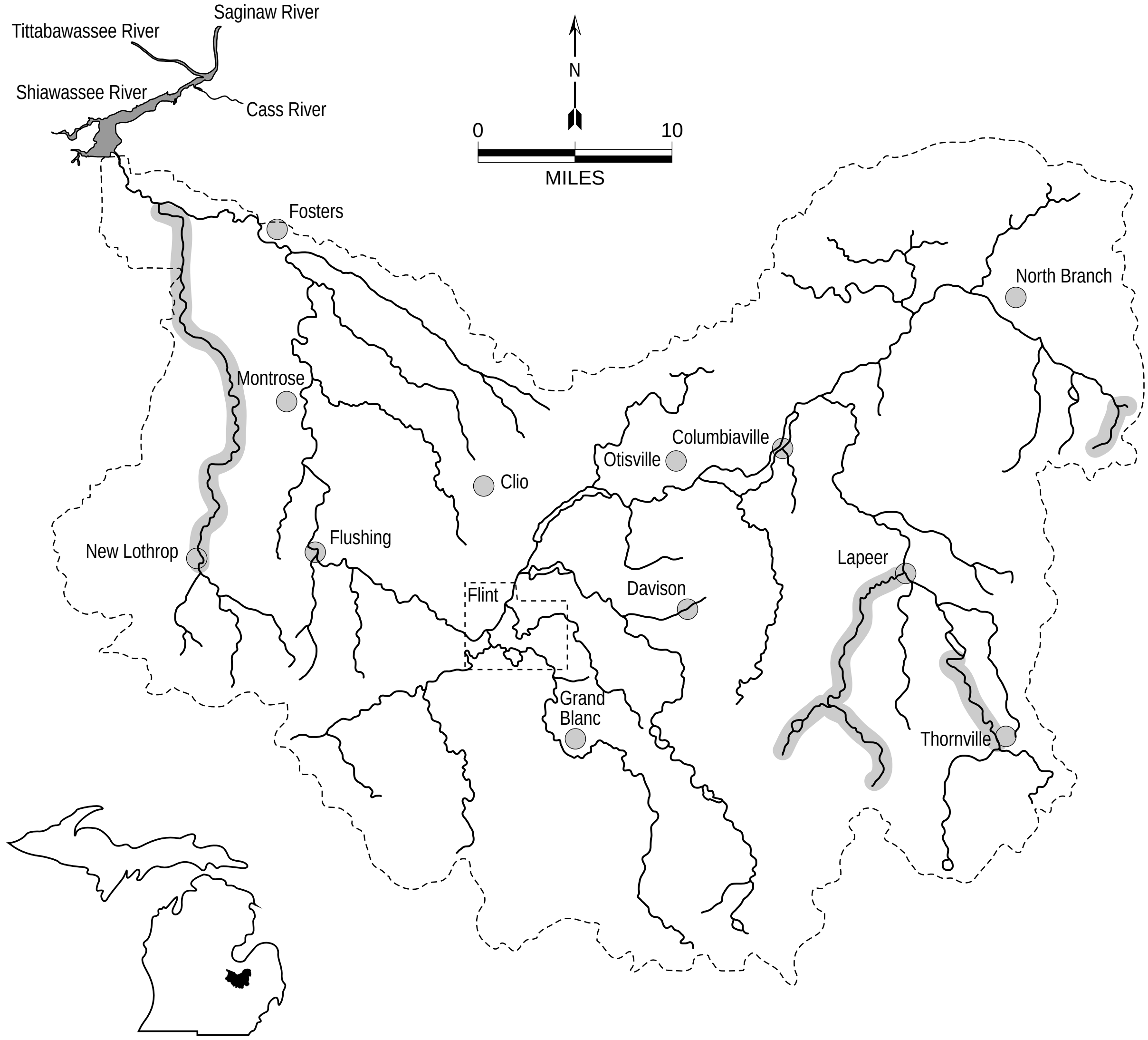


Fathead minnow (*Pimephales promelas*)

Habitat:

feeding - pools of small streams, lakes, and impoundments
- tolerant of turbidity, high temperatures, and low oxygen

spawning - on underside of objects in water 2 to 3 feet deep
- prefer sand, marl, or gravel substrate



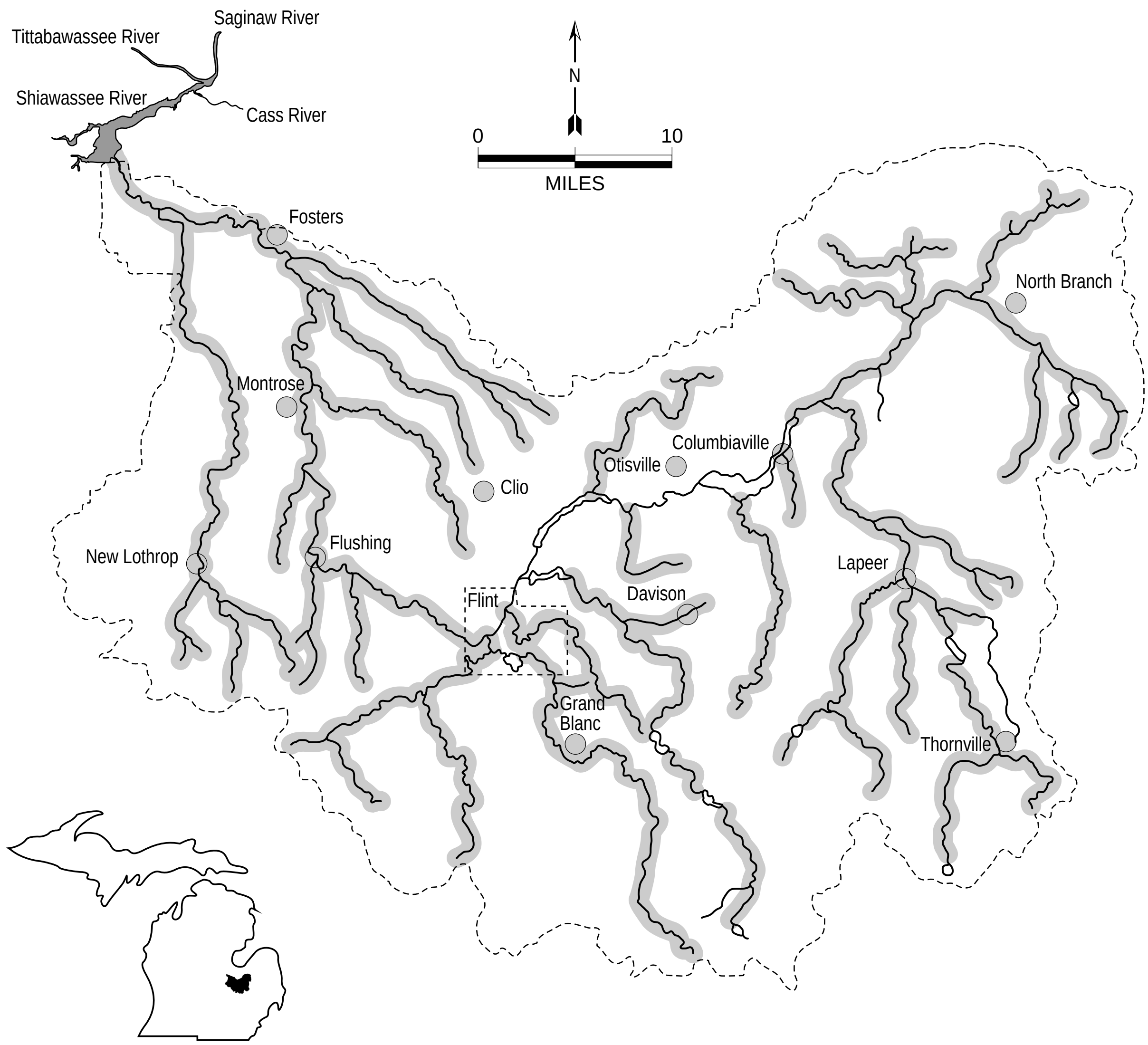
Blacknose dace (*Rhinichthys atratulus*)

Habitat:

feeding - moderate to high gradient streams
- sand and gravel substrate
- clear cool water in pools with deep holes and undercut banks
- does not tolerate turbidity and silt well

spawning - riffles with gravel substrate and fast current

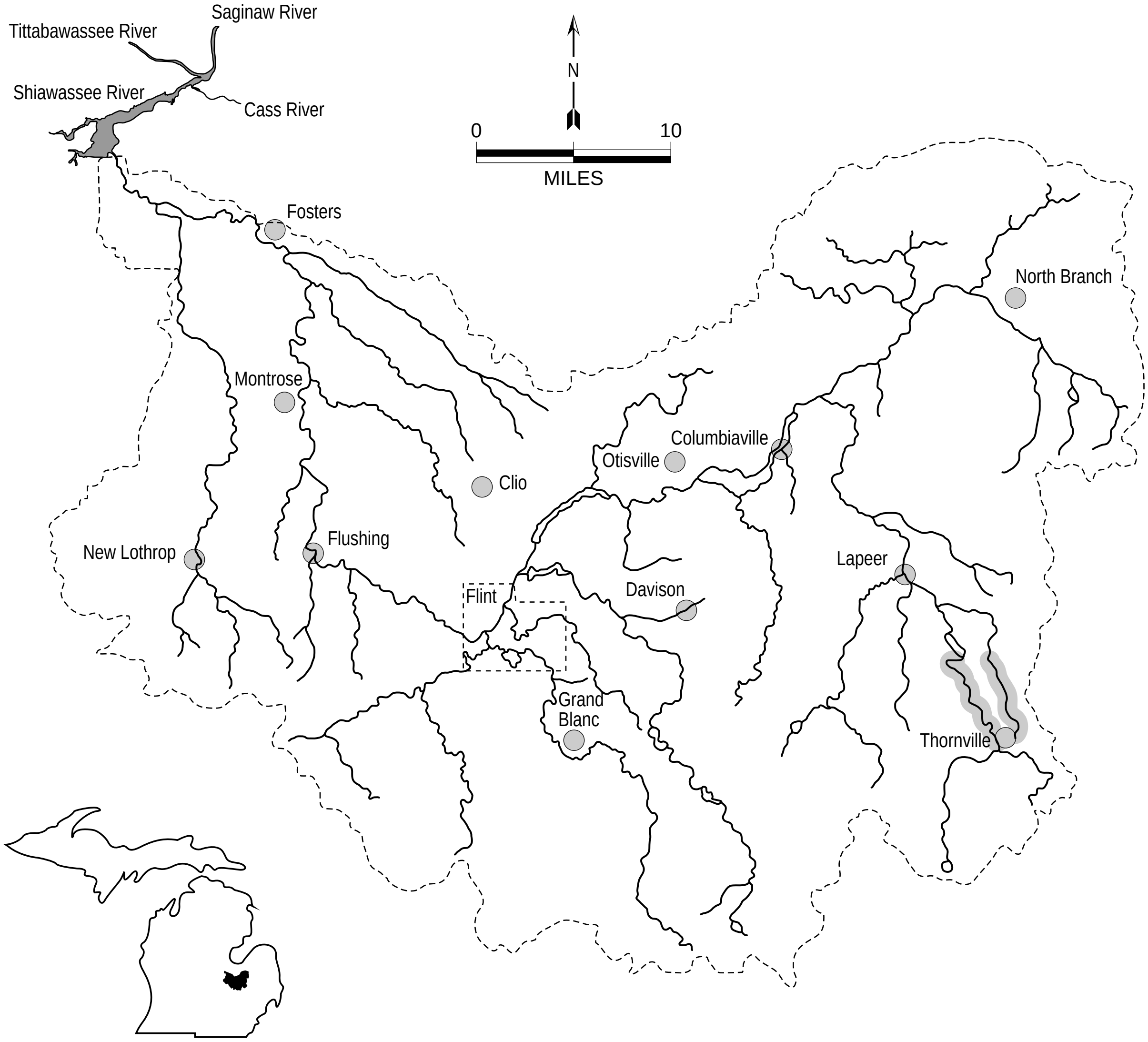
winter refuge - larger waters



Longnose dace (*Rhinichthys cataractae*)

Habitat:

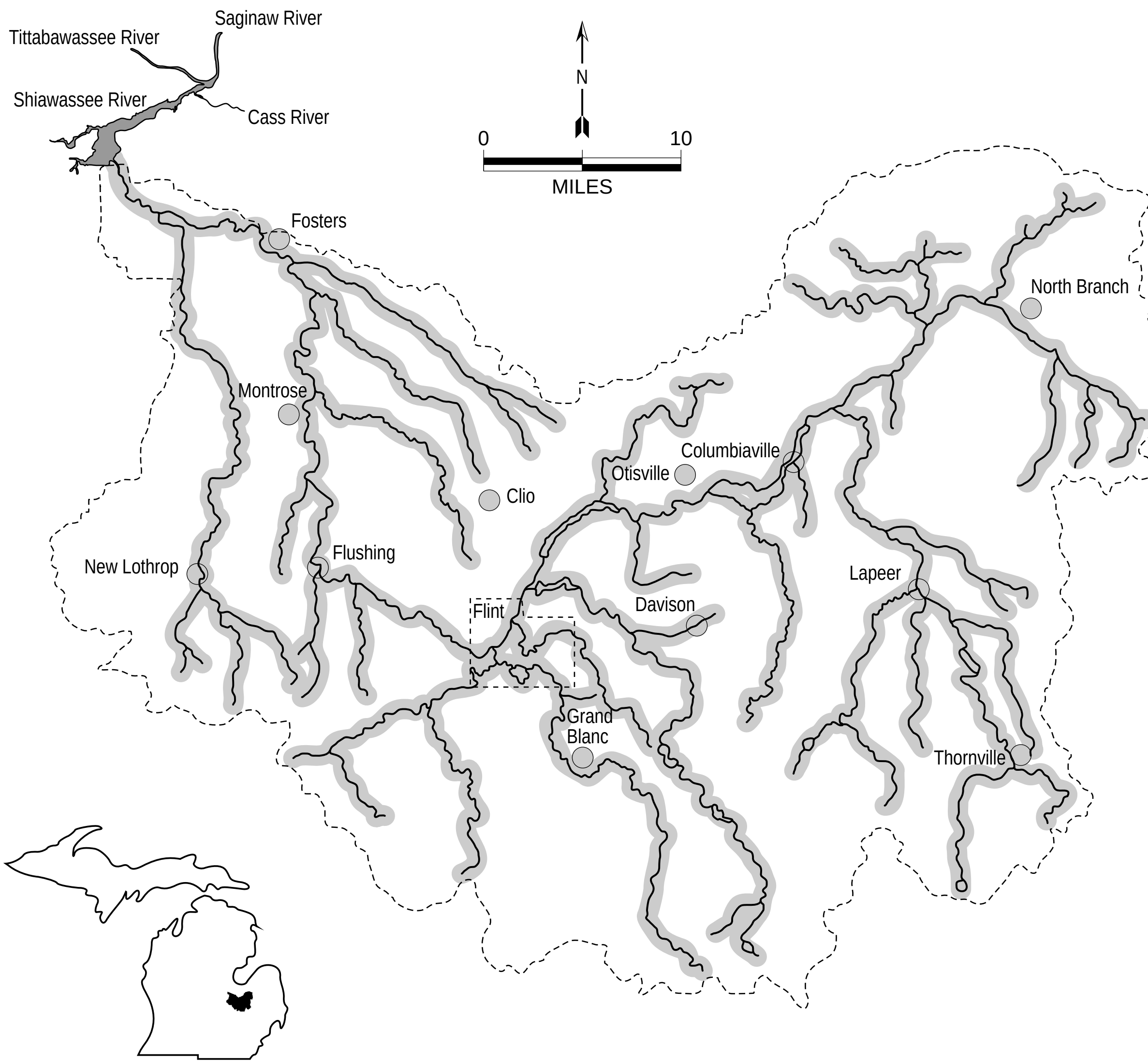
feeding - lakes and streams
- high gradient
- gravel or boulder substrate



Creek chub (*Semotilus atromaculatus*)

Habitat:

feeding	- streams, rivers, or shore waters of lakes and impoundments
	- can tolerate intermittent flows
	- tolerates moderate turbidity
spawning	- gravel nests
	- low current
winter refuge	- deeper pools and runs



Quillback (*Carpoides cyprinus*)

Habitat:

feeding
- clear to turbid water
- Lake Michigan
- sand, sandy gravel, sandy silt, or clay-silt substrate
- medium- to low-gradient rivers and streams; also lakes and sloughs

spawning
- streams or overflow areas of bends of rivers or bays of lakes
- scatter eggs over sand or mud substrate

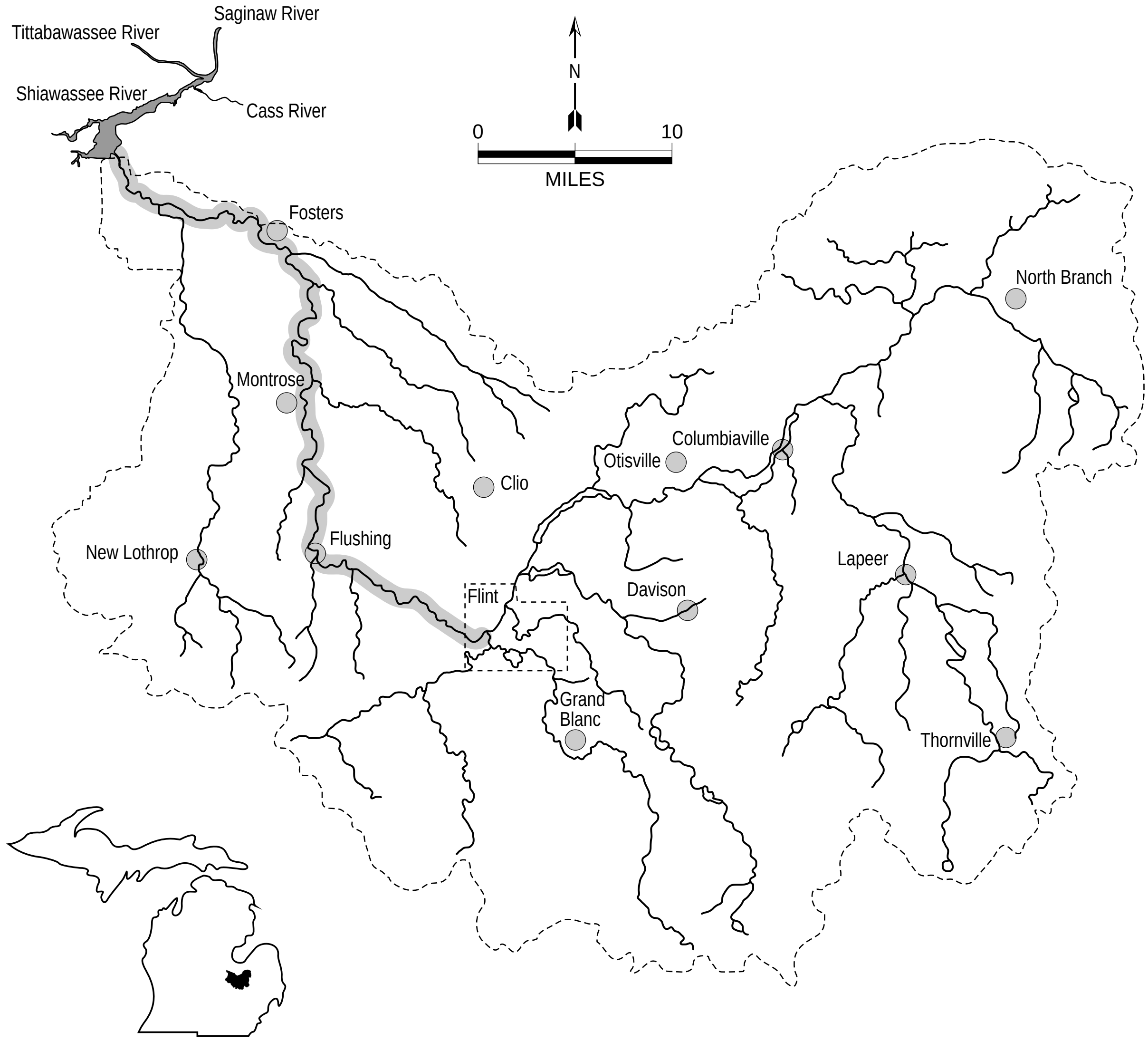


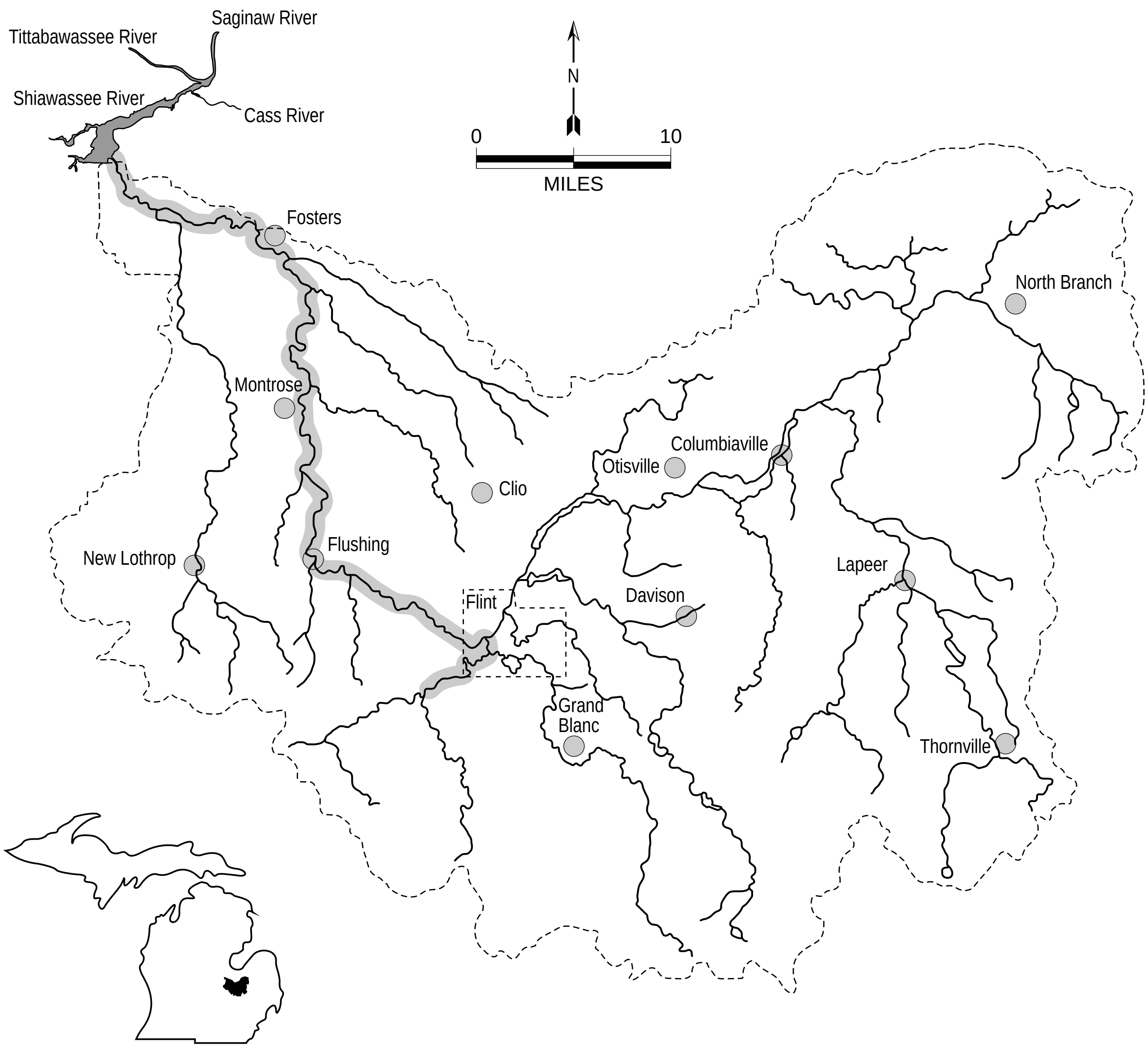
Figure 28.

Longnose sucker (*Catostomus catostomus*)

Habitat:

feeding - clear, cold rivers and lakes

spawning - in streams or lake shallows
- current
- gravel substrate

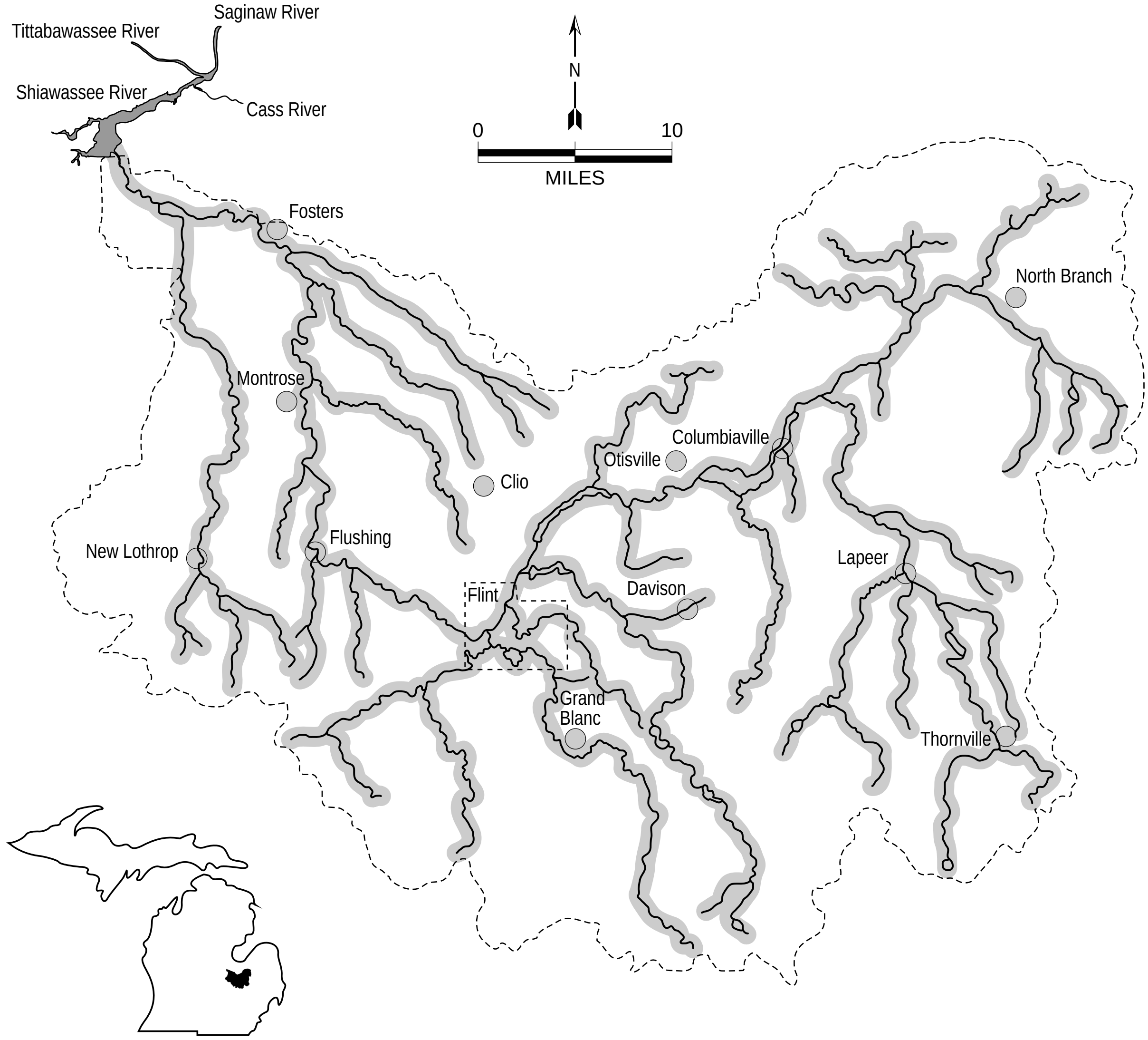


White sucker (*Catostomus commersoni*)

Habitat:

feeding - streams, rivers, lakes, and impoundments
- can inhabit highly turbid and polluted waters

spawning - quiet gravelly shallow areas of streams

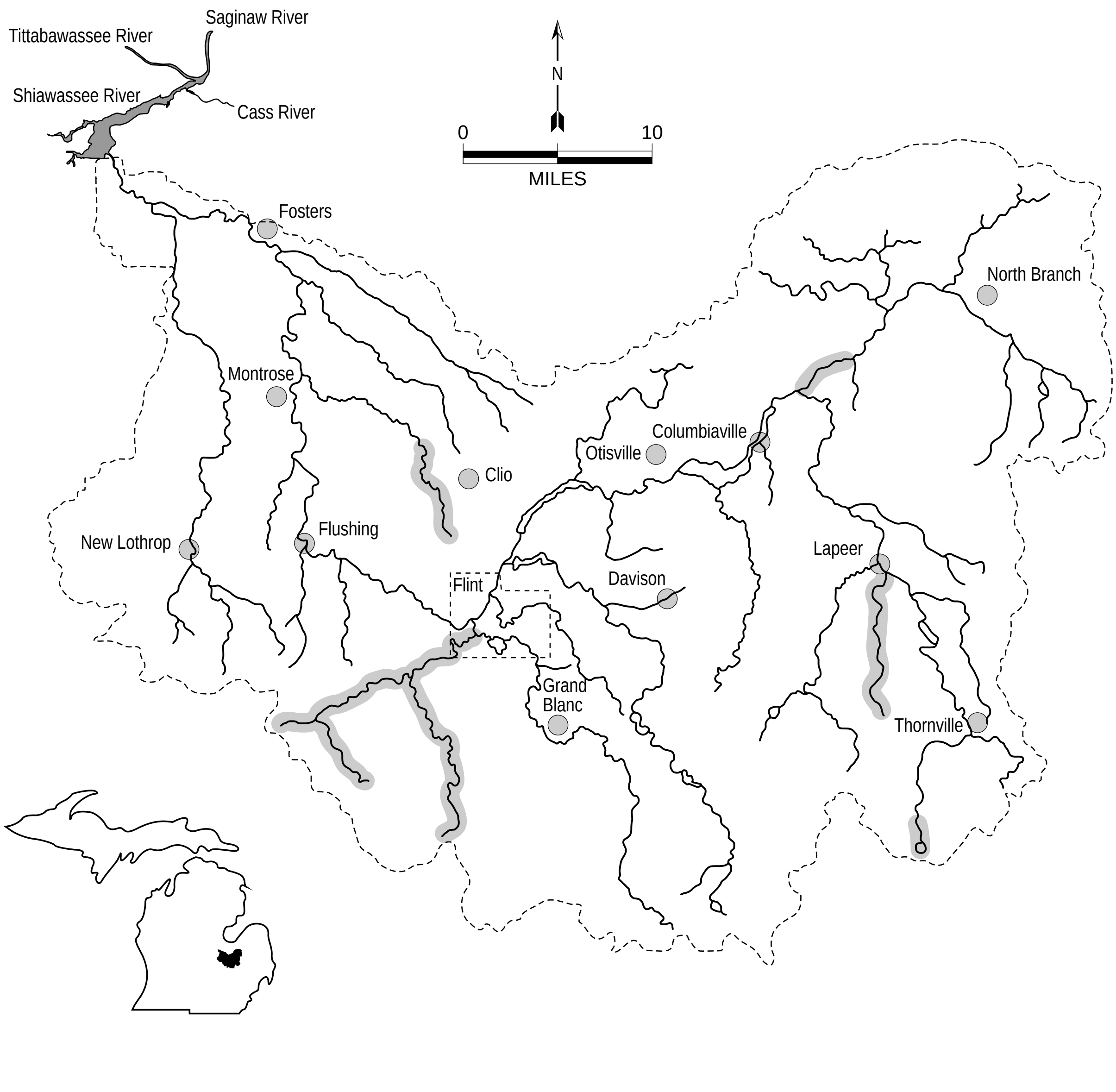


Lake chubsucker (*Erimyzon sucetta*)

