STATE OF MICHIGAN
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Black River Assessment

Robert C. Haas

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FISHERIES DIVISION
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Picture on front cover is courtesy of the Port Huron Museum. A logging crew cutting trees along Black River (Ca. 1880) for Howard & Son Lumber of Port Huron.

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EXECUTIVE SUMMARY

Introduction

This is one in a series of river assessments being prepared by the Michigan Department of Natural Resources, Fisheries Division, for Michigan rivers. This report describes the physical and biological characteristics of the Black River, discusses how human activities have influenced the river, and will serve as an information base for managing the river's future.

River assessments are intended to provide a comprehensive reference for citizens and agency personnel who need information about a river. These assessments provide information to help identify opportunities and solving problems related to aquatic resources in watersheds. It is hoped that this river assessment will increase public awareness of environmental challenges for the Black River and serve to promote a sense of public stewardship and advocacy for the resources of this watershed. The ultimate goal is to increase public involvement in the decision making process to benefit the river and its 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 Black 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. They are intended to provide a foundation for public discussion, setting priorities, and planning the future of the Black River.

Geography

The Black River drains an area of 710 square miles in Michigan's Thumb, north and west of the City of Port Huron. The main stem is 73 miles long, and its major tributary streams total an additional 118 miles. There are very few natural inland lakes in the Black River watershed. The headwaters originate in the Minden Bog area of Minden Township, Sanilac County, located at the border with Huron County. From its origin, the river flows south, largely through relatively flat agricultural areas of Sanilac County. Upon nearing the south border of Sanilac County, it enters, and is entrained by, a large, natural valley of glacial origin. Major parts of this portion of the main stem valley (about 16 river miles) through St. Clair County are contained within the Port Huron State Game Area managed for public recreation by the Michigan Department of Natural Resources. Where the main stem valley reaches the south end of Lake Huron, it turns in the southeast direction to Port Huron, where it flows into the St. Clair River.

For the purpose of discussion, the Black River main stem is divided into four major segments based on valley segment descriptions and artificial modifications of major river channels. The uppermost segment runs from north of Minden Bog to just upstream from the confluence of the main stem with Elk Creek. Segment 2 receives water from Elk Creek, which drains the largest subwatershed, and continues downstream to a point several miles below the City of Croswell where the river channel takes on a much more natural form. In Segment 3 the gradient quickly changes from relatively low at the upper end to very good in the rest of this segment as the river travels down towards the archaic lake plain. The river valley becomes more natural as it continues downstream and about 16 miles of the Black River main stem are contained within the Port Huron State Game Area. Segment 3 has the remaining subwatersheds entering as tributaries along its course, including Black, Silver, Plum, and Mill creeks. Segment 4 is 11 miles long encompassing the main stem from the Wadhams Road bridge to the mouth in the city of Port Huron. This segment of the main stem is characterized as very low to negligible gradient with significant affect from changing water levels in the upper St. Clair River. Stocks Creek, Howe Drain, and the Black River Canal comprise the only significant tributaries

History

The southern extent of the pine district (where pine could be profitably harvested) began just below the mouth of the Black River and extended across the state to Lake Michigan. The lumbering industry in Michigan got underway in the Black River watershed in the 1740s, because the area was the closest and had the most accessible source of cedar and pine for building ships, forts, and other structures around Detroit. Michigan’s first steam mill was built on the Black River in 1832, five years before statehood. Historians have determined that by 1880 the pineries of St. Clair and Sanilac counties had been completely depleted. Vast areas of the Black River watershed were composed of flat, poorly drained soils and many areas had significant wetlands in the early settlement period. Canals were dug along many riverine systems to promote soil drainage and flow of water away from the land for agricultural development. The Black River watershed continues to be severely affected by historical and current drainage practices.

Geology and Hydrology

In the upper reaches, the Black River has a very low gradient flowing over mostly fine to medium textured lacustrine deposits that are easily eroded. However, as it travels south the river increases gradient as it crosses between end moraines consisting of fine to very coarse grained glacial till. These deposits provide gravel, cobbles, and boulders for valuable substrate. 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 hydrogeomorphic diversity. The major end moraine to the east of Black River extends from Huron County south through much of St. Clair County separating the watershed from Lake Huron. At approximately Wadhams Road in St. Clair County, the Black River begins to head east cutting across beach ridges and moraines before entering the St. Clair River.

Soils and Land Use Patterns

Soils in the Black River basin are chiefly (80%) silt loams and sandy loams and are drained somewhat poorly to very poorly. A very large percentage of the land has been converted to agricultural production. Forested land went from 443,000 acres in 1800 to 85,000 acres in 1992. Cultivated lands account for most of the 359,000 acre difference. There are 10 cities, towns, and small villages in the Black River watershed the largest of which is Port Huron with a population of approximately 32,000 people.

Channel Morphology

The channel length and gradient varied considerably among segments, with the gradient being 2.9 feet per mile in Segment 1, only 1.9 feet per mile in Segment 2, 3.7 feet per mile in Segment 3 and undetectable in Segment 4. Black Creek, one of the smaller tributaries, had the highest gradient at 9.6 feet per mile. Mill Creek also has a relatively high gradient at about 5.0 feet per mile.

Dams and Barriers

While most large river systems in Michigan have many dams, there are only three major dams in the Black River watershed, two on the main stem of the river and one on Mill Creek. Dams have a direct affect on a river environment by altering the natural cycle of water flow, fragmenting river continuity, blocking fish passage, and modifying downstream flows, temperature, water quality, and habitat.

Water Quality

Stream water quality is a very important determinant affecting aquatic organisms and the health of the entire aquatic community within a watershed. Nonpoint source pollution is the greatest factor that degrades water quality in this watershed. The entire Black River and most, or all, tributaries suffer greatly from high sediment loading due to erosion from widespread channelization, extensive cultivation, and to some extent, poor land management. Unnaturally high-sediment loadings to a river system create a myriad of serious geomorphic and biological problems. The NPDES Phase II permitting process provides a framework with three components (municipal storm sewer, industrial storm water, and construction storm water) for addressing storm water and flow issues. Management plans for watersheds in St. Clair County are being developed under the leadership of the County's Stormwater Coordinator to fulfill the Environmental Protection Agency (EPA) and Michigan Department of Environmental Quality (MDEQ) Phase II National Pollutant Discharge Elimination System (NPDES) regulations. There are 52 NPDES permitted discharges to the surface waters in the Black River watershed.

Special Jurisdictions

Several government agencies have regulatory responsibilities that affect the river. The Michigan Department of Natural Resources and Department of Environmental Quality manage natural resources and state-owned lands, and enforce environmental regulations. The U. S. Fish and Wildlife Service (USFWS), U. S. Department of Agriculture, and U. S. Environmental Protection Agency all have responsibilities for specific federal mandates. Counties and townships are involved in planning and zoning activities. County drain commissioners have authority to establish designated county drains which allows for construction, maintenance, inspection, and improvement of all county drains. There are almost 1,000 miles of designated drains in the Black River watershed.

Biological Communities

Little information on the history of the fish community in the Black River watershed is available prior to 1972, and no creel surveys have been conducted on the main stem or its tributaries. Fisheries surveys since 1972 and other sources going back even further, show that 89 species of fishes occurred in the Black River drainage during the past 65 years. That is a relatively high number because there are essentially no natural lakes in the watershed. Most species are native, although three species have colonized and four species were introduced (some intentional and others accidental). Conditions prevalent due to watershed development have favored tolerant species with broad habitat requirements. Deforestation and agricultural activities have reduced flow stability and increased sediment load in streams throughout the watershed. The abundance of silt-tolerant fish species have increased, whereas fishes requiring clean gravel substrate or clean water with aquatic vegetation at some point in their life cycles have declined. Introduced pest species including common carp, purple loosestrife, and Phragmites have had negative effects on native fishes and invertebrates.

Fish sampling was conducted by Fisheries Division at numerous sites throughout the watershed during 1972 through 2006. Seventy-nine species of fish were caught, with mimic shiner, common shiner, bluntnose minnow, bluegill, white sucker, and golden redhorse being the most frequently seen species among sites. Recent fish sampling found that species richness has improved over the past four decades. These findings support the contention that there was improvement in water quality over the past thirty years. Earlier, the Black River supported a very diverse fish community and it is reasonable to think that it can be restored.

Invertebrates are less mobile than fish so their community can provide a direct indication of water quality. Water sampling was conducted by Michigan Water Resources personnel in 1973 to evaluate effects from municipal and industrial discharges in the vicinity of Croswell. Aquatic habitat in the Black River at that time was seriously compromised by pollution and the invertebrate community consisted mainly of tolerant species. Surveys have been conducted about every ten years since and have shown that a substantial improvement in habitat quality and invertebrate fauna has occurred. However, much of the watershed is still heavily affected by nonpoint source pollution.

Within the Black River watershed there are 19 of Michigan's native mussel species which are state listed as threatened, endangered, or of special concern with three of these species also being federally listed as endangered. The Black River, surveyed in 2003 by Michigan Natural Features Inventory (MNFI), found evidence of 22 native mussel species, 17 live and 5 shell only. In 2005, another survey observed 15 living species plus 6 more identified from dead shells. The Black River is a potential native mussel refuge because it has few boat launches and has relatively high mussel diversity which makes it less likely that zebra mussels will be introduced. Recent surveys of the East Sydenham River in Ontario documented populations of many mussels that were presumed to be common historically in the Black River, but are now rare or extirpated. The USFWS, at their Genoa National Fish Hatchery in Wisconsin, is culturing endangered and threatened mussels for rehabilitation into the wild. It would be feasible to culture and reintroduce some of the endangered and threatened mussels into the Black River watershed, assuming their habitat has recovered sufficiently to support them.

Minden Bog is a very unique and ecologically valuable natural resource to the State of Michigan. It is the only raised bog in Michigan and likely the most southerly example of a raised bog in North America. Minden Bog is truly domed forming parts of the headwater areas of the Cass and Black river watersheds. The raised portion of the bog is isolated from the water table and receives its water only from precipitation. Much of the natural bog that remains is in the Black River watershed and managed by MDNR Wildlife Division as part of the Minden City State Game Area.

The Port Huron State Game Area has many unique natural features making it the most valuable habitat for native plants and animals. It contains a large, contiguous riparian zone protecting the river and providing a variety of habitat types connected by the waterway. The game area supports many areas labeled by MNFI as “special botanical projects.” Extensive ravines along the Black River, heavily wooded with hemlock, provide shelter and moisture similar to habitats normally found in Michigan’s Upper Peninsula. These ravines are known to support over 200 species of plants including broad-leaved sedge (state endangered SE), large toothwort (state threatened ST), beak grass (ST), wahoo, goldenseal (ST), broad-leaved puccoon, heart-leaved plantain (SE), trailing arbutus, painted trillium (SE), pink moccasin flower, twisted stalk, rattlesnake plantain orchid, beaked hazelnut, and golden saxifrage.

Fishery Management

Intensity of fishery management of the Black River ranges from very low in Segments 1, 2, and 4 to moderate in Segment 3 and Mill Creek. Past management practices have included fish stocking, fishing regulations, and chemical reclamation to reduce competitors. A number of fish species have been stocked at various times and locations throughout the watershed. Current significant sport fisheries include seasonal steelhead and walleye fisheries on the lower portion of the Black River and Mill Creek. There are also occasional stocking efforts at several human-made ponds which are not connected directly to the Black River.

Recreational Use

Recreational use of the Black River is very limited in the upper two segments, but is high in Segment 3 and moderate in Segment 4. The recreation potential of portions of the watershed in state game areas is huge due to their large area, public ownership, and accessibility by Southeast Michigan residents. Many people use these areas for fishing, canoeing, bird watching, picnicking, trapping, and hunting. However, the potential use of the entire river is limited by public access and excessive silt and turbidity. Improved public access throughout the river and corrective action to reduce erosion will improve recreational potential.

Citizen Involvement

The aquatic environment in upper segments of the Black River watershed is very degraded because land managers have chosen to modify stream channels and artificially drain extensive areas of the landscape with little regard for native animal and plant communities. It will take great effort to increase public awareness and restore natural features of the upper Black River watershed. For the lower two segments of the watershed, St. Clair County government, by building a strong coalition of many local governmental agencies and public interest groups, has made very significant progress in obtaining that goal.

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Michigan Department of Natural Resources
Fisheries Special Report 51, 2009

BLACK RIVER ASSESSMENT

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INTRODUCTION

This river assessment is one of a series of documents being prepared by the Michigan Department of Natural Resources (MDNR), Fisheries Division, for rivers in Michigan. We have approached this assessment from an ecosystem perspective, as we believe that fish communities and fisheries must be viewed as parts of a complex ecosystem. Our approach is consistent with the mission of MDNR, Fisheries Division, namely to "protect and enhance the public trust in populations and habitat of fishes and other forms of aquatic life, and promote optimum use of these resources for benefit of the people of Michigan".

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

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

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

River assessments provide an organized approach to identifying opportunities and solving problems. They provide a mechanism for public involvement in management decisions, allowing citizens to learn, participate, and help direct decisions. They also provide an organized reference for Fisheries

Division personnel, other agencies, and citizens who need information about a particular aspect of the river system.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Copies of the draft assessment were distributed for public review in summer 2008. Two public meetings were held in St. Clair County on July 30, 2008, 22 people attended, and at Croswell Public Library, Crosswell on July 31, 2008, 9 people attended. Written comments were received through September 30, 2008. Comments were responded to in the Public Comment and Response section.

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

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

Michigan Department of Natural Resources
Fisheries Division
Southfield Operations Service Center
26000 W. Eight Mile Road
Southfield, MI 48034-5916

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

RIVER ASSESSMENT

Geography

The Black River drains an area of 710 square miles in Michigan's "Thumb Region" of the Lower Peninsula, north and west of the City of Port Huron. The main stem is 73 miles long, and its major tributary streams total an additional 118 miles (Figure 1). There are no natural inland lakes in the Black River watershed with public boating access. The headwaters originate in the Minden Bog area of Minden Township, Sanilac County, located at the border with Huron County. From its origin, the river flows south, largely through relatively flat agricultural areas of Sanilac County. From its origin, the main stem is bordered on the east by a relatively high glacial ridge which forces the river to flow south instead of entering Lake Huron (Figure 2). Upon nearing the south border of Sanilac County, the Black River enters, and is entrained by, a large, natural valley of glacial origin. Major parts of the main stem valley (about 16 river miles) in St. Clair County are contained within the Port Huron State Game Area which is managed for public recreation by the Michigan Department of Natural Resources. Where the main stem valley reaches the south end of Lake Huron, it turns southeast to Port Huron, where it flows into the St. Clair River. Physical and biological characteristics of the Black River change considerably from its headwater to mouth. Therefore, for purposes of discussion, the river was split into four segments based on field observations and valley segments that were identified using an ecological classification procedure (Seelbach et al. 1997). Valley segments represent portions of the river that share some common channel and landscape features and therefore represent fairly distinctive and homogenous ecosystems. Valley segments were identified using major changes in landform, hydrology, channel and valley shapes, catchment land cover, and surficial geology that were viewed and interpreted using the Michigan Rivers Inventory Geographical Information System database (Seelbach et al. 1997; Wiley and Seelbach 1997). These valley segments only describe the Black River main stem reaches and not the large network of streams and designated drains that are tributary to the segments.

Segment 1 (Headwaters)

Segment 1 is 15 miles long and extends from Mills Road near Minden Bog in Wheatland Township south to Hyde Road in Washington Township (Figure 3). This segment of the main stem consists entirely of designated drain and the river is small, highly channelized and straightened, with very high sediment loading. There is one major tributary system, Berry Drain subwatershed, that enters the Black River from the West at Wheeler Road in Bridgehampton Township. The town of Sandusky, year 2000 census population 2,745, is located in the southwestern part of Berry Drain subwatershed. Segment 1 also contains the small villages of Deckerville and Carsonville located east of the main stem.

Segment 2

This segment of the Black River main stem begins at Hyde Road and continues south 17 miles to Mortimer-Line Road in Worth Township (Figure 3). This segment is considerably larger since it receives water at the upper end from the Black River's largest tributary system, known as Elk Creek subwatershed (186 mi^2). Virtually all of the water courses in the Elk Creek subwatershed have been converted to designated drains that are channelized and straightened. In Segment 2 the Black River is very heavily influenced by the size and number of designated drains that it receives. The upper $2/3^{rd}$ of this Black River main stem segment also consists of designated drain that has been channelized and straightened. Drain designation ends approximately 2.5 mi north of the City of Croswell where the slope of the river channel begins to increase. The village of Applegate, population 287, and Croswell, population 2,467, are located on the river. Croswell has had a long history of agricultural and industrial river water use and these have been critical in setting channel morphology and water quality issues in this segment. An example is the construction of a major dam for industrial water supply. South of Croswell, the main stem, still affected by the dam, begins to transform into a more natural channel arrangement with meanders and riffle-pool sequences. However, the riparian zone is primarily residential development and highly modified.

Segment 3

This relatively large segment begins at Mortimer-Line Road in Sanilac County and continues 29 miles south to the river crossing at Wadhams Road in Clyde Township, St. Clair County (Figure 3). The gradient quickly changes from relatively low at the upper end to fairly steep in the rest of this segment as the river travels south toward the archaic lake plain. The river valley becomes more natural as it continues downstream and about 16 miles of the Black River main stem are contained within the Port Huron State Game Area where forested buffers provide valuable protection and wildlife habitat. This segment also has the best sequences of riffles and pools with much gravel and boulder habitat for fish and aquatic invertebrates. Segment 3 has the remaining subwatersheds entering as tributaries along its course, including Black, Silver, Plum, and Mill creeks. The Black Creek subwatershed is the most upstream of these tributaries and is substantial in size at 50 mi^2. It has many miles of designated drains and probably supplies a lot of sediment to the Black River. Silver and Plum creeks are relatively small subwatersheds, but they have significant areas of forested floodplain that provide wildlife habitat. Mill Creek is the second largest subwatershed, 184 mi^2, and has significant natural habitat value. Yale, population 2,063, is located on Mill Creek in Brockway Township and is the only city within the drainage area of this main stem segment. There is a low-head dam in the Yale city park. The Mill Creek Volunteer Monitoring Project (MCVMP), part of the Michigan Department of Environmental Quality's Volunteer Monitoring Program, has been monitoring biological indicators of water quality in the upper 17 miles of Mill Creek upstream from Yale. This segment of Mill Creek has been targeted for significant channel modifications by the Inter-County Drain Board.

Segment 4 (Mouth)

The final segment is 11 miles long encompassing the main stem from the Wadhams Road bridge to the mouth in the city of Port Huron where it empties into the St. Clair River only two miles downstream from Lake Huron (Figures 1 and 3). This main stem segment is characterized as very low to negligible gradient with significant affect from changing water levels in the upper St. Clair River. Stocks Creek, Howe Drain, and the Black River Canal comprise the only significant tributaries. The Black River Canal was dug in 1912 to connect the Black River with Lake Huron four miles upstream from the mouth of the Black River. This added flow of clean Lake Huron water to the Black River to dilute pollution concentrations in Port Huron.

History

The Black River and its watershed have been shaped by the Late Wisconsinan glacier, of the Pleistocene Epoch, 18,000 years ago (Farrand and Eschman 1974). The glacier was composed of several major lobes that were in general retreat from roughly 16,000 years ago, until the entire state was free of ice about 10,000 years ago. The entire Black River watershed was covered by two lobes of the Wisconsinan glacier—the Saginaw lobe, which advanced from the north and the Erie-Huron lobe from the northeast (Mozola 1953). The glacial retreat left varied moraine and outwash deposits that strongly influence local hydrology, channel morphology, and gradient of the main stem and tributaries. During the late part of the Wisconsinan glaciation, between 35 and 10 thousand years ago, the margin of the Laurentide ice sheet advanced in a series of sublobes that eventually covered the entire Great Lakes watershed (Larson and Schaetzl 2001). This expansion and subsequent withdrawal was characterized by a series of major and minor advances and retreats, evidence for which occurs in the stratigraphic record and in the cross-cutting relationship of end moraines. Glacial meltwater created several large great lakes during this interval (Figure 4) with variable water levels, which had significant effects on the drainage patterns and landforms we see today.

The earliest evidence of occupation in the Black River watershed dates to the Paleo-Indian period, over 10,000 years ago, when Indian people entered the area to hunt mastodon and other now-extinct game (Figure 5; Table 1). During the Paleozoic Era, beginning about 600 million years ago and ending about 230 million years ago, seawater invaded the Michigan Basin at least six times. As the seas receded and evaporated, mineral deposits such as rock salt and gypsum were left behind. The Black River watershed has large amounts of salt-laden groundwater deep within bedrock aquifers. In some locations in the lower river, these mineral laden aquifers made it to the surface. These "salt licks" attracted an abundance of game animals, including mastodon and wooly oxen, which were exploited by hunters; and may have been a source of salt for consumption, food preservation, and trading by local human inhabitants.

Native peoples adapted to changing ecosystems at the end of the Pleistocene by developing strategies to maximize their use of seasonally available game and food plants such as nuts, during the Archaic period. By 500 B.C., the beginning of the Woodland period, local peoples were experimenting with growing crops and making ceramics. The population seems to have greatly increased by the Late Woodland period, perhaps in part due to the adoption of the bow and arrow and corn horticulture.

The French explorer La Salle was the first European to sail a ship up through the St. Clair River and Lake Huron (Cleland 1992). He returned to the Great Lakes in 1677 to rebuild Fort Frontenac on Lake Ontario and construct a forty-five ton schooner, the Griffin to continue his search for a more direct shipping route to China (Lahontan 1703). La Salle, accompanied by Father Hennepin and Henri de Tonti, sailed the Griffin up through Lake Erie, Lake St. Clair, and Lake Huron in the fall of 1678.

> At length they were enabled to approach Lake Huron, but the violent current, increased by a northerly gale, prevented their advancing. The wind shifting to the south, they succeeded, with the aid of a dozen men towing on shore, as at the outlet of Lake Erie, in surmounting the rapids [at head of St. Clair River], which were pronounced by Hennepin almost as strong as those of Niagara. They entered the lake [Huron] August 23, the Franciscans chanting the "Te Teum" for the third time, and thanking the Almighty for their safe navigation thus far and for the sight of the great bay of Lake Huron, on the eastern shores of which their brethren had established one of the earliest missions in North America, sixty-four years before. [from Mansfield 1899]

Fort St. Joseph was constructed in 1687 by the French explorer Duluth at Port Huron to bar English traders from the upper lakes (Cleland 1992). The French fort was abandoned in 1688, but eventually became the site of Fort Gratiot. The Black River which passed by Fort St. Joseph was named Is Riviere Duluth in his honor. A hundred years later, French trappers and traders were calling it LaRiviere Noire, which means Black River. At that time, the Black River drained vast areas of bogs and swamps, which likely supplied water stained dark, or black, with tannic acid. The uppermost reaches of the Black River continue to be stained dark with tannin as it drains land in the area surrounding Minden Bog.

The arrival of the French in the seventeenth century began a period of depopulation brought about by the introduction of new diseases and social upheaval. The Indians interacted with European economic systems through the fur trade, which brought them metal, tools, cloth, and other valued items. Population movements and disputes among the Great Lakes tribes and colonial powers affected the entire region (B. Mead, Department of State, Office of the State Archaeologist, personal communication).

The land area within Michigan was part of the Province of Quebec in 1775, became part of the Northwest Territory in 1790, the Michigan Territory in 1805, and attained statehood in 1837.

The southern extent of the pine district began just below the mouth of the Black River and extended across the state to Lake Michigan (Dunbar and May 1995). The lumbering industry in Michigan really got underway in the Black River watershed in the 1740s, because it was the closest and most accessible source of cedar and pine for building ships, forts, and other structures around Detroit (Bay 1938). There was a water-powered saw mill at Marysville, just south of the mouth of the Black River in 1742 (Sommers 1977). During the next 175 years and peaking in the mid-1800s, immense numbers of trees were floated down the Black River to quite a few saw mills in the Port Huron area where they were cut into boards and planks which were rafted and floated or shipped by barge to Detroit (Figure 6). Michigan's first steam mill was built on the Black River in 1832, five years before statehood. By 1849, there were 559 steam-powered lumber mills operating in the state. Lumber from the Black River watershed was used to rebuild Detroit after the big fire of 1805 destroyed large areas of the city. A few years later, oak timbers and spars from the Black River were sent to Detroit to build Commodore Perry's fleet during the war of 1812. It has been estimated that a total of three billion feet of white pine and an enormous quantity of hardwood were cut from St. Clair County between 1870 and 1890.

Historians have determined that 1880 was the peak year in Michigan's lumbering era and, by that time, the pineries of St. Clair and Sanilac counties had been completely depleted a number of years earlier. Following a period of extensive drought, great fires started on October 8, 1871 in an area stretching from eastern Wisconsin to downtown Chicago to Port Huron, Michigan. The entire area of the Black River watershed, which had much residual woody fuel discarded by lumbering activity, burned during this fire. Not all of the woody debris was consumed by the 1871 fire and another large fire in 1881, known as the Thumb Fire, again destroyed most of the timber in Sanilac and St. Clair counties (Sommers 1977).

Salt mining became an important industry in St. Clair County in the late 1800s. Maps made around that time of Port Huron and the lower Black River show several "salt blocks" which were industrial sites producing salt from brine wells. In 1886, there were 75,000 barrels of salt produced in St. Clair County, and by 1910, salt production in the county had increased to 1.3 million barrels.

The southern end of Lake Huron and mouth of the Black River have been important to the shipping industry since the first sailing ship attempted to pass the rapids at the head of the St. Clair River. The first lighthouse on Lake Huron was constructed at Fort Gratiot on the north side of Port Huron in 1825. The first canal project for the lower Black River was proposed about 1837 by the Huron Land Company. Their scheme was to install a lock in the Black River with a head sufficient to pass ships around the rapids at the head of the St. Clair River. Sailing vessels had great difficulty making passage from the St. Clair River into Lake Huron because of the extremely fast and turbulent water over the rapids at the outlet of Lake Huron. It was common for sailing ships to be delayed near the mouth of the Black River for 15–20 days waiting for favorable weather and water conditions. The canal and lock proposal would allow ships to sail up the Black River and through the dug channel to Lake Huron, thus avoiding the rapids altogether. The economic panic and financial depression of 1837 caused abandonment of the project.

Vast areas of the Black River watershed, especially in the north sections, are composed of flat, poorly drained soils and many areas had significant wetlands in the early settlement period. Early European settlers interested in agriculture were eager to drain the land to promote growth and harvest of crops. Canals were dug along many riverine systems to promote soil drainage and flow of water away from the land (Figure 7). The first comprehensive drain law in Michigan was passed in 1839. According to Miller and Simons (1918) in the 1830s Sanilac County had 95,000 acres of drainable wetlands, St.

Clair County had 65,000 acres, and Lapeer County had 47,000 acres. The drain law was rewritten in 1897 and during the period from 1898 to 1917, 1.16 million dollars (equal to about 21 million dollars in 2008) was spent developing drains in Sanilac County alone, which was second highest of all counties in Michigan. Lapeer County spent $502,000 ($9,000,000 in 2008) and St. Clair County spent $341,000 ($6,000,000 in 2008) during the same time.

Natural shallow waters in the St. Clair River and lower Black River were hindering navigation. Dredging projects to improve navigation in the St. Clair River were begun in 1855 (Brunk 1968) and have continued to a lesser or greater degree to present. The rapids area at the head of the St. Clair River was dredged at this time allowing free passage of ships in and out of Lake Huron.

Deepening and widening of the lower Black River to improve navigation in the late 1800s exacerbated the low flow rate in the river through Port Huron to it's confluence with the St. Clair River. Sewage from over two-thirds of the city's population and much industrial effluent were being dumped directly into the Black River where they remained under most flow conditions. The City of Port Huron planning commission had taken up the pollution issue in 1889 as a recommendation to correct the severe contamination problem in the lower Black River in downtown Port Huron. The plan was to construct a canal 25 feet wide at the bottom and 8 feet deep to allow fresh, clean water to flow from Lake Huron to the Black River near the corner of Pine Grove Street and Holland Avenue, about four miles upstream from the mouth of the Black River. Clean Lake Huron water would flush some of the putrid water out into the St. Clair River. Construction of the Black River Canal connecting Lake Huron to the Black River was started in 1906 and continued until its completion in 1912. The canal proved to be quite successful under most flow conditions but has required extensive dredge maintenance to remove sand and other sediment that was transported into the canal from Lake Huron. Subsequent sewer improvement projects have prevented most of the raw effluent from getting into the river.

Geology

The Black River basin evolved during the retreat of the last of the glaciers which, at one time, covered the entire basin (Karrow 1984). The size, shape, and surface features as we see them today, are the end result of these glaciers and associated meltwater lakes. Suspended material deposited from the glaciers, collectively termed glacial drift, comprise one of the two major types of earth materials underlying the basin—the other major type being the consolidated, or bedrock, formations beneath the glacial drift. The drift varies in thickness from less than 50 to more than 350 feet. Over most of the basin, however, it ranges between 100 to 200 feet in thickness. Underlying the glacial till are the bedrock formations of shale and sandstone of Devonian and Mississippian age that dip to the west (Farrand and Eschman 1974). In sequence from youngest to oldest, these formations include the Marshall sandstone, Coldwater shale, Sunbury shale, Berea sandstone, Bedford limestone, and Antrim shale formations. The uppermost bedrock layers are oldest in the southeast and progressively younger in a westerly direction. The Marshall and Berea formations are the only ones capable of yielding much groundwater, and the quality of water from the latter is very poor due to extreme hardness. Salt minerals are abundant in these sedimentary rocks and mineral laden groundwater naturally seeps from the ground or is obtained from wells for industrial purposes in St. Clair County. Natural salt seeps have an effect on water quality in the Black River.

The last glacier covering the Black River watershed retreated about 13,000 years ago (Larson and Schaetzl 2001). At times several large, proglacial lakes covered the area during the ensuing 2,000 to 3,000 years (Figure 8). Suspended material was deposited by the glaciers which collectively is termed glacial drift. The drift, or till, consists of fine clay-like particles to huge boulders as big as cars that are not sorted by size. The proglacial lakes left relatively flat deposits of fine-grained material ranging in size from silt and clay to sand and gravel, which were well sorted by size.

The glacier stalled for periods of time and deposited many end moraines which parallel Lake Huron and Saginaw Bay shorelines. The meltwater at the margins of the glacier left lacustrine and fluvial deposits. These glacial features determine the general shape of the landscape in the watershed. A three-dimensional surface map (Figure 9) delineates the end moraines that set the eastern boundary of the watershed and prevent the Black River from trending to the east to enter Lake Huron. The map clearly shows how the short Lake Huron drainages run straight east to enter the lake, while the Black River runs south, even though it is only a very short distance west of the Lake Huron drainages (Figure 9). There are also several beach ridges associated with the end moraines on the east boundary, likely deposited when proglacial Lake Saginaw (about 13,000 years ago) or Lake Algonquin (about 11,800 years ago) were at high levels. Great Lakes water levels were much lower 5,000 years ago (Lake Stanley stage) than they are today and Lake Stanley (now Huron) drainage was east through the northern part of what is now Georgian Bay. A graph (Figure 9) shows a vertical land elevation profile of a west to east transect across the watershed. This graph clearly shows that the end moraine on the east boundary of the watershed is approximately 39 ft (12 m) higher than the highest point on the Black River valley on the west side of the transect.

The Black River flows over mostly fine to medium textured lacustrine (lake) deposits that are easily eroded (Figure 10). Ancient lake beds in the northern part of the watershed are principally sand and yield moderate quantities of groundwater. In the southern part of the watershed, lake beds are predominantly clay which, in general, is not a good source of groundwater (Farrand and Eschman 1974). However, as it travels south the river crosses between end moraines consisting of fine to very coarse grained glacial till, trending north-south, to the east and west. These end moraines are a better source of water and a source of gravel, cobbles, and boulders which provide valuable substrate in much of the river helping to prevent further erosion of finer underlying materials. The end moraine to the east of the Black River extends from around Verona Township in Huron County to just north of the City of St. Clair. The course of the Black River cuts several traces of former shorelines of glacial and proglacial lake stages. At approximately Wadhams Road in St. Clair County, the Black River begins to head east cutting across a former beach ridge, an end moraine to the east, and then across another former beach ridge before entering the St. Clair River.

Hydrology

Climatic factors determine a river's temperature and hydrologic conditions, which strongly influence biota and land use. The dynamics of water transport through river systems are determined by complex interactions between landscape elements and the climate (Wiley and Seelbach 1997). Understanding how the local climate functions is vital to resource management activities within a river and its watershed. Daily air temperature and precipitation data were collected from the National Climatic Data Center (NCDC), part of the Department of Commerce, National Oceanic and Atmospheric Administration (NOAA). Daily data were obtained from the three NOAA weather stations within the Black River watershed for periods of record (Figure 11). Daily maximum and minimum air temperatures were determined for Port Huron and Sandusky stations because they had longer periods of record. The Port Huron station is located at the very southeast margin of the watershed and the Sandusky station is located in the upper, middle area. Average maximum and minimum air temperatures and precipitation for each of the 12 months (Figure 12) and for all years in the periods of record (Figure 13) were calculated.

The Black River watershed is cooler than most of the rest of southern Lower Michigan and the growing season is 130 to 160 days (Dr. Fred V. Nurnberger, Michigan Climatologist, personal communication). Because most air flows over the Black River are from a westerly direction, the watershed experiences less lake moderation than the west side of the state. Extreme minimum temperature ranges from -24°F to -28°F. Mean monthly temperatures at Port Huron run from a low of 24.2°F in January to a high of 72.2°F in July. In Sandusky, mean monthly temperatures range from a low of 21.3°F in January to a high of 69.4°F in July. Port Huron receives 31.7 in of rainfall each year, while Sandusky receives 24.9 in, or 6.8 inches less than Port Huron. The warmer temperatures and heavier precipitation at Port Huron can be attributed to localized lake effects from Lake Huron.

A river system is generally defined by its annual stream flow characteristics, which are the results of a blend of the local geology, geography, and climate. To a large degree, the annual flow regime determines the ecological functions that will be supported and maintained. Annual Black River flow was examined by analyzing mean daily stream flow readings from six gauge stations (Figure 11) maintained by the United States Geological Survey (USGS) for their periods of record (as of 2005) (Table 2). Three USGS gauges are, or were, located on the main stem, two on Mill Creek, and one on a smaller, upstream tributary, Silver Creek. The most upstream gauge on the main stem is located at Jeddo Road in Segment 3, with a mean discharge of 301.5 cubic feet per second (cfs) during the period of record (Table 2). For reference, the mean daily flow was 63.2 cfs for the month of August (Table 2). August is the month of lowest flow and gives an indication of base flow conditions. Average annual flow rate at the Port Huron gauge (drainage area of 684 mi^2), the most downstream gauge on the main stem, was 284.9 cfs. The Port Huron discharge is considerably lower than 565.9 cfs reported for the downstream gauge on the Clinton River (drainage area of 734 mi^2) (Francis and Haas 2006) even though the drainage area is not much smaller. According to Francis and Haas (2006), the Clinton River watershed receives about 29.9 in of precipitation on average, which is higher than Sandusky, but lower than Port Huron. The lower river discharge can probably be explained by the slightly smaller area of watershed and lower precipitation in the upper reaches. An alternative explanation may be that the Black River watershed, having much less impervious surface, allowed more precipitation loss to groundwater or transpiration. Average discharges for the remaining five Black River watershed gauges (Table 2) range from 14.5 cfs at the historical Silver Creek gauge near Comstock Road to 96.9 cfs at the historical Mill Creek gauge near Abbottsford. Major tributaries to the upper two segments of the Black River, which have substantial flow, do not have a USGS flow gauge station. Annual discharge of the Black River varied considerably across years of the period of record (Figures 14 and 15).

Hydrologic characteristics were calculated and analyzed for changes over time using Indicators of Hydrologic Alteration (IHA) software (version 5.2, Smythe Scientific Software [The Nature Conservancy 2001]). Many hydrologic systems have experienced long-term accumulation of human modifications rather than a temporally discrete affect such as a dam. The IHA was used to compute and graph linear regressions on the daily flow data at the Jeddo Road gauge to assess these changes in the Black River watershed. A comparison of flow data for the period of 1944–79 and 1980–05 was made (Figure 14). The program evaluates the seven-day minimum flow running average which provides a measure of change in base flow in the river. This model confirms that there has been an increase in flow during the later period compared to the earlier period. Another way of evaluating changes over time is to evaluate changes in peak and mean annual flows. Changes in peak flow and changes in mean annual stream flow (Figure 15) at the Jeddo Road gauge station were examined. There was substantial variability in the peak flow, but overall, there was little, if any, change over the period of record. Similarly, there was a modest increase in annual flow at the Jeddo gauge. There are a number of possibilities that would contribute to an increase in discharge over time. A likely contributing factor is the increase in channelization in the upper portions of the watershed, which allows water to move through faster, thus lowering evaporation and transpiration losses.

Daily Stream Flow

Mean daily discharge in the Black River varied considerably across the periods of record (Table 3). The largest daily maximum discharge at the Jeddo Road gauge was 10,100 cfs in 1947 and the smallest daily maximum was 387 cfs in 1964, only 3.7% of the largest value. Similar values exist for the other gauge stations. Maximum and minimum flows were compared within years and these values are given in Table 3 as the smallest and largest maximum or minimum flow. Mean annual minimum discharge at the Jeddo Road gauge has ranged from 36 cfs in 1997 to 2 cfs in 1948.

Seasonal Stream Flow

Seasonal discharge of the Black River is quite variable. Monthly average discharge was evaluated during the period of record for USGS gauge stations on the main stem at Jeddo Road and on Mill Creek at the Avoca and Abbottsford gauge sites (Figure 16). Maximum discharge occurred in March following spring thaw at all gauge stations and the largest relative ranges were found at the Port Huron station where the monthly minimum discharge was only 2.5% of the maximum. Other gauge stations were characterized by minimum monthly discharges around 5–6% of maximum discharges and at all stations, monthly minimum flows occurred in August or September following the driest part of summer.

Standardized exceedence curves were constructed for the period of record at each USGS gauge station in the Black River watershed. These curves are typically used to examine variability in river discharge and to compare flows in rivers of different size. Exceedence values, representing discharges “exceeded” a given percentage of the time, were calculated from daily flow data grouped into 20 intervals. For example, the five percent (greatest) exceedence flow was surpassed five percent of the time. Exceedence flows were standardized by dividing by the median (50%) exceedence value. With this technique, the 50% standardized (median) discharge, for any river system, is always 1.0. For flows exceeded less than 50% of the time, low standardized values reflect relatively stable flows. Standardized high-flow exceedence curves for the period of record are given at four gauge stations in the Black River watershed (Figure 17). Five percent standardized exceedence values ranged from 15.5 at the Mill Creek Avoca gauge to 32.5 at the Black River Fargo gauge in Segment 3 of the main stem. That means that the flood flow at the Fargo gauge is 32.5 times greater than median flow. For comparison, the most stable streams in Michigan (Au Sable and Jordan rivers) have 5% exceedence flows that are less than twice their median flows. The Black River values are very high compared to some of the other southeastern Michigan streams and may be the highest in the state. However, some of this difference may be attributed to the relatively downstream locations for gauges in the Black River watershed compared to the other systems.

Standardized low flow exceedence curves for the period of record were also constructed for these gauge stations (Figure 17). These plots are used to examine patterns in base flows which may reveal information about groundwater supplies and retention structures. The higher the ratio between each exceedence rate and median discharge, the less variation there is in flow in the stream. The flow values at the 95% standardized exceedence level for the four gauge stations on the Black River vary from a low of 0.12 at Silver Creek to a high of 0.24 at Black River Fargo (Figure 17). Lower values suggest that only modest amounts of groundwater are entering above those gauges, or that water control structures may be intercepting water under base flow conditions and altering the delivery schedule. Michigan rivers with substantial groundwater supplies may have 95% standardized exceedence values above 0.50; for instance, the Au Sable River near Au Sable, Michigan has a value of 0.67 and the Jordan River near East Jordan, Michigan has a value of 0.87 (Figure 17). The 95% exceedence flows for the Black River and tributaries clearly show that low flows are unstable and that groundwater does not make up a large share of their discharge. Base flow is small and not stable throughout the year, indicating reliance on surface water flow. Throughout summer, when surface water flow is lower, base discharge falls. This is in direct contrast to hydrographs for the Jordan and Au Sable rivers. These rivers are dominated by groundwater inflows and have much more stable flows, even during summer months. In addition, peaks in flows created during precipitation events on the Jordan and Au Sable rivers are typically less than twice base flows. This contrasts with the Black River and tributaries, where rain events cause a many fold increase over base flows. Thus, the extremes (low flow and high flow) are significantly greater in the Black River system than they are in most Michigan rivers including others in southeastern Michigan rivers such as the Clinton River (Francis and Haas 2006).

Soils and Land Use

Soils in the Black River basin have been developed from the glacial and lacustrine deposits through weathering, oxidation, and leaching. Other factors influencing soil development include climate, topography, organisms, and time. Because of the variations in the parent materials and the changes due to weathering, a complexity of soil types exists in the basin. Having developed in a northern latitude, the soils belong to the podzolic group (Knutilla 1969). Soils in the Black River basin are chiefly (80 percent) silt loams and sandy loams and are drained somewhat poorly to very poorly. Of lesser areal extent, but scattered throughout the basin, are areas of well drained sands and loamy sands and there are isolated areas of organic soils. In the extreme southwestern corner of the basin soil types vary considerably and include organic soils, well drained loams, sands, sandy loams, and an isolated area of more poorly drained sandy soils.

Albert (1995) provided a regional classification of landscape ecosystems that encompass Michigan, Minnesota, and Wisconsin. That effort described and mapped functional land units differing significantly in biotic and abiotic components to provide a useful and productive framework for integrating resource management. The ecosystem components used to distinguish major landscapes were climate, physiography (landform and waterform), soil, and vegetation. According to Albert (1995) the Black River watershed lies within the Sandusky Lake Plain ecoregion consisting of broad expanses of level lake plain along its margins, but it also includes long, narrow till plains and ridges of end moraine that are parallel with Saginaw Bay or Lake Huron. On the end moraines, slopes are gentle to moderate, generally in the 2 to 6 percent slope class, and soils are moderately to well-drained. At the inland margin of the clay lake plain there is a broad sand channel, which is poorly drained. The till plain is quite flat and difficult to distinguish from the lake plain without examining till samples from borings. The end moraine is several miles wide and forms a low ridge, which has better drainage conditions than the surrounding lake plain. On the lake plain, slopes are typically in the 0 to 2 percent slope class. Approximately one-third of the soils are poorly drained or very poorly drained; while most of the remaining soils are moderately well drained. In the past, soils of the sandy channels on the lake plain were often poorly drained or very poorly drained. Low dunes within these channels had excessively drained soils which were too dry for agricultural use.

The watershed can be further divided into three smaller subregions. The eastern part of the watershed is composed of the ecological subsection called Erie-Huron Lake Plain (156 mi^2) because it was formed on the bottom of a large lake. Most of the lacustrine soils have been artificially drained to allow agricultural development of the land. Most peat soils have been burned or mined. Western and southern parts of the watershed are made up of the Southern Michigan and Northern Indiana Drift Plain (429 mi^2). These areas are called drift plains because of their flatness due to deposition by relatively uniform sheets of detached glacial ice as they melted in place.

The presettlement vegetation often differed greatly among the clay lake plain, sand lake plain, and end moraine (Albert 1995). Almost the entire clay plain was forested and dominated by upland conifer forests of eastern hemlock. Topography was flat, with slopes of less than 2 percent. These forests were not generally considered swamps, but the soils were probably wet. Hemlock often made up 40 percent or more of the overstory and other common species were beech, northern white-cedar, sugar maple, elm, balsam fir, paper birch, white pine, white ash, black ash, basswood, maple, and aspen. In the wettest parts of the lake plain, lowland hardwoods were prevalent; the common dominants were black ash and American elm. In closed depressions, lowland hardwoods dominated by black ash were common. On slightly steeper portions of the clay plain, where slopes were generally greater than 2 percent, northern hardwood forests of beech-sugar maple were numerous, sometimes making up more than 50 percent of the overstory; while hemlock was much less common. Forests of beech-sugar maple, with lesser quantities of hemlock, basswood, white ash, and red maple, grew on much of the moraines, which generally have better drainage conditions than the lake plain. Black ash dominated many of the wetland depressions within the moraines. Conifer swamps, dominated by northern white-cedar, occupied broad wetlands in floodplains. These cedar swamps also contained tamarack, balsam fir, hemlock, and some white pine, along with birch, aspen, and other hardwoods.

Prehistoric Native Americans had significant settlements in the Clinton River watershed as evidenced by the distribution and frequency of archeological sites (Figure 3). Settlement of Southeast Michigan by European immigrants was legalized in 1807 and Michigan obtained statehood and counties were organized in 1837. The Black River watershed is made up of parts of three counties; the north and biggest portion in Sanilac County (426.3 mi^2) with an estimated countywide population of 44,752 people in 2005. The next largest county is St. Clair (231.2 mi^2) with a population of 171,426. Lapeer County makes up 76.2 mi^2 and has a countywide population of 93,361. A very large percentage of the land in the watershed has been converted to agricultural production. Forested land went from 443,000 acres in 1800 to 85,000 acres in 1992. Cultivated lands account for most of the differences since they made up 359,000 acres (Figure 18; Table 4).

There are 10 cities, towns, and small villages in the Black River watershed. The largest is Port Huron which had an estimated population of 31,501 in 2005. Port Huron is the St. Clair County Seat and is located at the mouth of the Black River where it enters the St. Clair River. The other town on the Black River with a significant population is Croswell, population 2,548. The town of Sandusky, Sanilac County Seat, has a population of 2,745 and is located within the Berry Drain subwatershed. The town of Yale, with a population of 1,993, is located on the upper stretch of Mill Creek.

Channel Morphology

Geographical Information System (GIS) software (ArcView©, version 3.2) was used to map, examine, and measure some stream characteristics. Data on river length and general geographic features such as road crossings, dam locations, and USGS gauge stations were mapped and extracted from the county-based 1:24,000 scale Michigan Geographic Framework files or from the 1998 aerial photographs presented in MrSid© format and available from the MDNR (website http://www.mcgi.state.mi.us/mgdl/). The aerial photographs are digital orthorectified images each covering a quarter of a standard 7.5’ USGS Quadrangle map (DOQQs). Stream gradient is the drop in elevation over distance commonly measured in ft per mile.

Basic predictions concerning fish communities, channel characteristics, and hydraulic diversity can be made from gradient information. Hydraulic diversity refers to natural variation in depth, flow velocity, and turbulence. Generalized gradient classes, associated channel characteristics, and predicted fish habitats were obtained from G. Whelan, MDNR, Fisheries Division. Gradients of 0.0–2.9 ft/mi provide low valued fish habitat consisting of mostly runs with low hydraulic diversity. Gradients of 3.0–4.9 ft/mi are fair habitat with some riffles and modest hydraulic diversity. Gradients of 5.0–9.9 ft/mi provide good riffle-pool sequences with good hydraulic diversity. Gradients of 10.0–69.9 ft/mi make very good habitat with well established, regular riffle-pool sequences with excellent hydraulic diversity. Gradients above 70.0 ft/mi are rare to nonexistent in southern Michigan and produce only fair habitat and hydraulic diversity.

Landscape features and surface elevations were extracted from county-based, 30 m resolution, digital elevation maps (DEMs) (also available from the MDNR website) using ArcView software and the Spatial Analyst© extension. Three-dimensional maps were generated from data extracted from the DEMs using the gridding and surface mapping routines in SURFER© software. Individual data points extracted from the DEMs may have significant error because of the inherent 30 m accuracy. The general trend in land elevation from the high areas in the west and northwest edges of the watershed to the low southeast confluence of Lake Huron and the St. Clair River is quite evident (Figure 19). A vertical profile of the entire Black River main stem (Figure 19) shows general changes in the slope of the channel as it runs from Minden north of Deckerville Road (left edge of graph) to the mouth downstream from 10th Avenue in Port Huron. The present water level of Lake Huron is indicated by a horizontal line at 581 ft (177 m). Road crossings are marked on the graph by vertical drop lines. Four generalized changes in slope are evident along the main stem, which resulted in selection of four main stem segments for analysis in this report. Segment 1 has its downstream end just upstream from Washington Road, while Segment 2 ends two miles downstream from Peck Road. Segment 3 ends at the Wadhams Road bridge.

Segment 1 of the Black River (Figure 20) is highly channelized and runs south for 15 miles within 2–3 miles of, and paralleling the east boundary of the watershed. The entire length of this segment does not have a floodplain as it traverses intensely managed agricultural lands. There is virtually no residential or commercial development adjacent to the river evident on the aerial imagery. The vertical profile graph (Figure 20) provides more detail than the graph based on the entire main stem and shows fairly abrupt changes in elevation and slope. It is somewhat problematic to sort these changes from the variability in the DEM dataset. Segment 1 starts at about an elevation of 778 ft (237 m) and ends at an elevation of 735 ft (224 m). The gradient over this stretch is estimated to be 2.9 ft/mi which is at the upper end of the lowest gradient category for predicted fish habitats. It is important to note that the elevations indicated are for land surfaces and may not reflect the actual elevations and gradient of the channelized stream bed which should always have a greater slope.

An index of sinuosity provides a measure of the amount of meanders in the river. Sinuosity is calculated by dividing the stream thread length by the valley length, for each river segment. If the river were straight, with no meanders, then the sinuosity index would be equal to 1.0. River channels that have been modified to improve drainage typically have sinuosity indices near 1.0. Natural river channels tend to meander so their sinuosity indices would often be above 1.2. Rosgen (1994) classified rivers with an index of <1.2 as low sinuosity, 1.2 to 1.5 as moderate sinuosity, and >1.5 as very high sinuosity. Sinuosity for Segment 1 was 1.06 as determined from a multistate valley segment database (Zorn et al. in review). According to the Rosgen (1994) classification, this segment is very straight which is likely due to channelization to improve drainage for agriculture (Figure 20).

Segment 2 is slightly longer at 17.5 miles continuing south along the west edge of the end moraine that constitutes the east boundary of the watershed (Figure 21). Most of the length of this segment traverses intensely managed agricultural lands, however there are two towns along its banks, Applegate near the upper end and Croswell near the south end. There is a dam at Croswell that affects the river hydrology both upstream and downstream. Beginning elevation of Segment 2 is about 732 ft (223 m) and ending elevation about 699 ft (213 m). The average gradient was estimated to be only 1.9 ft per mile which is considerably lower than Segment 1, indicating poor potential for fish habitat. Most of this segment has very low gradient and crosses lacustrine, poorly drained soils creating drainage problems for agriculture. The portion of the river upstream from Applegate has been channelized and there have been some modifications downstream to Croswell. Sinuosity for Segment 2 was 1.17 as determined from a multistate valley segment database (Zorn et al. in review). The river channel is very straight downstream to Applegate, improves somewhat through Croswell, and approaches a natural river channel near the downstream end of Segment 2 (Figure 21).

Segment 3 is much longer at 29.5 miles continuing south along the west edge of the end moraine that constitutes the east boundary of the watershed (Figure 22). This segment is very different in that it has a large and well developed floodplain as it passes through large tracks of forested public and private riparian lands. Beginning elevation of Segment 3 is about 699 ft (213 m) and ending elevation about 590 ft (180 m). The average gradient was estimated to be 3.7 ft per mile which is considerably above that found for segments 1 and 2 indicating fair to good potential for fish habitat. The map (Figure 22) shows the major road crossings and the outer box covers 154,423 acres surrounding this river segment. Most of this segment has relatively good gradient and crosses a number of end moraines on its way to the lake plain in Segment 4. The end moraines supply gravel, cobble, and boulders which are a prevalent feature. It is likely that considerably more groundwater enters the river along this stretch which may improve temperature regimes for fish. Sinuosity for Segment 3 was 1.50 as determined from a multistate valley segment database (Zorn et al. in review). No part of the main stem has been channelized and the map (Figure 22) shows a normal pattern of meanders. Drainage courses with natural meanders provide many benefits including reduced downstream flooding, floodplains that provide natural flood storage, reduced instream flow velocities and reduced bank erosion, and, improved water quality, habitat, and recreational use opportunities. An effort should be made to restore a more natural, meandering river channel in segments 1 and 2. There is a major dam located just upstream from the Beard Road crossing which is a barrier to all fish migration.

Segment 4 is the shortest at 10.9 miles from the Wadhams Road bridge where turns to the east cutting across the end moraine and several ancient beach ridges on its way to the St. Clair River (Figure 23). This stretch of river has so little gradient that the errors in elevations extracted from the DEM make it impossible to estimate the slope. It is barely enough to keep water flowing, and under rare weather conditions may actually reverse direction when the St. Clair River water rises. Sinuosity for Segment 4 was 1.36 as determined from a multistate valley segment database (Zorn et al. in review). The map (Figure 23) shows the major road crossings and the outer box covers 55,196 acres surrounding this river segment. Most industrial and residential effects to the Black River main stem occur in this segment.

The Berry Drain subwatershed and its tributary to the Black River (Figure 24) are very highly channelized and run south and east for 7.6 miles. This subwatershed contains the town of Sandusky. The entire length of this tributary traverses intensely managed agricultural lands and, true to its name, has been channelized. Beginning elevation of Berry Drain is about 771 ft (235 m) and ending elevation about 748 ft (228 m). The average gradient was estimated to be 3.0 ft per mile which is at the low end of the range indicating fair potential for fish habitat. The map (Figure 24) shows the major road crossings and the outer box covers 74,018 acres surrounding it. The lower parts of this segment have very low gradient and cross lacustrine, poorly drained soils creating drainage problems for agriculture. The map (Figure 24) shows that sinuosity is negligible due to development of drains.

The Elk Creek subwatershed is much larger than Berry Drain being the largest subwatershed. This tributary to the Black River (Figure 25) has been very highly channelized. The tributary runs northeast for 28.3 miles to its confluence at the Black River. The entire length of this tributary traverses intensely managed agricultural lands and has been channelized. Beginning elevation of Elk Creek is about 807 ft (246 m) and ending elevation about 732 ft (223 m). The average gradient was estimated to be 2.7 ft per mile which is towards the upper end of the range indicating poor potential for fish habitat. The map (Figure 24) shows the major road crossings and the outer box covers 297,713 acres surrounding the subwatershed. The entire segment has very low gradient and crosses lacustrine, poorly drained soils creating drainage problems for agriculture. Sinuosity for Elk Creek was 1.12 as determined from a multistate valley segment database (Zorn et al. in review). The map (Figure 25) shows that sinuosity is negligible due to development of drains.

The Black Creek subwatershed is smaller than Elk Creek but larger than Berry Drain. This tributary to the Black River (Figure 26) has been very highly channelized except within a mile or two of its confluence with Black River. The tributary runs east and northeast for 16.3 miles to the Black River. Again, the entire length of this tributary traverses intensely-managed agricultural lands. Beginning elevation of Black Creek is about 846 ft (258 m) and ending elevation about 689 ft (210 m). The average gradient was estimated to be 9.6 ft per mile which is towards the upper end of the range indicating good potential for fish habitat. The map (Figure 26) shows this river segment plus the major road crossings and the outer box covers 110,439 acres surrounding it. This segment has good gradient and crosses some glacial features that may produce decent physical conditions for fish. The map (Figure 26) shows that sinuosity has been reduced due to development of drains.

The Silver Creek subwatershed is small compared to those described earlier. The tributary is much shorter at 11.5 miles traveling northeast until reaching the Black River north of Jeddo Road (Figure 27). This segment is different in that its lower reach has a large and well developed floodplain as it passes through forested riparian land belonging to the Boy Scouts of America. Beginning elevation of Silver Creek is about 745 ft (227 m) and ending elevation about 663 ft (202 m). The average gradient was estimated to be 7.1 ft per mile which is considerably above that found for segments 1 and 2 indicating good potential for fish habitat. The map (Figure 27) shows the major road crossings and the outer box covers 77,011 acres surrounding this river segment. Most of this segment has relatively low gradient that dramatically increases as it crosses an end moraine on its way to the Black River in Segment 3. The end moraines supply gravel, cobble, and boulders which are a prevalent feature in lower sections. It is likely that relatively more groundwater enters the river along this stretch which may improve temperature regimes for fish. Sinuosity for Silver Creek was 1.33 as determined from a multistate valley segment database (Zorn et al. in review). However, most of the upper parts of this subwatershed have been channelized and a normal pattern of meanders occurs only between Cribbens Road and the Black River (Figure 27).

The Plum Creek subwatershed is only about half the area of the Silver Creek subwatershed. The tributary is also shorter at 9.3 miles traveling northeast until reaching the Black River south of Comstock Road (Figure 28). This subwatershed is similar to Silver Creek in that its lower reach has a large and well developed valley and floodplain as it passes through private and public forested riparian lands. Beginning elevation of Plum Creek is about 758 ft (231 m) and ending elevation about 650 ft (198 m). The average gradient was estimated to be 11.6 ft per mile which is the best in the Black River watershed indicating excellent potential for fish habitat. The map (Figure 28) shows the major road crossings and the outer box covers 38,064 acres surrounding this river segment. Most of this segment has decent gradient that dramatically increases as it crosses an end moraine on its way to the Black River in Segment 3. The end moraines supply gravel, cobble, and boulders which are a prevalent feature in lower sections of this subwatershed. It is likely that considerable groundwater enters the river along this stretch which may improve temperature regimes for fish. Sinuosity for Plum Creek was 1.38 as determined from a multistate valley segment database (Zorn et al. in review). However, some of the upper parts of this subwatershed have been channelized and the map (Figure 27) shows a normal pattern of meanders only downstream from Cribbens Road. This stretch also has a tendency to dry up during warm summer months, maybe a result of low flow water infiltrating into coarsely textured moraine.

The Mill Creek subwatershed is the second largest in the Black River basin, only slightly smaller than the Elk Creek subwatershed. The tributary is quite long at 53.2 miles traveling mostly east until reaching the Black River just north of Imlay City Road (Figure 29). This subwatershed is also characterized by its lower reach developing into a large floodplain as it passes through forested public riparian land belonging to the MDNR. Beginning elevation of Mill Creek is about 860 ft (262 m) and ending elevation about 600 ft (183 m). The average gradient was estimated to be 4.9 ft per mile which is very near that indicating good potential for fish habitat. The graph shows that the gradient is considerably steeper at the upper end where it arises from a moraine and again towards the lower end where it crosses more moraines on its way to the Black River. The map (Figure 29) shows the major road crossings and the outer box covers 377,950 acres surrounding this river subwatershed. Much of the middle of this subwatershed has relatively low gradient and has been channelized for agricultural development. The end moraines at the lower end supply gravel, cobble, and boulders which are a prevalent feature in lower sections of this subwatershed. It is likely that considerable groundwater enters the river along the lower stretch which may improve temperature regimes for fish. Sinuosity for the heavily channelized upper segment of Mill Creek was 1.03 as determined from a multistate valley segment database (Zorn et al. in review), while sinuosity for the lower segment was 1.52. The map (Figure 29) shows that sinuosity starts to increase between Capac Road and the first Yale Road crossing and develops into a natural pattern of meanders close to Norman Road.

Dams and Barriers

Dams prevent upstream fish migration, block important river functions such as sediment transport, and elevate water temperature more than a river in its natural state because impounded water behind the dam is wider and slower flowing. Dams also are impediments to recreational boating and may create safety hazards under high flow conditions. Eight dams, only three of which are structures significantly affecting flow and elevating temperature of the river, were identified from State of Michigan digital records available from the MDEQ, Land and Water Management Division, Dam Safety Unit (Figure 30; Table 5). The Black River and tributaries have very few dams compared with the Clinton, Huron, and Rouge rivers which have 79, 96, and 62 dams respectively (Francis and Haas 2006; Hay-Chmielewski et al. 1995; Beam and Braunscheidel 1998). These rivers have similar watersheds in Southeast Michigan. Two important dams are located on the Black River main stem, one in the town of Croswell in river Segment 2 and another, Wingford Dam, just north of state road M-136 in river Segment 3, Clyde Township (Figure 30). There is also one low-head dam, Yale Woolen Mill Dam, on Mill Creek at Yale. There are also remnants of a dam on the main stem just upstream from the Wadhams Road bridge in Clyde Township. It is not known whether this relic structure constitutes a barrier to fish migration and a peril to navigation. All three, Croswell, Wingford, and Yale dams should be targeted for removal under long-range planning because of their detrimental affect on natural river processes, fish passage, and associated biological communities. Wingford dam would be the highest priority for removal because that would open up a long stretch of excellent physical fish habitat that flows through MDNR lands having good public access. Removal of Croswell dam would not be a fisheries management priority until Wingford dam had been removed.

Water Quality

Stream water quality is a very important determinant affecting aquatic organisms and the health of the entire aquatic community within a watershed. The entire Black River and most, or all, tributaries suffer greatly from high sediment loading due to erosion from widespread channelization and poor land management practices. Unnaturally high-sediment loadings to a river system create a number of serious geomorphic and biological problems.

The MDNR, Fisheries Division classified many streams throughout the state (Seelbach et al. 1997; Anonymous 2000) based on several characteristics including stream temperature. However, the Black River was not part of those surveys, so in 2006, 13 continuously recording temperature monitors were placed at strategic locations throughout the main sections of the river. There were nine monitors spread throughout the entire length of the Black River main stem, three in Mill Creek and one in Elk Creek (Figure 31). The summer water temperatures throughout the watershed were quite warm (Figure 32). Warmest temperatures were recorded in July and Mill Creek consistently displayed the coolest water. Lower stretches of Mill Creek have good riparian vegetation and relatively high groundwater infiltration. One encouraging result for the Black River was that water temperatures in the stretch from Galbraith-Line Road downstream to Beard Road had cooled down more than one degree F compared to upstream areas. At this time, there is no convincing explanation for this cooling but important considerations would be; 1) increased shading from riparian vegetation, and 2) influx of substantial groundwater. This stretch of river passes through the MDNR Port Huron State Game Area which provides a wide forested buffer. Elk Creek has been highly affected by agricultural drainage and the high water temperatures observed there were not surprising.

Management plans for watersheds in St. Clair County are being developed under the leadership of the County's Stormwater Coordinator to fulfill the Environmental Protection Agency (EPA) and Michigan Department of Environmental Quality (MDEQ) Phase II National Pollutant Discharge Elimination System (NPDES) regulations. This watershed management plan seeks to identify and prioritize water pollutant sources and threats, and the actions needed to manage storm water discharges. To develop watershed plans, governmental entities that have jurisdiction over land use and storm water discharges have formed the St. Clair County's Northeastern Watersheds Advisory Group (SCCN) (Kristen Jurs, St. Clair County Watershed Advisory Group, unpublished report).

There are 52 permitted discharges to the surface waters in the Black River watershed (Table 6). The Black River and tributaries have relatively few discharges compared with nearby Clinton, Huron, and Rouge rivers which have 521, 80, and 75 permits respectively (Francis and Haas 2006; Hay-Chmielewski et al. 1995; Beam and Braunscheidel 1998). Geographic location of each permit on the Black River are given (Figure 33) with an ID number linking the site to data (Table 6). These discharges are permitted through the National Pollution Discharge Elimination System (NPDES). NPDES permits are issued by the Water Bureau of MDEQ and are intended to control direct discharges into the surface waters of the state by imposing effluent limits and other conditions necessary to meet state and federal requirements. Municipal discharges include effluent from wastewater treatment plants, water treatment facilities, storm sewers, and combined sewer overflows. Industrial discharges include contact and noncontact cooling waters, process wastewater, and sanitary wastewater. Permits issued to these dischargers contain limits for parameters of concern (metals, organics, dissolved oxygen, carbonaceous biochemical oxygen demand, solids, nutrients, oil, grease, temperature, and chlorine) and are specific to each discharge. Limits of these parameters are based on the assimilative capacity of the receiving water and may incorporate mixing zones.

Section 303(d) of the federal Clean Water Act and the United States Environmental Protection Agency's Water Quality Planning and Management Regulations require states to develop Total Maximum Daily Loads (TMDLs) for waters not meeting water quality standards. The TMDL process establishes the allowable loadings of pollutants based on the relationship between pollution sources and instream water quality conditions. The TMDLs provide states a basis for determining the pollutant reductions necessary from both point and nonpoint sources to restore and maintain the quality of their water resources. According to the SCCN, there is one TMDL that needs to be developed for the lower Black River, from the mouth upstream 1.5 miles, to identify the allowable levels of *E. coli*, mercury, and PCBs that will result in the attainment of the water quality standards.

The following TMDLs for the Black River watershed are reported by MDEQ (Stephanie Kammer, personal communication) to be active or planned for the near future. There are exceedences of water quality standards for dissolved oxygen, nuisance plant growth, phosphorus concentration, and poor macroinvertebrate community in Berry Drain from it's confluence with the Black River upstream to

Stoutenberg Road (Sunday 2006). Excessive *E. coli* levels have occurred in Mill Creek in the vicinity of Yale due to discharges of untreated sewage. Levels of pollutant PCB's are exceeding water quality standards at many locations throughout the Black River watershed.

Originally, several of the sewer systems in the Black River watershed were combined to carry both storm water and sanitary wastes in the same pipe. In a combined system, when the carrying capacity of the sewer is exceeded, they are designed to overflow into the river causing combined sewer overflows (CSOs). Extensive efforts have taken place in recent years to correct CSOs and most combined systems in the watershed have been converted so that raw sewage, during high flow periods, is directed to sewage treatment plants, while road runoff flows directly to the river. However, work remains to be completed in Port Huron on the remaining CSO to the Black River, which was scheduled for elimination in 2006.

Much of the mercury entering the Great Lakes comes from airborne deposition. Mercury enters the atmosphere from waste incinerators, coal burning power plants, metal smelting plants, and natural processes. The mercury TMDL in the Lower Black River is also associated with contaminated sediments from historical point source discharges and spills.

The Department of Environmental Quality conducted six surveys in 1968, 1973, 1983, 1992, 2002, and 2007 of the water quality in the Black River as it relates to biological conditions. It is worthwhile noting here that water quality has dramatically improved over the 39 year period particularly due to reductions in nutrient inflows from municipalities and industrial sites. Today, the primary water quality concerns are related to excessive sediment loads, nutrients, and dissolved solids.

Water from the streams in the Black River basin is very hard. This hardness is of the calcium-magnesium bicarbonate type and remains this type under high and low flow conditions. The water is also generally high in sulfates and locally high in chloride (Knutilla 1969). In 1968, the water quality of the Black River basin was described as having good dissolved oxygen (D.O.) and fairly low Biological Oxygen Demand (BOD) concentrations in the upper reaches (MWRC 1968). Below population centers and near the mouth, there was a seasonal variation in D.O. and BOD. The D.O. dropped to very low concentrations at certain times in the year. Total and fecal coliform densities exhibited a definite increase during the summer months. Chloride concentrations near the mouth had been increasing in recent years. In 1968, downstream of the Michigan Sugar company discharge in Croswell, D.O. was reduced to 0.6–1.0 mg/l, temperature increased by 17°F (from 46°F to 63°F), and disagreeable odors, increased turbidity, discoloration of the water and extensive deposition of black sludge were detected.

A 1973 study of the effects of CSOs on the lower Black River (MDNR 1975) generally found no serious water quality problems. The Lake Huron diversion canal had apparently improved water quality in the lower Black River, particularly in regard to Total Dissolved Solids (TDS) concentration, where summer TDS concentrations were reduced in half while the flow control gates were open. However, based on increased fecal coliform concentrations, the effects of the CSOs were still evident.

An MDNR study in 1990 found sediments in the mid-channel of the lower Black River in Port Huron to consist of sand, silt, and some clay and toxic sediment conditions were present at all sites sampled. Elevated lead and zinc levels, typical of effects from urban drainage, were identified near the boat launch ramp near I-94. Downstream of a nonpermitted Mueller Brass discharge near the 10th Street bridge, copper and zinc levels were elevated, but lead declined. Traces of PCB were detected at stations downstream of the railroad bridge near E.B. Eddy and downstream of the 10th Avenue Bridge (MDNR 1990). In 1992, the concentration of metals in the sediments generally decreased downstream of Croswell and no pesticides, PCBs, or chlorohydrocarbons were detected (Walterhouse 1994).

Based on the results of St. Clair County's 2004 Road Crossing Survey at 46 sites on the lower Black River (Kristen Jurs, St. Clair County Stormwater Coordinator, personal communication) 42.5% were rated as good and 42.5% fair overall. Turbidity was present or abundant in 36% of the Black River tributaries. The presence of trash was recorded at 11% of the sites. Other conditions documented by the 2004 Road Stream Crossing Survey included low base flows, streams accessible to cattle, recovery from dredging, excessive erosion, and sedimentation. Streamside and riparian vegetation varied widely. Most sites had either bare eroded banks, a lack of riparian buffers (mowed turf grass), or were overgrown with cattails.

The series of eight historical and recent aerial photographs (Appendix A) clearly demonstrates some of the harsh land management practices that have seriously degraded the aquatic habitat in the Black River due to excessive erosion and siltation. These photos, which span a period of 65 years, cover the same 1,216 acre area bisected by Fisher Road including a 2.1 mile stretch of the Black River. They document very significant changes to the landscape and river channel caused by development and operation of a large sand and gravel surface mine that is currently expanding mining operations to the south along the river. The photos taken in 1941 and 1949 show mainly agricultural land practices and do not show that mining had begun. In 1969, several areas of mining activity are apparent and heavy silt loading to the river is evident. Photos taken in 1971 and 1980 show dramatic expansion of the operation and significant dredging of the river channel plus installation of dams or similar retaining devices. Continued expansion of the mining operation was apparent in the 1982, 1998, and 2005 photographs with development of several large ponds which were at times apparently connected directly to the Black River. It is important to be aware that such large scale land manipulations are occurring and that they have a dramatic and negative effect on the river and aquatic organisms at that location and downstream for a considerable distance. The author participated in a hydrological assessment of river condition and probable effects using the Rosgen River Classification System (Rosgen 1996) at a site in the Port Huron State Game area between Comstock Road on the north and Norman Road to the south approximately 5 mi downstream from the Fisher Road site. Through this analysis, it was concluded that the Black River in the Port Huron State Game Area is undergoing excess sediment deposition. This results from a high sediment supply and a low sediment transport capacity. Since this area of the river has only a slight potential for channel enlargement and a wide buffer of riparian vegetation, the river has considerable potential to restore itself once the excess sediment supply is reduced. The highly channelized drains described in more detail in the next section are also sources of much excess sediment to the river. A long-range drainage plan needs to be adopted which provides for multistage channel designs that allow development of an active meandering channel supporting natural, stable flows and a much wider "floodplain" channel to dissipate water and energy during extreme flood events.