Habitat:

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

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



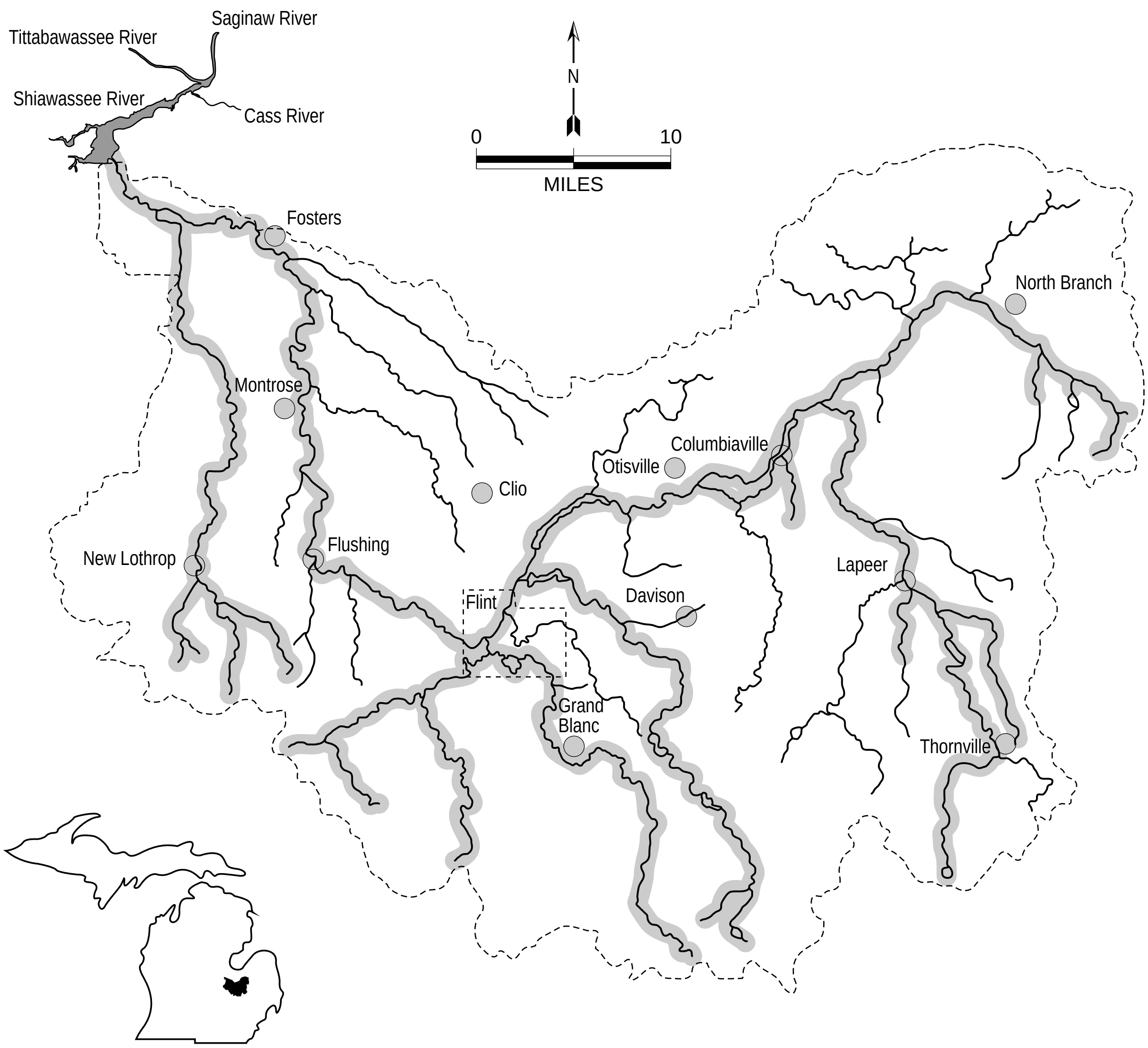
Northern hog sucker (*Hypentelium nigricans*)

Habitat:

feeding
- gravel or rubble substrate
- riffles and adjacent pools of warm shallow streams
- clear water
- doesn't like turbidity or siltation
- avoids profuse amounts of aquatic vegetation

spawning
- riffles
- shallow gravel substrate
- high gradient

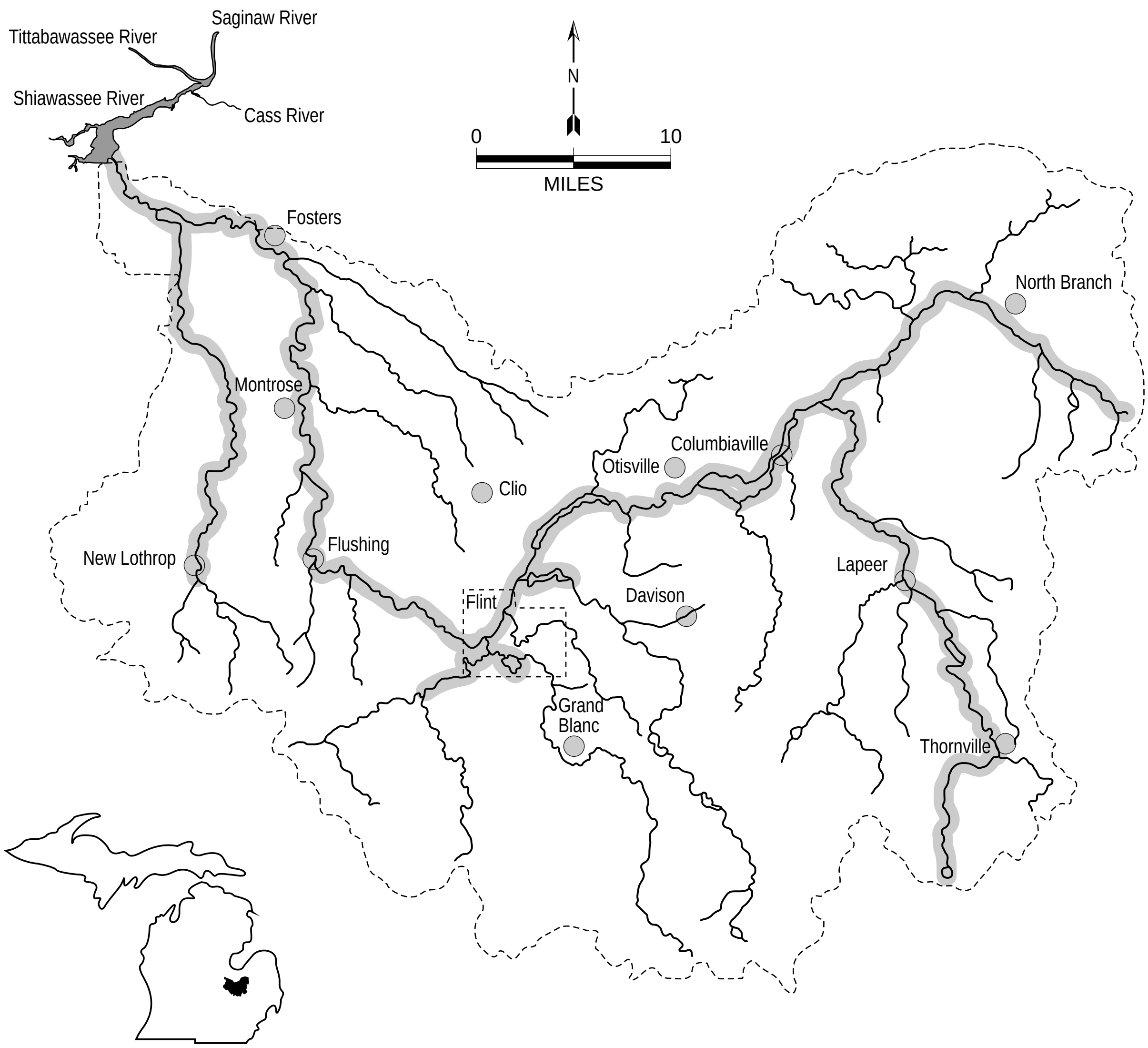
winter refuge
- deeper quieter pools



Golden redhorse (*Moxostoma erythrurum*)

Habitat:

feeding	-	warm medium gradient streams and rivers
	-	clear riffly streams
	-	medium size streams and rivers
	-	tolerates some turbidity and silt
spawning	-	shallow gravelly riffles
winter refuge	-	larger streams

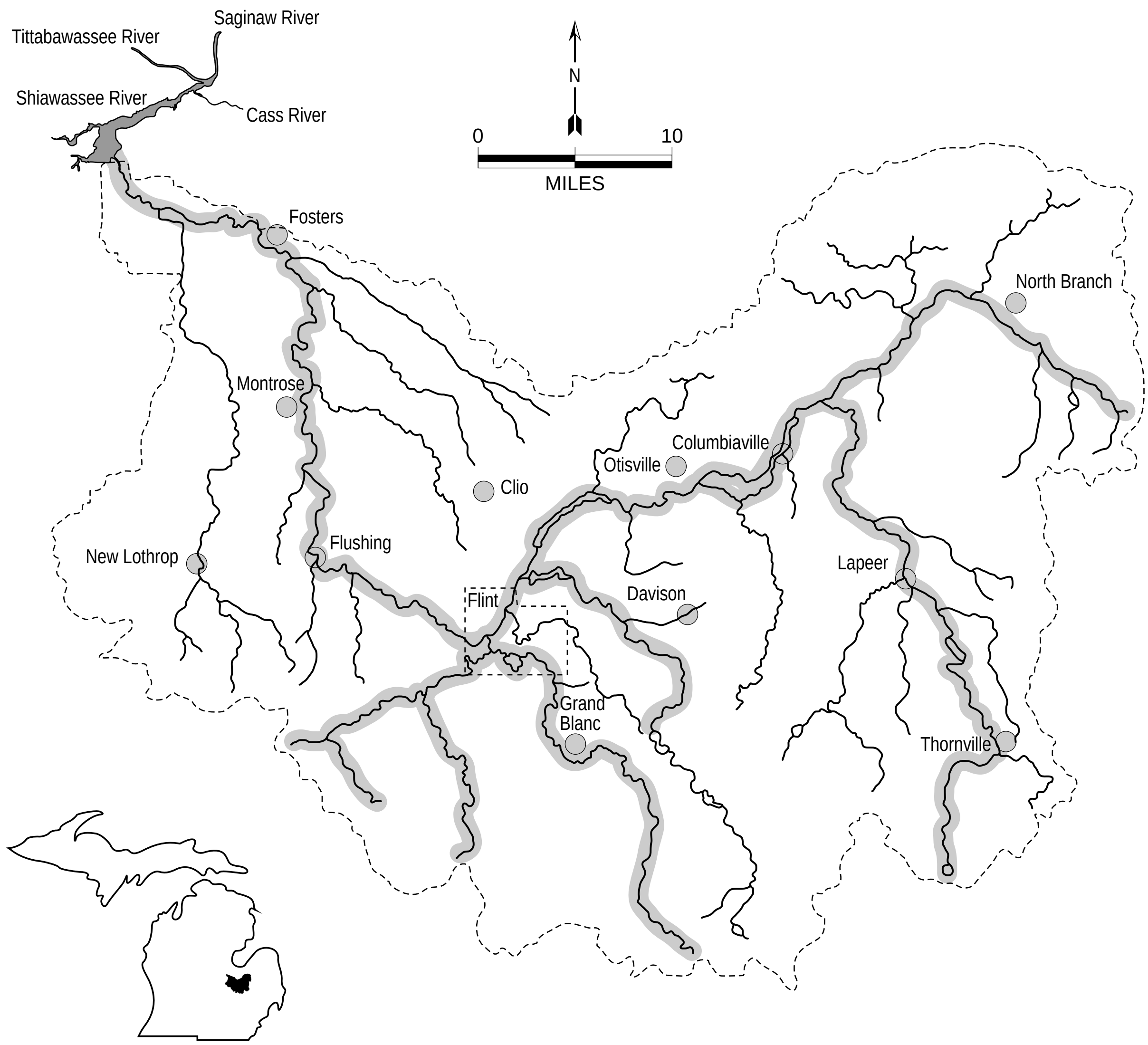


Shorthead redhorse (*Moxostoma macrolepidotum*)

Habitat:

feeding
- downstream sections of large rivers, lakes, and impoundments
- rocky substrates
- swift water near riffles
- clear to slightly turbid water

spawning
- gravelly riffles in smaller feeder streams

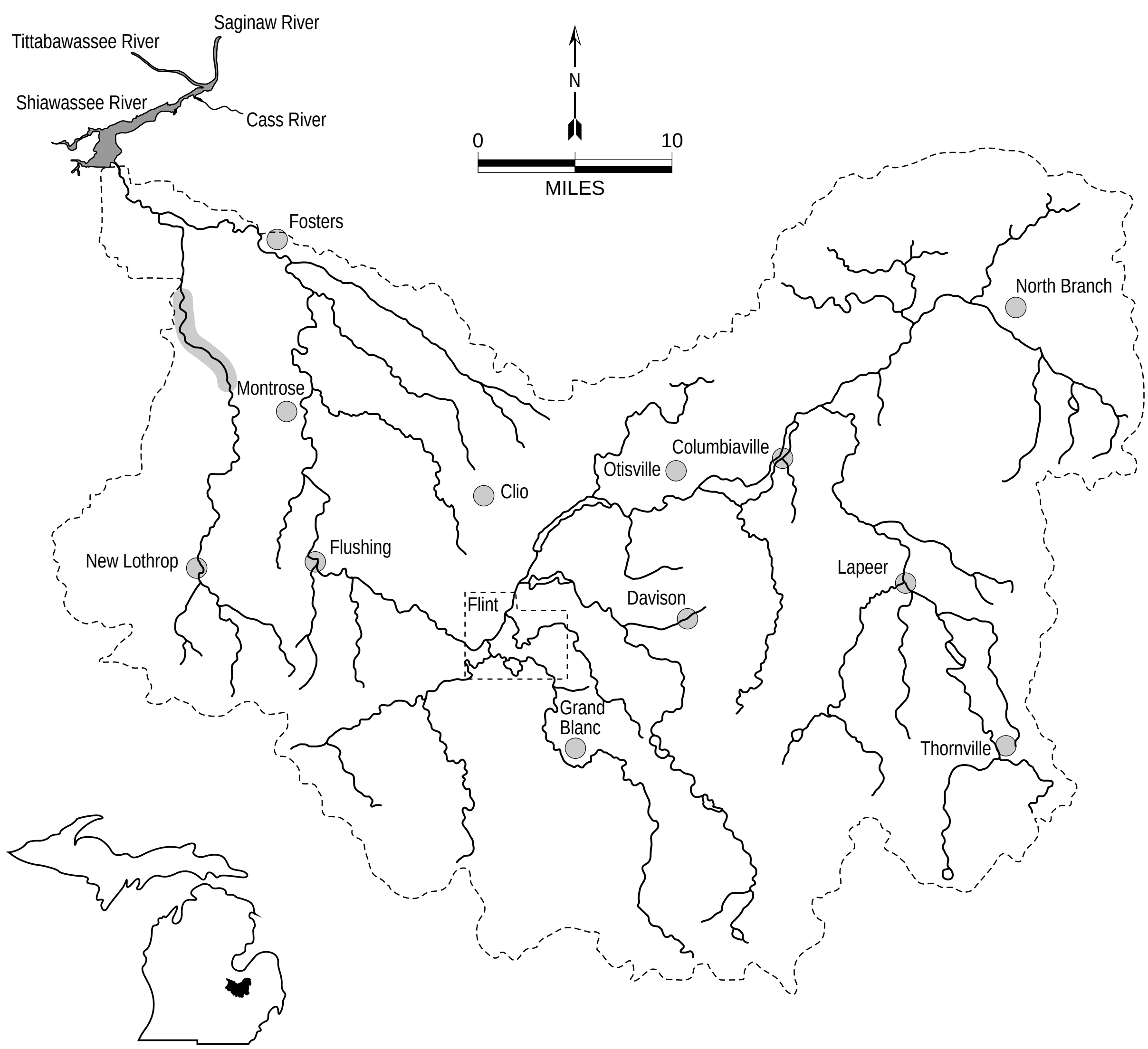


Greater redhorse (*Moxostoma valenciennesi*)

Habitat:

feeding - large clear streams
- clean sand, gravel, or boulder substrate
- intolerant of excessive turbidity and chemical pollutants

spawning - moderately rapid current

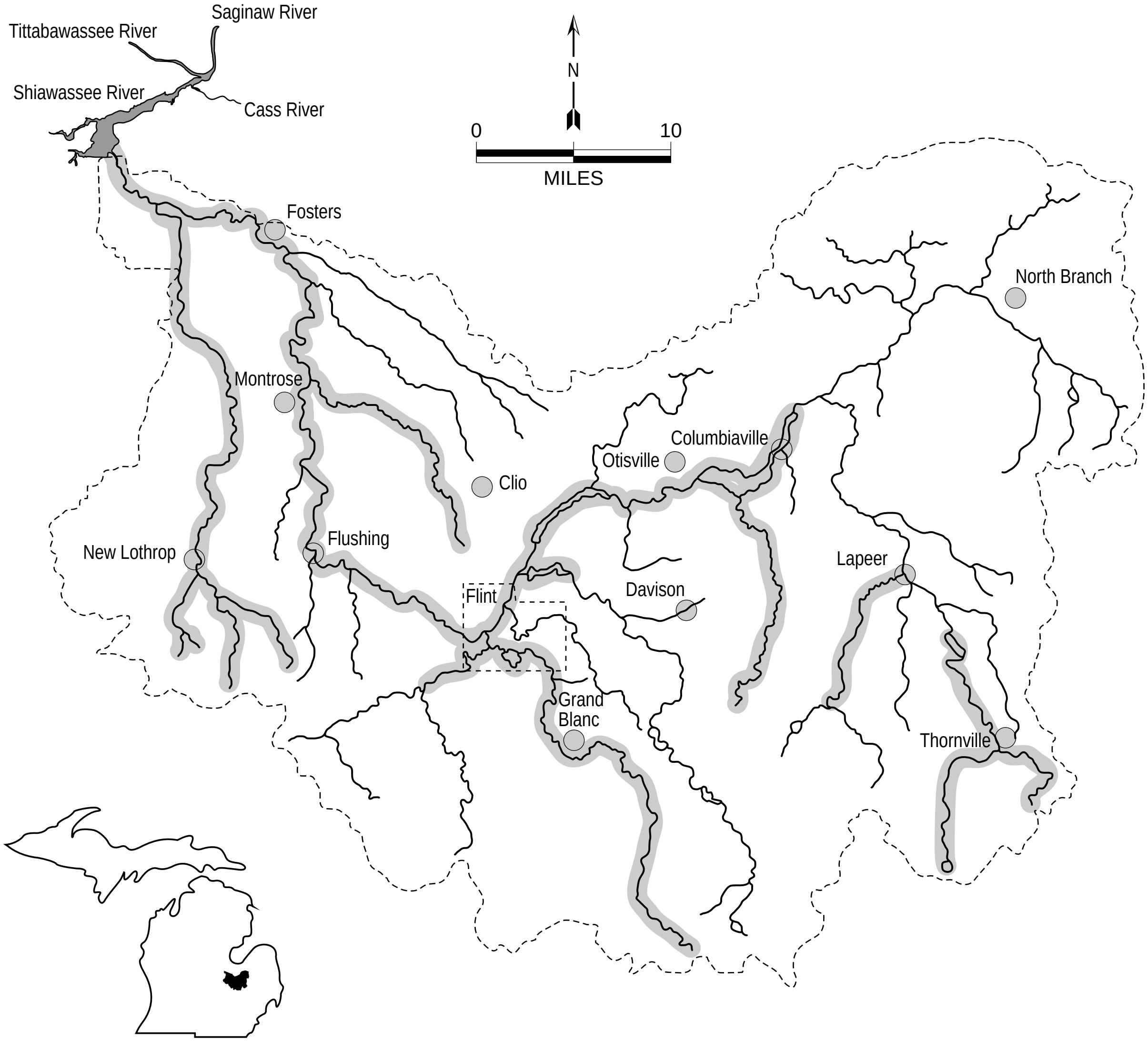


Yellow bullhead (*Ameiurus natalis*)

Habitat:

feeding
- clear flowing water
- heavy vegetation
- low gradient streams, lakes, and impoundments
- tolerant of low oxygen

spawning
- nest under a stream bank or near stones or stumps



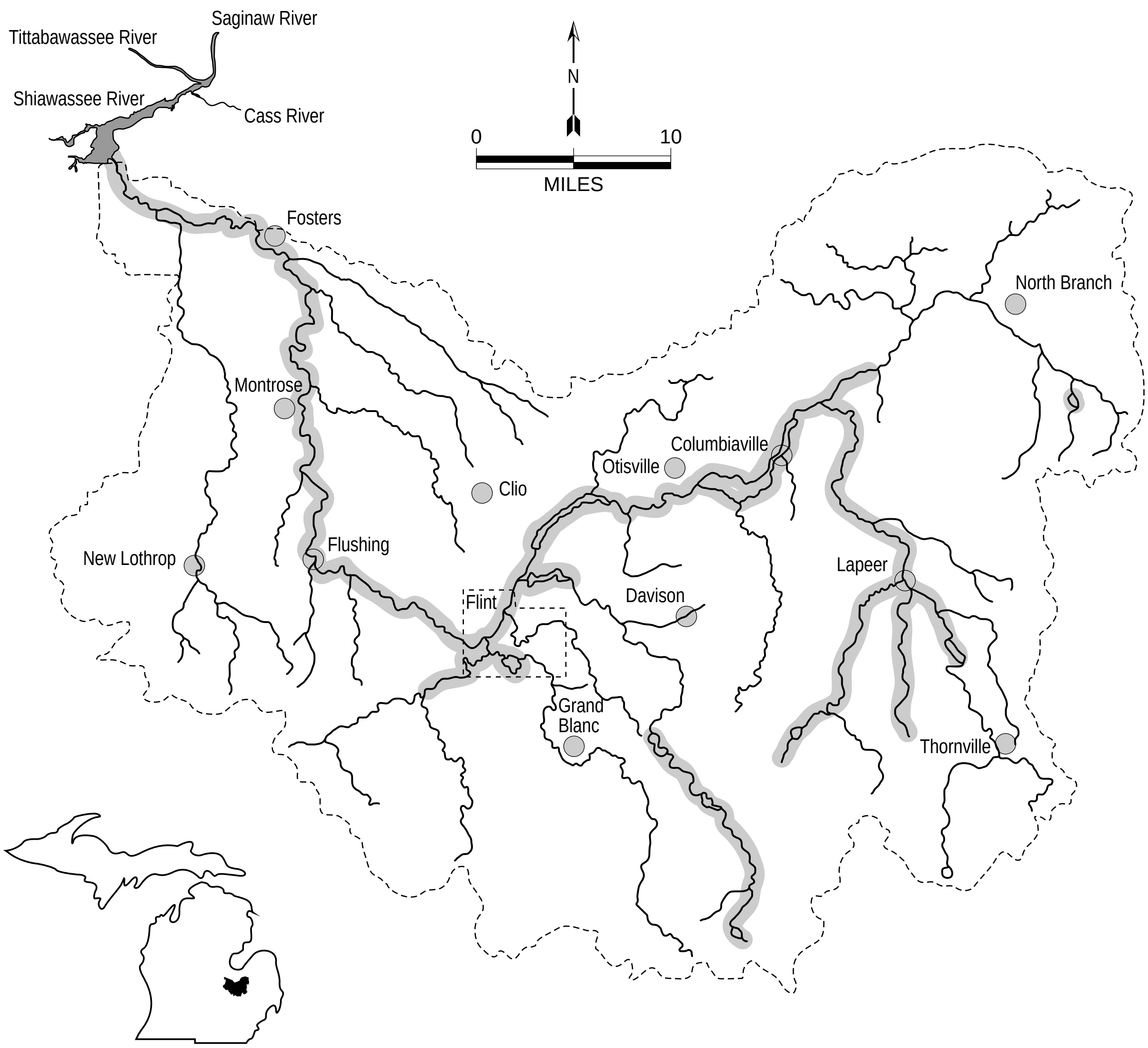
Brown bullhead (*Ameiurus nebulosus*)

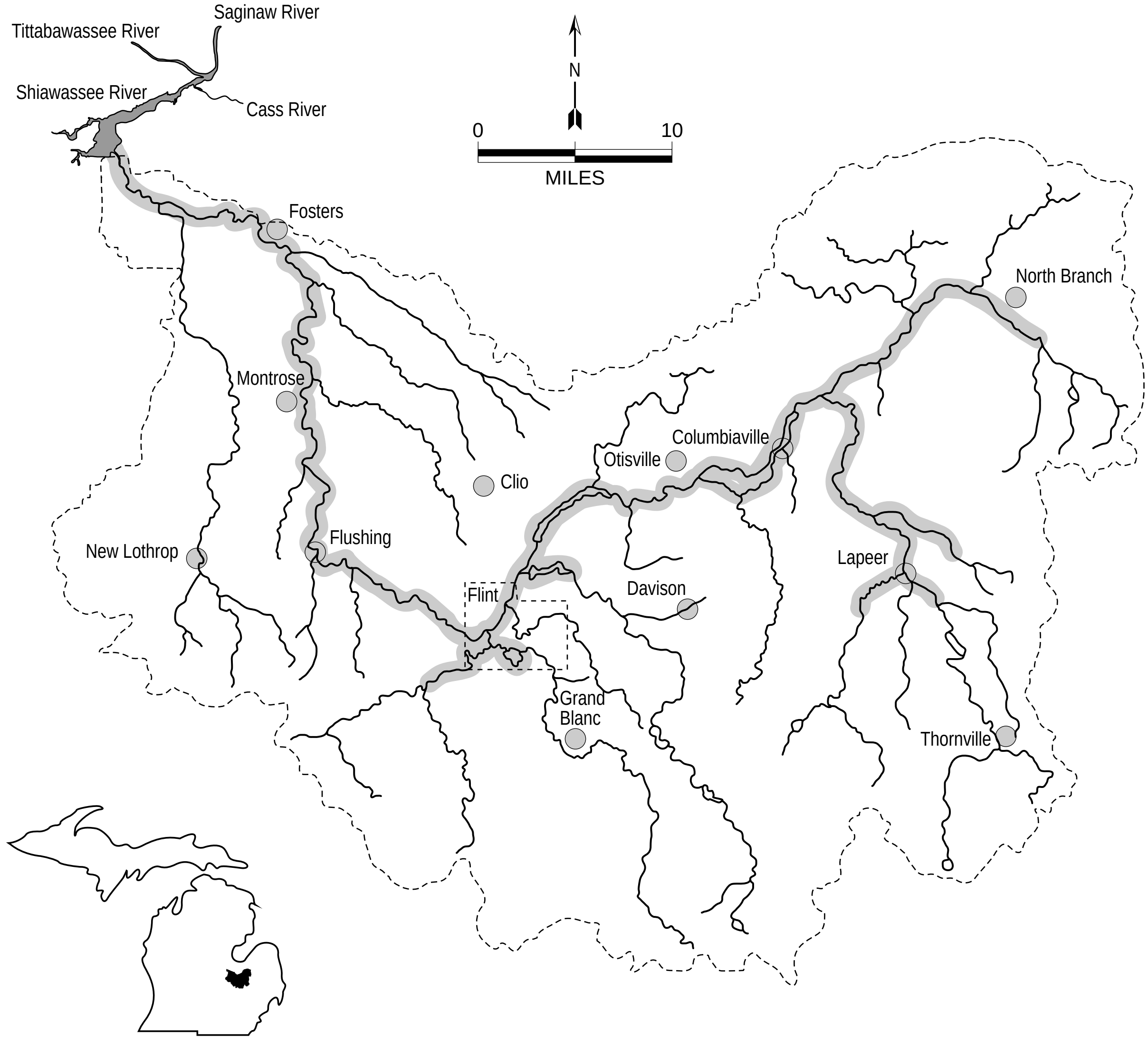
Habitat:

feeding - larger streams and rivers, lakes and impoundments
- clear cool water with little clayey silt
- moderate amounts of aquatic vegetation
- sand, gravel, or muck substrate
- not tolerant of turbid water
- tolerant of warm water and low oxygen

spawning - nest in mud or sand substrate among rooted aquatic vegetation usually near a stump, tree, or rock

winter refuge - in muddy bottoms





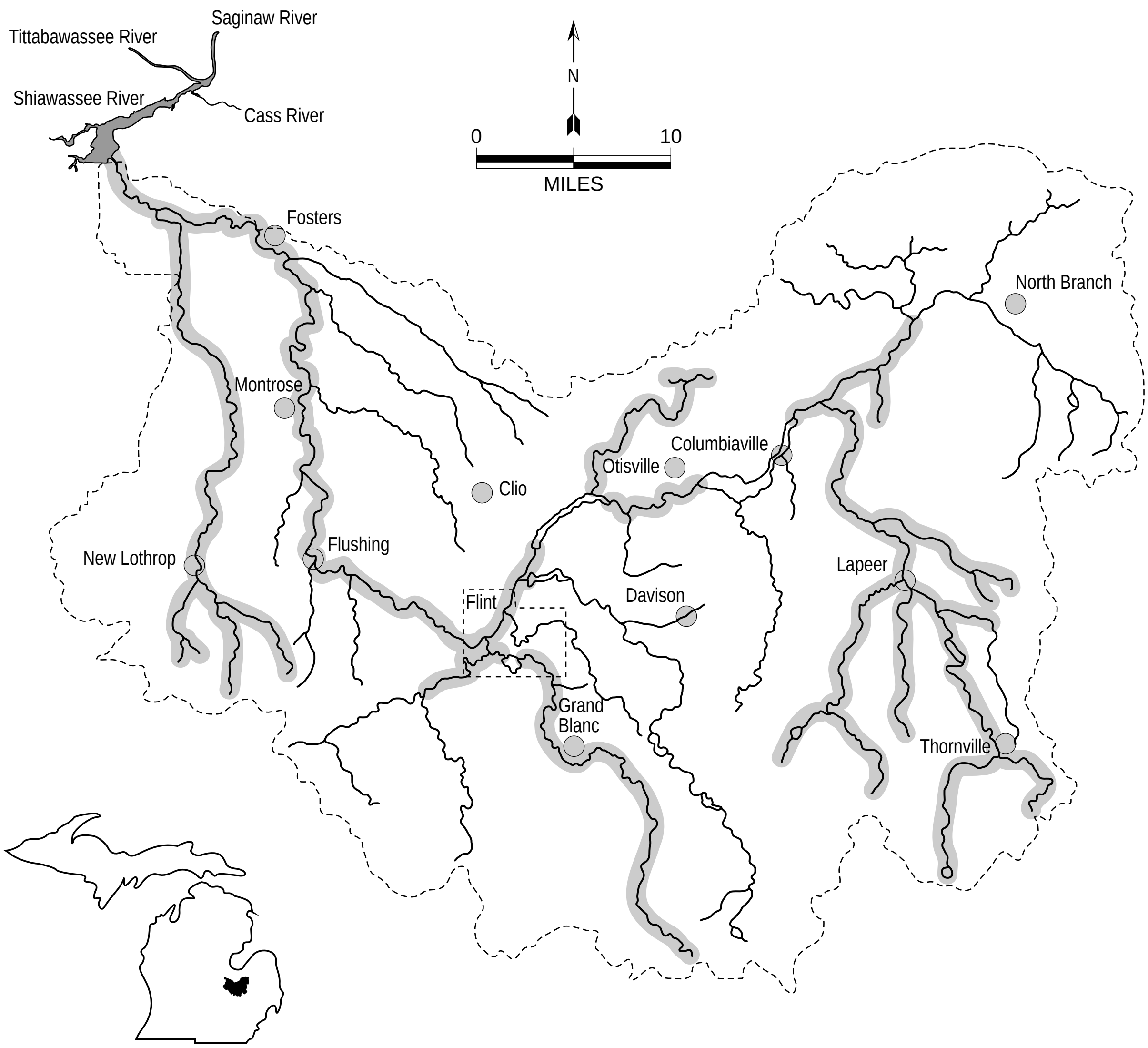
Tittabawassee River
Saginaw River
Shiawassee River
Cass River
N
0
10
MILES
Fosters
North Branch
Montrose
Columbiaville
Otisville
Clio
Flushing
New Lothrop
Lapeer
Davison
Flint
Grand
Blanc
Thornville

Stonecat (*Noturus flavus*)

Habitat:

feeding
- consistent low to moderate gradient flowing water
- rocky riffles of larger streams and smaller rivers
- not tolerant of silt
- tolerant of low oxygen and pollution

spawning
- eggs deposited beneath stones
- shallow rocky areas of streams or lakes

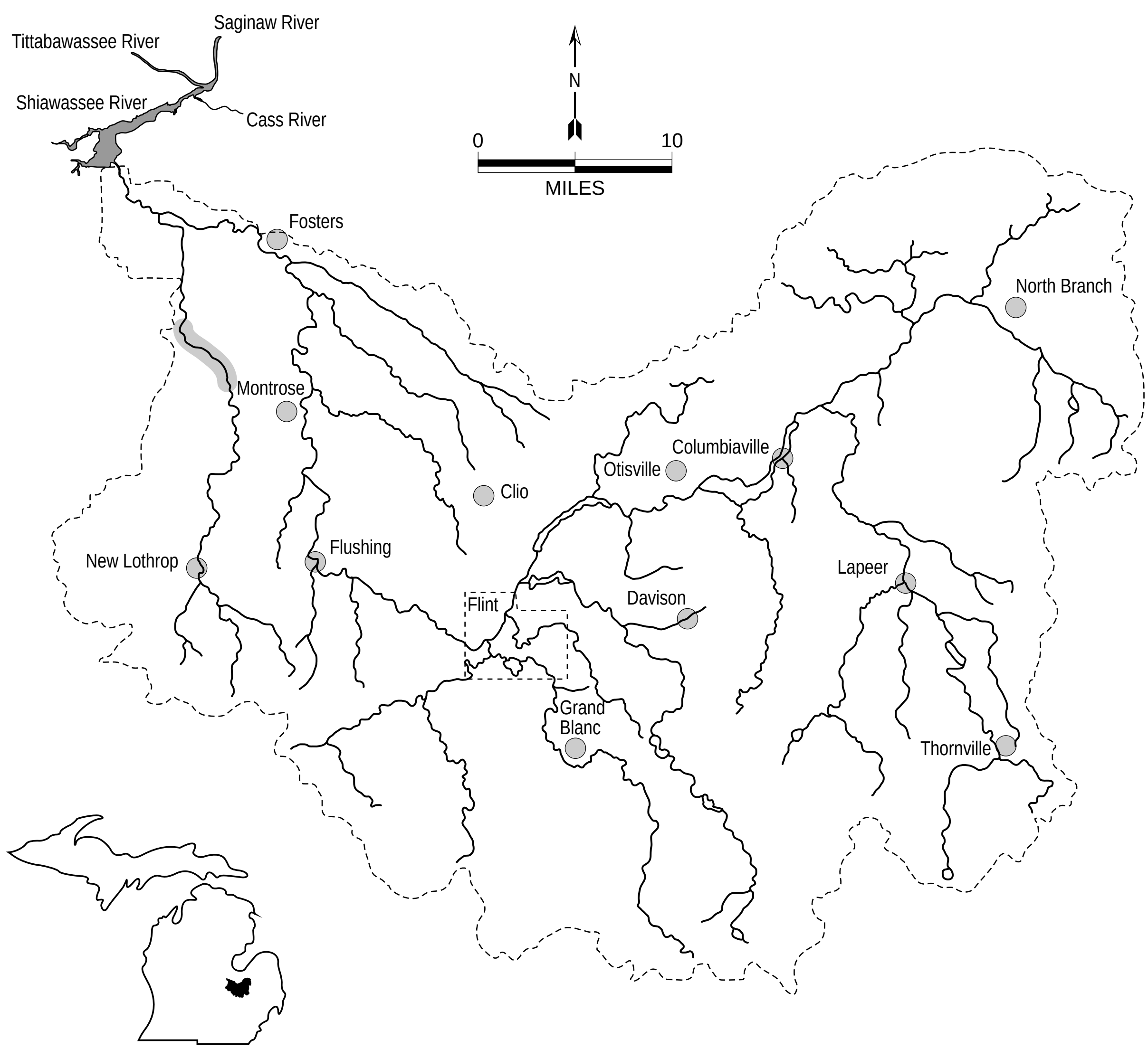


Tadpole madtom (*Noturus gyrinus*)

Habitat:

feeding
- vegetative cover in low-moderate current waters
- muddy substrate with extensive vegetation
- clear waters of streams, rivers, and lakes

spawning
- mostly in rivers, sometimes shallows of lakes
- nests in dark cavities (ex: beneath boards, logs, crayfish burrows)

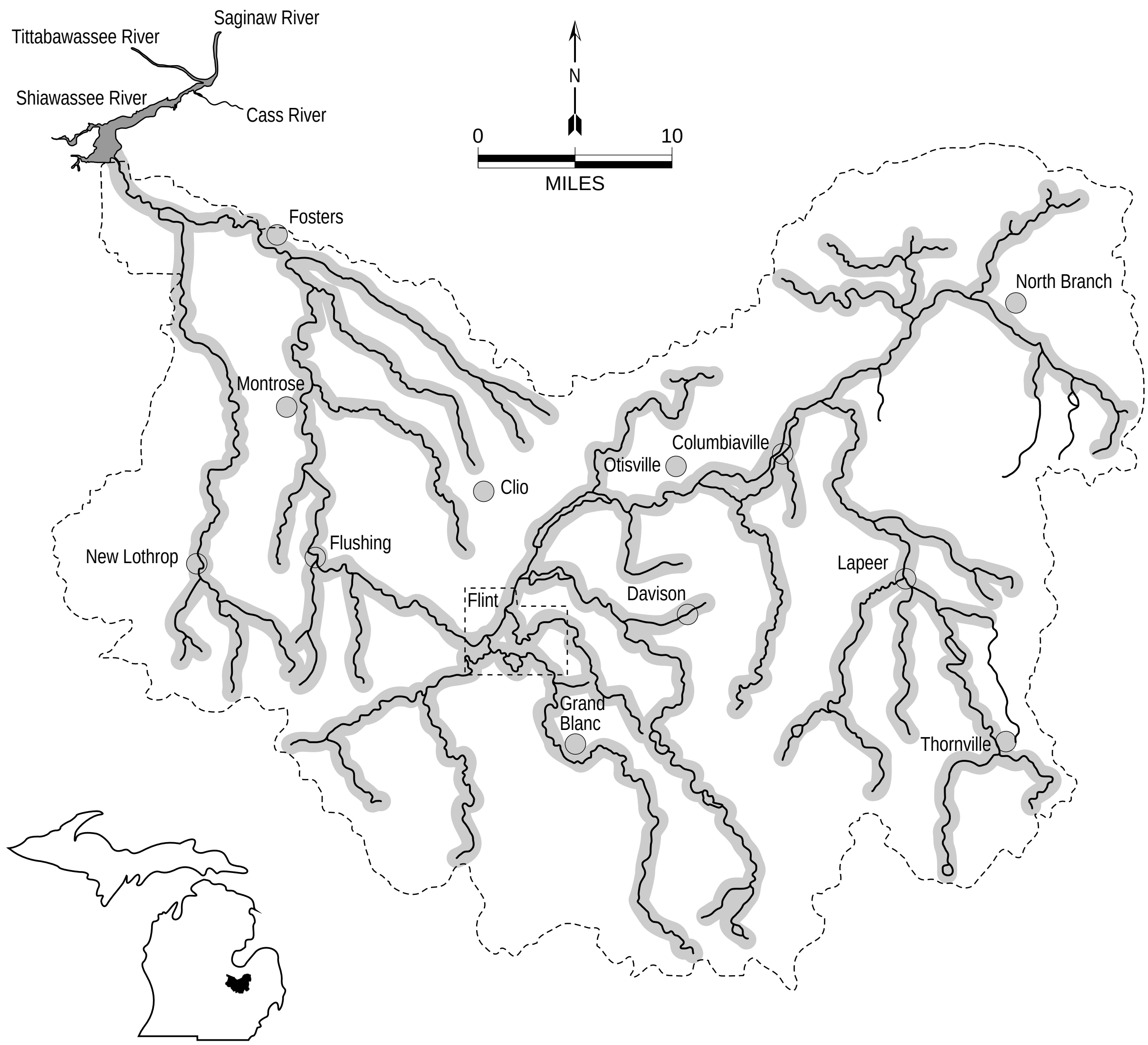


Grass pickerel (*Esox americanus vermiculatus*)

Habitat:

feeding
- juveniles: along shore
- adults: in deeper portions of streams, rivers, lakes, and impoundments
- clear water, little current, dense vegetation
- tolerates low oxygen concentrations

spawning
- broadcast spawner over submerged vegetation

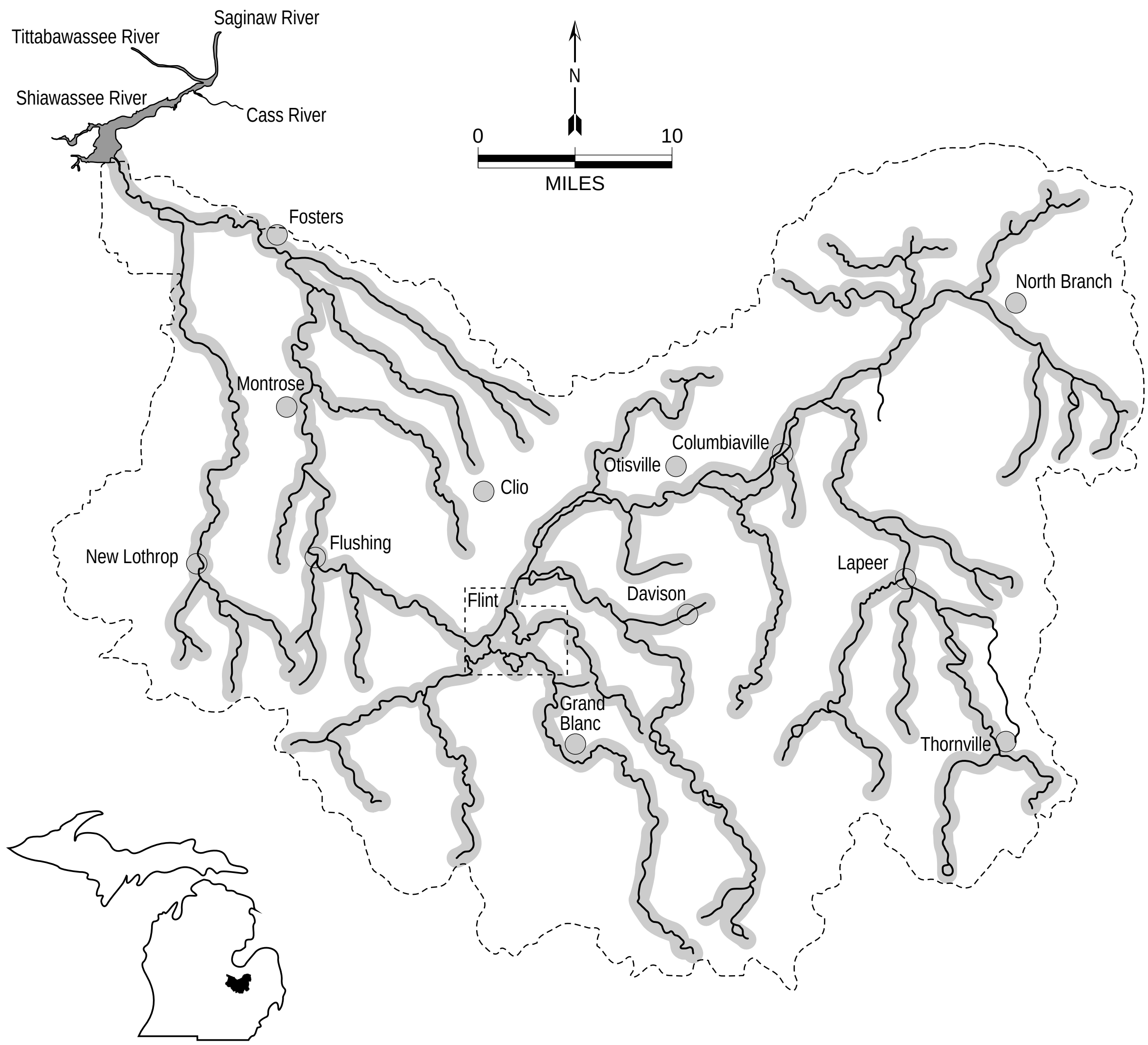


Northern pike (*Esox lucius*)

Habitat:

feeding - cool to moderately warm streams, rivers, lakes, and impoundments
- vegetation in slow to moderate current

spawning - submerged vegetation with slow current in shallow water

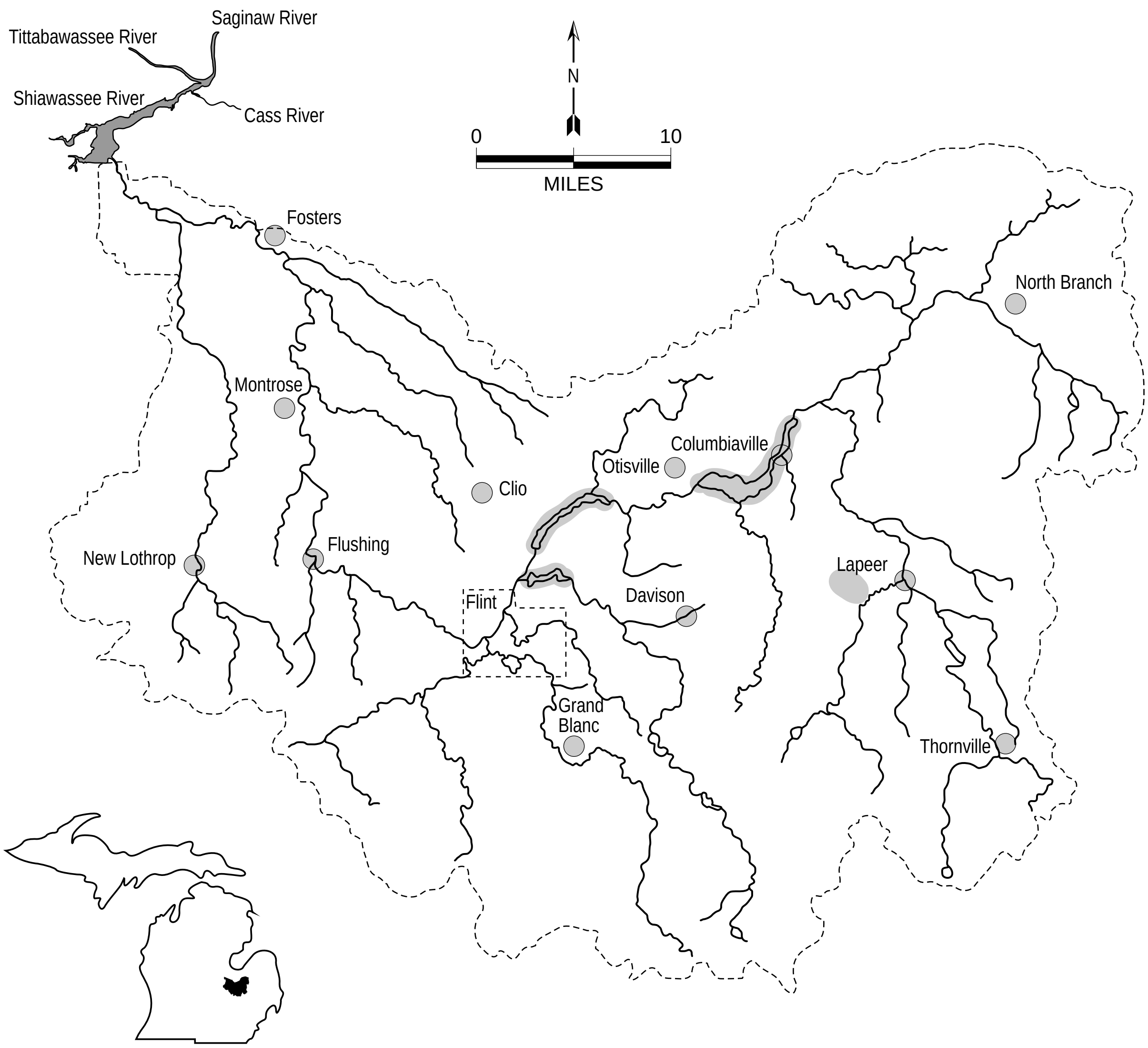


Tiger muskellunge (*Esox masquinongy x E. lucius*)

Habitat:

feeding - intermediate between muskellunge and northern pike

spawning - hybrid species; muskellunge x northern pike
- occasionally produced in wild, but most often from hatcheries
- males are sterile, females may be fertile

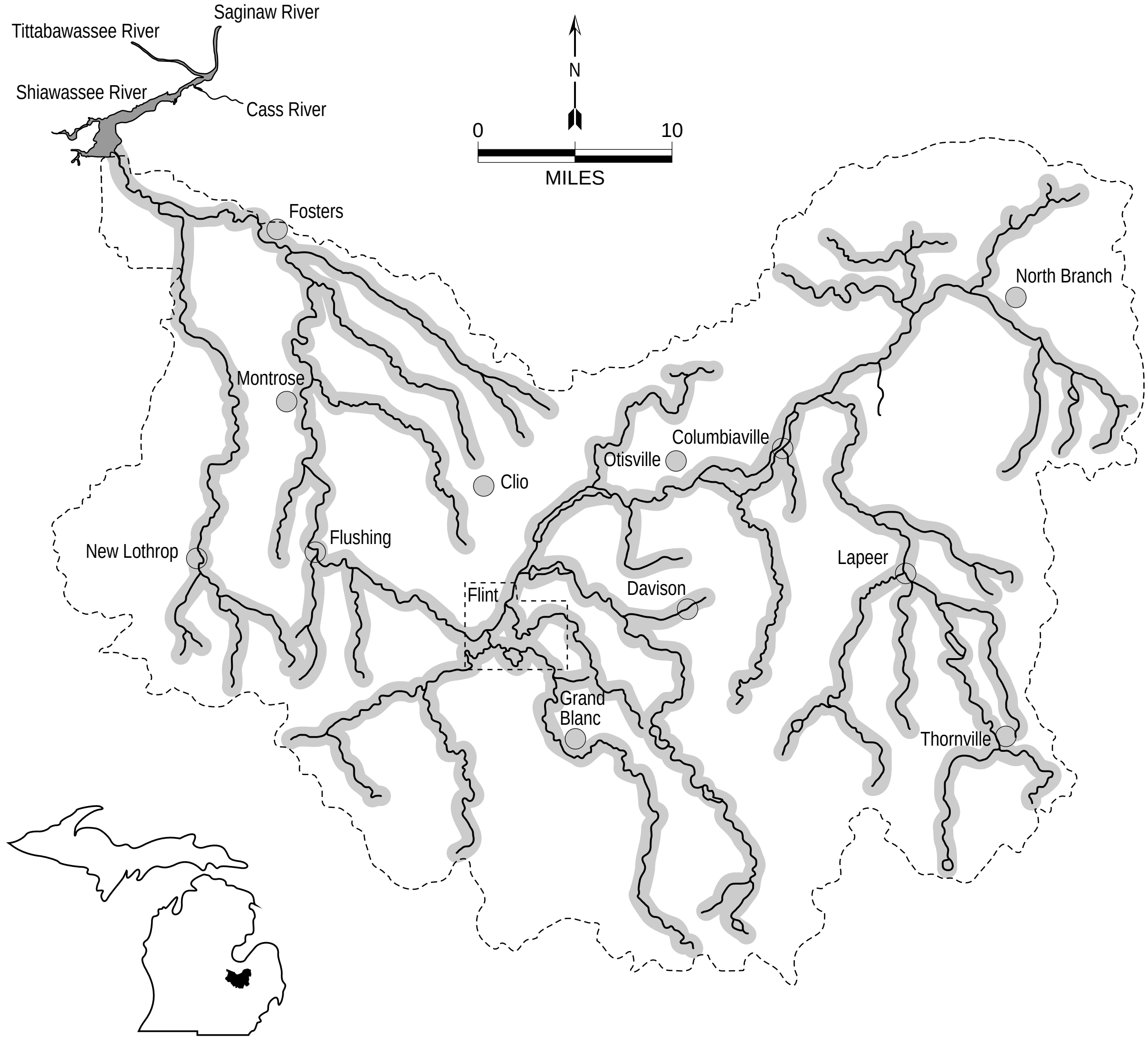


Central mudminnow (*Umbra limi*)

Habitat:

feeding - undisturbed clear, low-gradient streams or rivers and lakes and impoundments
- organic debris, muck, or peat substrates
- aquatic vegetation

spawning - floodplain areas, on vegetation

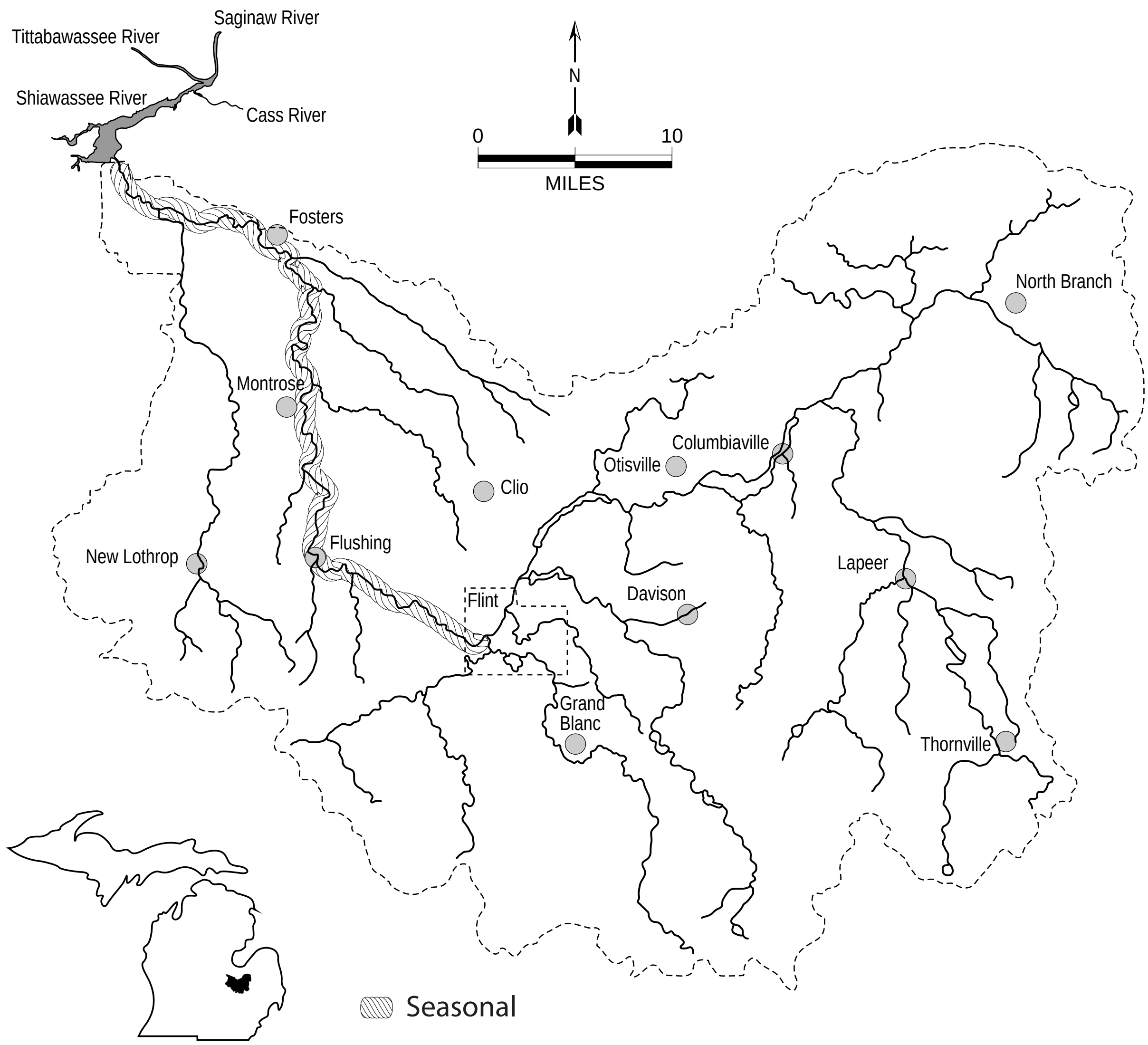


Coho salmon (*Oncorhynchus kisutch*)

Habitat:

feeding - adults: Lake Huron
- young: shallow gravel substrate in cold streams, later into pools

spawning - cold streams and rivers
- swifter water of shallow gravelly substrate

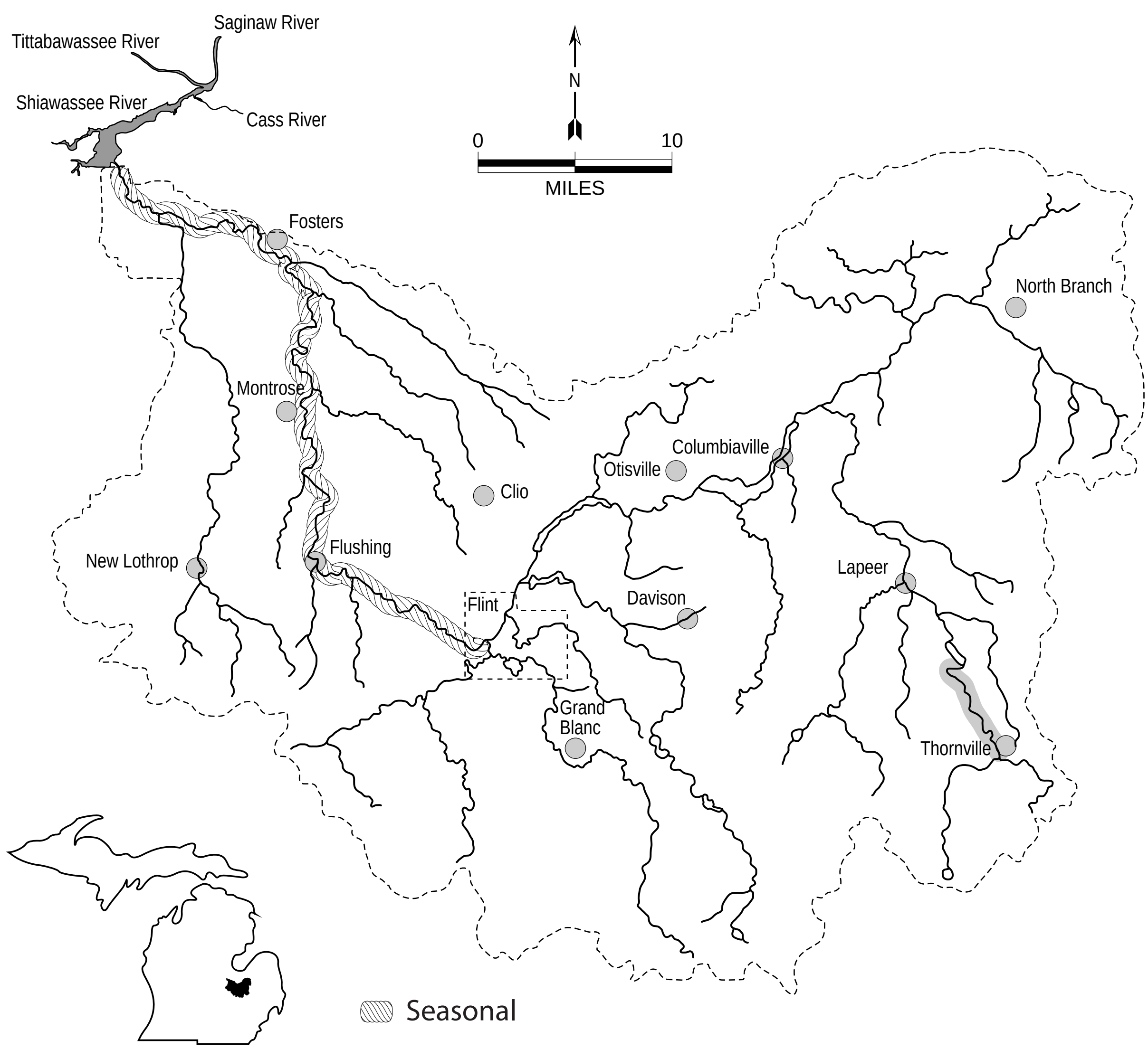


Rainbow trout (*Oncorhynchus mykiss*)