Special Jurisdictions

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 county drains. Activities carried out under authority of the Drain Code do not require MDEQ approval if applied to drains designated before 1972. There are almost 1,000 miles of designated drains in the Black River watershed (Figure 34). The characteristics of these drains can vary dramatically, ranging from very small waterways routed through an enclosed pipe to modestly altered streams with moderate habitat for biological communities. Many drains in the upper parts of the watershed consist of large, v-shaped channels, which were dug to substantially straighten the watercourses and convey water as fast as possible. These changes have very dramatic effects on river hydrology because they increase water velocity and soil erosion. They promote sedimentation and nutrient loading to rivers and contribute to loss and degradation of wetlands. Drains reduce or eliminate water storage and alter discharge patterns, which destroys natural flow sequences in a river system. Even the main stem of the Black River is a designated drain through most of Sanilac County. Drains exist throughout the watershed, but the majority are in the upper two segments and their subwatersheds, which drain mostly flat, impermeable soils (Figures 35–44; Table 7).

A Black River Resource Plan was developed in 1997 by the St. Clair Local Coordinating Committee of the Binational Public Advisory Council to complete stage 2 of the St. Clair River Remedial Action Plan. This plan, reported by the United States Department of Agriculture, provides the following quotation related to agricultural drainage practices in the Black River watershed.

> "In an attempt to promote agricultural drainage, periodic dredging has occurred in the Black River watershed. In 1957, over twelve miles of the South Branch of Mill Creek were dredged and straightened. In 1964, the North Branch of Mill Creek was channelized in a fifteen mile federal project. In 1987, twenty-eight miles of the upper Black River were dredged and channelized. Although dredging projects have been deemed necessary by drain boards, these projects can have severe impacts on the watershed. Upstream water is drained off farm fields quicker, resulting in flooding and erosion downstream. Water tables are lowered resulting in draining of wetlands. It is very often necessary to strip the banks of trees and other natural cover to make room for machinery used to widen, deepen and straighten drains and water courses. This process completely destroys the natural character of streams and causes soil erosion."

The St. Clair County Drain Commissioner has been taking measures for several years to achieve and maintain a more naturalized state of the drainage courses over which they have jurisdiction. The commissioner's office is trying to move more toward "stream restoration" as opposed to channelization, although in some cases channelization may be necessary. Stream restoration measures aim to restore vegetative buffers, canopy cover, and instream habitat and allow the drainage course to reestablish a natural meandering pattern.

Wildlife Division, MDNR has jurisdiction and management responsibility over very significant portions of the lands within the Black River watershed, especially those making up the 7,000 acre Port Huron State Game Area. Another important land area under MDNR management is the Minden State Game Area which contains significant parts of Minden Bog. The Minden State Game area and Minden Bog are located at the uppermost end of the watershed.

Biological Communities

Original Fish Communities

There is a lack of information on the history of the fish community in the Black River watershed prior to the first recorded survey conducted by the Michigan Conservation Department in 1972. No creel surveys have been conducted on the Black River main stem or its tributaries. Creel surveys were conducted on three Lapeer County lakes (Mitchell, Cranberry, and Elk) within the Black River watershed in the 1940's and 1950's. These lakes only have a combined surface area of 129 acres and do not support a significant publicly accessible resource. These creel surveys were not considered to be a relevant source of information for this assessment.

Factors Affecting Fish Communities

The Black River watershed has been altered drastically by human activity since the first European settlers arrived about 1680 AD. Deforestation, agriculture, and industrial/residential development have been major factors changing landscape, channel characteristics, hydrology, water quality, and biological communities of the river.

Settlement started from a need for improved navigation on the Great Lakes and a demand for timber products to supply growing populations in other parts of the country. After the vast timber stands were harvested from the watershed, land was rapidly settled for farming. Clearing of the mature forests followed by agricultural use were, and still are, major factors altering the quality of the Black River. Agricultural land uses tend to increase runoff, destabilize flow, temperature, and channel morphology, and reduce water quality by supplying excess amounts of nutrients and sediments. Major negative effects to the Black River watershed come from increased soil erosion and extensive human-made river channel modifications to accelerate surface drainage. Riparian clearing also affects stream habitat by limiting the resupply of large woody debris. Large woody debris is important in a river because it stabilizes beds and banks, creates habitat diversity by the formation of undercut banks and pools, provides nutrients for benthic invertebrates, and shelters fish from high flows and predators (Finkenbine et al. 2000). These processes often result in a loss of fish biotic integrity (Wang et al. 2001). Cities and towns, such as Port Huron, Yale, Croswell, and Sandusky sprang up along the river causing increased water withdrawal and discharge of pollution-bearing effluent. Continued development also brought about construction of dams on the Black River and Mill Creek for industrial and recreational purposes. Dams alter the natural cycle of flow of a river, fragment the continuity of a river, block fish passage, and modify downstream flows, temperature, water quality, and habitat (Winston et al. 1991; Kanehl et al. 1997; Bednarek 2001). These changes are responsible in altering the fish biodiversity. However, it is encouraging that dam removals have been shown to reverse this process (Kanehl et al. 1997; Bednarek 2001).

As cities and towns developed, little consideration was given to environmental concerns including the health of the river and related biota. The Black River and tributaries were seen as a dump for industrial and municipal waste. During the middle of the twentieth century, water quality had greatly deteriorated across the country leading to passage of the Clean Water Act in 1972. Since 1972, many of these destructive influences have been reversed. However; aquatic organisms, such as fishes, mussels, and invertebrates, have been negatively affected. Pollution intolerant species were reduced or eliminated from the river, and in severe areas, even pollution tolerant species were eliminated. This resulted in reduced species richness, reduced river production, and lost recreational opportunities.

Fish Community During Past 35 Years

Prior to passage of the Clean Water Act, little fish survey work had been done in the Black River watershed so the structure of the early fish community is largely unknown. The first fish survey by MDNR Fisheries Division was conducted in 1972, and there have been 13 additional surveys since (Figures 45–50). To facilitate the Black River fisheries assessment, data from these surveys were compiled and entered into the MDNR Fish Division’s Fish Collection System computer database. This database provides easy access to all division employees for analyses and reporting. Types of data collected included counts of all fish by species, length measurements, length of stream surveyed, duration of effective sampling effort, and habitat observations.

Based on fish sampling by MDNR, Fisheries Division, lamprey survey data from the United States Fish and Wildlife Service, and the Michigan Fish Atlas (Bailey et al. 2004), the Black River basin supports 87 species of fish (Table 8). Field data were recorded by site, which was the contiguous area sampled at a single geographic location each day, usually at or near a road crossing. For this report, site locations were entered into a GIS and positioned over georeferenced aerial photographs. The lineal distance traversed during each site survey had been recorded. This distance was used to create polygons based on the apparent width of the stream channel on the georeferenced aerial photograph along that stretch of river. The GIS polygons were used to generate estimates of surface water acreage sampled for each combination of site, gear, and date.

Five types of fish population surveys were conducted in the Black River watershed; backpack shocker, stream shocker, boom shocker, impoundment nets (mostly trap nets), and rotenone (Table 9). Rotenone is the naturally occurring pesticide chemical which is normally used when a piscicide application is required. Different fish collection equipment has been designed to capture fish under various conditions. The following are various forms of fish capture used in recent times on the Black River.

Rotenone is a chemical used to collect fish from all sizes of streams. This method is most effective in wadeable stream sections where blocking nets can be temporarily placed across the stream from top to bottom. Fish affected by the chemical in the water, drift downstream into the blocking nets and are captured. Another chemical is then applied downstream of the blocking net to neutralize the rotenone. This method results in the death of the fish captured, but can give a rather complete assessment of the fish population in a given reach of stream.

Electricity is used to stun fish so that they can be easily be netted with hand nets. These fish are identified, measured and weighted and then returned unharmed to the water. When the appropriate electrical equipment is used in a given habitat, the result can be a fairly accurate qualitative assessment of the fish population. Three methods using electricity to collect fish were employed in the Black River where the habitat dictated that it was the best method of capture:

1. Backpack electroshockers have a small effective range and are used specifically in small, rather shallow streams—usually headwater areas. The backpack is not appropriate for larger, deeper stream sections.

2. Stream shockers are used in moderately sized, wadeable streams and can be used with 2 or 3 probes to cover a larger effective range. This method employs a small, unmanned boat to hold an electrical generating unit, which is manually towed upstream. The method requires a staff of 3 to 6 fish collectors. Stream shockers are not effective in large, nonwadeable river sections, nor can they be used in small, headwater streams.

3. Boom shockers are used in large, deep water which usually cannot be waded. This method usually employs at least three people in a self propelled boat with electrical generation and forward electrical probes. This method cannot be used in shallow, non navigable waters. Boom shockers were used mostly in the lowest, largest sections of the Black River.

Impoundment gear used in these surveys consisted of trap and fyke nets. These nets are stationary and are placed in larger bodies of water with low velocity such as impoundments upstream of dams or lakes. They were set and anchored from a boat and tended on a daily basis so the fish could be enumerated and released unharmed.

A thorough analysis of MDNR fish surveys was used to describe the fish community during the 35 year period from 1972 through 2006. A total of 77 fish species were captured during all MDNR surveys in the watershed (Figures 51–52; Table 10). The GIS database of MDNR Fisheries Division fish survey data was analyzed further to determine the percentage of surveys within major sections of the Black River and Mill Creek that captured each species (Table 11). While it is tempting to draw conclusions about fish population changes through time, it does not appear that these data clearly show any trend. The best evidence that there has been some recent improvement comes from stream shocker data collected in 2005 and 2006 which show more species captured than at any earlier time. Such an improvement is consistent with well documented reductions in point source pollution at several locations along the Black River.

Individual maps (Appendix B) were created for each fish species recovered in MDNR surveys or reported in the Michigan Fish Atlas (Bailey et al. 2004). The Michigan fish atlas database contains point location information compiled from a large number of sources reporting collections dating back to the late 1800s. The maps (Appendix B) show location captured, whether records are from survey or fish atlas, and, for those 77 species recovered in MDNR surveys, a density estimate as number caught per acre. There were seven fish species in the fish atlas that were not reported from the MDNR surveys. Four of them were species that migrate seasonally from Great Lakes into tributary waters and should not be expected in typical summer survey catches. The other three probably occurred at very low abundance levels in the early days of biological field sampling and have since either declined further or disappeared entirely from the Black River watershed.

Based on the water temperatures collected for this study, the Black River would have been classified as second-quality warmwater suggesting that game fish would be appreciably limited by temperature-related phenomena of pollution, competition, or inadequate reproduction (Anonymous 2000). Average July water temperatures were very high and stable (Figure 53). Compared to an analysis of 171 river sites located across the Lower Peninsula of Michigan by Wehrly et al. (2003), the summer Black River temperature regime was best suited to warmwater fishes such as common carp and channel catfish.

According to the database on fish contaminants available on the MDEQ website http://www.deq.state.mi.us/fcmp/, very few fish have been tested from the Black River. Ten carp were collected on April 20, 1989 in the Croswell Impoundment just upstream from the Croswell dam. Contaminant analyses showed elevated levels of PCBs. According to the Michigan Department of Community Health "2007 Michigan family fish consumption guide" available online at http://www.michigan.gov/documents/FishAdvisory03_67354_7.pdf, the only fish species listed with a consumption advisory from the Black River is common carp and they are limited to one meal per week for women and children because of slightly elevated levels of PCBs.

Segment 1

Segment 1 is 15 miles long and extends from Mills Road near Minden Bog in Wheatland Township south to Hyde Road in Washington Township. While this segment of the main stem consists entirely of designated drain and the river is small, the fish community has included 43 species. However, the nine species that were found in 50 percent or more of the 14 surveys were fish that are known to be tolerant of a wide range of habitat types and quality. Two species, rock bass and northern pike, are desirable sport fish. Other sport species in lesser abundance were bluegill, pumpkinseed, northern longear sunfish, hybrid sunfish, yellow perch, channel catfish, smallmouth bass, and largemouth bass. None of the remaining species were among those considered sensitive to pollution indicating that the quality of fish habitat in this segment is degraded. There is one major tributary system, Berry Drain subwatershed, that enters the Black River from the West at Wheeler Road in Bridgehampton Township. None of the MDNR site sampling events occurred in Berry Drain so the fish population there is largely unknown. The water and habitat quality in Berry Drain has been severely degraded by dredging and straightening so it is likely that the fish community would reflect that condition.

Common carp was the only exotic fish species captured in Segment 1 by MDNR surveys and there were no species captured that are on the Michigan list of endangered, threatened, or special concern status. There is one record in the Michigan fish atlas database of an eastern sand darter, a state threatened species, from the most downstream area of this Segment (Figure 54). There is more information regarding this species in the description for Segment 2.

The Sea Lamprey Management Program was established in 1955 to reduce and manage parasitic sea lamprey abundance in the Great Lakes, thus allowing for restoration of the Great Lakes' fishery. Since the Great Lakes form a portion of the international boundary between the United States and Canada, the Great Lakes Fishery Commission was created in part to develop and implement measures to control sea lampreys. The U.S. Fish and Wildlife Service (USFWS), along with the Department of Fisheries and Oceans Canada, serve as agents of the Great Lakes Fishery Commission in accordance with the Convention on Great Lake Fisheries of 1955 and the Commission's Strategic Vision. These agencies also work in cooperation with various federal, provincial, state, and tribal agencies in maintaining sea lamprey *Petromyzon marinus* abundance at or below acceptable levels. In order to carry out their mission, the USFWS conducts stream surveys to monitor sea lamprey spawning activity and abundance of juvenile lampreys. Streams and rivers that support abundant sea lampreys are treated with a lampricide chemical to eliminate as many as possible. There are five species of lamprey found in Michigan (all native except sea lamprey), four lamprey species, including sea lamprey, occur in the Black River watershed. Personnel from the USFWS have surveyed the Black River on numerous occasions at many different sites (Figure 55). The USFWS provided all survey data from the Black River watershed for this report and it was analyzed to determine location and extent of sea lamprey populations. Field identification to species level for juvenile stages of some species (Genus *Ichthyomyzon*) is difficult, but larval sea lamprey (ammocetes) are readily discernable (Jeff Slade USFWS, personal communication). There were two lamprey survey stations in Segment 1 and no lamprey species were found. This is not too surprising because Croswell and Wingford (formerly Ford's) dams are located downstream, blocking upstream lamprey spawning migration from their adult habitats in the Great Lakes. Lamprey are also quite intolerant of degraded stream conditions so Segment 1 probably does not supply quality spawning and juvenile habitat.

Segment 2

This segment of the Black River main stem begins at Hyde Road and continues south 17 miles to Mortimer-Line Road in Worth Township. This segment is considerably larger since it receives water at the upper end from the Black River's largest tributary system, 186 mi^2, known as Elk Creek subwatershed. There were 11 MDNR fish population site surveys in this segment and three surveys in Elk Creek (Table 11). This segment is characterized by highly modified and straightened channels in the majority of the upper areas and tributaries but more natural channel features from just upstream of the City of Croswell to the lower end of the segment. The MDNR fish surveys in the Black River caught a total of 43 species (the same number as in Segment 1). Of the eight species that were found in half or more of the 11 surveys, all were fish that are known to be tolerant of a wide range of habitat types and quality. Four of these, rock bass, pumpkinseed, northern longear sunfish, smallmouth bass, and northern pike, are desirable sport species. Other sport species in lesser abundance were bluegill, black crappie, white crappie, channel catfish, yellow perch, and largemouth bass. Most of the remaining species were among those considered sensitive to pollution indicating that the quality of fish habitat in this segment is degraded. There is a dam in the City of Croswell which prevents upstream movement of fish except during very high flow conditions. The water impounded by the dam creates habitat conditions similar to those found in lakes which likely accounts for presence of fish species such as black crappie and white crappie.

There were three site surveys in Elk Creek capturing 22 species, only slightly more than half of the number in either Segment 1 or 2 of the Black River. However, only three surveys do not provide a sound basis for calculating species percentages and it would be unwise to make many conclusions regarding the fish community. Elk Creek is known to be heavily affected by channel modifications and agricultural practices which have degraded the fish habitat.

Just as in Segment 1, common carp was the only exotic fish species captured by MDNR surveys. However, there was a single eastern sand darter *Ammocrypta pellucida* captured, and another observed (but evaded capture), at a site upstream from the City of Croswell in 2006. The eastern sand darter is legally protected in Michigan. This is a bottom dwelling species found where there are clean, stable substrates composed primarily of sand. Sand darters bury themselves tail first in the sand, leaving only their eyes exposed, where they are able to dart out and snatch prey without being detected. Their bodies are almost entirely transparent which renders them undetectable to most predators. In the Black River watershed, most of the clean sandy substrate required by this species was likely covered over by silts and clays washing into the river, after the land was cleared and developed for agricultural and residential uses. The presence of this species in this section of the Black River is very surprising and merits further field study to determine their population status, habitat availability, and proper protective actions to ensure their survival.

There was one USFWS lamprey survey station in Segment 2 and no lamprey species were found, presumably for the same reasons as stated above for Segment 1.

Segment 3

This relatively large segment begins at Mortimer-Line Road in Sanilac County and continues 29 miles south to the river crossing at Wadhams Road in Clyde Township, St. Clair County. The gradient quickly changes from relatively low at the upper end to relatively steep in the rest of this segment as the river takes on more natural hydrologic character. Approximately 16 miles of the Black River main stem are contained within the Port Huron State Game Area where excellent forested buffers provide valuable protection and wildlife habitat. Of all segments, Segment 3 also has the best sequences of riffles and pools with abundant gravel and boulder habitat for fish and aquatic invertebrates. The MDNR fish surveys in this segment of the Black River caught a total of 56 species, the largest number of all the segments (Table 11). Greater fish diversity in this segment likely has resulted because aquatic habitats of higher quality and variety exist here. Of the ten species that were found in half or more of the 20 surveys, all were fish that are known to be tolerant of a wide range of habitat types and quality. Three of these, rock bass, bluegill, and smallmouth bass are desirable sport species. Other sport species in lesser abundance were pumpkinseed, black crappie, white crappie, channel catfish, yellow perch, largemouth bass, and walleye. As in Segment 1, none of the remaining species were among those considered sensitive to pollution indicating that the quality of fish habitat in this segment is degraded. Wingford Dam (formerly Ford’s Dam) is located on the Black River in this segment (Figure 30). It has a head of approximately 20 feet which effectively blocks upstream fish migration. The water impounded by the dam creates habitat conditions similar to those found in lakes which likely accounts for presence of fish species such as black crappie and white crappie.

Common carp, white perch, and round goby were the only exotic fish species captured in Segment 3 by MDNR surveys and there were no species captured that are on the Michigan list of endangered, threatened, or special concern status. Round goby are a recent invader of the state’s fish fauna. Their capture in this segment and in the lower segment of Mill Creek likely resulted from greater sampling effort and blockage by dams to upstream movement.

There were 10 USFWS lamprey survey stations in Segment 3, 2 above Wingford Dam and 8 below. No lamprey species were found above the dam, presumably for the same reasons as for Segment 1. Some juveniles (ammocetes) belonging in the Genus *Ichthyomyzon* (native lampreys) were found at some of the sites below the dam (Figure 56).

Segment 4 (Mouth)

The final segment is 11 miles long encompassing the main stem from the Wadhams Road bridge to the mouth in the city of Port Huron where it empties into the St. Clair River only two miles downstream from Lake Huron. This segment of the main stem is characterized as very low to negligible gradient with significant affect from changing water levels in the upper St. Clair River. There is access for migrating Great Lakes fish to the Black River through the Black River Canal at

Lake Huron or where the river enters the St. Clair River. There were 11 MDNR fish population site surveys in this segment. This segment is also characterized by highly modified and straightened channels along the entire length. The MDNR fish surveys in this segment caught a total of 41 species, a much higher number than anticipated based on poor habitat quality and availability. One possible reason for this unexpected species diversity is that Great Lakes fish of many species migrate into tributaries for short periods of time. The relative mix of fish species in this segment is very characteristic of shallow, productive bays in the lower Great Lakes (Table 11). Of the seven species that were found in half or more of the 11 surveys, all were fish that are known to be tolerant of a wide range of habitat types and quality. Four of these, largemouth bass, pumpkinseed, bluegill, and yellow perch, are highly desirable sport species. Other sport species in lesser abundance were white crappie, black crappie, channel catfish, walleye, northern pike, and smallmouth bass. All remaining species were infrequently captured and were among those considered sensitive to pollution, indicating that the quality of fish habitat in this segment is degraded.

Common carp were the only exotic fish species captured in Segment 4 by MDNR surveys and there were no species captured that are on the Michigan list of endangered, threatened, or special concern status. Round goby are presumed to be present in Segment 4 but they are not vulnerable to capture in the sampling gear used to survey bigger, deeper waters.

Large numbers of longnose gar and turtles were observed spawning and using the partly constructed Mallard Creek Marina just upstream of route I-94 on the south bank of the Black River (David Dortman, Michigan Department of Environmental Quality, personal communication).

There were eight USFWS lamprey survey events in Segment 4 finding some ammocetes in the Genus *Ichthyomyzon*, and some American brook lamprey *Lampetra appendix* and northern brook lamprey *Ichthyomyzon fossor* that were identifiable to species in the field (Figures 56, 57, and 58).

Mill Creek (Lower Segment)

Mill Creek is the second largest subwatershed and it has significant natural aquatic habitat throughout its lower reaches. Yale is the only city within the drainage area of this segment and there is a low-head dam in the Yale city park that may block upstream fish movement during most flow conditions. In this segment, the river channel has not been modified to a significant degree. The Mill Creek Volunteer Monitoring Project (MCVMP), part of the Michigan Department of Environmental Quality's Volunteer Monitoring Program, has been monitoring biological indicators of water quality in the upper 17 miles of Mill Creek upstream from Yale since 1999. The MCVMP volunteers did not sample fish but collected and recorded data on a core set of parameters, particularly benthic macroinvertebrates and habitat in order to rank sites for water quality.

Much of Mill Creek downstream from Yale has good vegetative riparian buffers and the lowest reaches are located in the Port Huron State Game Area. This segment has excellent sequences of natural riffles and pools with much gravel and boulder habitat for fish and aquatic invertebrates. The 14 MDNR fish surveys in this segment of Mill Creek caught a total of 53 species which was only three less than the largest number from Segment 3 of the Black River, even though there were six fewer site surveys. This suggests that Mill Creek supports the best fish species diversity within the Black River watershed. Greater fish diversity in this segment likely has resulted because aquatic habitats of higher quality and variety exist here. Most of the 16 species that were found in half or more of the 11 surveys were fish that are known to be tolerant of a wide range of habitat types and quality. However, rosyface shiner was found in 50% of the Mill Creek surveys and they are considered to be a sensitive species that cannot tolerate excessive siltation and turbidity. Northern pike, pumpkinseed, and smallmouth bass were among the 16 common species and they are highly desirable sport species. Other sport species in lesser abundance were bluegill, northern longear sunfish, largemouth bass, channel catfish, yellow perch, white crappie, black crappie, walleye, and hybrid sunfish.

Common carp and round goby were the only exotic fish species captured in lower Mill Creek by MDNR surveys and there were no species captured that are on the Michigan list of endangered, threatened, or special concern status. As in Segment 3, round goby captured in this segment likely resulted either from relatively more sampling effort in recent years compared to other segments or not having enough time to migrate further upstream. It is notable that common carp were only found in 42.9% of the survey catches, whereas, in all other segments this species was present in above 50% of the surveys.

There were 75 USFWS lamprey survey events in the lower segment of Mill Creek finding numerous ammocetes in the Genus *Ichthyomyzon*, and some American brook lamprey *Lampetra appendix*, northern brook lamprey *Ichthyomyzon fossor*, silver lamprey *Ichthyomyzon unicuspis* and a few sea lamprey (Figures 56, 57, 58, 59, and 60). Sea lamprey comprised a very small percentage of the total lamprey found and the USFWS does not consider the Black River watershed to be a significant source of parasitic sea lamprey adults to the Great Lakes population. The high density of native lampreys in this segment attests to the relatively good quality of aquatic habitat found here. Populations of lamprey would likely be higher in upstream segments of the Black River main stem if dams did not prevent spawning migrations. Opening up more spawning and juvenile habitat for exotic sea lamprey would be one negative effect from removal of the most downstream dam.

Mill Creek (Upper Segment) and Other Tributaries

There were three MDNR fish survey sites in the upper segment of Mill and Elk creeks and one each in Black Creek and Silver Creek (Table 11). The upper Mill Creek surveys captured 24 species, Elk Creek surveys had 22 species, and Black and Silver creeks had 13 and 14 respectively. Because there were relatively few survey efforts in these stretches of river, it is difficult to make judgments on the status of the fish populations. Fish habitat in all of the segments, with the possible exception of Silver Creek, has been severely damaged by channel modification and erosion. Even for Silver Creek, the upper reaches were modified for agricultural development and construction of the DTE Energy Greenwood Power Plant.

Common carp were the only exotic fish species captured in these segments by MDNR surveys and there were no species captured that are on the Michigan list of endangered, threatened, or special concern status.

There were 10 USFWS lamprey survey events in the upper segment of Mill Creek finding some ammocetes in the Genus *Ichthyomyzon*, and some northern brook lamprey that were identifiable to species in the field (Figures 56 and 58). The low-head dam in the City of Yale may block some upstream migration of spawning adults and habitat quality is much more limiting in these stream reaches.

Invertebrates

The invertebrate community often provides a direct indication of water quality problems because of its immobility relative to fish. The presence or abundance of pollution tolerant species may indicate persistent degraded stream quality and it is possible to pinpoint specific problems by comparing species composition among sites. Some intolerant invertebrates, like most mayfly, caddisfly, and stonefly species are only found in streams with good water quality. There have not been many state biological surveys in the Black River main stem or tributaries that have evaluated water quality in conjunction with the invertebrate community. Eight surveys were conducted between 1968 and 2007 by the Michigan Water Resources Commission and Michigan Department of Environmental Quality to assess water and habitat quality in relation to municipal and industrial permitting activities (Figure 61). As mentioned above, the Mill Creek Volunteer Monitoring Project has been monitoring biological indicators of water quality in Mill Creek since 1999 and their results will be reported under that segment.

Segment 1

The only biological surveys in the Black River watershed influencing Segment 1 were conducted in Berry Drain (stations 1-3, Figure 62; and G-M, Figure 63) and the Black River (stations 1 and A-F, Figure 63) by the MDEQ Water Bureau (Morse 1993; Schmitt 2005; Schmitt 2008) in 1992, 2004-05, and 2007. The stated purposes were to identify nonpoint impairment areas and to evaluate the effect of the City of Sandusky Waste Water Treatment Plant (WWTP) discharge to aquatic macroinvertebrates, physical habitat, and water quality of the upper Black River and Berry Drain. Survey procedures were performed according to a qualitative biological protocol for wadable streams developed by the Great Lakes and Environmental Assessment Section (GLEAS) called Procedure 51 (MDEQ 1990). Using this system, macroinvertebrate communities are scored with metrics that rate water bodies from excellent (+5 to +9) to poor (-5 to -9). Macroinvertebrate ratings from +4 to -4 are considered acceptable. All site-specific biosurvey data are considered by MDEQ to determine habitat suitability for indigenous aquatic life. In 1992, aquatic habitat was rated poor upstream and downstream of the WWTP and the macroinvertebrate community was rated fair upstream of the WWTP but poor downstream. There were three stations located along the drain (Figure 62) during the 2004/05 survey. In September of 2004 and August of 2005 macroinvertebrate communities were rated “acceptable” at stations 1, 2 and “poor” at station 3. Habitat was rated “good”, “marginal”, and “poor” in that order at the three stations in 2004 and “marginal”, “marginal”, and “poor” in 2005. The macroinvertebrate community was rated acceptable at station 1 (Figure 63) in 2007 (Schmitt 2008). The 2005 report (Schmitt 2005) provides a summary of MDEQ survey results:

> The macroinvertebrate community, habitat quality, and water chemistry data collected during the September 21, 2004 and the August 22, 2005, biological surveys indicate that Berry Drain is not attaining the requirements of the Michigan Water Quality Standards. Land use practices have channelized Berry Drain and changed the habitat quality from its headwaters to the confluence with the Black River. Poor macroinvertebrate communities could be a result of the less than ideal available habitat found immediately downstream of the Sandusky WWTP. Elevated levels of total phosphorus, ammonia, and nitrate+nitrite were also found immediately downstream of the Sandusky WWTP and could be a cause of the nuisance cladophora conditions noted in the 2004 visit. The data collected during 2004 and 2005 will be used to support a TMDL for Berry Drain.

In addition to the regular biological sampling sites in 2007, 18 targeted sites, 16 within Segment 1 (Figure 63), were visually surveyed (Schmitt 2008). Targeted sites were selected to fulfill specific monitoring requests or needs. McManus Drain was visually assessed at four locations (Stations A, B, C, and E) for nuisance plant growth. All locations had no flow and were channelized. Duckweed was present at all locations, but not at nuisance conditions. Water chemistry samples were collected at two locations to evaluate nutrient concentrations in the Berry Drain watershed (Stations G through M). Total phosphorus concentrations ranged from 0.08 to 0.31 milligrams per liter (mg/l). Nuisance plant growth was not observed anywhere in the Berry Drain watershed at the time of the survey. Carsonville Drain was visually assessed at two locations (Stations N and O) to determine possible untreated sanitary waste discharges. Station N was dry and Station O was stagnant with no flow and no discharges were observed at either location.

Segment 2

This segment has been the focus for most of the MDEQ biological survey work in the Black River watershed because the City of Croswell WWTP, the Michigan Sugar Company, and other industrial sites in Croswell were thought to be major sources of contamination of the river. The first of five surveys was done in September (preoperational) and November (postoperational) of 1968 (Willson 1969) to "evaluate impact of discharges from the Michigan Sugar Company on habitat and aquatic life" in the Black River. Qualitative collections of aquatic animals were made at eight stations (Figure 64), one upstream of Croswell and seven located downstream to check for changes downstream. Stations 6, 7, and 8 were located far enough downstream to be in river Segment 3. The macroinvertebrate populations were evaluated based on the frequency of tolerant, intolerant, and facultative species. Some summary statements for each station from Willson (1969) are important to consider here because they highlight the extremely bad conditions that existed in many rivers in the United States during that period which led to the enactment of the Clean Water Act in 1972:

> <u>Station 1</u>. [Approximately 6 miles upstream from the City of Croswell] This station supported a variety of aquatic animals and the community structure was in a state of normal balance. Of the 28 species found in September 4 were intolerant, 23 facultative, and 1 tolerant. In November, 24 species were found: 6 intolerant, 23 facultative, and 3 tolerant. Dominant animals were midges, caenid and baetid mayflies, psychomyiid caddisflies, and washboard clams. During the November survey washboard clams (*Amblema costata*) were collected alive for use in another Water Resources Commission project. In less than 30 minutes two people collected over 80 mature clams. This extremely dense population of adult clams indicates that high water quality has existed at this location for a long period of time.
>
> <u>Station 2</u>. [Approximately 500 yards downstream from Michigan Sugar condenser discharge at that time] The benthic community found at this location in September expressed a better balance than that of the control station 1. Qualitative collections revealed the presence of 26 species of which 6 were intolerant, 18 facultative, and 2 tolerant. Intolerant representatives included stoneflies, mayflies, caddisflies, and darters. Mayflies of the genus Stenonema were extremely abundant on cobbles and other hard surfaces. An excellent littoral fauna existed. The November operational survey found dishwater gray-brown water flowing over a substrate completely covered with a black flocculent, organic sludge. The bottom fauna was found to consist of three species: tolerant red midges, tolerant leeches, and facultative water boatmen.
>
> <u>Station 3</u>. [Approximately 75 yards downstream from Croswell WWTP outfall at that time]. During the preoperational survey, animal species were found to be reduced in both numbers and quality from those found at station 2. Qualitative collections revealed the presence of 19 species: 14 facultative and 5 tolerant. Intolerant forms were not present. The November operational survey found that strong disagreeable odors were emitted from both the water and sediments. Qualitative collections of animal life produced only five species of which four were facultative and one was tolerant. Red midges and water boatmen were dominant.
>
> <u>Station 4</u>. [Approximately 900 yards downstream from the Sugar Company Condenser outfall at that time]. A total of 13 species were found in September, of which nine were facultative and four tolerant. Qualitative collections [in November] of aquatic animal life revealed the presence of only five species: 3 facultative and 2 tolerant.
>
> <u>Station 5</u>. [Approximately 1.3 miles downstream from the Sugar Company Condenser outfall at that time]. A diverse fauna of 23 species was found at this location in September. This included 20 facultative and 3 tolerant species with intolerant forms absent. Qualitative collections (November) revealed the presence of only eight species: 5

> facultative and 3 tolerant. Stream conditions were so obnoxious to field personnel that collecting was difficult.
>
> Summary:…5. The November study found that habitat conditions in the Black River were seriously altered and destroyed.
>
> 6. Biological collections in November showed a virtual destruction of the downstream benthic animal community. Biological recovery was not complete at a distance 6.6 miles downstream.
>
> 7. Conditions were totally repulsive to any recreational uses for over 3.8 river miles.

The next survey involving this segment was done by Michigan Water Resources Commission in 1973 (Pecor and Hay 1975). This was the most comprehensive of the five surveys in the watershed in terms of area covered. There were 24 stations located from the village of Applegate at the upstream end to the mouth of the Black River in Segment 4. Six of these stations (labeled 1–6) were located in Segment 2 (Figure 65). The primary objective of the study was to document existing water quality conditions in the Black River, including assessment of the effects of wastewater discharges from the Croswell Wastewater Treatment Plant, Michigan Sugar Company and Port Huron Paper Company on the river's water quality and biota. Quantitative methods were used during this survey so it is not directly comparable with the 1968 study. However, findings were generally similar and results from the 1973 survey showed that, in October, the benthic community was severely degraded for over 8 miles downstream from Croswell most likely due to the combined effluents from the WWTP and Michigan Sugar Company. Standing crop of macroinvertebrates at control stations 1 and 2 above Croswell was found to be 4,720 and 4,211 individuals/m^2 with the generally intolerant mayfly and caddisfly nymphs making up a major portion. At stations 4–6 below the Croswell WWTP standing crop decreased to approximately 50% of the control stations and was dominated by tolerant and facultative midge larvae.

There were two biological assessments in 1982 by the Water Quality Division which at that time had become part of the Michigan Department of Natural Resources. The first, conducted in April, was a field survey of Spring Creek Drain, Potts Drain, and Elk River to evaluate a request by the Village of Peck to discharge sewage lagoon effluent (Johnson 1982). This survey was primarily qualitative but concluded that Spring Creek Drain and Potts Drain were significantly affected by channelization which essentially eliminated physical and habitat heterogeneity. The Elk River (now called Elk Creek) in this area was not found to be significantly affected by channelization. There was habitat diversity present and a relatively abundant benthic macroinvertebrate community; however, it is very likely that this area of Elk Creek has since been channelized.

The second 1982 survey, conducted only in September, was a qualitative biological examination of the Black River in the vicinity of the City of Croswell to assess any changes in stream quality due to improved sewage processing by the upgraded WWTP (Johnson 1983). There were six stations with five (labeled 1–5) located in Segment 2 (Figure 66). Station 6 was located a relatively short distance downstream in Segment 3 and will be considered part of this discussion. An excerpt from the 1983 report provides a concise summary:

> Improved conditions in the Black River downstream of the Croswell WWTP discharge were clearly evident in the 1982 survey. The macroinvertebrate communities downstream of the Croswell WWTP in 1982 contained pollution intolerant organisms and were better balanced than in previous surveys. An average of 23 macroinvertebrate taxa were found at each station downstream of the WWTP in 1982 as compared to ten or fewer taxa at the same stations in 1973. At least two pollution intolerant taxa were found at every station downstream of the WWTP in 1982 where none were found in 1973. Biotic indices at

> stations downstream of the WWTP averaged 21 in 1982, less than five in 1973, and ten in 1968.

Another qualitative biological sampling of the Black River watershed was conducted by staff from the Surface Water Quality Assessment Section of MDEQ between June and September of 2002 (Goodwin 2007). Survey procedures were carried out according to GLEAS Procedure 51 (MDEQ 1990). Ten stations (numbered 10–19) spread across river segments 2, 3, and lower Mill Creek were sampled (Figure 67). Station 10, on Beals and Frizzle Drain, and station 11 on the Black River just south of Croswell were located in Segment 2. Habitat at station 10 was rated "marginal" suggesting moderate impairment and macroinvertebrates were rated "acceptable." Habitat at station 11 was rated "good" or slightly impaired while macroinvertebrates were rated "acceptable."

Another qualitative biological sampling of the Black River watershed was conducted by staff from the Surface Water Quality Assessment Section of MDEQ during July and September of 2007 (Schmitt 2008). Five stations (numbered 2–6) were sampled (Figure 63). Habitat was rated "marginal" at all stations except station 6 which was rated "good" suggesting moderate impairment and macroinvertebrates were rated "acceptable" at all stations.

Segment 3

Parts of this segment were also included in sampling by five of the seven MDEQ surveys, including the first survey in 1968 (Figure 64) which had three stations in Segment 3. Excerpts from the 1969 report are continued here:

> Station 6. [Approximately 3.8 miles downstream from the Sugar Company Condenser outfall at that time]. Qualitative samples revealed a biotic community of 21 species in September, of which 18 were facultative and 3 tolerant. The macrofauna detected [in November] by qualitative sampling consisted of only eight species: 4 facultative and 4 tolerant.
>
> Station 7. [Approximately 5.2 miles downstream from the Sugar Company Condenser outfall at that time]. A diverse and relatively well balanced fauna of 23 species was found at this location in September. Of the forms represented 4 were intolerant, 17 facultative, and 2 tolerant. Of the 18 species found in qualitative samples [in November] 1 was intolerant, 11 facultative, and 6 tolerant.
>
> Summary:…4. Degradation of the fauna was detected in September, but recovery was rapid in the downstream reaches. Recovery was essentially complete at a point 5 miles downstream. [See also summary item 5 above].

The next survey involving this segment was done by Michigan Water Resources Commission in 1973. Of the 24 stations, eight (labeled 7–14) were located in this segment (Figure 65). During fall operations of the sugar plant in Croswell, degraded benthic communities were obvious downstream to station 11 and some effect was detected as far downstream as station 13. These results show a dramatic worsening of benthic habitat and invertebrate communities compared to 1968. This study also detected increased silt load and turbidity caused by discharge of wash water from the Mid-Michigan Materials Company, a large gravel and sand mining operation on the river near station 10. Standing crop of macroinvertebrates at stations 8–13 ranged from 2,412 (station 13) to 6,821 individuals/m^2 (station 8) consisting of approximately equal numbers of mayfly-caddisfly nymphs and midge larvae. At downstream station 14, mayfly-caddisfly nymphs dominated (84%) the benthic community which had a standing crop of 11,000 individuals/m^2.

Another survey was conducted by Surface Water Quality Division of MDNR during August 1992 largely within this segment. The purpose was to qualitatively evaluate point source and nonpoint source pollution effects on the Black River below Croswell WWTP (Walterhouse 1994). This study was performed according to GLEAS Procedure 51. There were four stations (labeled 4-1 downstream) with station 4 positioned in the most downstream reach of Segment 2 and stations 3 through 1 spread across Segment 3 (Figure 68). Consideration of results from all four stations will be included in this discussion. The macroinvertebrate community was rated “good” which reflects only slight impairment at all four stations. Habitat ratings were even better with stations 1, 2, and 4 rated “excellent” suggesting no impairment. Station 3 was rated “good” reflecting slight impairment. The aquatic habitat and biological community inhabiting the Black River below the City of Croswell had improved dramatically since 1968. This survey revealed that the biotic integrity of the macroinvertebrate community in 1992 was only slightly impaired. However, Walterhouse (1994) offered that some of the apparent improvement could be due to significant drought conditions during recent years which may have significantly reduced inputs of eroded soils from nonpoint sources throughout the watershed.

The 2002 survey by Goodwin (2007) reported results from four stations in Segment 3, station 12 on Black Creek, stations 13 and 15 on the Black River, and station 14 on Silver Creek (Figure 67). Habitat at stations 12–14 was rated “excellent” and “good” at station 15. Macroinvertebrate communities were rated “excellent” at station 13, but only “acceptable” at stations 14 and 15. The river at station 15, which is a relatively short distance downstream from station 13, has been significantly degraded by erosion and heavy silt accumulation from the gravel and sand mining operation between the two stations. Except for effects from the mining operation, it appears that improvements in habitat and biota, first observed in 1992, were maintained.

The 2007 survey by Schmitt (2008) reported results from three stations numbered 8, 14, and 15. Habitat was rated good to excellent and macroinvertebrates were rated excellent. This section of the Black River main stem is positively influenced by the presence of naturally vegetated buffers along both sides of the river.

Segment 4

The 1973 biological survey was the first to sample benthic invertebrates within this segment. Of the 24 stations, ten (labeled 15–24) were located in this segment (Figure 65). This study found that macroinvertebrate standing crop was dominated by midge larvae and varied greatly at stations 16, 17, and 18. From station 19 downstream to the mouth of the Black River standing crop declined sharply averaging 3,900 individuals/m^2. Stations below the Port Huron Paper Company discharge had the lowest standing crop averaging about 800 individuals/m^2 mostly composed of very tolerant oligochaetes. The Port Huron Paper Company has changed ownership several times and has undergone several large-scale machine renovations. Their discharge of industrial waste has likely diminished so the aquatic habitat and biological community may have improved from station 19 downstream. The 2007 biological survey at stations 12 and 13 (Figure 63) determined that habitat was marginal and macroinvertebrate populations were acceptable.

Mill Creek

The 2002 biological surveys by Goodwin (2007) and Schmitt (2008) were the only ones conducted by MDEQ on Mill Creek. In 2002, station 16 was located on the South Branch of Mill Creek and 17–19 were located in the lower segment of Mill Creek (Figure 67). Habitat was rated “marginal” at station 16 and “good” at the three stations on Mill Creek. Macroinvertebrate communities were rated “acceptable” at stations 16–18 and “excellent” at station 19 which is in the MDNR Port Huron State Game Area. The 2007 biological survey (Schmitt 2008) was conducted at stations 9, 10, and 11 (Figure 63) and found that habitat was marginal, good, and excellent in the downstream direction. Macroinvertebrates were ranked acceptable to excellent.

Mill Creek is the second largest subwatershed and has significant natural habitat for aquatic organisms and much fisheries potential. The South Branch of Mill Creek downstream to a point on the main part of Mill Creek two miles upstream from Yale has been targeted for significant channel modifications by the Inter-County Drain Board. There is also a low-head dam in the Yale city park. The Mill Creek Volunteer Monitoring Project (MCVMP), established in 1999 as part of the Michigan Department of Environmental Quality's Volunteer Monitoring Program, monitors biological indicators of water quality in the upper 17 miles of Mill Creek upstream from Yale (Gill 2000, 2005). This MDEQ project has the goal of increasing the number of stream miles assessed in Michigan by developing partnerships with citizen-volunteer groups. Volunteers with MCVMP collect and record data, on MDEQ forms, for a core set of parameters that measure quality of benthic macroinvertebrates and aquatic habitat. This information is supplied to MDEQ where it is entered into a database used by state biologists to rank sites for water quality in the Black River watershed. Annual surveys, beginning in 1999, have been conducted at up to ten sites spread from station 7 at the upstream reach of the South Branch of Mill Creek to station 9 on the main part of Mill Creek well downstream from the City of Yale (Figure 69). A geographic location for site 10 was not available. The focus of the study was to evaluate the effects of channel modifications on aquatic habitat and biota. Stations were established in areas that had natural river channels (controls) and in test areas where the channel had been artificially dredged and straightened to accelerate flow. Six of the monitoring sites were within the proposed dredging area to compare environmental damage from channel dredging versus potentially less damaging river restoration techniques recommended by the United States Corps of Engineers (Institute of Environmental Sciences 1982). Volunteers monitored these six sites in the spring and fall of 1999, before a portion of the river, encompassing survey sites 6 and 7, was dredged in the winter of 1999-2000. These six sites, plus a seventh volunteer training site, have been monitored every spring and fall since 1999. Three additional sites were subsequently added (two in 2001 and one in 2003) so that sites within the compromise project area could be compared to historically dredged and nondredged sites outside the compromise drainage project area.

Excerpts from the 2005 report provide a concise summary of the MCVMP survey results:

> Site #6 and Site #7, the two sites dredged in 1999/2000, still have sediment as deep as 24 inches. The channel at both sites is choked with algae and vegetation. Nearly five years after dredging, Site #6 still has partially bare banks. The lowest water quality score for each spring and fall monitoring session has always come from a dredged site. Site #6 has scored lowest 5 times, Site #7 four times, and Site #8 (dredged in 1965), 3 times.
>
> The highest water quality score for each spring and fall monitoring session has always come from a site that was never dredged. Site #2 has scored highest four times, Site #9 and Site #10, three times each, Site #3, two times, and Site #1, once. Site #2 and Site #3 tied for highest score in the spring of 2002.
>
> The only dredged sites to have tested "excellent" are Site #4 and Site #5, after river restoration techniques were applied. Site #4 tested "excellent" in spring, 2002 and the fall and spring of 2003. Site #5 tested "excellent" in the spring of 2002.
>
> Only the completely natural sites, #9 and # 10, with no river restoration or dredging, have scored above 60 points for water quality. These are also the only sites to have higher average scores in the fall rather than spring.
>
> Mill Creek Volunteer Monitoring Project data clearly indicates that dredging has negatively impacted the water quality of Mill Creek. Water quality scores are consistently lowest at dredged sites and highest at sites that have never been dredged. River restoration seems to have been an effective tool, without the harmful effects of dredging.

After river restoration techniques were applied, sediment began to clear throughout the river restoration section.

Mussels

Freshwater mussels might be the most imperiled freshwater fauna in North America. There are approximately 300 species of native unionid mussels in North America with at least 77 of these considered in immediate danger of extinction and 21 of these species probably extinct (Williams et al.1993). Currently, 19 of Michigan's native species are state listed as threatened, endangered, or special concern with 3 of these species also being federally listed as endangered (Badra and Goforth 2003). At least 18 freshwater mussel species had been historically found in the Black River (Trdan and Hoeh 1995). An unpublished survey was conducted on the Black River in 2003 by personnel from the Michigan Natural Features Inventory and found evidence of 22 native mussel species, 17 live and 5 shell only (Peter Badra, Michigan Natural Features Inventory, personal communication). The threeridge *Amblema plicata* and the white heelsplitter *Lasmigona complanata* were the most abundant (Table 12). Notably, the state endangered salamander mussel *Simpsonaias ambigua* was found alive, but at very low abundance level. Dead shells were found from wavy-rayed lampmussel *Lampsilis fasciola* which is a state threatened species. Four special concern species were also found, two living and two dead shells (Table 12).

Another mussel survey of portions of the Black River watershed was conducted in 2005 (Sweet 2005). Five stations in the Black River main stem were surveyed, two in Segment 2 and three in Segment 3 (Figure 70). A total of 15 species were observed alive plus six more identified from dead shells (Table 13). As found in 2003, the threeridge and white heelsplitter were the most abundant. However, fairly high densities of live elktoe *Alasmidonta marginata*, a state special concern species, were found at stations 4 and 5. Station 6 had the highest density of native mussels at 8.8 per m^2 due to abundant threeridge and Wabash pigtoe *Fusconaia flava* which were only found at one other station (Table 13). Station 2 was the only one where no live mussels were observed. This section is just downstream from the Jeddo Road bridge at the lower end of the large gravel and sand mining operation identified above as continuing to have deleterious effects on aquatic habitat and biota (see invertebrates, Segment 3). There may also be high concentrations of lead shot in the river substrate along this stretch which have accumulated from frequent target shooting at a large conservation club with ranges located adjacent to the river. Native mussels are known to be very sensitive to heavy metal poisoning.

Apparently, no exotic mussels, including zebra mussel *Dreissena polymorpha*, were observed in any of these surveys. According to Sweet (2005) the Black River is a potential native mussel refuge because it has few boat launches and has relatively high mussel diversity which makes it unlikely that zebra mussels will be introduced. If they were, it would be unlikely their population would get high enough to affect native mussels.

Recent surveys of the East Sydenham River in Ontario documented populations of many mussels that were presumed to be common historically in the Black River, but are now rare or extirpated. They included rayed bean *Villosa fabalis*, salamander mussel, snuffbox *Epioblasma triquetra*, and northern riffleshell *Epioblasma torulosa biloba* (Sweet 2005). The nearby Sydenham River is located due east of the Black River and has many identical characteristics. The USFWS, at their Genoa National Fish Hatchery in Wisconsin, and Thomas Watters at The Ohio State University are culturing endangered and threatened mussels for rehabilitation into the wild. It would be feasible to culture and reintroduce some of the endangered and threatened mussels into the Black River watershed. There have been genetic analyses which support the importance of using mussel populations in the Sydenham River as the source for riffleshell and snuffbox in the event that propagation and reintroduction will be attempted. Zanatta and Murphy (2007 and 2008) analyzed genetics for northern riffleshell and snuffbox, each of which are *Epioblasma spp*. and both assessments include material from the Sydenham River. While the riffleshell analysis did not include any populations from Michigan, they did find that the Sydenham River population was clearly distinct from the Ohio River populations and its genetic diversity was quite high, indicative of a much larger population. They surmised that this may be the result of “a large amount of gene flow between the populations in the Sydenham River and the historically large population in the Detroit River”. In addition, Zanatta and Murphy (2008) did include material from Davis Creek in the Huron River watershed in southeast Michigan. As expected, the Sydenham River and Davis Creek populations were more closely related to each other then to other sites. These analyses indicate that historically there was likely good gene flow between the riffleshell populations within the Sydenham and Black rivers, and lends support for the argument that any riffleshell reintroduction effort should come from the Sydenham River and not from more distant sources.

Amphibians and Reptiles

Amphibians and reptiles are an important part of the fauna in the Black River watershed. They are a valued consumer of a variety of plant and animal materials and they are an important food source for other species including fish, mammals, and birds. Nine species of turtles, 1 lizard, 15 species of snakes, 7 species of salamanders, and 10 species of frogs and toads are known to occur in the watershed (Table 14). However, little information is available on the distribution and abundance of amphibians and reptiles in the basin.

Most species of amphibians and reptiles in the Black River watershed are carnivorous, feeding on rodents, fish, birds, crayfish, insects, spiders, and other snakes and amphibians. In addition, frog and toad tadpoles feed largely on algae and other aquatic plant materials and many turtles are omnivorous, feeding on both plants and animals. Amphibians and reptiles are also eaten by a great variety of natural predators, including mink, otters, foxes, raccoons, opossums, foxes, skunks, shrews, herons, bitterns, hawks, snakes, turtles, frogs, and fish (Harding 1997).

The destruction and fragmentation of natural habitats is undoubtedly one of the greatest threats to all types of Michigan’s native animals and plants. This is especially true for amphibian and reptile populations because they have several different life stages requiring much different habitat characteristics. Different habitat types must be present in close proximity because, unlike birds, reptiles and amphibians are not highly mobile. In the Black River watershed much of the landscape has been converted to agricultural use accompanied by draining of many wet areas. In addition, the widespread use of chemical herbicides and pesticides is undoubtedly detrimental to insect eating species (Harding and Holman 1990).

Birds

A comprehensive survey of breeding birds in Michigan has been compiled each year (Breeding Bird Atlas Explorer 2008). A total of 157 species of birds have been observed displaying breeding behavior in the area encompassing the Black River watershed (Table 15). Of the birds observed nesting, seven species are designated special concern by the State of Michigan. Three more are designated state threatened, and one, Short-eared Owl, is listed as state endangered. Cerulean Warbler, Forster’s Tern, and Red-shouldered Hawk are considered threatened. Cooper’s Hawk, Grasshopper Sparrow, Northern Harrier, Marsh Wren, Dickcissel, Louisiana Waterthrush, and Hooded Warbler are listed as species of concern. In addition, there are a number of species that are not known to breed in, but seasonally migrate through, the watershed.

River valleys with ample riparian vegetation have been shown to provide very important habitat and food for migrating birds of all kinds. National Weather Service Radar has been used to track bird migrations and the importance of river valleys has often been observed (Gauthreaux 1995). Large flocks of birds, often composed of many species of songbirds, have been observed on radar moving at night and stopping in river valleys at daylight to rest and feed during the day. The Black River watershed is located in a major migratory route for songbirds that need to avoid traversing the long distances over water necessary to cross the Great Lakes. Data on occurrence of breeding activity were compiled and mapped at the most specific level available (Figure 71). The greatest species diversity among breeding birds appeared to occur along the major sections of the Black River and Mill Creek. The MDNR State Game areas, where riparian vegetation is heaviest, had the most species of breeding birds.

Mammals

Much of the Black River watershed has been altered through land-use practices such as urbanization and agriculture. This has had an influence on the abundance and variety of mammal species that are present. Burt (1957) listed 42 species of mammals that had a range in the watershed (Table 16). The least shrew is now listed as threatened and the Indiana bat is now listed as endangered.

Other Natural Features of Concern

The Michigan Natural Features Inventory maintains a list of rare vascular plants and animals, as well as rare and high quality natural communities. Vascular plants are the most commonly listed group of threatened or endangered species in the basin. Plant communities include bogs, emergent marshes, hardwood-conifer swamps, prairie fens, mesic northern forests, and relict conifer swamps.

Minden Bog is a very unique and ecologically valuable natural resource to the State of Michigan. It is the only raised bog in Michigan, the largest bog in the southern part of the state, and probably the farthest south raised bog in North America (Madsen 1999). The bog is truly domed forming parts of the headwater areas of the Cass River and Black River watersheds. The raised portion of the bog is isolated from the water table and receives its water from precipitation only. Most of the time there is little or no standing water in this area. Much of the natural bog that remains is in Segment 1 of the Black River watershed and is owned by the state and managed by MDNR Wildlife Division as part of the Minden City State Game Area. The biological and geological processes that produced the peat found at Minden Bog began about 12,000 years ago after the last large lake receded. Because the area is very flat with poor drainage, mineral laden groundwater and surface rainwater were available to support the unique types of plants that build raised bogs. The bottom layers of Minden Bog were formed in a fen with subsequent layers being produced by a true sphagnum bog (Madsen 1999).

The most unique and notable plant communities of the game area are bog, poor conifer swamp, and muskeg that together form the complex known as Minden Bog (Karr 2003). The plant community in the bog consists mostly of sphagnum moss, sedges, leatherleaf, and highbush blueberry. Other common plants include cotton grass, bog laurel, laborador tea, and low bush blueberry. Common trees found in the bog are bog birch, tamarack, jack pine, white pine, and northern white cedar. Peatlands of this type store great amounts of water which is mostly released through evapotranspiration, not flow of groundwater. They have a moderating effect on streamflow because they store storm water instead of releasing it quickly to the stream.

The Port Huron State Game Area has many unique natural features making it the most valuable habitat for native plants and animals. It contains a large, contiguous riparian zone protecting the river and providing a variety of habitat types connected by the waterway. The game area supports many areas labeled as "special botanical projects" (Kafcas 2002). Extensive ravines along the Black River that are heavily wooded with hemlock stands provide shelter and moisture conditions similar to habitats normally found in Michigan's Upper Peninsula. These ravines are known to support over 200 species of plants including trailing arbutus *Epigaea repens*, painted trillium *Trillium undulatum*, pink moccasin flower *Cypripedium acaule*, red barberry *Berberis thunbergii*, twisted stalk *Streptopus amplexifolius*, rattlesnake plantain orchid *Goodyera schlectendaliana*, beaked hazelnut *Corylus cornuta*, and golden saxifrage *Chrysosplenium americanum* (Kafcas 2002). Painted trillium is a state endangered plant.

Pest Species

Pest species are defined as those species that have been intentionally or accidentally introduced and pose a significant threat to native species or their habitat. Most species do not pose a threat unless present in high densities. Following are examples of some exotic species that are currently found in the Black River watershed and the effects they have on the aquatic community:

Sea lampreys are an invading species that entered the lower Great Lakes in the late 1800s and early 1900s. Sea lampreys are an aggressive parasite that attack fish with a sucking disk and sharp teeth and then feed on body fluids. This results in scars and often death to the host fish. Sea lampreys have not been found in large numbers in the Black River watershed and they were thoroughly discussed above along with three native lamprey species.

Another exotic fish species in the Black River is the round goby. The round goby entered Lake St. Clair in the late 1980s via ballast water discharge from transoceanic vessels. Distribution and abundance of round gobies in the watershed were discussed above. Their effect on the Black River fish community is unknown at this point, but their effect on several native fish species in Lake St. Clair has been documented. However, gobies are also preferred prey for Lake St. Clair game fishes such as smallmouth bass and yellow perch.

Zebra mussels are not well established in the Black River and may only occur in the most downstream reaches near Lake Huron and the St. Clair River. Zebra mussels attach to any hard surface and can clog water intakes. They can become a nuisance on docks and piers and may compete with resident aquatic species that filter algae and zooplankton for food.

There are two common exotic wetland plant species that are, or may become, a nuisance in the Black River watershed: purple loosestrife *Lythrum salicaria*, and Phragmites or common reed *Phragmites australis*. Both are exotic species that live in wetland environments. Purple loosestrife and Phragmites are hardy plants that rapidly degrade wetlands, diminishing their value for wildlife habitat. MDNR is currently involved in a research project on Lake St. Clair to find ways to control and kill established Phragmites; however, the best course of action currently available is to prevent their expansion to new habitats.

Fisheries Management

Fisheries management refers to management actions taken to improve the recreational fishery. MDNR, Fisheries Division has probably managed fisheries in the Black River watershed since the 1920s, although recorded actions prior to 1972 were not located. Management options can include fishing regulations, fish stocking, habitat enhancements, and rough fish removal. Historical and current fisheries management in each main stem section is discussed below.

Segment 1

There has not been significant fisheries management activity in the most upstream section of the Black River. The river has been completely dredged, channelized, and straightened to augment agricultural drainage. It is also small, shallow, and steep-sided with no shading vegetation along its banks in most areas. There is little game fish habitat and these species are sparse and too small to provide any type of fishery. There are no records that any game fish were stocked in this section of the Black River by MDNR (Figure 72).

Berry Drain is a significant tributary to this section of the Black River. The entire length is designated drain and has been channelized. There is a lack of game fish habitat in Berry Drain.

Fish management in this section would require that the artificial channel be widened and restructured to allow the river to form a longer, more natural channel. That would also slow the current flow and create meanders and alternating series of riffles, runs, and pools which would be critical to support a desirable fish community.

Segment 2

There has been some fisheries management activity in Segment 2 of the Black River even though natural features of the river have suffered similarly to Section 1. For the majority of this section, the river has been channelized and the banks managed to quickly pass heavy runoff events. Fish surveys in the 1970's had documented that the fish population was dominated by noxious fish, mostly common carp. Restoration of a natural fish community with an assortment of desirable sport fishes would require that the noxious fish be controlled. A chemical treatment using the piscicide rotenone was conducted in 1983 to eradicate these noxious fish.

A total of 106,000 game fish of five species were stocked by MDNR in this section during 11 years from 1983–93 (Figure 72; Table 17). These fish were stocked to restore a valuable sport fish population that had been seriously degraded by environmental damage and expansion of invasive species, especially common carp.

Segment 3

There has been more fisheries management activity in Segment 3 of the Black River because it offers the most quality habitat and public access of all segments. Much of this segment lies within the Port Huron State Game Area. A chemical treatment using the piscicide rotenone was also conducted in this segment during 1983 to eradicate noxious fish.

There is one human-made pond, Hewitt Pit, on the state game area that supports considerable sport fishing activity at this location. Public access is provided at the PHSGA parking lot on Hewitt Road by hiking in. No records are available on fishing effort, but anglers have been observed at this location by the author on a regular basis. The Black River is only 100 yards east of the pond so good river fishing opportunities are also available at this location.

A total of 130,623 warm and coolwater game fish of five species were stocked by MDNR in this section during five years from 1984–88 (Figure 72; Table 17). These fish were stocked to restore a valuable sport fish population that had been seriously degraded by environmental damage and expansion of invasive species, especially common carp.

A total of 461,000 rainbow (steelhead) trout have been stocked from 1981 to 2007 in lower Mill Creek (mostly) and Segment 3 of the Black River to provide a seasonal steelhead fishery (Table 18). These fish are expected to migrate downstream to Lake Huron and the St. Clair River to grow and mature before returning to the Black River to spawn and provide angling opportunity. Water temperature data collected in Mill Creek and the Black River confirmed that these waters are too warm to support trout through the summer. Wingford Dam (formerly Ford's Dam) prevents movement of fish upstream from the lower part of this segment of the Black River, so all of the steelhead were stocked below the dam. Removal of Wingford Dam would allow steelhead and other Great Lakes migratory species to move upstream through the Port Huron State Game Area to spawn and be caught by anglers.

Segment 4

There has been considerable fisheries management activity in Segment 4 of the Black River because it offers direct connections to Lake Huron and the St. Clair River, allowing easy movement of migrating fish from Great Lakes and connecting waters. It also has convenient public access for boating. A chemical treatment using the piscicide rotenone was also conducted in this segment during 1983 to eradicate as many noxious fish as possible, prior to restocking with game fish.

A total of 130,249 game fish of four species were stocked by MDNR in this section during 13 years from 1979 to 1991 (Figure 72; Table 17). There is a large human-made pond, 40th Street Pond, located in this segment of the watershed south of the Black River. Ample public access is provided at this site including two public fishing piers. Most of these fish were stocked to create a valuable sport fish population in 40th Street Pond (Table 17).

A total of 664,000 brown trout have been stocked from 1980 to 2007 in Segment 4 at the mouth of the Black River to provide a recreational fishery (Table 19). These fish are expected to migrate downstream to Lake Huron and the St. Clair River to grow, mature, and provide a fishery before returning to the mouth of the Black River to spawn.

Recreational Uses

The Black River watershed offers a variety of recreational activities, such as hunting, fishing, canoeing, hiking, bird watching, berry and mushroom picking, biking, rustic camping, and wildlife viewing which are accessible from a mixture of types of publicly owned lands. State land, mainly held within boundaries of MDNR state game areas make up the largest single category of all public lands. No significant survey information was located documenting the level of recreational use for any section of the Black River or its watershed.

Segment 1

The only significant public lands in this segment lie within the Minden City State Game Area (Figure 73). Within this game area there are 5,875 acres of state land managed by MDNR within the Black River watershed. A large share of the game area is part of the Minden Bog. The bog has many natural features that make it very attractive for wild plant and animal viewing. It is also a major hunting area for ruffed grouse, turkeys, deer, waterfowl, and other small game (Karr 2003). There are five public parking areas that provide foot access into the game area (Figure 73). Because the game area forms the headwaters of the watershed, the river is too small to provide much sport fishing opportunity.

Segment 2

Little is known about the recreational uses of the river in this segment. Some fishing occurs at or near road crossings and limited opportunities exist for canoeing. Upstream from Elk Creek the channel is very highly modified with very steep banks so the river is not readily accessible for fishing or canoeing. Downstream from the confluence of Black River and Elk Creek the main stem is large enough to afford some fishing and canoeing opportunities even though for the most part the channel has been dredged and straightened. There are several city parks in Croswell that are located on the

Black River offering access to the river for picnicking, canoeing, and fishing. The City of Croswell also has a small park and rustic campground on the Black River upstream from town. The impounded water above the dam in Croswell provides fishing opportunities for largemouth bass, northern pike, and several panfish species. Every road crossing in this segment downstream from Croswell provides limited access for canoeing and fishing. However, there is very little space available for vehicle parking which severely limits recreational activities on the river.

Segment 3

The most significant public lands in this segment lie within the Port Huron State Game Area (Figure 74). Within this game area there are 5,732 acres of state land managed by MDNR in the Black River watershed. A large share of the game area is part of the Black River valley which has many natural features that make it very attractive for wild plant and animal viewing. About 16 miles of the Black River main stem are contained within the game area where forested buffers provide valuable wildlife protection and habitat. This section of the Black River and Mill Creek have the highest quality aquatic habitat found in the watershed for fish and other aquatic organisms, partly due to the natural condition of the riparian zone. It is also a major hunting area for turkeys, deer, waterfowl, and other small game (Kafcas 2002). There are 24 public parking areas that provide excellent foot access into the game area (Figure 74). A number of the parking areas are located adjacent to bridges so they provide excellent fishing and canoeing access.

The game area has many other attractive features that provide recreational opportunity. It is widely known to ardent birders for being one of the best locations in Michigan for observing numerous species of songbirds, including a wide variety of warblers, during their migration and nesting activities. Other activities include berry and mushroom picking, cross-country skiing, field dog trials, and educational field trips. Military personnel from Selfridge Air National Guard Base are also permitted to conduct limited training activities on the game area.

The Michigan Nature Association’s mission is to preserve unique natural habitats and rare species. They own, protect, and provide public access to several nature sanctuaries in, or near, this segment of the Black River watershed.

The St. Clair County Parks and Recreation Commission (PARC) is working in conjunction with 13 local units of government to develop a recreational trail system that will cover many miles and scenic features within the county. The Wadhams to Avoca Trail, running through the Black River watershed is a nonmotorized trail open year round to walkers, hikers, bicyclists, and horse riders. The centerpiece of the trail is the 640 foot-long Mill Creek Trestle. Originally built for the railroad crossing in the late 1800’s, the 60 foot-high trestle has been restored to provide safe access to walkers and bicyclists. It has new decks, railings, and four overlook areas so users can take full advantage of the beautiful views up and down Mill Creek. Another trail system, the Poly Ann Trail, is being developed in Oakland and Lapeer counties. It will eventually cross the most western part of the watershed and tie into other public trail systems.

Segment 4

The lower segment of the Black River is characterized by sluggish flow and relatively wide channels that permit boat access through most of its length. The Black River Canal allows some recreational boating access directly from the river to Lake Huron (Figure 23). Port Huron owns and operates five marina facilities (the largest municipal marina system in the state) on the Black River that provide temporary and permanent mooring facilities for 520 vessels. There are two boat ramps on the Black River in Port Huron that are open to the public. Lake Huron and the upper stretch of the St. Clair River provide excellent fishing and boating opportunities. The lower reach of the Black River is a protected haven for boaters and is reasonably close to those Great Lakes resources.

Many people enjoy watching ships pass up and down the St. Clair River in Port Huron. A nonprofit corporation, known as “BoatNerd”, has its main facility at the mouth of the Black River. It is located within Acheson Ventures’ Desmond Landing Development Project which is a mile-long mixed-use development located on the Black River and St. Clair River, featuring a promenade and fishing pier. The BoatNerd Corporation is organized for the purpose of enhancing the general public knowledge of the maritime commercial operations and history on the Great Lakes and St. Lawrence Seaway.

Citizen Involvement

Citizen involvement in the management of the Black River occurs through interactions with government agencies that manage water flows, water quality, animal populations, land use, and recreation, and cooperation with various conservation and user groups. Government agencies include the USFWS, United States Department of Agriculture, MDNR, MDEQ, Michigan Department of Agriculture, county offices such as drain commission, road commission, departments of health, conservation districts, and local governments.

Management plans for watersheds in St. Clair County, including the Black River watershed, are being developed under the leadership of the County’s Stormwater Coordinator to fulfill the Environmental Protection Agency (EPA) and Michigan Department of Environmental Quality (MDEQ) Phase II National Pollutant Discharge Elimination System (NPDES) regulations. Phase II permits require that a public education plan be developed and implemented (Jurs 2005). There was an extensive public participation process used in St. Clair County to involve and educate the community in the development of the watershed management plan (WMP), and the public education campaign that will be used to implement this WMP (Table 20). Three of the most important goals for watershed management endorsed by all public participants were: 1) identify and preserve high-quality natural areas including; forested areas, floodplains, riparian buffers, wetlands, open space, and greenways, 2) protect and improve the warm water and cool water fisheries and conditions for other indigenous aquatic life and wildlife, and 3) protect and improve water-related recreation.

The MCVMP, established in 1999 under the Michigan Department of Environmental Quality’s Volunteer Monitoring Program, monitors biological indicators of water quality in the upper 17 miles of Mill Creek upstream from Yale (see **Biological Resources**).

PARC is working in conjunction with 13 local units of government to develop a recreational trail system that will cover many miles and scenic features within the county (see **Recreational Uses**).

Much of the land area is managed as farmland. Common agricultural practices have not been conducive to preservation of natural animal and plant communities, so it is critical that incentives be available to agricultural land managers for maintaining or restoring some natural plant communities, riparian buffers, and wetland areas. Some of these programs currently in use are: wetlands reserve program, managed by the USDA Natural Resources Conservation Service (NRCS); the Conservation Reserve Program, also a NRCS program; and the Conservation Technology Information Center, a public/private partnership providing reliable, profitable solutions to improve the relationship between agriculture and the environment.

Other organizations which play a role in land and watershed management include Michigan Nature Association, Pine River Nature Center, the Thumb Land Conservancy formed in 2008, Seven Ponds Nature Center, Great Lakes Bioregional Land Conservancy, Sporting Lands Alliance, and Blue Water Audubon Society.

MANAGEMENT OPTIONS

The Black River system has been severely altered by human influences. Factors such as deforestation, channel modifications and agricultural land use practices, point and nonpoint source pollution, and dams have had a dramatic effect on the watershed. These alterations have affected flow, water quality, and temperature which have had an influence on the habitat and aquatic communities. 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 identified options are consistent with the mission statement of Fisheries Division. This mission is to protect and enhance public trust in populations and habitat of fishes and other forms of aquatic life, and promote optimum use of these resources for the benefit of the people of Michigan. In particular, the division seeks to protect and maintain healthy aquatic environments and fish communities and rehabilitate those now degraded; provide diverse public fishing opportunities to maximize the value to anglers; and foster and contribute to public and scientific understanding of fish, fishing, and fishery management.

Geology and Hydrology

The Black River system has very unstable flows throughout. Extensive areas of farmland have been tiled to accelerate drainage and the river channels have likewise been dredged and straightened to accommodate more flow. Other factors that contribute to the unstable flows include differences in topography and soils, and watershed development and land use changes.

Option: Protect and restore wetlands, natural river channels, and flood plains for water retention during high flow conditions. Develop an inventory of existing and potential areas for creation and protection of wetlands, with emphasis on riparian areas.

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

Option: Protect and restore flow stability by developing a hydrologic routing model for the entire river system that describes both ground and surface water routes in response to changes on the landscape. Such a model would allow various alternatives to be examined and drive future planning processes by providing fundamental information critical for proactive landscape and storm water management planning.

Option: Support stream flow monitoring at all critical points throughout the watershed. This is particularly important in this watershed due to the lack of continuous historical data which are essential for hydrologic modeling efforts.

Soils and Land Use Patterns

Many land use practices cause degradation to the river through loss of riparian features and changes in stream flow. Loss of wetlands, constructing land drainage systems, converting agricultural lands to urban and industrial uses, and destroying naturally forested areas along the river corridor all contribute to a decline in river quality.

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

Option: Protect lands through land-use planning and zoning guidelines that emphasize protection of critical areas and discourage alteration of natural drainage patterns.