Habitat:

feeding - cold clear water of rivers and Lake Huron
- moderate current

spawning - gravelly riffles above a pool
- smaller tributaries

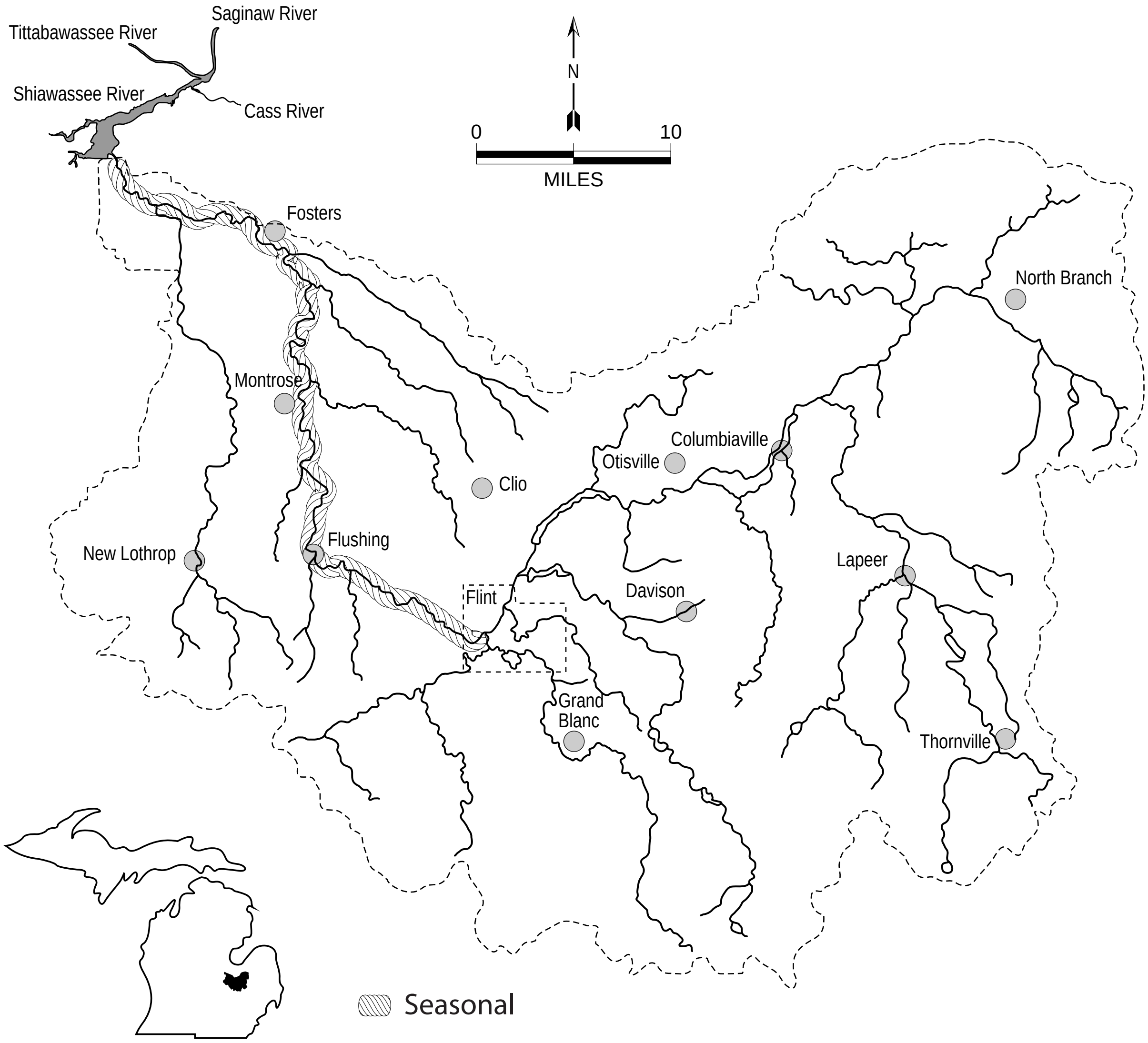


Chinook salmon (*Oncorhynchus tshawyscha*)

Habitat:

feeding - adults: Lake Huron
- young: shallow gravel substrate in cool streams, later into pools

spawning - gravelly substrate in cool streams

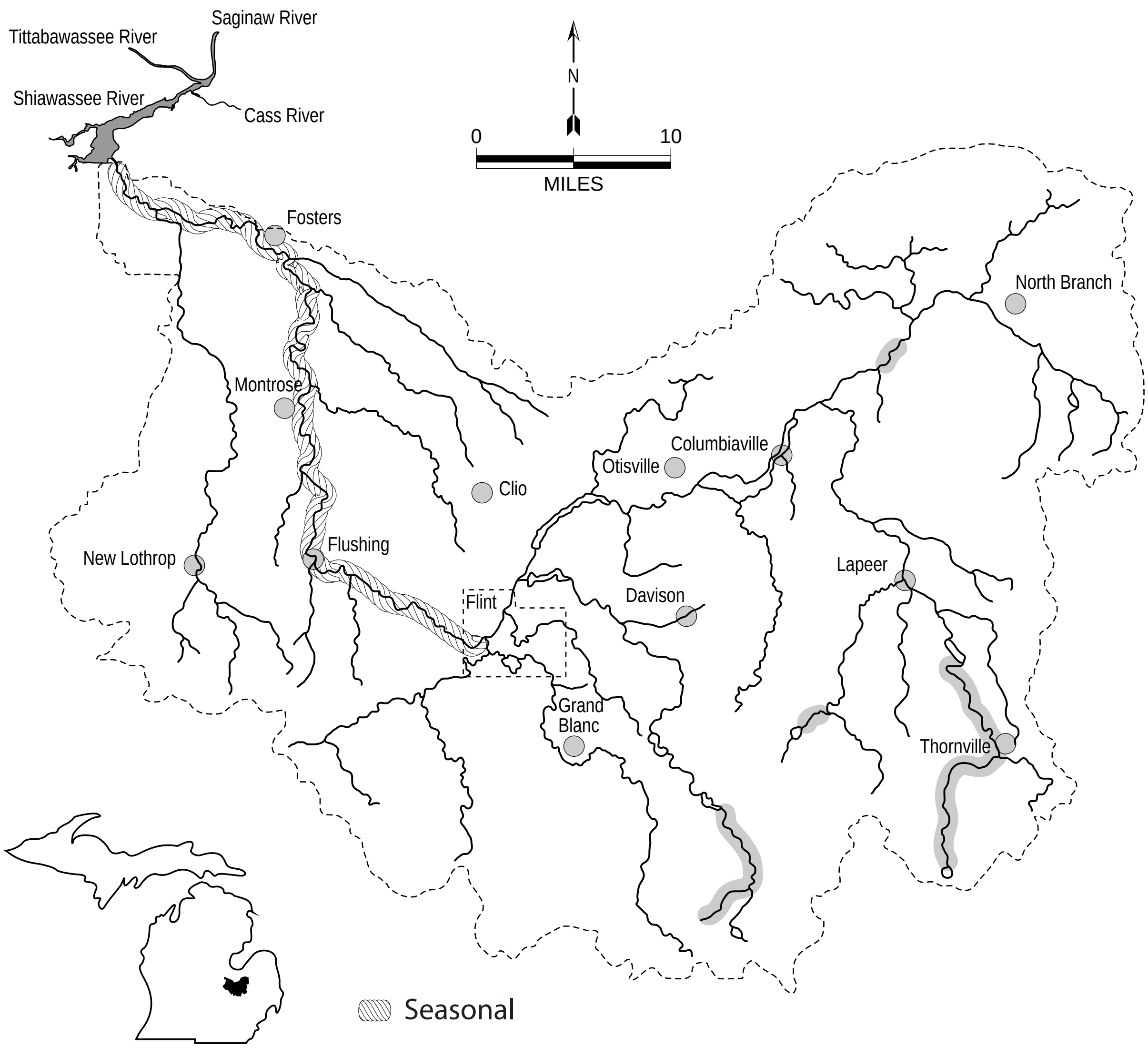


Brown trout (*Salmo trutta*)

Habitat:

feeding
- cold, clear streams, rivers, and lakes (not >70°F)
- medium to swift current in streams
- does not tolerate silt well
- prefers few individuals and species around
- abundance of aquatic and land insects

spawning
- gravelly riffles; shallow headwater areas

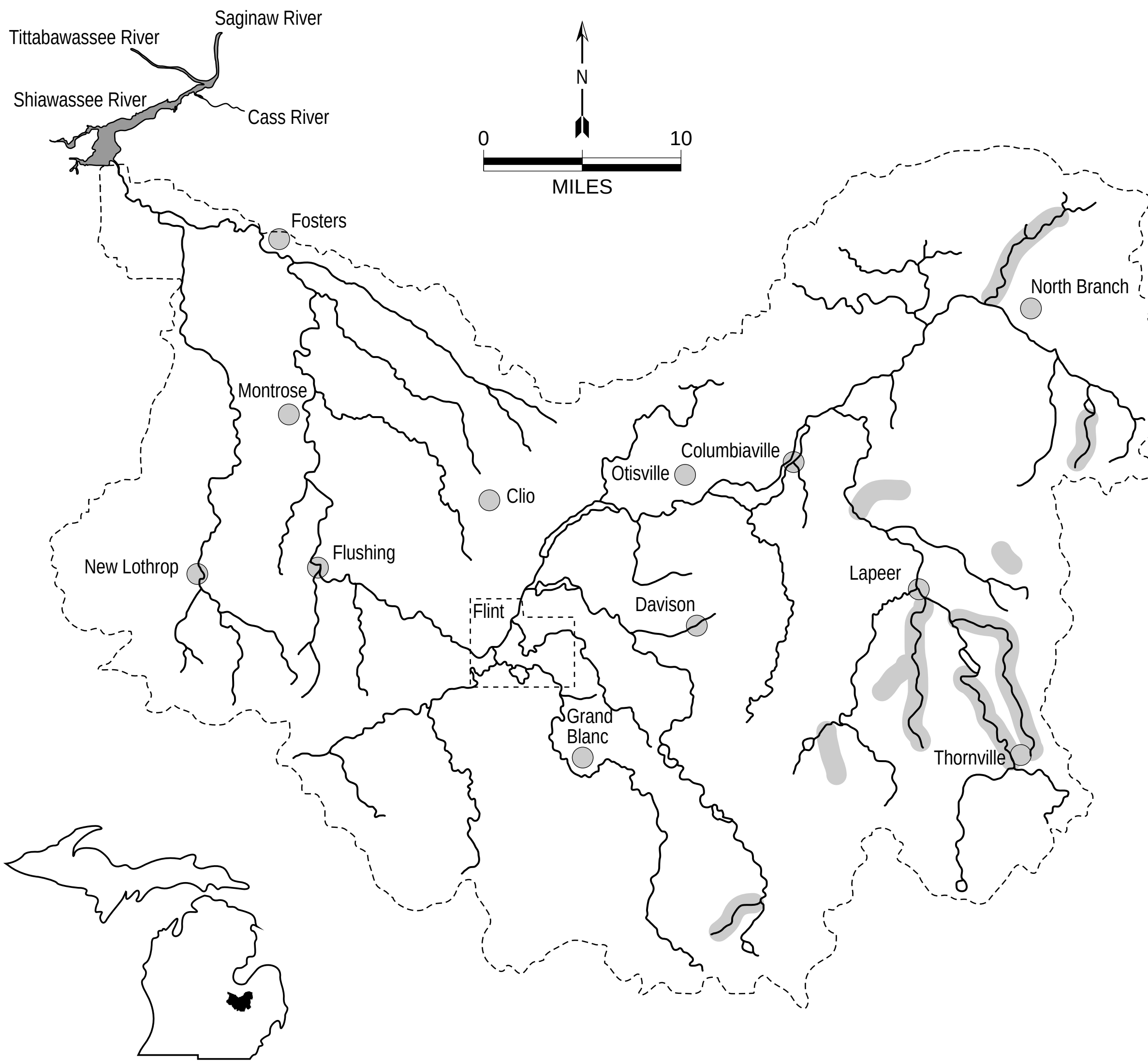


Brook trout (*Salvelinus fontinalis*)

Habitat:

feeding - cold, clear streams, rivers, and lakes (not >65°F)
- low current
- well oxygenated water

spawning - gravelly riffles; shallow or headwater streams

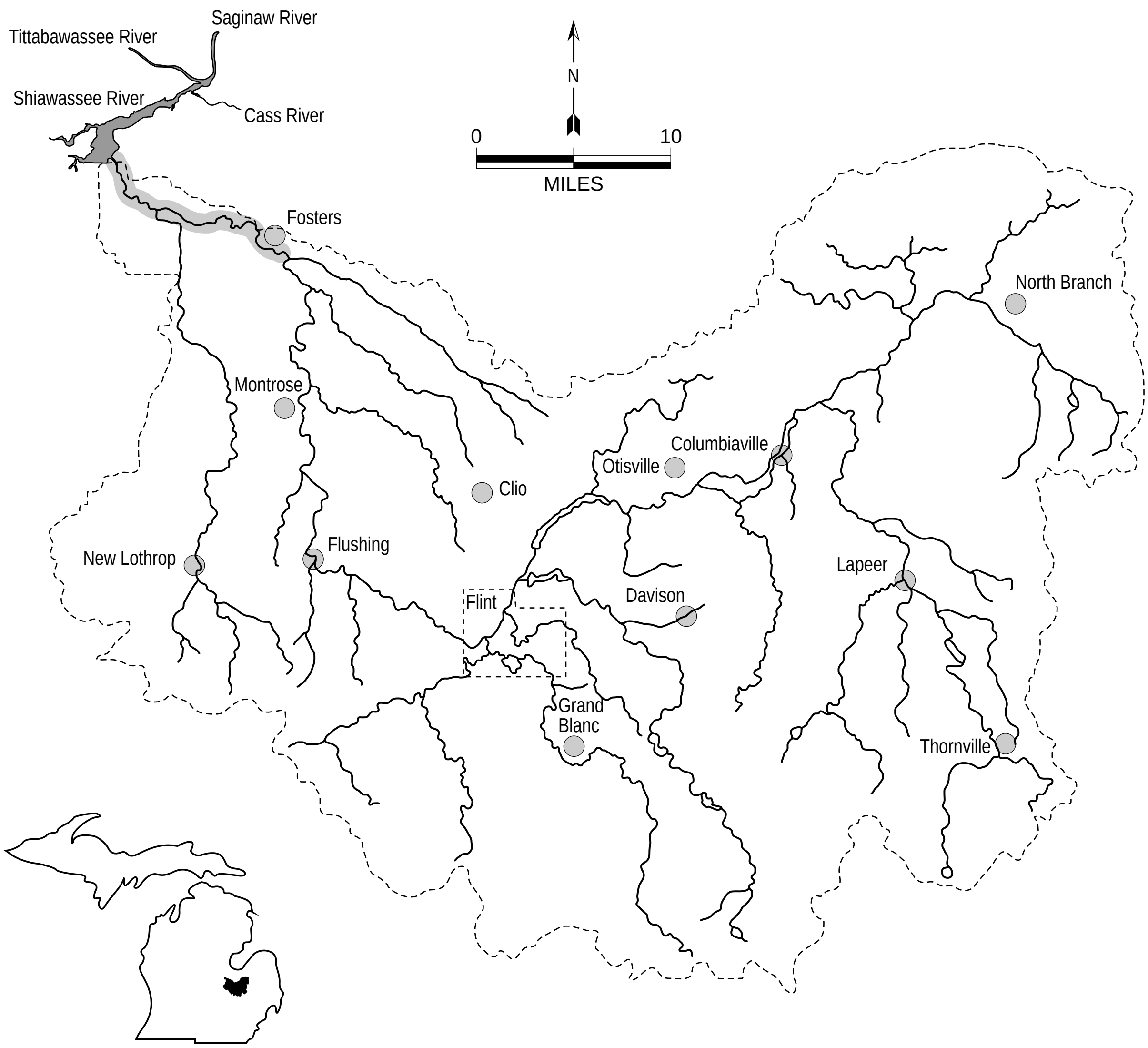


Trout-perch (*Percopsis omiscomaycus*)

Habitat:

feeding
- clean sand or fine gravel substrate
- long deep pools in low gradient streams and Lake Huron
- highly intolerant of clayey silts
- avoids rooted aquatic vegetation

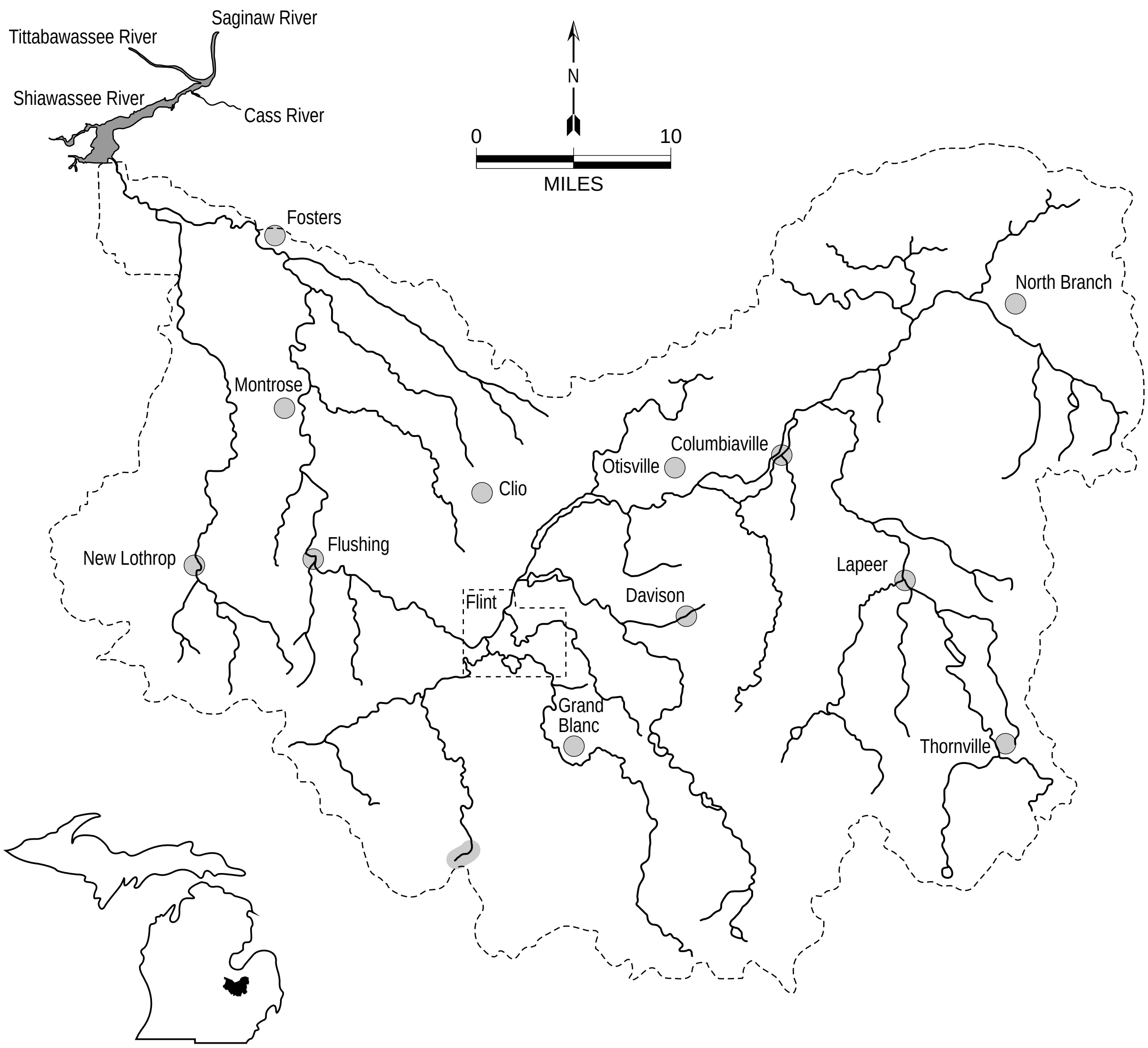
spawning
- over rocks in shallows
- over sand and gravel substrates in Lake Huron



Pirate perch (*Aphredoderus sayanus*)

Habitat:

feeding
- oxbows, overflow ponds, marshes, estuaries, pools
- medium to large rivers
- low gradient, less than 3ft/mi
- sand or muck substrates covered with organic debris
- pools bordered by emergent aquatic vegetation
- clear, warm, quiet water

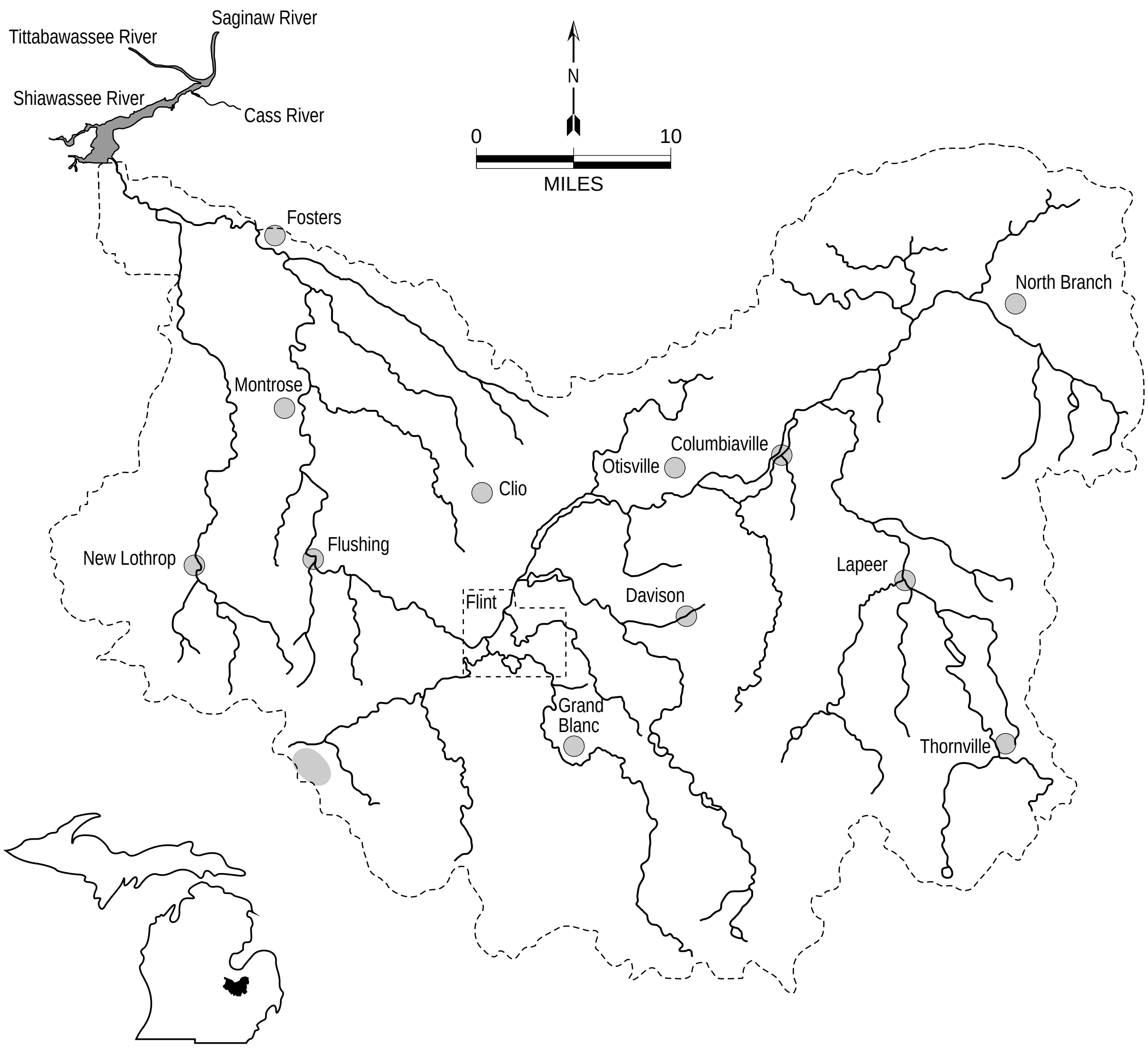


Banded killifish (*Fundulus diaphanus*)

Habitat:

feeding - quiet backwaters at the mouths of streams and lakes
- substrate of sand, gravel, and a few boulders
- also found over detritus substrate where patches of submerged aquatic vegetation are present

spawning - quiet areas of weedy pools

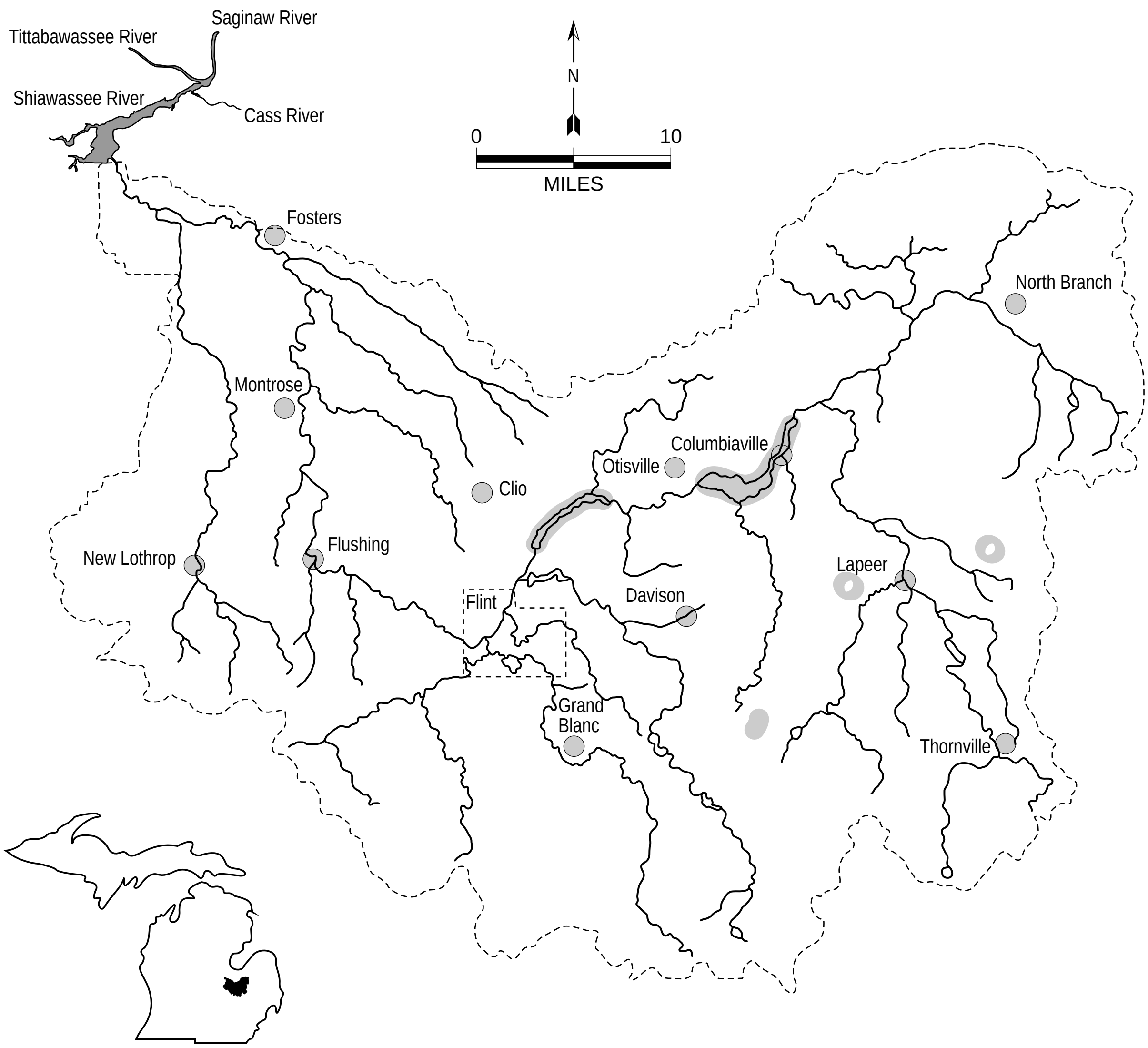


Brook silverside (Labidesthes sicculus)

Habitat:

feeding - clear, warm pools in streams and rivers; also lakes
- does not tolerate turbidity
- most frequently at surface

spawning - in and around aquatic vegetation or over gravel substrate with a moderate current

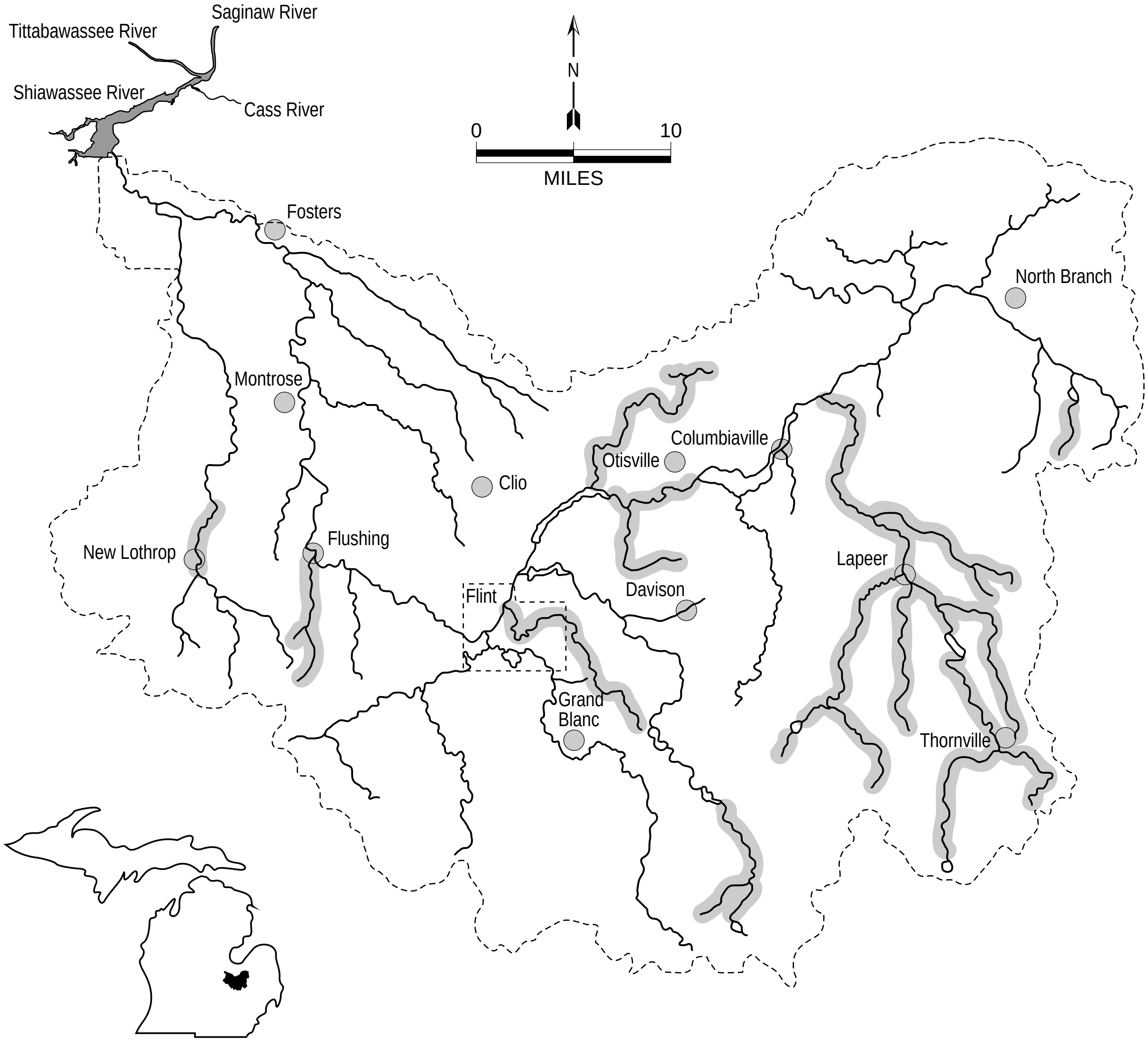


Brook stickleback (*Cluaea inconstans*)

Habitat:

feeding
- clear, cold, densely vegetated streams, and swampy margins of lakes
- low gradient
- muck, peat, or marl substrate
- not tolerant of turbidity

spawning
- shallow cool (<66°F) water
- aquatic reeds or grasses necessary

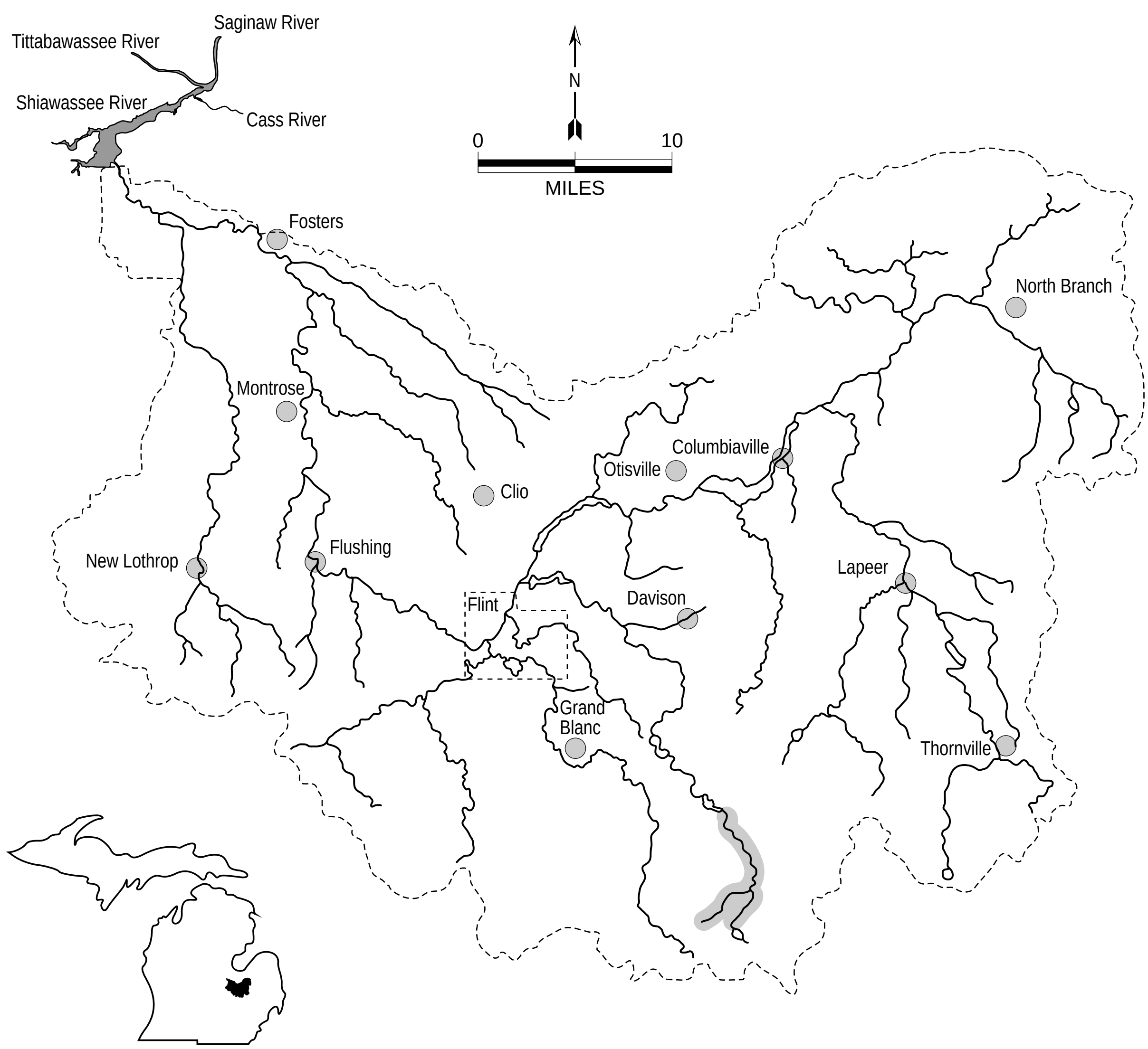


Mottled sculpin (*Cottus bairdi*)

Habitat:

feeding - cool to cold streams
- riffle and rock substrates preferred
- clear to slightly turbid shallow water

spawning - nests under logs or rock

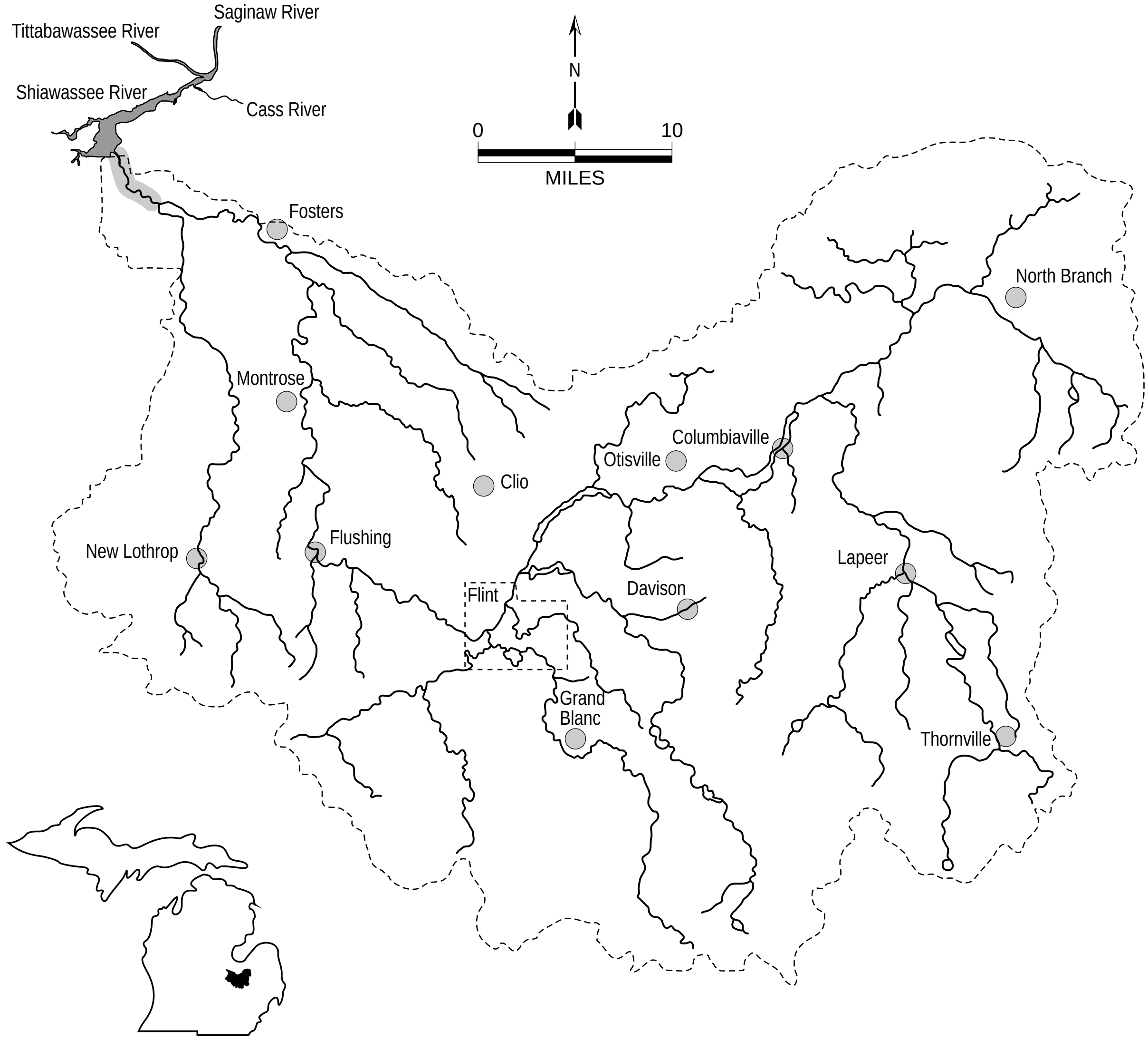


White perch (*Morone americana*)

Habitat:

feeding - clear, warm water of low-gradient streams, lakes, impoundments, and Lake Huron

spawning - shallow water over firm substrate

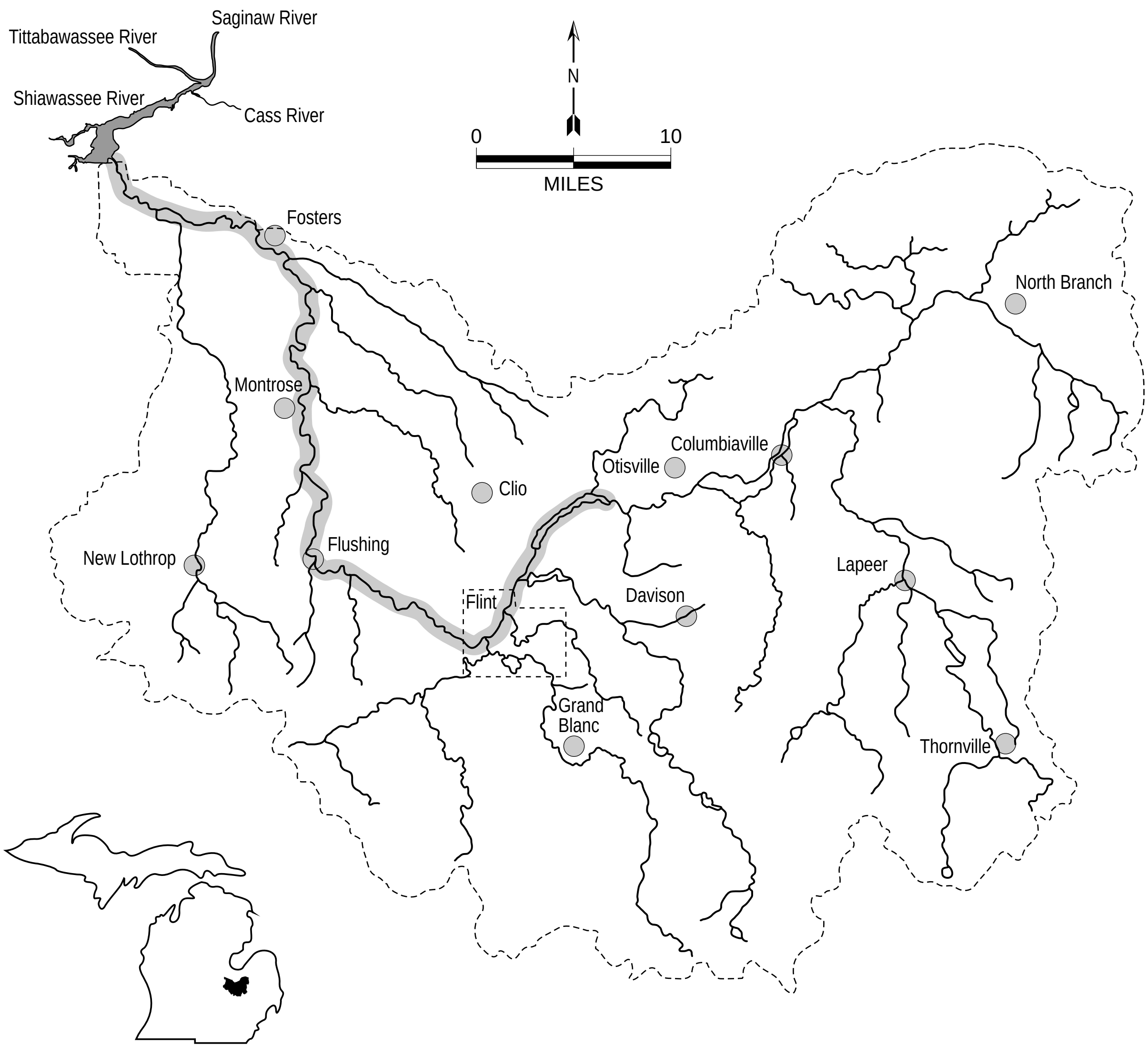


White bass (*Morone chrysops*)

Habitat:

feeding - large lakes, impoundments, and Lake Huron
- clear water of 30 feet or less depth
- firm substrate

spawning - tributary streams or



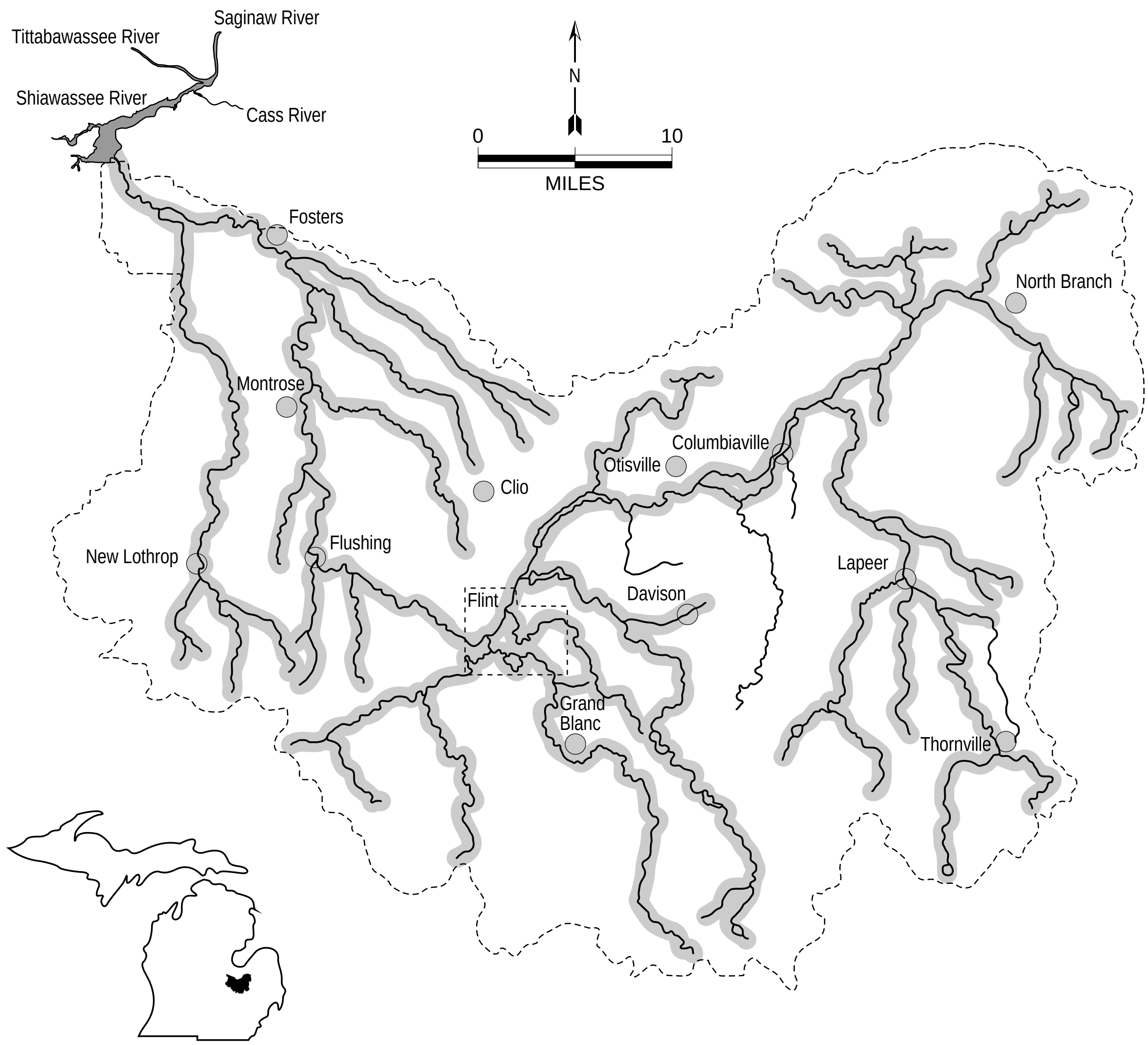
Rock bass (*Ambloplites rupestris*)

Habitat:

feeding - clear, cool streams, rivers, and lakes
- rocky to sand substrate
- woody or vegetative cover

spawning - sand or gravel nests
- shallow water

winter refuge - deep water

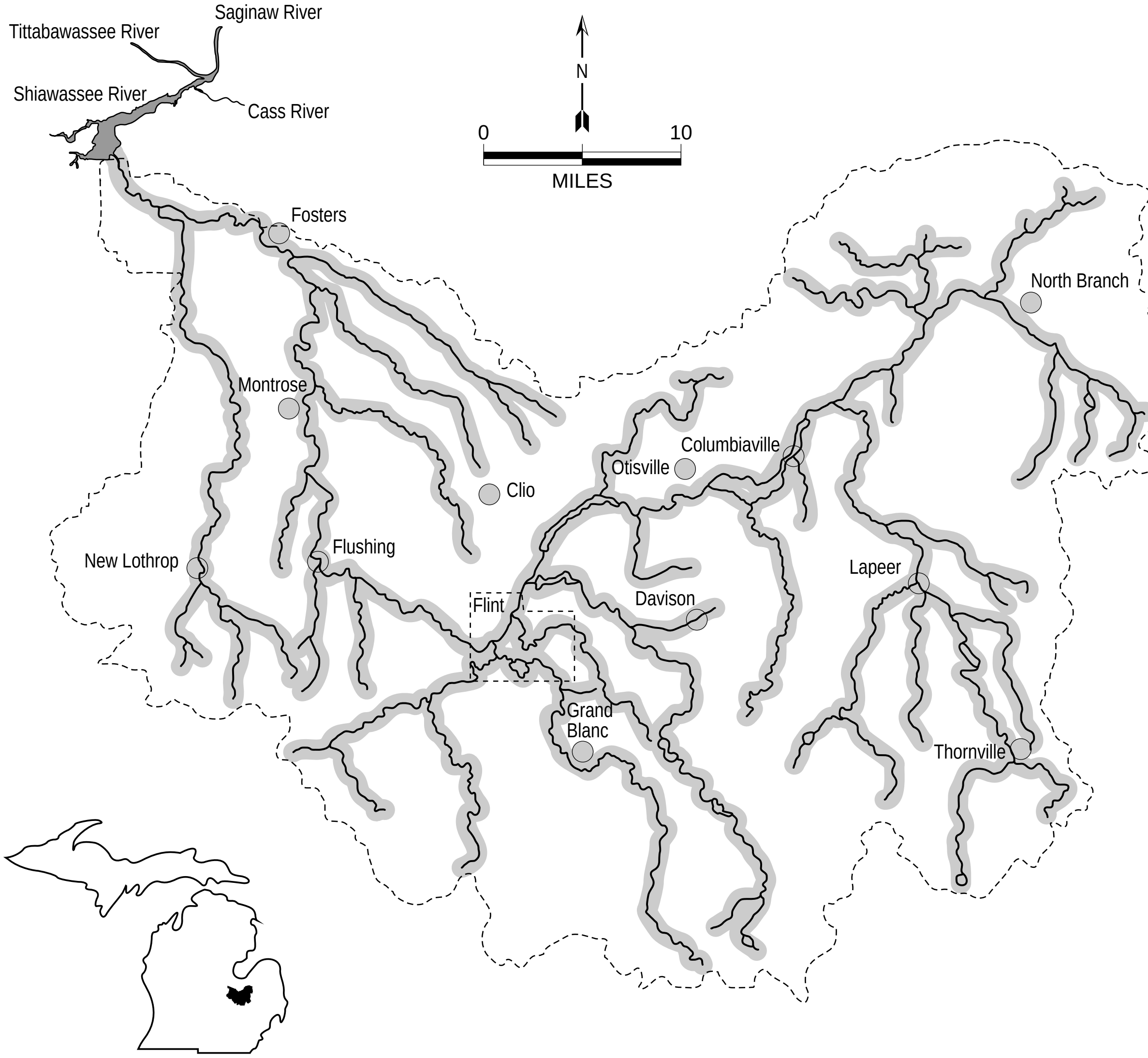


Green sunfish (*Lepomis cyanellus*)

Habitat:

feeding - impoundments and lakes, and low-current streams and rivers
- no substrate preference

spawning - nests in shallow areas sheltered by rocks, logs, or aquatic vegetation

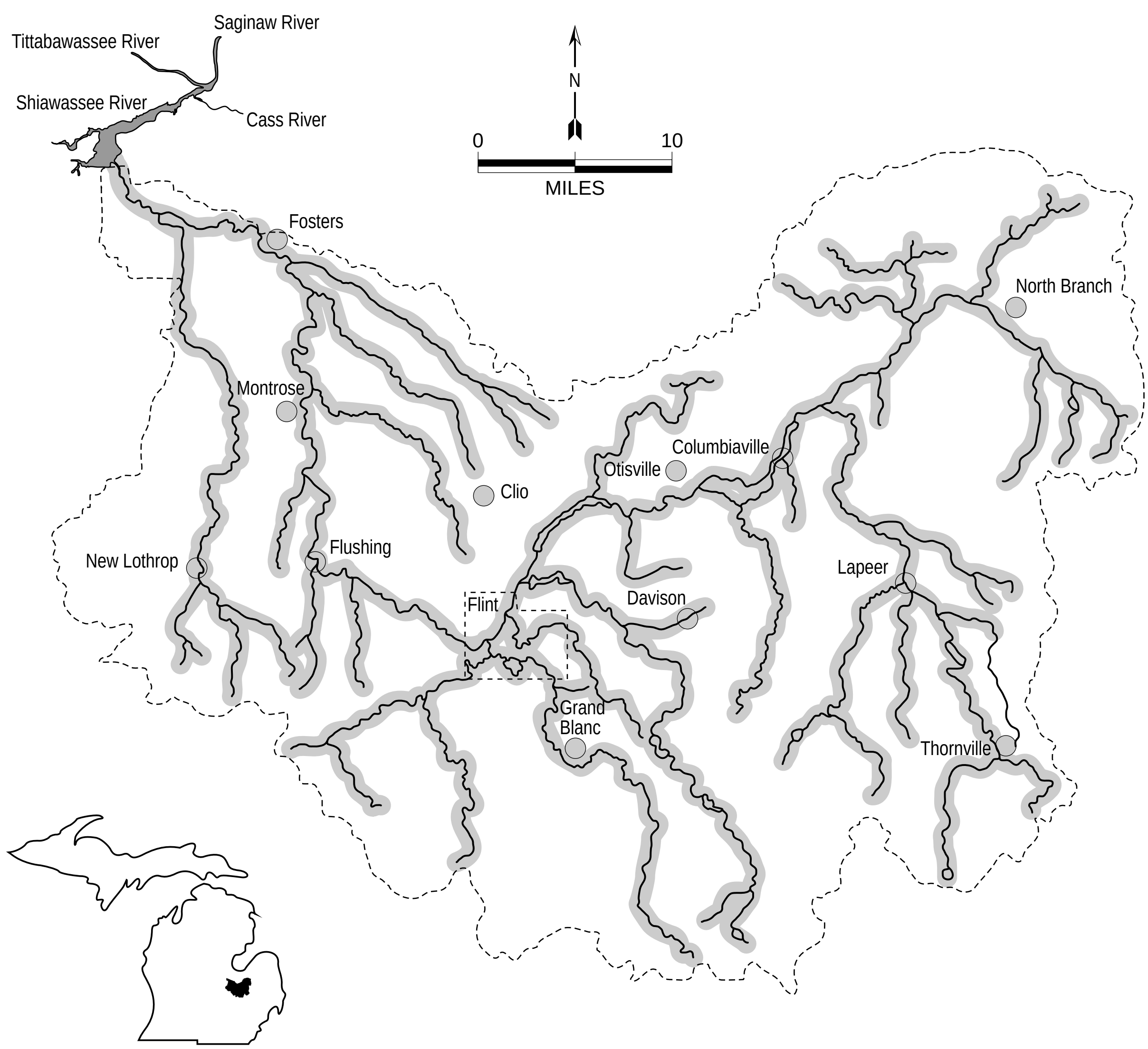


Pumpkinseed sunfish (*Lepomis gibbosus*)

Habitat:

feeding
- non-flowing clear water in streams and rivers; also lakes and impoundments
- muck or sand partly covered with organic debris substrate
- dense beds of submerged aquatic vegetation

spawning
- nest in sand, gravel, or rock substrate
- in shallow water near submerged vegetation

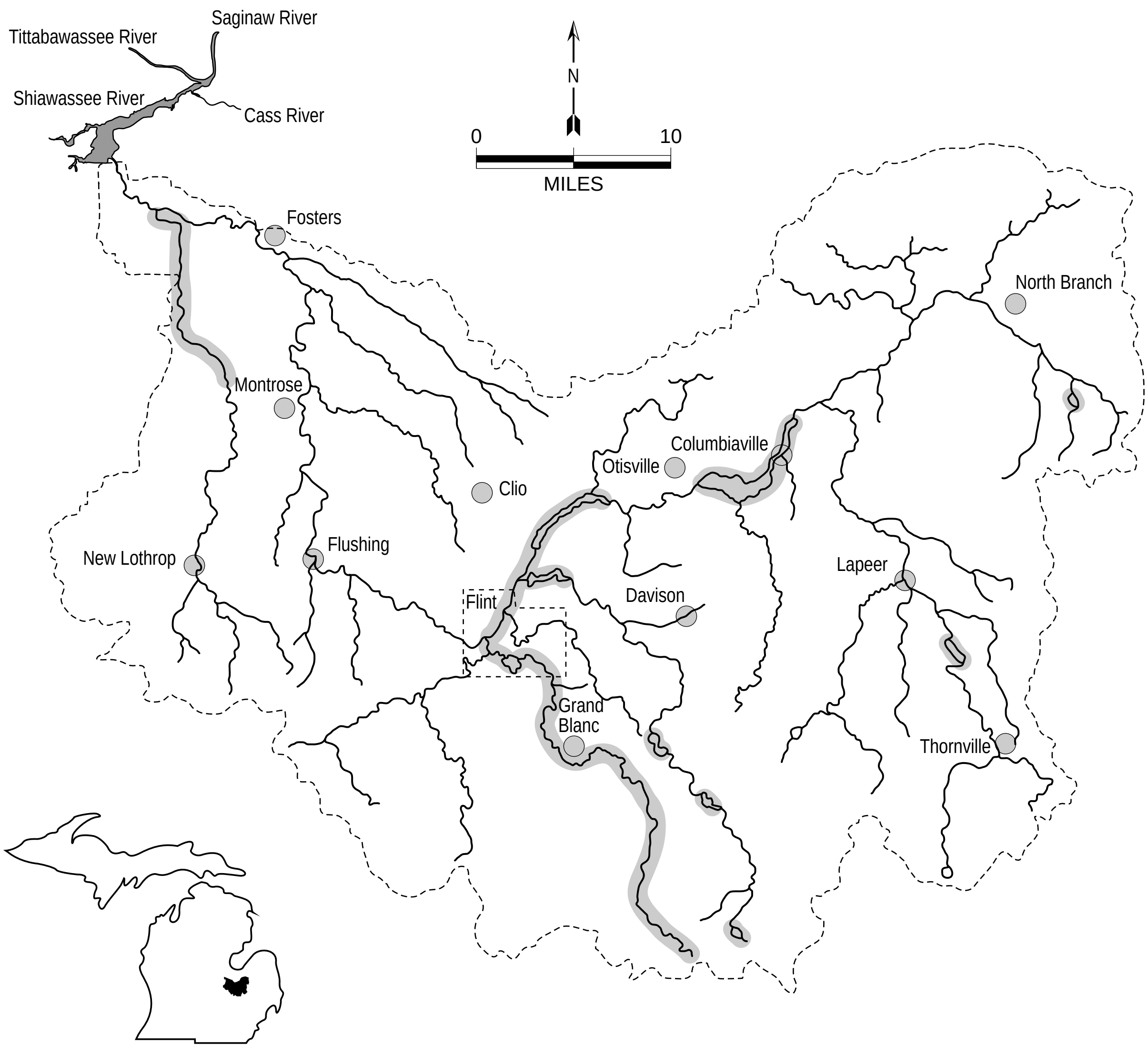


Warmouth (*Lepomis gulosus*)

Habitat:

feeding
- clear lakes and impoundments and very low-gradient streams
- abundant aquatic vegetation
- silt-free water
- mucky substrate often covered with organic debris

spawning
- nesting sites in loose silt, sand with silt, or rubble over silt near stumps, roots, or vegetation