Option: Protect productivity of land and streams from sedimentation by supporting enforcement of soil sedimentation and erosion laws.

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

Option: Protect channel from excessive sediment delivery by using best management practices at road-stream crossings.

Channel Morphology

The channel morphology of the Black River system has changed as a result of alterations to the system. Dredging, straightening, and high sediment loads along with removal of natural vegetation and lack of woody structure, causes the channel to be simple, over-wide, shallow, and lacking diversity.

Option: An effort should be made to restore a more natural, meandering river channel in Black River segments 1 and 2.

Option: Protect tributaries from channelization and discontinue the practice of directing unwanted surface water directly into a waterway. Encourage water diversion into natural wetlands and retention areas to facilitate groundwater recharge.

Option: Protect diverse stream channel habitats by preventing the removal of large woody structure now in the river and restore recruitment of woody structure by developing and managing wooded greenbelts on riparian lands.

Option: Restore critical higher-gradient habitat by removing dams no longer used for their original purpose and dams that are a safety hazard.

Option: Promote and support best management practices by the agriculture and urban communities to reduce inflows of nutrients and sediments to the river.

Dams and Barriers

There were three dams identified in the Black River watershed that have a negative effect on aquatic resources. Dams block the migration of resident and potamodromous fishes, trap sediments and wood, and alter flow and temperature regimes in the system.

Option: Restore fragmented river reaches by removing dams no longer needed for their original purpose. All three dams should have a high priority for removal because of potential fisheries benefits. Wingford Dam (formerly Ford's Dam) has the highest priority for removal because that would provide upstream access to the highest valued fish habitat and public fishing access on the Black River. Yale Dam on Mill Creek and Croswell Dam on the Black River main stem have lower priority. Croswell Dam should only be considered after Wingford Dam has been removed. Opening up more spawning and juvenile habitat for exotic sea lamprey would be one negative effect from dam removal.

Option: Protect habitat by opposing construction of dams and inline detention basins.

Water Quality

Water quality in the Black River has improved since the 1970s, after years of abuse. However, storm sewers, NPDES discharges, and particularly, nonpoint sources continue to influence the water quality of the river.

Option: Protect and restore water quality by promoting public stewardship of the watershed and support educational programs teaching best management practices that prevent further degradation.

Option: Protect water quality by protecting existing wetlands and riparian corridors, rehabilitating former wetlands, and maximizing the use of wetlands and floodplains as natural filters. Use GIS tools to create a prioritized list.

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

Option: Protect the river from further degradation by surveying loading of nutrients and sediments to the river and develop strategies to reduce identified problems.

Option: Protect fish spawning in the lower Black River and adjacent downstream areas of the St. Clair River by restricting dredging to the windows from December 1st through March and July 1st through October 15th, or roughly 63% of the year, which we have determined to minimally affect fish spawning.

Option: Protect and restore water quality by identifying illegal sewer connections and failing septic fields and implement corrective actions.

Option: Establish a goal of properly maintaining the wastewater treatment plants in the Black River watershed to ensure that they meet NPDES permit requirements.

Option: Protect water quality by conducting a survey of road crossings in the watershed and prioritizing road crossings that have erosion problems.

Option: Protect water quality by supporting County Health Departments in their efforts to monitor and regulate septic tanks to prevent contamination of the river from these sources.

Special Jurisdictions

The State of Michigan manages natural resources and environmental quality. County drain commissioners have authority over designated drains. Township and city officials control zoning and ordinances. All jurisdictions have influence, both direct and indirect, on the quality of the watershed.

Option: Protect recreational use of the river by advocating legislative adoption of the recreational definition of navigability. Work with all agencies to increase public access to these navigable waters.

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

Option: Restore designated drains by encouraging drain commissioners to use stream management approaches that protect and restore natural processes rather than traditional deepening, straightening, and widening practices that emphasize moving water away quickly with little consideration for the effects on the stream or biota.

Option: Restore designated drains to natural stream status where such designation is no longer appropriate or where past drainage modifications have been excessive.

Option: Protect rivers and streams by repairing bridges and overpasses that contribute sediments and runoff, and increase soil erosion.

Biological Communities

Habitat for aquatic organisms has improved in segments 2 and 3 of the watershed since the 1960s due to improvements in water quality. The invertebrate community shows a similar pattern; improvements in some areas, but losses in others. Accelerated soil erosion and stream sedimentation in certain areas has reduced the availability of clean gravel-cobble habitat that is important to many aquatic organisms. Mussel diversity has declined because of siltation and unstable flow as a result of watershed land use practices. Amphibians and reptiles are on the decline presumably due to loss of habitat variability.

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

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

Option: Protect native species from predation, competition, and habitat loss from exotic pest species (e.g., sea lamprey, zebra mussels, rusty crayfish, Phragmites, and purple loosestrife), by suppressing the spread and population expansion of pest species through education and chemical or biological control when feasible.

Option: Survey the distribution and status of amphibians and reptiles within the watershed and protect critical habitat. Eliminate artificially hardened shoreline wherever possible and protect important habitat features such as woody debris and access to nesting sites. Special attention should be paid to threatened and endangered species such as massasauga rattlesnake, eastern fox snake, spotted turtle, and Blanding's turtle.

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

Option: Survey the distribution and status of mussels in the Black River watershed and protect critical habitat. Use the Black River as a refugium for native mussel species that have been seriously compromised in other waters by effects from exotic species like zebra mussels. Consider culturing and reintroducing native mussel species that have been extirpated from the Black River watershed.

Fishery Management

Angling opportunities vary throughout the Black River system. The small size and lack of access in Segment 1 limits fisheries opportunities. Segment 2 provides modest fishing opportunity for channel catfish, largemouth bass, and panfish on the main stem, particularly in Croswell Impoundment. Segment 3 has ample public access and good habitat characteristics in both the main stem and Mill Creek for smallmouth bass, largemouth bass, northern pike, and channel catfish. The seasonal runs of steelhead also provide the primary fishing opportunities in Segment 1. Sections of the North Branch provide good fishing opportunities in the main stem to Wingford Dam and into Mill Creek. There is not much public access on Mill Creek above the Port Huron State Game Area except at road crossings and in the Yale public park. Fishing in Segment 4 is targeted at coolwater species such as northern pike, yellow perch, sunfishes, smallmouth bass, largemouth bass, and walleye.

Option: Survey the fisheries on public waters to evaluate ongoing management efforts and look for new opportunities. A multiuse survey is particularly needed in the Port Huron State Game Area which provides a lot of fishing, as well as hunting and other recreation. No surveys have been done so this is a very critical element.

Option: Improve public access to rivers for fishing and canoeing by pursuing additional access opportunities.

Option: Restore fisheries that have been degraded by restoring habitat that has been lost.

Option: Continue stocking programs that have created a successful fishery and evaluate opportunities that arise to establish new programs. Pursue dam removals to open up more habitat and fishing opportunities.

Recreational Use

The watershed provides excellent recreational opportunities in two state-owned wildlife management areas. The river provides recreational opportunities for fishing, canoeing, recreational boating, picnicking, hiking, and nature watching. However, most portions of the river are not in public ownership and have very limited public access. Many river reaches have been so highly modified for drainage that their recreational potential has been lost. Recreational uses could be greatly enhanced by increased public access and river channel restoration.

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 and other private organizations.

Option: Develop a stream public right-of-way, by purchasing easements for angler access from private landowners. Work with local governments to provide public access, including vehicle parking, for fishing and canoeing at all road crossings on the Black River main stem and Mill Creek.

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

Citizen Involvement

Citizen involvement is a critical component to the management of the Black River watershed. Continuous interaction between management entities, user groups, and interested citizens is needed to support fisheries management activities.

Option: Protect and restore watershed integrity by building public support through a network of local governments and citizen involvement groups.

Option: Protect and restore the watershed by educating river users and property owners on sound watershed management.

Option: We encourage both aquatic stewards and environmental professionals to learn to identify mussel species in the Black River watershed and use them to gauge the quality of the river's aquatic habitat. We recommend "A Field Guide to the Freshwater Mussels of Chicago Wilderness" for information on biology, distribution, and identification of species. It is available in PDF format for free from the Web site at: Http://www.fieldmuseum.org/chicagoguides.

Option: Protect the river by supporting efforts of interest groups seeking funding to protect and improve the river system.

Option: Work with and encourage schools, sporting clubs, and other organizations to educate the public about the unique and special resources of the Black River thereby drawing more attention and "ownership" in the watershed with hopes of developing more stewardship of the resource.

PUBLIC COMMENT AND RESPONSE

The draft of the Black River Assessment was distributed for public review in summer of 2008. Digital copies on a CD were available from the MDNR Lake St. Clair Fisheries Research Station and an electronic copy from the State of Michigan, DNR Fisheries web site. Statewide MDNR Press Releases were issued in conjunction with the release of this draft. In addition, digital copies were sent to: numerous local and state-wide conservation organizations; local, state, and federal units of government; and any public that requested copies. A letter explaining the purpose of the assessment and requesting review comments was enclosed with all copies.

Two public meetings were held to receive comments concerning the river assessment draft. St. Clair County, July 30, 2008 (27 people attended, picture compliments of Kristen Jurs below) and Croswell Public Library, July 31, 2008 (9 people attended).

The public comment period for the river assessment draft ended September 30, 2008. Comments of similar subject were combined to avoid unnecessary duplication. All comments received were considered. Where Fisheries Division agreed with comments, changes were made. Where Fisheries Division disagreed with comments, reasons why are stated in the response.

Introduction

Comment: At the beginning of the presentation this evening, you said that seven river assessments have been done. How often are rivers assessed?

> Response: The MDNR does not currently have a schedule to repeat these river assessments. The first assessment was completed in 1995 on the Huron River in southeast Michigan and only half of the major watersheds in the state have now been assessed. It takes a minimum of three years to do each assessment. A very significant part of each assessment deals with history, geology, and other factors that will not change much through time so each one will need some modifications as relevant new information becomes available.

Comment: Has there been an attempt to make residents in the upper portion of the Black River watershed aware of the fisheries assessment and public hearings? I live near Croswell and did not see much in the way of announcements. Will there be publication of a summary document of any type?

> Response: MDNR issued a public notice of the assessment and public hearings through its normal chain of news outlets. The draft fisheries assessment was also sent to Sanilac County officials with an announcement that there will be a public hearing in Croswell. An Executive summary will be published as an integral part of the assessment document but not necessarily printed because of MDNR budget constraints. The report will be available from the MDNR Fisheries Division website in PDF-file format when complete. Comments from the public are due by September 1, 2008. The original due date for comment was August 15th, but that was moved to September 1st.

Comment: The St Clair County Drain Office suggested that the Sanilac and Lapeer county drain offices be sent a printed copy of the final fisheries assessment document because they do not have adequate access to the internet to download and print their own. This is not necessary for St. Clair County which has ample ability to retrieve their copy.

> Response: Thank you for this suggestion. We feel that the county drain offices are particularly important to management of aquatic resources in the watershed and we will make every effort to provide them with a hard copy of the assessment.

Comment: We did not see announcements for these hearings in the regular news outlets in the Croswell area.

> Response: We are aware that these MDNR news releases are not considered important enough by the local media to be published in some areas of the state. We are always open to suggestions on how to improve this.

Geology and Hydrology

Comment: No comments received for this section.

Soils and Land Use Patterns

Comment: No comments received for this section.

Dams and Barriers

Comment: How many dams are there on the Black River and are they necessary?

Response: There are three major dams, Croswell Dam and Wingford (formerly Ford's) Dam on the Black River main stem and Yale Dam on Mill Creek. None of these dams are essential for maintaining flow control or water supply. The Croswell Dam was originally put in by the sugar company to guarantee their water supply, but they say they do not need it any more. We have spoken with the sugar company, they do not take water from the river now, and they would allow the dam to be removed. However, removing a dam is not as easy as taking a bulldozer and knocking it down. Besides being a very expensive job, a silt problem will occur. Under high flow conditions at the Croswell Dam, enough water flows over the dam to eliminate the head which may allow many fish to pass. And with no natural lakes in this system, the dam at Croswell provides significant fishing opportunity in the impoundment upstream from the dam. Also since there is a major dam (Wingford Dam) below the Croswell dam, removing the Croswell Dam would not allow fish migrating up from the Great Lakes to go upstream until Wingford Dam has been removed. The MDNR does not stock sport fish above these dams, in part, due to the warmer water temperatures. We are in favor of removing some or all of these dams to restore natural river conditions and free passage of native fishes as public support and proper funding become available.

Comment: I have a picture of water flooding a house along the Black River with a man getting out of the second story into a row boat. With siltation being such a big problem, should more dredging be allowed?

Response: Flooding has been exacerbated by development of hard surfaces and extensive agricultural drainage projects. Better management of riparian lands and vegetative cover along the river could reduce a significant part of the silt. Riparian vegetation is very important for restoring and maintaining quality river habitat.

Comment: If Croswell residents were aware that the DNR is in favor of removing the Croswell Dam, many more people would have attended this hearing. I feel that the residents of Croswell would not be in favor of its removal because of the impoundment's scenic and recreational value.

Response: We generally support removal of dams or other structures that degrade natural aspects of the river channel and prevent passage of native fish species. We recognize that impoundments behind dams have some recreational and scenic value which must be taken into account during the decision making process.

Comment: How do dams prevent flooding and were the dams on the Black River constructed to prevent flooding?

Response: The three dams in question on the Black River were constructed for different reasons; Yale and Croswell dams to assure water supplies for industrial purposes and Wingford (Ford's) Dam to create a lake that would attract waterfowl for recreational hunting. Flood control dams are designed to have the ability to hold back water during high runoff which is released more slowly than would have occurred naturally.

Water Quality

Comment: Is there data on sediment quality for the Black River?

> Response: A number of studies of water quality have been conducted by MDEQ which are referenced in the report. An additional 2007 MDEQ study of habitat quality was recently published (Schmitt 2008) and has been obtained and added as a reference for this fisheries assessment. Some of these investigations included examination of sediment quality and they reported that water and sediment quality analyses did not indicate that water quality standards had been exceeded.

Comment: The Sanilac County drains are like little green houses because of the lack of trees. These drains have not been managed properly but you cannot fight the agricultural interests. I think we need to better organize other groups within the public that are interested in maintaining a more natural river system.

> Response: Yes, we definitely agree that agricultural channelization and drainage management have had a very bad influence. We hope that this fisheries assessment will encourage and assist other individuals and groups to fight for restoration of a more natural and scenic river system.

Comment: The Michigan Department of Environmental Quality receives applications annually from the City of Port Huron to dredge the lower Black River. The area dredged most often is from seventh street bridge down to the mouth, with occasional dredging upstream by the city marina near I-94. I am wondering whether this annual dredging (March 15th through April) has been included in the assessment as a significant impact to the river. Jim Francis from MDNR has provided comments on these applications asking not to dredge after March 15^{th}, however, given the annual sediment deposition in the target dredge areas, and the fact that ice sometimes is still present until after March 15^{th}, as well as repeated requests from the city to allow more time, MDEQ has allowed dredging into April. I'm wondering if this April dredging, or any dredging for that matter, should be considered when assessing the river as a significant impact.

> Response: Yes, we definitely agree that we need to protect fish spawning in the lower Black River and adjacent downstream areas of the St. Clair River by restricting dredging to the windows from December 1st through March and July 1st through October 15^{th}, or roughly 63% of the year, which we have determined to minimally affect fish spawning.

Special Jurisdictions

Comment: What type of interaction is there between the Department of Agriculture and MDNR? Education is a powerful force to promote better stewardship and more cooperation. For instance, most counties do not get a lot of money to pay farmers for buffer zones.

> Response: There have been significant improvements made and one of the main objectives for these assessments is to bridge the gap. We are aware that some counties are more progressive, but they generally do not have large amounts of money to do river restoration and maintenance.

Comment: St. Clair County gets only a small amount of federal monies to support protection and restoration of rivers. However, to allow cattle access to a stream is ridiculous. Documents like this river assessment will definitely help support the county's efforts to get more federal money. The county needs federal money to be able to patrol and protect the banks of the Black River from erosion and to provide more public access to the river.

> Response: We definitely agree and will continuing working on better support to local units of government for river protection and restoration.

Comment: There was a meeting of the Inter-County Drainage Board this morning and residents of Sanilac County want the Black River dredged again. The engineering firm under contract has opposed the dredging idea. Some recent proposals to increase drainage tiles in tributaries have also been denied. Reports like this fisheries assessment help people see the value of natural water courses which results in improvements to their approach to their management.

> Response: We think this is very good news since channelization and agricultural drainage systems are some of the most damaging land management practices for fish habitat in the Black River.

Biological Communities

Comment: Is there reproduction of sport fish occurring in the Black River, possibly smallmouth bass and northern pike, because they are tolerant to a turbulent river?

> Response: Siltation is very damaging to spawning of native fishes, especially to survival of their eggs and fry. The main branch is severely silted in because of erosion of soils exacerbated by poor land management practices. Excessive amounts of silt can remain in the river for many years. Most sport fish species would find conditions in the main branch difficult for successful reproduction because of this. Some species like channel catfish and rock bass are better adapted to handle turbid water so they are expected to do better. Mill Creek has less siltation and therefore supports more successful reproduction of sport fish like smallmouth bass. Northern pike do best where vegetated land adjacent to the river is allowed to flood during spring runoff. Now that flooding is largely mitigated by channel modifications, successful northern pike reproduction is minimal.

Comment: Have any studies been done on the bat populations in the Black River watershed? I believe that St. Clair County has been included in a grant to study the Indiana Bat.

> Response: We did not find studies of bats or other mammals that provided population information specific to the Black River watershed. However, we agree that it would be valuable information that could be used to protect and enhance habitat for native species in this watershed.

Comment: The Boy Scout Camp on Silver Creek used to be the only place where white trout lily was found and the Black River watershed has the few known locations for painted trillium which is a protected plant.

> Response: The Black River watershed was well known for its rare and unique vegetation. Under current political and economic constraints, it is very difficult to protect natural

landscape features, especially indigenous vegetation. We are not even aware that surveys are being conducted to keep track of rare plants in the watershed.

Comment: Does the Black River assessment take into account shoreline hardening and resulting impacts to the river and loss of shallow water habitat? There are many applications to MDEQ to place steel seawall or riprap along the lower Black River where none currently exist. MDEQ typically denies these requests, but does permit replacement seawalls (steel in front of steel/wood walls). I have personally observed turtles (snapping, soft shell, common map, as well as painted, and sliders) on the Black River loafing along vertical steel walls or on floating logs or boards. I think it is important to address how shoreline armoring negatively impacts fish and reptiles by eliminating woody debris, shallow water habitat, and preventing access to nesting sites.

Response: Thank you for providing these important observations and recommendations. We definitely agree that hardening of the shoreline reduces habitat for fish and reptiles and protection of soft shoreline remains a very high priority.

Comment: There is a large depositional zone in the lower Black River just upstream from the I-94 bridge and across from Mallard Creek Marina. Much of this area has been exposed and covered by wetland vegetation. Many of the landowners along this stretch have been mowing the vegetation which does not require a MDEQ permit but does have negative impacts on wildlife habitat. Many of the residential properties in this area that once had vertical seawalls abutting open water; now accumulate enough sediment to produce wetland habitat at the water's edge. The assessment should document the benefits these new wetlands provide to fish, reptiles, and amphibians.

Response: We strongly concur that additional protection is needed for the “new” wetland habitats that are created by natural forces of the river. Several management recommendations made in the Black River assessment address this issue.

Fishery Management

Comment: As mentioned in Mr. Haas’s presentation, it would be great if DNR employees could survey recreational use and the Black River fishery.

Response: Thank you. The fishery managers consider this to be a high priority need for the Black River watershed and will pursue implementation as economic and personnel resources become available.

Comment: Why are steelhead and brown trout planted in the Black River?

Response: These trout stockings are intended to produce angling fisheries as the adults return to the planting site after spending most of their life in open waters of the Great Lakes. MDNR does not anticipate that these species will successfully reproduce in the Black River or its tributaries.

Comment: I would like to see more brown trout planted in the Black River. Many people cannot afford to go north. I have caught about 15 pound fish from shore and there are shore areas that are handicapped accessible. We can have great resources here by stocking more brown trout. I have fished next to people from Germany who have come to the St. Clair River to fish. There is no reason why this cannot be a great sport fishing area.

> Response: The MDNR now stocks 20,000 brown trout annually in the vicinity of the lower Black River/St. Clair River. For many years, we stocked 50,000 brown trout in the St. Clair River. We decreased the number planted because we were not getting reports that a trout fishery of sufficient magnitude was being created.

Comment: The MDNR needs more people out in the field to know what is going on. I've only been checked for a fishing license once in 15 years. During last three weeks I have been seeing lamprey and I caught a 30 inch brown. You don't see any 30 inch browns in the Au Sable River.

> Response: About four years ago there was a creel survey targeting the St. Clair River at boat access sites only, including the access site on the lower Black River. To do a shore fishing creel census is very expensive and you need three people working each site. In the early1980s and early 1970s St. Clair River shore fishing was surveyed.

Comment: In the past we had good trout in Mill Creek. It is important that you know that the Black River from Sandusky downstream is full of silt due to agriculture. The river is too small in Minden swamp area for much fishing. Mill Creek, however, has very good fishing and it is an important fishery.

> Response: That is important information and we are in agreement.

Comment: I Fish in Mill Creek and the Black River during spring to catch trout and wonder if and when steelhead are stocked in Mill Creek?

> Response: We have stopped planting steelhead in Mill Creek because we had not heard that a significant fishery had developed and public access is quite limited. We decided to use what fingerlings are available in several other Great Lakes tributaries in southeast Michigan with more public access and apparently viable steelhead fisheries.

Comment: Has the MDNR collected temperature data from the river and what does that say about habitat for fish?

> Response: Yes, and we found that the upper section of Mill Creek has the coldest water in the Black River watershed. There are several graphs and maps in the document that show temperatures and locations where they were taken. In general, the temperatures are within the range typically associated with a warm water fish community and would not be conducive to survival of cold water fishes like trout.

Comment: With the bad economy and high gas prices no one is going up north to fish so we need to plant more fish here. I fish the St. Clair River where the Black River comes in and I've caught rainbows up to 15-16 pounds. The fish still have plenty of food with the high populations of smelt and minnows. As an example of the abundant bait fish, the bait companies come down daily to catch emerald shiners.

Response: We agree that there has been some decent trout fishing at times in the upper St. Clair River, but that is not within the area covered by the Black River fisheries assessment. As mentioned above, the MDNR has not heard much recently from trout anglers in the Port Huron area so fingerling stockings have been concentrated in other areas of southeast Michigan.

Comment: When does the MDNR conduct their fish population surveys?

Response: Our fish sampling may occur at varies times but we usually try to sample in streams when they are at low volume in July or August. This is also the time when the water is warmest and conditions are at levels that may be limiting to less tolerant fish species. This allows us to evaluate the status of the fish habitat and determine what species should be present as well as which ones actually are.

Comment: Can fish population surveys be done when river flow is high?

Response: Water in rivers tends to be very muddy in the spring and with electrofishing survey techniques, targeting fish communities made up of many species, you must be able to see fish to catch them. However, these survey techniques may be suitable under high river flow conditions to catch certain species, like walleye for example.

Comment: What is the status of native mussel populations in the Black River and can they be restored?

Response: There is a strong recommendation in this document for that. Native mussels are the most endangered group of aquatic organisms and the Black River historically supported a very large and diverse mussel community. Now their populations consist of tolerant species found mainly in areas below dams. Heavy silt loading to rivers has devastating effects on mussels and dams tend to remove silt from the water. The US Fish and Wildlife Service is doing research on native mussel rearing for restoration purposes. The Black River watershed may offer a good opportunity to apply these techniques and we have recommendations in the assessment to do that.

Recreational Uses

Comment: The Port Huron State Game Area has no access for fishing and there are no facilities at road crossing to park so there are no good fishing opportunities.

Response: We have several maps in the Black River Assessment showing locations of access sites on state land in the Port Huron and Minden state game areas. There are 24 sites within the Port Huron State Game Area, most of which provide walk-in fishing access. We agree that fishing access is very limited outside of public lands managed by governmental units and encourage development of additional access facilities at road crossings and other reasonable locations.

Comment: Conservation is good as long as it is done responsibly. On the Croswell City's sesquicentennial video there is footage from 1947 taken during the swinging bridge festival showing that they had a fishing tournament which has continued, along with the swinging bridge festival, up to the present. I am not a fisherman so I am unsure what they catch, probably the lesser fish like suckers. There is also cardboard boat race with prizes for fastest boat, best sinking, etc. Some of the cardboard boats hold up to 10 or 12 people. Originally, the cardboard boat race was held in Port Huron but it had to be cancelled due to high levels of e-coli bacteria. The boat race came here and has been here ever since. The levels of e-coli in the river at Croswell are tested by the city and there has not been a problem. Some areas of the impoundment behind the Croswell Dam are 8 to 10 ft deep. In the past, there were motor boats and jet skis being used there, but now there is a no wake zone. There likely is not as much fishing in the Croswell Impoundment as there used to be but not really sure. I regularly see people fishing along the river banks below the dam. Michigan Steelheaders will be sponsoring a kids fishing tournament next week during the Swinging Bridge Festival. The fishing contest will be held in the morning and there will be a duck drop after the boat races. Plastic ducks with numbers on the bottom are dropped into the water and the duck that gets downstream fastest wins.

> Response: Thank you very much for that interesting and useful information on recreational activities associated with the Croswell Impoundment. This information will be particularly useful during future deliberations regarding fisheries management in the impoundment and decisions regarding removal of the dam.

Comment: The City of Croswell is talking about putting in a fountain in the park adjacent to the impoundment. A master plan was developed in 1986. An old body shop has been torn down and the city wants to turn that area into public parking with a fountain and green space. The gazebo and green space have been constructed thanks to funds obtained from a grant. The rest of the development is supposed to happen once the sewers are moved from the back of buildings to the middle of the street. Also on the plan is a boardwalk along the impoundment which will be a great asset.

> Response: This sounds like a very nice recreational development for the City of Croswell which might actually be enhanced by restoration of the natural, scenic river channel. There are now many examples of similar results in cities across the country.

Comment: I would like to be able to canoe the Black River and tried to rent a canoe but couldn't' find any on the Black River. There used to be a canoe livery near Fargo but that has been gone for a while.

> Response: One of the major recommendations in our assessment is to create more public access to the river for boating and fishing. We do not know why the canoe rental business on the Black River has disappeared, but suspect that high insurance costs may be partially responsible. More facilities with public parking and canoe access to the river at strategic locations on the Black River and Mill Creek are definitely needed. We definitely encourage establishment of canoe rental businesses, both public and private.

Citizen Involvement

Comment: I live on Harsens Island and am very aware that MDEQ and MDNR are against hard shorelines. I can personally afford to repair my seawall but cannot afford to replace it with a softer, more environmentally friendly one. I assume that many landowners are living under similar circumstances.

> Response: That is important information and we are well aware that many private individuals cannot afford to do shoreline restoration on their own. However, these individuals can do much by building a better understanding of the societal values from natural shorelines and

possibly join with volunteer and government funded efforts to make environmentally friendly improvements.

Comment: Ms Terry Gill has headed up a volunteer program which is mentioned in the Assessment and in September they will be looking for volunteers to train to be monitors.

Response: Yes, we definitely agree that the efforts of Ms Gill and the Mill Creek Volunteer Monitoring Project, in conjunction with MDEQ, have and continue to provide very valuable information and support for habitat protection and restoration in the Black River watershed. We hope that this fisheries assessment will encourage other individuals and groups to join with these important volunteer efforts.

Comment: There is a watershed committee in Sanilac County that is just getting started and they will be developing a master watershed management plan for the Black River.

Response: Yes, we are aware of this effort and have made our fisheries assessment and other resources available to contribute to this valuable project in every way possible.

Comment: How will the completed river assessment be distributed to the public? Could it be printed and made available for a fee plus shipping charges? It would be logical to pay to for copy since one would go through two ink cartridges to print their own. It is also important to understand that there are not a lot of computers in this area, especially with broad band service. The major industry is agricultural and, while they do collect data for crops, they won't pay $40 per month for internet service.

Response: The finished document will be posted on the web but, due to a tight state budget, we might not be able to print any hard copies of the assessment. We appreciate these comments very much and will look into the possibility of offering the document in printed form for a small fee from our State of Michigan website at: http://apps.michigan.gov/MichiganeStore/public/Home.aspx.

Management Options

Comment: No comments received for this section.

GLOSSARY

ammocete – juvenile lampreys that burrow in stream substrates for a number of years before emigrating

assimilative capacity – The ability of a body of water to cleanse itself; its capacity to receive waste waters or toxic materials without deleterious effects and without damage to aquatic life or humans who consume the water

base flow – groundwater discharge to the river

benthic – associated with the bottom of a stream or lake

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

biotic – relating to, produced by, or caused by living organisms

BOD – Biological Oxygen Demand

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

confluence – place where two or more streams join into one

CSOs – combined sewer overflows

DEMs – digital elevation data or maps describing the shape of land surfaces

D.O. – dissolved oxygen

effluent – the polluted outflow of a sewer, septic tank, municipality, industry

entrain – to pass through industrial processes in cooling water; varying percentages of fish entrained are killed

exceedence flow – a discharge amount that is exceeded by the stream for a given percentage of time

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

extirpation – to make extinct, eliminate completely

facultative organisms – organisms that can survive under a variety of environmental conditions

fauna – the animals of a specific region or time

FCMP – Fish Contaminant Monitoring Program

Fed E – Abbreviated label for Federal-listed endangered species

floodplain – a relatively flat valley floor formed by floods which extends to the valley walls

GLEAS – Great Lakes Environmental and Assessment Section of the Department of Environmental Quality

gradient – drop in elevation over a specified length of river

headwaters – as the most distant point (from the river mouth) in the drainage basin from which water runs year-around, or, alternatively, the furthest point from which water could possibly flow

heterogeneity – having composition of dissimilar parts

Holocene – a geological epoch, which began approximately 11,550 calendar years BP (about 9600 BC). According to traditional geological thinking, the Holocene continues to the present

Hydrogeomorphic – a system developed by the US Army Corps of Engineers to classify all wetlands based on three factors that influence how they function: position in the landscape (geomorphic setting), water source (hydrology), and the flow and fluctuation of the water once in the wetland (hydrodynamics)

hydrology – the study of water

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

lacustrine – pertaining to lakes

land cover – primary character or use of an area of land (i.e., forest, wetland, agriculture, urban, etc.)

littoral – the relatively shallow waters of a river or lake where sufficient light penetrates to the bottom to support plant growth.

lobes – projecting parts of an glaciers

macroinvertebrates – animals without a backbone that are visible by the human eye

main stem – the primary branch of a river of stream

MCVMP – Mill Creek Volunteer Monitoring Project

MDEQ – Michigan Department of Environmental Quality

MDNR – Michigan Department of Natural Resources

MIRIS – Michigan Resource Inventory System

MNFI – Michigan Natural Features Inventory

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

NPDES – National Pollution Discharge Elimination System

Oligochaetes – a subclass in the biological phylum Annelida and includes various earthworms

outwash – sand and gravel washed from a glacier by the action of meltwater

PARC – St. Clair County Parks and Recreation Commission

PCB – polychlorinated biphenyl

PHSGA – Port Huron State Game Area

piscicide – a chemical applied to water which selectively kills fish

potamodromous – a fish that migrates from a freshwater lake to a freshwater stream to spawn

refugium – any local environment that has escaped regional ecological change and therefore provides a habitat for endangered species

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

riparian – relating to or living or located on the bank of a river or lake

SC – Abbreviated label for state-listed species of special concern

SCCN – St. Clair County's Northeastern Watersheds Advisory Group

SE – Abbreviated label for state-listed endangered species

sinuosity – the degree of bending, winding, or curving of a river or stream

ST – Abbreviated label for state-listed threatened species

Stratigraphic – a branch of geology, studies rock layers and layering (stratification). It is primarily used in the study of sedimentary and layered volcanic rocks

tannic acid – any of various complex phenols extracted from decaying plants

tannin – tannic acid or any of its derivatives

taxa – groups of organisms constituting one of the categories or formal units in scientific classification

TDS –Total Dissolved Solids

TMDLs – Total Maximum Daily Loads

USFWS – the U. S. Fish and Wildlife Service

valley segment – reaches of a river with similar ecological characteristics

watershed – a drainage area or basin, both land and water, that flow toward a central collector such as a stream, river, or lake at a lower elevation

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

WWTP – Waste Water Treatment Plant

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FIGURES

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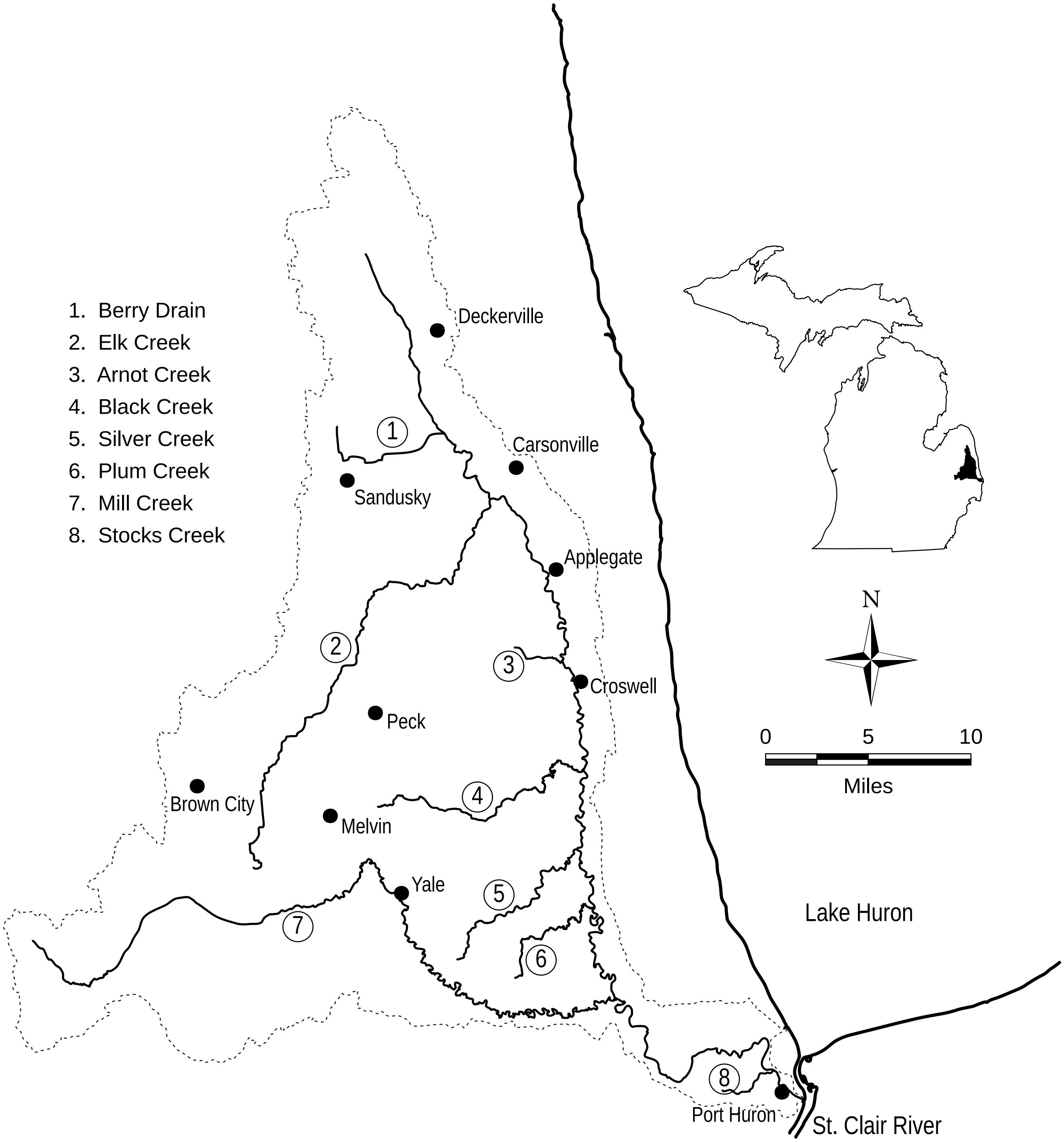


Figure 1.–Major tributaries to the Black River.

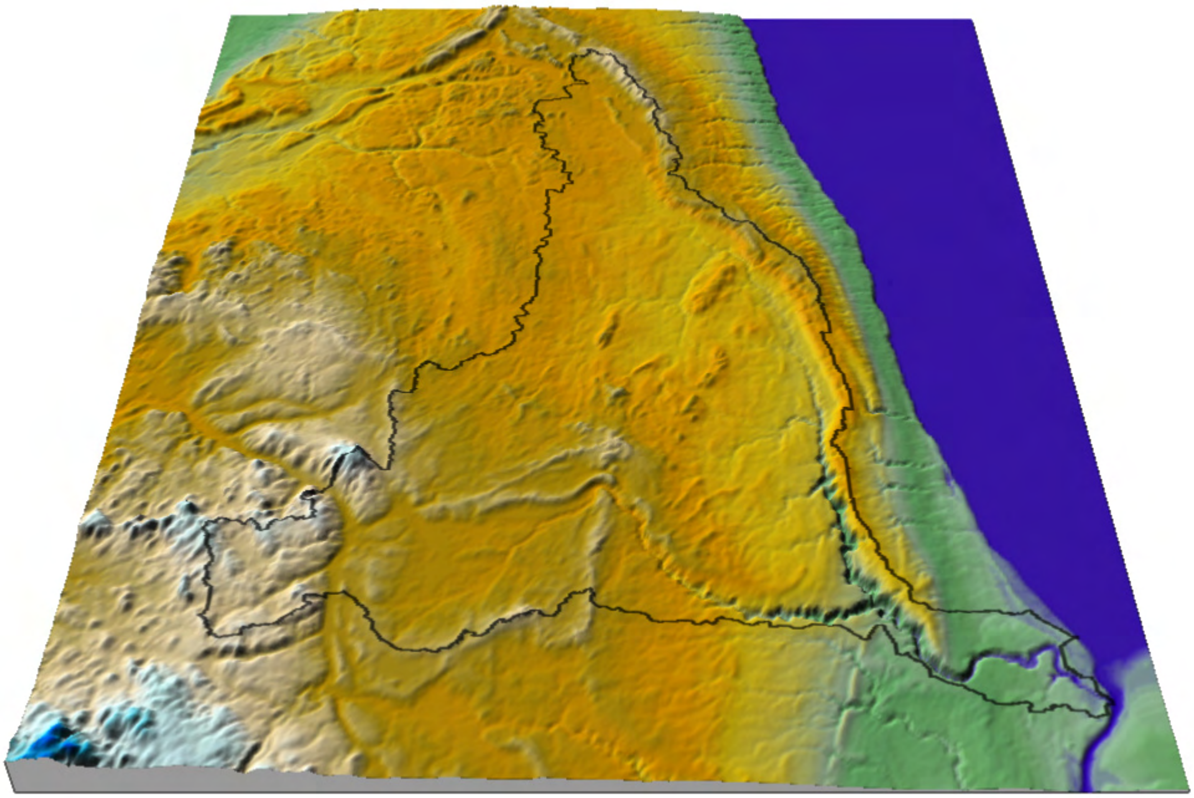


Figure 2.–Three dimensional map of the Black River watershed showing glacial features that shape the Black River valley. Black lines show boundaries of the major subwatersheds.

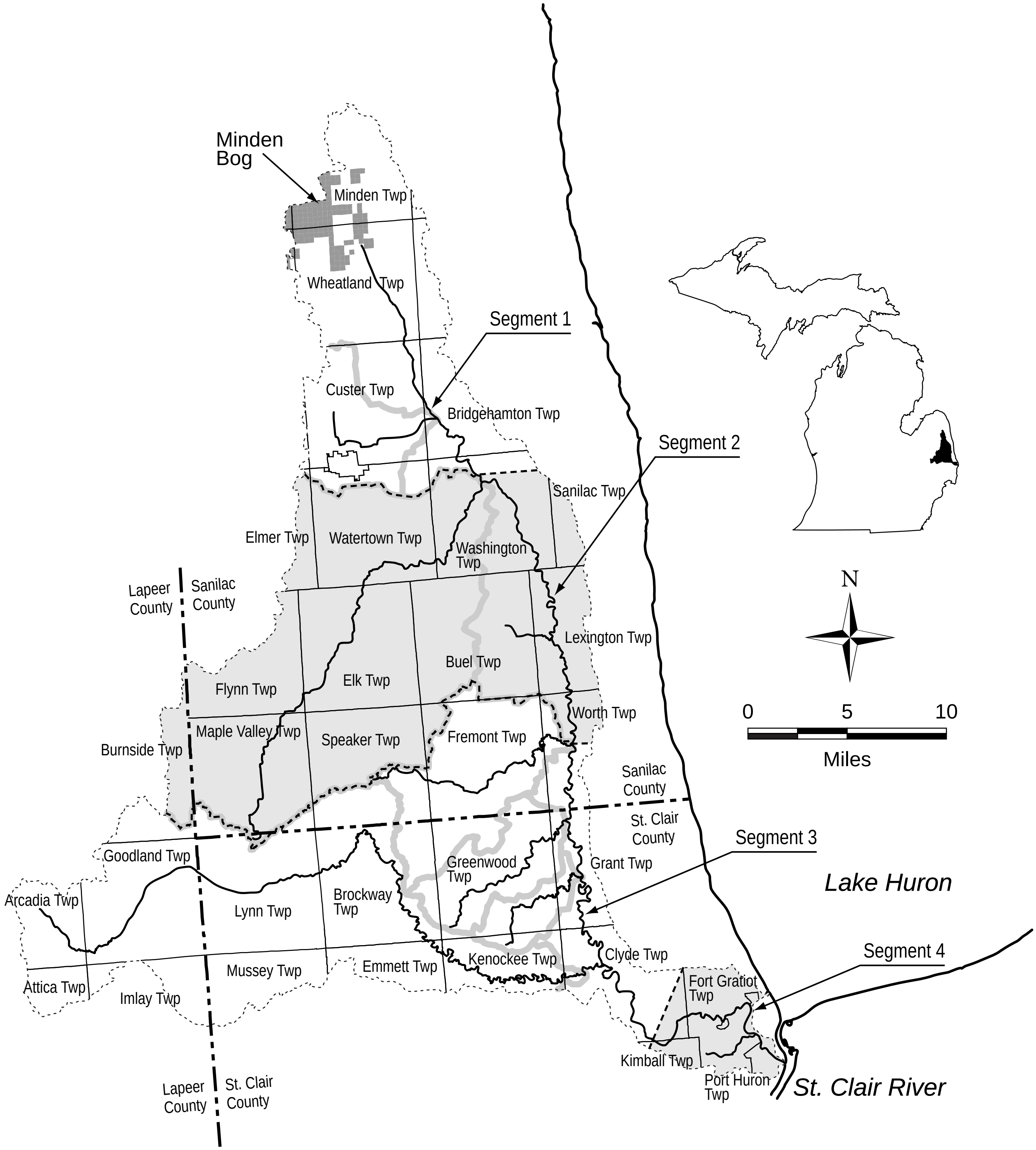


Figure 3.–Segments of the Black River main stem. Subwatersheds are bounded by solid gray lines.

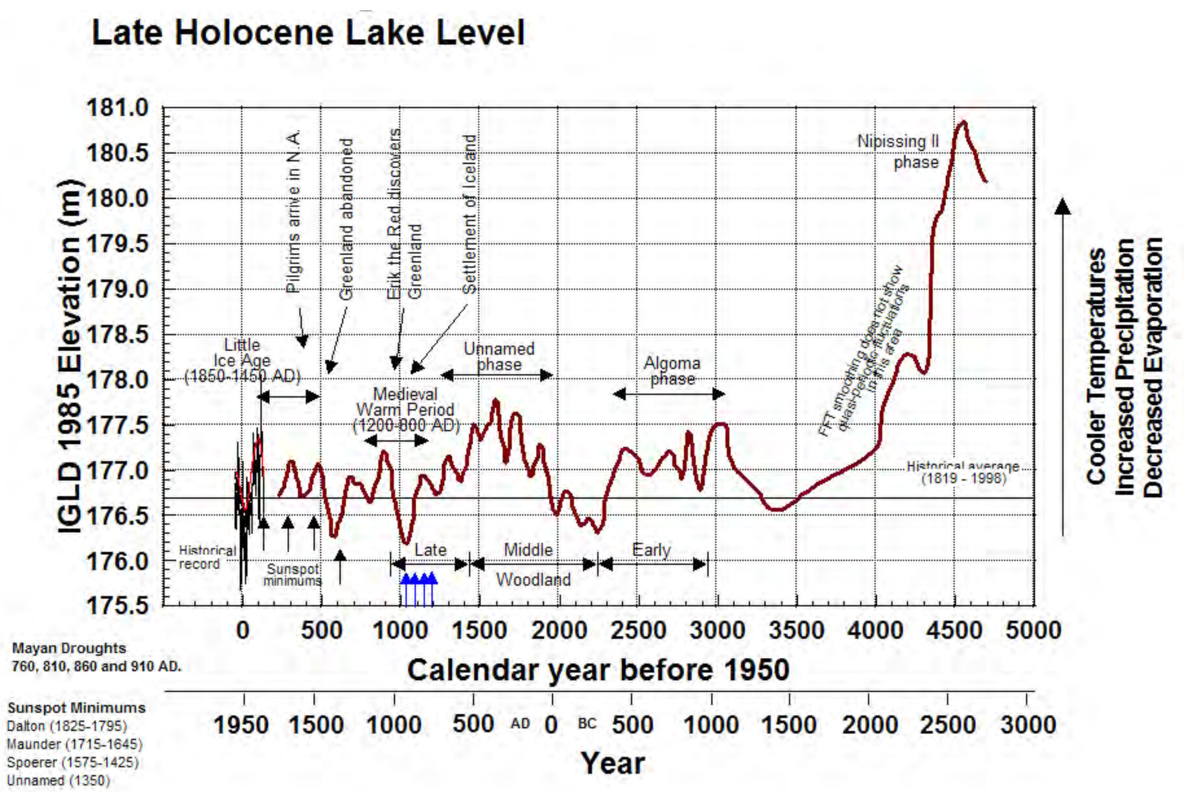


Figure 4.– Graph of late Holocene time span showing some important historical and environmental events as they relate to Lake Huron lake level. Graph courtesy of Dr. Douglas Wilcox, United States Geological Survey, Great Lakes Science Center.

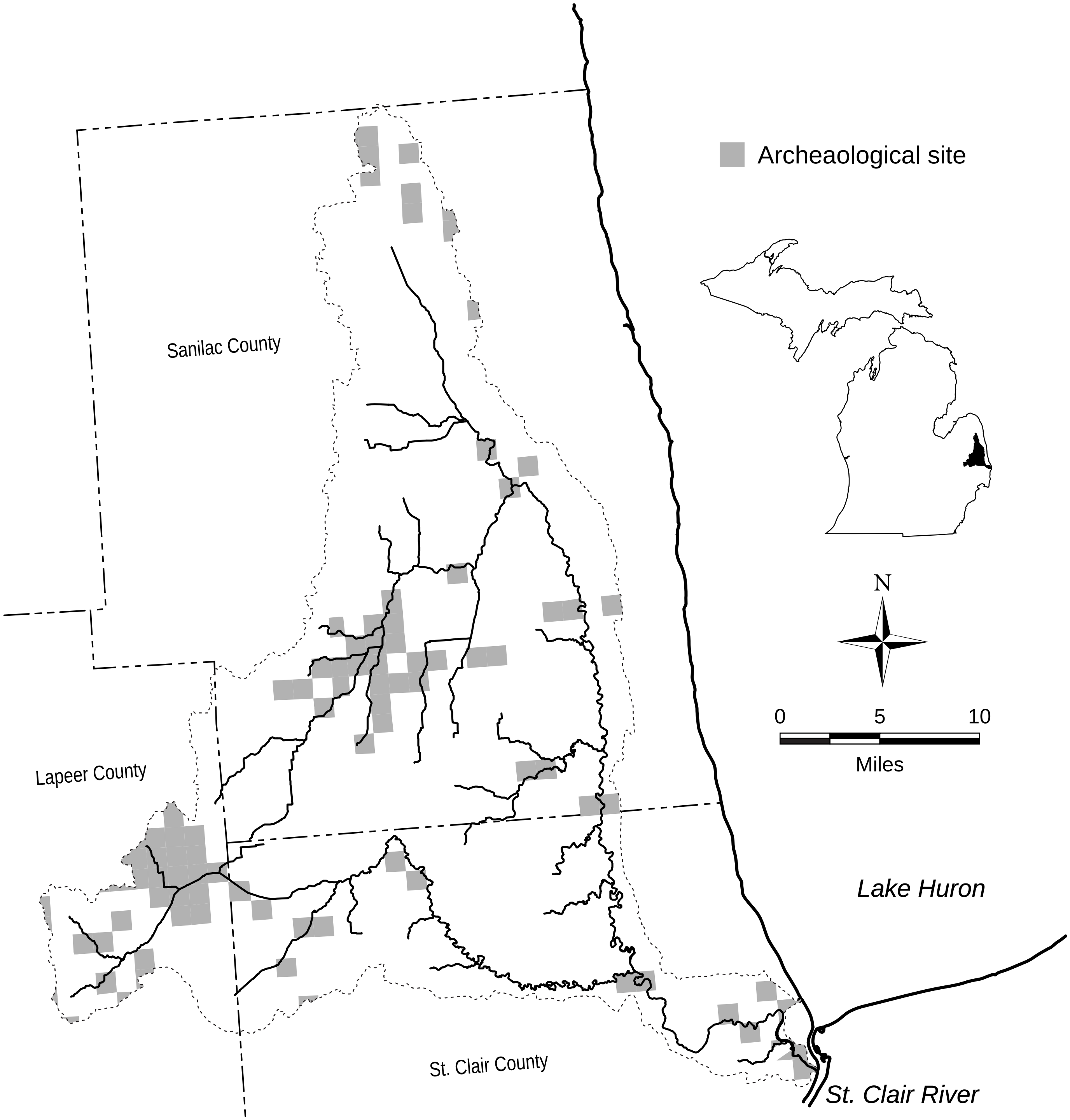


Figure 5.–Spatial distribution of archaeological sites within the Black River watershed indicating strong association between rivers and settlement by prehistoric Native Americans.

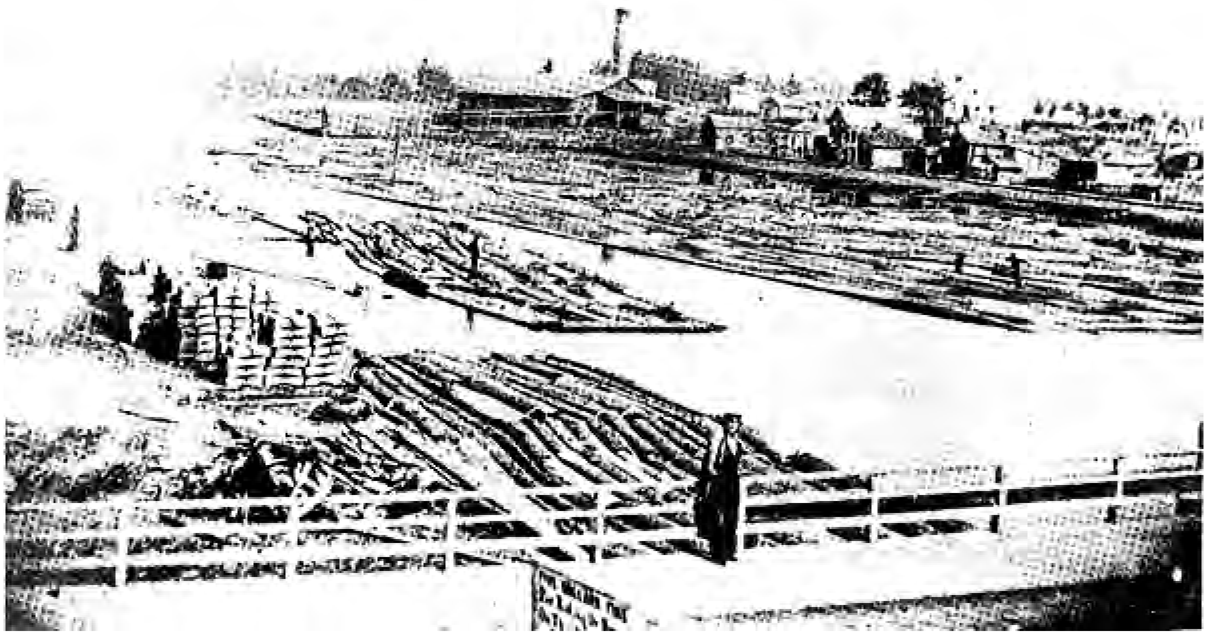
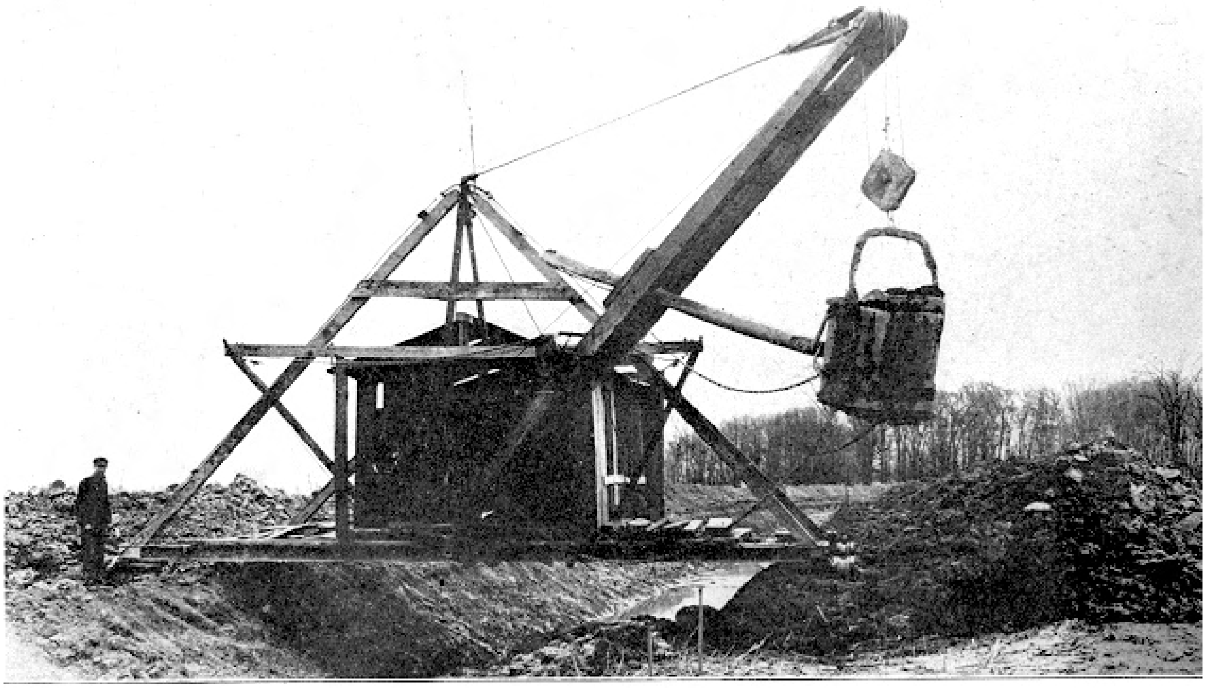


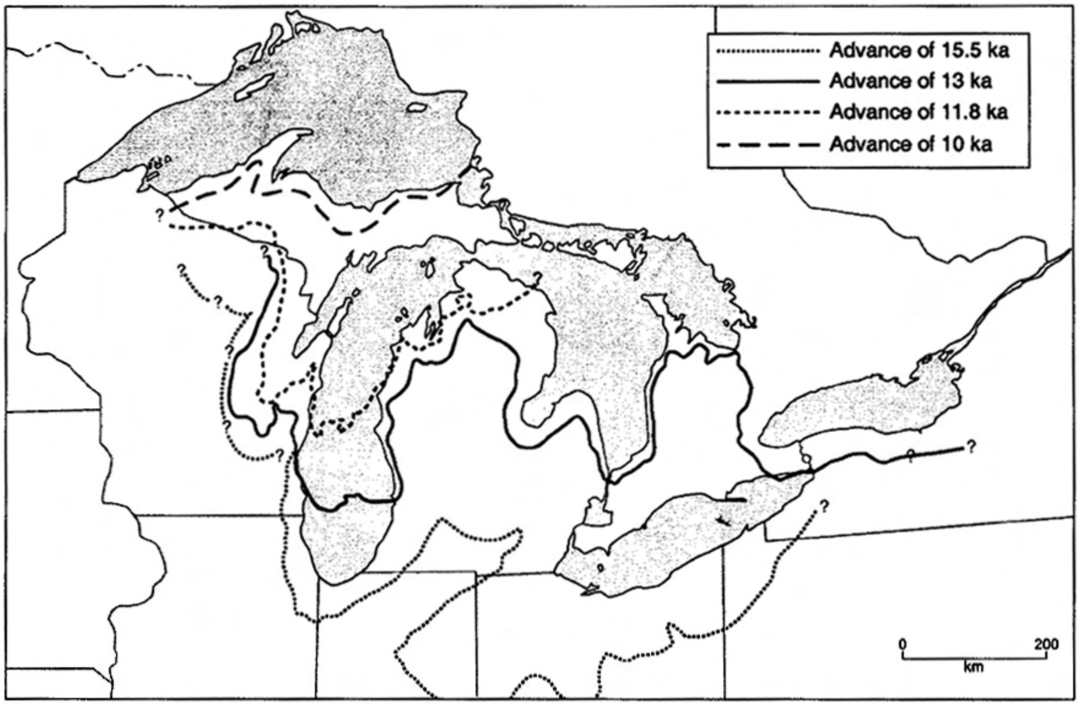
Figure 6.– Early photographs (1864 top; 1904 bottom) of logjams from lumbering operations in the Black River watershed.



LAND DREDGE CONSTRUCTING DRAIN SHOWN IN PLATE VI. ST. CLAIR COUNTY

DRAIN EIGHT FEET BOTTOM WIDTH, EIGHT AND ONE HALF FEET DEEP, CONSTRUCTED BY DREDGE SHOWN IN PLATE V, IN 1917, AT COST OF $7.25 PER ROD (ABOUT $.08½ PER CUBIC YARD) TO REPLACE SHALLOW TEAM AND SCRAPER DRAIN CONSTRUCTED IN 1914 AT A COST OF $1.00 PER ROD.

Figure 7.– Early photographs (1917) of agricultural drain construction in the Black River watershed. A very large portion of the river courses in this watershed have been similarly channelized.



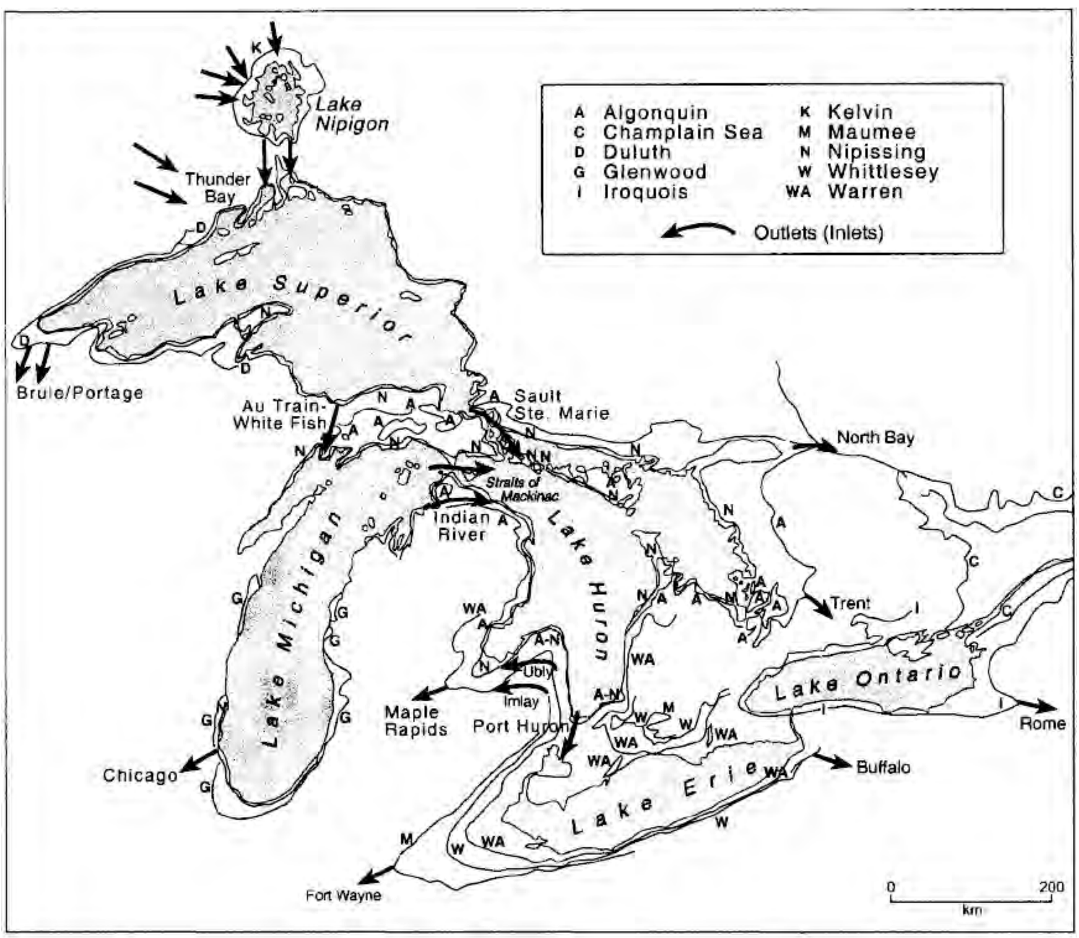


Figure 8.– Limit of the ice readvances of 15.5, 13.0, 11.8 and 10.0 thousand years ago from Larson et al. (1994) (upper figure) and locations of shorelines of prominent proglacial lakes in the Great Lakes watershed, and their spillways and outlets from Karrow (1984) (lower figure).

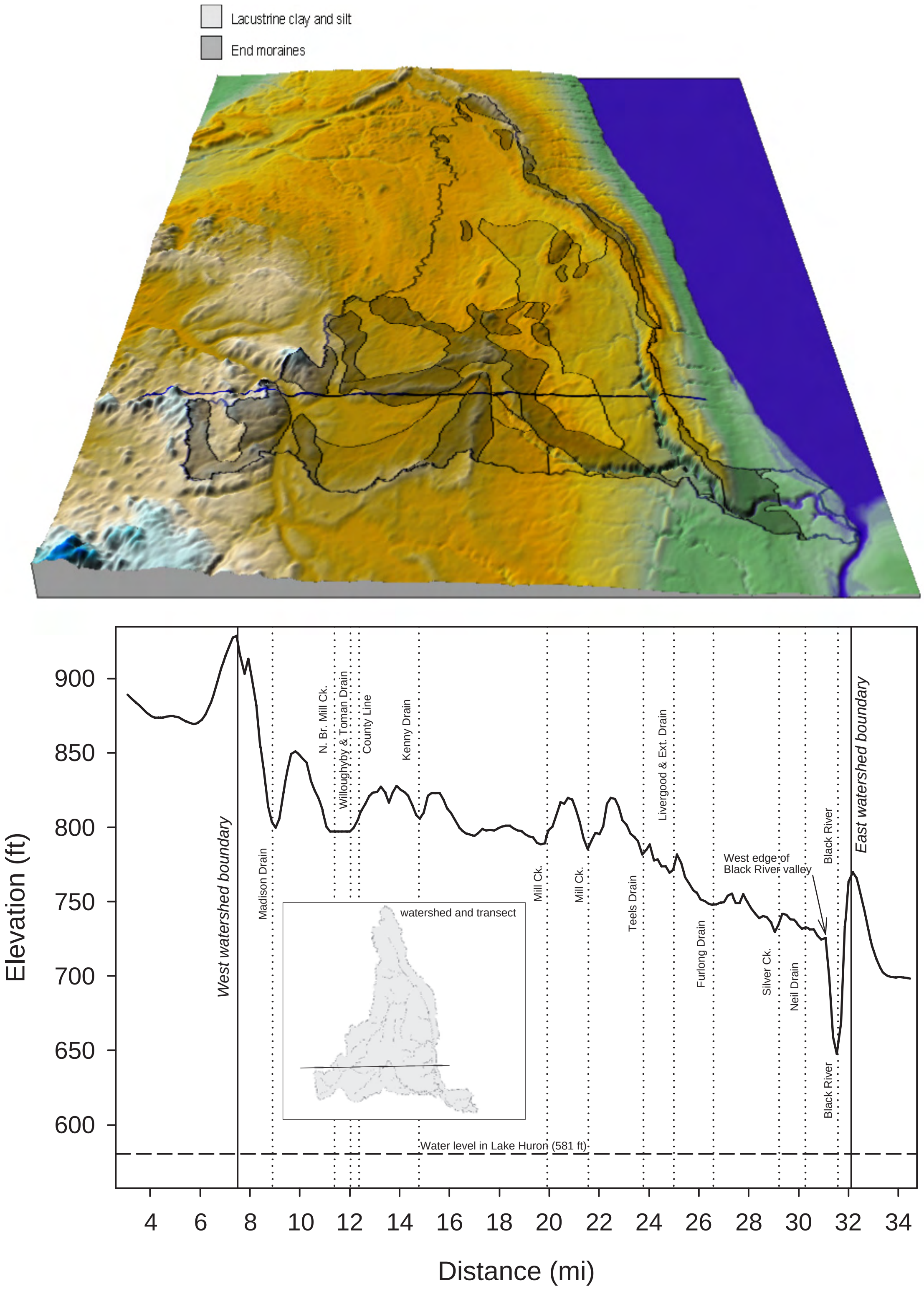


Figure 9.– Three dimensional map (top) showing distribution of glacial end moraines and lacustrine silt and clay within the Black River watershed. Graph shows vertical profile of land elevations along a transect across the watershed. The geographic location of the transect is shown on a surface map and on graph inset. Vertical dotted lines show where the transect line intersects tributaries and the Black River.

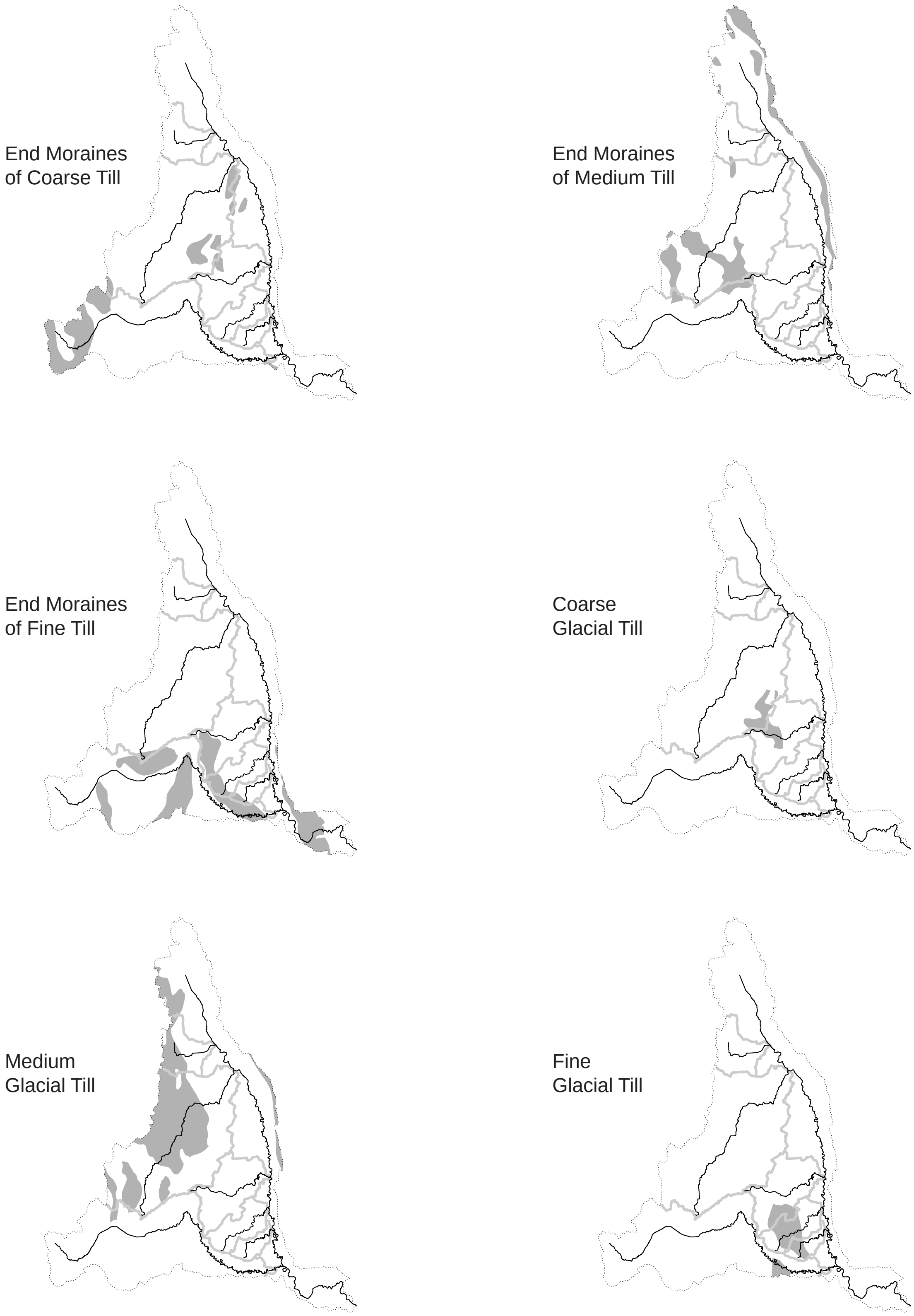


Figure 10.– Distribution of eleven glacial deposits within the Black River watershed shown as crosshatching. Gray lines show boundaries of subwatersheds, black lines show the Black River and major tributaries (Michigan Resource Information System, Michigan Department of Natural Resources, Real Estate Division, Lansing).