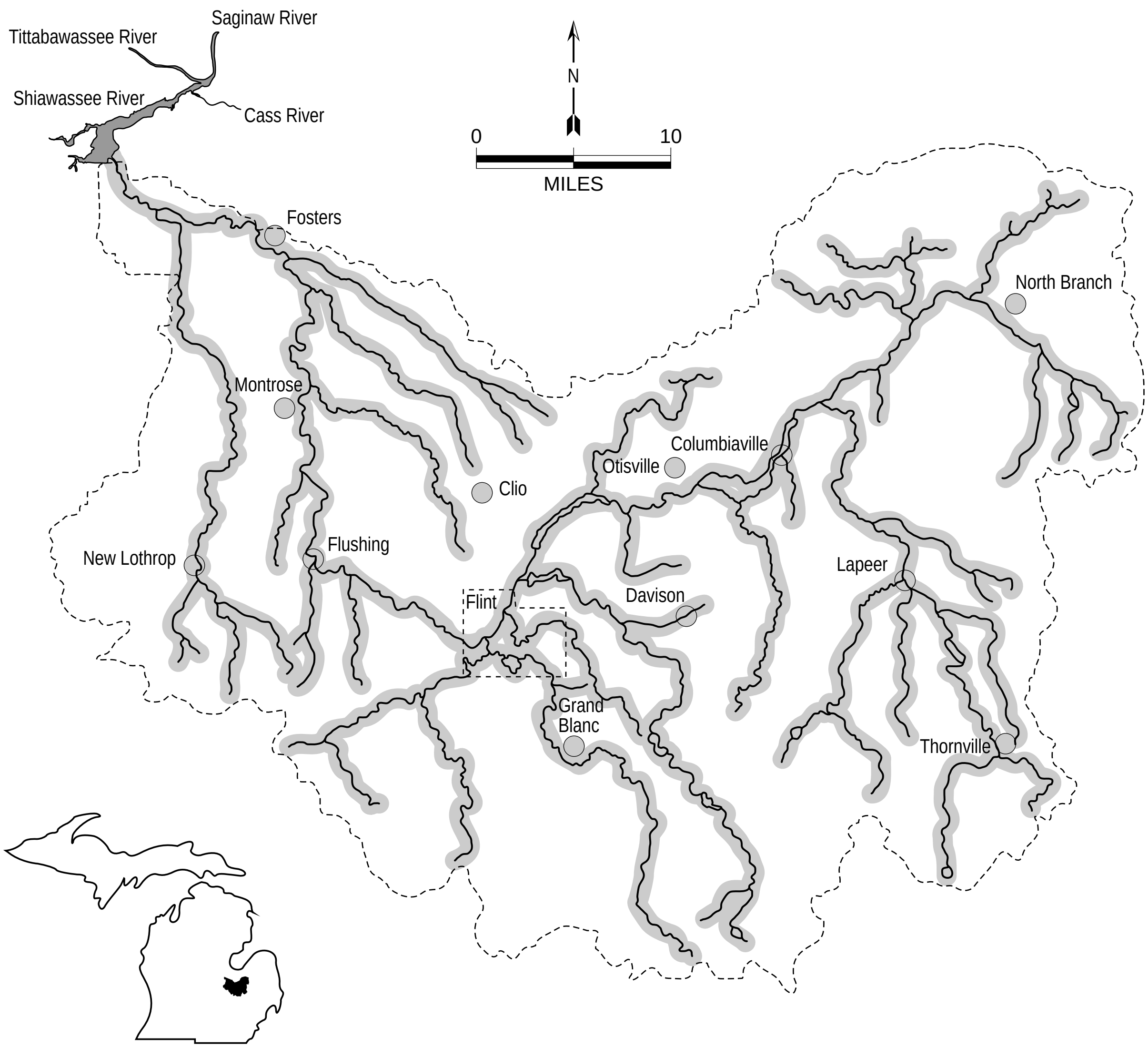
Bluegill (*Lepomis macochrius*)

Habitat:

feeding
- non-flowing clear streams and rivers; also lakes and impoundments
- sand, gravel, or muck containing organic debris substrate
- scattered beds of aquatic vegetation
- cannot tolerate low oxygen or continuous high turbidity and siltation

spawning
- nests in firm substrate of gravel, sand, or mud

winter refuge
- deep water

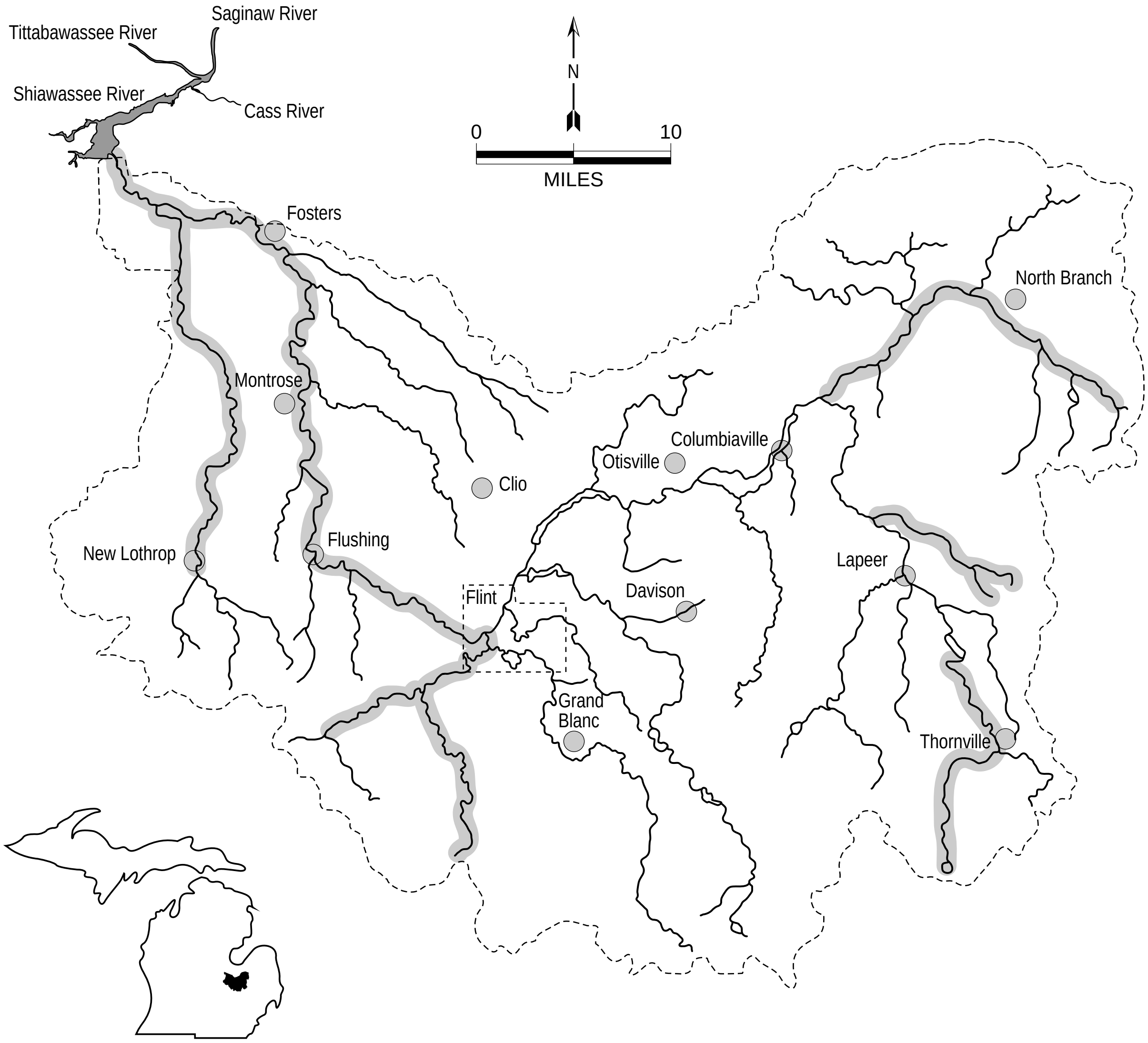


Longear sunfish (*Lepomis megalotis*)

Habitat:

feeding - clear moderate-sized shallow streams with moderate vegetation
- rocky substrates
- little to no current

spawning - nests in gravel, sand, or hard rock substrate

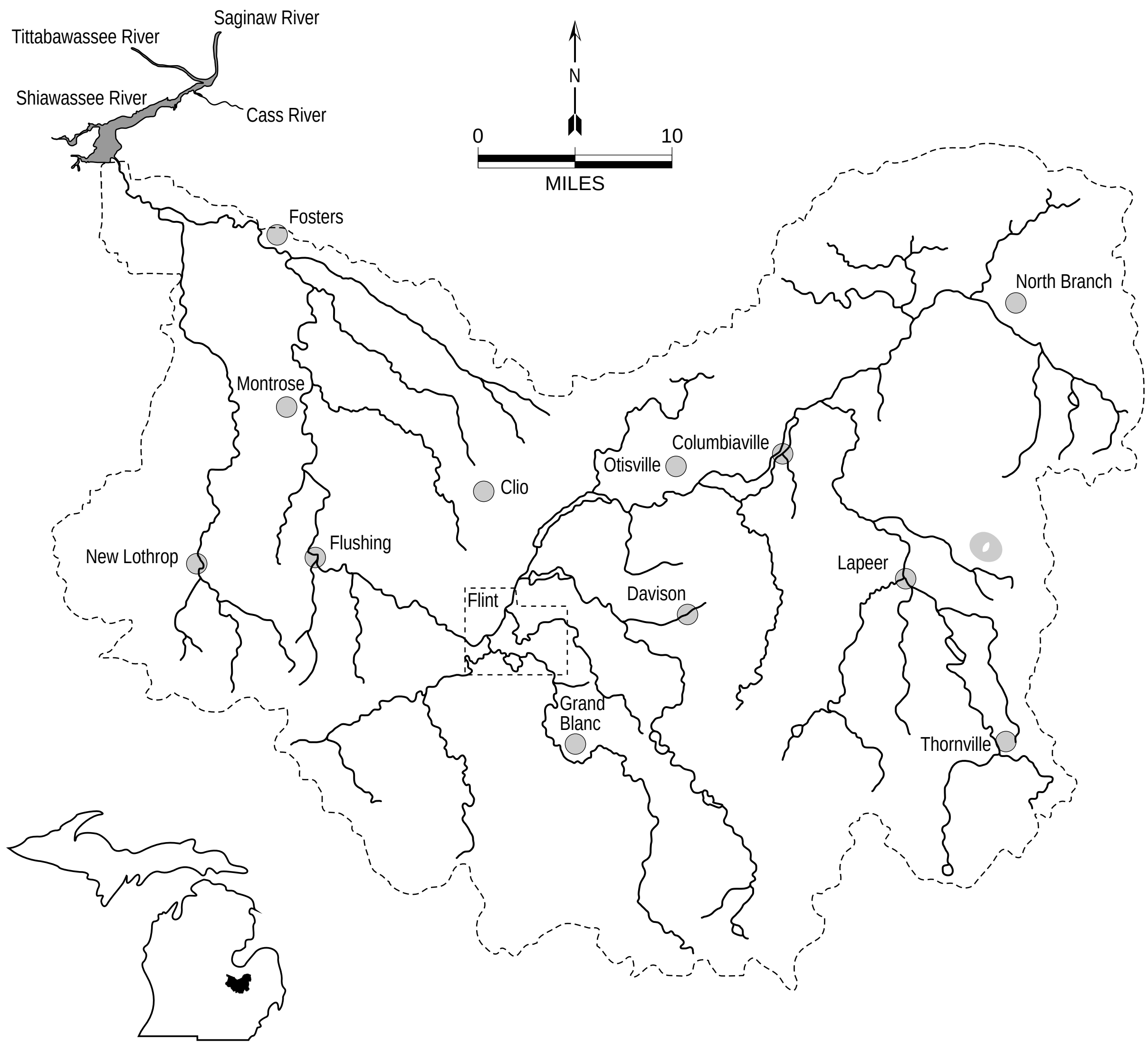


Redear sunfish (*Lepomis microlophus*)

Habitat:

feeding - non-flowing clear waters of streams and lakes
- some aquatic vegetation

spawning - nest in silt or gravel substrate



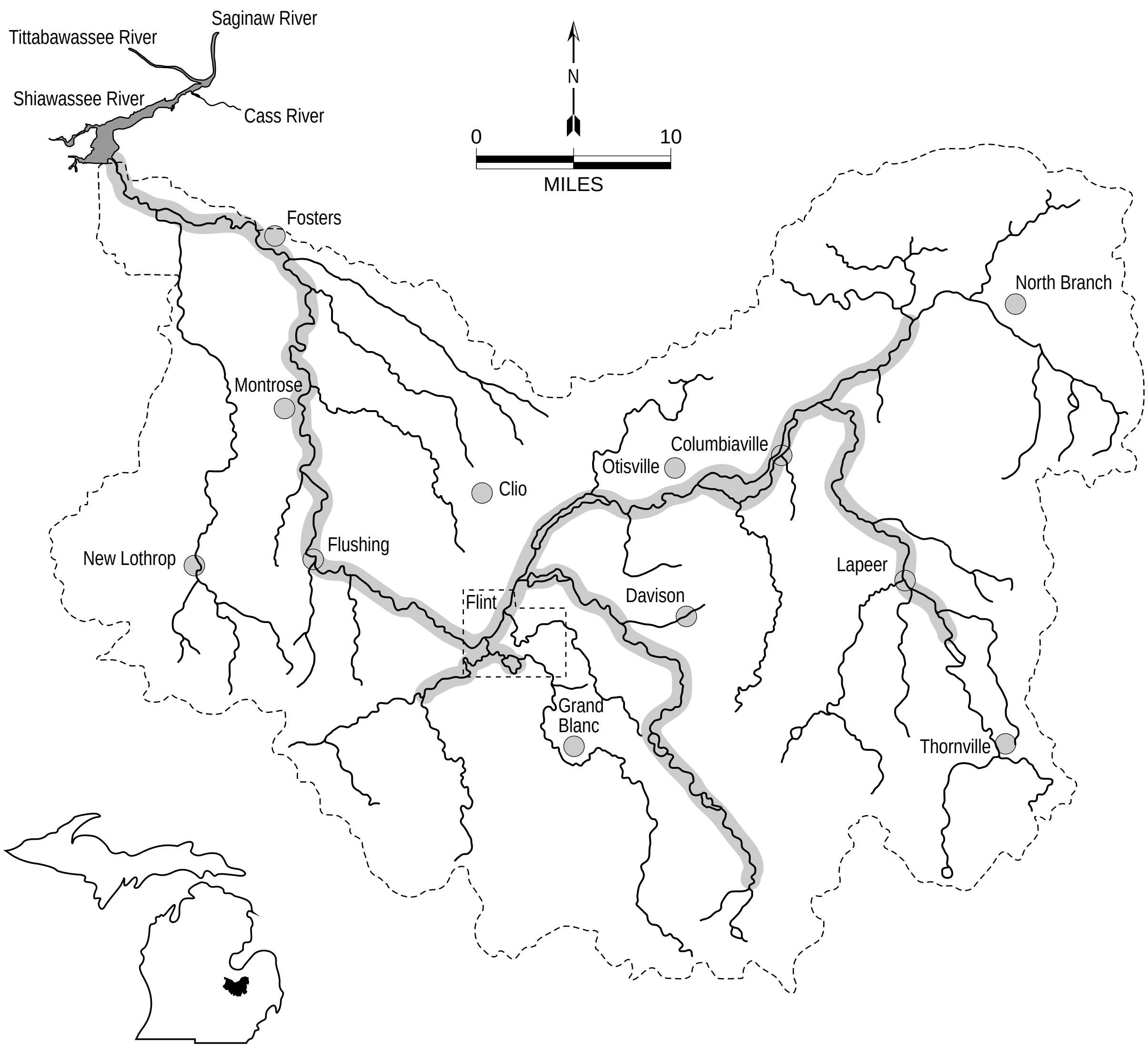
Smallmouth bass (*Micropterus dolomieu*)

Habitat:

feeding
- clear, cool, deep lakes and rivers
- streams where 40% consists of riffles over clean gravel, boulder, or bedrock substrate
- in pools with a current and >4 feet of depth
- gradients between 4 and 25 feet per mile

spawning
- nest in sandy, gravel, or rocky substrate
- gradients 7 to 25 feet per mile
- streams 20 to 100 feet wide

winter refuge
- larger deeper waters with gradients between 3 to 7 feet per mile

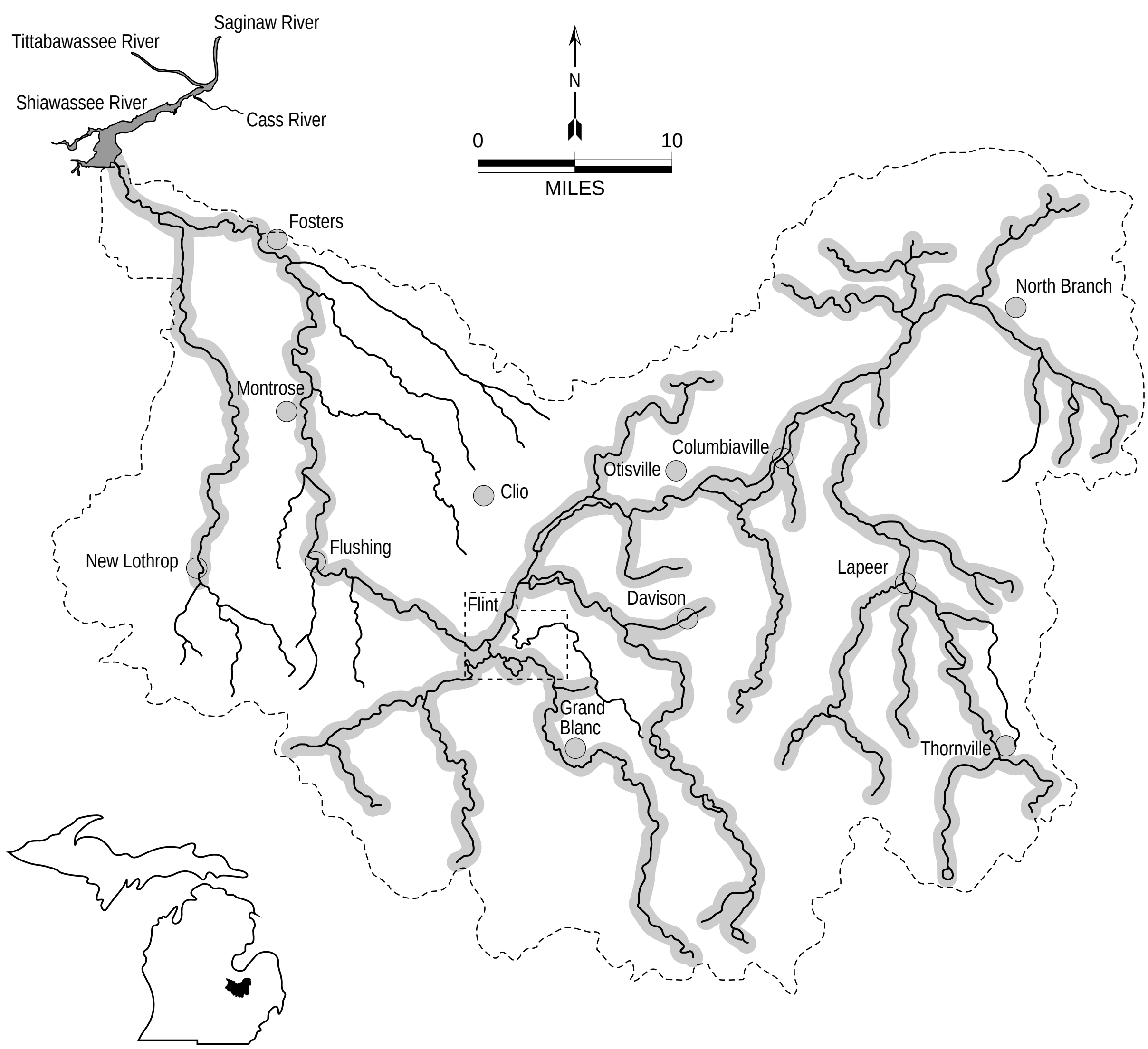


Largemouth bass (*Micropterus salmoides*)

Habitat:

feeding
- non-flowing clear waters - lakes, impoundments, and pools of streams
- abundant aquatic vegetation
- soft muck, organic debris, gravel, sand, and hard non-flocculent clay substrates

spawning
- nest in gravelly sand to marl and soft mud substrates
- emergent vegetation
- quiet shallow bays; no current

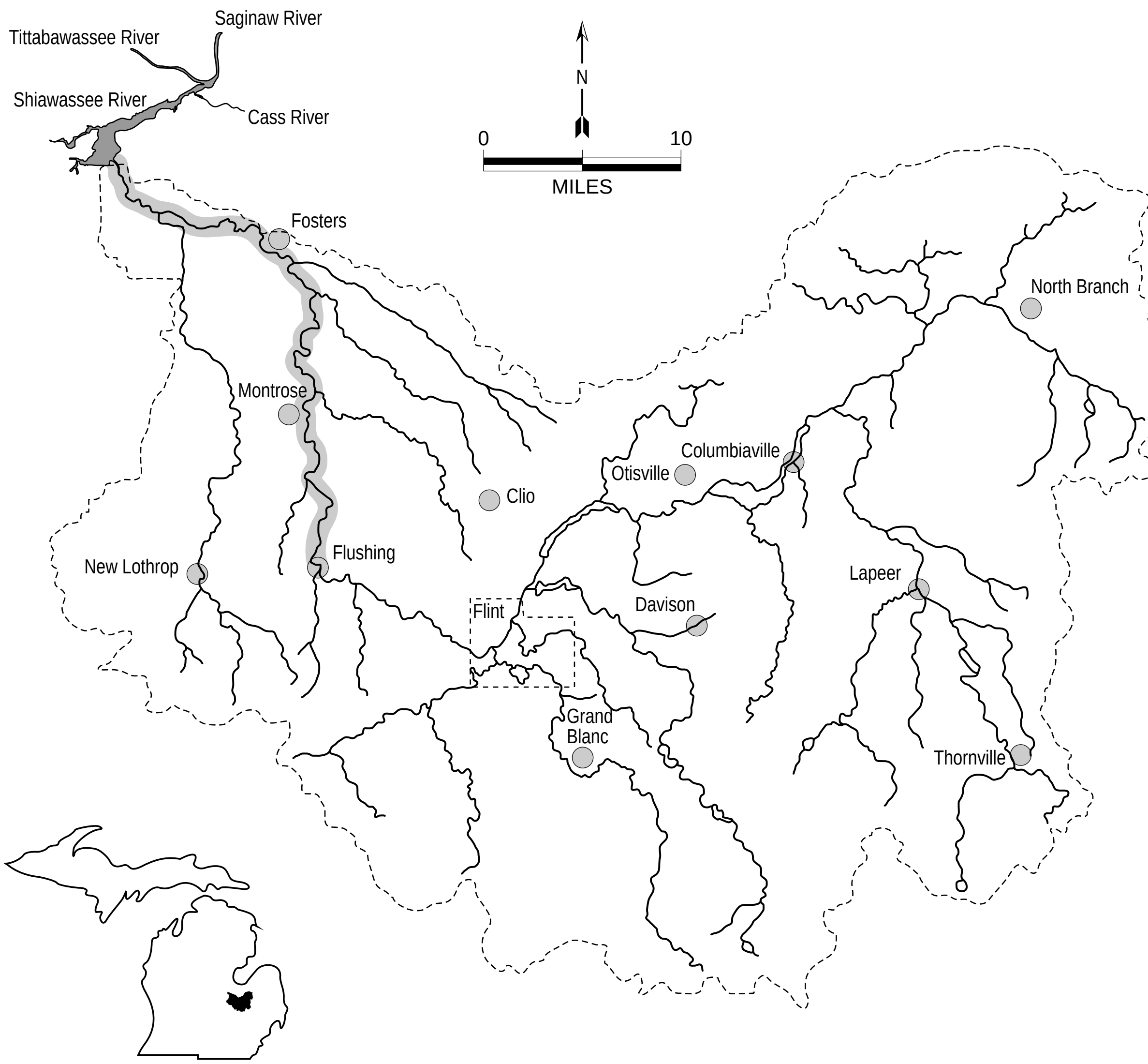


White crappie (*Pomoxis annularis*)

Habitat:

feeding
- lakes and impoundments >5 acres
- sluggish pools of moderate to large low-gradient rivers
- no substrate preference
- can tolerate severe turbidity and rapid siltation

spawning
- various substrates usually beside rooted aquatic vegetation
- sometimes under banks

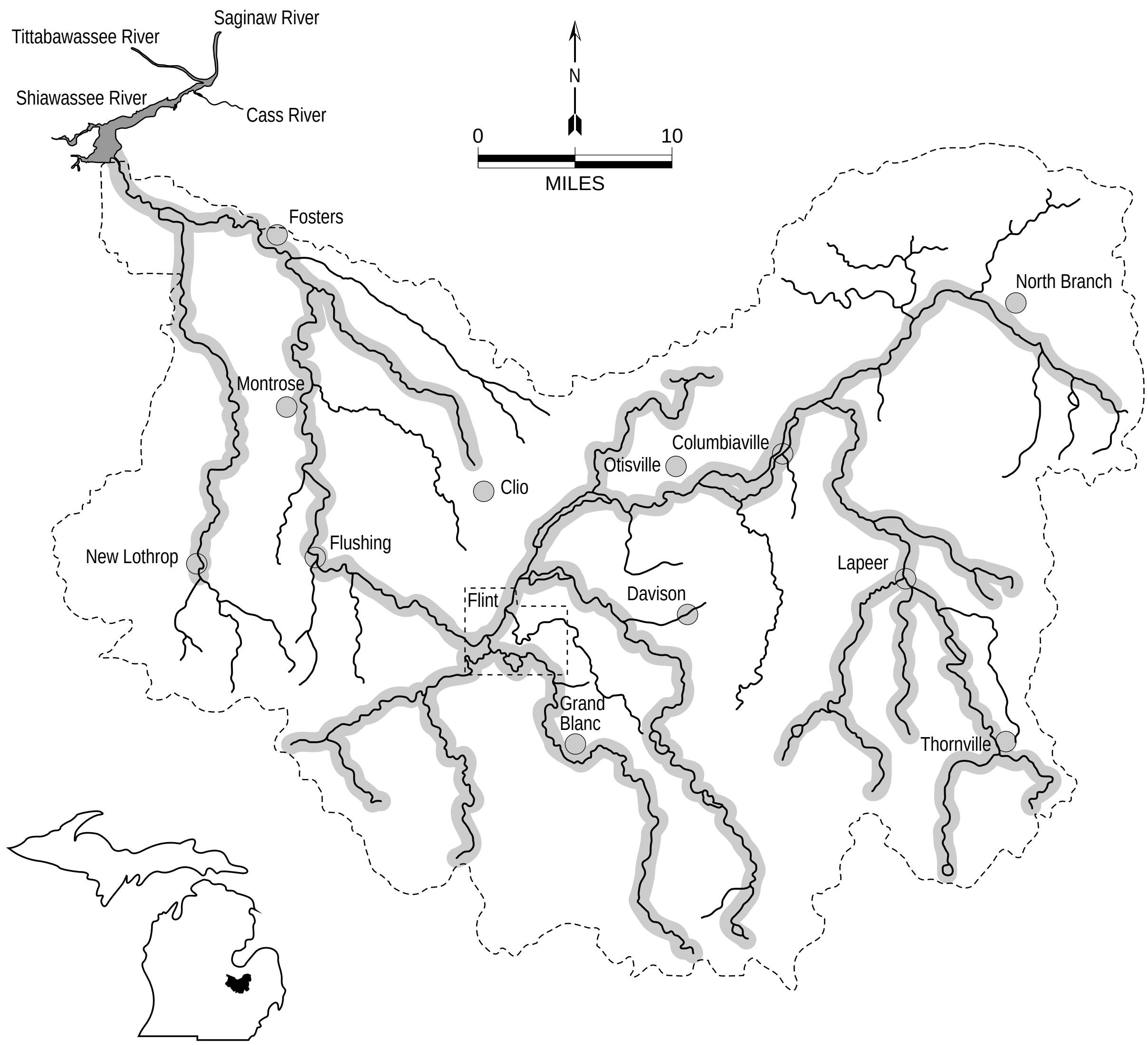


Black crappie (*Pomoxis nigromaculatus*)

Habitat:

feeding
- larger clear non-silty low-gradient rivers; also in lakes and impoundments
- clean hard sand or muck substrate
- associated with submerged aquatic vegetation
- does not tolerate silt or turbidity well

spawning
- nests in gravel, sand, or mud substrate
- some vegetation must be present
- sometimes nests under banks

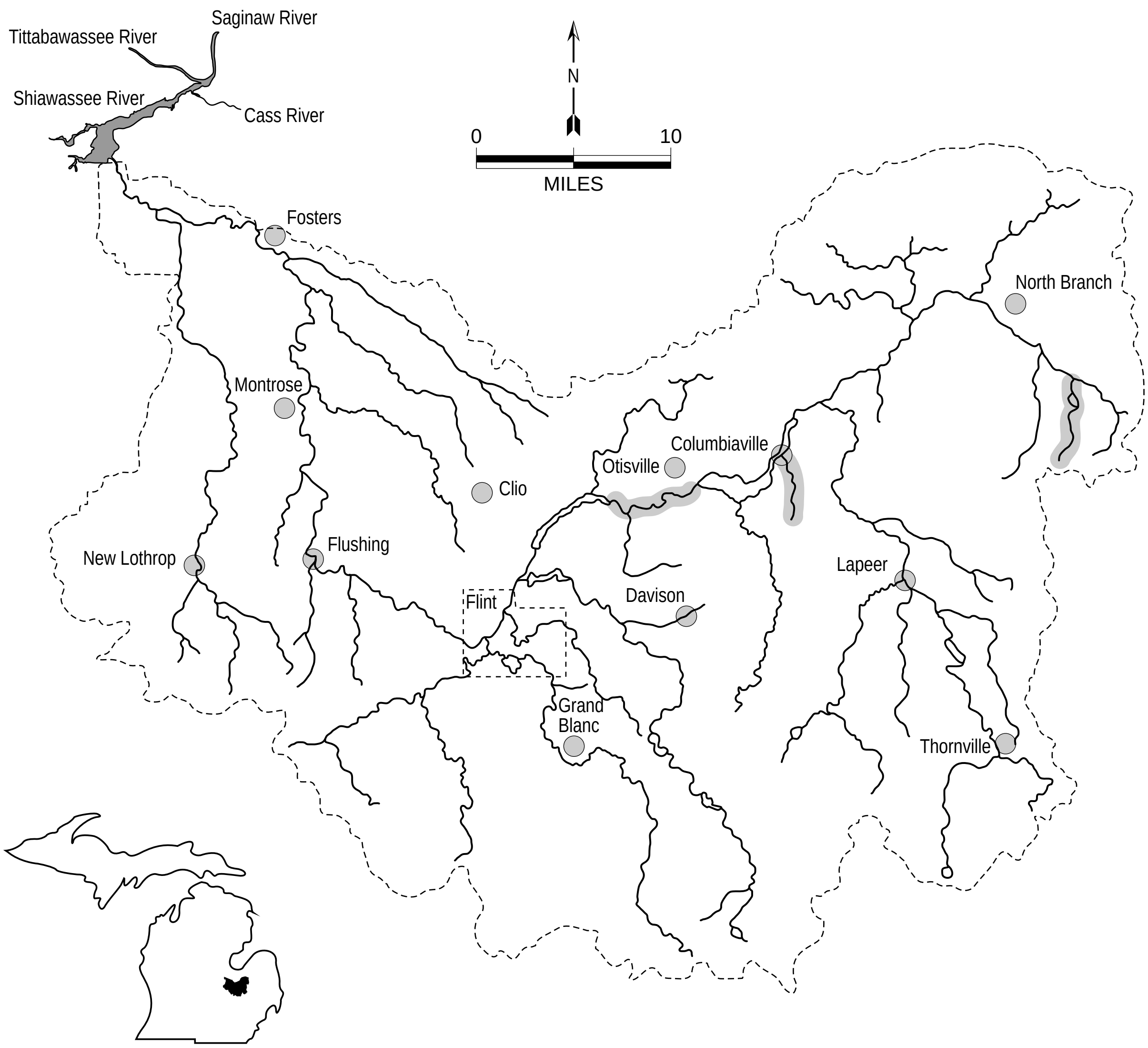


Greenside darter (*Etheostoma blennioides*)