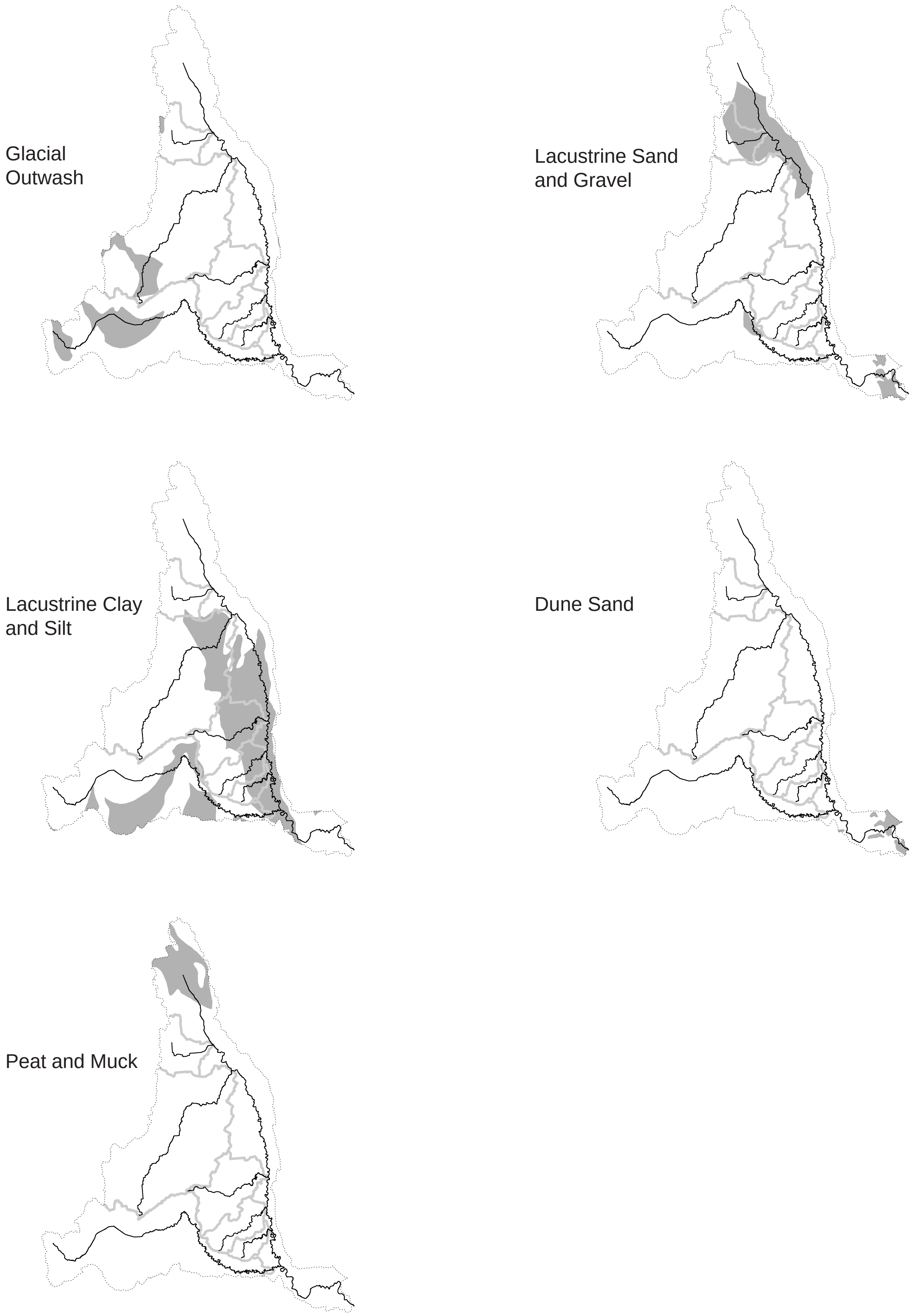
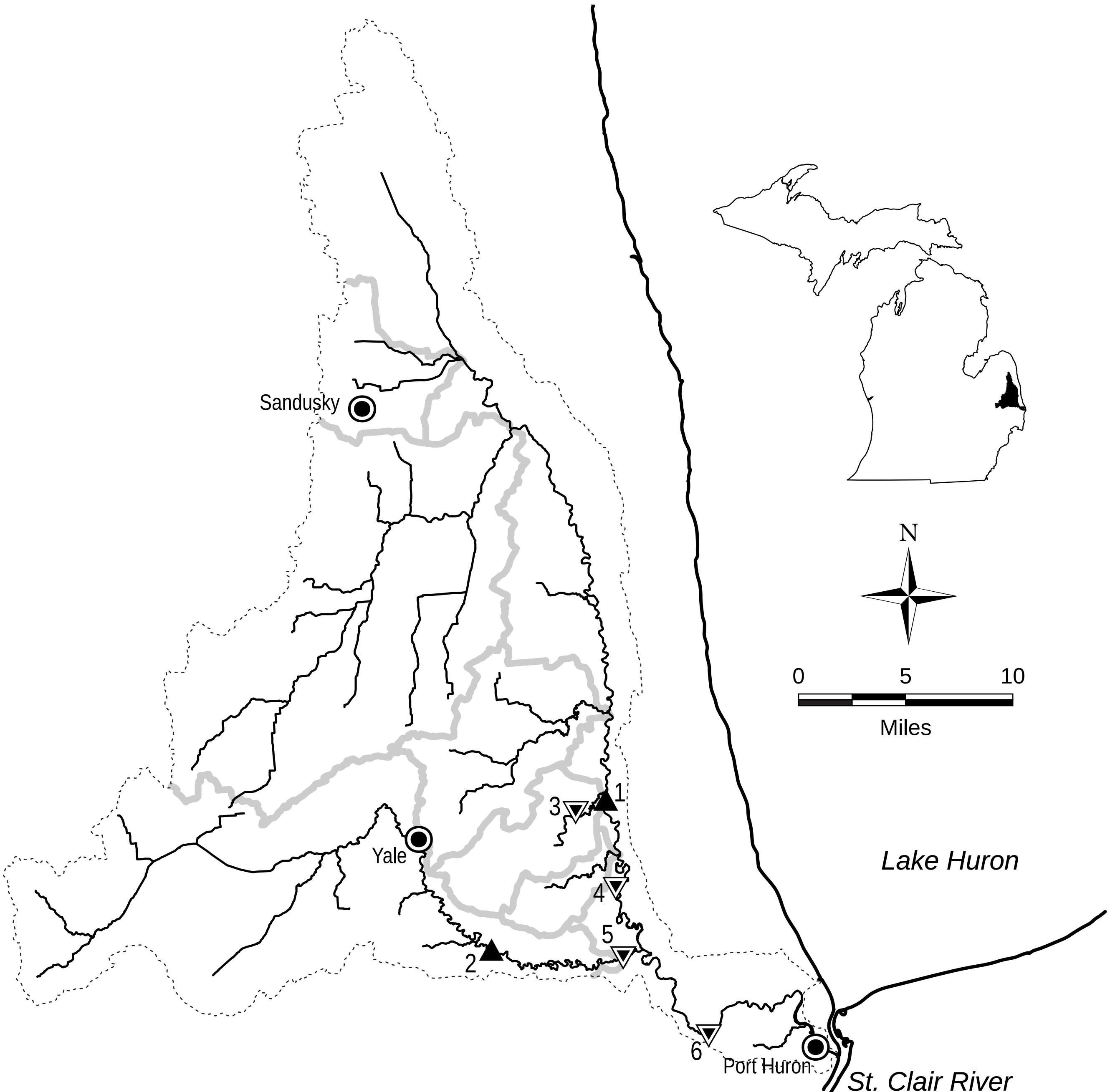


Figure 10.–Distribution of eleven glacial deposits within the Black River watershed shown as crosshatching. Gray lines show boundaries of subwatersheds, black lines show the Black River and major tributaries (Michigan Resource Information System, Michigan Department of Natural Resources, Real Estate Division, Lansing).



Sandusky weather station (207350 – 1909 to present)
Yale weather station (209188 – 1926 to present, partial data)
Port Huron weather station (206680 – 1948 to present)

1 – Black River gauge near Jeddo (04159492 - 1/1/1978 to present)
2 – Mill Creek gauge near Avoca (04159900 - 3/1/1944 to present)
3 – Silver Creek gauge (04159488 - 1/1/1978 to 9/30/1982)
4 – Black River gauge near Fargo (04159500 - 3/1/1944 to 9/30/1991)
5 – Mill Creek gauge near Abbottsford (04160000 - 6/1/1947 to 9/30/1964)
6 – Black River gauge near Port Huron (04160050 - 10/1/1932 to 12/31/1943)

Figure 11.– Locations for National Oceanic and Atmospheric Administration weather stations (solid dots) and United States Geological Survey river gauge stations (black triangles indicate contemporary, gray triangles historic). The text gives station names, numbers, and period of record. Gray lines show boundaries of subwatersheds, black lines show the Black River and major tributaries.

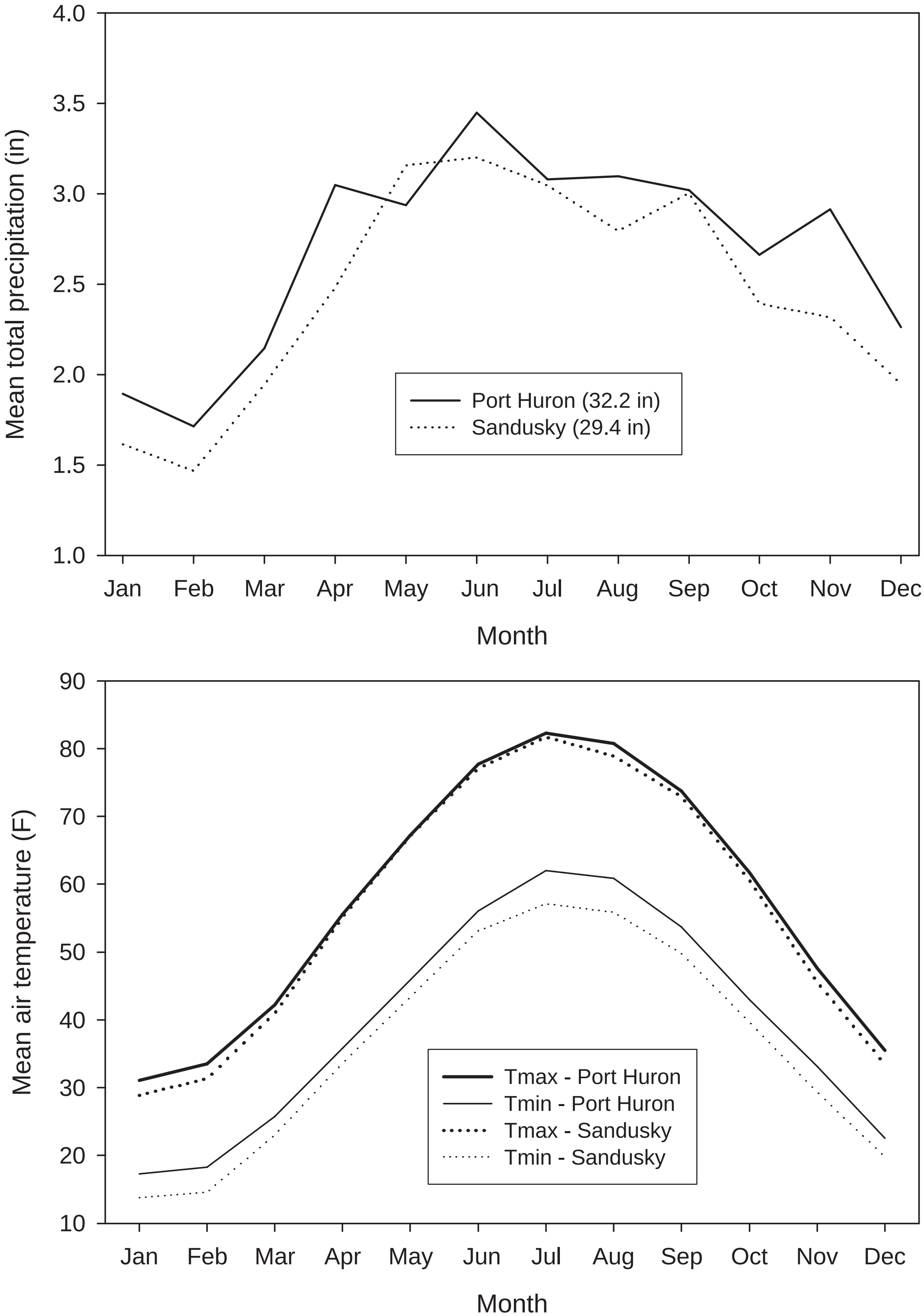


Figure 12.– Average monthly precipitation (inches, upper graph) and average maximum and minimum air temperature (lower graph) across the Black River watershed for periods of record.

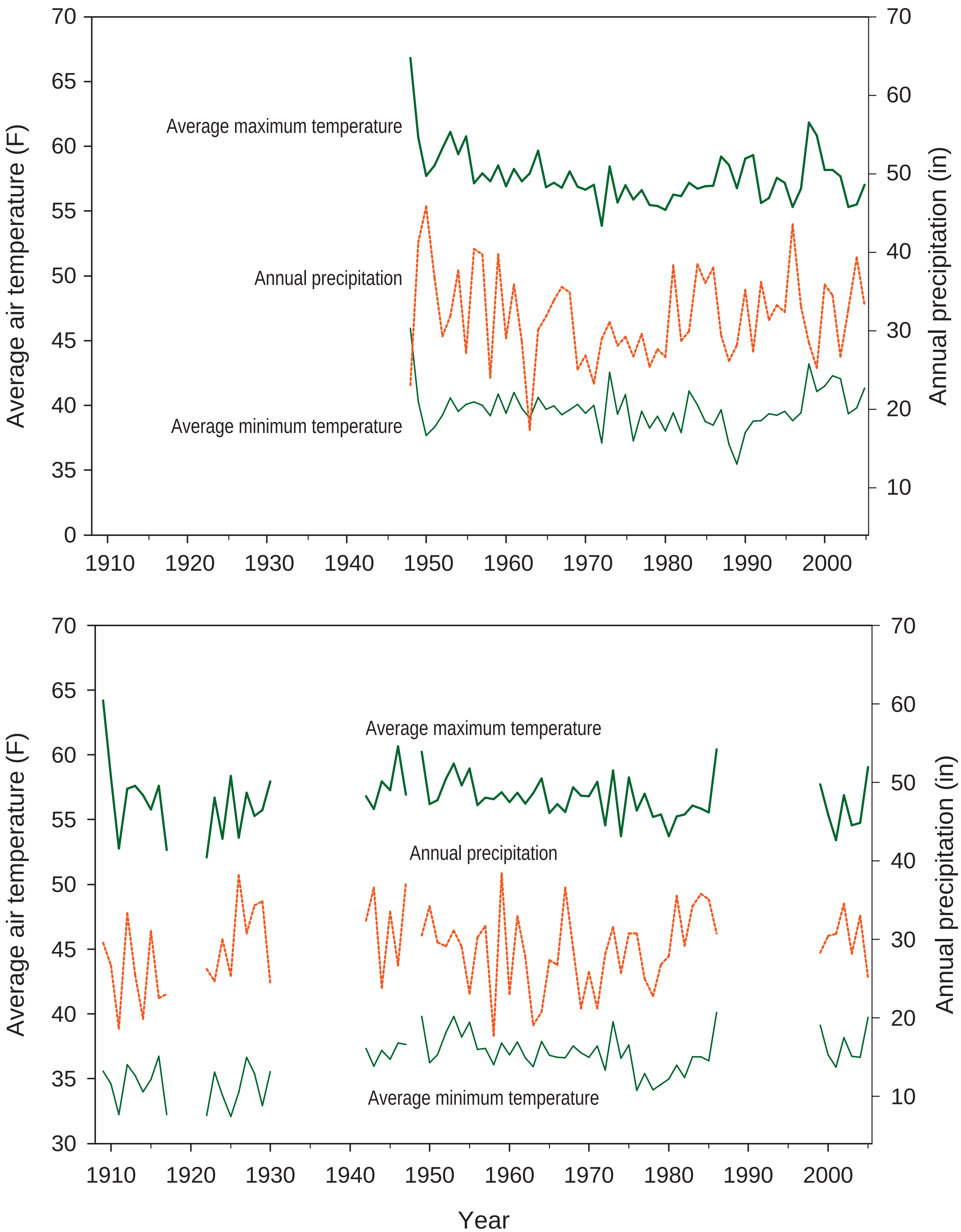


Figure 13.– Average annual maximum (solid line) and minimum (dotted line) air temperature and total precipitation (dashed line) at Port Huron (upper graph) and Sandusky (lower graph). Temperature values are associated with left axis and precipitation with the right axis.

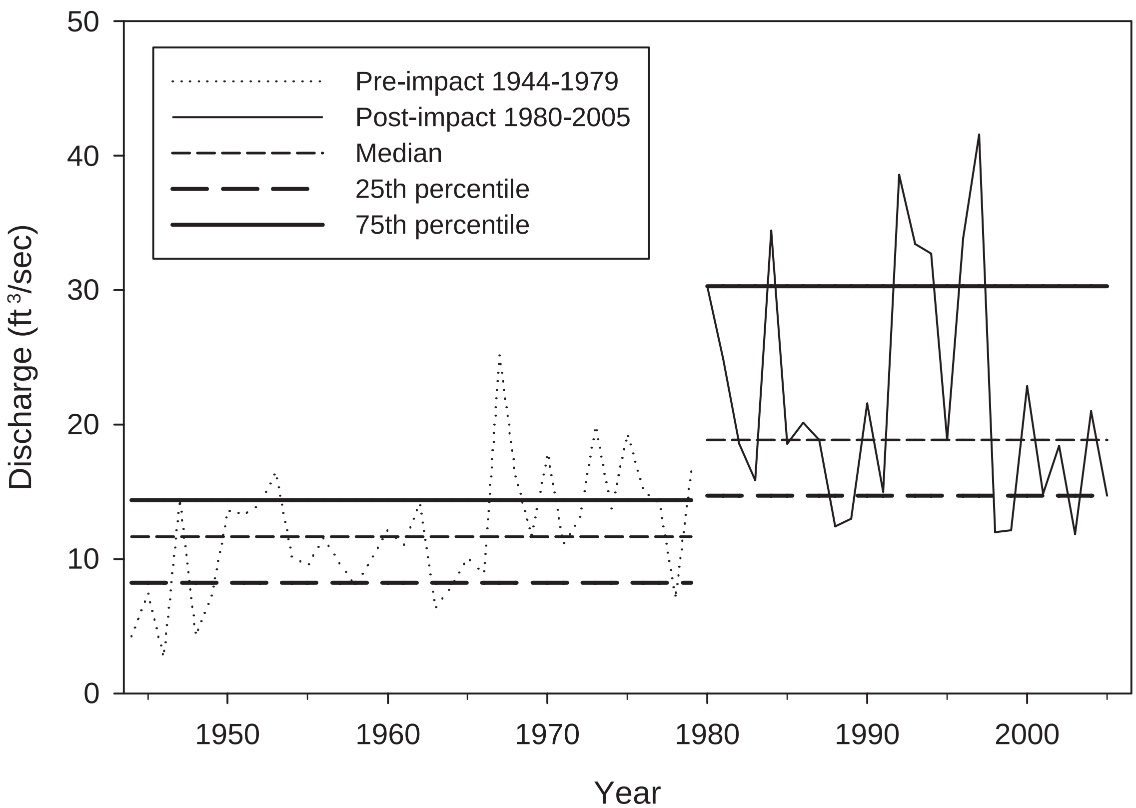


Figure 14.– Change in base flow at the Black River near Jeddo gauge, based on the Indicators of Hydrologic Alteration model (The Nature Conservancy 2007).

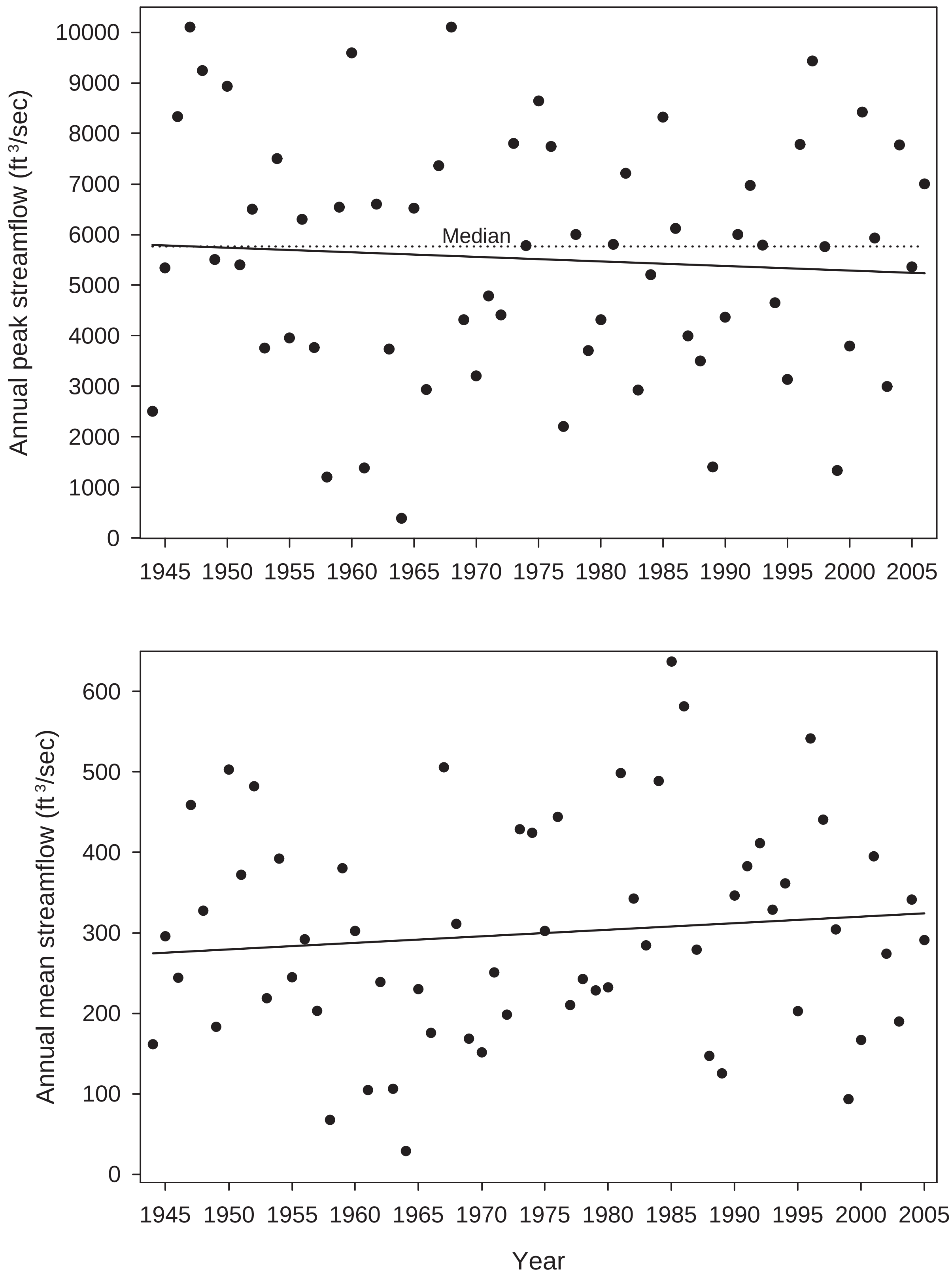


Figure 15.– Peak annual discharge (top graph) and average annual daily discharge (bottom graph) for the Black River measured at the Jeddo Road gauge.

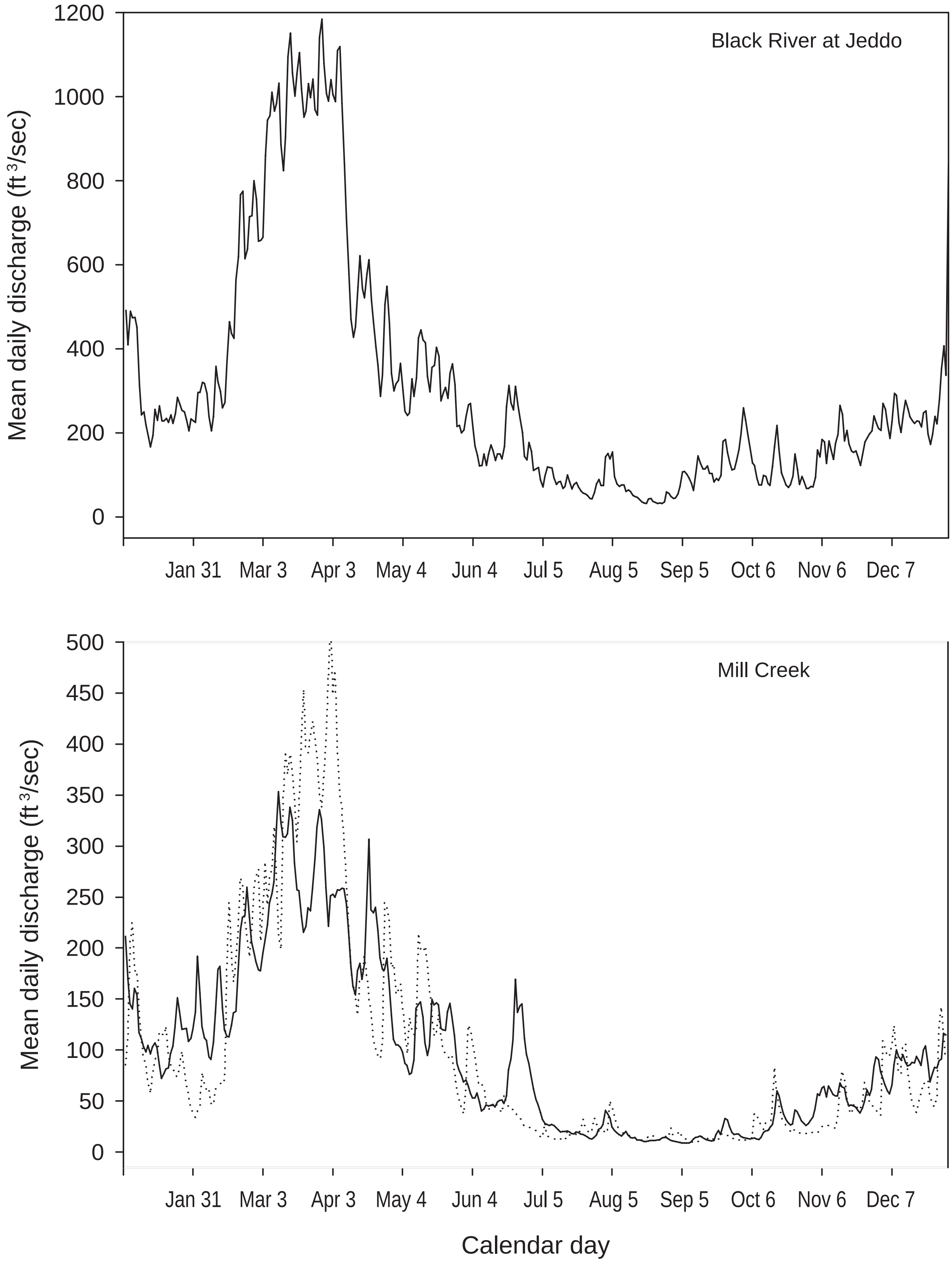


Figure 16.– Average daily discharge at the Black River gauge at Jeddo (top graph) and Mill Creek gauges (bottom graph where solid line is Avoca gauge and dotted line is Abbottsford gauge) over years 1944 to 2006.

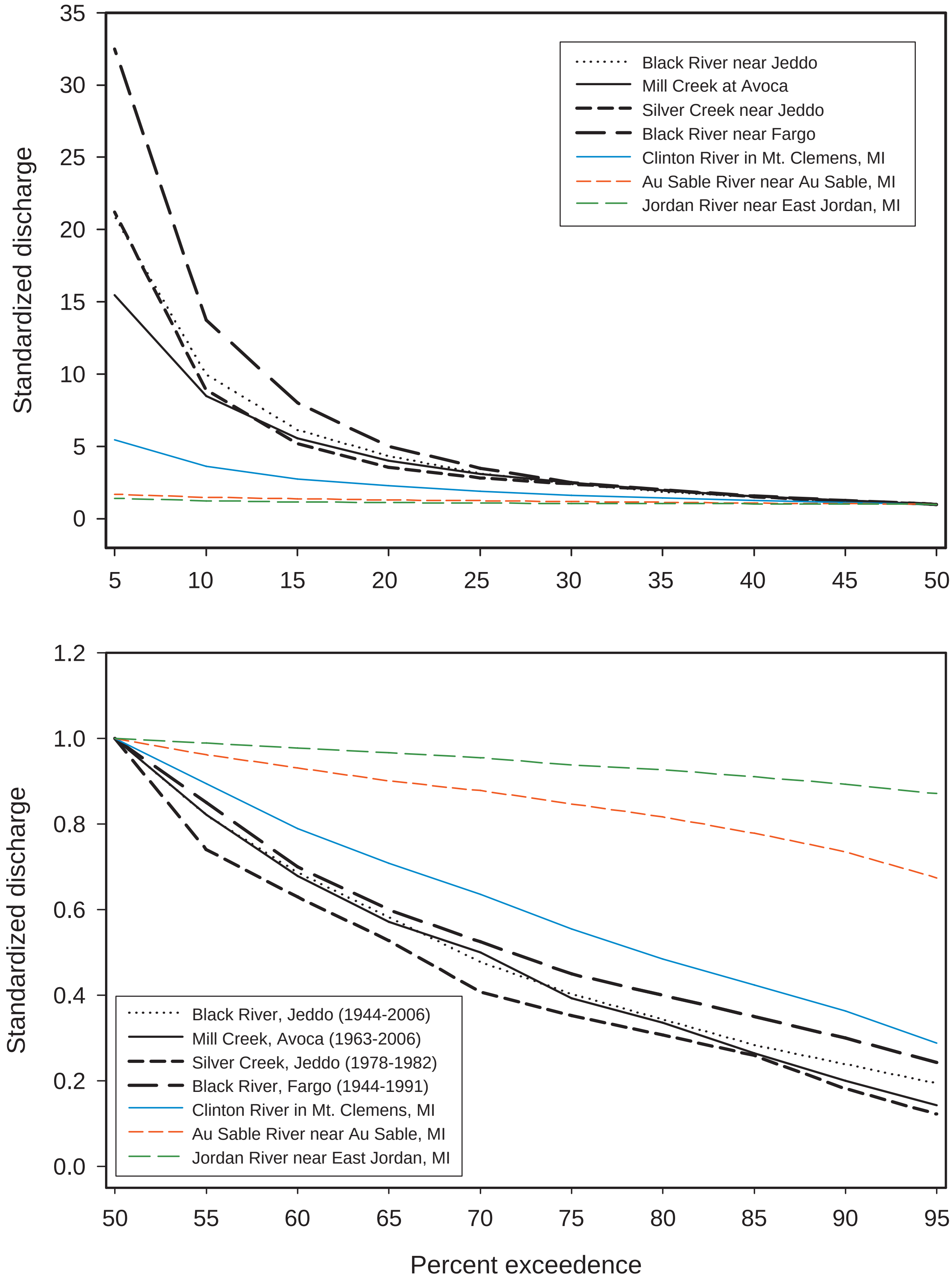


Figure 17.– Standardized high flow exceedence (top graph) and low flow exceedence (bottom graph) at four gauge sites on the Black River, Mill Creek, and Silver Creek. Data are plotted for the Clinton, Au Sable, and Jordan rivers for comparison purposes.

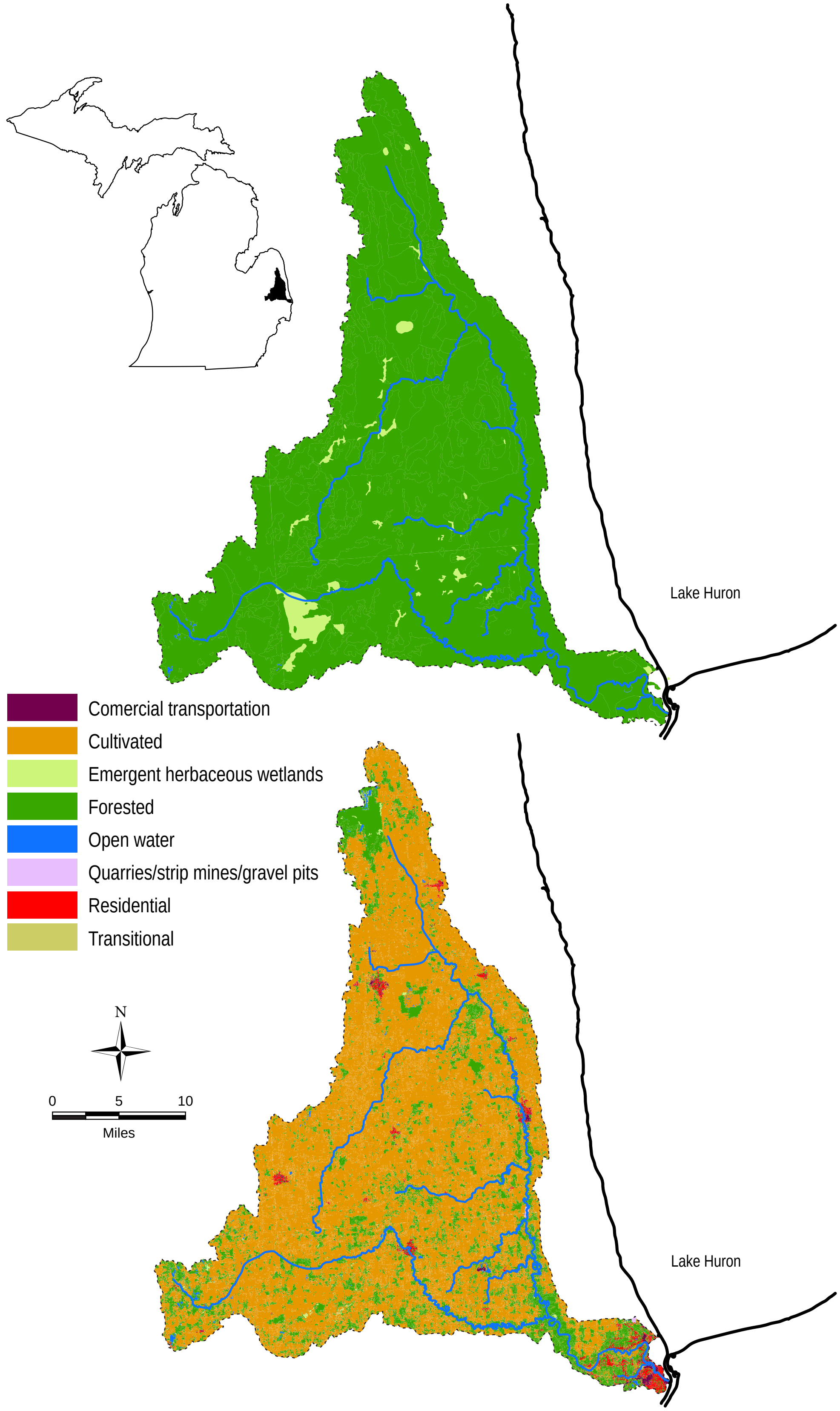
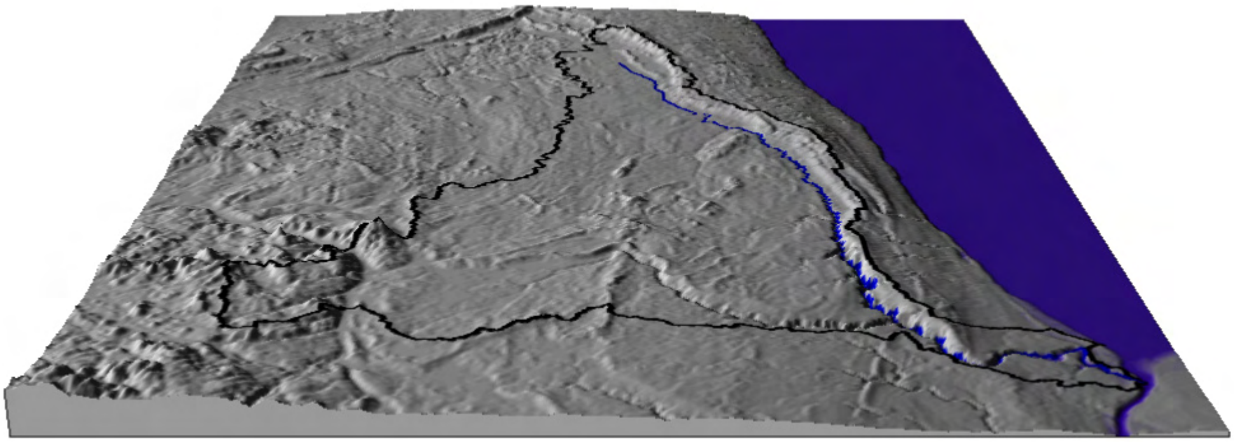


Figure 18.– Change in watershed cover type between pre-settlement times (upper) and 1992 (lower).



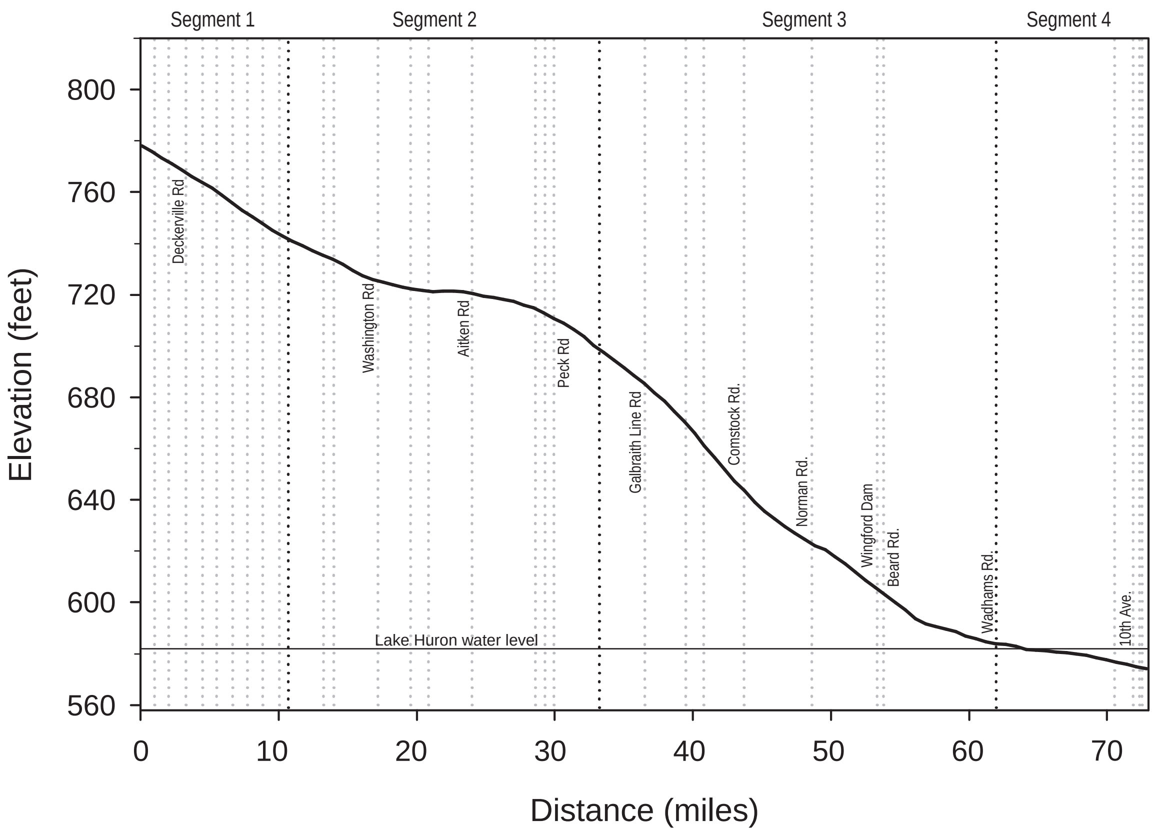


Figure 19.– Surface map (upper figure) shows general land surface features of the Black River main stem. Dark line (smoothed) on graph (bottom figure) shows vertical profile of entire length of main stem with gradual and steeper portions clearly visible. Gray vertical lines on graph indicate locations of road crossings, segment boundaries, and Wingford Dam. Horizontal black line on graph shows current water level in Lake Huron.

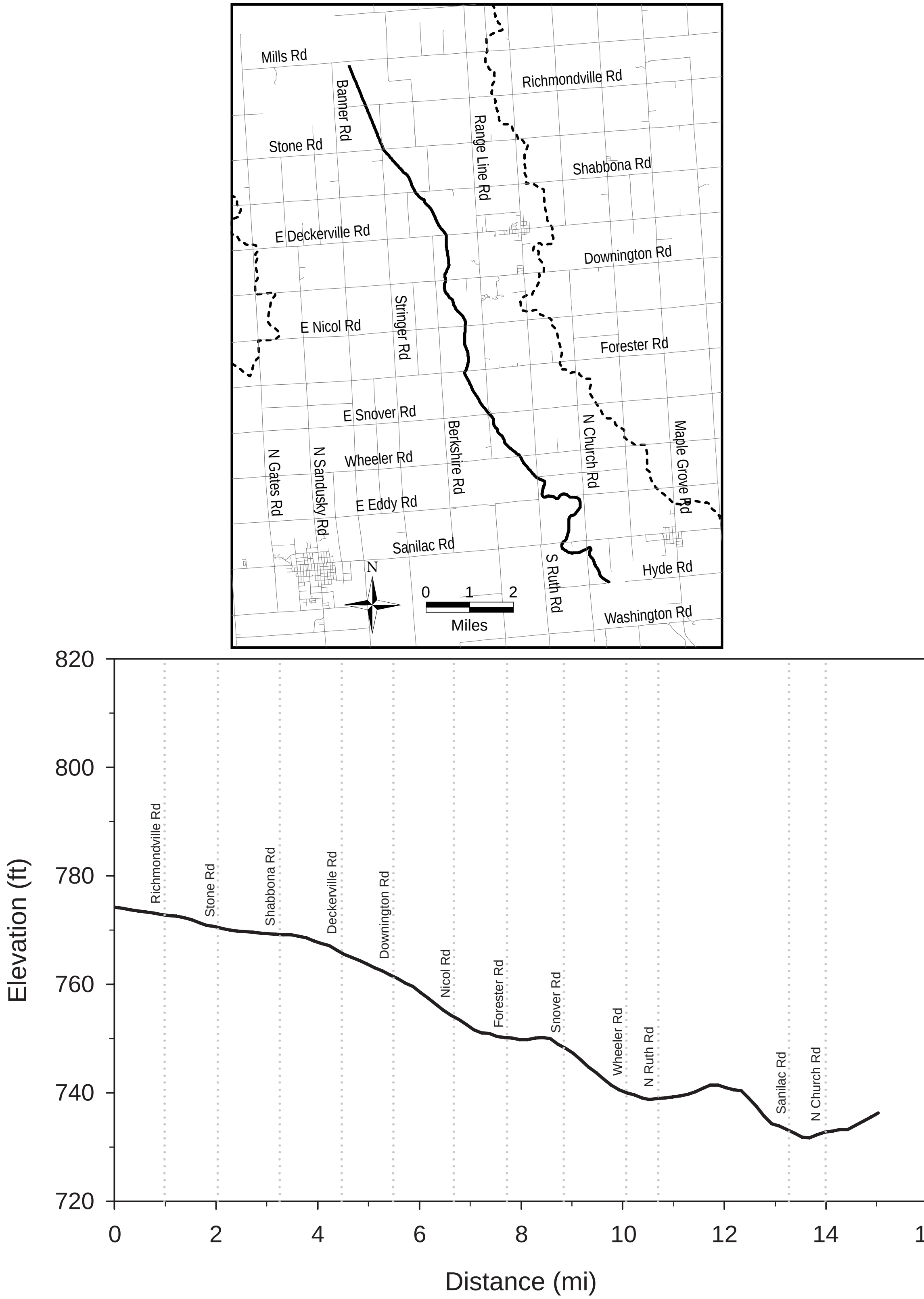


Figure 20.– Segment 1 (headwaters) of the Black River main stem (upper) with all road crossings for geographic reference. The outer rectangle covers 100,217 acres and the river segment is 15.0 miles long. River flow is southeast. Lower graph shows elevation change along this river segment. Smoothed line may indicate higher elevations downstream due to inherent errors in the source for digital elevation.

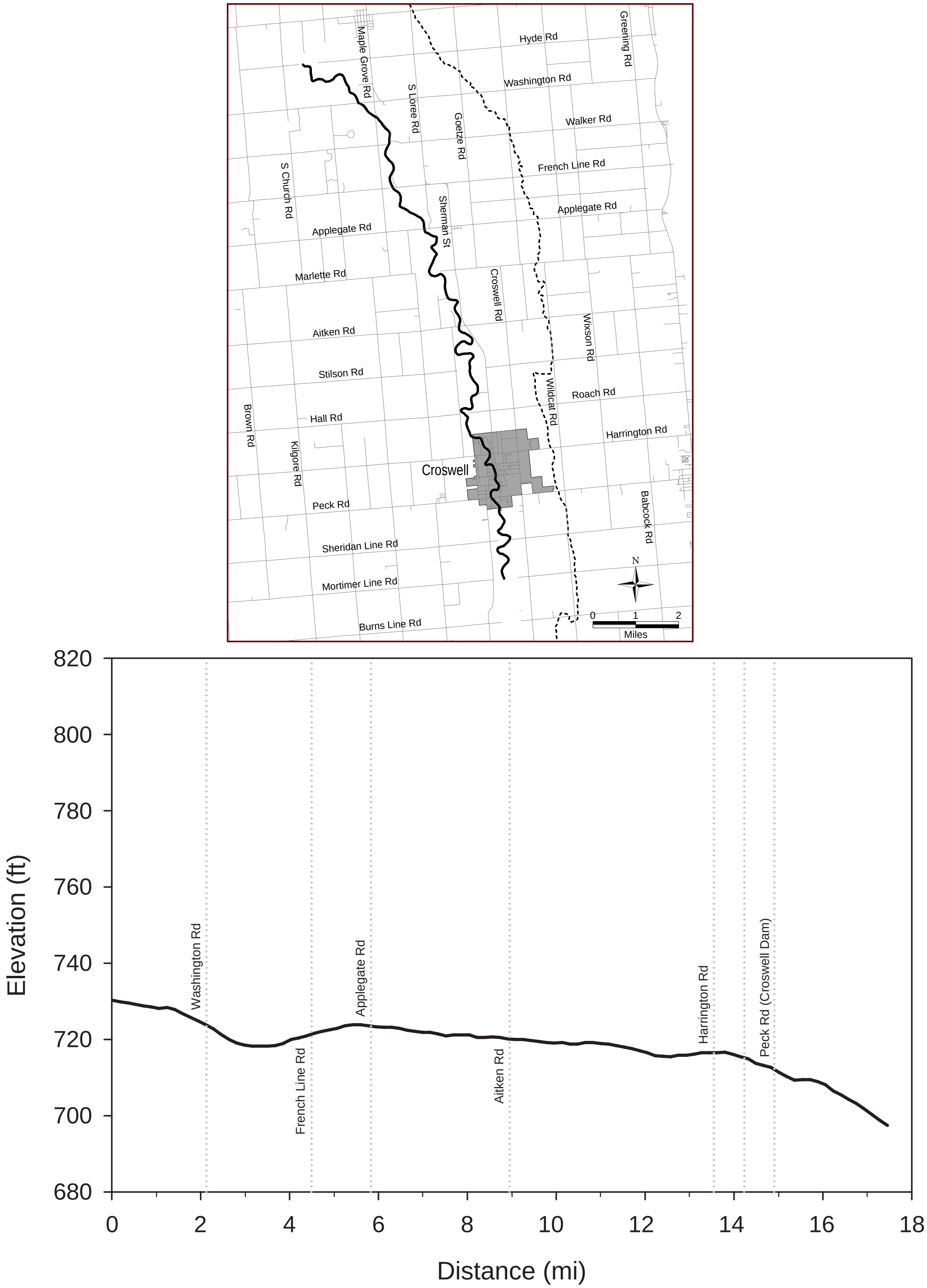


Figure 21.– Segment 2 of the Black River main stem (upper) with all road crossings for geographic reference. The outer rectangle covers 100,287 acres and the river segment is 17.5 miles. River flow is south. Lower graph shows elevation change along this river segment. Smoothed line may indicate higher elevations downstream due to inherent errors in the source for digital elevation.

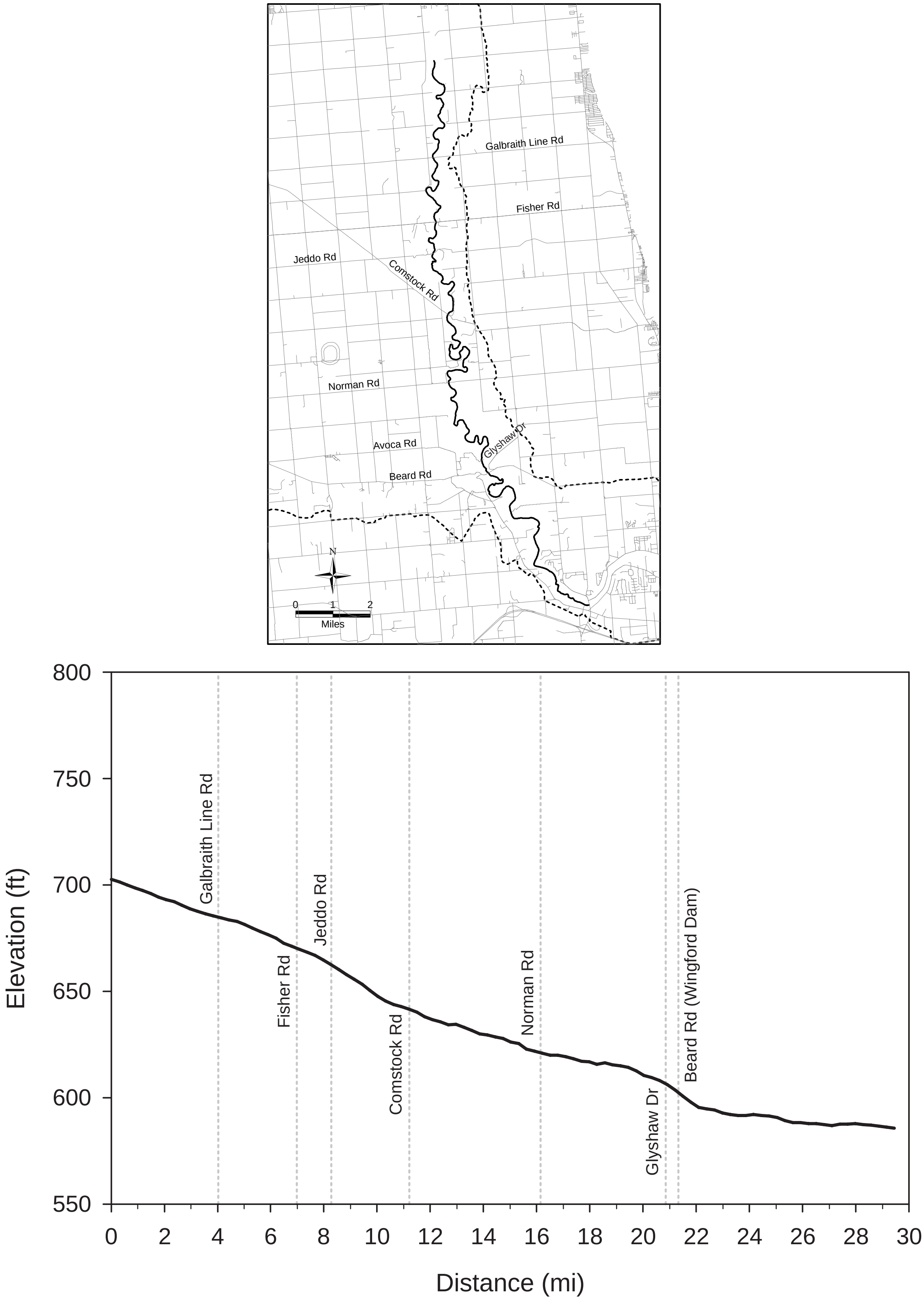


Figure 22.– Segment 3 of the Black River main stem (upper) with all road crossings for geographic reference. The outer rectangle covers 154,423 acres and the river segment is 29.5 miles. River flow is south. Lower graph shows elevation change along this river segment.

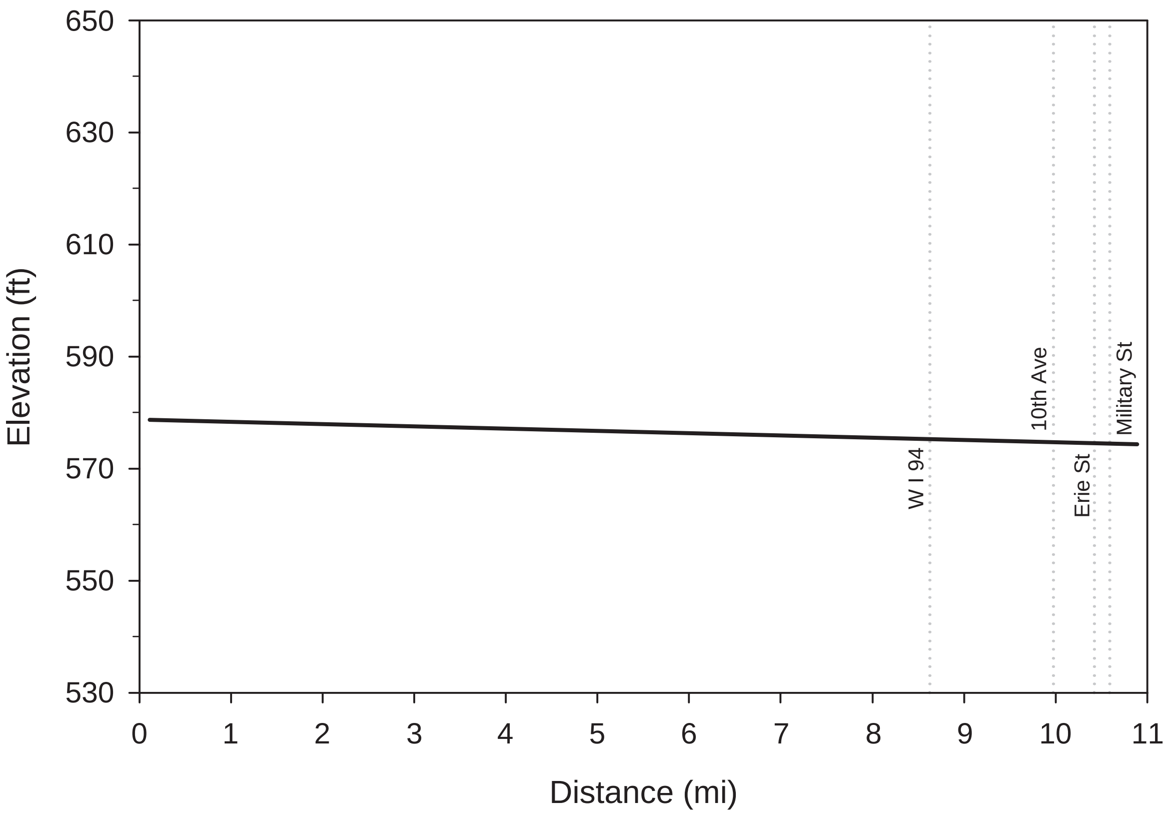
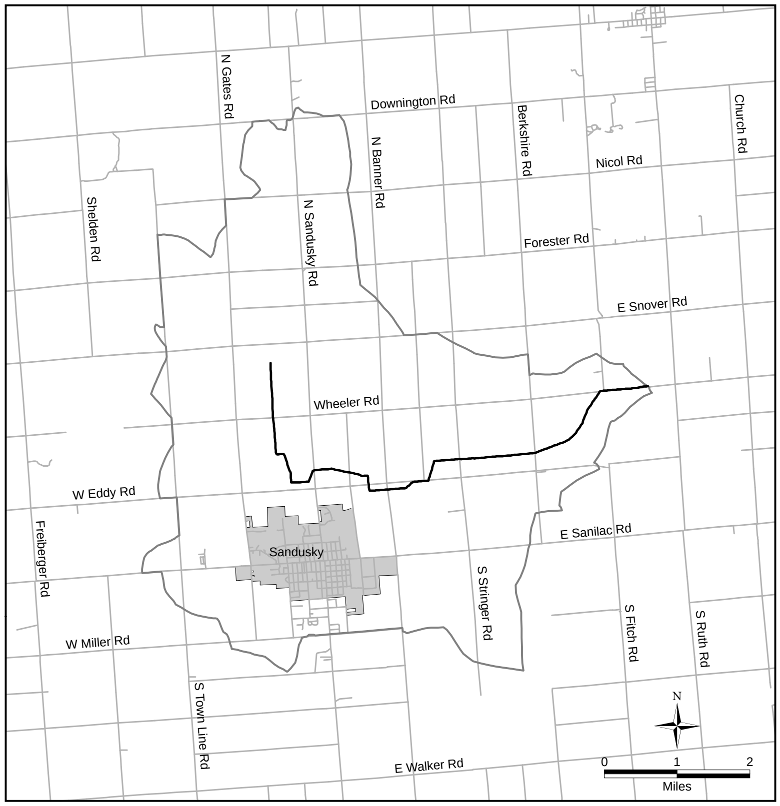


Figure 23.– Segment 4 of the Black River main stem (upper) with all road crossings for geographic reference. The outer rectangle covers 55,196 acres and the river segment is 10.9 miles. River flow is east. Lower graph shows elevation change along this river segment..



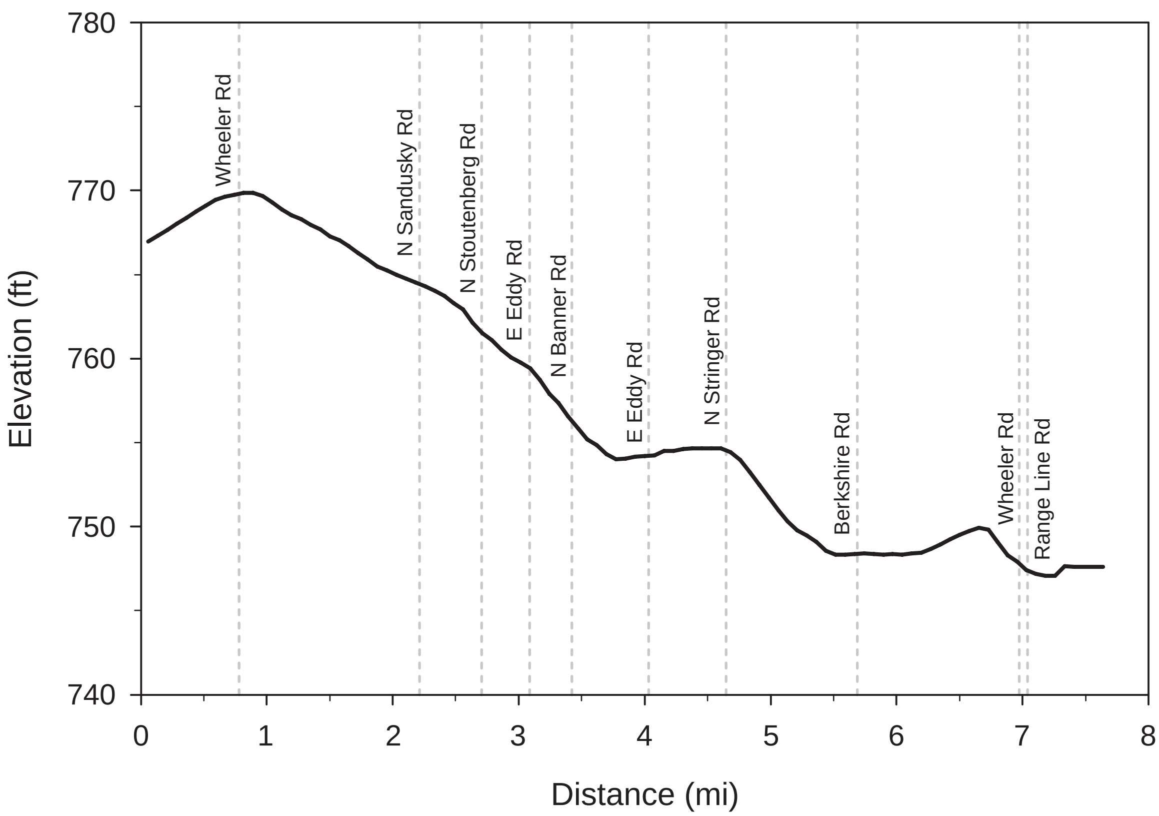
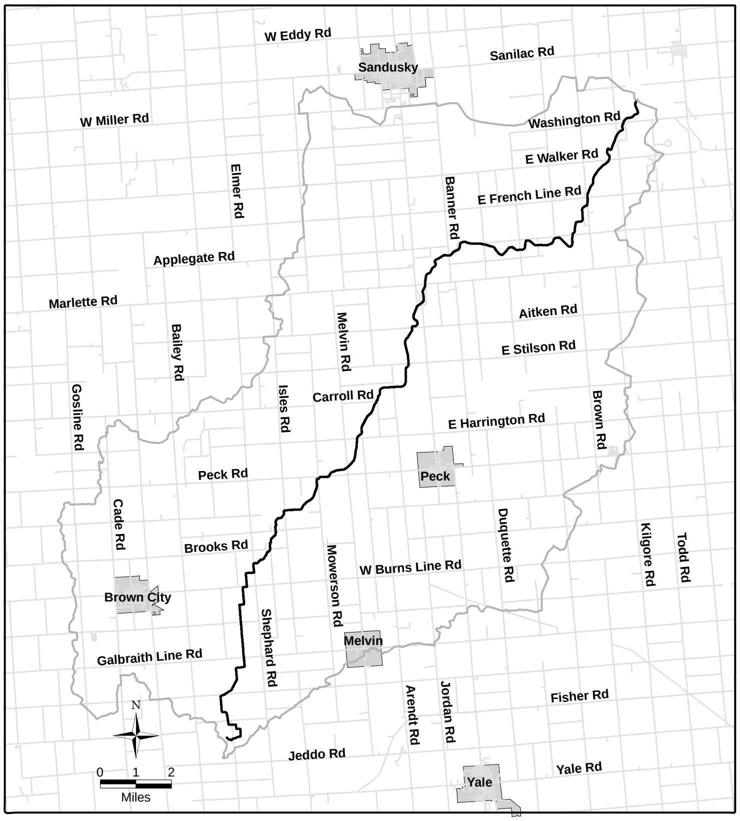


Figure 24.– Berry Drain subwatershed (upper) with all road crossings for geographic reference. The outer rectangle covers 74,018 acres and the river segment is 7.6 miles. River flow is east. Lower graph shows elevation change along this tributary.



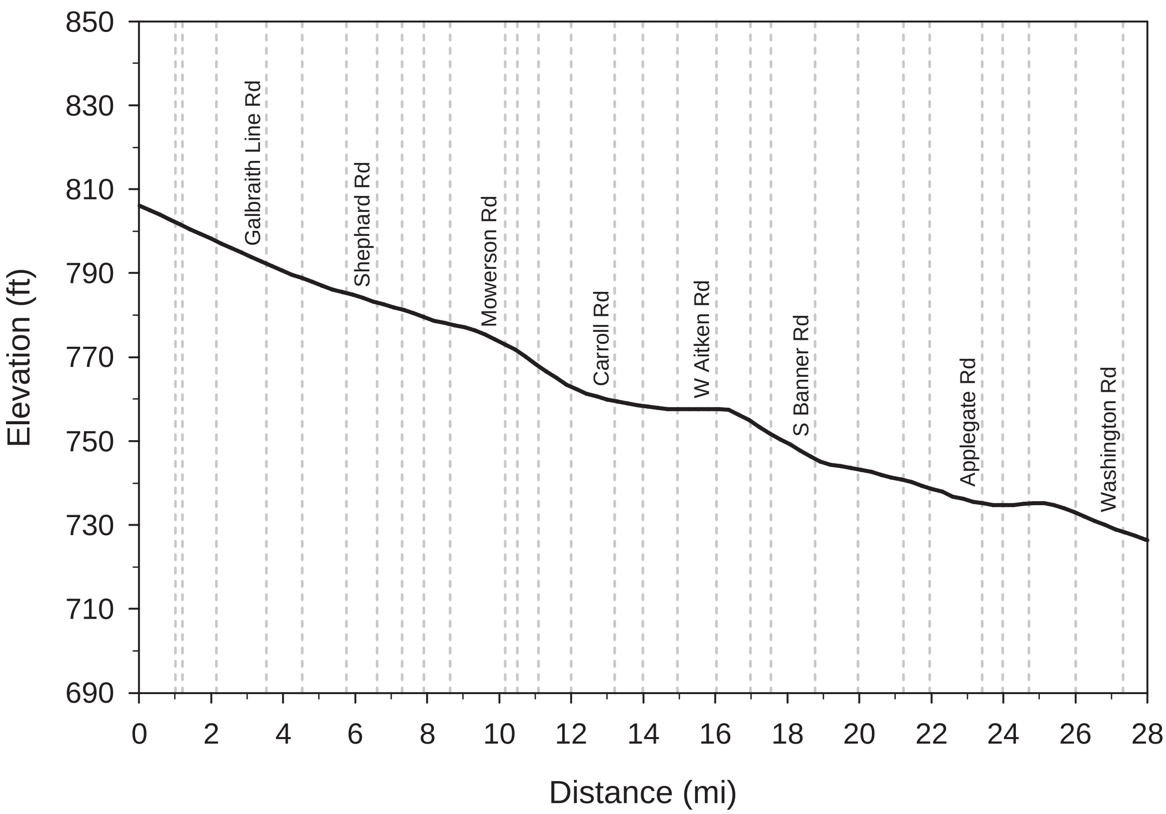
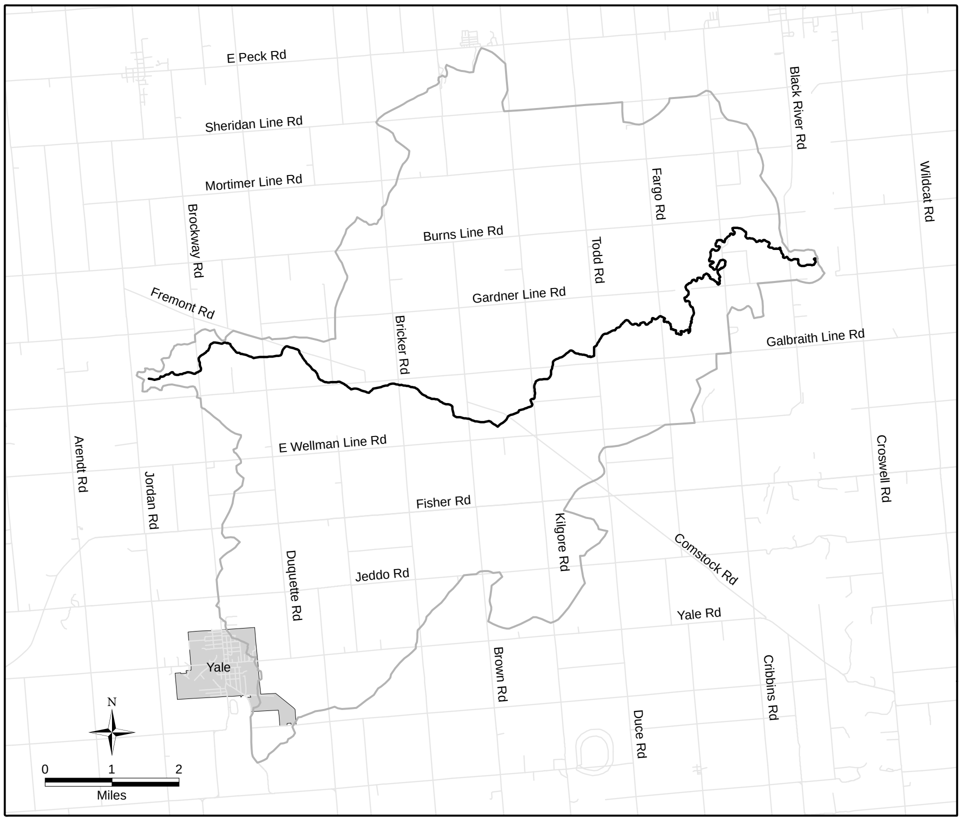


Figure 25.– Elk Creek subwatershed (upper, dotted boundary) with all road crossings for geographic reference. The outer rectangle covers 297,713 acres and the river segment is 28.3 miles. River flow is northeast. Lower graph shows elevation change along this tributary.



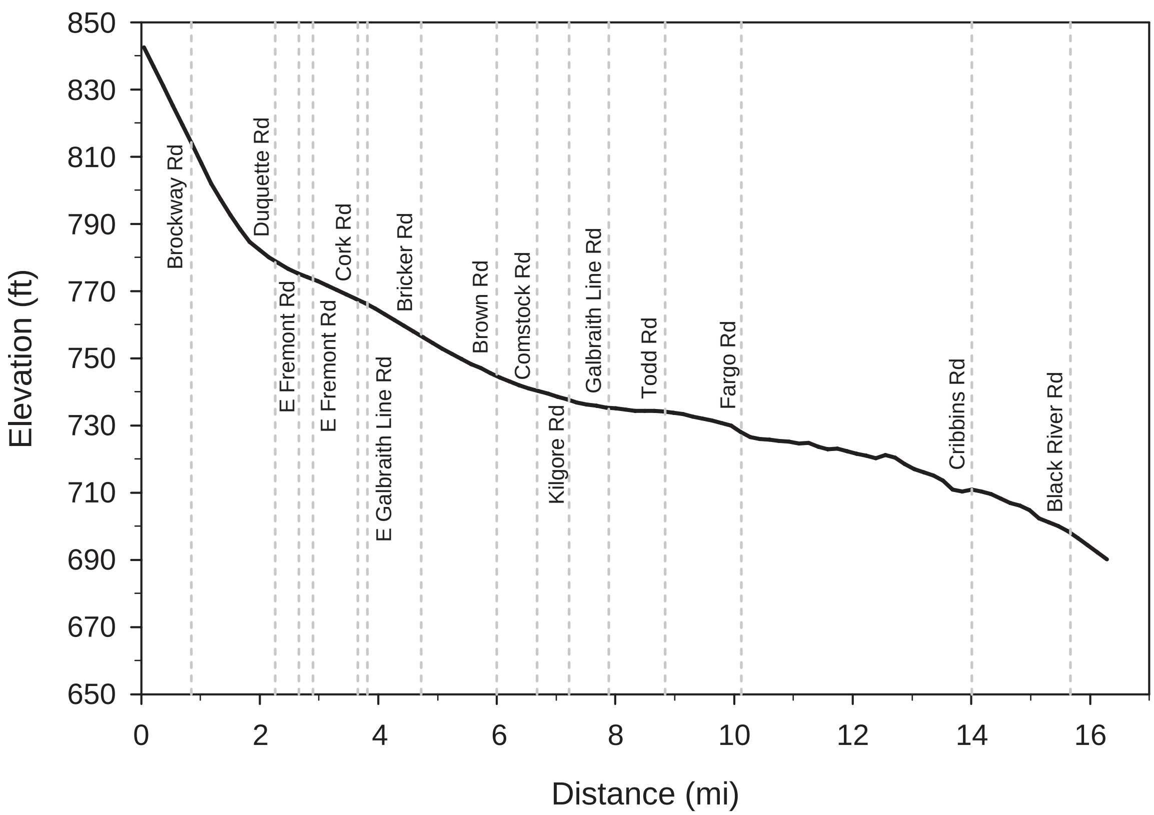
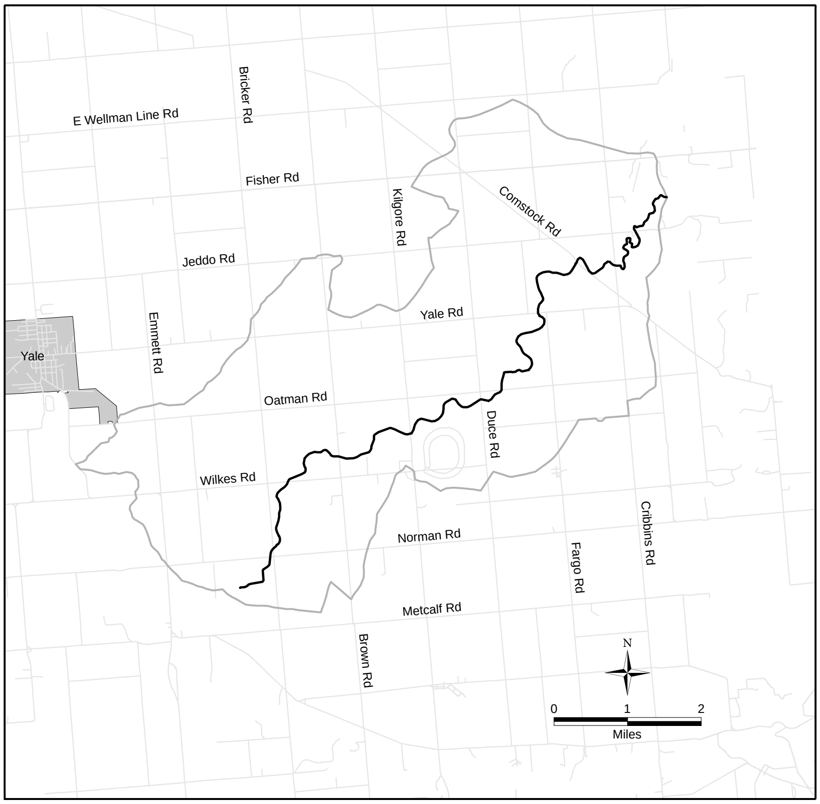


Figure 26.– Black Creek subwatershed (upper, dotted boundary) with all road crossings for geographic reference. The outer rectangle covers 110,439 acres and the river segment is 16.3 miles. River flow is east. Lower graph shows elevation change along this tributary.



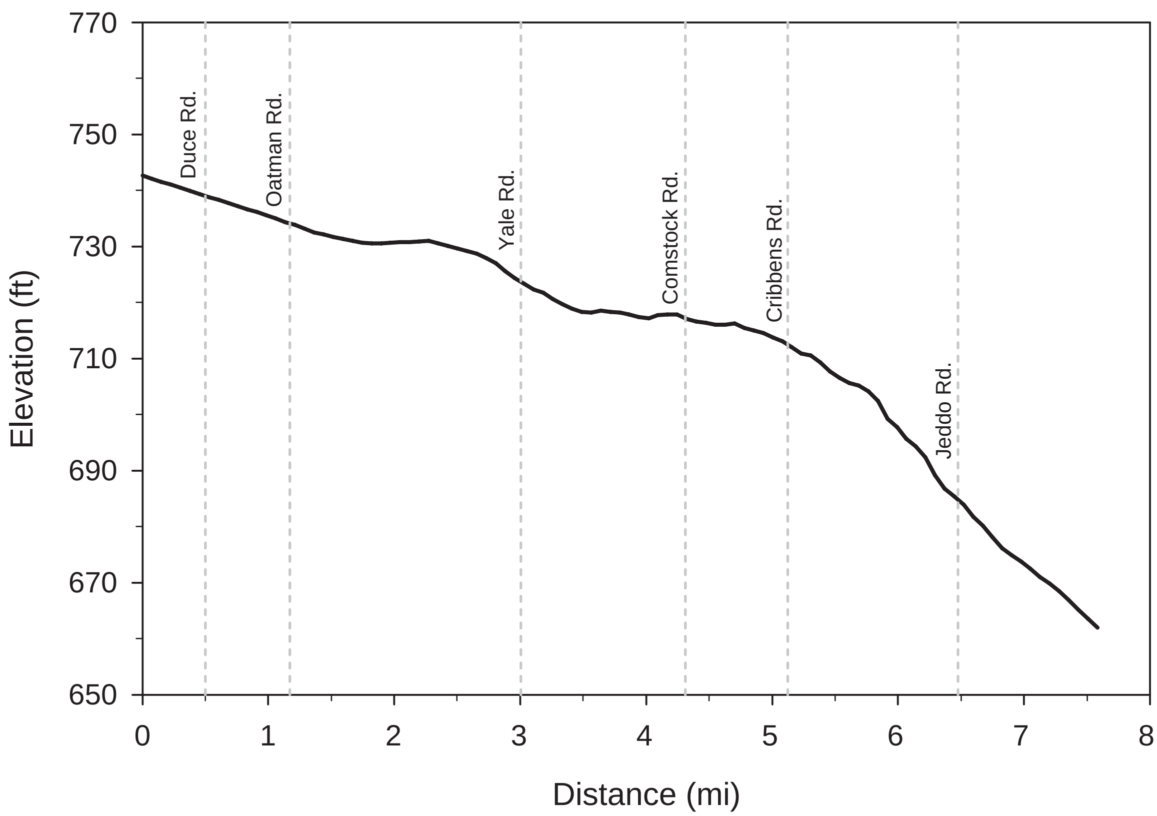


Figure 27.– Silver Creek subwatershed (upper, dotted boundary) with all road crossings for geographic reference. The outer rectangle covers 77,011 acres and the river segment is 11.5 miles. River flow is east. Lower graph shows elevation change along this tributary.

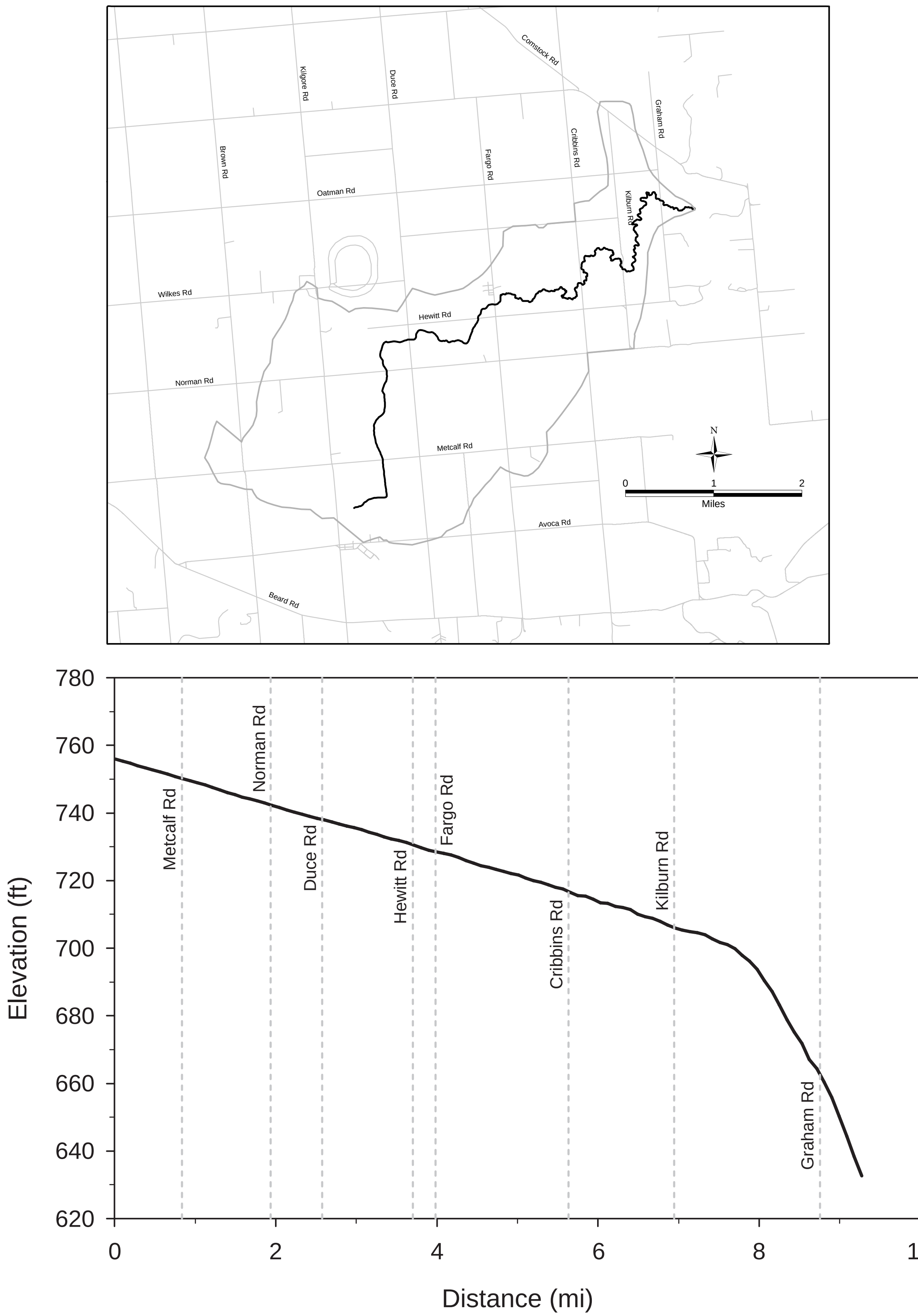
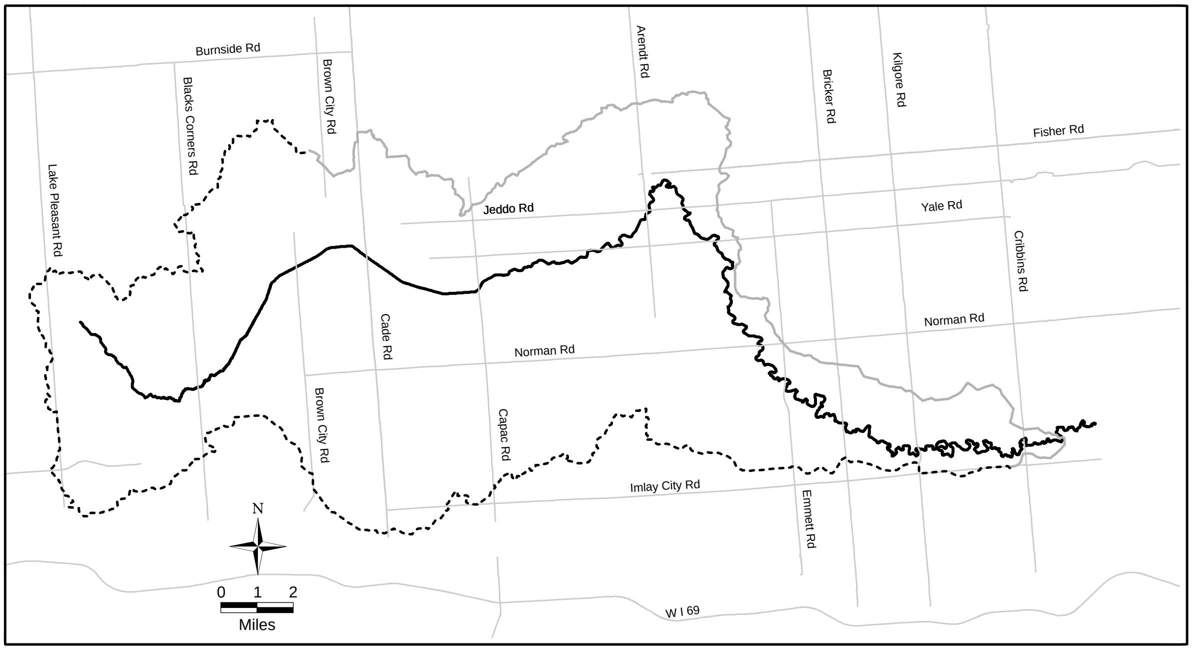


Figure 28.– Plum Creek subwatershed (upper, dotted boundary) with all road crossings for geographic reference. The outer rectangle covers 38,064 acres and the river segment is 9.3 miles. River flow is northeast. Lower graph shows elevation change along this tributary.



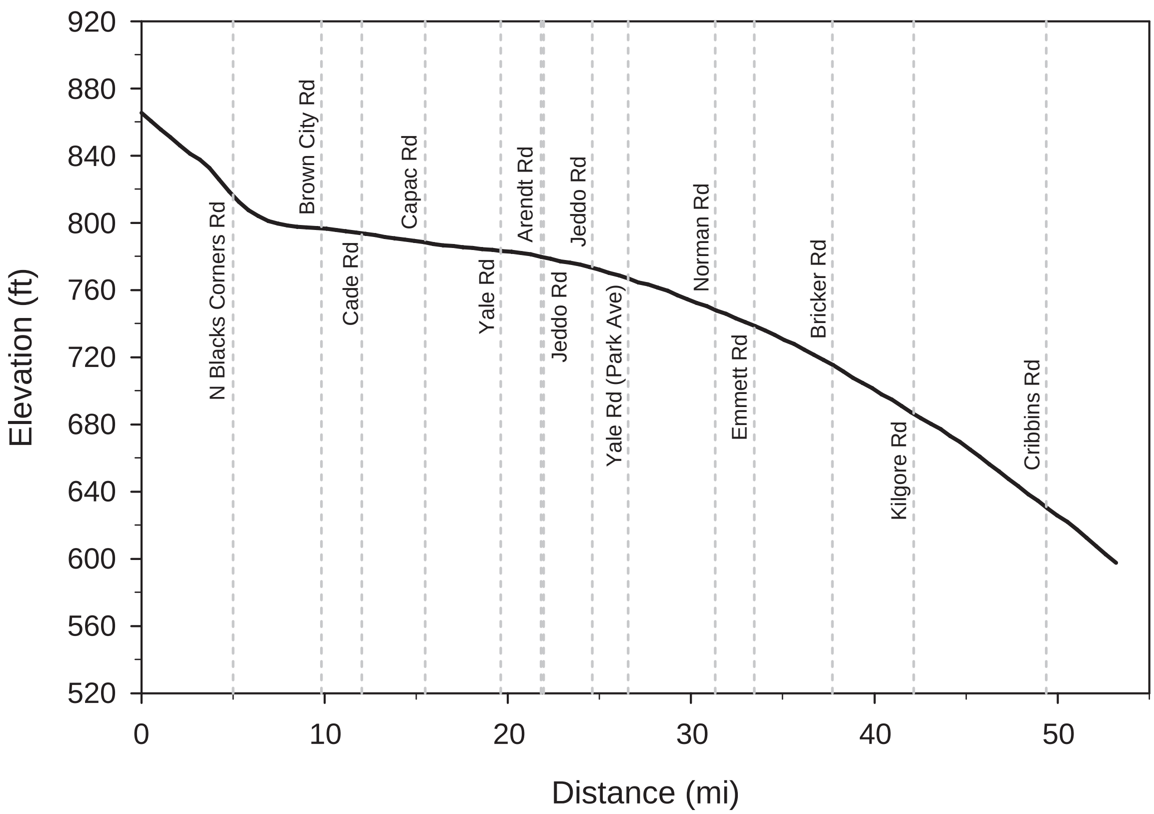


Figure 29. Mill Creek subwatershed (upper, dotted boundary) with all road crossings for geographic reference. The outer rectangle covers 377,950 acres and the river segment is 53.2 miles. River flow is northeast to southeast. Lower graph shows elevation change along tributary.–

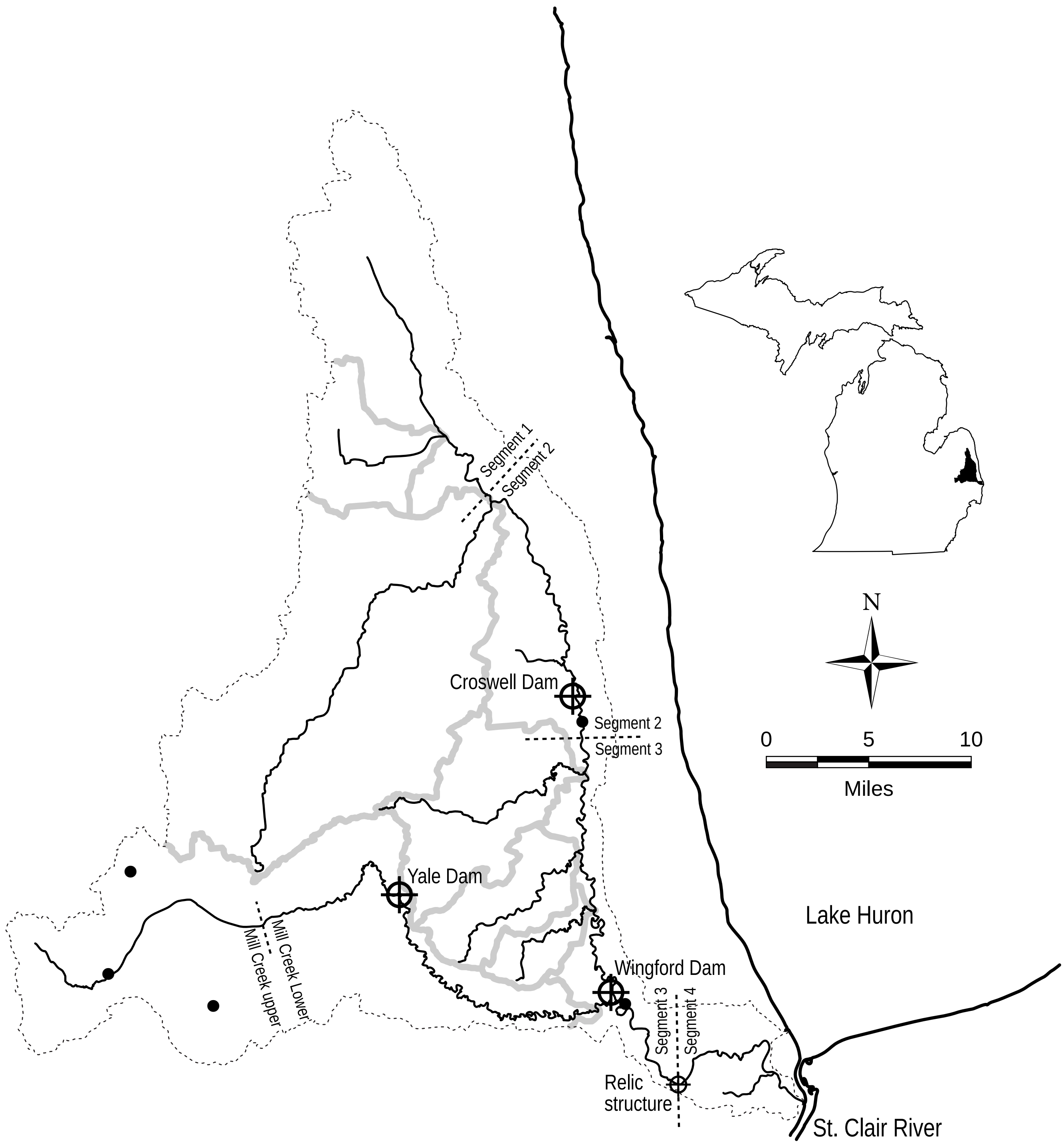


Figure 30.–Locations for three significant dams, two on the Black River main stem and one on Mill Creek indicated by large crosshair symbols. The smaller crosshair symbol shows location of a relic dam structure. Small, black dots show locations of small, mostly private dams listed in the Michigan Department of Environmental Quality dams database. Gray lines show boundaries of subwatersheds, solid black lines show the Black River and major tributaries. Dotted black lines delineate river segments.

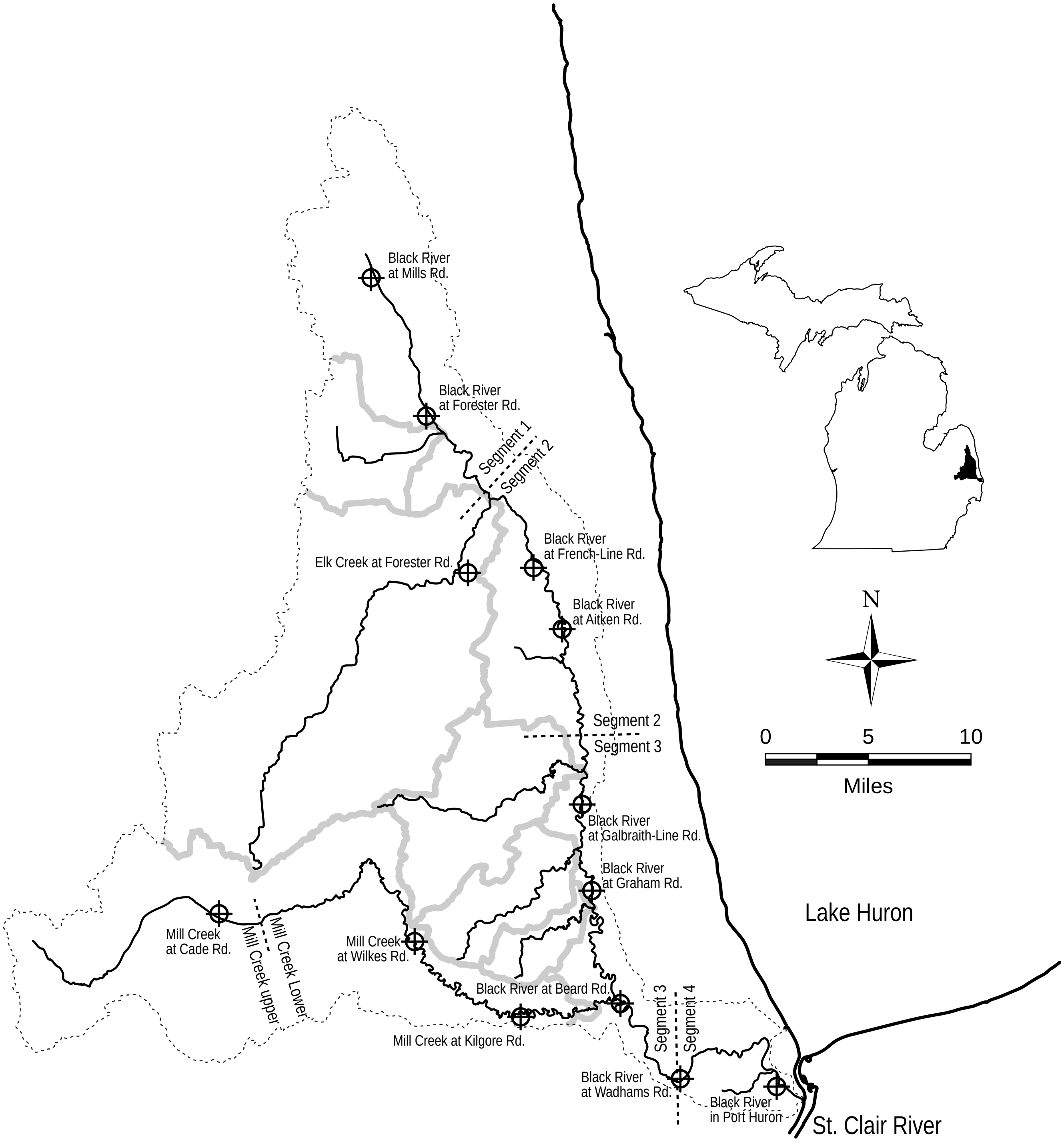


Figure 31.– Geographic locations (usually near road crossing) for Michigan Department of Natural Resources water temperature sensors deployed in the Black River watershed. Dotted lines divide major analysis segments of the Black River main stem and Mill Creek.

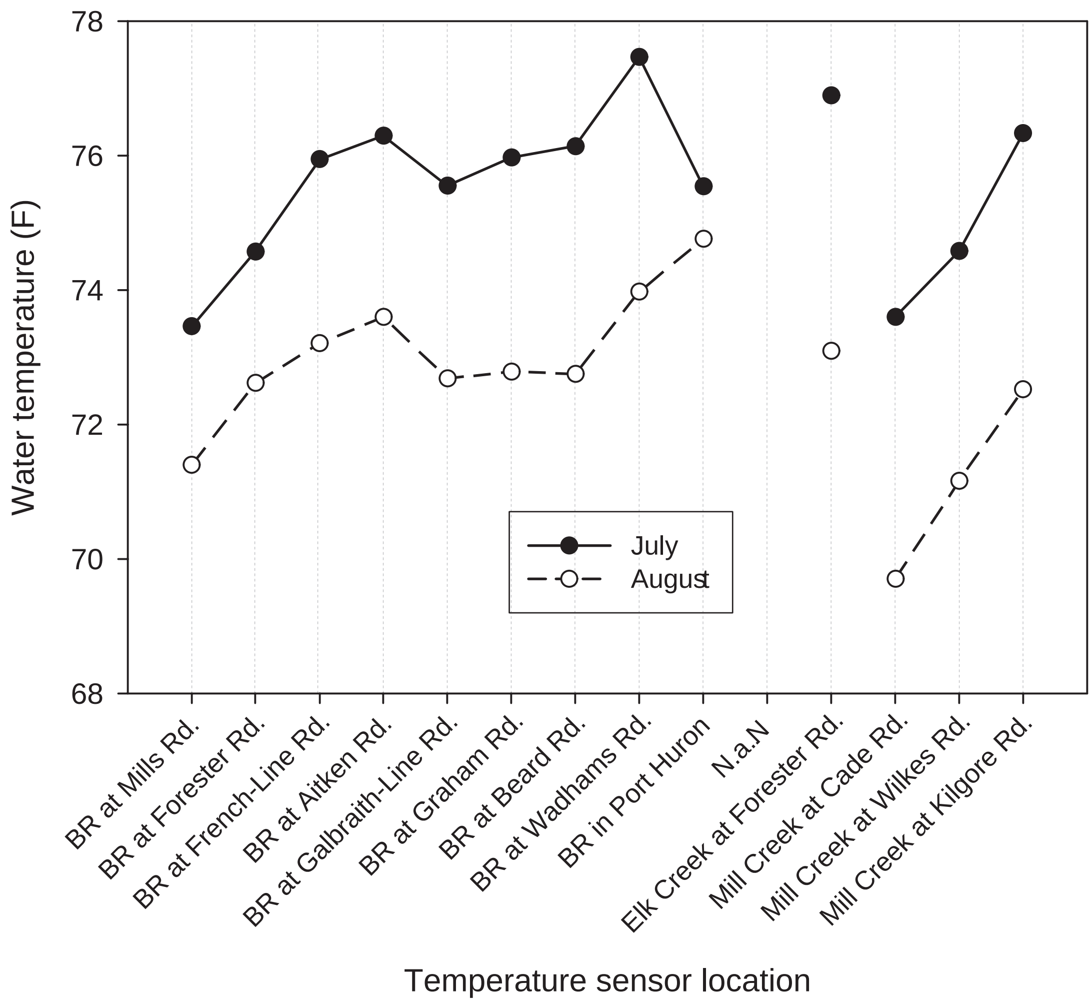


Figure 32.– Average water temperature during July and August at nine stations located near road crossings in the Black River (BR) main stem, one station in Elk Creek, and three stations in Mill Creek.

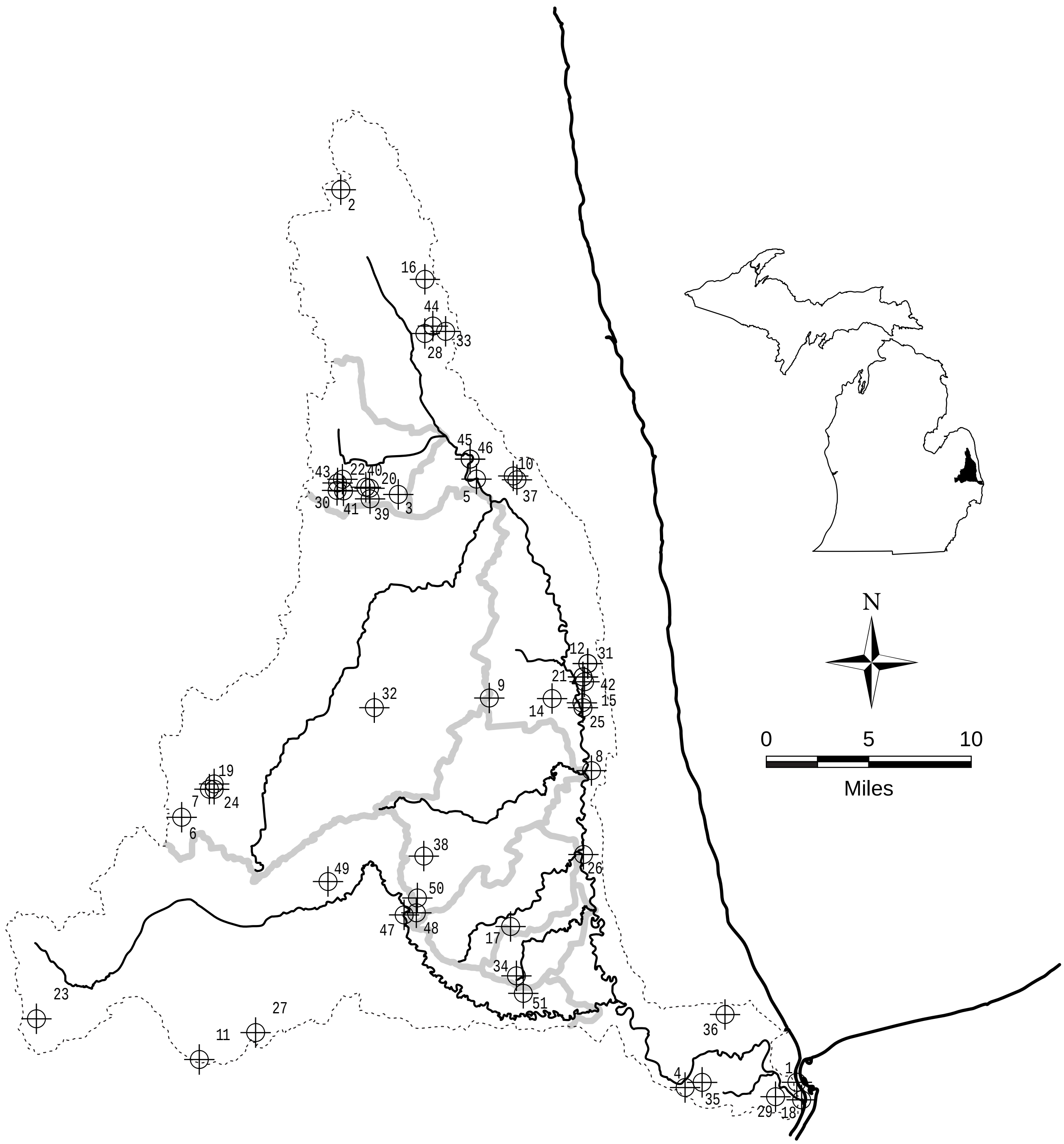


Figure 33.– Map of commercial and municipal entities that have National Pollutant Discharge Elimination System (NPDES) permits in the Black River watershed. Numbers identify the permitted activities listed in Table 6.

Figure 34.– Map of 996.6 miles of designated drains within the Black River watershed. Dark line shows the watershed boundary.

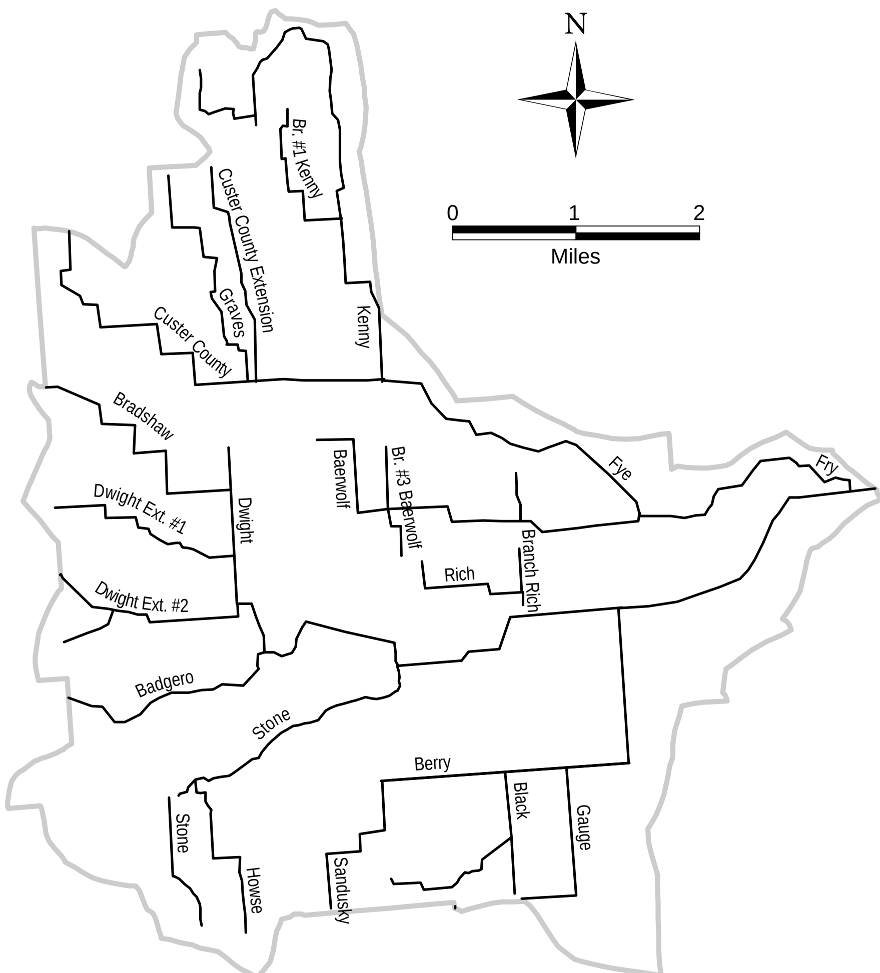


Figure 35.– Map of 56.1 miles of designated drains within the Berry Drain subwatershed. Dotted line shows the subwatershed boundary.

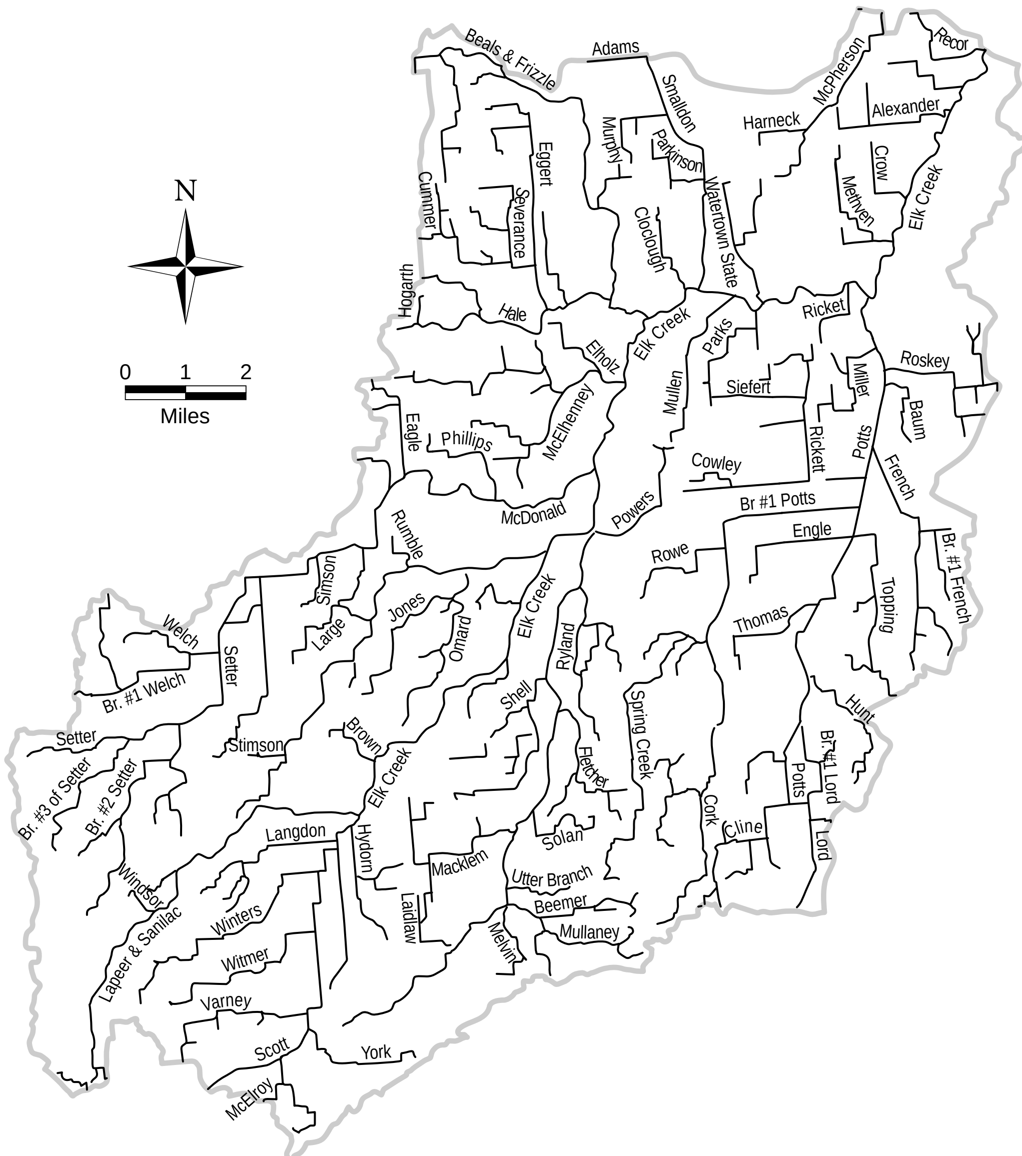


Figure 36.– Map of 347.2 miles of designated drains within the Elk Creek subwatershed. Dotted line shows the subwatershed boundary.

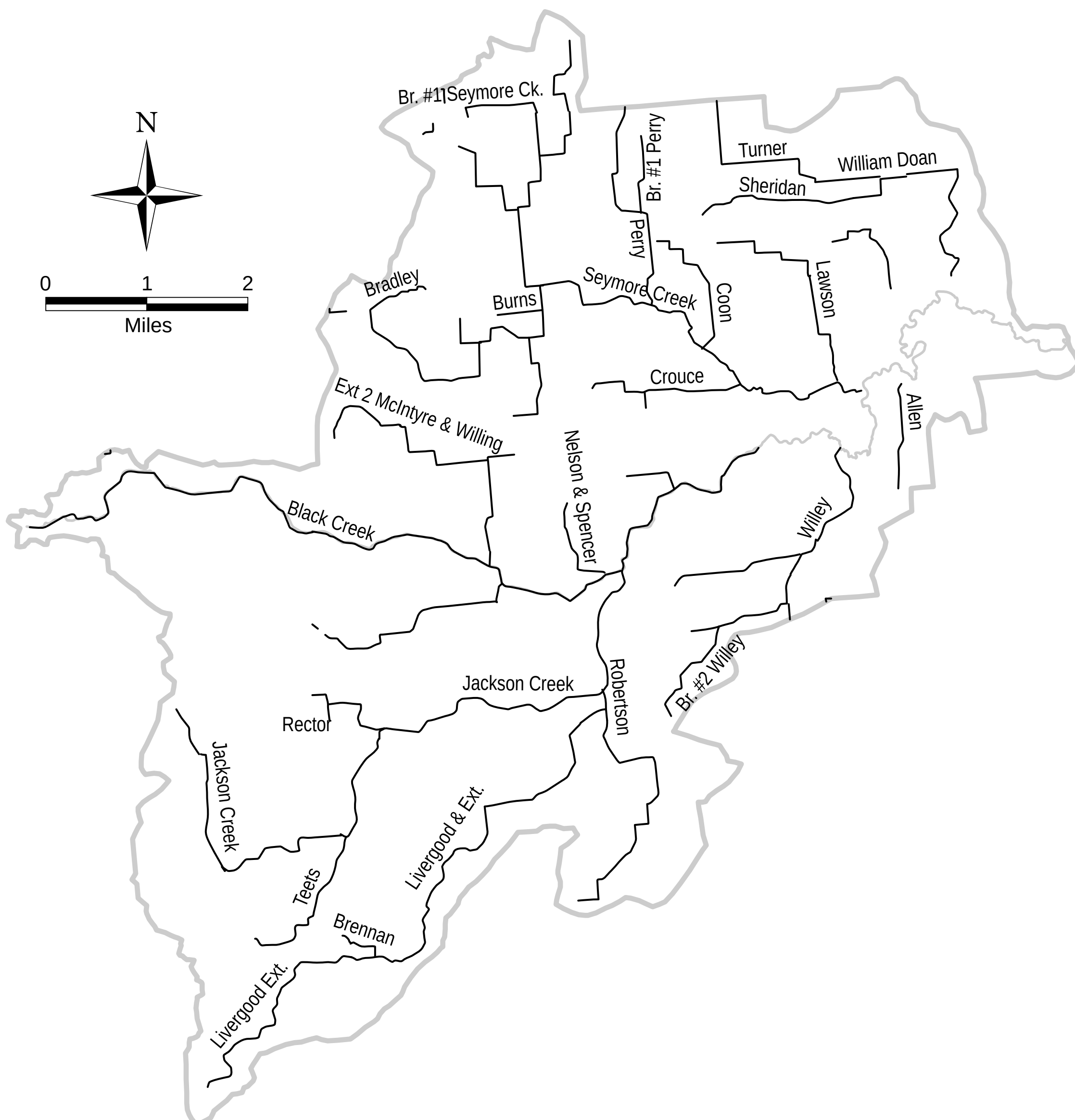


Figure 37.– Map of 75.3 miles of designated drains within the Black Creek subwatershed. Dotted line shows the subwatershed boundary and lighter gray line shows portion of Black Creek not having drain designation.

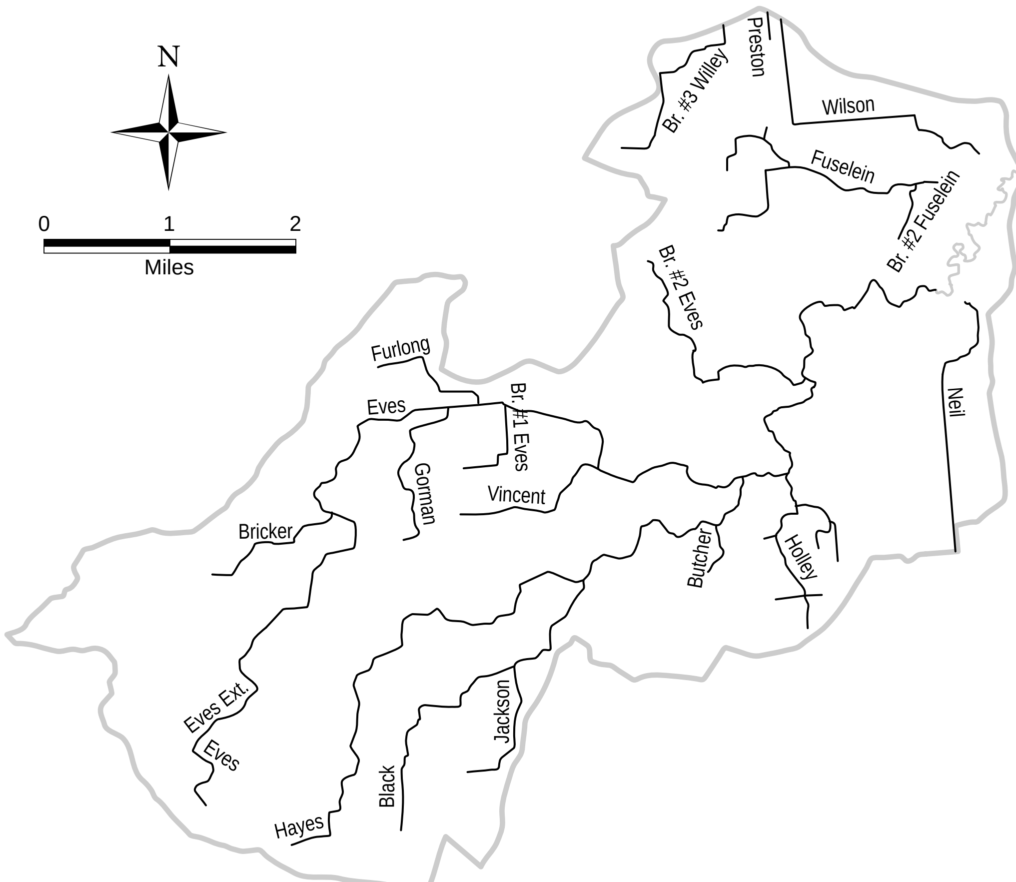


Figure 38.– Map of 43.9 miles of designated drains within the Silver Creek subwatershed. Dotted line shows the subwatershed boundary and lighter gray line shows portion of Silver Creek not having drain designation.

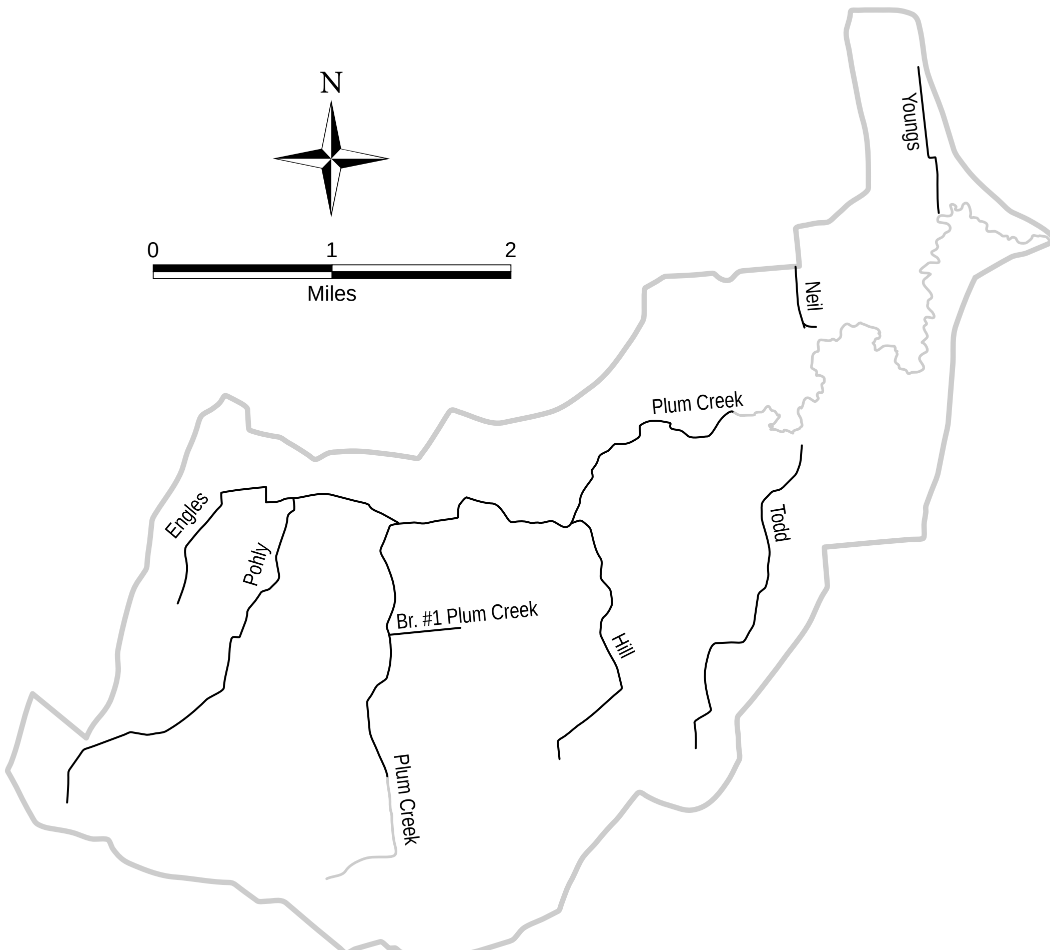


Figure 39.– Map of 13.0 miles of designated drains within the Plum Creek subwatershed. Dotted line shows the subwatershed boundary and lighter gray line shows portion of Plum Creek not having drain designation.

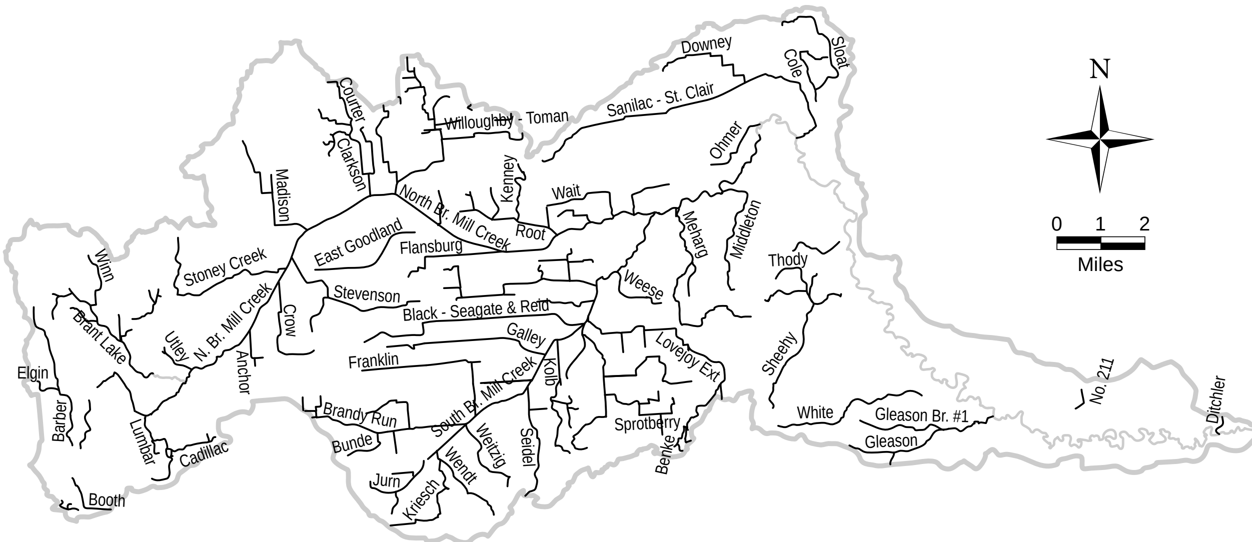


Figure 40.– Map of 166.2 miles of designated drains within the Mill Creek subwatershed. Dotted line shows the subwatershed boundary and lighter gray line shows portion of Mill Creek not having drain designation.

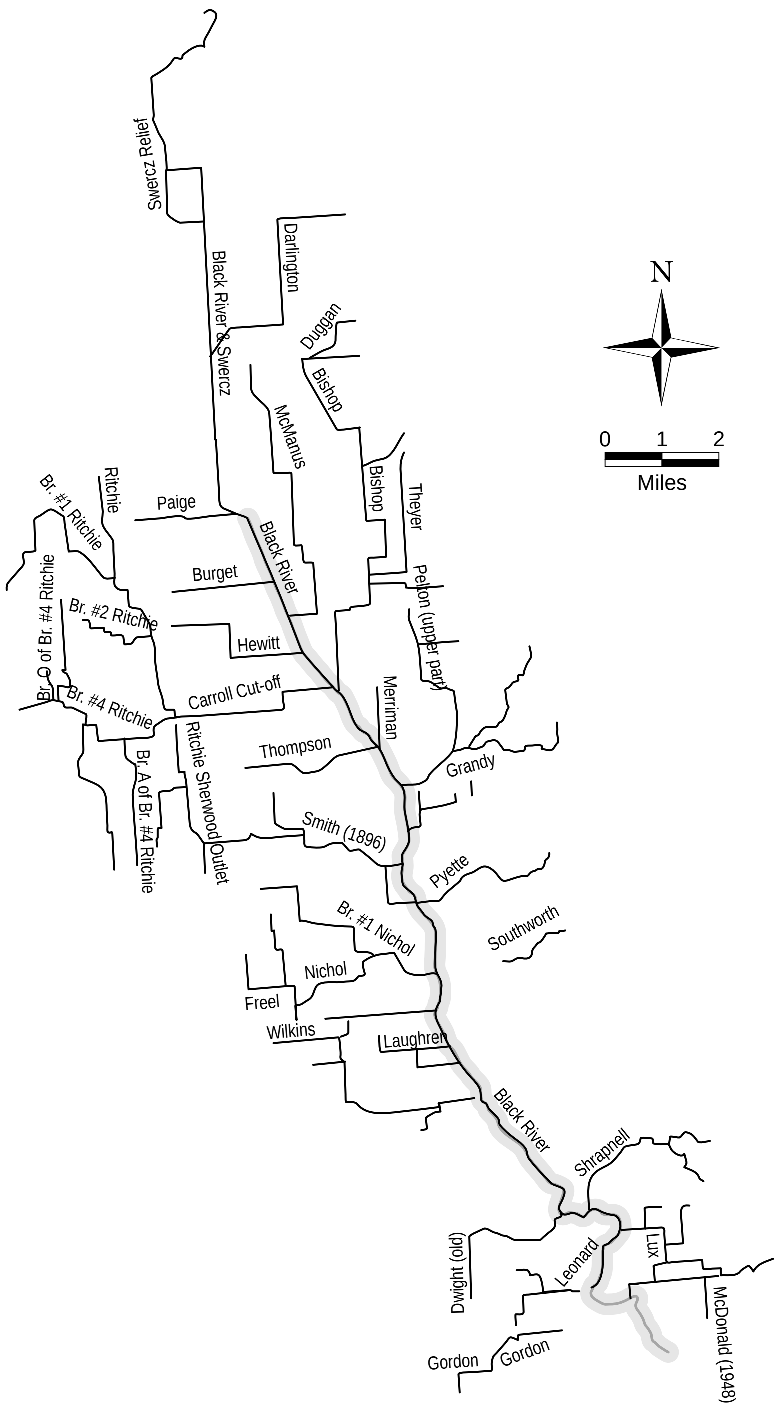


Figure 41.– Map of 124.8 miles of designated drains within Segment 1 of Black River watershed. Gray buffer shows actual stretch of river assigned to Segment 1.

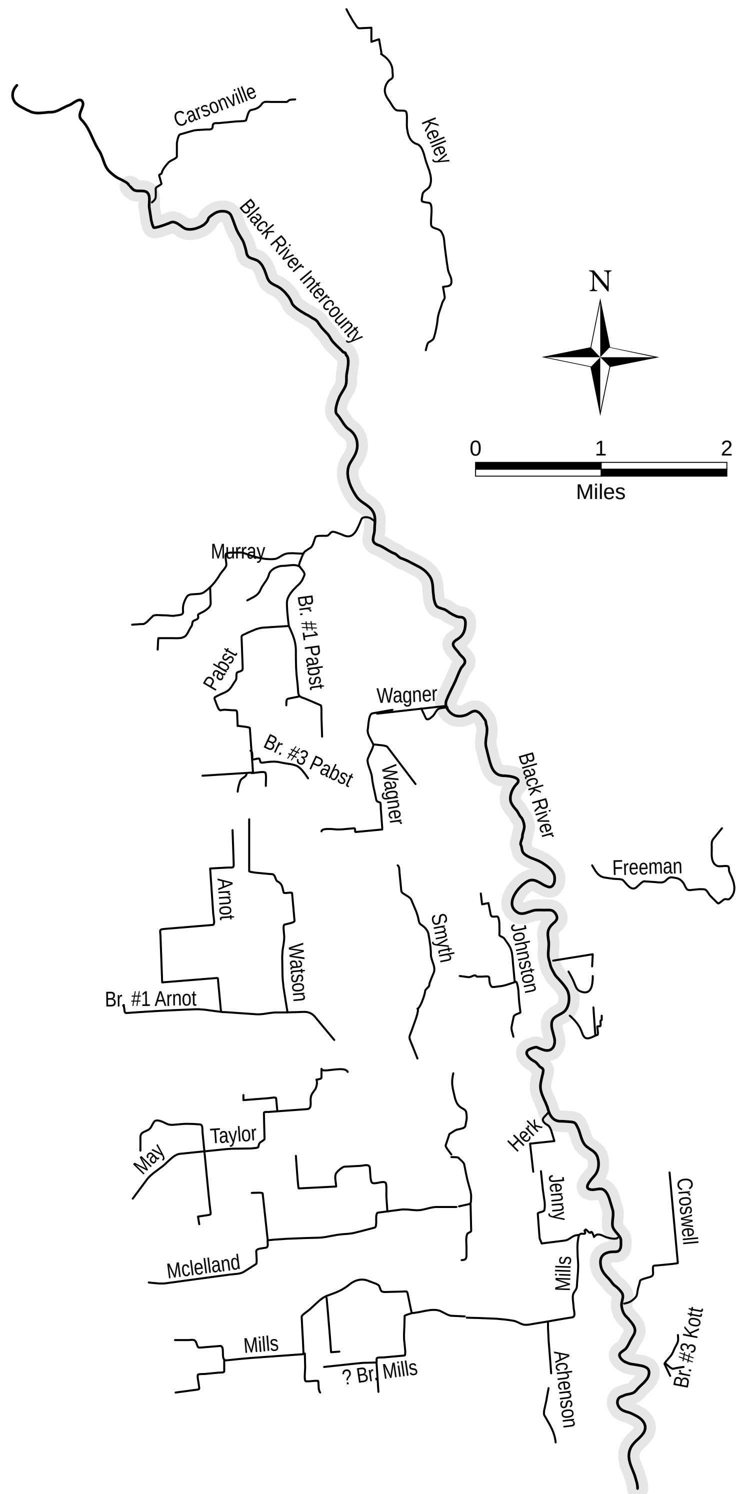


Figure 42.– Map of 72.5 miles of designated drains within Segment 2 of Black River watershed which includes the upper portion of the main stem. Gray buffer shows actual stretch of Black River main stem assigned to Segment 2.

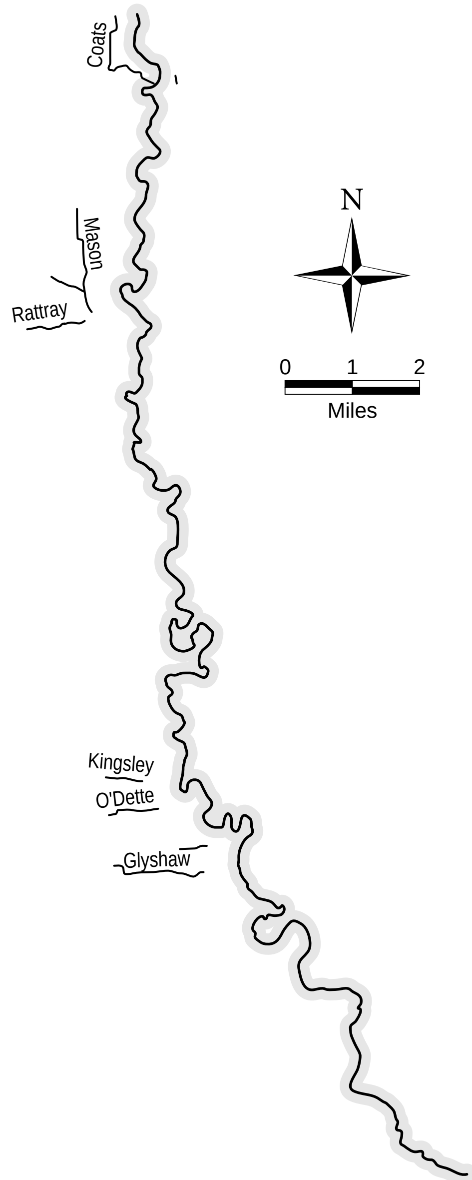


Figure 43.– Map of 8.0 miles of designated drains within Segment 3 of Black River watershed. Gray buffer shows actual stretch of Black River main stem assigned to Segment 3. None of the Black River main stem is designated a drain in this segment.

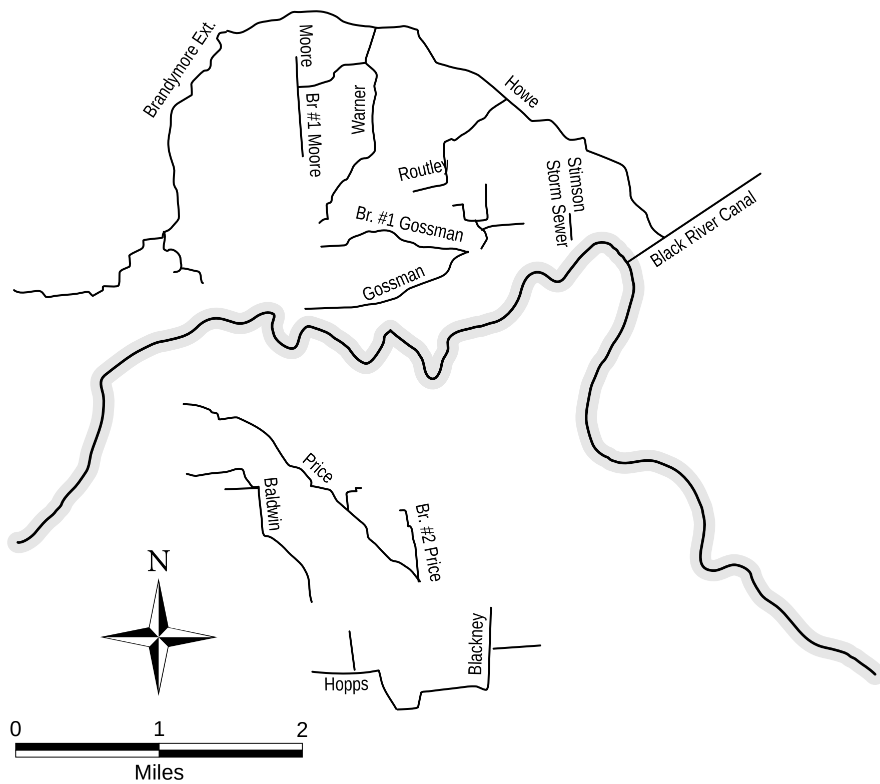


Figure 44.– Map of 23.9 miles of designated drains within Segment 4 of Black River watershed. Gray buffer shows actual stretch of Black River main stem assigned to Segment 4. None of the Black River main stem is designated a drain in this segment.

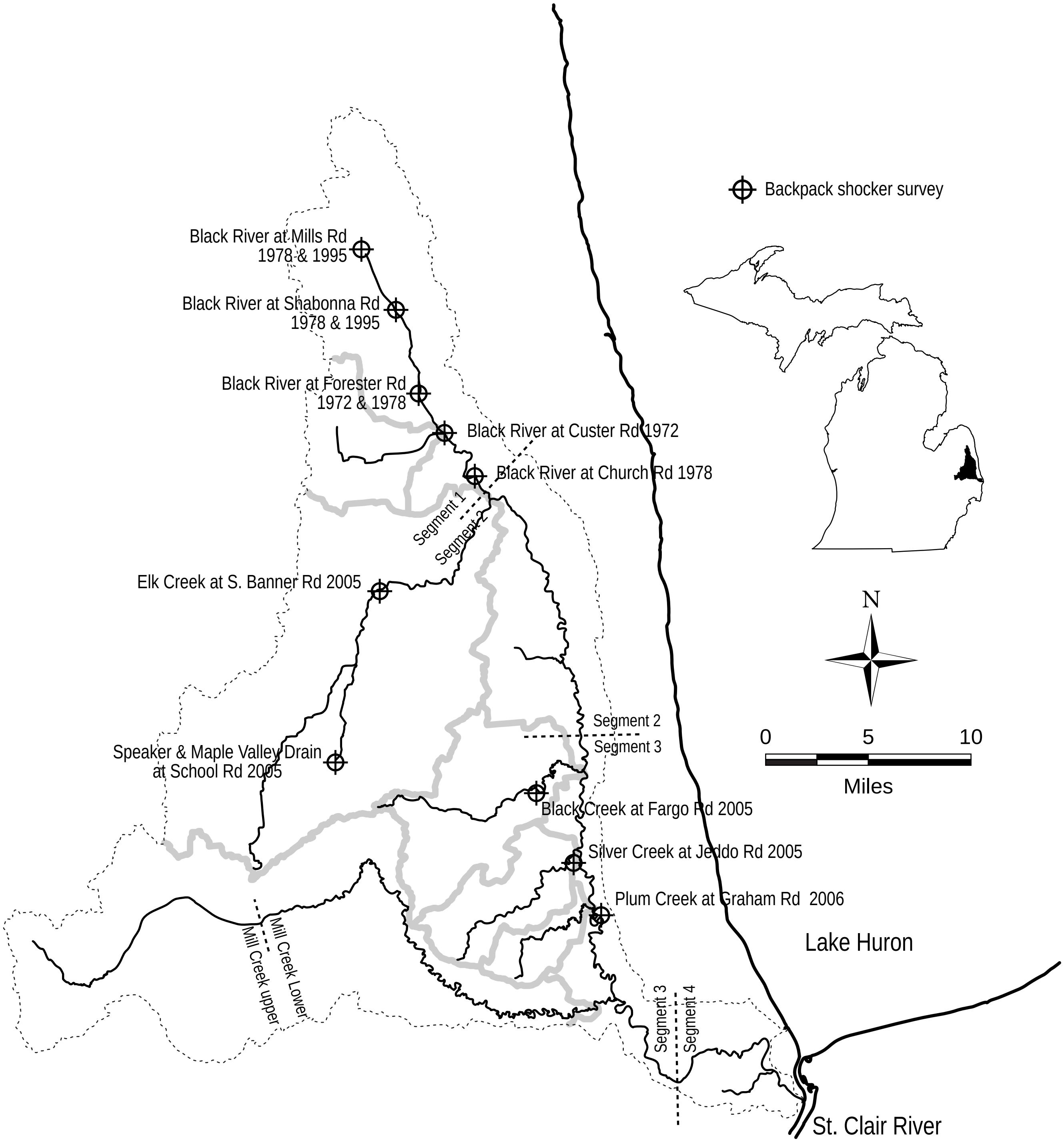


Figure 45.–Geographic locations (usually near road crossing) and year surveyed for Michigan Department of Natural Resources fish sampled with a backpack shocker in the Black River watershed. Dotted lines divide major analysis segments of the Black River main stem and Mill Creek.

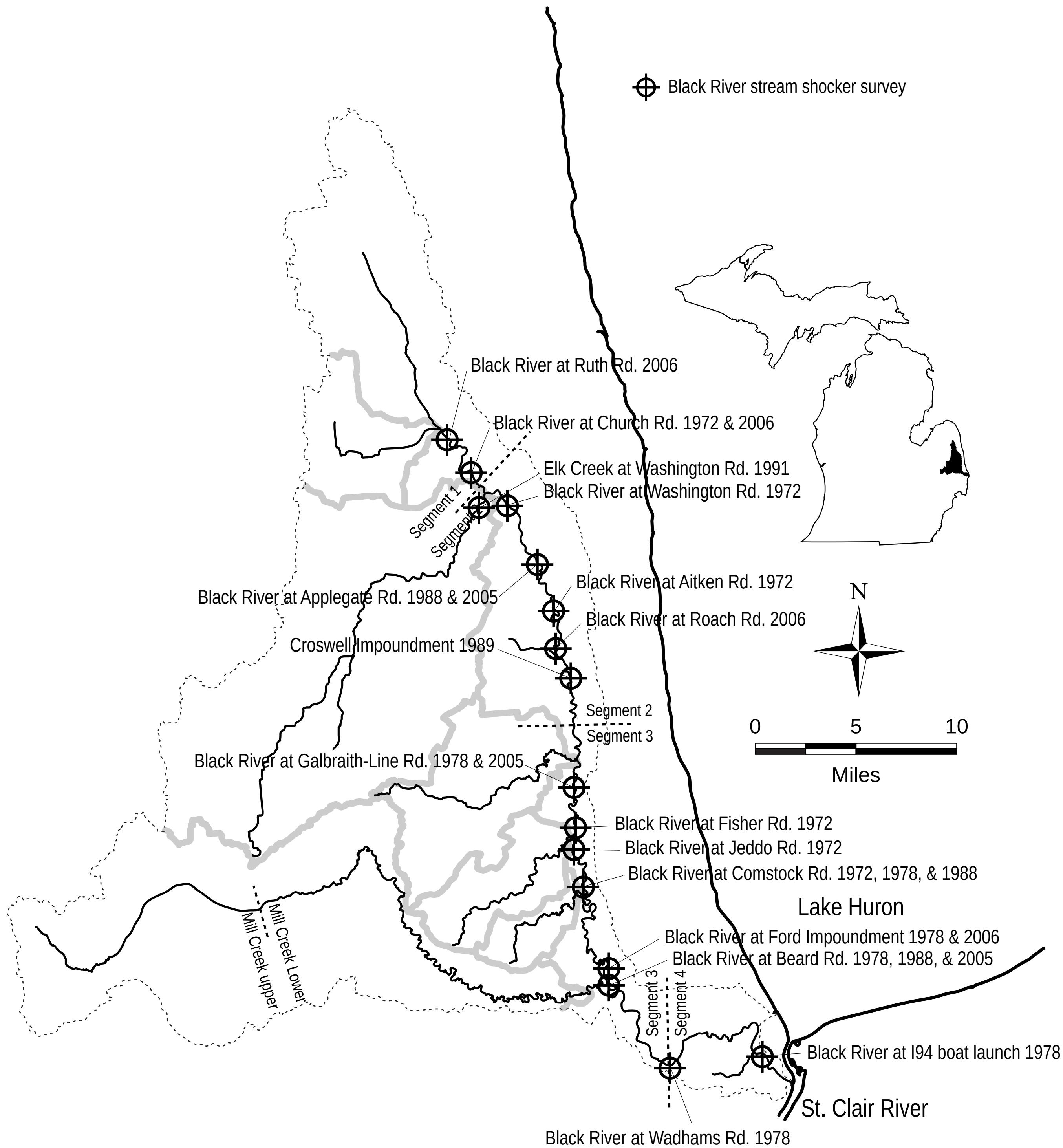


Figure 46.–Geographic locations (usually near road crossing) and year surveyed for Michigan Department of Natural Resources fish sampled with a stream shocker in the main stem of the Black River. Dotted lines divide major analysis segments of the Black River main stem.