Habitat:

feeding - young: in quiet water
- swift gravelly riffles or pools with current of streams and rivers

spawning - filamentous algae necessary for egg deposition

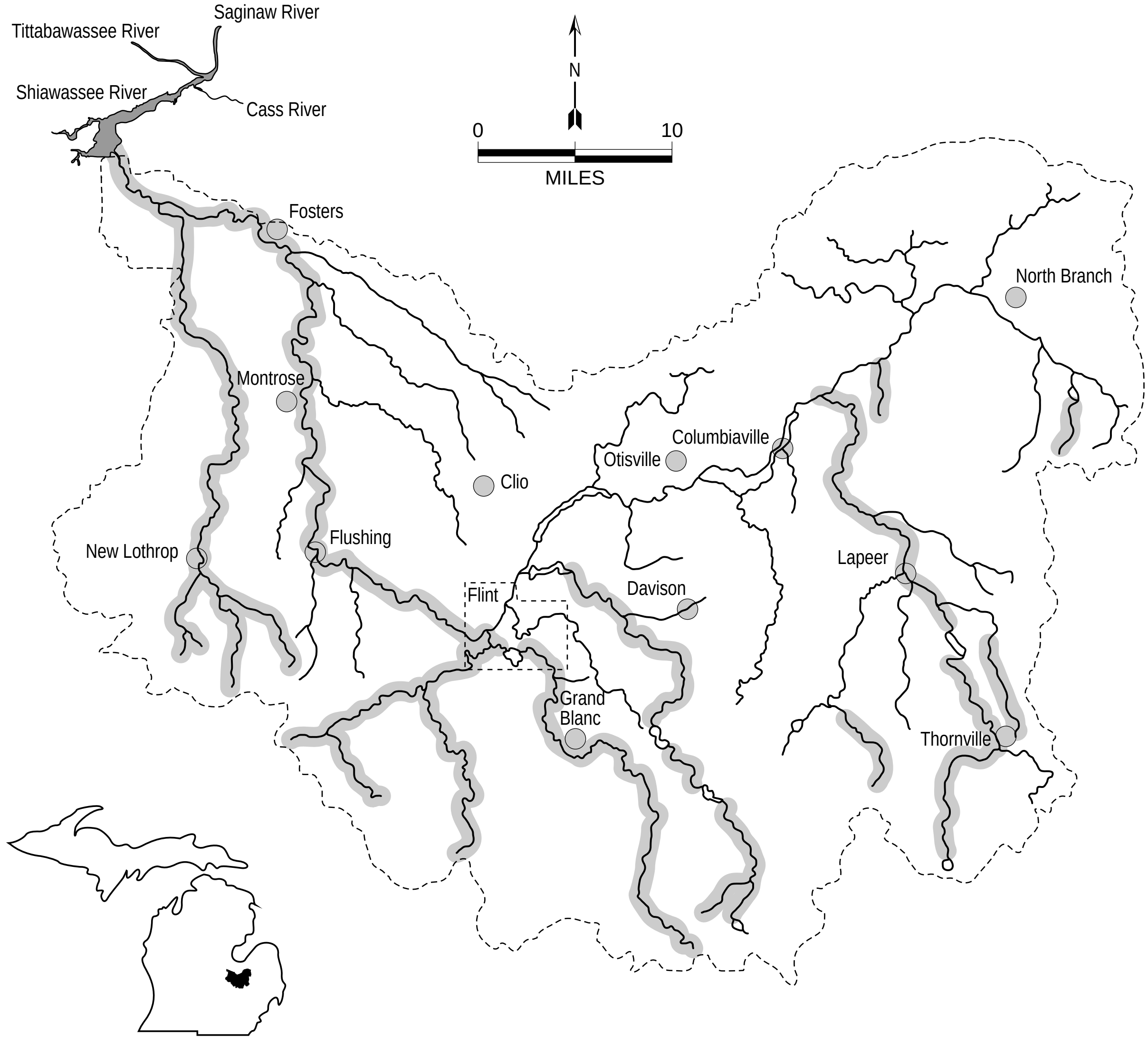


Rainbow darter (*Etheostoma caeruleum*)

Habitat:

feeding - gravelly high gradient riffles
- clear, moderate to large streams
- in shallows (average 1 foot)

spawning - gravel or rubble riffles

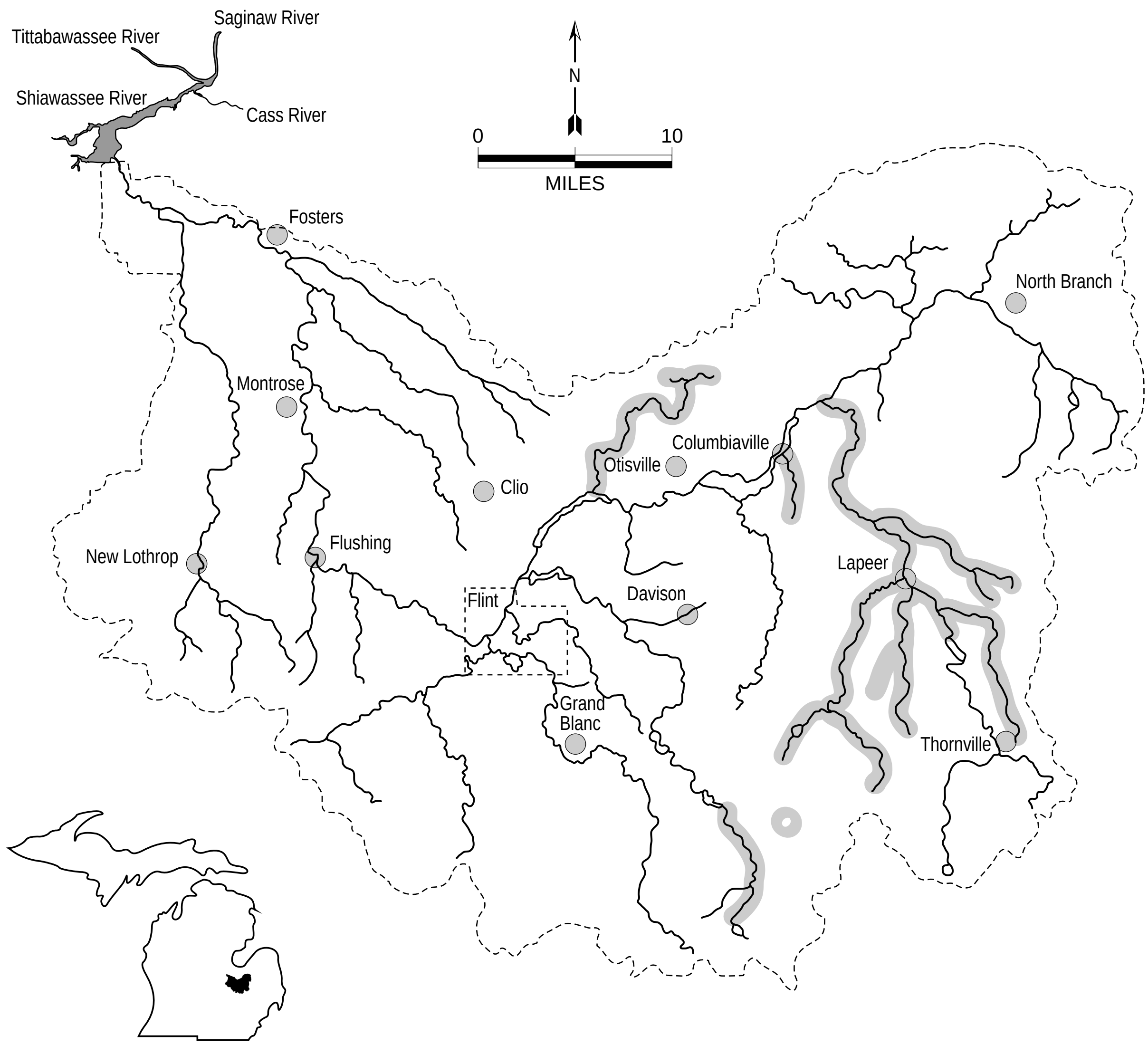


Iowa darter (*Etheostoma exile*)

Habitat:

feeding
- clear, slow moving streams and lakes
- sandy to muddy substrates
- intolerant of turbid water
- lives in rooted aquatic vegetation

spawning
- in pond-like extensions of streams on organic matter or roots
- in shallows



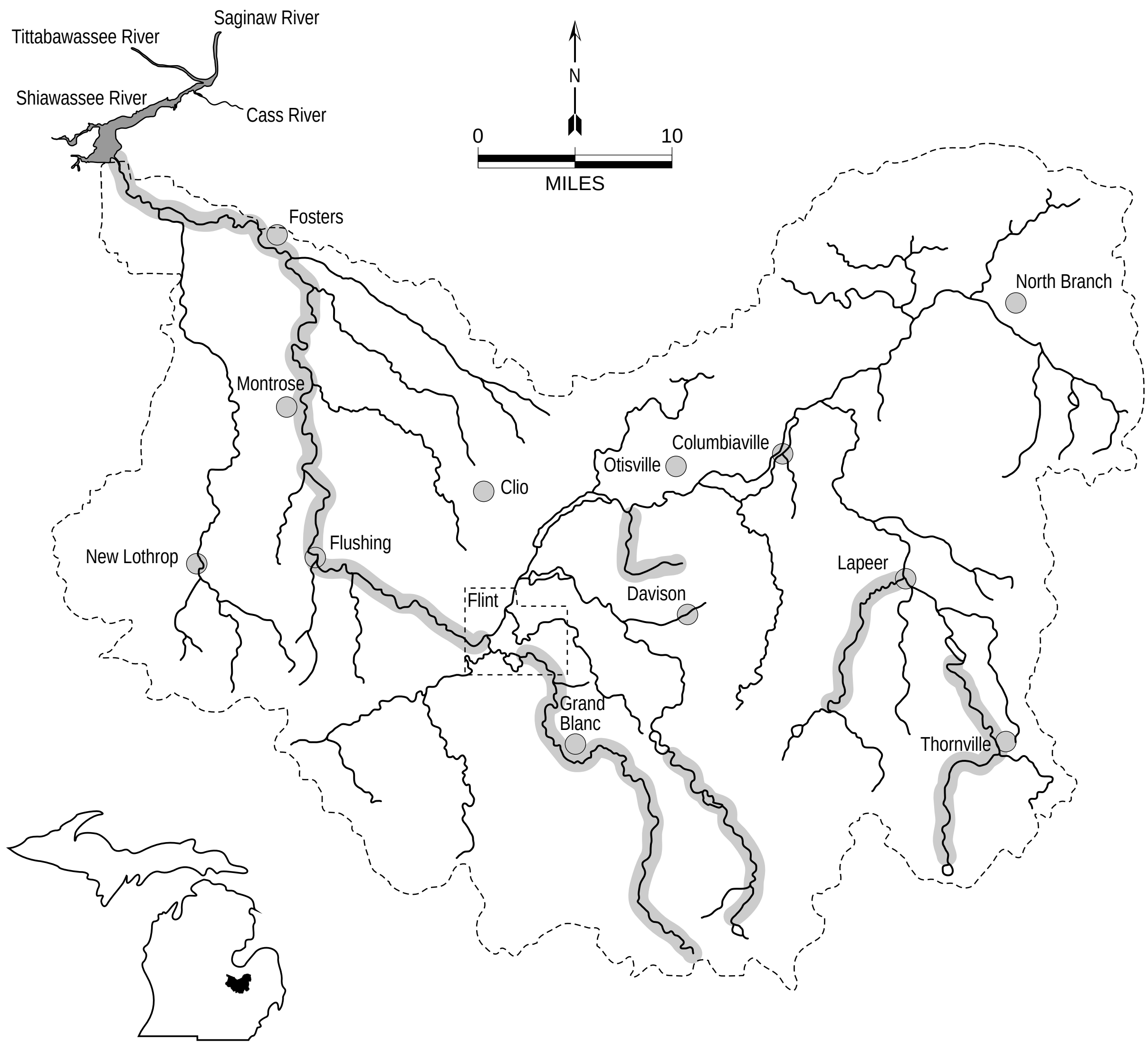
Fantail darter (*Etheostoma flabellare*)

Habitat:

feeding
- small, shallow (<18 inches) streams
- some tolerance of turbidity and siltation
- clear warm waters
- slow to moderate current
- gravel and boulder substrate

spawning
- gravel in slower water
- lays eggs on underside of rocks, male guards and fans them

winter refuge
- moves downstream to larger and deeper waters

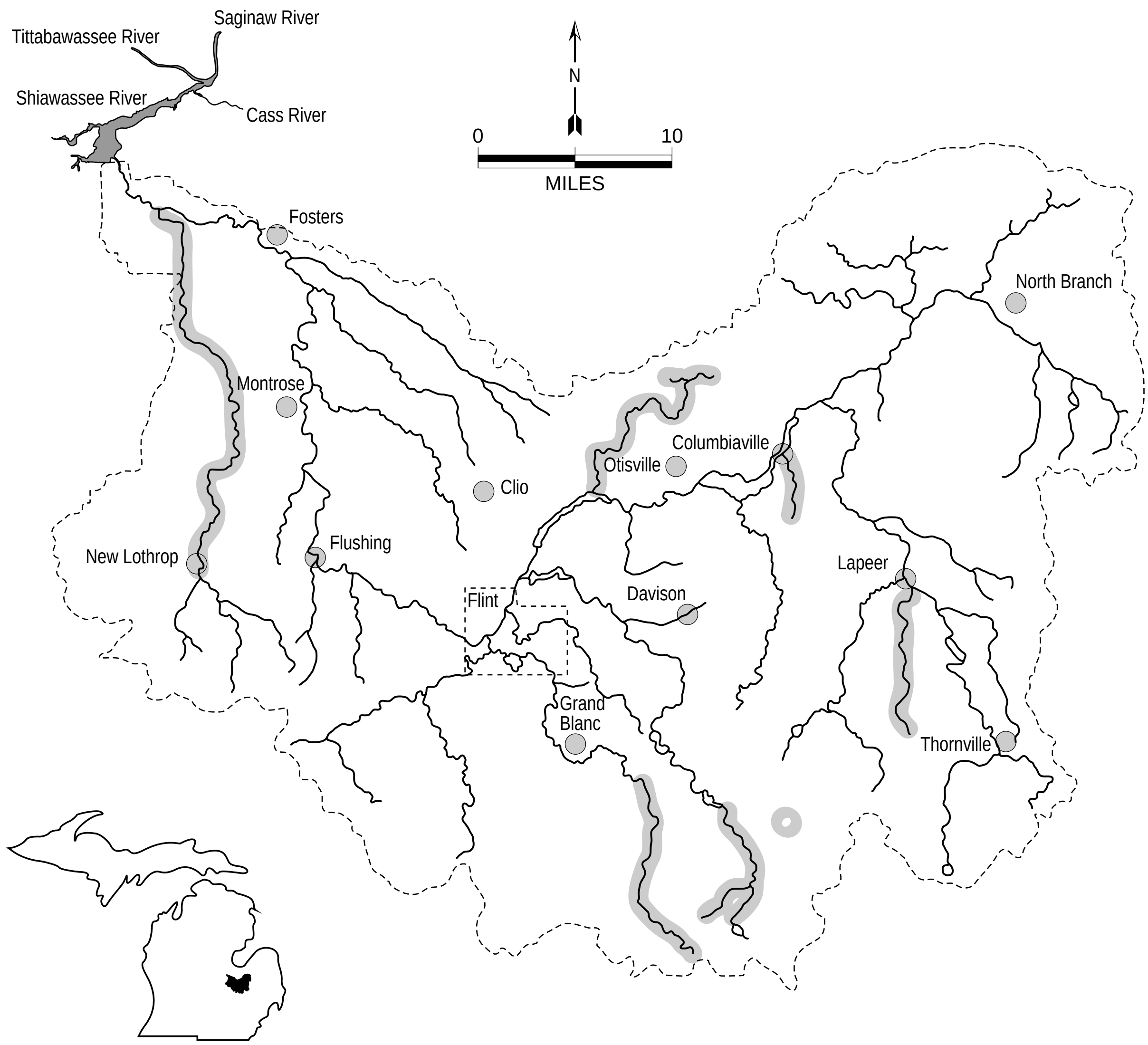


Least darter (*Etheostoma microperca*)

Habitat:

feeding - moderate to warm temperature
- clear quiet low-gradient vegetated streams (wetlands, floodplains)
- soft substrate

spawning - spawning occurs on stems of plants
- male guards a territory in a vegetated area

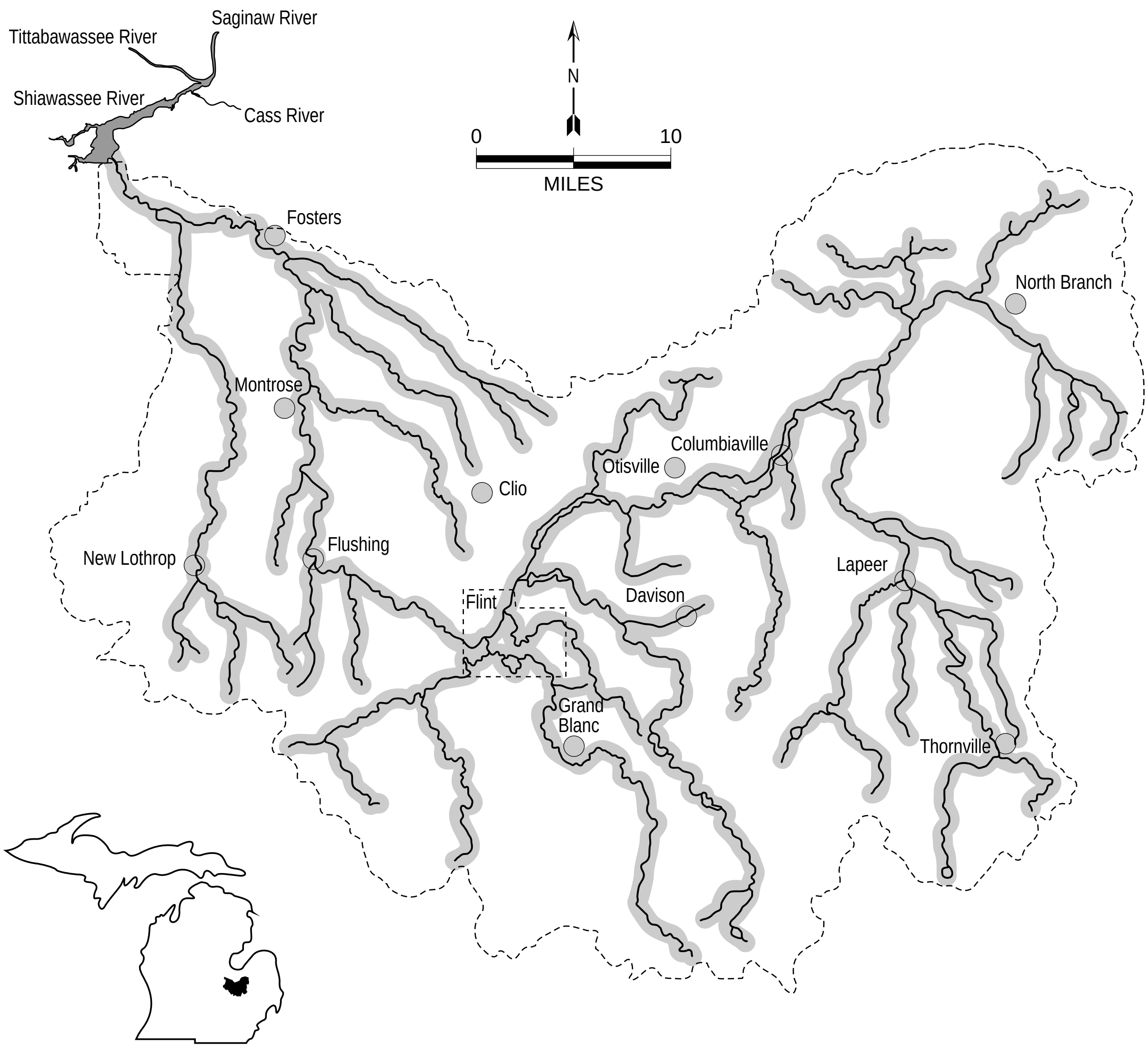


Johnny darter (*Etheostoma nigrum*)

Habitat:

feeding
- sand and silt substrate
- little to moderate current
- shallow areas of streams, rivers, lakes, and impoundments
- tolerant of many organic and inorganic pollutants and turbidity

spawning
- underneath rocks
- in stream pools or protected shallows of lakes

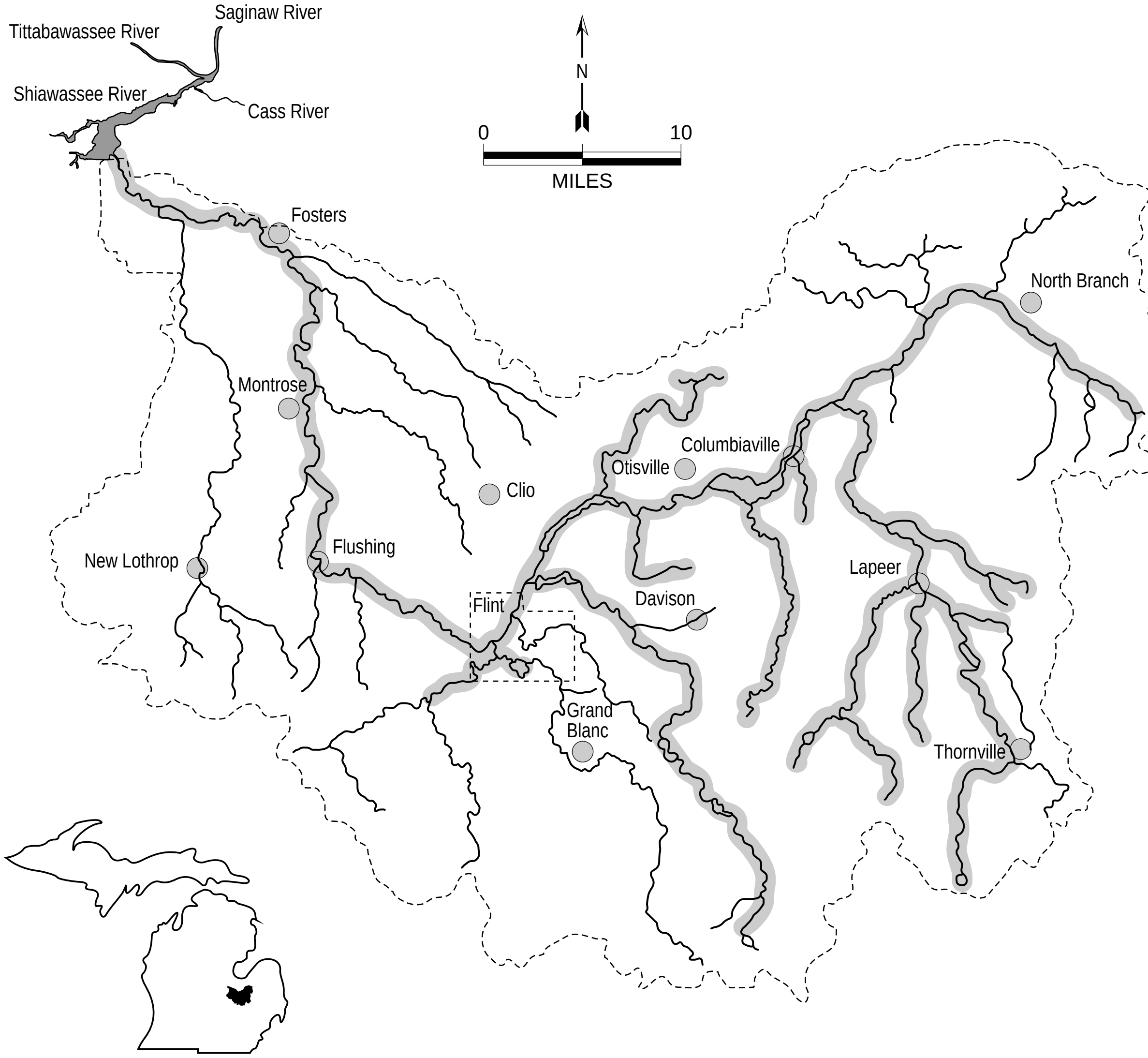


Yellow perch (*Perca flavescens*)

Habitat:

feeding
- clear lakes and impoundments; also Lake Huron
- low gradient rivers
- abundance of rooted aquatics
- muck, organic debris, sand, or gravel substrate
- does not tolerate turbidity and siltation

spawning
- shallows of lakes, tributaries of streams
- occurs over rooted vegetation, submerged brush, fallen trees
- may occur over sand or gravel

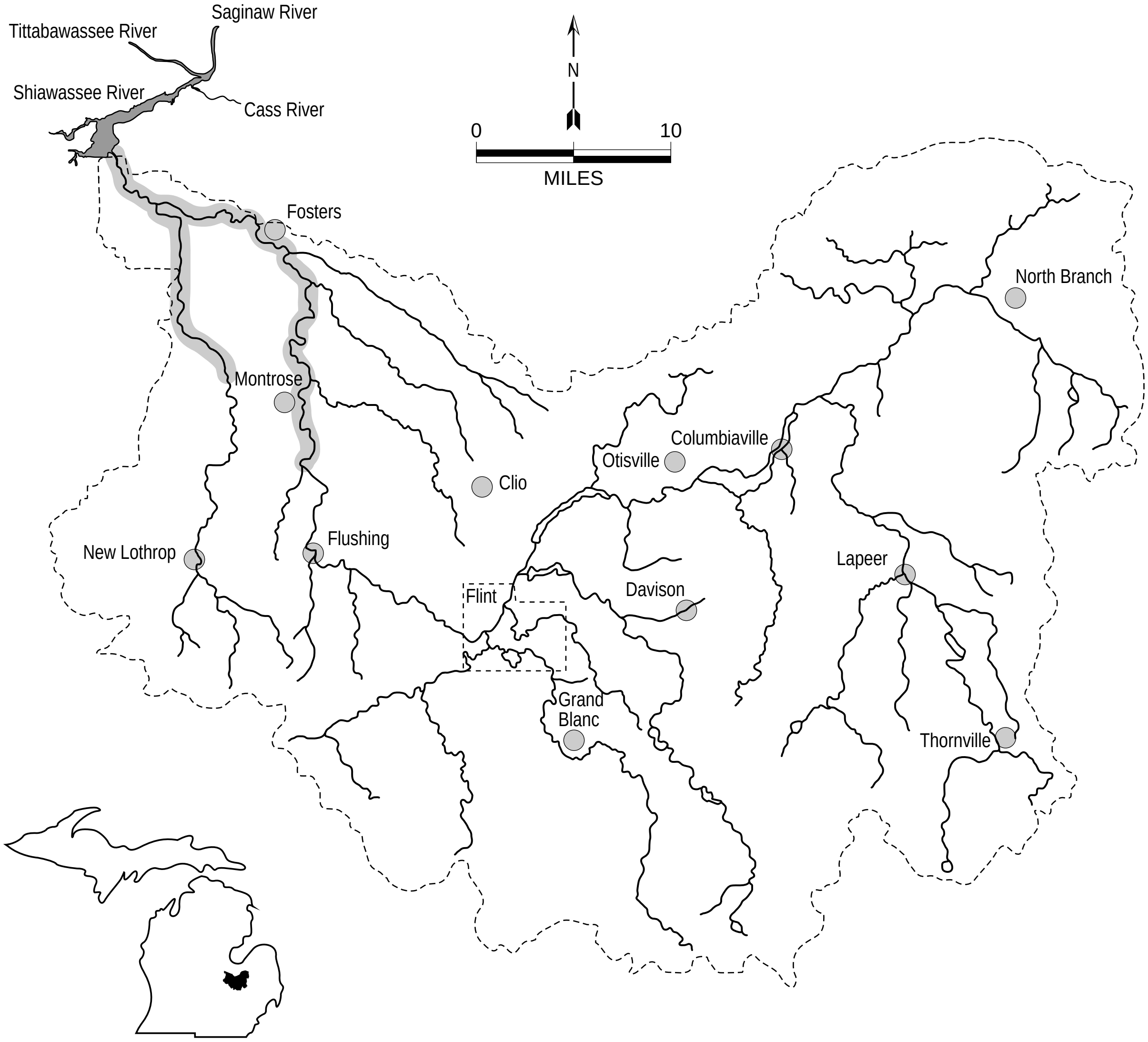


Logperch (*Percina caprodes*)

Habitat:

feeding - gravel riffles, deeper slower sections of rivers
- medium size streams; also lakes, impoundments, and Lake Huron
- sand, gravel, or rock substrate
- avoids turbidity and silt

spawning - riffles or sandy in-shore shallows

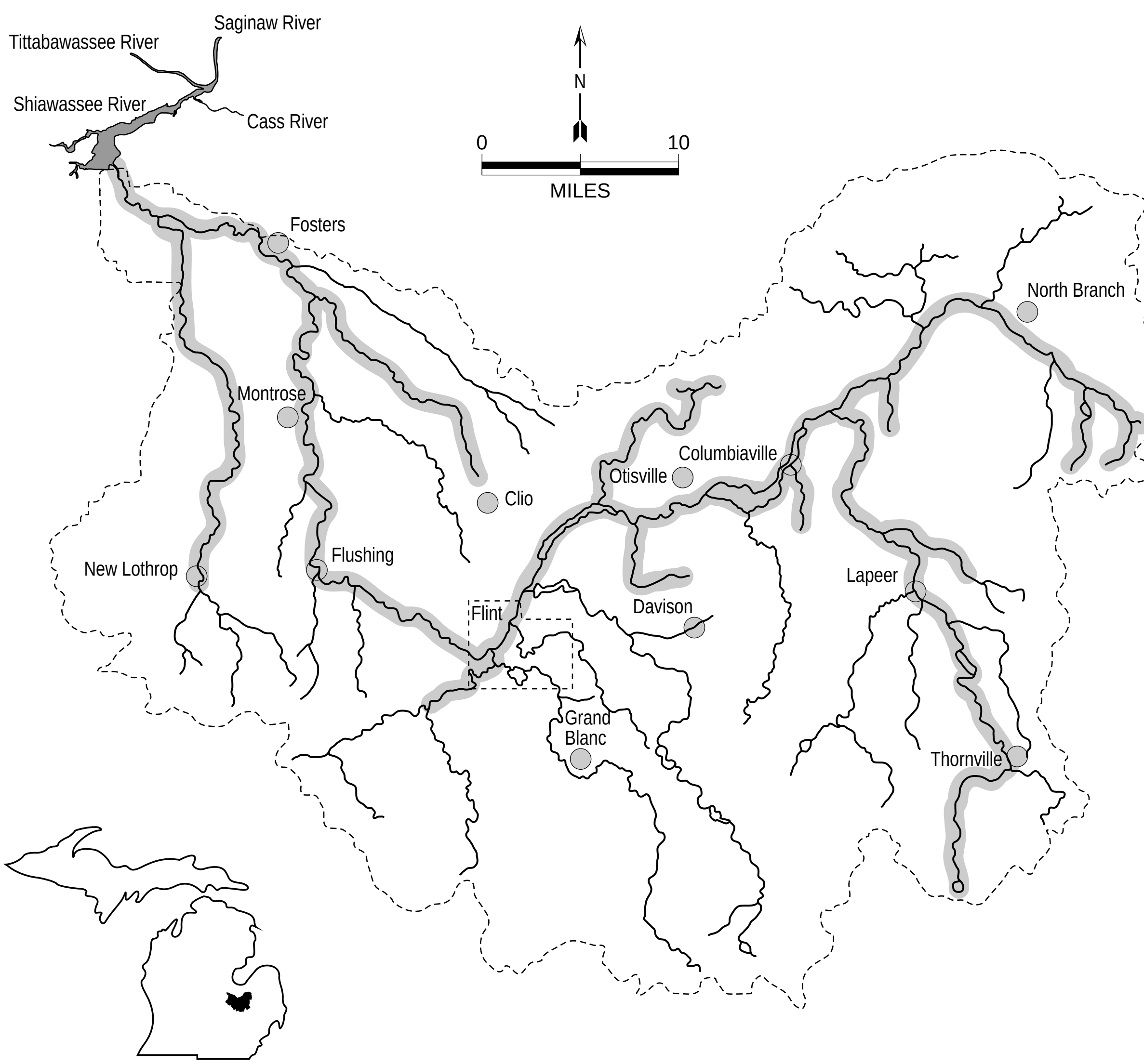


Blackside darter (*Percina maculata*)