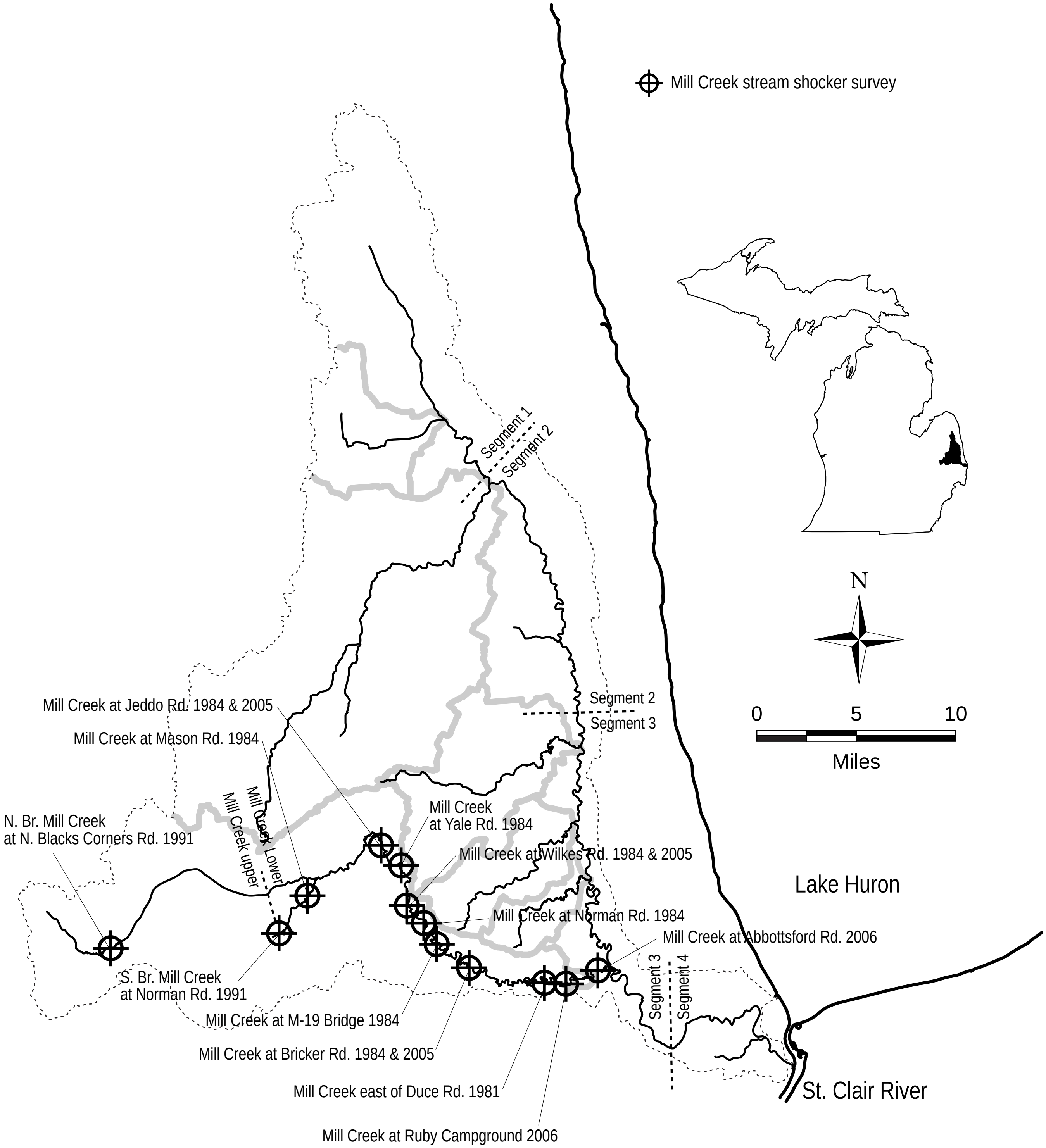


Figure 47.–Geographic locations (usually near road crossing) and year surveyed for Michigan Department of Natural Resources fish sampled with a stream shocker in Mill Creek which is a major tributary of the Black River. Dotted lines divide major analysis segments of the Black River main stem and Mill Creek.

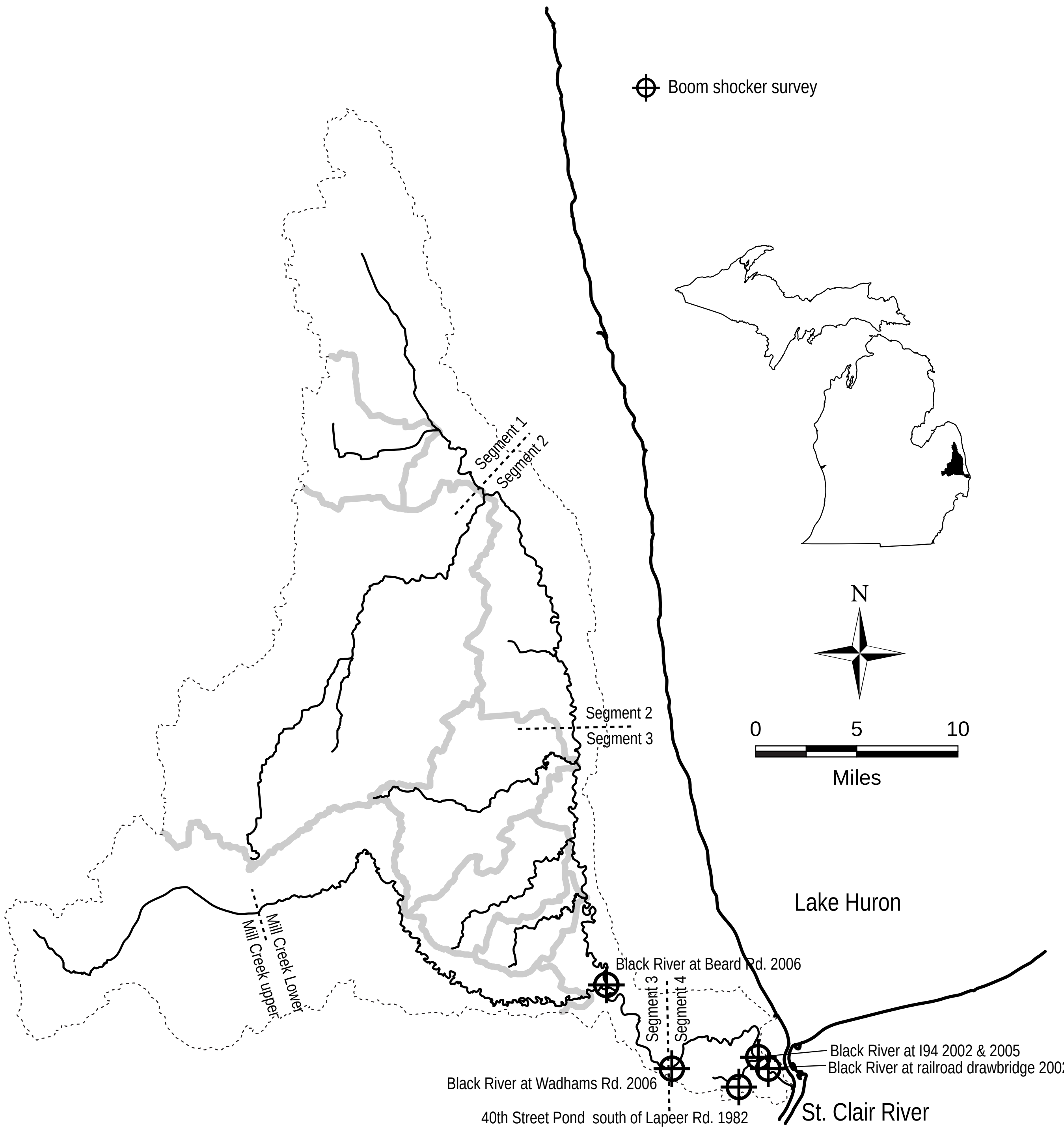


Figure 48.–Geographic locations (usually near road crossing) and year surveyed for Michigan Department of Natural Resources fish sampled with a boom shocker in the main stem of the Black River. Dotted lines divide major analysis segments of the Black River main stem.

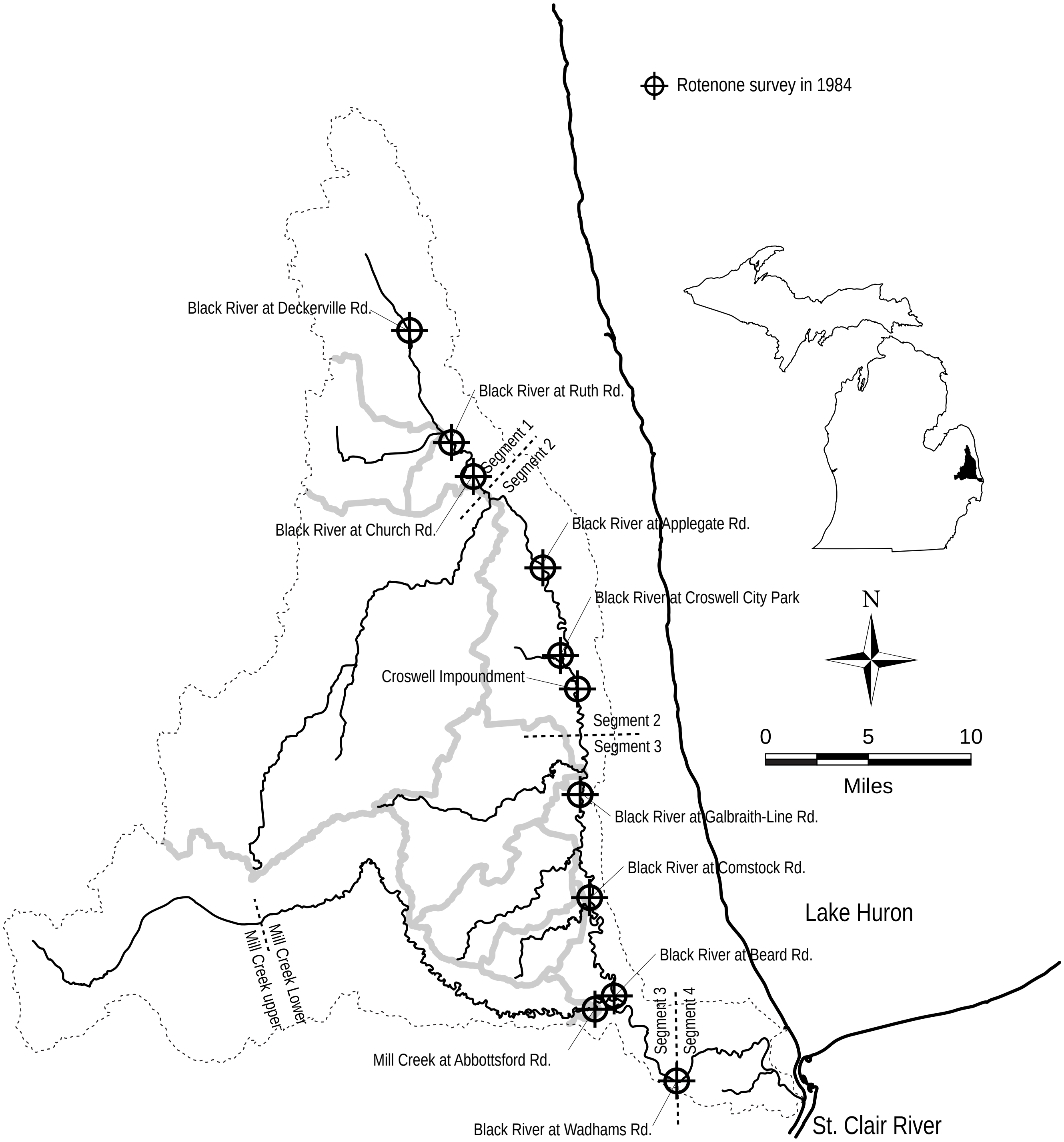


Figure 49.–Geographic locations (usually near road crossing) and year surveyed for Michigan Department of Natural Resources fish sampled with rotenone in the main stem of the Black River and lower Mill Creek. Dotted lines divide major analysis segments of the Black River main stem and Mill Creek.

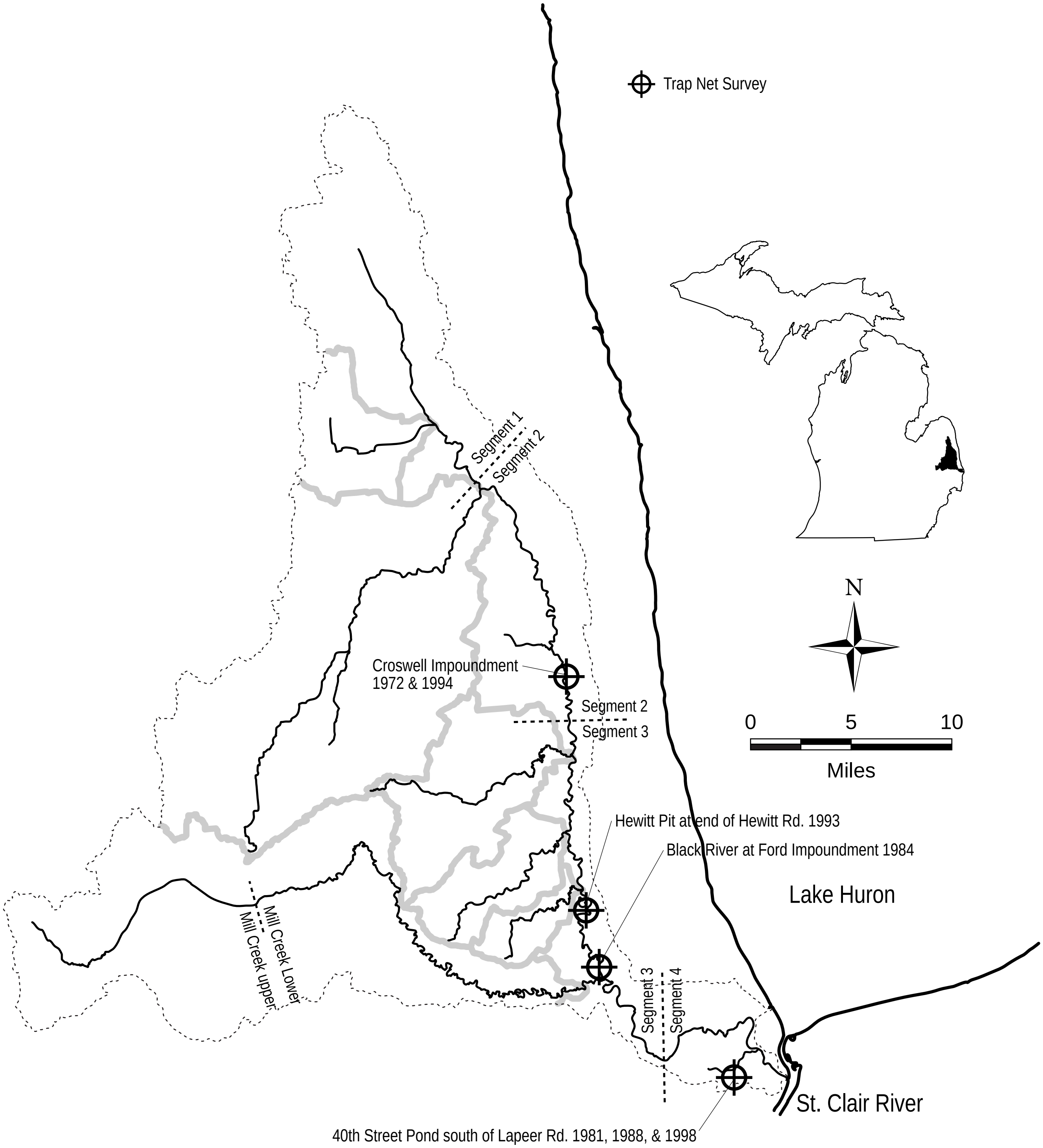


Figure 50.–Geographic locations (usually near road crossing) and year surveyed for Michigan Department of Natural Resources fish sampled with trap nets in backwater areas above dams on the main stem of the Black River and in two human-made ponds located close to the river. Dotted lines divide major analysis segments of the Black River main stem and Mill Creek.

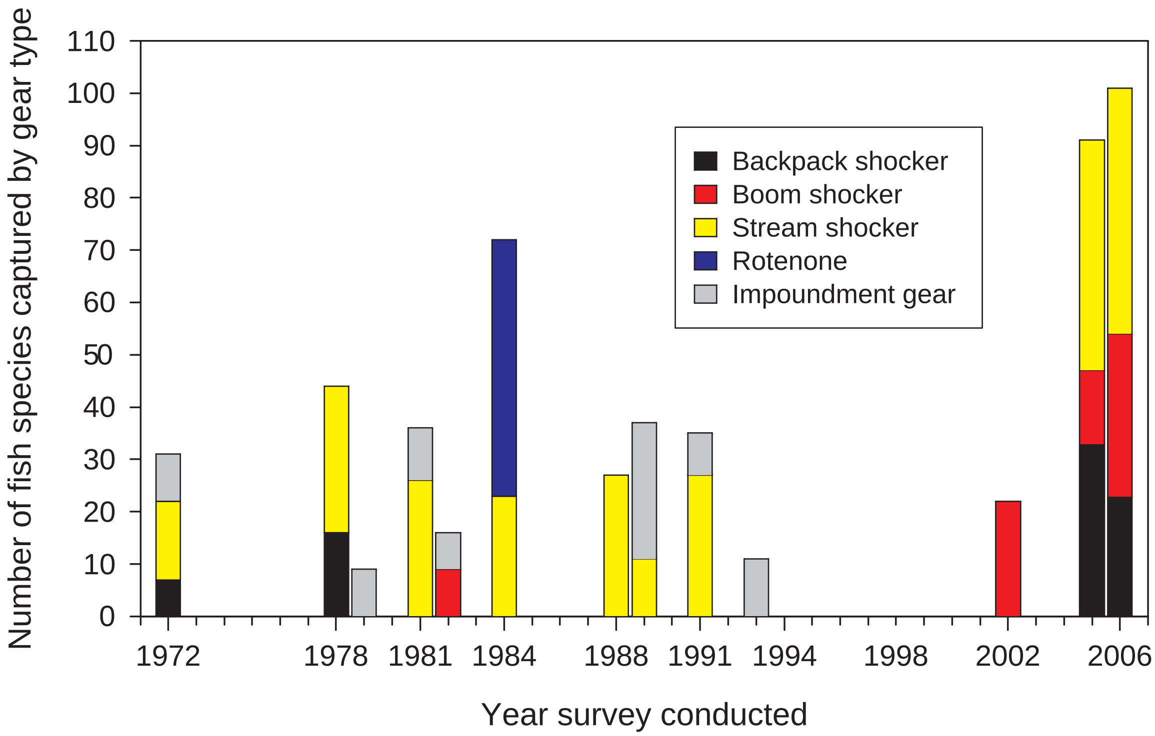


Figure 51.–Number of fish species captured in Michigan Department of Natural Resources surveys by year for each of five sampling techniques. Surveys were conducted in 14 of 35 years between 1972 and 2006.

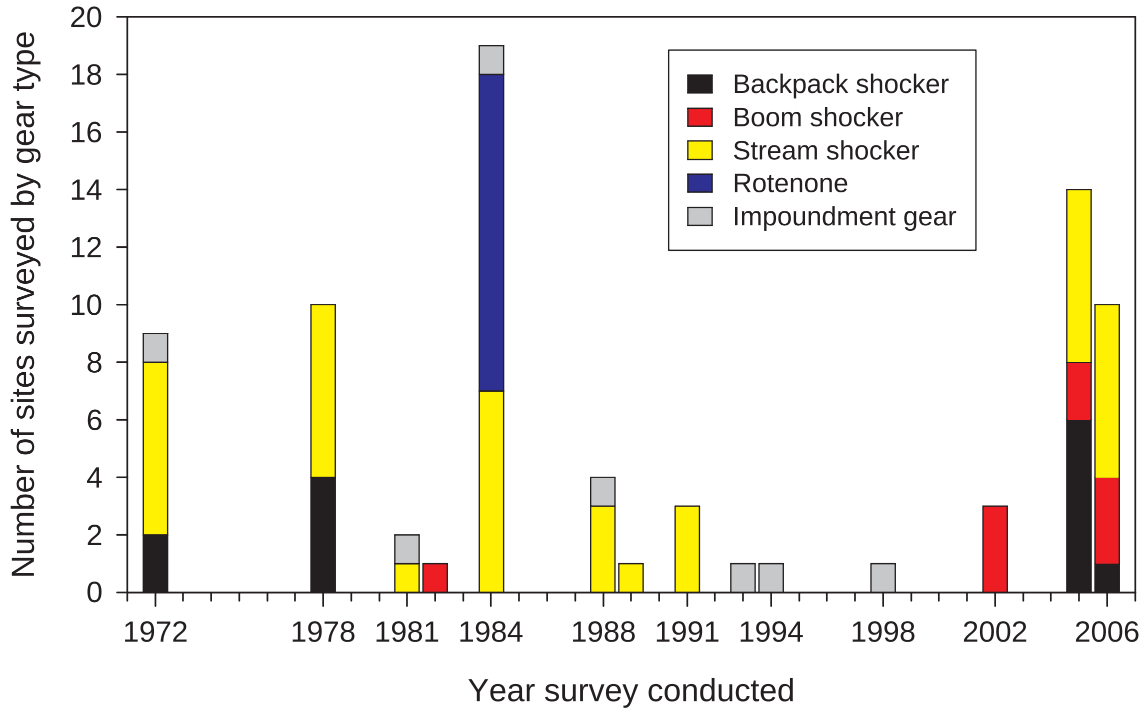


Figure 52.–Number of sites that fish populations were surveyed in the Black River watershed by Michigan Department of Natural Resources by year and each of five sampling techniques. A site was considered to be the contiguous area sampled at a single geographic location, usually at or near a road crossing. Surveys were conducted in 14 of 35 years between 1972 and 2006.

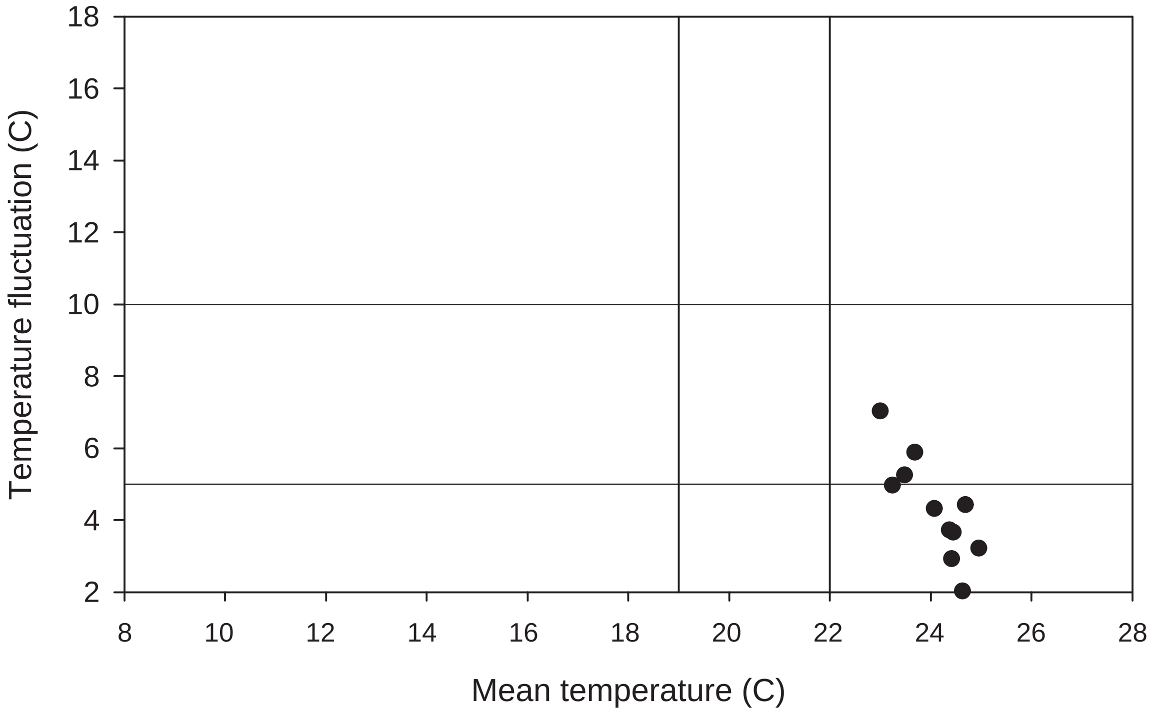


Figure 53.–July water temperature at 11 sites in the Black River plotted on axes designed to separate meaningful fish habitat thermal regimes (Wehrly et al. 2003). Thermal category boundaries for each axis are defined as: cold (<19 0C), cool (19 to <22 0C), and warm (≥22 0C) mean temperatures; and stable (<5 0C), moderate (5 to <10 0C), and extreme (≥10 0C) temperature fluctuations.

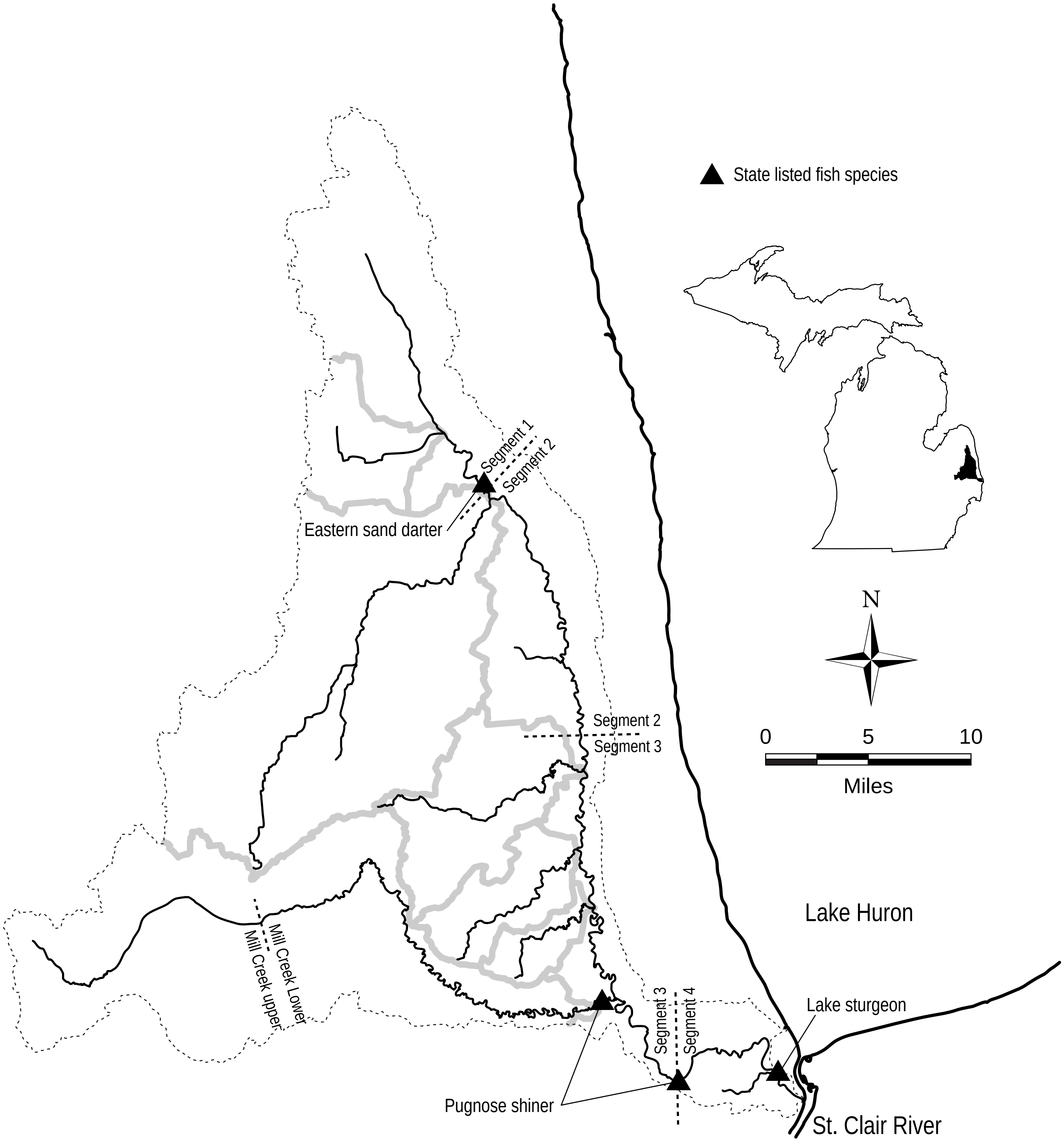


Figure 54.–Geographic locations within the Black River watershed for fish records in the Michigan Fish Atlas database that have status on the state list of species of special concern. Eastern sand darter (Ammocrypta pellucida) and lake sturgeon (Acipenser fulvescens) are state threatened species and pugnose shiner (Notropis anogenus) is a species of special concern.

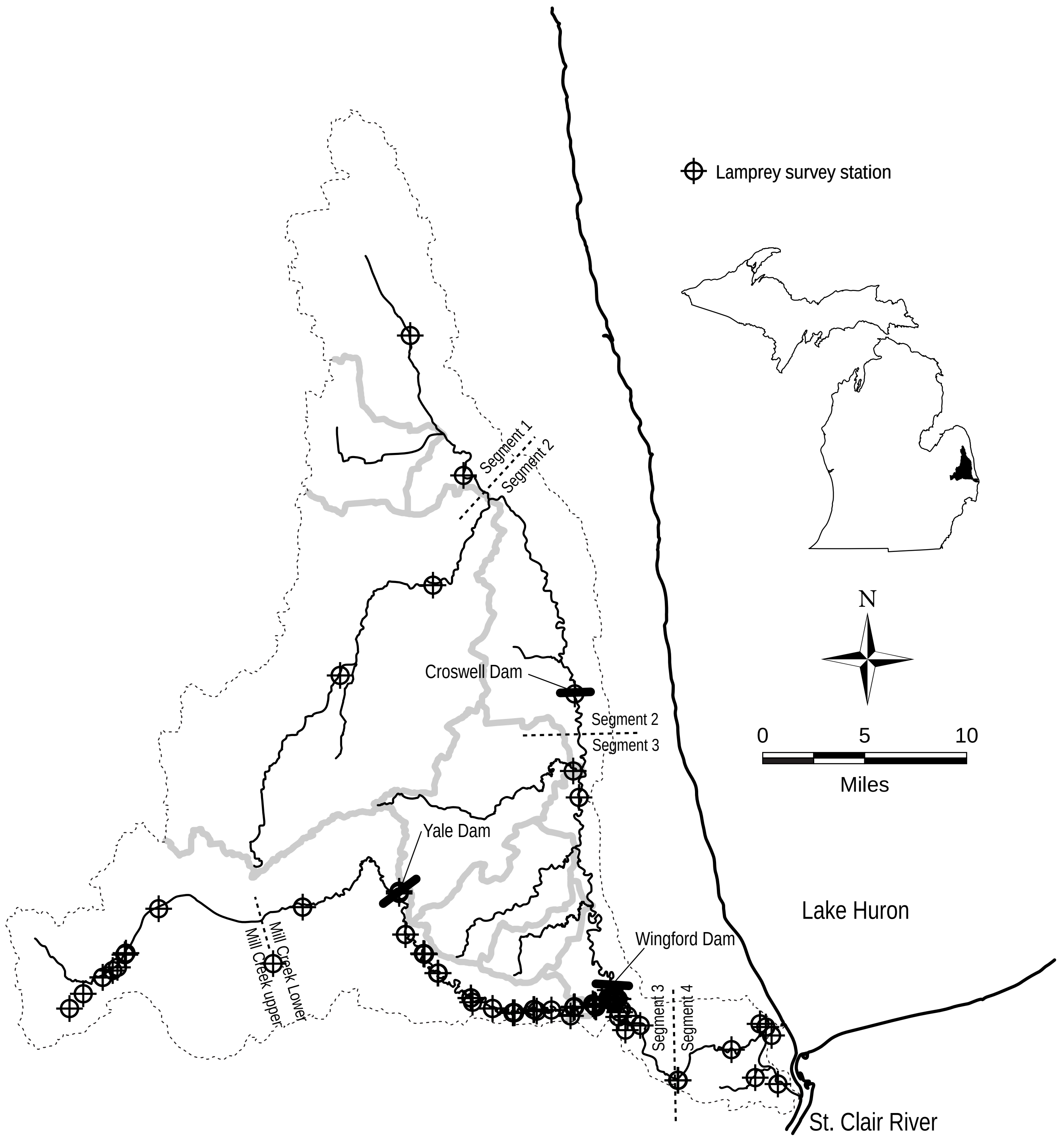


Figure 55.–Geographic locations (usually near road crossing) for all United States Fish and Wildlife Service sea lamprey survey activities in the Black River watershed. Heavy lines show dams that are significant barriers to upstream fish migration. Ford's Dam is now known as Wingford Dam.

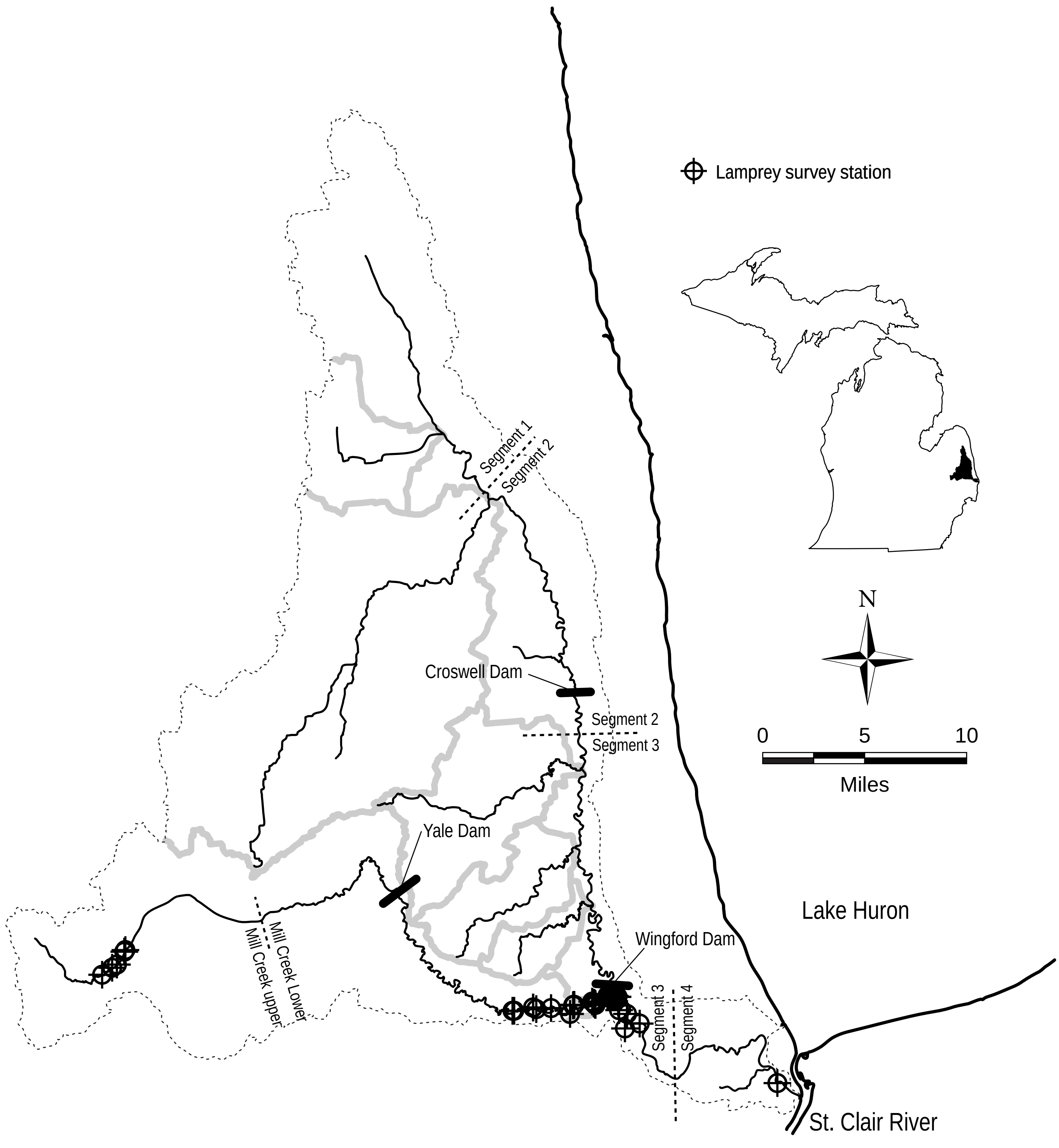


Figure 56.–Lamprey ammocete *Ichthyomyzon* spp. capture locations during United States Fish and Wildlife Service survey activities in the Black River watershed. These ammocetes are not readily identified to species in the field. Heavy lines show dams that are significant barriers to upstream fish migration. Ford's Dam is now known as Wingford Dam.

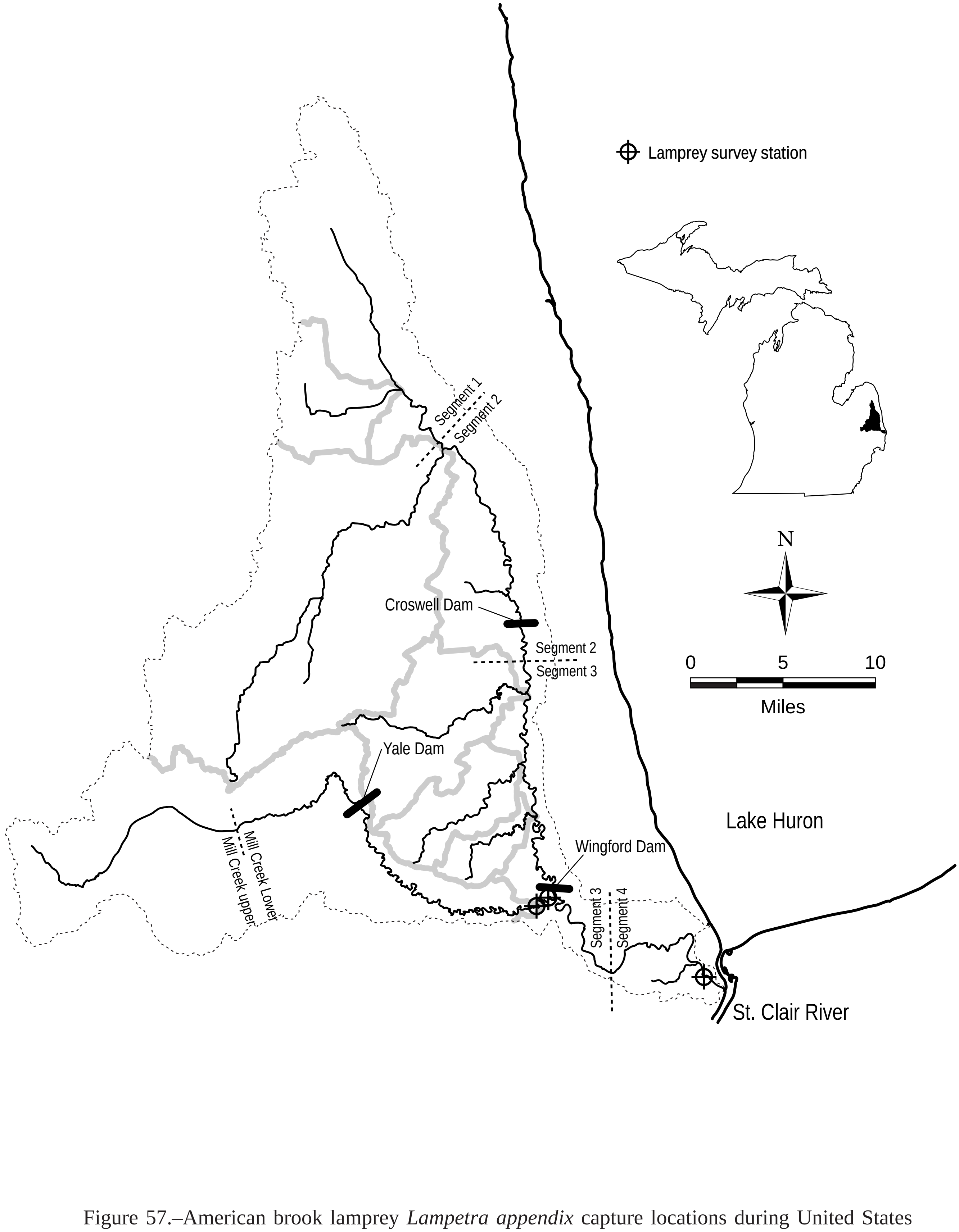


Figure 57.–American brook lamprey *Lampetra appendix* capture locations during United States Fish and Wildlife Service survey activities in the Black River watershed. Heavy lines show dams that are significant barriers to upstream fish migration. Ford's Dam is now known as Wingford Dam.

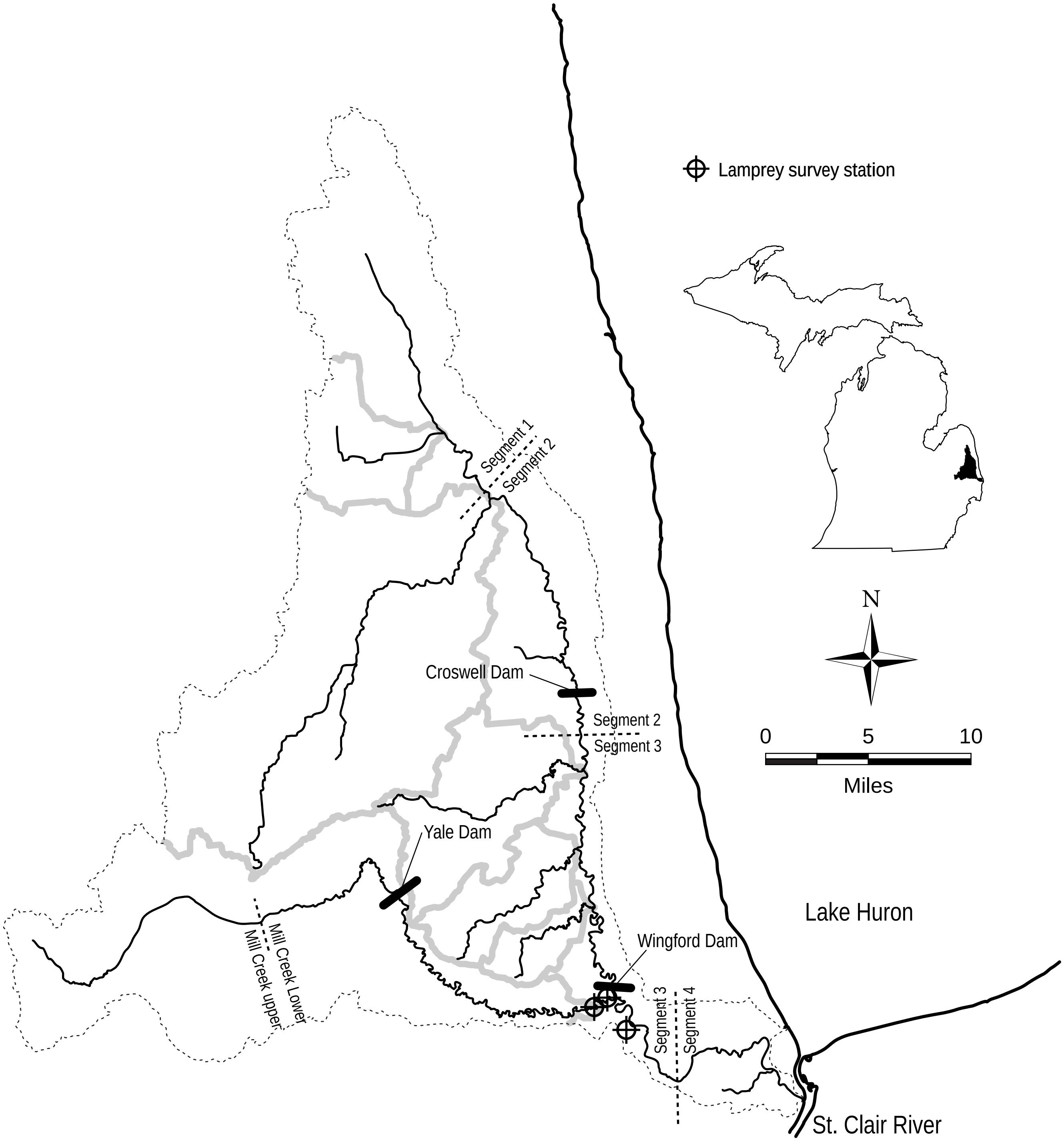


Figure 58.–Northern brook lamprey *Ichthyomyzon castaneus* capture locations during United States Fish and Wildlife Service survey activities in the Black River watershed. Heavy lines show dams that are significant barriers to upstream fish migration. Ford's Dam is now known as Wingford Dam.

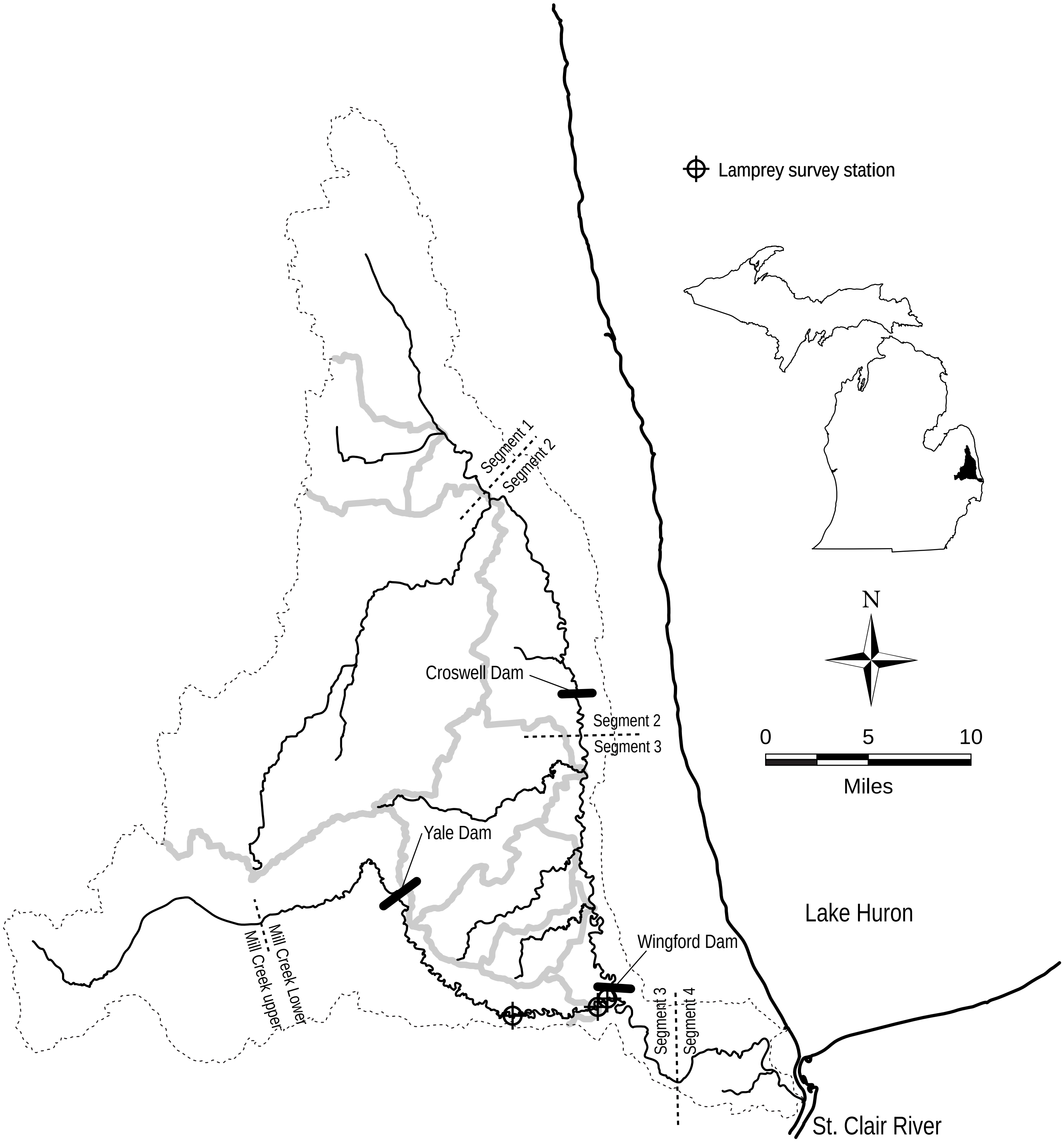


Figure 59.–Silver lamprey *Ichthyomyzon unicuspis* capture locations during United States Fish and Wildlife Service survey activities in the Black River watershed. Heavy lines show dams that are significant barriers to upstream fish migration. Ford's Dam is now known as Wingford Dam.

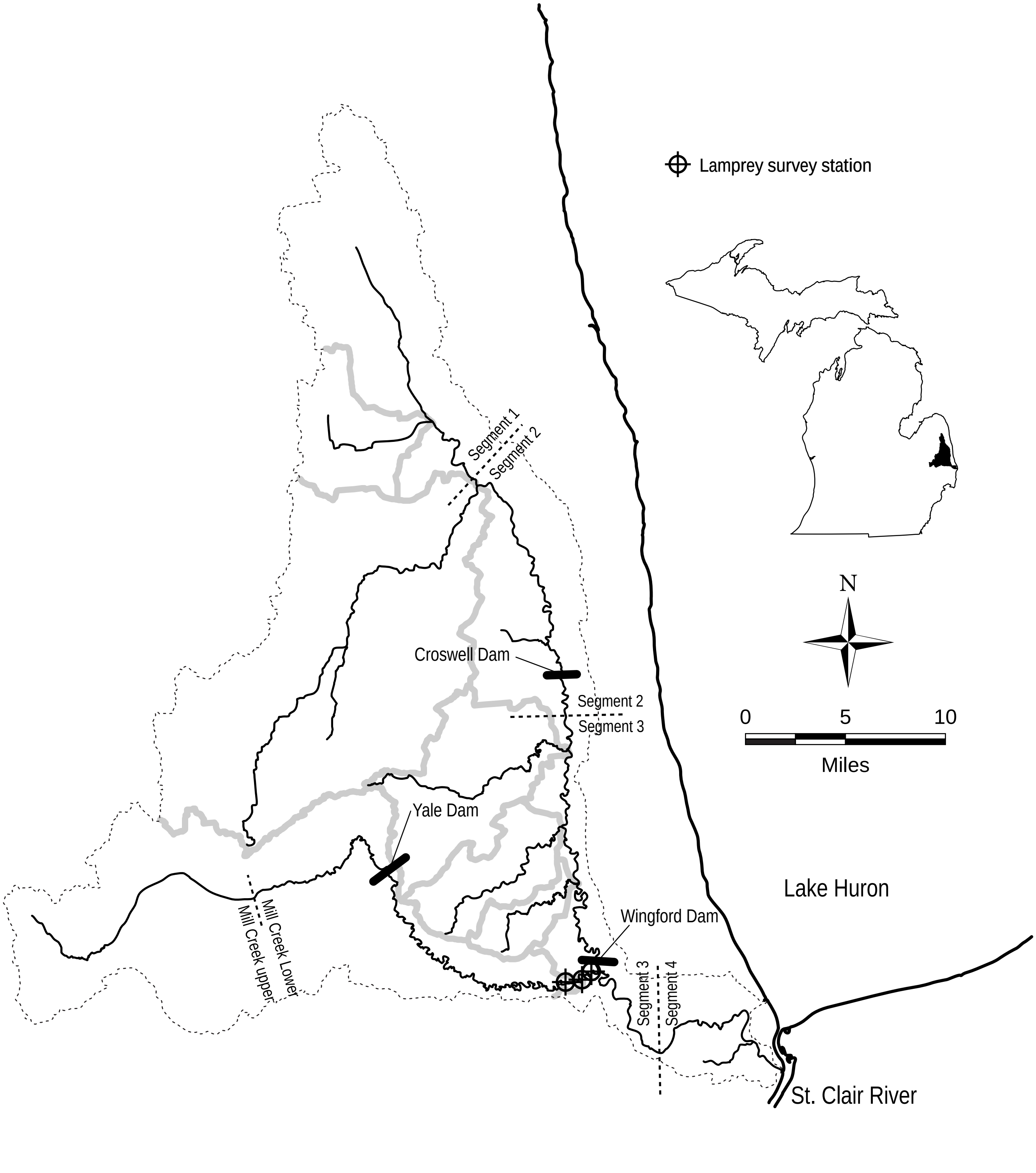


Figure 60.–Sea lamprey *Petromyzon marinus* capture locations during United States Fish and Wildlife Service survey activities in the Black River watershed. Heavy lines show dams that are significant barriers to upstream fish migration. Ford's Dam is now known as Wingford Dam.

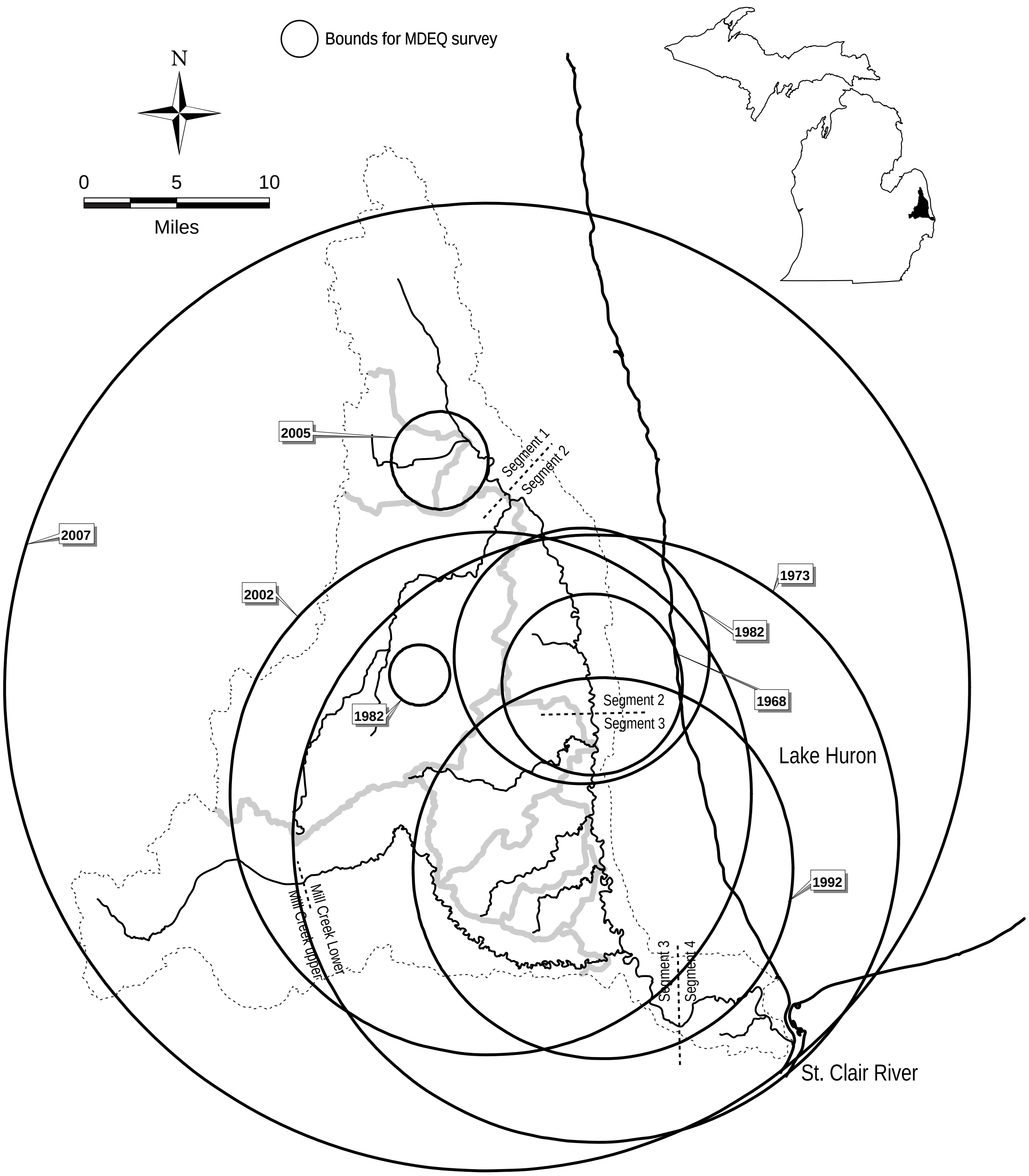


Figure 61.–Map of eight Michigan Water Resources Commission (now Michigan Department of Environmental Quality) biological surveys in the Black River watershed. Circles cover stretches of river that had sample stations each year that a survey was conducted.

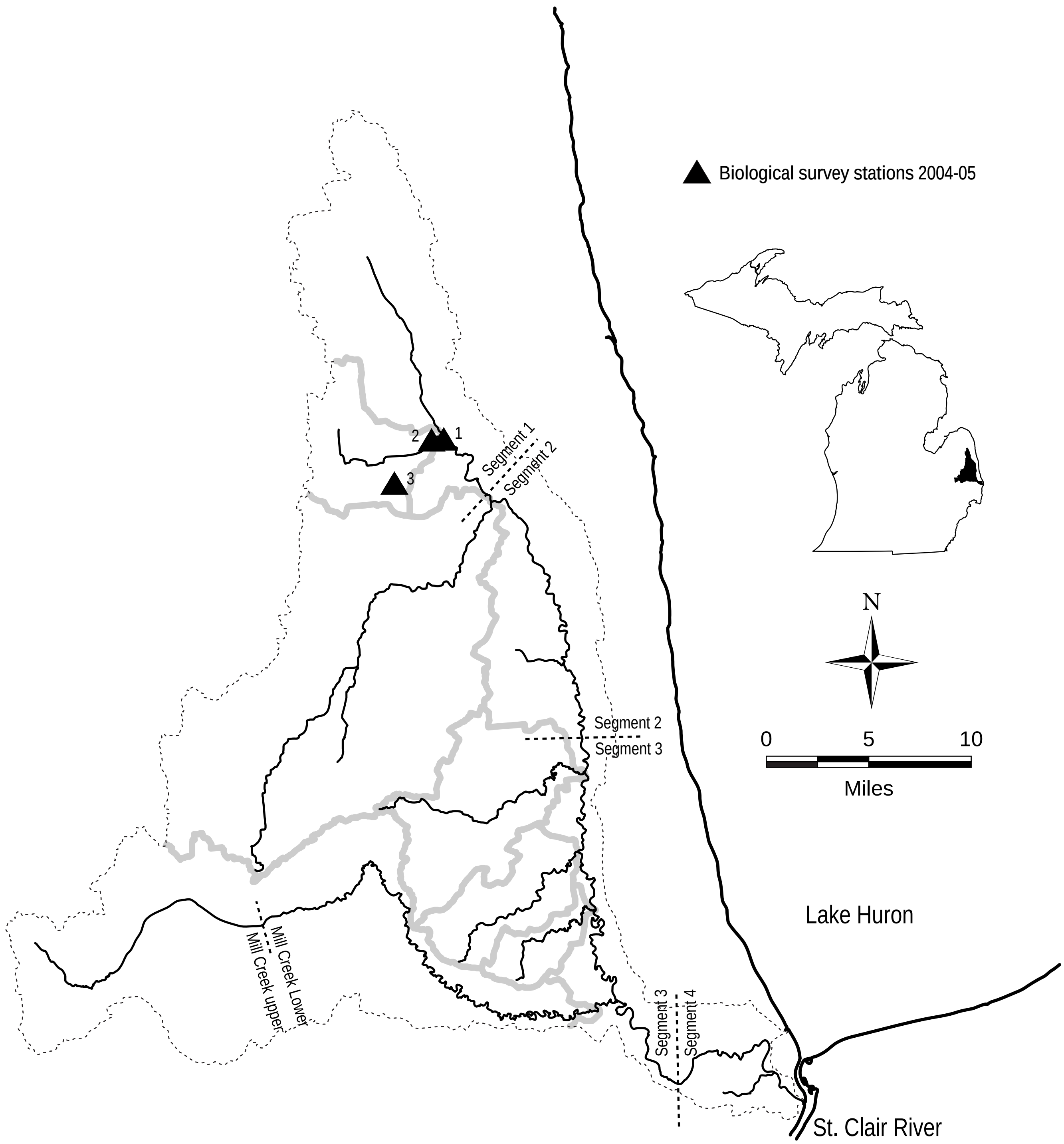


Figure 62.–Geographic locations (usually near road crossing) for Michigan Department of Environmental Quality Water Bureau 2004-05 biological survey stations (3) in Berry Drain, the major tributary to the Black River in Segment 1.

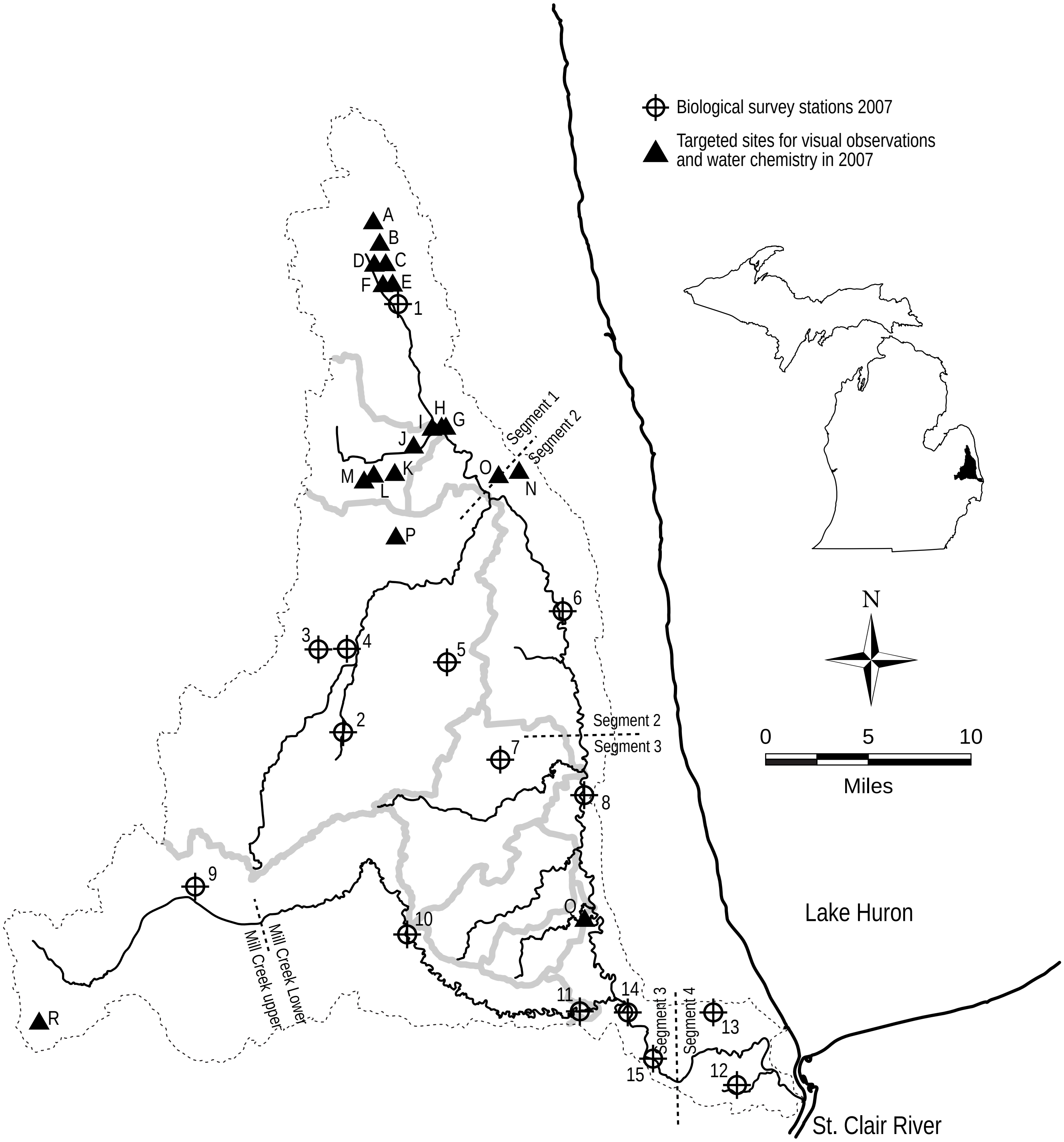


Figure 63.–Geographic locations (usually near road crossing) for Michigan Department of Environmental Quality Water Bureau during 2007 at 15 random biological survey stations (numbered) and 18 fixed targeted stations (lettered) for visual observations and water chemistry in the Black River and major tributaries (Schmitt 2008).

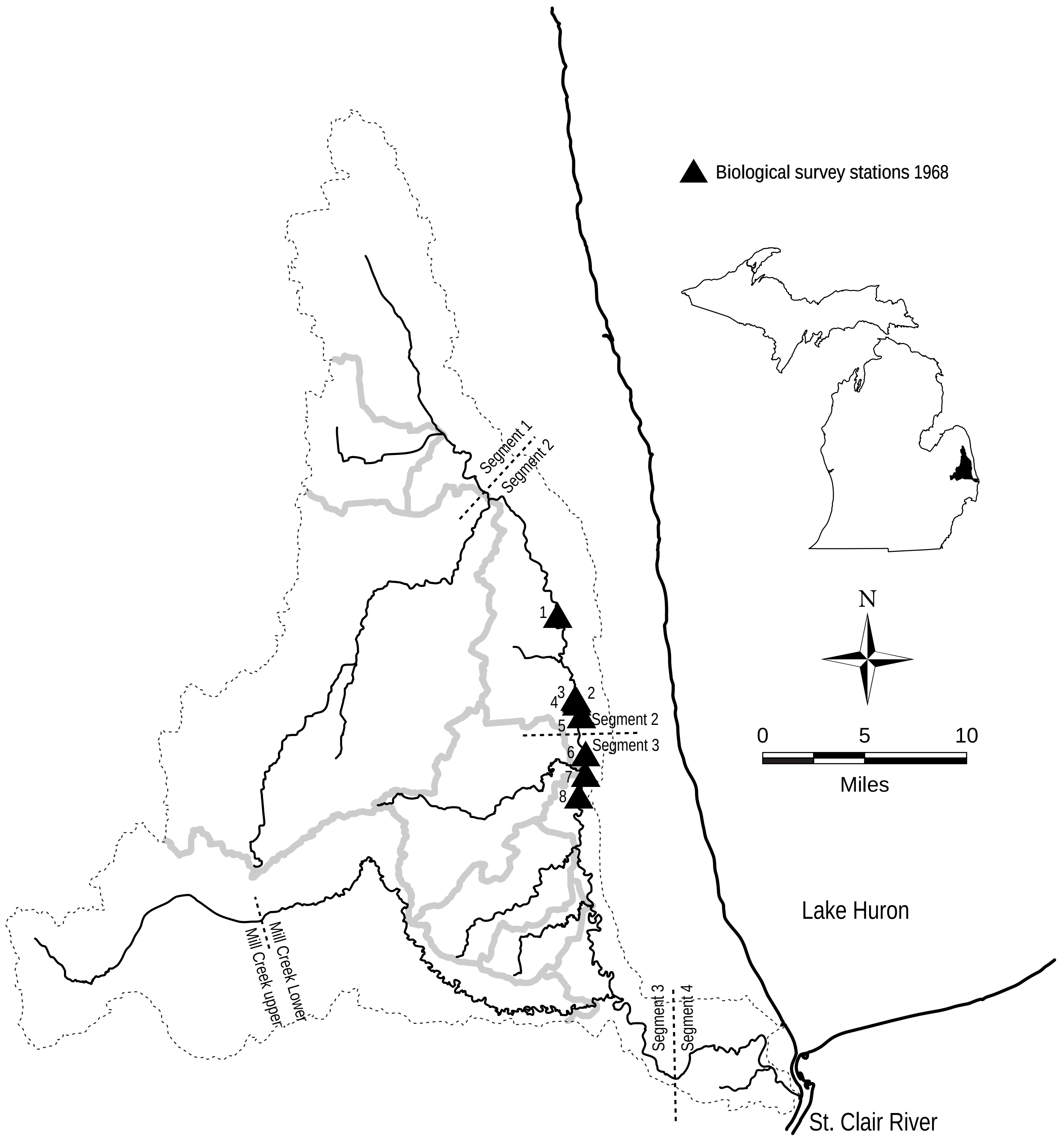


Figure 64.–Geographic locations (usually near road crossing) for Michigan Water Resources Commission (now Michigan Department of Environmental Quality) 1968 biological survey stations (8) in the vicinity of Michigan Sugar Company (segments 2 and 3 of the Black River).

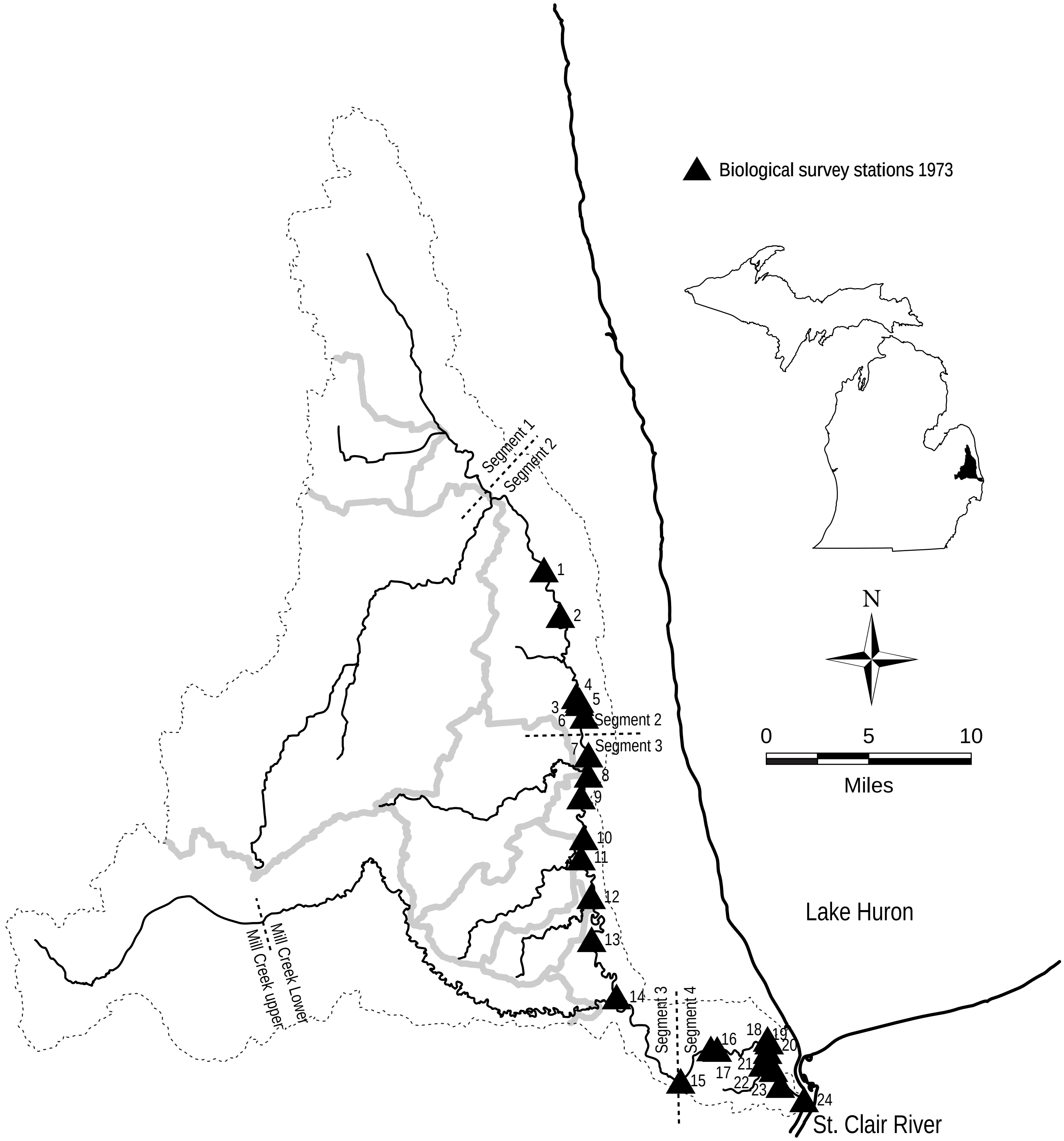


Figure 65.–Geographic locations (usually near road crossing) for Michigan Water Resources Commission (now Michigan Department of Environmental Quality) 1973 biological survey stations (24) in the Black River (segments 2, 3, and 4).

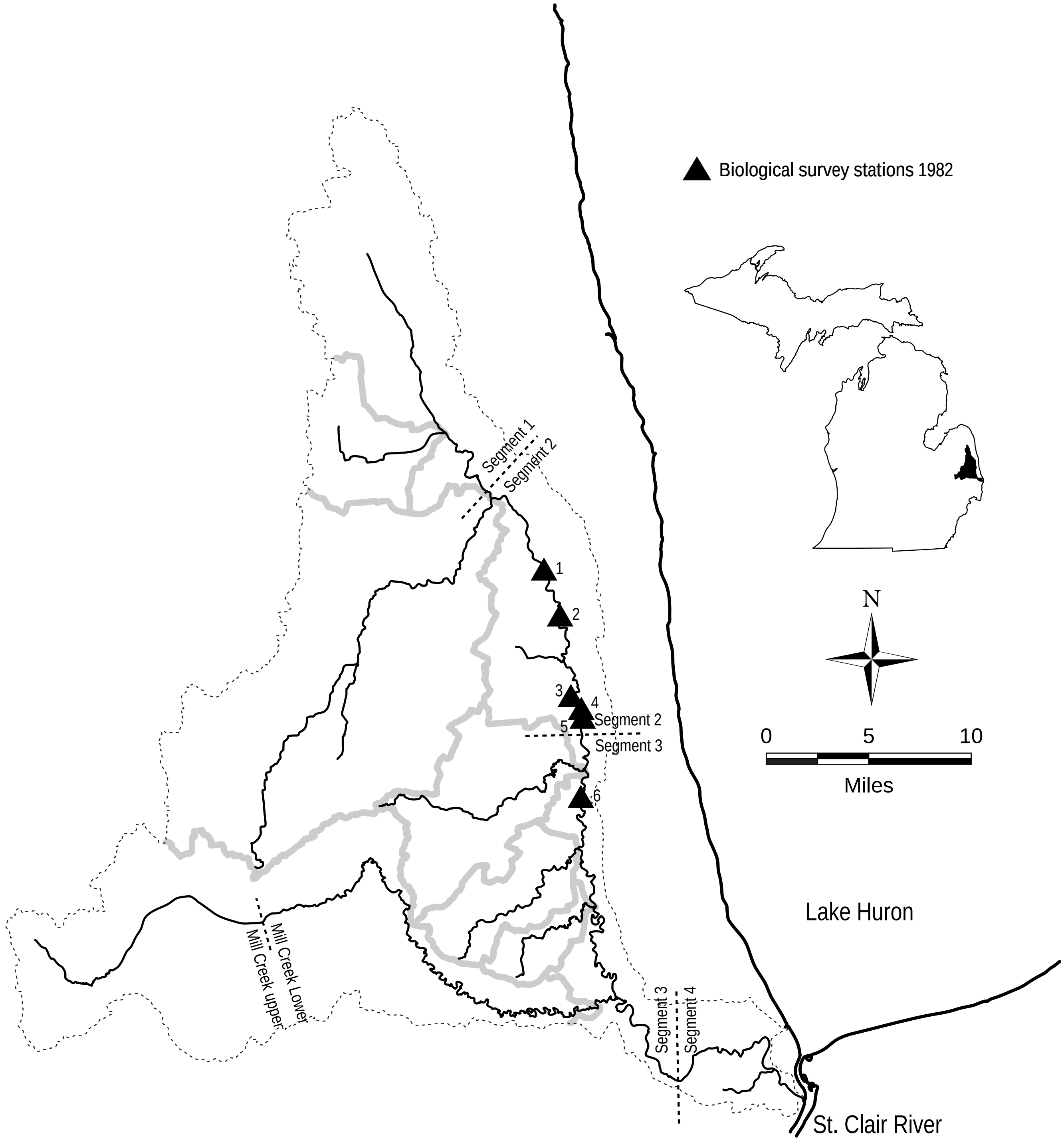


Figure 66.–Geographic locations (usually near road crossing) for Michigan Department of Natural Resources Surface Water Quality Division (now in Michigan Department of Environmental Quality) 1982 biological survey stations (6) in the Black River near Croswell (segments 2 and 3).

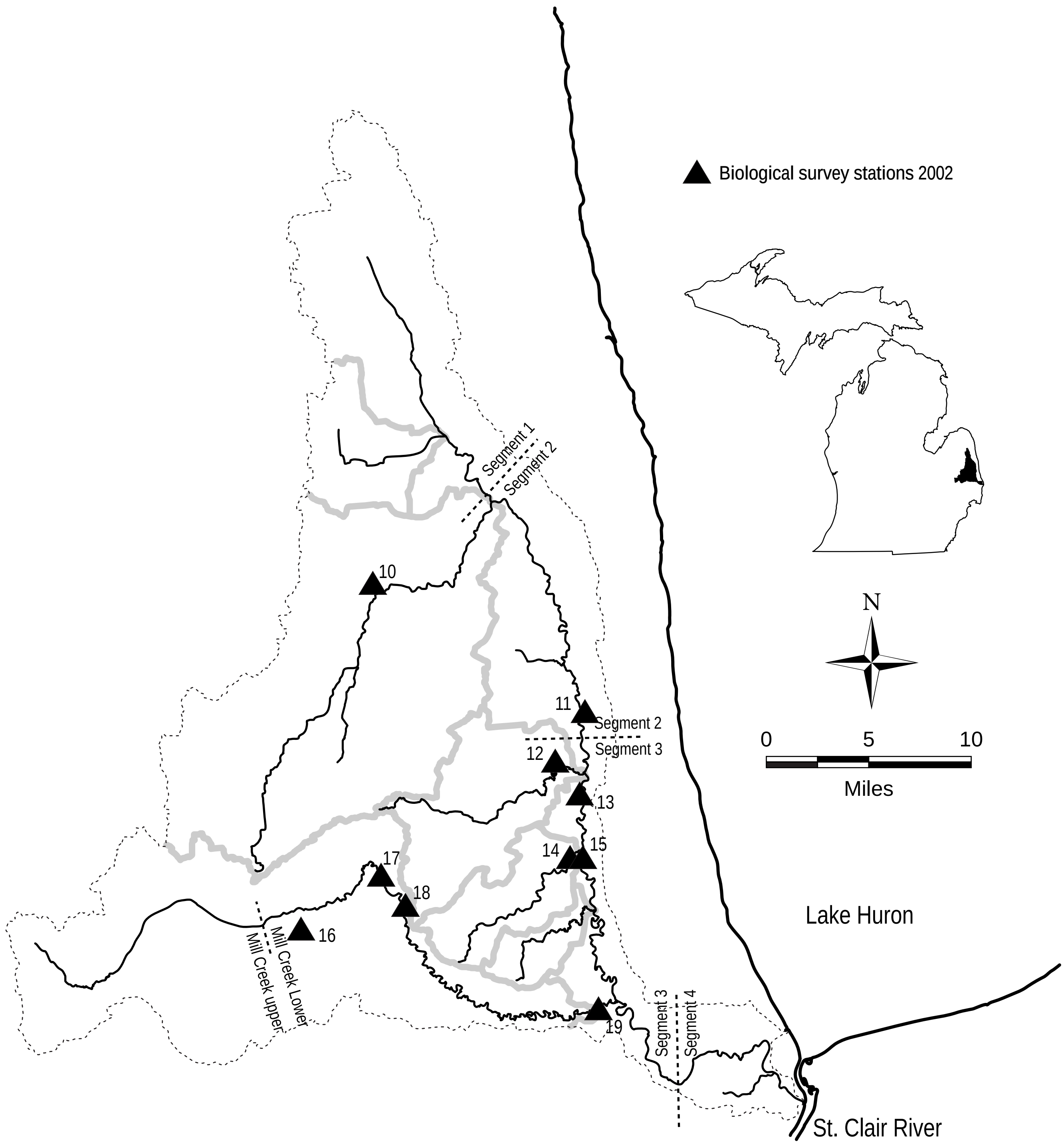


Figure 67.–Geographic locations (usually near road crossing) for Michigan Department of Environmental Quality Water Bureau 1992 biological survey stations (20) in the Black River (segments 2 and 3), lower segment of Mill Creek (16-19), Elk Creek (10), Black Creek (12), and Silver Creek (14).

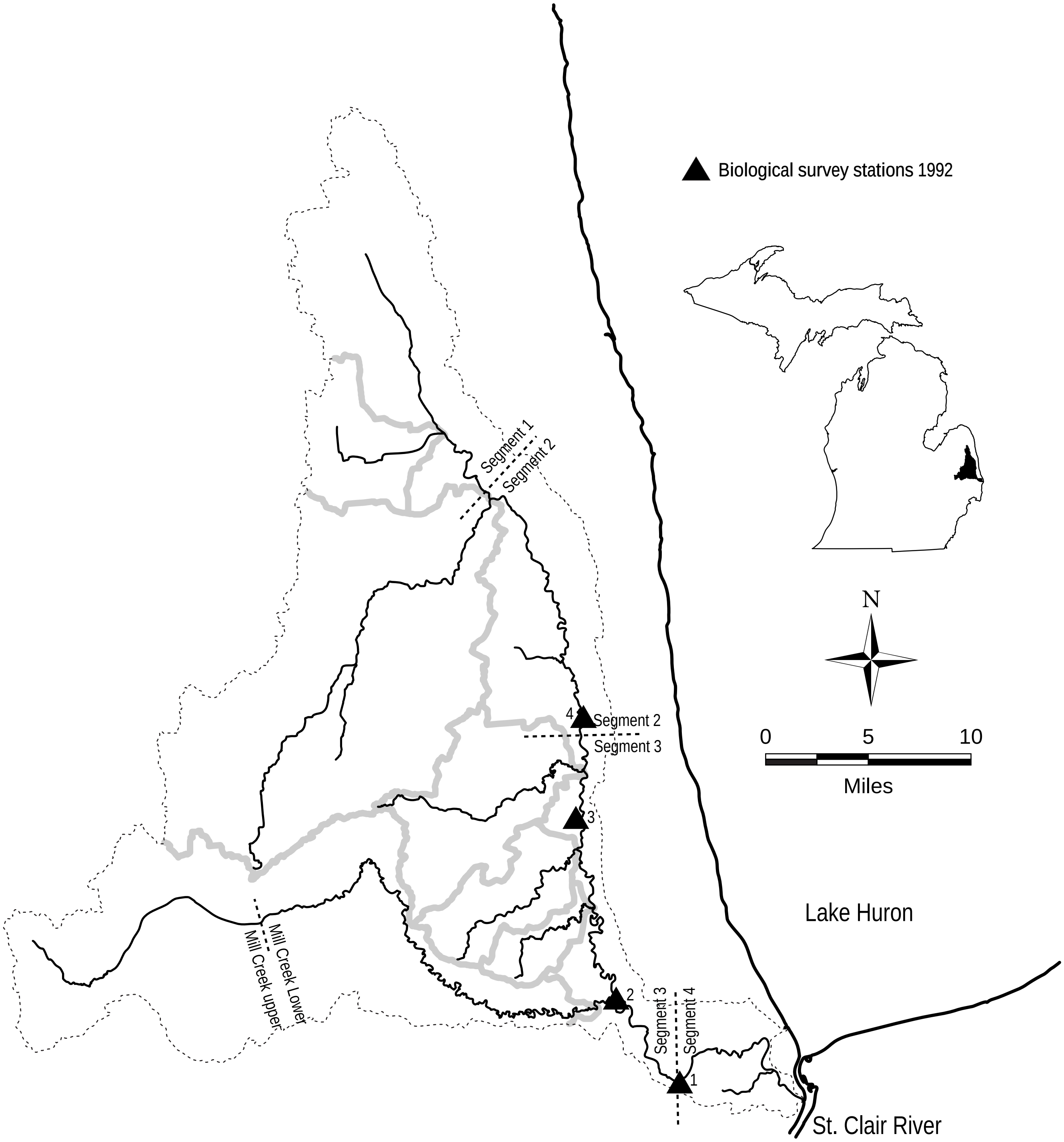


Figure 68.–Geographic locations (usually near road crossing) for Michigan Department of Natural Resources Surface Water Quality Division (now in Michigan Department of Environmental Quality) 1992 biological survey stations (4) in the Black River (segments 2, 3, and 4).

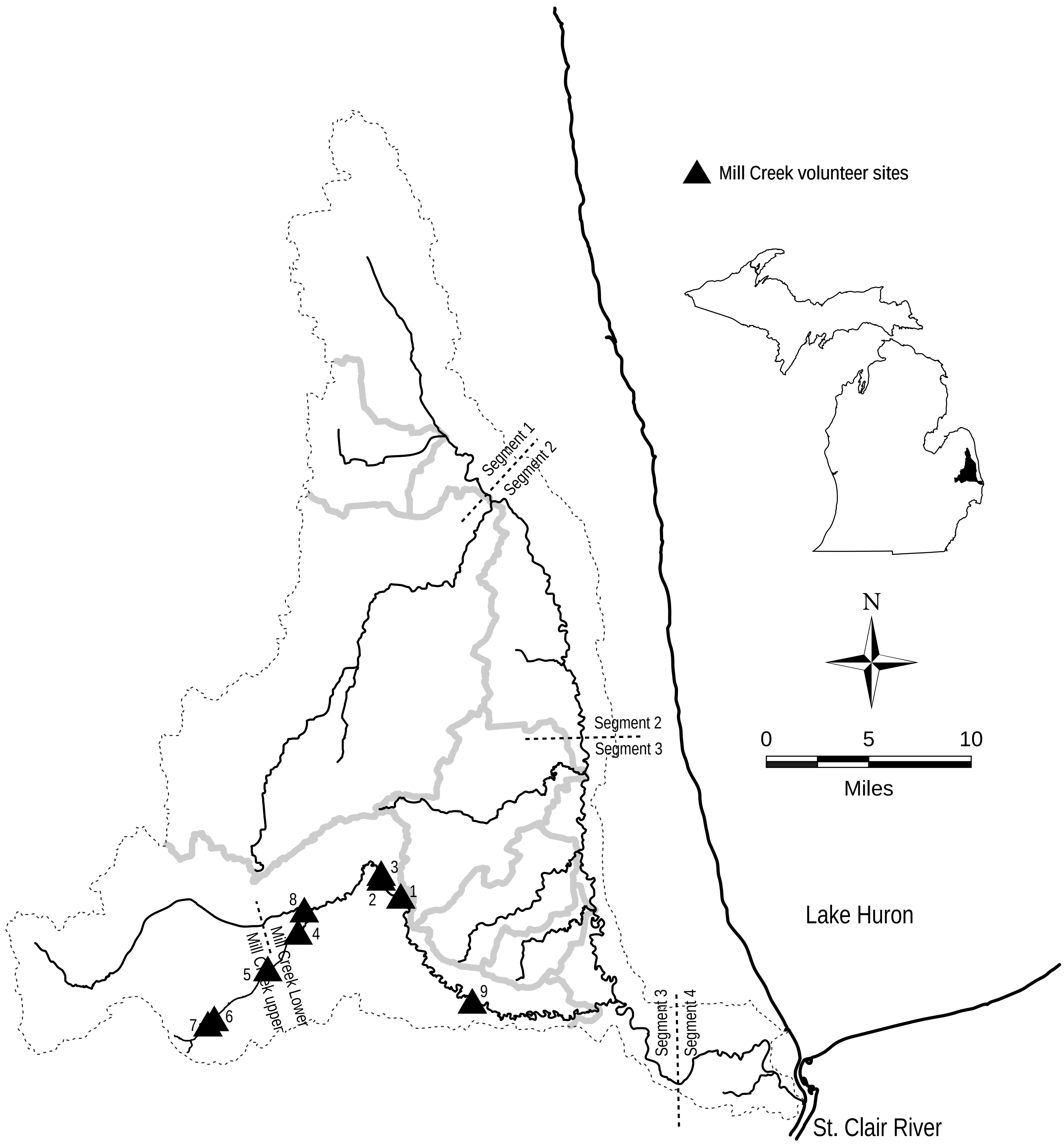


Figure 69.–Geographic locations for nine survey sites used since 2003 by participants in the Mill Creek Volunteer Monitoring Project, in cooperation with Michigan Department of Environmental Quality, to assess the quality of aquatic habitats and biota in Mill Creek. Station numbers are those used by project personnel.

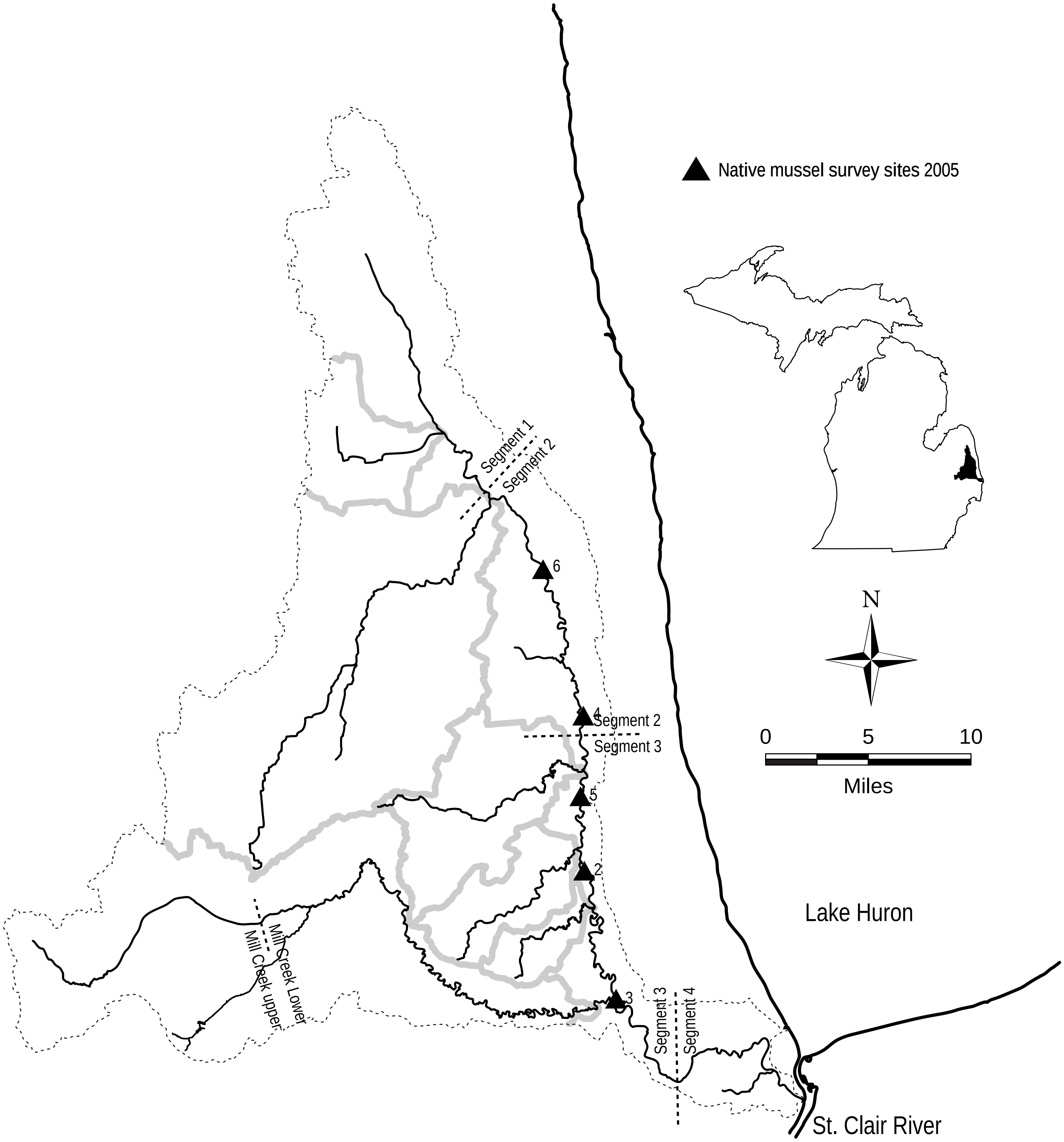


Figure 70.–Geographic locations for five native mussel survey sites used in 2005 by Douglas Sweet for the Michigan Natural Heritage Program (Sweet 2005). Station numbers are those used by the author.

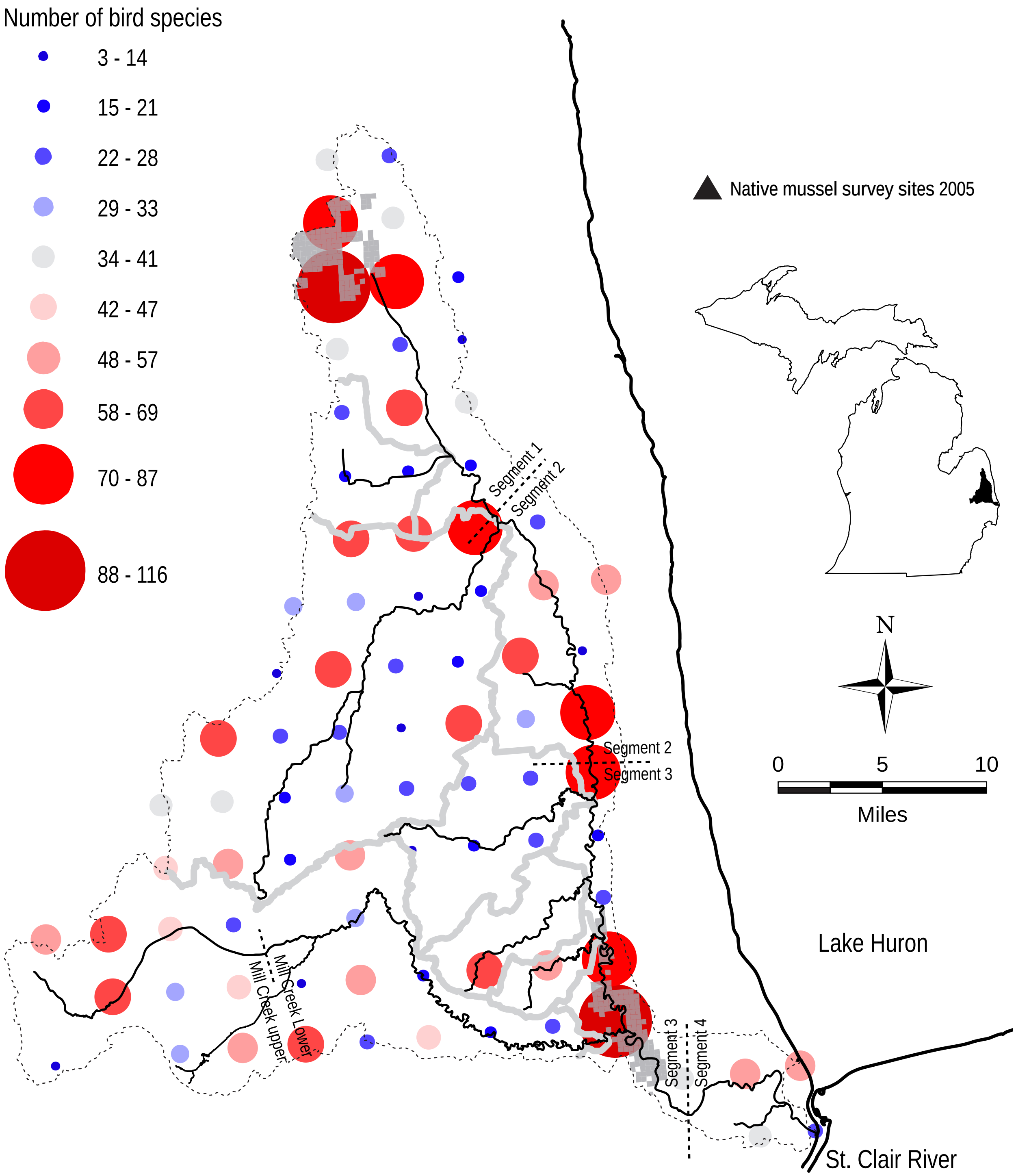


Figure 71.–Map of the number of bird species observed during breeding activities within the Black River watershed. Data, obtained from Breeding Bird Atlas Explorer (2008), were summarized by 9.5 mi2 blocks and plotted at the block center as circles sized to represent the number of species. Gray blocks show Michigan Department of Natural Resources state game areas.

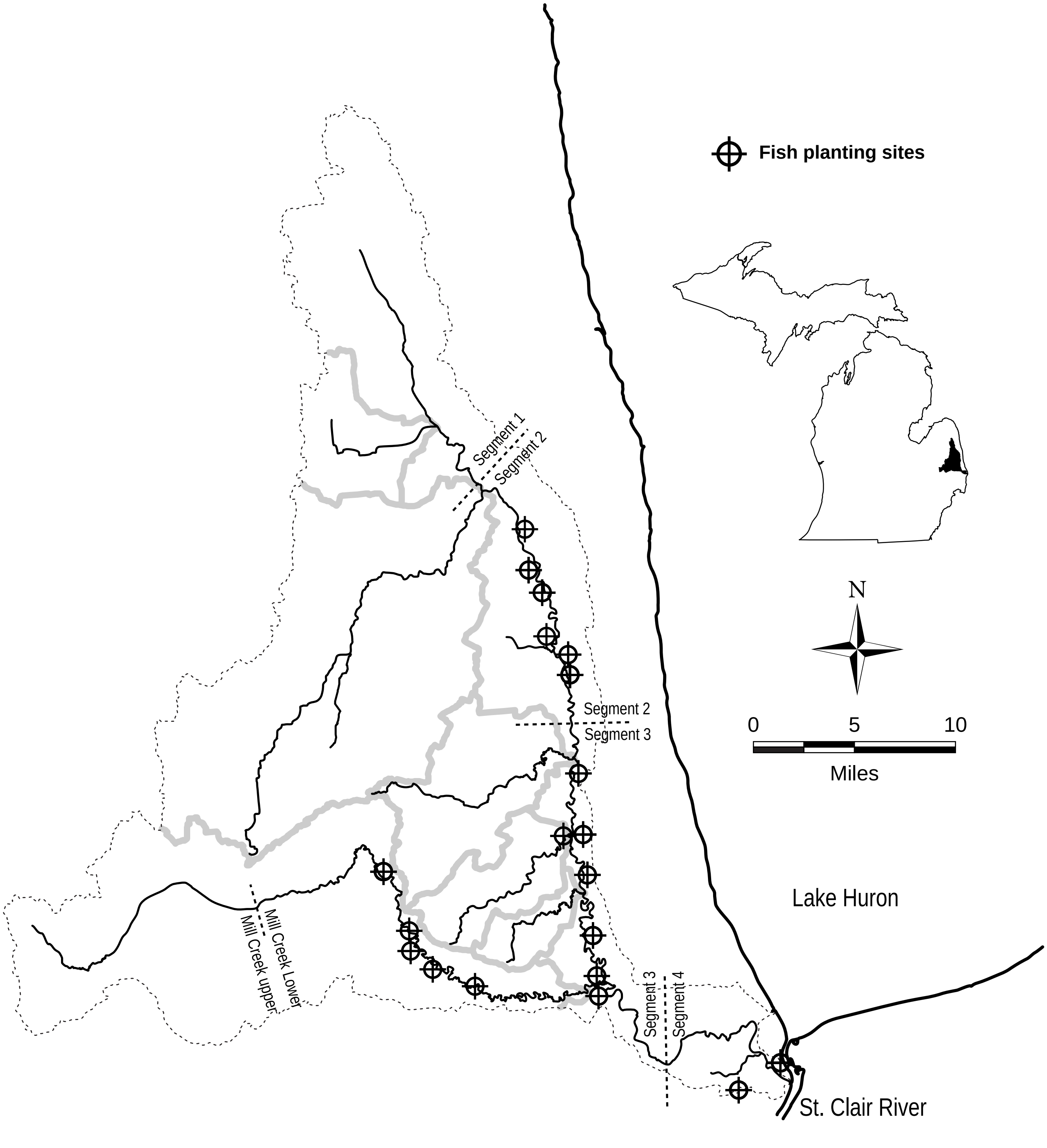


Figure 72.–Geographic locations (usually near road crossing) for Michigan Department of Natural Resources fish stocked in the main stem of the Black River (segments 2 and 3) and lower Mill Creek. Dotted lines divide major analysis sections of the Black River main stem and Mill Creek.

Figure 73.–Map of Michigan Department of Natural Resources lands (MDNR) (shaded squares) within both the Black River watershed and the Minden City State Game area. There are 5,875 acres of land open to public access with five public parking areas maintained by Wildlife Division of MDNR. These parking lots provide excellent access to the land and river for hunting, fishing (very small streams), and many other outdoor activities.

Figure 74.–Map of Michigan Department of Natural Resources (MDNR) lands (shaded squares) within both the Black River watershed and the Port Huron State Game area. There are 5,732 acres of land open to public access with 24 public parking areas maintained by Wildlife Division of MDNR. These parking lots provide excellent access to the land and river for hunting, fishing, bird watching, and many other outdoor activities.

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TABLES

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Table 1.–Number of archaeological sites within the Black River drainage listed by county, township, and range.

County	Township	Number of sites
Lapeer	T. 07 N, R. 11 E	4
	T. 07 N, R. 12 E	2
	T. 08 N, R. 11 E	6
	T. 08 N, R. 12 E	18
	T. 09 N, R. 12 E	6
Sanilac	T. 09 N, R. 14 E	2
	T. 09 N, R. 15 E	2
	T. 09 N, R. 16 E	2
	T. 10 N, R. 13 E	4
	T. 10 N, R. 14 E	17
	T. 10 N, R. 15 E	3
	T. 10 N, R. 16 E	2
	T. 11 N, R. 14 E	1
	T. 11 N, R. 15 E	2
	T. 12 N, R. 15 E	1
	T. 13 N, R. 15 E	2
	T. 14 N, R. 14 E	8
	T. 14 N, R. 15 E	1
St. Clair	T. 06 N, R. 17 E	5
	T. 07 N, R. 13 E	3
	T. 07 N, R. 16 E	2
	T. 07 N, R. 17 E	7
	T. 08 N, R. 13 E	4
	T. 08 N, R. 14 E	2

Table 2.–Mean annual discharge, drainage area, and yield at six United States Geological Survey gauge sites in the Black River watershed. Discharge units are cubic feet per second (cfs).

Gauge site	Gauge number	Period of record	Drainage area (mi^2)	Mean annual discharge (cfs)	Yield (cfs/mi^2)	Mean daily flow in August (cfs)
Silver Creek near Jeddo	4159488	1978–82	21	14.5	0.69	3.2
Black River near Jeddo	4159492	1944–06	464	301.5	0.65	63.2
Black River near Fargo	4159500	1944–91	480	262.8	0.55	58.5
Mill Creek near Avoca	4159900	1963–06	169	96.7	0.57	16.5
Mill Creek near Abbottsford	4160000	1947–64	208	96.9	0.47	18.8
Black River near Port Huron	4160050	1932–43	684	284.9	0.42	3.2

Table 3.–Period of record maximum and minimum daily discharges (year of occurrence in parentheses) at United States Geological Survey gauging stations on the Black River. Data from United States Geological Survey. Discharge units are cubic feet per second (cfs).

Gauge site	Gauge number	Maximum flow (cfs)		Minimum flow (cfs)		Full years of data in record
		Largest	Smallest	Largest	Smallest	
Silver Creek near Jeddo	4159488	701 (1981)	348 (1979)	0.7 (1979)	0.1 (1978)	4
Black River near Jeddo	4159492	10,100 (1947)	387 (1964)	36.0 (1997)	2.0 (1948)	63
Black River near Fargo	4159500	10,100 (1947)	387 (1964)	13.0 (1952)	2.0 (1948)	22
Mill Creek near Avoca	4159900	3,940 (1975)	64 (1964)	13.0 (1992)	0.9 (1964)	31
Mill Creek near Abbottsford	4160000	2,870 (1962)	350 (1958)	8.3 (1953)	2.9 (1963)	16
Black River near Port Huron	4160050	10,600 (1942)	2,250 (1941)	17.0 (1943)	4.6 (1941)	11

Table 4.–Cover type in the Black River watershed in acres. Presettlement data were taken from Michigan Department of Natural Resources, Michigan Resource Inventory System (MIRIS). Land cover in 1992 was determined from the United States Geological Survey (USGS) National Land Cover Data (NLCD).

Cover type	Presettlement (*c*. 1800)	Current 1992	Percent change 1800–1992
Commercial	0	1,625	+100
Cultivated	0	358,642	+100
Emergent herbaceous wetland	10,370	692	-87
Forested	442,885	84,694	-68
Open water	1,342	2,085	+22
Gravel pit	0	176	+100
Residential	0	6,546	+100
Transitional	0	130	+100

Table 5.–Dams in the Black River watershed, sorted by county. Date is the year of construction; location is provided by township (T.), range (R.), and section (Sec.); Owner indicates ownership as private, state, or local government; question marks indicate data are missing. Data from L. Szabo Kraft (Michigan Department of Natural Resources Spatial Information Resource Center).

Dam name	Water body	Date	T.	R.	Sec.	Owner	Head (ft)	Pond area (acres)	Storage (acre-ft)
Sanilac									
Croswell Dam	Black River	1902	10N	16E	29	Private	8	42	300
Donovan Dam	Unnamed tributary	?	09N	16E	5	Private	?	3	?
Lapeer									
N. Br. Mill Creek Dam	N. Br. Mill Creek	1965	08N	12E	29	Local	18	250	2,965
Baggerly Dam	Madison Drain	?	09N	12E	33	Private	?	4	?
St. Clair									
Ford's (Wingford) Dam	Black River	1930	07N	16E	8	Private	17	93	3,000
Port Huron SGA No. 4	Walker Flats flooding	1966	07N	16E	16	State	7	45	180
Yale Woolen Mill Dam	Mill Creek	?	08N	14E	10	Local	1	20	?
Cade Road Dam	South Branch Drain	?	07N	13E	6	Private	3	1	?

Table 6.–National Pollution Discharge Elimination System permits issued in the Black River watershed. Data from Michigan Department of Environmental Quality, Surface Water Quality Division.

Valley segment or subwatershed City	Receiving water	Designated name	Permit type	ID number
Segment 1				
Carsonville	Black River	Waste Management of Michigan, Incorporated	Industrial storm water	45
		Waste Management of Michigan, Incorporated	Industrial storm water	46
Deckerville	Grandy Drain	Plastacoat, Incorporated	Industrial storm water	33
		Trim Trends Company LLC	Individual	44
Minden City	Black River	Bay Houston Towing Company, Incorporated	Industrial storm water	2
Carsonville	Black River	Black River Hardwoods	General seasonal	5
Deckerville	Pelton Drain	Deckerville WWSL	Industrial storm water	16
	Flannigan Drain	Midwest Rubber Company	Industrial storm water	28
Segment 2				
Croswell	Black River	Conveyor Components Company	Industrial storm water	12
		Cotterman Company	General seasonal	13
	Unnamed	Country Hill Pines MHP	Individual	14
	Black River	City of Croswell	Industrial storm water	15
		Jay & Kay Manufacturing Incorporated	Individual	21
		Michigan Sugar Company	Industrial storm water	25
	Unnamed tributary to Black River	Paramount Industries Incorporated	Industrial storm water	31
		Theut Concrete Products, Incorporated	General seasonal	42
Carsonville	Unnamed	Carsonville WWSL	Industrial storm water	10
	Carsonville Drain	Randy's Auto Salvage	Industrial storm water	37
Segment 3				
Jeddo	Black River	Mid-Michigan Materials Incorporated	General seasonal	26
Brown City	Elk Creek	Brown City WWSL	General seasonal	8
Segment 4				
Fort Gratiot	Unnamed	Port Huron Area Schools	Industrial storm water	36
Kimball	Black River	Black River Concrete	General seasonal	4
Port Huron	Black River	Port Huron Area School District	Industrial storm water	35
		Acheson Colloids Company	Industrial storm water	1
		Desmond Marine, LLC	Industrial storm water	18
		Mueller Brass Company	General seasonal	29

Table 6.–Continued.

Valley segment or subwatershed City	Receiving water	Designated name	Permit type	ID number
Berry Drain				
Sandusky	Stoney Creek Drain	Jensen Bridge & Supply Company	General seasonal	22
	Unnamed	Sunset Mobile Home Park WWSL	Individual	41
		Trelleborg YSH, Incorporated	Individual	43
	Potts Drain	Bay Houston Towing Company, Incorporated	Industrial storm water	3
	Berry Drain	Fred J. Breiten Lumber Company	Industrial storm water	20
		Numatics, Incorporated	Industrial storm water	30
	Black Drain	Sandusky Concrete & Supply Incorporated	Individual	39
	Unnamed	City of Sandusky	Industrial storm water	40
Elk Creek				
Croswell	Unnamed	Buel Hill MHP WWSL	General seasonal	9
Brown City	Unnamed	Brown City Camp	General seasonal	6
Peck	Unnamed	Peck WWSL	General seasonal	32
Brown City	Unnamed	Brown City Water Treatment Plant	Industrial storm water	7
	Lapeer Sanilac Drain	Frank Industries, Incorporated	Industrial storm water	19
		Link Technologies	Industrial storm water	24
Black Creek				
Yale	Mill Creek	Redall Industries Incorporated	General seasonal	38
	Unnamed	Parkview Property Management Incorporated	General seasonal	48
	Mill Creek	City of Yale	General seasonal	50
Silver Creek				
Avoca	Unnamed	Detroit Edison Company	Industrial storm water	17
Plum Creek				
Avoca	Unnamed	Plum Creek Estates, LLC	Individual	34
Mill Creek				23
Attica	Unnamed	Lapeer County Education and Technology Center	General seasonal	47
Yale	Mill Creek	Yale Industries	Industrial storm water	49
		Yale Steel Incorporated	Groundwater	11
Imlay City	Unnamed	Champion Bus Incorporated	General seasonal	51
Avoca	Mills Creek	City of Yale	Individual	27
Capac	Unnamed	Mid-Michigan Gas Storage Company	Groundwater	23

Table 7.–Designated drain names, length (mi), and establishment date (Est.) in the Black River watershed by valley segment. Information provided by each county drain office.

Drain	Length (mi)	Est.
Main Stem Valley Segment 1		
Sanilac County		
• *Bridgehampton Township*		
Black River	4.469	
Dwight	1.364	1969
Leonard	0.999	1913
Lux	0.394	
McDonald	4.293	1888
Pyette	1.571	1893
Shrapnel	3.454	1910
Southworth	1.114	
Unknown McDonald connecter	1.237	
• *Custer Township*		
Anderson	1.121	1904
Black River	3.355	1957
Custer Twp Hwy	1.534	1901
Dwight	1.082	1894
Freel	1.005	
Kirkpatrick	0.900	1910
Laughren	1.189	1938
Nichol	5.670	1904
O'Connell	0.833	1916
Pyette	0.717	1893
Wilkins	5.022	
• *Marion Township*		
Deckerville	0.202	
Flannigan	0.115	1907
Grandy	3.957	1895
Pelton	1.078	1885
• *Minden Township*		
Bishop	1.407	1895
Black River & Swercz	7.182	1957
Sanilac County–continued		
• *Minden Township–continued*		
Darlington	3.606	1903
Duggan	0.947	
McManus	1.080	1914
Swercz Relief	1.151	1914
• *Washington Township*		
Gordon	2.516	1887
McDonald	0.886	1888
• *Watertown Township*		
Gordon	0.950	1990
• *Wheatland Township*		
Bishop	5.408	1895
Black River	6.821	1957
Burget	1.414	1906
Carroll Cut-Off	2.184	1914
Churchill	0.249	1887
Flannigan	0.940	1907
Hewitt	2.270	1894
McMannus	3.335	1914
Merriman	0.858	1907
Paige	1.413	1906
Pelton	2.715	1885
Ritchie	5.544	1911
Sherwood	0.415	1902
Smith	2.582	1911
Terpenning	0.561	1907
Theyer	2.180	1912
Thompson	1.976	1893
Berry Drain Subwatershed		
Sanilac County		
• *Bridgehampton Township*		
Berry	0.651	1910
Fry	0.630	1892
• *Custer Township*		
Badgero	1.921	1896
Baerwolf	4.684	1913
Berry	5.091	1910
Custer County	5.945	1901
Dwight	9.140	1894
Fye	4.106	1892
Graves	2.176	1914
House	0.101	1912
Sanilac County–continued		
• *Custer Township–continued*		
Kenny	6.493	1890
Rich	1.517	
Stone	2.283	1910
• *Watertown Township*		
Berry	1.926	1910
Black	2.185	1912
Gauge	1.458	1911
Howse	1.409	1912
Sandusky	1.452	1905
Stone	1.130	1901

Table 7.–Continued.

Drain	Length (mi)	Est.	Drain	Length (mi)	Est.
Main Stem Valley Segment 2					
Sanilac County			*Sanilac County–continued*		
• *Bridgehampton Township*			• *Lexington Township–continued*		
Kelley	0.663		Herk	0.791	
• *Buel Township*			Jenny	1.069	
Arnot	5.004		Johnston	2.154	
May	0.830		Kott	0.613	
Mclelland	5.597		Mclelland	1.900	
Mills	6.063		Mills	2.249	
P. O. E. Perry	0.696		No. 2 County Road	0.483	
Pabst	2.306		No. 3 County Road	0.453	
Smyth	1.955		Rosenstil	0.858	
Taylor	4.211		Wagner	0.346	
Vincent	0.557	1883	• *Worth Township*		
Wagner	1.915	1889	Achenson	0.529	
Watson	2.161		• *Washington Township*		
• *Lexington Township*			Black River Intercounty	9.593	
Black River	1.942		Carsonville	1.966	1923
Chenson	0.476		Kelly	3.228	
Croswell	1.578		Murray	2.917	
Freeman	2.348		Pabst	5.065	1895
Elk Creek Subwatershed					
Lapeer County			*Sanilac County–continued*		
• *Burnside Township*			• *Elk Township–continued*		
Ellis "Relief"	0.379	1898	Cowley	0.997	1907
Lapeer & Sanilac	2.675	1908	Elk & Buel	0.404	1889
Setter	4.247	1899	Elk Creek	7.228	1899
Sanilac County			Elk, Flynn & Maple Valley	1.841	1889
• *Buel Township*			Elk-Speaker	1.578	1909
Baum	1.472	1889	Elsholz	0.688	1916
County Rd. drain No. 1	0.658	1929	Engle	1.178	1913
Engle	1.146	1913	Fletcher	0.698	1894
French	7.089	1892	Jones	1.058	1896
Hunt	1.133	1897	Maedel	0.233	1913
Maedel	0.501	1913	McCauley	1.434	1907
Miller	3.270	1938	McDonald	3.207	1894
Oak & Buel	1.037		McElhenney	6.637	1890
Potts	8.333	1894	Mullen	1.624	1902
Rickett	2.524	1889	Omard	1.034	1906
Roskey	5.744	1897	Parks	1.286	1894
Siefert	0.552	1892	Phillips	1.776	1924
Thomas	0.534	1899	Potts	4.583	1894
Topping	4.387	1894	Powers	2.673	1906
Wannamaker	0.539	1910	Rickett	1.594	1889
• *Elk Township*			Rowe	2.204	
Barr	1.258	1897	Ryland	2.877	1892
Bowers	1.101	1913	Shell	0.888	

Table 7.–Continued.

Drain	Length (mi)	Est.
Sanilac County–continued		
• *Elk Township–continued*		
Siefert	1.003	1892
Smafield	1.468	1913
Speaker & Maple Valley	3.803	
Spring Creek	2.360	1889
Squires	1.307	1912
Tenniswood	2.141	
Thomas	1.736	1899
• *Elmer Township*		
Beals & Frizzle	4.113	1883
Cummer	2.787	1894
Hale	3.788	1883
McElhinney	0.367	1890
Severance	0.217	1889
• *Flynn Township*		
Brown	0.936	1954
Campbell	0.615	
Eagle	2.495	1918
Elk Creek	1.618	1909
Elk, Flynn & Maple Valley	4.984	1889
Hector	0.425	1893
Jones	2.597	1896
Large	2.968	1905
McElhinney	0.324	1890
Omard	2.165	1906
Phillips	0.396	1924
Rumble	0.786	1893
Setter	17.677	1894
Simson	1.059	
Stimson	0.791	1889
Tuer	0.991	
Welch	4.020	1909
• *Fremont Township*		
Hunt	1.777	1897
Lord	3.962	1898
• *Maple Valley Township*		
Brown	0.324	
Brown City	0.685	
Elk Creek	7.448	1899
Elk, Flynn & Maple Valley	1.115	1889
Hydorn	3.508	1909
Laidlaw	1.314	1899
Langdon	4.425	1902
Lapeer & Sanilac	5.799	1889
Macklem	3.951	1906
McElroy	1.121	1906

Drain	Length (mi)	Est.
Sanilac County–continued		
• *Maple Valley Township–continued*		
Payne	0.554	
Scott	1.621	1926
Setter	3.534	1894
Shoemaker	2.390	1908
Speaker & Maple Valley	2.881	
Valley Center	2.738	1912
Varney	3.477	1909
Willoughby & Toman	0.083	
Windsor	0.660	1912
Winters	4.701	1889
Witmer	3.456	1903
York	2.430	1910
• *Speaker Township*		
Beemer	2.553	1907
Cline	2.915	1908
Cork	4.418	1911
Elk-Speaker (Donnelly 1892)	3.097	1909
Fletcher	3.332	1894
Kern	1.067	
Lord	0.981	
Macklem	1.584	1906
Melvin	1.826	1951
Mullaney	3.315	1907
Potts	4.265	1894
Putney	2.703	1953
Shell	0.787	
Solan	2.084	1910
Speaker & Maple Valley	3.994	1905
Spring Creek	3.311	1991
Utter Branch	1.189	
Weston	0.990	
• *Washington Township*		
Alexander		1893
Crow		
Elk Creek		1899
Hayes	0.503	1906
McPherson	2.770	1889
Methven	2.430	
Meyers (Myers)	1.670	
Potts	0.752	1894
Recor	1.944	1890
Rickett	0.483	1889
Roskey	0.135	1897
Washington	0.704	1912

Table 7.–Continued.

Drain	Length (mi)	Est.	Drain	Length (mi)	Est.
Elk Creek Subwatershed					
Sanilac County–continued			*Sanilac County–continued*		
• *Watertown Township*			• *Watertown Township–continued*		
Adams	0.979	1891	McElhinney	0.890	1890
Beals & Frizzle	7.710	1883	McPherson	1.782	1889
Cloclough	1.684		Methven	0.873	
Cummer	0.492	1894	Mullen	1.382	1902
Eggert	5.370	1904	Murphy	1.830	1895
Elholz	1.220	1916	Parkinson	1.670	1888
Elk Creek	5.071	1899	Parks	1.455	1894
Hale	2.550	1883	Ricket	0.862	1889
Harneck	0.992	1915	Severance	3.190	1889
Hayes	0.298	1906	Smalldon	4.306	1899
Johnson-Barrett	1.804	1915	Walker	1.189	1888
Maitland	0.326		Watertown State	3.753	1904
Main Stem Valley Segment 3					
Sanilac County			*Sanilac County–continued*		
• *Fremont Township*			• *Worth Township–continued*		
Barnes	0.170		VanSickle	0.111	
Rattray	0.580		*St. Clair County*		
• *Worth Township*			• *Clyde Township*		
Barnes	0.366		Glyshaw	1.458	1915
Coats	1.647		Kingsley	0.536	1964
Mason	1.601		No. 208	0.399	1920
Rattray	0.320		O'Dette	0.763	1912
Black Creek Subwatershed					
St. Clair County			*Sanilac County–continued*		
• *Brockway Township*			• *Fremont Township–continued*		
Brennan	0.111	1914	Coon	1.474	
Jackson Creek	2.655	1909	Crouce	1.686	
Livergood & Ext.	2.330	1906	Jackson Creek	6.543	
Teets	1.473	1914	Lawson	2.328	
• *Greenwood Township*			Livergood	0.284	
Brennan	0.330	1914	Massacar (Bigger)	1.076	
Jackson Creek	1.128	1909	McIntyre & Willing	3.476	
Livergood & Ext.	3.972	1906	Nelson & Spencer	0.938	
Robertson	2.694	1909	Perry	3.002	
Teets	0.150	1914	Rector	0.783	
Sanilac County			Robertson	0.287	
• *Buel Township*			Seymore Creek	12.343	
Br. #1 Seymore Ck.	1.734		Sheridan	1.529	
• *Fremont Township*			Turner	2.310	
Allen	1.030		W. M. Doan	0.670	
Black Creek	5.508		Willey	3.995	
Bradley	0.788		• *Speaker Township*		
Burns	0.436		Black Creek	3.558	
Conroy & Ferriby	1.289		Jackson Creek	0.497	

Table 7.–Continued.

Drain	Length (mi)	Est.
Sanilac County–continued		
• *Speaker Township–continued*		
Lavell	0.069	
Rector	0.386	
Sanilac County–continued		
• *Worth Township*		
William Doan	1.734	
Silver Creek Subwatershed		
St. Clair County		
• *Brockway Township*		
Eves	0.964	1906
• *Greenwood Township*		
Black	1.979	1929
Bricker	1.238	1907
Butcher	0.435	1965
Eves	13.949	1906
Furlong	1.043	1908
Fuselein	3.615	1945
Gorman	1.489	1908
Hayes	4.200	1908
Holley	2.928	1948
Jackson	4.114	1907
Neil	1.732	1914
St. Clair County–continued		
• *Greenwood Township–continued*		
Vincent	1.326	1907
Willey	0.325	1963
Wilson	0.125	1914
• *Grant Township*		
Fuselein	0.109	1945
Neil	0.798	1914
Wilson	0.583	1914
Sanilac County		
• *Fremont Township*		
Preston	0.415	
Willey	1.402	
Wilson	1.932	
Plum Creek Subwatershed		
St. Clair County		
• *Grant Township*		
King	0.070	
Youngs	0.817	
• *Greenwood Township*		
Engles	1.743	1907
St. Clair County–continued		
• *Greenwood Township–continued*		
Hill	1.592	1914
Plum Creek	4.244	
Pohly	2.315	
Todd	1.948	
Mill Creek Subwatershed		
Lapeer County		
• *Arcadia Township*		
Barber	0.368	1890
Brant Lake	3.190	1904
Devall	1.889	1903
Elgin	0.721	1925
Lister	1.070	1917
Mud Lake	2.734	1908
Rogers & Swamp Corners	2.943	1892
Simmons Lake	0.603	1905
Soper	0.784	1913
Utley	0.070	1920
Winn	1.475	1917
• *Attica Township*		
Barber	0.979	1890
Booth	1.538	1905
Cadillac	0.303	1908
Lapeer County–continued		
• *Attica Township–continued*		
Fern	0.810	1908
Lumbar	2.899	1903
Rogers & Swamp Corners	0.821	1892
• *Burnside Township*		
Clarkson	0.243	1910
Evans & McKillan	1.687	1910
• *Goodland Township*		
Anchor	1.069	1911
Barnes	1.151	1941
Black Segate & Reid	1.711	1899
Clarkson	1.688	1910
Courter	2.030	1911
Crow	2.584	1898
East Goodland	2.702	1904
Evans & McKillan	1.458	1910

Table 7.–Continued.

Drain	Length (mi)	Est.
Lapeer County–continued		
• *Goodland Township–continued*		
Flansberg	0.416	1914
Franklin	1.468	1908
Galley	0.963	1889
Madison	3.615	1893
N. Br. Mill Creek	8.289	1963
Stevenson	3.653	1870
Stoney Creek	4.386	1908
Utley	0.887	1920
Willoughby & Toman	0.628	1808
• *Imlay Township*		
Brandy run	3.407	1896
Bunde	1.135	1900
Cadillac	1.294	1908
Hughes	1.199	1914
Jurn	2.906	1940
Marrosvet	0.521	1948
Mudcat State	0.163	1900
South Branch Mill Creek	2.736	1894
Sanilac County		
• *Maple Valley Township*		
Willoughby & Toman	4.735	
• *Speaker Township*		
Cole	1.747	
Downey	2.796	
Sanilac & St. Clair Intercounty	3.837	
Sloat	3.480	
St. Clair County		
• *Brockway Township*		
Lovejoy	1.137	1901
McLane	0.838	1904
Meharg	3.858	1916
Middleton	3.253	1913
Ohmer	1.703	1909
Sanilac – St. Clair	1.208	1889
Sec. 27	0.752	1954
Sheehy	2.496	1905
South Branch Mill Creek	3.615	1893
Thody	2.868	1909
Thompson	1.383	1913
• *Clyde Township*		
Ditchler	0.532	1898
• *Emmett Township*		
Benke	1.176	1908
Gleason	4.987	1953
Lovejoy Ext.	1.700	1901

Drain	Length (mi)	Est.
St. Clair County–continued		
• *Emmett Township–continued*		
Sheehy	1.131	1905
White	3.858	1907
• *Kenockee Township*		
Gleason	1.390	1953
No. 211	0.575	1922
• *Lynn Township*		
Black – Seagate & Reid	3.824	
Dowling	1.189	
Flansburg	2.265	
Franklin	1.766	
Fraser	5.770	
Galley	2.937	
Kaufman	2.046	
Kenney	1.772	
Kolb	0.906	
Lovejoy	4.001	
Lynn	1.918	
Lynn – Mussey State	1.510	
Lynn County	2.107	
Meharg	1.596	
North Branch Mill Creek	6.313	
Ostrander	1.400	
Raymo – No. 2	1.152	
Root	4.298	
Sanilac – St. Clair	3.302	
South Branch Mill Creek	5.957	
Stuever	1.457	
Wait	2.148	
Weese	1.629	
Willoughby – Toman	4.277	
• *Mussey Township*		
Benke	1.749	
Cannis	3.738	
Dowling	1.103	
Franklin	0.775	1906
Hughes	0.117	1914
Kaufman	1.633	1890
Kriesch	1.861	1905
Lynn - Mussey State	2.550	1882
Molb	0.139	
Mudcat State	1.051	1900
Seidel	3.625	1940
South Branch Mill Creek	2.693	1893
Sprotberry	3.744	1905
Weitzig	2.082	1908
Wendt	1.941	1905

Table 7.–Continued.

Drain	Length (mi)	Est.
Main Stem Valley Segment 4		
St. Clair County		
• *Clyde Township*		
Brandymore	1.605	
• *Fort Gratiot Township*		
Black River Canal	1.087	
Brandymore	3.641	
Collins	1.127	1958
Gossman	2.386	1927
Howe	2.400	1890
Moore	1.244	1931
St. Clair County – continued		
• *Fort Gratiot Township–continued*		
Routley	1.091	1914
Stimson Storm Sewer	0.178	1966
Warner	1.629	1917
• *Port Huron Township*		
Baldwin	1.791	1868
Blackney	1.626	1919
Hopps	1.045	1962
Price	3.080	1893

Table 8.–List of fish species historically found in the Black River watershed. Origin: N=Native, C=Colonized, I=Introduced; Status: P=Considered present in 2008, U=Unknown. Species that are state-listed are labeled endangered (SE), threatened (ST), and special concern (SC).

Common name	Scientific name	Origin	Status
Lampreys	Petromyzontidae		
northern brook lamprey	*Ichthyomyzon fossor*	N	P
silver lamprey	*Ichthyomyzon unicuspis*	N	P
American brook lamprey	*Lampetra appendix*	N	P
sea lamprey	*Petromyzon marinus*	C	P
Sturgeons	Acipenseridae		
lake sturgeon (ST)	*Acipenser fulvescens*	N	U
Gars	Lepisosteidae		
longnose gar	*Lepisosteus osseus*	N	P
Bowfins	Amiidae		
bowfin	*Amia calva*	N	P
Herrings	Clupeidae		
alewife	*Alosa pseudoharengus*	C	P
gizzard shad	*Dorosoma cepedianum*	N	P
Carps and minnows	Cyprinidae		
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	P
striped shiner	*Luxilus chrysocephalus*	N	P
common shiner	*Luxilus cornutus*	N	P
redfin shiner	*Lythrurus umbratilis*	N	P
hornyhead chub	*Nocomis biguttatus*	N	P
river chub	*Nocomis micropogon*	N	P
golden shiner	*Notemigonus crysoleucas*	N	P
pugnose shiner (SE)	*Notropis anogenus*	N	P
emerald shiner	*Notropis atherinoides*	N	P
ghost shiner	*Notropis buchanani*	N	P
silverjaw minnow	*Notropis buccatus*	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
bluntnose minnow	*Pimephales notatus*	N	P
fathead minnow	*Pimephales promelas*	N	P
blacknose dace	*Rhinichthys obtusus*	N	P
creek chub	*Semotilus atromaculatus*	N	P

Table 8.–Continued.

Common name	Scientific name	Origin	Status
Suckers	Catostomidae		
quillback	*Carpiodes cyprinus*	N	P
white sucker	*Catostomus commersonii*	N	P
lake chubsucker	*Erimyzon sucetta*	N	P
northern hog sucker	*Hypentelium nigricans*	N	P
black buffalo	*Ictiobus niger*	N	P
spotted sucker	*Minytrema melanops*	N	P
silver redhorse	*Moxostoma anisurum*	N	P
black redhorse	*Moxostoma duquesnei*	N	P
golden redhorse	*Moxostoma erythrurum*	N	P
shorthead redhorse	*Moxostoma macrolepidotum*	N	P
greater redhorse	*Moxostoma valenciennesi*	N	P
Bullhead catfishes	Ictaluridae		
black bullhead	*Ameiurus melas*	N	P
yellow bullhead	*Ameiurus natalis*	N	P
brown bullhead	*Ameiurus nebulosus*	N	P
channel catfish	*Ictalurus punctatus*	N	P
stonecat	*Noturus flavus*	N	P
tadpole madtom	*Noturus gyrinus*	N	P
Pikes	Esocidae		
grass pickerel	*Esox americanus*	N	P
northern pike	*Esox lucius*	N	P
Mudminnows	Umbridae		
central mudminnow	*Umbra limi*	N	P
Trouts	Salmonidae		
rainbow trout	*Oncorhynchus mykiss*	I	P
brown trout	*Salmo trutta*	I	P
Trout-perches	Percopsidae		
trout-perch	*Percopsis omiscomaycus*	N	P
Silversides	Atherinidae		
brook silverside	*Labidesthes sicculus*	N	P
Sticklebacks	Gasterosteidae		
brook stickleback	*Culaea inconstans*	N	P
Sculpins	Cottidae		
mottled sculpin	*Cottus bairdii*	I	P
Striped basses	Moronidae		
white perch	*Morone americana*	C	P
white bass	*Morone chrysops*	N	P

Table 8.–Continued.

Common name	Scientific name	Origin	Status
Sunfishes	Centrarchidae		
rock bass	*Ambloplites rupestris*	N	P
green sunfish	*Lepomis cyanellus*	N	P
pumpkinseed	*Lepomis gibbosus*	N	P
bluegill	*Lepomis macrochirus*	N	P
northern longear sunfish	*Lepomis peltastes*	N	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	Percidae		
eastern sand darter (ST)	*Ammocrypta pellucida*	N	
greenside darter	*Etheostoma blennioides*	N	P
rainbow darter	*Etheostoma caeruleum*	N	P
Iowa darter	*Etheostoma exile*	N	P
fantail darter	*Etheostoma flabellare*	N	P
least darter	*Etheostoma microperca*	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	*Sander vitreus*	N	P
Drums	Sciaenidae		
freshwater drum	*Aplodinotus grunniens*	N	P
Gobies	Gobiidae		
round goby	*Neogobius melanostomus*	I	P

Table 9.–Types of fish surveys conducted by the Michigan Department of Natural Resources in the Black River watershed. Sites are individual locations on the river which were normally accessed at road crossings. Area sampled is an estimate of the total water surface surveyed by each gear type. Impoundment gear included trap and fyke nets (usually trap nets) which were used in reservoirs above dams and human-made ponds close to the Black River.

Gear type	Number sites surveyed	Area sampled (acres)	Number years
Backpack shocker	13	4.3	4
Stream shocker	40	80.9	9
Boom shocker	6	43.5	4
Rotenone	11	12.5	1
Impoundment gear	8	20.9	7

Table 10.–Total catch of fish during all Michigan Department of Natural Resources fisheries surveys conducted in the Black River watershed during 1972–2006 ordered from most to least abundant. Species that are state-listed are labeled endangered (SE), threatened (ST), and special concern (SC).

Species	Total caught	Sample occurrences
mimic shiner	2,665	18
common shiner	2,334	40
bluntnose minnow	2,121	44
bluegill	1,860	36
white sucker	1,686	53
golden redhorse	1,669	36
creek chub	1,396	36
rock bass	1,333	61
johnny darter	1,325	46
greenside darter	1,025	24
blackside darter	934	49
common carp	875	49
sand shiner	856	11
pumpkinseed	826	42
stonecat	772	30
central stoneroller	743	18
spotfin shiner	714	27
northern hog sucker	713	34
green sunfish	626	31
rainbow darter	480	18
smallmouth bass	377	37
white crappie	321	14
gizzard shad	315	14
mudminnow	275	4
rosyface shiner	275	11
freshwater drum	270	10
blacknose shiner	260	8
black bullhead	241	27
channel catfish	241	20
golden shiner	223	12
logperch	210	11
yellow bullhead	207	21
largemouth bass	185	21
northern pike	164	38
central mudminnow	143	16
striped shiner	129	5
pugnose shiner (SE)	128	2
redear sunfish	124	1
emerald shiner	111	10
silver redhorse	109	18
brassy minnow	85	4
hornyhead chub	71	14
shorthead redhorse	69	8
quillback	63	8
redfin shiner	62	9

Table 10.–Continued.

Species	Total caught	Sample occurrences
yellow perch	61	19
greater redhorse	60	9
brown bullhead	45	6
black crappie	44	14
longear sunfish	44	8
Iowa darter	43	8
round goby	39	2
blacknose dace	36	4
white bass	36	8
river chub	33	5
walleye	32	8
hybrid sunfish	29	4
fantail darter	24	9
spotted sucker	24	5
fathead minnow	22	5
spottail shiner	19	4
tadpole madtom	18	6
brook stickleback	17	4
alewife	14	1
black redhorse	13	3
brook silverside	9	4
black buffalo	8	1
goldfish	8	2
grass pickerel	8	3
least darter	7	2
blackchin shiner	6	1
white perch	4	2
trout-perch	3	1
brown trout	2	1
bowfin	1	1
creek chubsucker	1	1
eastern sand darter (ST)	1	1
longnose gar	1	1
silver lamprey	1	1

Table 11.–Percent of Michigan Department of Natural Resources Fisheries Division site surveys that captured each species of fish during 1972–2006 analyzed within major segments of the Black River watershed. The number of site surveys was used to calculate percent. Species that are state-listed are labeled endangered (SE), threatened (ST), and special concern (SC).

Species common name	River segment 1	River segment 2	River segment 3	River segment 4	Lower Mill Creek	Upper Mill Creek	Elk Creek	Black Creek	Silver Creek
Number of site surveys	14	11	20	11	14	3	3	1	1
black bullhead	42.9	45.5	20.0	18.2	42.9	66.7	100.0		
black crappie		18.2	25.0	36.4	14.3	33.3			
black redhorse	7.1				7.1				
blacknose shiner	7.1	9.1	30.0		7.1		33.3	100.0	100.0
blackside darter	92.9	54.5	70.0	9.1	64.3	33.3	100.0	100.0	100.0
bluegill	21.4	18.2	65.0	63.6	42.9	66.7	100.0		
bluntnose minnow	42.9	36.4	50.0	27.3	100.0	66.7	100.0	100.0	100.0
brassy minnow	7.1						100.0		
brook silverside			10.0	9.1	7.1				
brook stickleback	7.1	9.1	5.0				33.3		
brown bullhead	14.3			18.2	7.1				
central mudminnow	57.1	36.4	5.0	9.1		100.0	100.0		
central stoneroller	14.3	27.3	30.0		28.6				100.0
channel catfish	7.1	36.4	35.0	45.5	21.4				
common carp	57.1	72.7	80.0	54.5	42.9	66.7	66.7	100.0	100.0
common shiner	64.3	36.4	45.0	18.2	71.4	100.0	33.3	100.0	100.0
creek chub	85.7	36.4	40.0		50.0		100.0	100.0	100.0
eastern sand darter (ST)		9.1							
emerald shiner			25.0	36.4	7.1				
fantail darter	14.3				35.7				
fathead minnow		9.1	5.0				33.3	100.0	100.0
freshwater drum			20.0	27.3	21.4				
gizzard shad			25.0	63.6	14.3				
golden redhorse	35.7	81.8	70.0	54.5	85.7		33.3		
golden shiner	14.3	18.2	20.0		7.1		100.0		
grass pickerel	14.3					33.3			
greater redhorse		18.2	5.0	18.2					
green sunfish	42.9	27.3	35.0	36.4	42.9	66.7	100.0		

Table 11.–Continued.

Species common name	River segment 1	River segment 2	River segment 3	River segment 4	Lower Mill Creek	Upper Mill Creek	Elk Creek	Black Creek	Silver Creek
greenside darter	35.7	27.3	35.0	9.1	35.7		33.3	100.0	100.0
hornyhead chub	7.1		10.0	9.1	57.1	66.7			
hybrid sunfish		9.1	10.0		7.1				
Iowa darter	14.3	9.1	5.0			33.3	100.0		
johnny darter	78.6	36.4	60.0	9.1	71.4	100.0	100.0	100.0	100.0
largemouth bass	7.1	18.2	30.0	63.6	21.4	66.7			
least darter								100.0	100.0
mimic shiner	21.4	27.3	25.0	27.3	28.6	33.3	33.3		
northern hog sucker	35.7	45.5	70.0	18.2	57.1				
northern logperch			30.0		35.7				
northern longear sunfish	7.1	27.3			21.4	33.3			
northern pike	71.4	72.7	30.0	36.4	50.0	33.3	66.7		
pugnose shiner (SE)				9.1	7.1				
pumpkinseed	35.7	72.7	40.0	54.5	71.4	100.0	66.7		
quillback			15.0	36.4	7.1				
rainbow darter	21.4	18.2	25.0		50.0				
redfin shiner	14.3	27.3	10.0		14.3				
river chub			15.0		14.3				
rock bass	92.9	100.0	75.0	45.5	85.7	100.0	33.3		
rosyface shiner	7.1	9.1	10.0		50.0				
round goby			5.0		7.1				
sand shiner	21.4	18.2	20.0		14.3				
shorthead redhorse		9.1	15.0	18.2	7.1				
silver redhorse	7.1	18.2	15.0	36.4	7.1				
smallmouth bass	28.6	63.6	60.0	36.4	71.4				
spotfin shiner	28.6	27.3	45.0	27.3	35.7				
spottail shiner			10.0	18.2					
spotted sucker			5.0	36.4					
stonecat	50.0	27.3	40.0	9.1	50.0	33.3		100.0	100.0
striped shiner	7.1				21.4			100.0	100.0
tadpole madtom	14.3					33.3			
walleye			15.0	36.4	7.1				

Table 11.–Continued.

Species common name	River segment 1	River segment 2	River segment 3	River segment 4	Lower Mill Creek	Upper Mill Creek	Elk Creek	Black Creek	Silver Creek
lake chubsucker			5.0						
white bass			15.0	36.4	7.1				
white crappie		36.4	35.0	9.1	14.3				
white perch			5.0			33.3			
white sucker	92.9	81.8	60.0	27.3	64.3	100.0		100.0	100.0
yellow bullhead		45.5	20.0	27.3	42.9	66.7			
yellow perch	14.3	18.2	35.0	54.5	14.3				

Table 12.–Relative abundance (fraction of total found) of native mussel species found in the Black River (St. Clair and Sanilac Counties) during summer 2003 by staff of Michigan Natural Features Inventory. Species that are state-listed are labeled endangered (SE), threatened (ST), and special concern (SC).

Common name	Scientific name	Relative abundance
elktoe (SC)	*Alasmidonta marginata*	0.041
slippershell (ST)	*Alasmidonta viridis*	0.003
threeridge	*Amblema plicata*	0.481
cylindrical papershell	*Anodontoides ferussacianus*	Shell only
spike	*Elliptio dilatata*	0.003
Wabash pigtoe	*Fusconaia flava*	0.012
wavy-rayed lampmussel (ST)	*Lampsilis fasciola*	Shell only
fatmucket	*Lampsilis siliquoidea*	0.076
pocketbook	*Lampsilis ventricosa*	0.021
white heelsplitter	*Lasmigona complanata*	0.228
creek heelsplitter	*Lasmigona compressa*	0.008
fluted-shell	*Lasmigona costata*	0.058
fragile papershell	*Leptodea fragilis*	0.008
round pigtoe (SC)	*Pleurobema sintoxia*	Shell only
pink heelsplitter	*Potamilus alatus*	0.005
kidney-shell	*Ptychobranchus fasciolaris*	0.001
giant floater	*Pyganodon grandis*	0.033
mapleleaf	*Quadrula quadrula*	0.003
salamander mussel (SE)	*Simpsonaias ambigua*	0.001
strange floater	*Strophitus undulatus*	0.018
deertoe	*Truncilla truncata*	Shell only
rainbow (SC)	*Villosa iris*	Shell only

Table 13.–Number of native mussels per square meter at five locations in the Black River during summer 2005. Beard Road is the most downstream site and Applegate Road the most upstream. Data were taken from Sweet 2005. Species that are state-listed are labeled endangered (SE), threatened (ST), and special concern (SC); federal-listed endangered are labeled (Fed E).