Habitat:

feeding - small to medium streams
- low to medium gradient
- gravel and sand substrate
- tolerate some turbidity

spawning - gravel and sand substrate



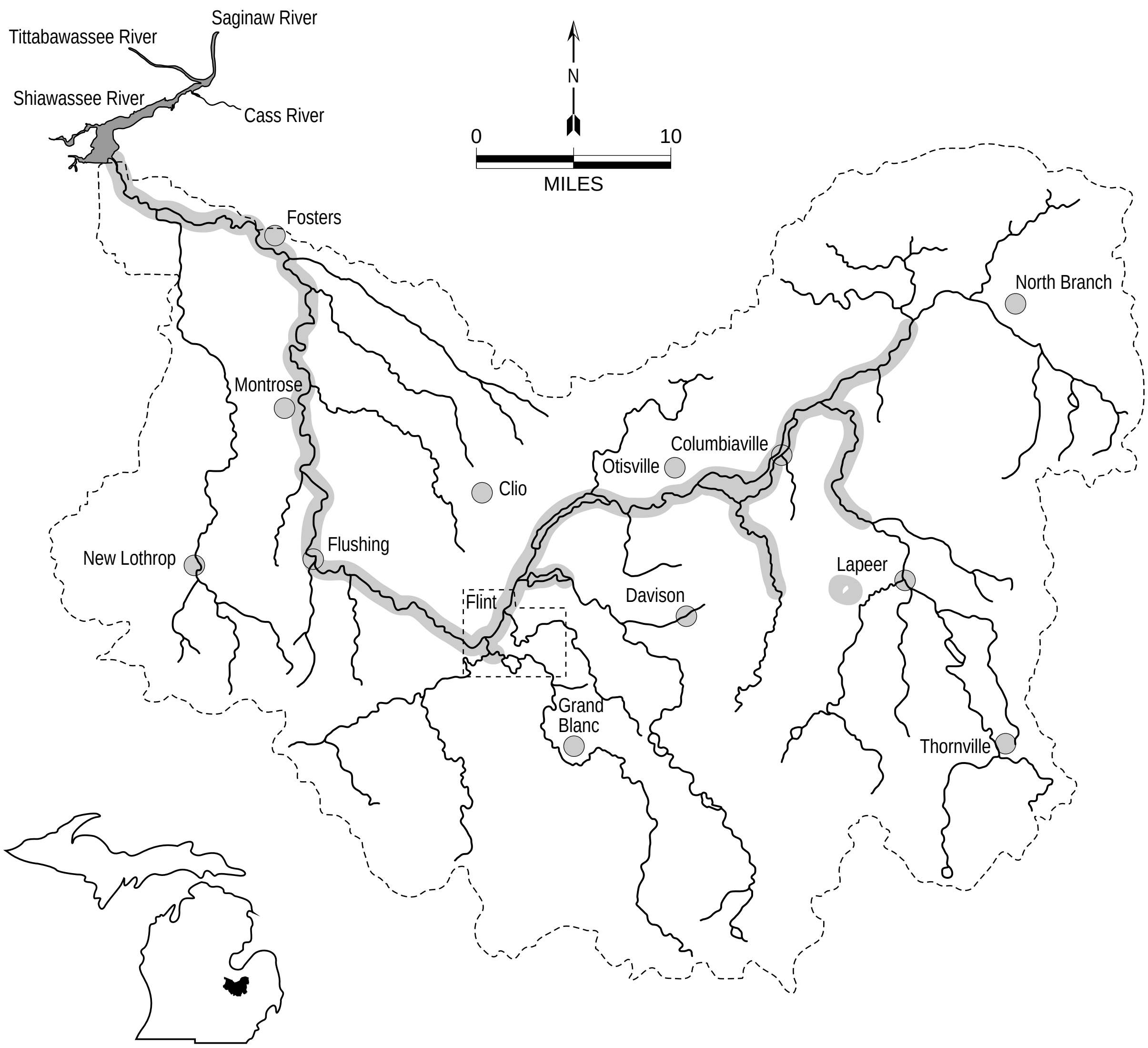
Walleye (*Stizostedion vitreum*)

Habitat:

feeding - larger, deeper streams and in large, shallow, turbid lakes and impoundments; also Lake Huron
- gravel, bedrock, and firm substrates preferred
- does not tolerate a lot of turbidity or low oxygen

spawning - rocky substrates in high gradient water in rivers
- boulder to coarse gravel shoals in lakes

winter refuge - avoids strong currents

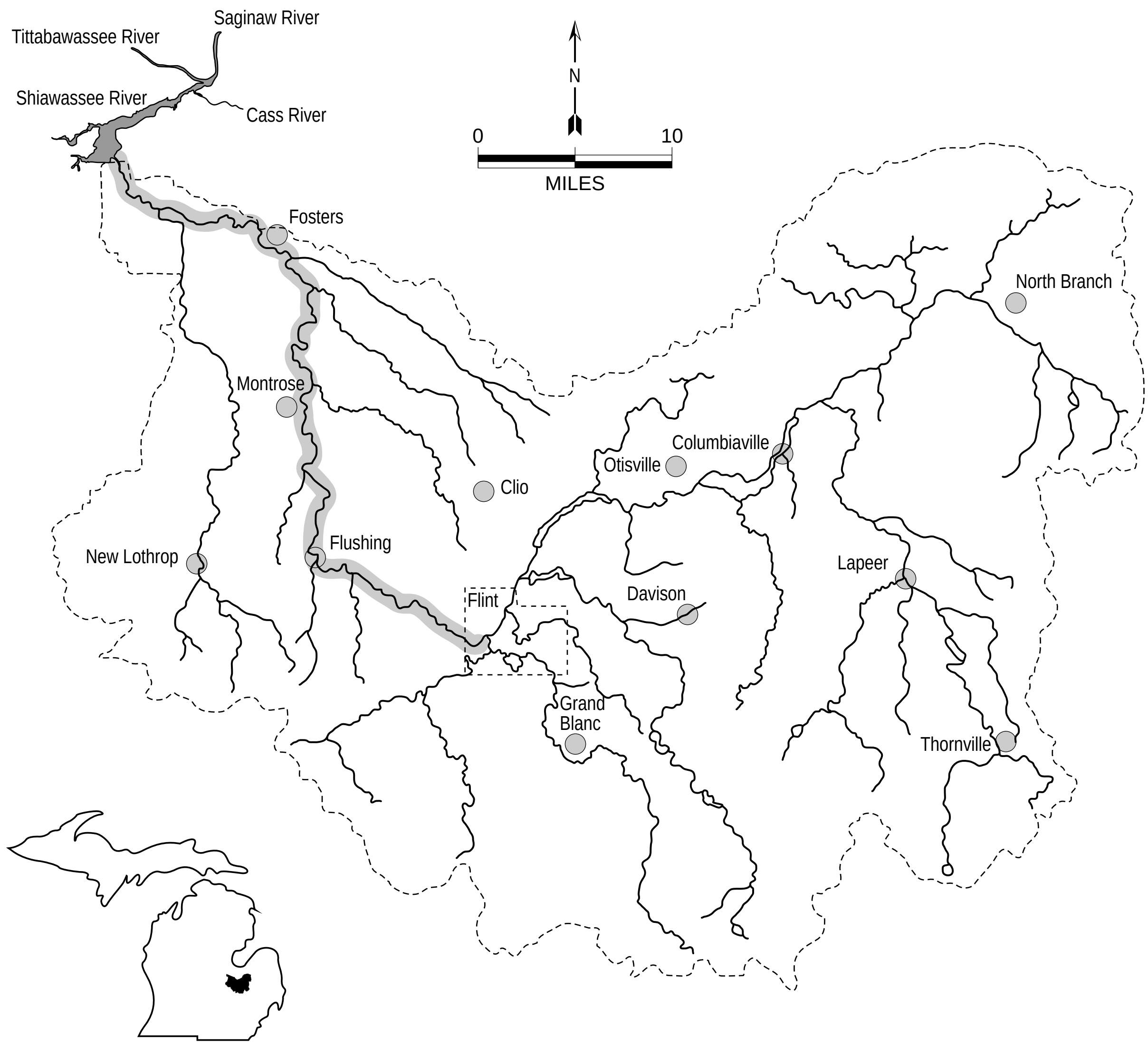


Freshwater drum (*Aplodinotus grunniens*)

Habitat:

feeding - deeper pools of rivers and Lake Huron
- in shallows
- prefers clear waters and clean substrates
- can adapt to high turbidity levels

spawning - pelagically, in open water, over sand or mud substrate
- occurs in bays or lower portions of marshes



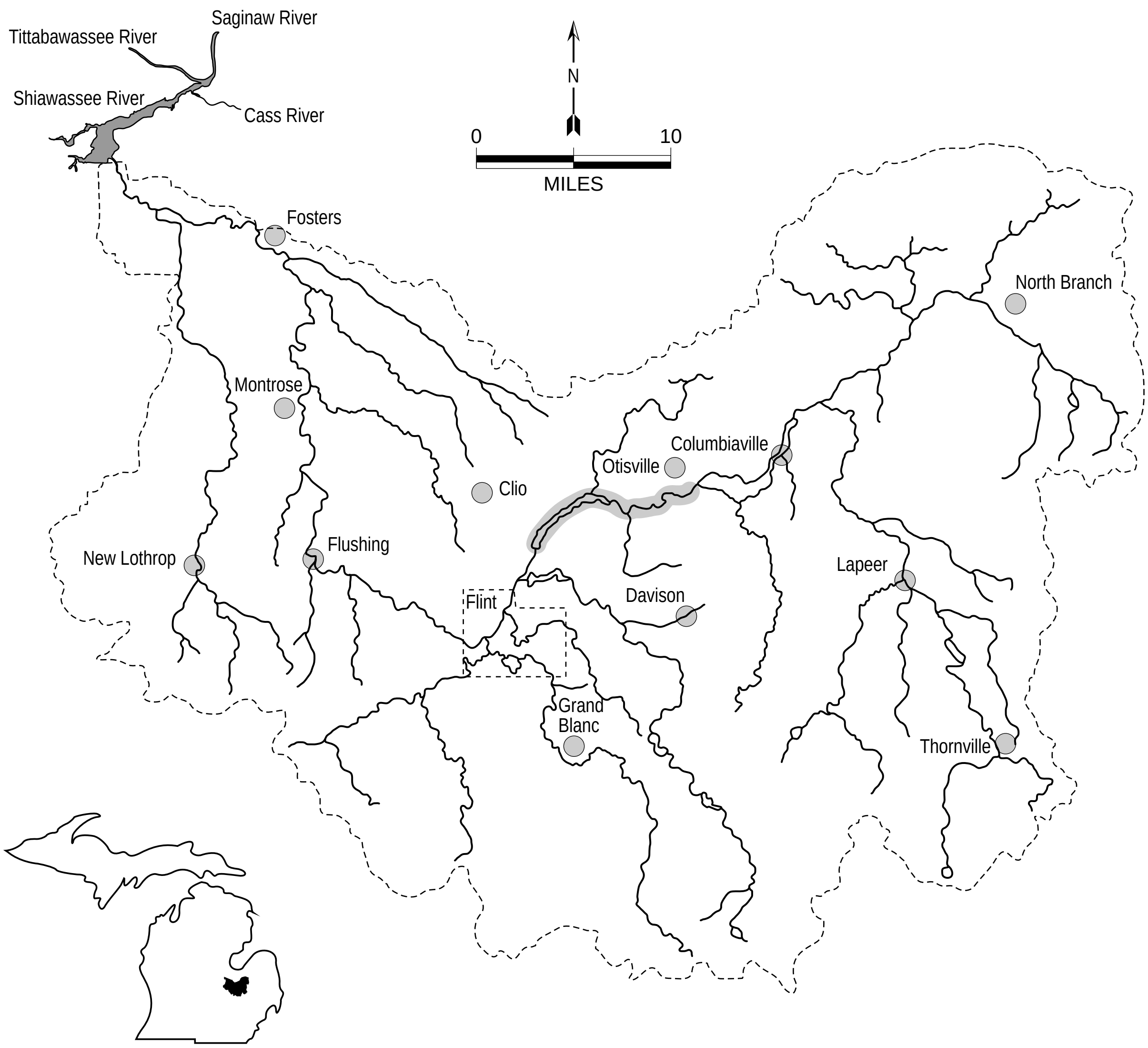
Round goby (*Neogobius melanostomus*) – non-native species

Habitat:

feeding - rock,cobble,riprap,and vegetate areas of rivers and lakes
- young found over sand substrate

spawning - rocky substrate with large interstitial spaces

winter refuge - rocky substrate with large interstitial spaces
- deep water



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Appendix 4

Historic Creel Data, 1929-64

Historic creel data from the Flint River watershed 1929-64. Data from Michigan Department of Natural Resources, Fisheries Division.

Appendix 4.

Segment and water body	Location	Year	Angler hours	Brook trout	Brown trout	Rainbow trout	Black Crappie	Yellow Perch	Walleye	Northern pike	Bullhead	Carp	Channel catfish	Sucker	Smallmouth bass	Rock bass	Largemouth bass	Bluegill	Pumpkinseed	Bowfin
Upper South Branch																				
South Branch	Lapeer County	1929	3.0	7		3														
South Branch	Lapeer County	1949	20.0	12						5				8						
South Branch	Lapeer Township	1932	11.5		1					12										
South Branch	Metamora Township	1944	7.5							12										
South Branch	Metamora Township	1949	353.5							23				33		55				
Winns Pond	Lapeer Township	1936	12.0							5										
Winns Pond	Lapeer Township	1937	18.0							5										
Winns Pond	Lapeer Township	1942	17.0							6										
Middle South Branch																				
Pine Creek	Metamora Township	1932	1.0	6																
Pine Creek	Metamora Township	1934	4.0		5															
Pine Creek	Attica Township	1941	63.0	52																
Pine Creek	Attica Township	1942	28.0	11																
Pine Creek	Attica Township	1943	82.0	107																
Pine Creek	Attica Township	1944	161.0	200																
Pine Creek	Attica Township	1945	62.0	20																
Pine Creek	Attica Township	1949	58.0	32																
Pine Creek	Attica Township	1950	137.0	97																
Pine Creek	Attica Township	1951	107.0	35																
Pine Creek	Attica Township	1952	17.0	2																
Pine Creek	Attica Township	1953	57.0	11																
Pine Creek	Attica Township	1956	11.0	1																
Pine Creek	Attica Township	1960	24.0	11																
Pine Creek	Attica Township	1962	32.0	17																
Pine Creek	Attica Township	1963	27.0	12																
Pine Creek	Attica Township	1964	25.0	8																
Hunters Creek	Lapeer County	1929	10.0	33																
Hunters Creek	Lapeer County	1933	6.0	5																
Hunters Creek	Lapeer County	1936	8.0	29																
Hunters Creek	Lapeer County	1949	50.0	48																
Hunters Creek	Lapeer Township	1930	9.0	58																
Hunters Creek	Lapeer Township	1934	4.0	2																

Appendix 4.–Continued.

Segment and water body	Location	Year	Angler hours	Brook trout	Brown trout	Rainbow trout	Black Crappie	Yellow Perch	Walleye	Northern pike	Bullhead	Carp	Channel catfish	Sucker	Smallmouth bass	Rock bass	Largemouth bass	Bluegill	Pumpkinseed	Bowfin
Middle South Branch (continued)																				
Hunters Creek	Lapeer Township	1941	96.0	54																
Hunters Creek	Lapeer Township	1942	48.0	23																
Hunters Creek	Lapeer Township	1943	197.0	258																
Hunters Creek	Lapeer Township	1944	201.0	244																
Hunters Creek	Lapeer Township	1945	21.0	14																
Hunters Creek	Lapeer Township	1946	6.0																3	
Hunters Creek	Lapeer Township	1947	3.5															17	3	
Hunters Creek	Lapeer Township	1950	123.0	58							17									
Hunters Creek	Lapeer Township	1951	85.0	21																
Hunters Creek	Lapeer Township	1952	69.0	44																
Hunters Creek	Lapeer Township	1953	64.0	89																
Hunters Creek	Lapeer Township	1954	21.0	28																
Hunters Creek	Lapeer Township	1960	85.0	48																
Hunters Creek	Lapeer Township	1962	21.0	11																
Hunters Creek	Lapeer Township	1963	49.0	29																
Hunters Creek	Lapeer Township	1964	26.0	11																
Hunters Creek	Metamora Township	1932	12.0	27																
Hunters Creek	Metamora Township	1941	2.0	2																
Farmers Creek	Elba Township	1941	3.0							2										
Farmers Creek	Elba Township	1946	12.0							1				1						
Farmers Creek	Elba Township	1949	77.0							3				17		3				
Farmers Creek	Elba Township	1950	64.0							3				7		2				
Farmers Creek	Elba Township	1951	13.0							3				4						
South Branch	Lapeer County	1950	78.0							4				2		21				
South Branch	Lapeer County	1952	115.0				7							140		8		2		
South Branch	Lapeer Township	1944	34.5							5				21						
South Branch	Lapeer Township	1946	18.0								1			1		1				
South Branch	Lapeer Township	1947	2.0							3										
South Branch	Lapeer Township	1950	2.0													6				
South Branch	Lapeer Township	1951	340.0				34			8				72		87		6	2	
Lower South Branch																				
Cedar Creek	North Branch Township	1951	6.0							1						3				

Appendix 4.–Continued.

Segment and water body	Location	Year	Angler hours	Brook trout	Brown trout	Rainbow trout	Black Crappie	Yellow Perch	Walleye	Northern pike	Bullhead	Carp	Channel catfish	Sucker	Smallmouth bass	Rock bass	Largemouth bass	Bluegill	Pumpkinseed	Bowfin
Lower South Branch (continued)																				
Bottom Creek	North Branch Township	1960	20.0	6																
Bottom Creek	North Branch Township	1962	30.0	14																
Bottom Creek	North Branch Township	1963	24.0	11																
North Branch	Marathon Township	1949	55.0							4				5						
North Branch	Marathon Township	1950	83.0													17				
North Branch	Marathon Township	1951	187.5							4				13		11				1
North Branch	Marathon Township	1952	6.0															1		
South Branch	Oregon Township	1946	10.0				1			1						9				
South Branch	Oregon Township	1950	24.0											10	2					
South Branch	Oregon Township	1953	93.0							1				20		46				
Upper Flint																				
Hasler Creek	Davison Township	1962	20.5							13										
Duck Creek	Oakland County	1964	18.0	5																
Lake Louise	Brandon Township	1943	39.0				6	22									7	15		
Lake Louise	Brandon Township	1946	39.0					1										3	1	
Lake Louise	Brandon Township	1948	5.0				6											13	4	
Lake Louise	Brandon Township	1949	27.5					12		2						1	3	31	9	
Lake Louise	Brandon Township	1952	324.0				1	3		30							10	214	12	
Lake Louise	Brandon Township	1953	99.0				10	24		12								80	2	
Lake Louise	Brandon Township	1955	90.0				26	8		4	12				2	2	4	95	11	
Lake Louise	Brandon Township	1956	10.0							3										
Lake Louise	Brandon Township	1957	46.0				9	5		1								19	5	
Lake Louise	Brandon Township	1958	55.0				18			1							1	12	1	
Lake Louise	Brandon Township	1960	126.0				3	2		2							1	107	19	
Lake Louise	Brandon Township	1961	204.0					8		6						3	10	171	7	
Lake Louise	Brandon Township	1964	13.0													1		25	2	
Goodrich Mill Pond	Atlas Township	1929	7.0							1				1				4	1	
Goodrich Mill Pond	Atlas Township	1932	19.0							4						3	4	12	4	
Goodrich Mill Pond	Atlas Township	1933	5.0							1								5		
Goodrich Mill Pond	Atlas Township	1935	5.0				16			2										
Goodrich Mill Pond	Atlas Township	1939	33.0														6	122	14	
Goodrich Mill Pond	Atlas Township	1942	8.0				4			1										

Appendix 4.–Continued.

Segment and water body	Location	Year	Angler hours	Brook trout	Brown trout	Rainbow trout	Black Crappie	Yellow Perch	Walleye	Northern pike	Bullhead	Carp	Channel catfish	Sucker	Smallmouth bass	Rock bass	Largemouth bass	Bluegill	Pumpkinseed	Bowfin
Upper Flint (continued)																				
Goodrich Mill Pond	Atlas Township	1943	18.0															51		
Goodrich Mill Pond	Atlas Township	1958	38.0				36			4								102		
Goodrich Mill Pond	Atlas Township	1961	13.0				20											7		
Goodrich Mill Pond	Atlas Township	1962	7.0							2								7		
Goodrich Mill Pond	Atlas Township	1964	10.5													2			1	
Goodrich Mill Pond	Atlas Township	1965	8.5				4	21										47		
Kearsley Creek	Atlas Township	1958	50.0							2								16	11	
Kearsley Creek	Atlas Township	1960	7.5				22													
Atlas Mill Pond	Atlas Township	1929	13.0					2							1			3	6	
Atlas Mill Pond	Atlas Township	1930	9.0							9										
Atlas Mill Pond	Atlas Township	1932	5.0								1					2				
Atlas Mill Pond	Atlas Township	1933	2.0															11	2	
Atlas Mill Pond	Atlas Township	1934	4.0							1										
Atlas Mill Pond	Atlas Township	1935	19.0				41			4										
Atlas Mill Pond	Atlas Township	1939	6.0							4							2			
Atlas Mill Pond	Atlas Township	1942	15.0				1			2										
Atlas Mill Pond	Atlas Township	1943	5.0							1										
Atlas Mill Pond	Atlas Township	1957	16.0				24			1								19	3	
Atlas Mill Pond	Atlas Township	1958	72.0				26			1								178	4	
Atlas Mill Pond	Atlas Township	1960	47.0				4			4								125	11	
Atlas Mill Pond	Atlas Township	1961	18.0				65													
Atlas Mill Pond	Atlas Township	1962	62.0							7								105		
Atlas Mill Pond	Atlas Township	1963	160.5				32	155										313	8	
Atlas Mill Pond	Atlas Township	1964	91.5							4								207		
Atlas Mill Pond	Atlas Township	1965	93.0				5											230		
Kearsley Creek	Davison Township	1930	6.0											14						
Kearsley Creek	Davison Township	1931	16.0								7			35						
Kearsley Creek	Davison Township	1932	6.5											7						
Kearsley Creek	Genesee Township	1931	7.0							3										
Kearsley Creek	Burton Township	1931	10.0							4						9	1			
Kearsley Creek	Burton Township	1958	8.0							4						4				
Kearsley Creek	City of Flint	1935	26.0				48	12		7										
Kearsley Creek	City of Flint	1958	92.0				82			7						80				

Appendix 4.–Continued.

Segment and water body	Location	Year	Angler hours	Brook trout	Brown trout	Rainbow trout	Black Crappie	Yellow Perch	Walleye	Northern pike	Bullhead	Carp	Channel catfish	Sucker	Smallmouth bass	Rock bass	Largemouth bass	Bluegill	Pumpkinseed	Bowfin
Upper Flint (continued)																				
Kearsley Creek	City of Flint	1959	286.0				334			5								557		
Kearsley Creek	City of Flint	1960	123.0				316									2		3		
Kearsley Creek	City of Flint	1962	81.5				79			5						3		102	6	
Kearsley Creek	City of Flint	1964	15.5				5			1										
Kearsley Creek	Flint Township	1931	6.5							4										
Kearsley Creek	Flint Township	1932	52.0					6		4	97			35					5	
Kearsley Creek	Flint Township	1933	21.0							2	15			23						
Kearsley Creek	Flint Township	1934	36.0								24				2	9	1	13		
Kearsley Reservoir	Flint Township	1935	19.0				23	2		1										
Kearsley Reservoir	Flint Township	1937	21.0				23	24		3								28		
Kearsley Reservoir	Flint Township	1939	38.5				29			3		17					2	18	11	
Kearsley Reservoir	Flint Township	1942	114.0				188			1								6		
Kearsley Reservoir	Flint Township	1943	29.5				44	17		1										
Kearsley Reservoir	Flint Township	1957	11.0				23													
Kearsley Reservoir	Flint Township	1958	364.0				1475				5							2		
Kearsley Reservoir	Flint Township	1960	138.5				449			3								230	11	
Kearsley Reservoir	Flint Township	1961	253.5				739									18		541		
Kearsley Reservoir	Flint Township	1962	18.0				47			1										
Kearsley Reservoir	Flint Township	1963	171.0				491											34		
Kearsley Reservoir	Flint Township	1964	42.5				13			1								8		
Kearsley Reservoir	Flint Township	1965	89.5				131													
Thread Creek	City of Flint	1962	8.0								5									
Thread Creek	Flint Township	1930	2.0											5						
Thread Creek	Flint Township	1932	5.0								1			6						
Thread Lake	Burton Township	1942	39.0				4			7										
Thread Lake	Burton Township	1943	12.0							3										
Thread Lake	Burton Township	1958	15.0				2			1										
Flint River	Lapeer County	1939	7.0							4				14		11	1			
Flint River	Lapeer County	1942	146.0	5						22						5				
Flint River	Lapeer County	1943	136.0							4				131						
Flint River	Lapeer County	1944	105.5							3				57						
Flint River	Deerfield Township	1941	4.0							1										
Flint River	Deerfield Township	1946	19.0							1										

Appendix 4.–Continued.

Segment and water body	Location	Year	Angler hours	Brook trout	Brown trout	Rainbow trout	Black Crappie	Yellow Perch	Walleye	Northern pike	Bullhead	Carp	Channel catfish	Sucker	Smallmouth bass	Rock bass	Largemouth bass	Bluegill	Pumpkinseed	Bowfin
Upper Flint (continued)																				
Holloway Reservoir	Oregon Township	1956	89.0				2	1		7		48				2		9		
Holloway Reservoir	Oregon Township	1959	136.0				67											69	7	
Holloway Reservoir	Oregon Township	1960	122.0				104			2		6						30	1	
Holloway Reservoir	Oregon Township	1962	330.5				406			1		4						54	1	
Holloway Reservoir	Oregon Township	1963	192.0				86	3		1								97	21	
Holloway Reservoir	Oregon Township	1964	466.0				794	9				9		8				42		
Flint River	Marathon Township	1941	16.0							4						8				
Flint River	Marathon Township	1946	4.0													1				
Flint River	Marathon Township	1950	38.0							1										
Flint River	Marathon Township	1952	9.0											14						
Flint River	Marathon Township	1960	57.0				7					8						8		
Flint River	Oregon Township	1946	4.0													4				
Flint River	Oregon Township	1959	51.0				2							9						
Flint River	Oregon Township	1964	85.0				23			1	2	7		19						
Flint River	Richfield Township	1946	6.0							3										
Flint River	Richfield Township	1957	760.0							90										
Flint River	Richfield Township	1958	287.0							46										
Flint River	Richfield Township	1960	12.5					75		1										
Flint River	Richfield Township	1961	21.5					128												
Flint River	Richfield Township	1962	156.0				673	22		3								124		
Flint River	Richfield Township	1963	212.0				779			2								2		
Flint River	Richfield Township	1964	227.5				1138									4		73		
Flint River	Richfield Township	1965	113.0				361	138	1									129		
Flint River	Genesee Township	1958	44.0							6										
Flint River	Mt. Morris Township	1934	1.0							1										
Flint River	Davison Township	1931	10.0							2				85						
Flint River	Davison Township	1934	1.0							1										
Flint River	Burton Township	1931	5.0								4									
Flint River	Flint Township	1929	40.0					7	1	1	1			60						
Flint River	Flint Township	1930	15.5							6				4	1	8				
Flint River	Flint Township	1931	5.0								9			20		5				
Flint River	Flint Township	1932	18.0							2				18						
Flint River	Flint Township	1933	19.0											17						

Appendix 4.–Continued.

Segment and water body	Location	Year	Angler hours	Brook trout	Brown trout	Rainbow trout	Black Crappie	Yellow Perch	Walleye	Northern pike	Bullhead	Carp	Channel catfish	Sucker	Smallmouth bass	Rock bass	Largemouth bass	Bluegill	Pumpkinseed	Bowfin
Upper Flint (continued)																				
Flint River	Flint Township	1958	155.0				31			38										
Middle Flint																				
Flint River	Flushing Township	1932	13.0											27		2				
Flint River	Flushing Township	1933	4.0									1		2						
Flint River	Montrose Township	1930	8.0							3		1		9						
Flint River	Montrose Township	1931	6.0							1		3		11						
Flint River	Montrose Township	1932	5.0							1				7						
Flint River	Montrose Township	1933	6.0							1				5						
Lower Flint																				
Misteguay Creek	Hazelton Township	1946	30.0											43						
Misteguay Creek	Maple Grove Township	1944	33.0											104						
Misteguay Creek	Maple Grove Township	1945	18.0											6						
Misteguay Creek	Maple Grove Township	1948	14.0							2										
Misteguay Creek	Maple Grove Township	1953	9.0								4									
Misteguay Creek	Maple Grove Township	1959	14.5											8						
Misteguay Creek	Maple Grove Township	1960	54.0								10	1		3		15			9	
Flint River	Spaulding Township	1942	7.0											11						
Flint River	Spaulding Township	1945	12.0							5		4								
Flint River	Spaulding Township	1953	37.0					8			4	22	2			2				
Flint River	Taymouth Township	1959	2.0											4						
Flint River	Saginaw County	1961	24.0					1			5									