Common name	Scientific name	South of Beard Road (3)	Comstock and Jeddo Road (2)	Galbraith Line Road (5)	Sheridan Line Road (4)	Applegate Road (6)
three-ridge	*Amblema plicata*	0.00	0.00	0.17	0.00	4.51
Wabash pigtoe	*Fusconaia flava*	0.00	0.00	0.22	0.00	3.17
white heelsplitter	*Lasmigona complanata*	0.15	0.00	0.50	0.27	0.25
giant floater	*Pyganodon grandis*	0.00	0.00	0.00	0.00	0.38
deertoe	*Truncilla truncata*	0.37	0.00	0.00	0.00	0.00
fragile papershell	*Leptodea fragilis*	0.30	0.00	0.00	0.00	0.00
elktoe (SC)	*Alasmidonta marginata*	0.00	0.00	0.22	0.27	0.06
pink heelsplitter	*Potamilus alatus*	0.22	0.00	0.00	0.00	0.00
fluted shell	*Lasmigona costata*	0.07	0.00	0.11	0.18	0.19
fatmucket	*Lampsilis siliquoidea*	0.00	0.00	0.17	0.09	0.19
plain pocketbook	*Lampsilis cardium*	0.15	0.00	0.00	0.00	0.00
rainbow (SC)	*Villosa iris*	0.00	0.00	0.00	0.09	0.00
mapleleaf	*Quadrula quadrula*	0.07	0.00	0.00	0.00	0.00
creeper	*Strophitus undulatus*	0.07	0.00	0.00	0.00	0.00
Total		1.41	0.00	1.39	0.89	8.76
creek heelsplitter	*Lasmigona compressa*			Live in qualitative sample		
northern riffleshell (SE; Fed E)	*Epioblasma torulosa*			Dead shells only		
kidneyshell	*Ptychobranchus fasciolaris*			Dead shells only		
wavy-rayed lamp mussel (ST)	*Lampsilis fasciola*			Dead shells only		
round pigtoe (SC)	*Pleurobema sintoxia*			Dead shells only		
spike	*Elliptio dilatata*			Dead shells only		
slippershell (ST)	*Alasmidonta viridis*			Dead shells only		

Table 14.–List of reptiles and amphibians found in the Black River watershed (Harding 1997). Species that are state-listed are labeled endangered (SE), threatened (ST), and special concern (SC).

Common name	Scientific name
Turtles	
snapping turtle	*Chelydra serpentine*
common musk turtle	*Sternotherus odoratus*
spotted turtle (ST)	*Clemmys guttata*
Blanding's turtle	*Emydoidea blandingii*
common map turtle	*Graptemys geographica*
painted turtle	*Chrysemys picta*
spiny softshell	*Apalone spinifera*
Lizards	
five-lined skink	*Eumeces fasciatus*
Snakes	
northern water snake	*Nerodia sipedon*
queen snake	*Regina septemvittata*
brown snake	*Storeria dekayi*
northern red-bellied snake	*Storeria occipitomaculata occipitomaculata*
common garter snake	*Thamnophis sirtalis sirtalis*
Butler's garter snake	*Thamnophis butleri*
northern ribbon snake	*Thamnophis sauritus septentrionalis*
northern ringneck snake	*Diadophis punctatus edwardsi*
eastern hognose snake	*Heterodon platirhinos*
blue racer	*Coluber constrictor foxii*
eastern fox snake	*Elaphe vulpine gloydi*
eastern milk snake	*Lampropeltis triangulum triangulum*
eastern smooth green snake	*Opheodrys vernalis*
eastern massasauga rattlesnake	*Sistrurus catenatus catenatus*
Salamanders	
mudpuppy	*Necturus maculosus maculosus*
eastern newt	*Notophthalmus viridescens*
spotted salamander	*Ambystoma maculatum*
blue-spotted salamander	*Ambystoma laterale*
red-backed salamander	*Plethodon cinereus*
Frogs and Toads	
eastern American toad	*Bufo americanus americanus*
Blanchard's cricket frog (ST)	*Acris crepitans blanchardi*
striped chorus frog	*Pseudacris triseriata*
northern spring peeper	*Pseudacris crucifer crucifer*
gray treefrog	*Hyla versicolor*
bullfrog	*Rana catesbeiana*
green frog	*Rana clamitans melanota*
wood frog	*Rana sylvatica*
northern leopard frog	*Rana pipiens*
pickerel frog	*Rana palustris*

Table 15–List of breeding birds in the Black River watershed arranged by frequency of observed nesting activity (data compiled from Breeding Bird Atlas Explorer 2008). Species that are state-listed are labeled endangered (SE), threatened (ST), and special concern (SC).

Common name	Scientific name	Frequency
Song Sparrow	*Melospiza melodia*	86
American Robin	*Turdus migratorius*	83
European Starling	*Sturnus vulgaris*	82
Red-winged Blackbird	*Agelaius phoeniceus*	80
House Sparrow	*Passer domesticus*	79
Barn Swallow	*Hirundo rustica*	77
Mourning Dove	*Zenaida macroura*	77
Killdeer	*Charadrius vociferus*	74
Common Grackle	*Quiscalus quiscula*	73
American Goldfinch	*Cardeulis tristis*	70
Savannah Sparrow	*Passerculus sandwichensis*	69
Brown-headed Cowbird	*Molothrus ater*	67
American Crow	*Corvus brachyrhynchos*	66
Eastern Kingbird	*Tyrannus tyrannus*	66
Chipping Sparrow	*Spizella passerine*	58
Eastern Meadowlark	*Sturnella magna*	58
Cedar Waxwing	*Bombycilla cedrorum*	57
Gray Catbird	*Dumetella carolinensis*	55
Horned Lark	*Eremophila alpestris*	55
Bobolink	*Dolichonyx oryzivorus*	54
Northern Cardinal	*Cardinalis cardinalis*	54
Yellow Warbler	*Dendroica petechia*	53
Common Yellowthroat	*Geothlypis trichas*	50
Tree Swallow	*Tachycineata bicolor*	50
Blue Jay	*Cyanocitta cristata*	49
Yellow-shafted Flicker	*Colaptes auratus*	47
House Wren	*Troglodytes aedon*	46
Ring-necked Pheasant	*Phasianus colchicus*	46
Rock Pigeon	*Columba livia*	44
Wood Thrush	*Hylocichla mustelina*	44
Northern Bobwhite	*Colinus virginianus*	42
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	42
Baltimore Oriole	*Icterus galbula*	41
Brown Thrasher	*Toxostoma rufum*	40
Great Crested Flycatcher	*Myiarchus crinitus*	40
Turkey Vulture	*Cathartes aura*	40
Downy Woodpecker	*Picoides pubescens*	39
Black-capped Chickadee	*Parus atricapillus*	38
Indigo Bunting	*Passerina cyanea*	38
Red-tailed Hawk	*Buteo jamaicensis*	38
Red-eyed Vireo	*Vireo olivaceus*	37
Willow Flycatcher	*Empidonax traillii*	37
American Kestrel	*Falco sparverius*	35
Field Sparrow	*Spizella pusilla*	31
Mallard	*Anas platyrhynchos*	31
Warbling Vireo	*Vireo gilvus*	31

Table 15–Continued.

Common name	Scientific name	Frequency
Eastern Bluebird	*Sialia sialis*	29
Eastern Towhee	*Pipilo erythrophthalmus*	29
Eastern Wood-pewee	*Contopus virens*	29
White-breasted Nuthatch	*Sitta carolinensis*	29
Vesper Sparrow	*Pooecetes gramineus*	28
Belted Kingfisher	*Ceryle alcyon*	27
Bank Swallow	*Riparia riparia*	26
Great Blue Heron	*Ardea herodias*	25
Eastern Phoebe	*Sayornis phoebe*	24
Northern Harrier (SC)	*Circus cyaneus*	24
Ruby-throated Hummingbird	*Archilochus colubris*	23
Green Heron	*Butorides striatus*	22
Tufted Titmouse	*Parus bicolor*	21
Eastern Screech-owl	*Otus asio*	20
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	20
Ovenbird	*Seiurus aurocapillus*	20
Chimney Swift	*Chaetura pelagica*	19
Red-bellied Woodpecker	*Melanerpes carolinus*	19
Canada Goose	*Branta canadensis*	18
House Finch	*Carpodacus mexicanus*	18
Spotted Sandpiper	*Actitis macularia*	18
Veery	*Catharus fuscescens*	18
American Redstart	*Setophaga ruticilla*	17
American Woodcock	*Scolopax minor*	17
Hairy Woodpecker	*Picoides villosus*	17
Wood Duck	*Aix sponsa*	17
Cliff Swallow	*Petrochelidon pyrrhonata*	16
Purple Martin	*Progne subis*	16
Least Flycatcher	*Epidonax minimus*	15
Northern Flicker	*Colaptes auratus*	15
Red-headed Woodpecker	*Melanerpes erythrocephalus*	15
Black-billed Cuckoo	*Coccyzus erythropthalmus*	12
Blue-gray Gnatcatcher	*Polioptila caerulea*	12
Scarlet Tanager	*Piranga olivacea*	12
Wild Turkey	*Meleagris gallopavo*	12
Mourning Warbler	*Oporornis philadelphia*	11
Blue-winged Warbler	*Vermivora pinus*	10
Alder Flycatcher	*Empidonax alnorum*	9
Chestnut-sided Warbler	*Dendroica pensylvanica*	8
Grasshopper Sparrow (SC)	*Ammodramus savannarum*	8
Great Horned Owl	*Bubo virginianus*	8
Purple Finch	*Carpodacus purpureus*	8
Ruffed Grouse	*Bonasa umbellus*	8
Swamp Sparrow	*Melospiza georgiana*	8
Yellow-billed Cuckoo	*Coccyzus americanus*	8
Brewer’s Blackbird	*Euphagus cyanocephalus*	7
Cooper’s Hawk (SC)	*Accipiter cooperii*	7
Black-and-white Warbler	*Mniotilta varia*	6

Table 15–Continued.

Common name	Scientific name	Frequency
Ring-billed Gull	*Larus delawarensis*	6
Sedge Wren	*Cistothorus platensis*	6
Upland Sandpiper	*Bartramia longicauda*	6
Clay-colored Sparrow	*Spizella pallida*	5
Golden-winged Warbler	*Vermivora chrysoptera*	5
Sandhill Crane	*Grus canadensis*	5
Sora	*Porzana carolina*	5
Yellow-throated Vireo	*Vireo flavifrons*	5
Black-throated Green Warbler	*Dendroica virens*	4
Blue-winged Teal	*Anas discors*	4
Common Nighthawk	*Chordeiles minor*	4
Marsh Wren (SC)	*Cistothorus palustris*	4
Nashville Warbler	*Vermivora ruficapilla*	4
Acadian Flycatcher	*Empidonax virescens*	3
Broad-winged Hawk	*Buteo platypterus*	3
Henslow's Sparrow (SE)	*Ammodramus henslowii*	3
Lincoln's Sparrow	*Melospiza lincolnii*	3
Orchard Oriole	*Icterus spurius*	3
Pied-billed Grebe	*Podilymbus podiceps*	3
Pileated Woodpecker	*Dryocopus pileatus*	3
Red-shouldered Hawk (ST)	*Buteo lineatus*	3
Whip-poor-will	*Caprimulgus vociferus*	3
Wilson's Snipe	*Gallinago gallinago*	3
American Coot	*Fulica americana*	2
Blackburnian Warbler	*Dendroica fusca*	2
Brown Creeper	*Certhia americana*	2
Cerulean Warbler (ST)	*Dendroica cerulean*	2
Dark-eyed Junco	*Junco hyemalis*	2
Dickcissel (SC)	*Spiza americana*	2
Magnolia Warbler	*Dendroica magnolia*	2
Northern Parula	*Parula americana*	2
Northern Shoveler	*Anas clypeata*	2
Northern Waterthrush	*Seiurus noveboracensis*	2
Pine Warbler	*Dendroica pinus*	2
Sharp-shinned Hawk	*Accipiter striatus*	2
White-throated Sparrow	*Zonotrichia albicollis*	2
Yellow-breasted Chat	*Icteria virens*	2
Yellow-rumped Warbler	*Dendroica coronata*	2
Bald Eagle	*Heliaeetus leucocephalus*	1
Barred Owl	*Strix varia*	1
Black-throated Blue Warbler	*Dendroica caerulescens*	1
Blue-headed Vireo	*Vireo solitarius*	1
Brewster's Warbler	*Vermivora sp. hybrid*	1
Canada Warbler	*Wilsonia canadensis*	1
Carolina Wren	*Thryotherus ludovicianus*	1
Common Merganser	*Mergus merganser*	1
Common Moorhen	*Gallinula chloropus*	1
Forster's Tern (ST)	*Sterna forsteri*	1

Table 15–Continued.

Common name	Scientific name	Frequency
Green-winged Teal	*Anas crecca*	1
Hooded Merganser	*Laphodytes cucullatus*	1
Hooded Warbler (SC)	*Wilsonia citrine*	1
Louisiana Waterthrush (SC)	*Seiurus motacilla*	1
Northern Mockingbird	*Mimus polyglottos*	1
Northern Pintail	*Anas acuta*	1
Northern Saw-whet Owl	*Aegolius acadicus*	1
Olive-sided Flycatcher	*Contopus cooperi*	1
Palm Warbler	*Dendroica palmarum*	1
Redhead	*Aythya americana*	1
Ruddy Duck	*Oxyura jamaicensis*	1
Short-eared Owl (SE)	*Asio flammeus*	1
Virginia Rail	*Rallus limicola*	1
Winter Wren	*Troglodytes troglodytes*	1
Yellow-bellied Sapsucker	*Sphyrapicus varius*	1

Table 16.–List of 42 mammals found in the Black River watershed (Burt 1957). Species that are state-listed are labeled endangered (SE), threatened (ST), and special concern (SC).

Common name	Scientific name
opossum	*Didelphis marsupialis*
eastern mole	*Scalopus aquaticus*
starnose mole	*Condylura cristata*
masked shrew	*Sorex cinereus*
least shrew (ST)	*Cryptotis parva*
shorttail shrew	*Blarina brevicauda*
little brown bat	*Myotis lucifugus*
Indiana bat (SE)	*Myotis sodalis*
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 nivalis*
mink	*Mustela vison*
river otter	*Lutra canadensis*
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	*Tamiascuirus hudsonicus*
eastern gray squirrel	*Sciurus carolinensis*
eastern fox squirrel	*Sciurus niger*
southern flying squirrel	*Glaucomys volans*
beaver	*Castor canadensis*
deer mouse	*Peromyscus manicultatus*
white-footed mouse	*Peromyscus leucopus*
southern bog lemming	*Synaptomys cooperi*
meadow vole	*Microtus pennsylvanicus*
woodland (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*

Table 17.–Numbers of eight fish species stocked each year in the Black River watershed by the Michigan Department of Natural Resources. These fish were stocked in the lower section of Mill Creek, three sections of the Black River, and 40th Street Pond to boost their local populations and improve sport fishing success.

Year stocked	Species	Number stocked	River section	Number of sites
1992	Black crappie	75	Section 2	1
1980	Bluegill	18,000	Section 4	1
1980	Channel catfish	44	Section 4	1
1982	Channel catfish	91	Section 2	2
1983	Channel catfish	70	Section 2	1
1986	Channel catfish	44,000	Section 2	5
1986	Channel catfish	52,017	Section 3	5
1987	Channel catfish	14,390	Section 2	4
1987	Channel catfish	23,860	Section 3	5
1988	Channel catfish	17,070	Section 2	4
1988	Channel catfish	23,860	Section 3	5
1979	Largemouth bass	3,600	Section 4	1
1980	Largemouth bass	1,560	Section 4	1
1991	Largemouth bass	67	Section 4	1
1992	Largemouth bass	39	Section 4	1
2001	Largemouth bass	48	Section 4	1
1980	Northern pike	66,250	Section 4	1
1986	Northern pike	16,500	Section 2	4
1986	Northern pike	17,500	Section 3	5
1987	Northern pike	4,870	Section 2	2
1987	Northern pike	3,350	Section 3	1
1988	Northern pike	1,000	Section 2	1
1988	Northern pike	4,310	Section 3	2
1991	Northern pike	3,000	Section 2	1
1991	Northern pike	4,500	Section 4	1
1993	Northern pike	1,500	Section 2	1
1993	Northern pike	2,250	Section 4	1
1993	Redear sunfish	20,979	40th Street Pond	1
1994	Redear sunfish	10,000	40th Street Pond	1
1995	Redear sunfish	20,912	40th Street Pond	1
1984	Smallmouth bass	5,442	Lower Mill Creek	10
1986	Smallmouth bass	262	Section 2	2
1986	Smallmouth bass	262	Section 3	2
1986	Walleye	600	Section 2	1
1986	Walleye	22	Section 3	1
1987	Walleye	2,558	Section 2	3

Table 18.–Number of rainbow trout stocked each year in the Black River watershed by the Michigan Department of Natural Resources. These fish were stocked in the lower section of Mill Creek and Black River to encourage their use of suitable habitat in the St. Clair River and southern Lake Huron.

Year stocked	Number stocked	River section	Number of sites
1981	30,000	Lower Mill Creek	1
1982	20,000	Lower Mill Creek	2
1983	20,000	Lower Mill Creek	1
1984	10,000	Lower Mill Creek	1
1985	15,000	Lower Mill Creek	1
1986	20,000	Lower Mill Creek	1
1987	20,020	Lower Mill Creek	1
1987	8,640	Segment 4	1
1988	17,300	Lower Mill Creek	1
1989	14,310	Lower Mill Creek	1
1989	30,000	Segment 4	1
1990	12,920	Lower Mill Creek	1
1991	12,800	Lower Mill Creek	1
1992	14,000	Lower Mill Creek	1
1993	14,500	Lower Mill Creek	1
1994	15,850	Lower Mill Creek	1
1995	14,500	Lower Mill Creek	2
1996	14,500	Lower Mill Creek	1
1997	16,000	Lower Mill Creek	1
1998	15,084	Lower Mill Creek	1
1999	15,580	Lower Mill Creek	1
2000	15,397	Lower Mill Creek	1
2001	15,000	Lower Mill Creek	1
2002	15,752	Lower Mill Creek	1
2003	16,002	Lower Mill Creek	1
2004	16,000	Lower Mill Creek	1
2005	10,200	Lower Mill Creek	1
2006	11,094	Lower Mill Creek	1
2007	10,100	Lower Mill Creek	1

Table 19.–Number of brown trout stocked each year in the Black River watershed by the Michigan Department of Natural Resources. These fish were stocked in Segment 4 of the river to encourage their use of suitable habitat in the St. Clair River and southern Lake Huron.

Year stocked	Number stocked	Number of sites
1980	2,500	1
1981	25,000	1
1982	22,500	1
1983	20,000	2
1984	38,000	2
1985	35,600	2
1986	49,800	2
1987	35,100	2
1988	20,044	2
1989	40,180	2
1990	19,998	3
1991	25,000	1
1992	19,400	1
1993	35,402	2
1994	20,180	2
1995	18,550	1
1996	18,742	1
1997	19,995	1
1998	19,500	1
1999	19,990	1
2000	23,980	2
2001	16,000	2
2002	22,600	2
2003	24,000	2
2004	20,000	1
2005	20,000	1
2006	25,000	3
2007	6,433	1

Table 20.–Partner agencies, current activities, and products implemented by St. Clair County to increase public awareness of watershed issues and management plans (Jurs 2005).

Partner agencies
Blue Water Land Conservancy
Binational Public Advisory Council (BPAC)
East Michigan Environmental Action Council
Friends of the St. Clair River
Michigan Farmland and Community Alliance
Michigan Farm Bureau
Southeast Michigan Land Conservancy
United States Department of Agriculture
USFWS Partners for Fish and Wildlife Program
Michigan Department of Environmental Quality
Activities and products
Blue Water*shed* Newsletter
Watershed Management Brochure
Southeast Michigan Partners for Clean Water Mass Media Efforts
Tributary /Watershed Road Signs
River Day
Earth Fair
“Water Quality” Table-Top Exhibit
Municipal Newsletter Articles
Storm Water Website
“Adopt-A-Stream” Program
MDEQ Pollution Prevention Programs
Storm Drain/Curb Marking Program
“Pollution Solutions” Presentation
24-Hour Water Quality Hotline
OSDS Maintenance Brochure
IDEP Brochure
Water Quality Magnet
“Improving Water Quality” Presentations
Children’s Activity Booklet
Household Hazardous Waste Collection Program
Riparian Management Brochure
Beach Brochure
Home *A*Syst Workshops
Chamber of Commerce materials
WAG Meetings

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APPENDICES

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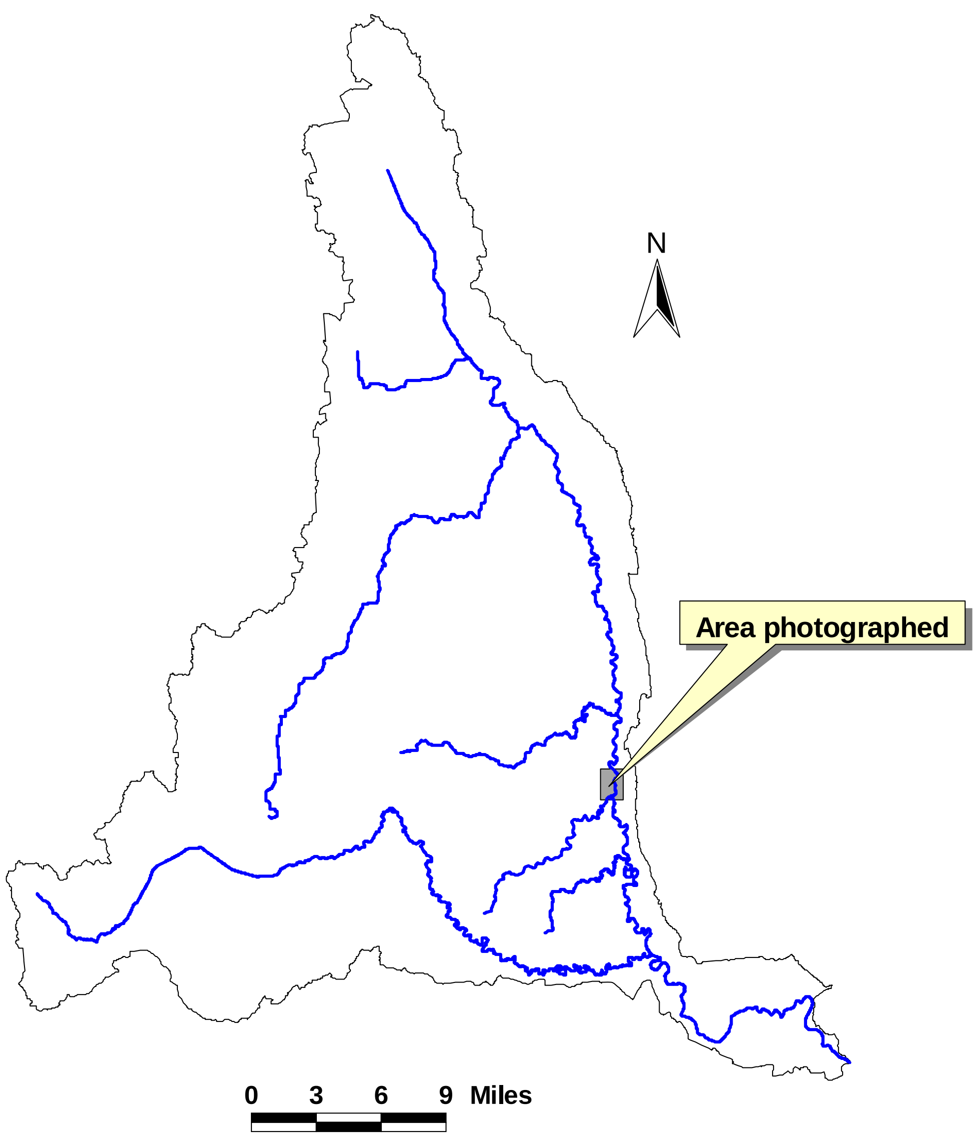
Appendix A

Aerial photographs of a 1,216 acre area along the mainstem of the Black River

This appendix contains eight historical and recent aerial photographs of the same 1,216 acre area bordering a 2.1 mile stretch of the Black River. These photographs document very significant changes to the landscape and river channel caused by development and operation of a large sand and gravel surface mine that is currently expanding mining operations to the south along the river.



First of eight aerial photos of the Black River at Fisher Rd. in September of 1941.

Second of eight aerial photos of the Black River at Fisher Rd. in October of 1949.

Third of eight aerial photos of the Black River at Fisher Rd. in September of 1963.

Fourth of eight aerial photos of the Black River at Fisher Rd. A mining operation is apparent with heavy silt loading into the river in May, 1971.

Fifth of eight aerial photos of the Black River at Fisher Rd. The mining operation has expanded with modifications apparent in the river channel in September, 1980.

Sixth of eight aerial photos of the Black River at Fisher Rd. The mining operation has continued to expand by May, 1982.

Seventh of eight aerial photos of the Black River at Fisher Rd. The mining operation has continued to expand with large ponds visibly connected to the river in 1998.

Eighth of eight aerial photos of the Black River at Fisher Rd. The mining operation has made apparent improvements to the river channel and disconnected ponds from the river in 2005.

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Appendix B

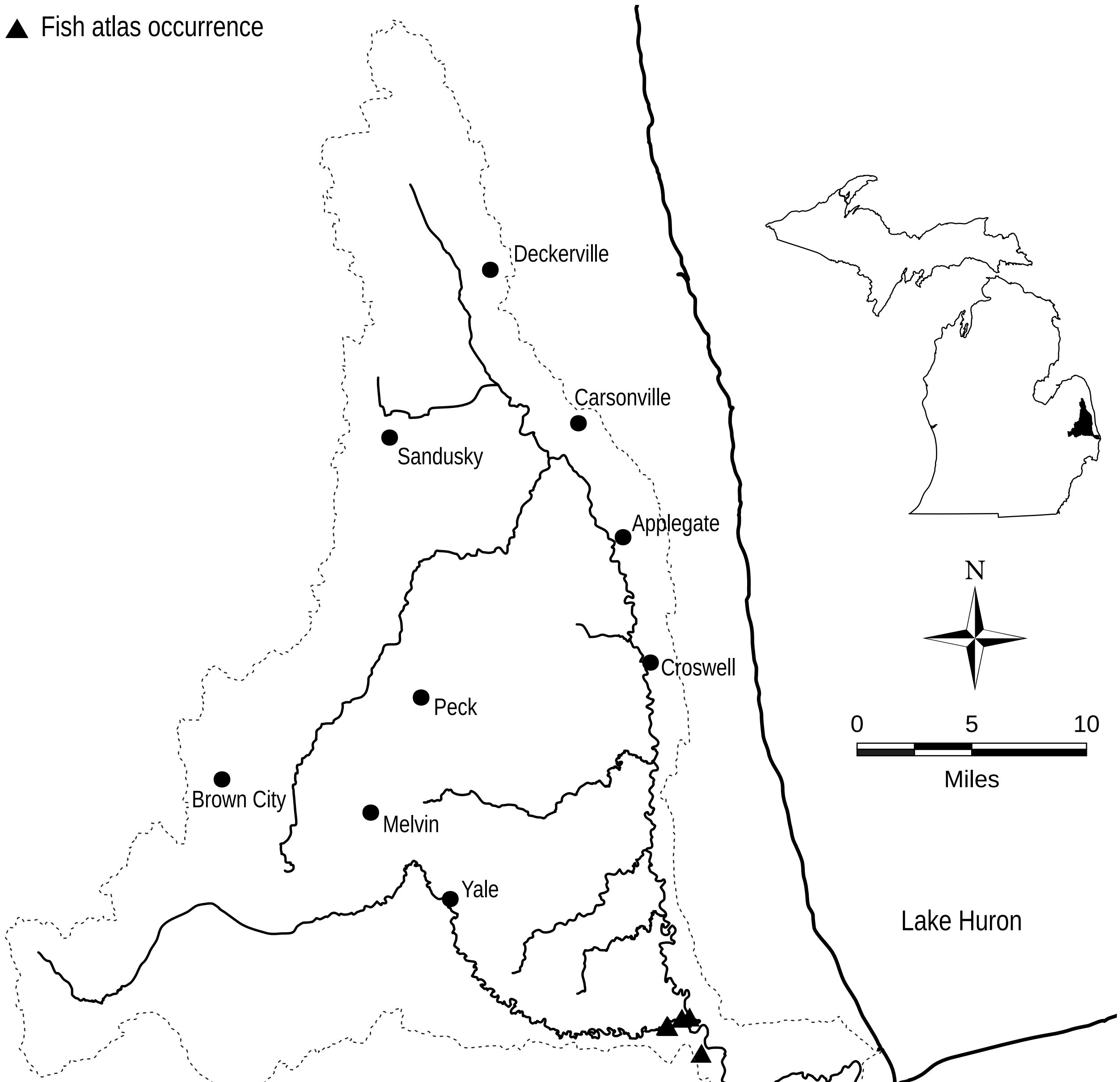
Abundance and presence/absence data for fish in the Black River watershed.

This appendix contains known past and present fish distributions (except for four species of lamprey and two species of trout shown in the main report) in the Black River system. Distributions of fishes were compiled from records located at the University of Michigan Museum of Zoology, Michigan Department of Natural Resources Institute for Fisheries Research, and from the Michigan Department of Natural Resources Lake Erie Management Unit. Specific locations and density estimates were generated and plotted by the author. Exotic species are noted following their species name.

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), Fishes of the Great Lakes Region (Hubbs and Lagler 1947), and Kraft et al. 2006.

Images of fish species were provided by the New York State Department of Environmental Conservation (Kraft et al. 2006).

APPENDIX B INDEX

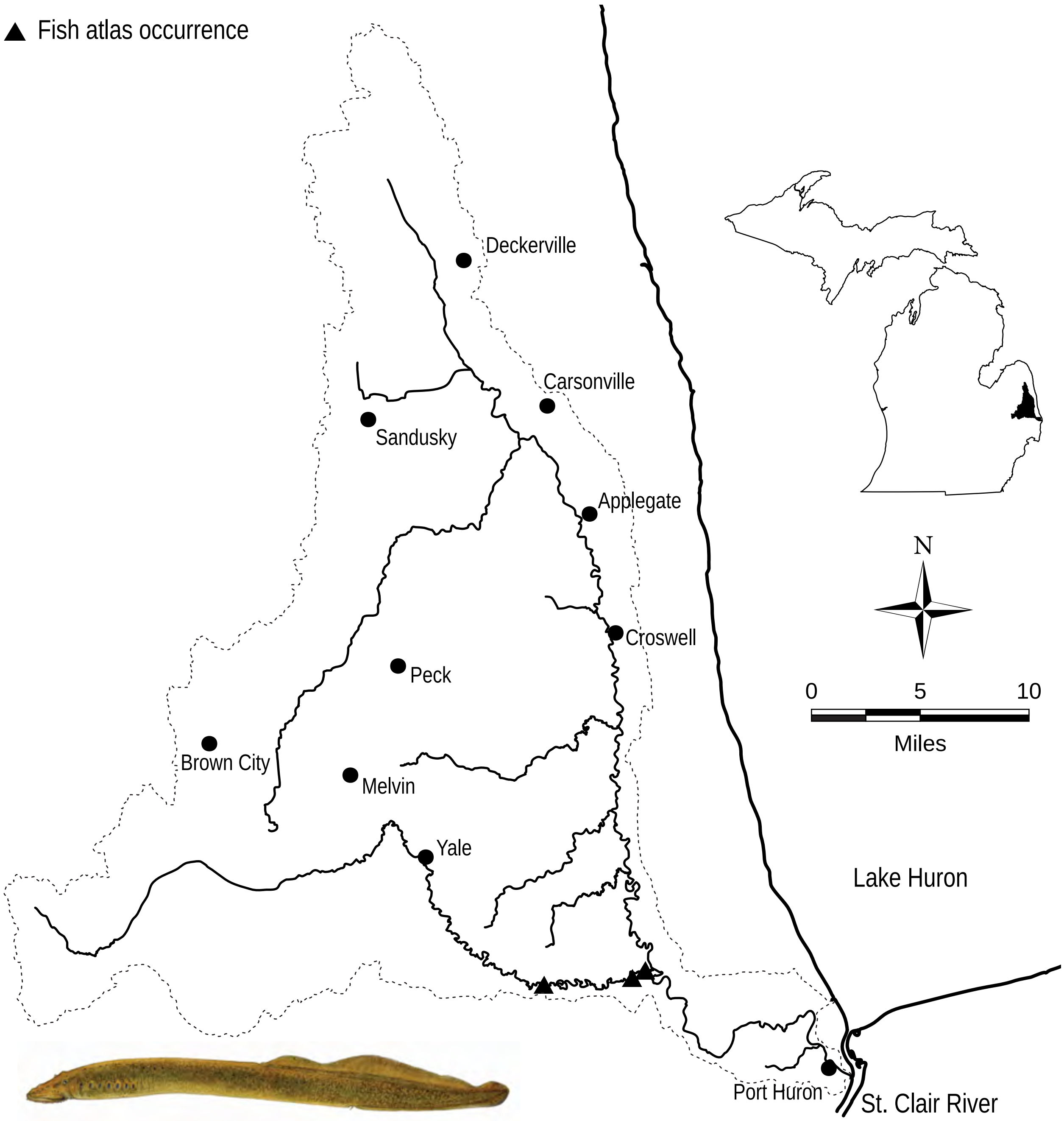


Northern brook lamprey (*Ichthyomyzon fossor*)

Habitat**:**

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

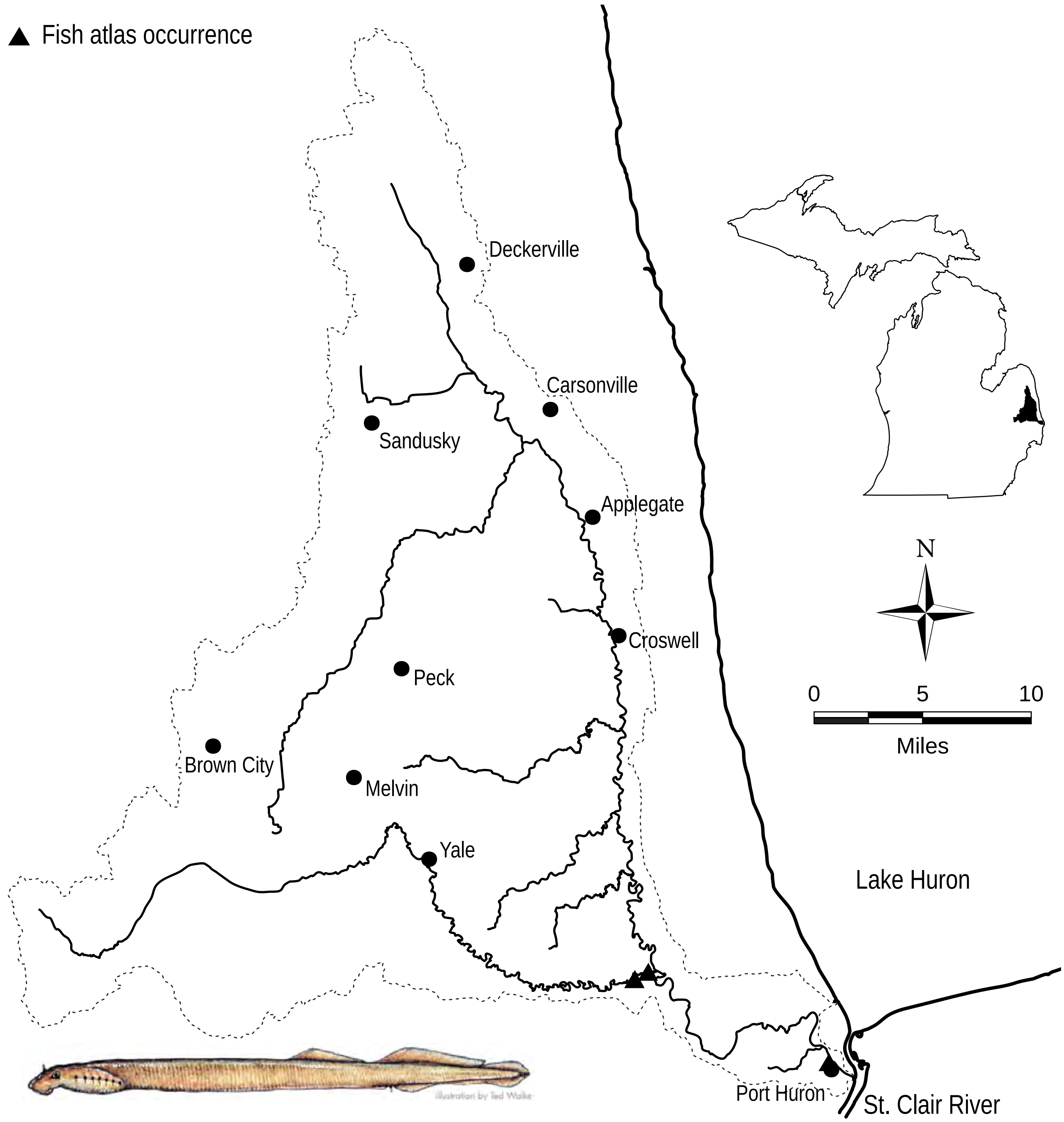
spawning - clear, high gradient streams (<15 feet wide)
- riffles with sand or gravel substrate



Silver lamprey *(Ichthyomyzon unicuspis)*

Habitat**:**

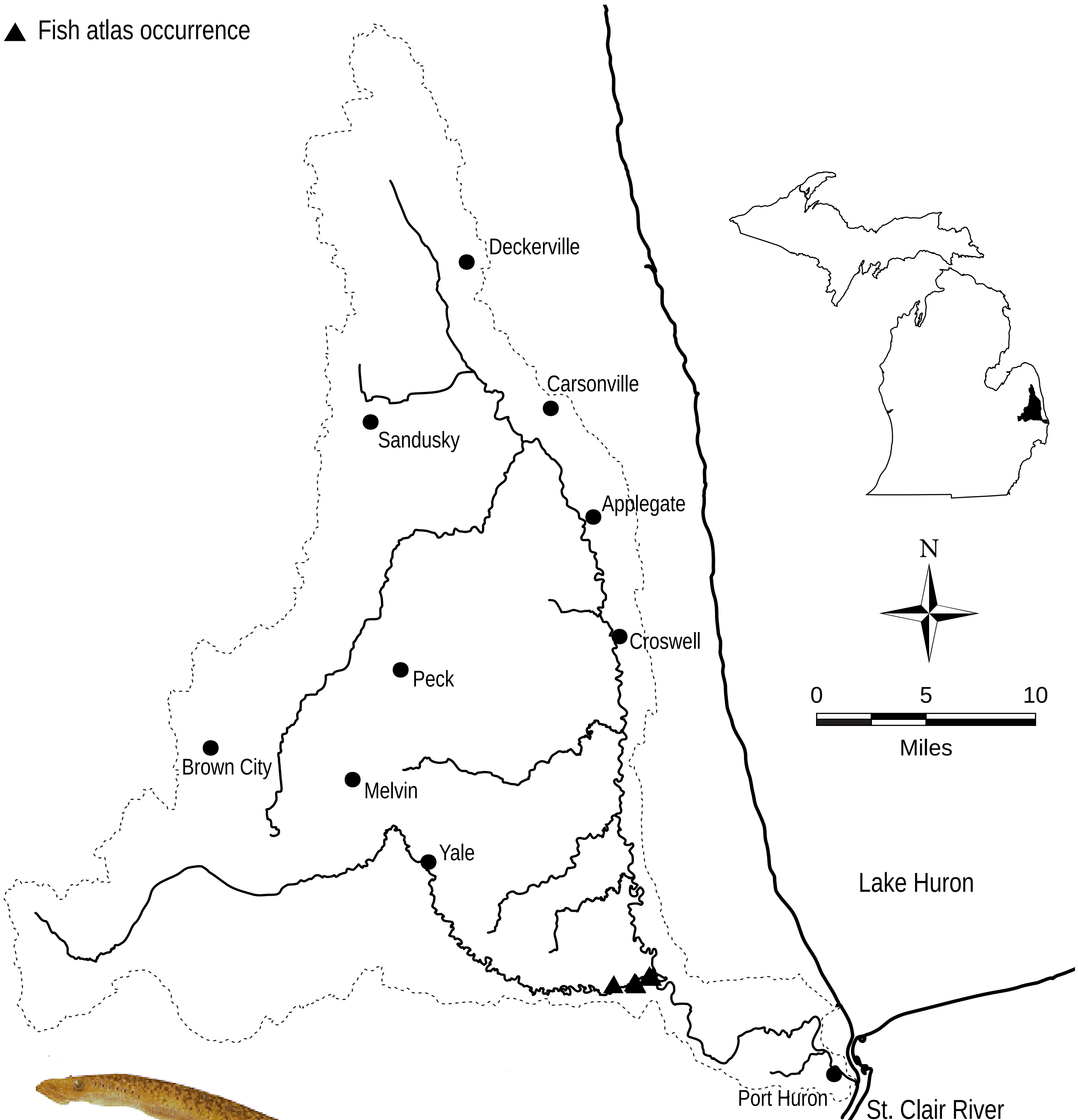
feeding	-	young: sand, muck, or organic debris substrate
	-	adults: clear river water with prey species
spawning	-	gravel and sand substrate
	-	moderate gradient
	-	moderate size stream
	-	cannot tolerate silt
	-	no dams
winter refuge	-	amnocetes burrow for 4 to 7 years in mud and silt at river margins



American brook lamprey *(Lampetra appendix)*

Habitat**:**

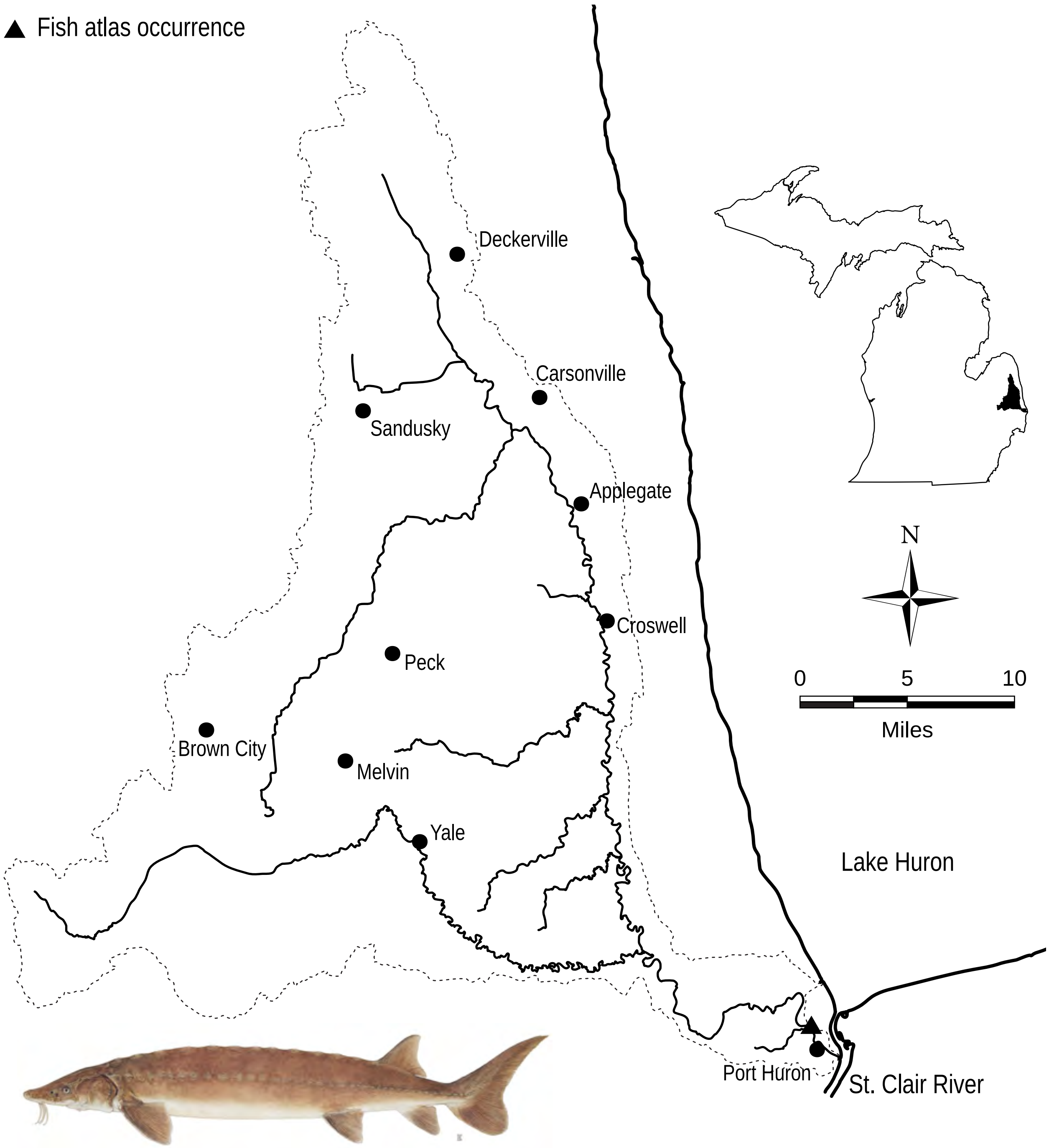
feeding	-	young: low gradient, substrate with bars and beds of mixed sand and organic debris
	-	clear cool stream water, sensitive to turbidity
spawning	-	clear, high gradient streams (>15 feet wide)
	-	cold water
	-	gravel substrate
winter refuge	-	sand or silt substrate for amnocetes



Sea lamprey (*Petromyzon marinus*)

Habitat**:**

feeding	-	young: substrate with beds of sand mixed with organic debris
	-	cannot tolerate silt
	-	adults: clear cool water of Lake Michigan
spawning	-	no dams
	-	riffles with sand and gravel substrates

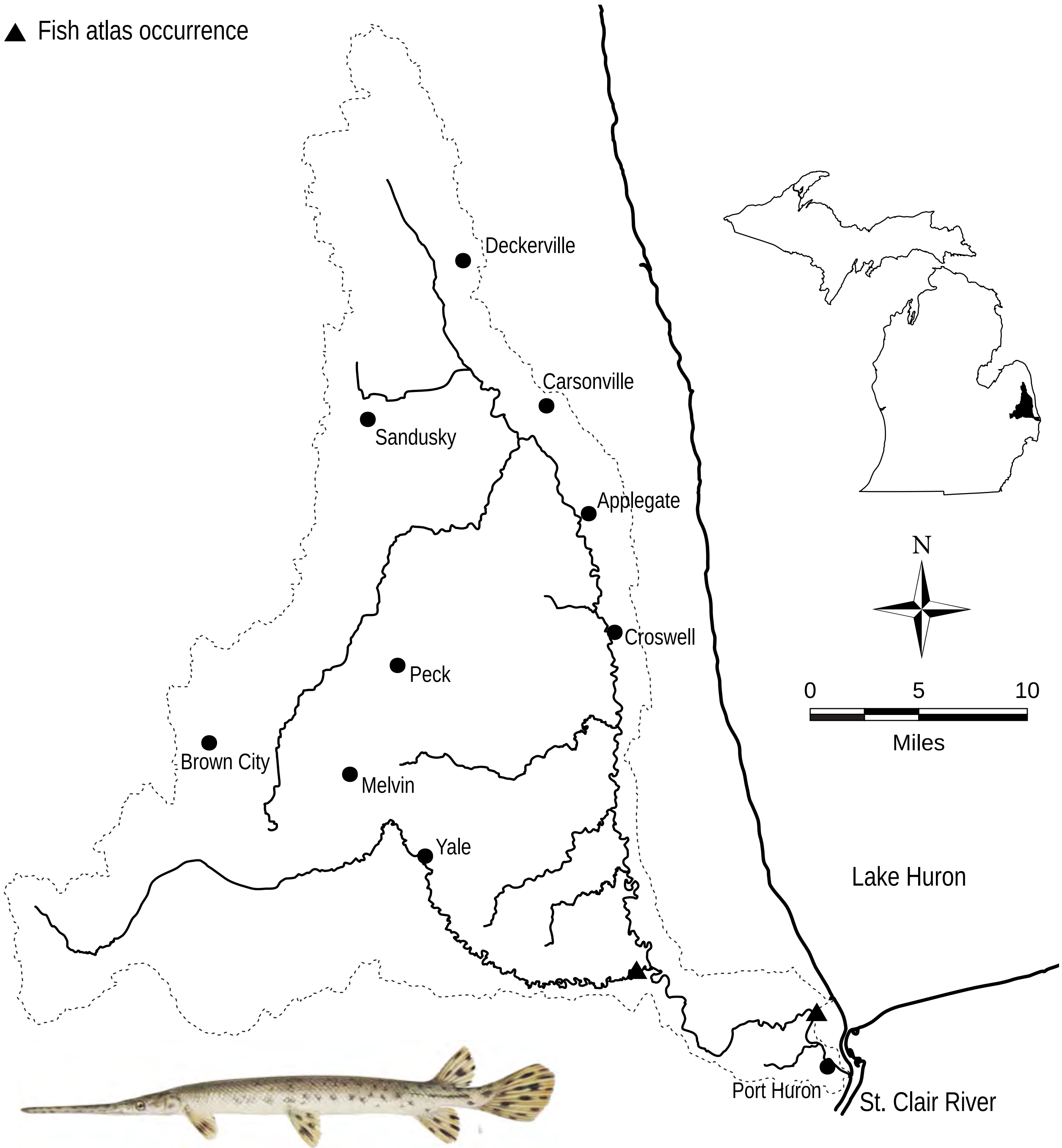


Lake sturgeon (*Acipenser fulvescens*) - threatened

Habitat:

feeding - shoal areas of large rivers, lakes, and impoundments
- gravel, sand, rock substrates

spawning - in or before rapids, at the base of dams in rivers
- in 2-15 feet of water
- swift current
- rocky ledges or around rocky islands in Great Lakes

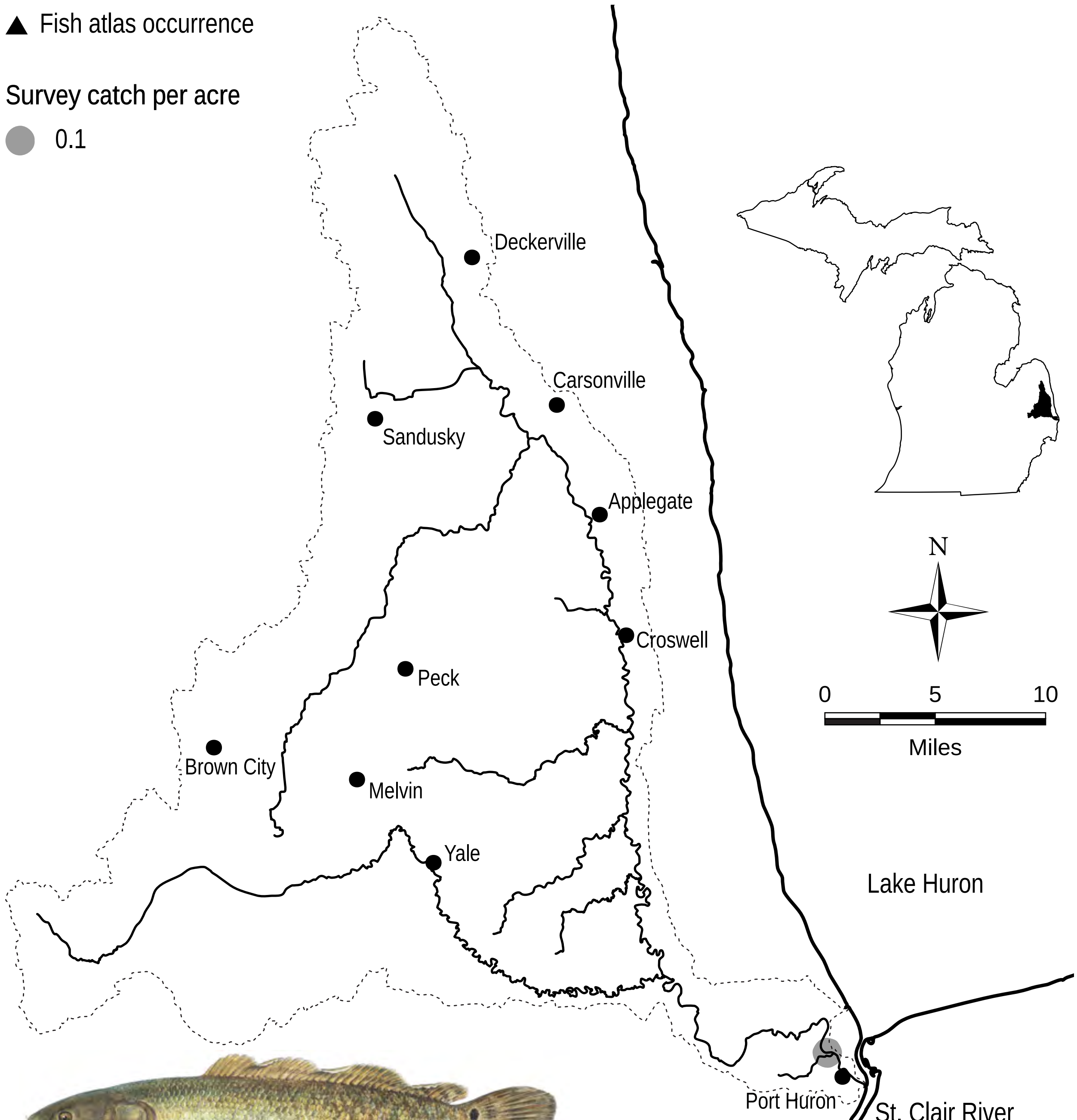


Longnose gar (*Lepisosteus osseus*)

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

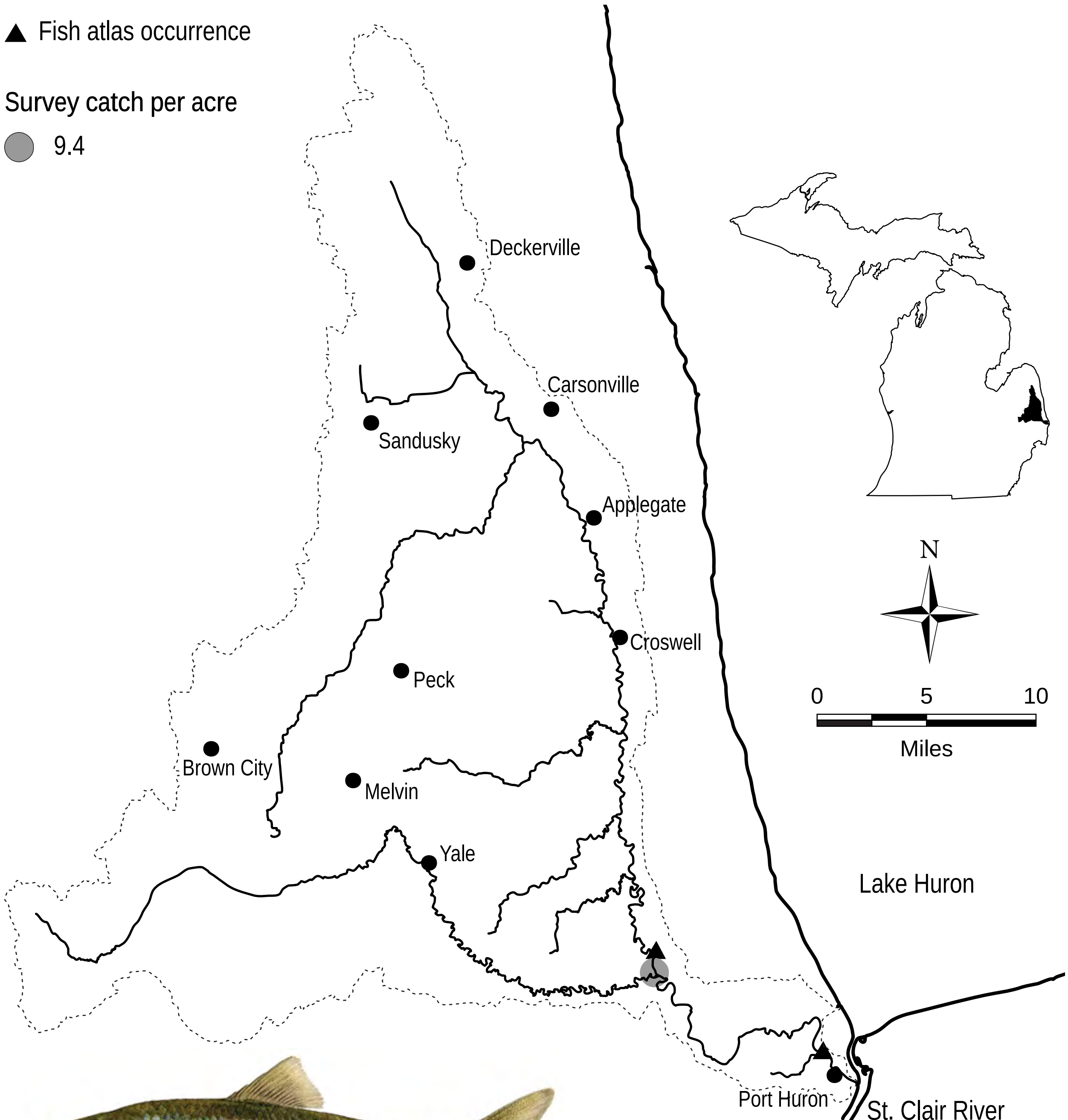
spawning - warm shallow water of lakes or streams over vegetation



Bowfin (*Amia calva*)

Habitat:

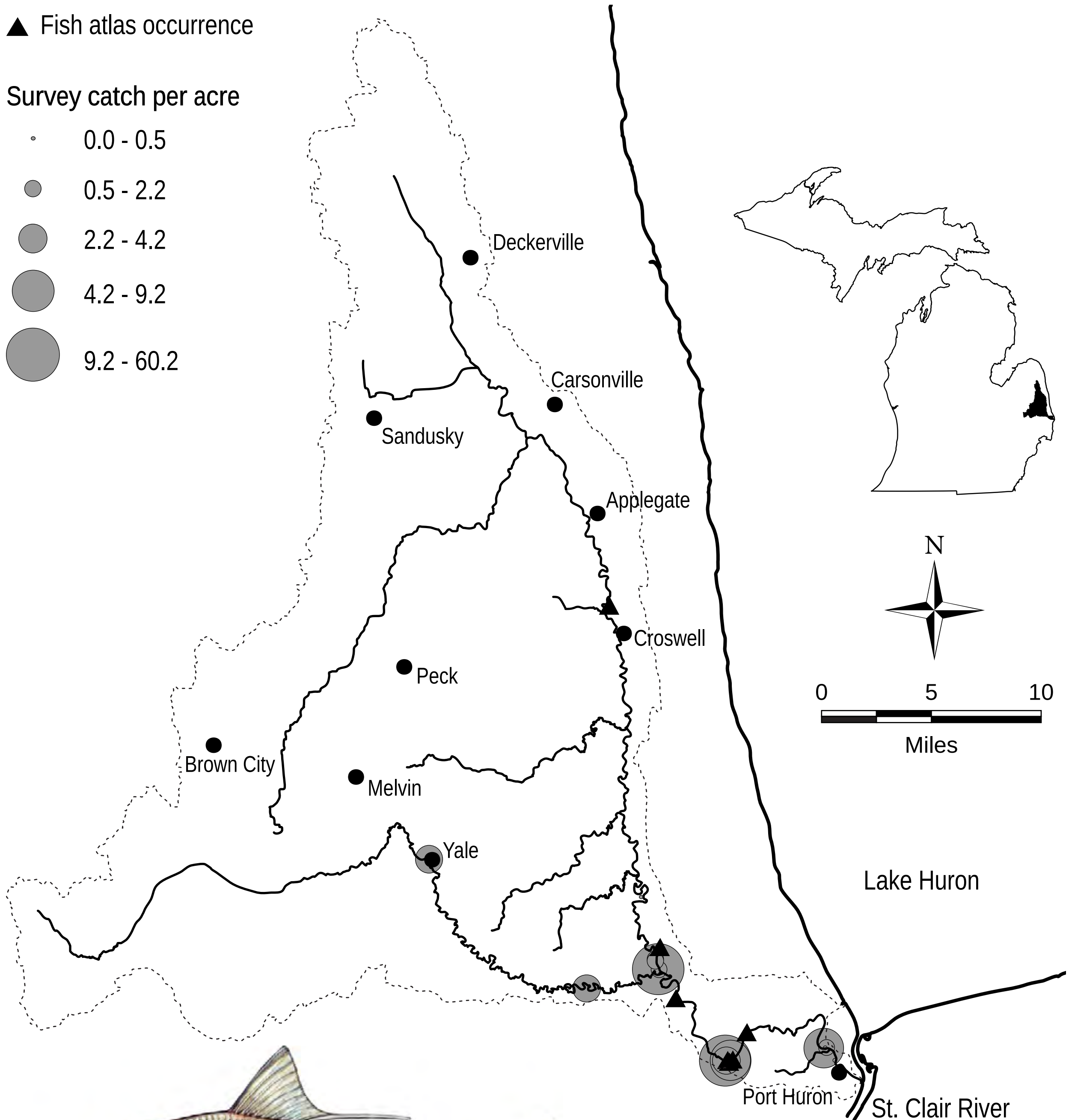
feeding	-	clear water
	-	abundant rooted aquatic vegetation
	-	low gradient streams, lakes, and impoundments
	-	tolerate only small amount of silt
spawning	-	need vegetated water, 1 to 2 feet deep
	-	can spawn under logs, stumps, or bushes
winter refuge	-	gravelly pockets among aquatic vegetation

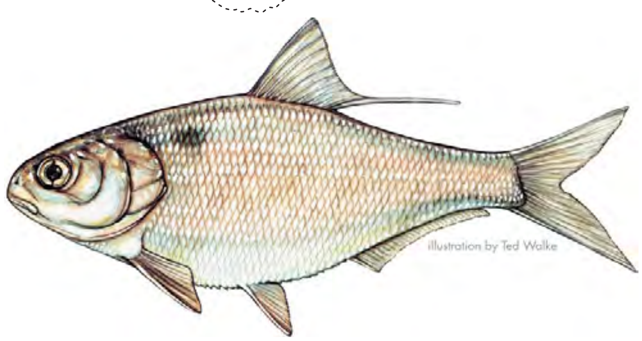


Alewife (*Alosa pseudoharengus*)

Habitat**:**

- feeding - adults: deep water of Lake Michigan
  - young: shallow water of Lake Michigan
  - prefers warmer waters
- spawning - streams or shallow beaches of lake
  - sand or gravelly substrate
- winter refuge - deep water



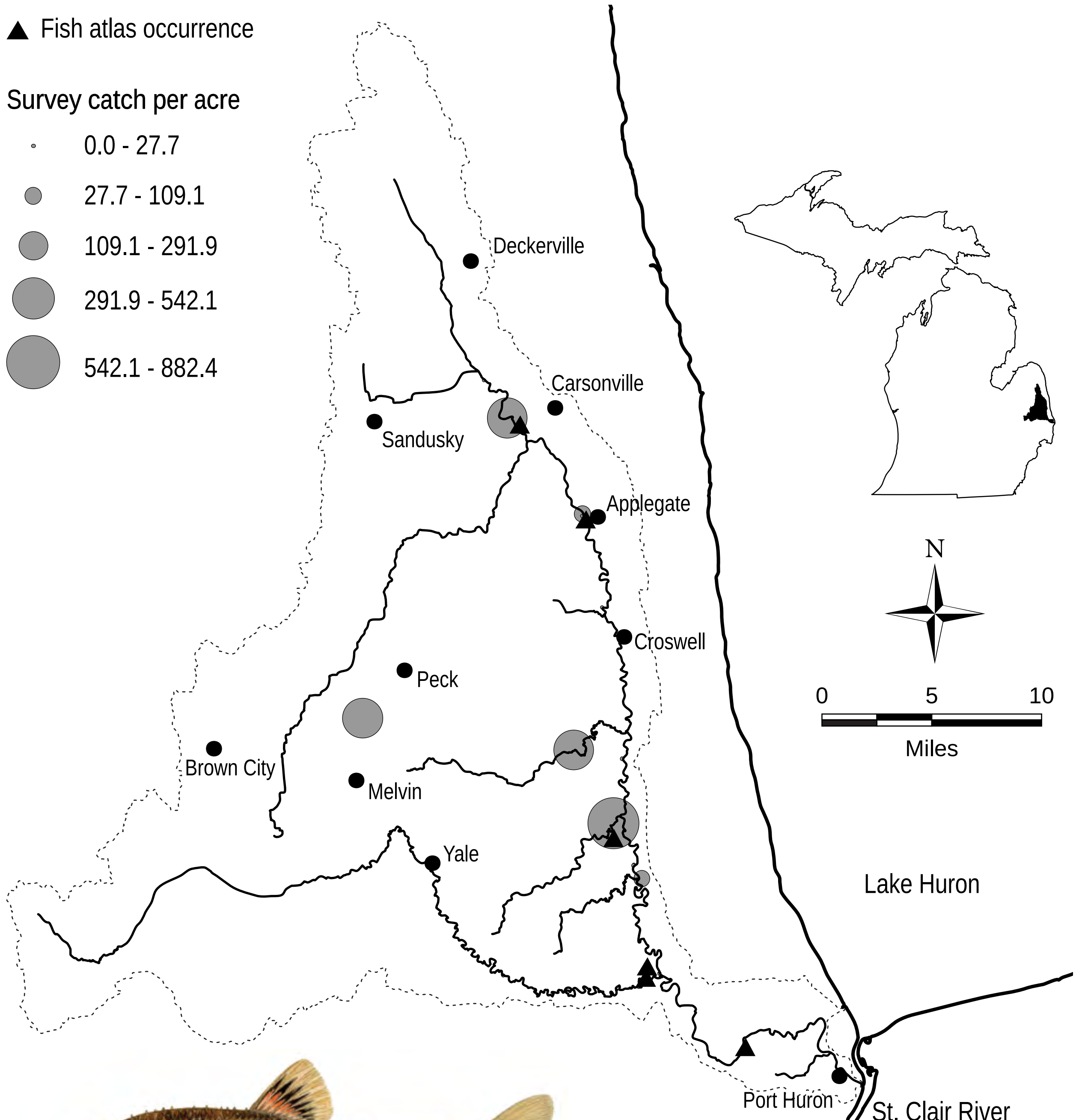


Gizzard shad (*Dorosoma cepedianum*)

Habitat**:**

feeding - large streams with low gradient, impoundments
- tolerant of clear and turbid water

spawning - shallow areas of ponds, lakes, and large rivers
- low gradient

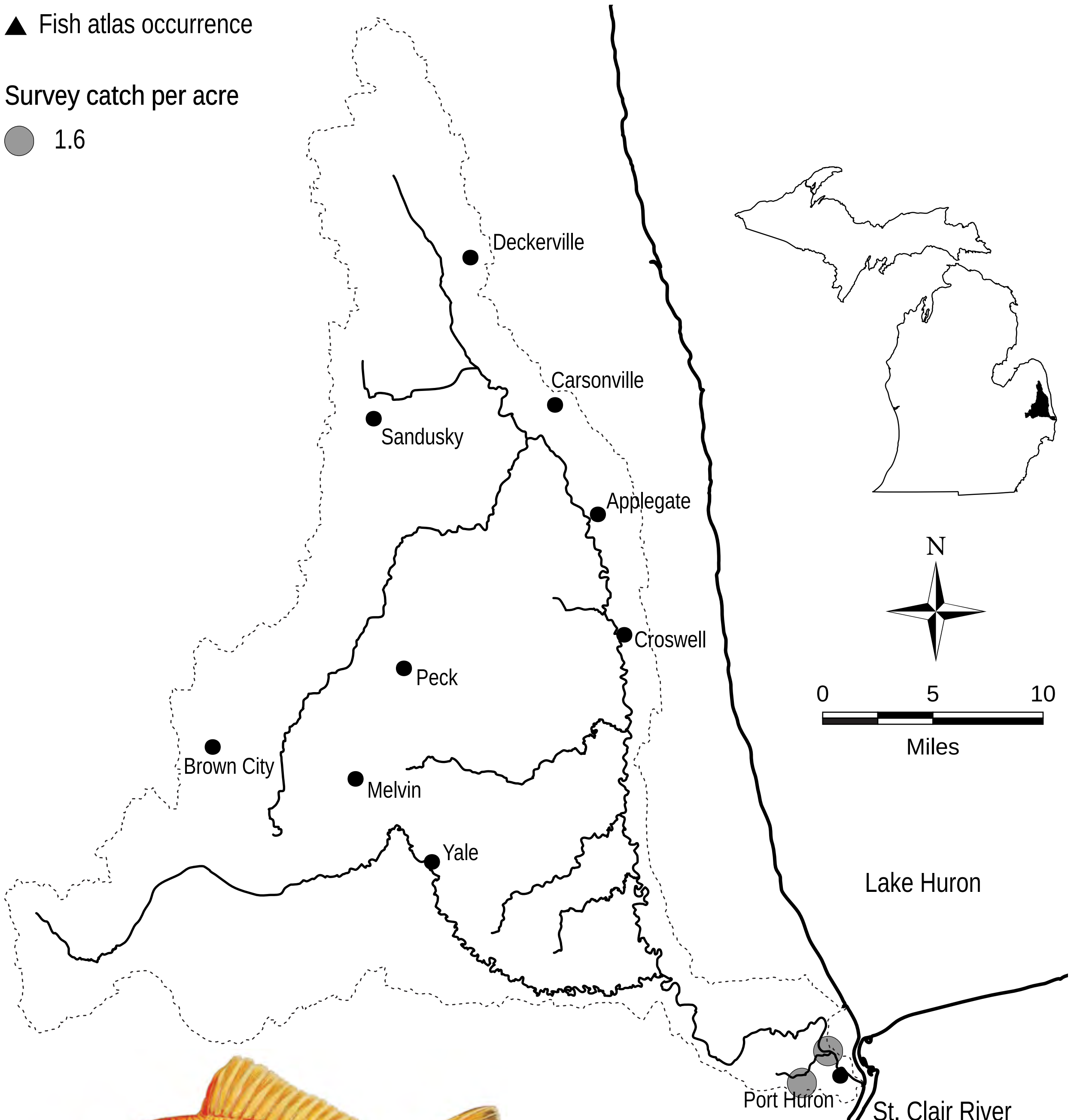


Central stoneroller (*Campostoma anomalum pullam*)

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

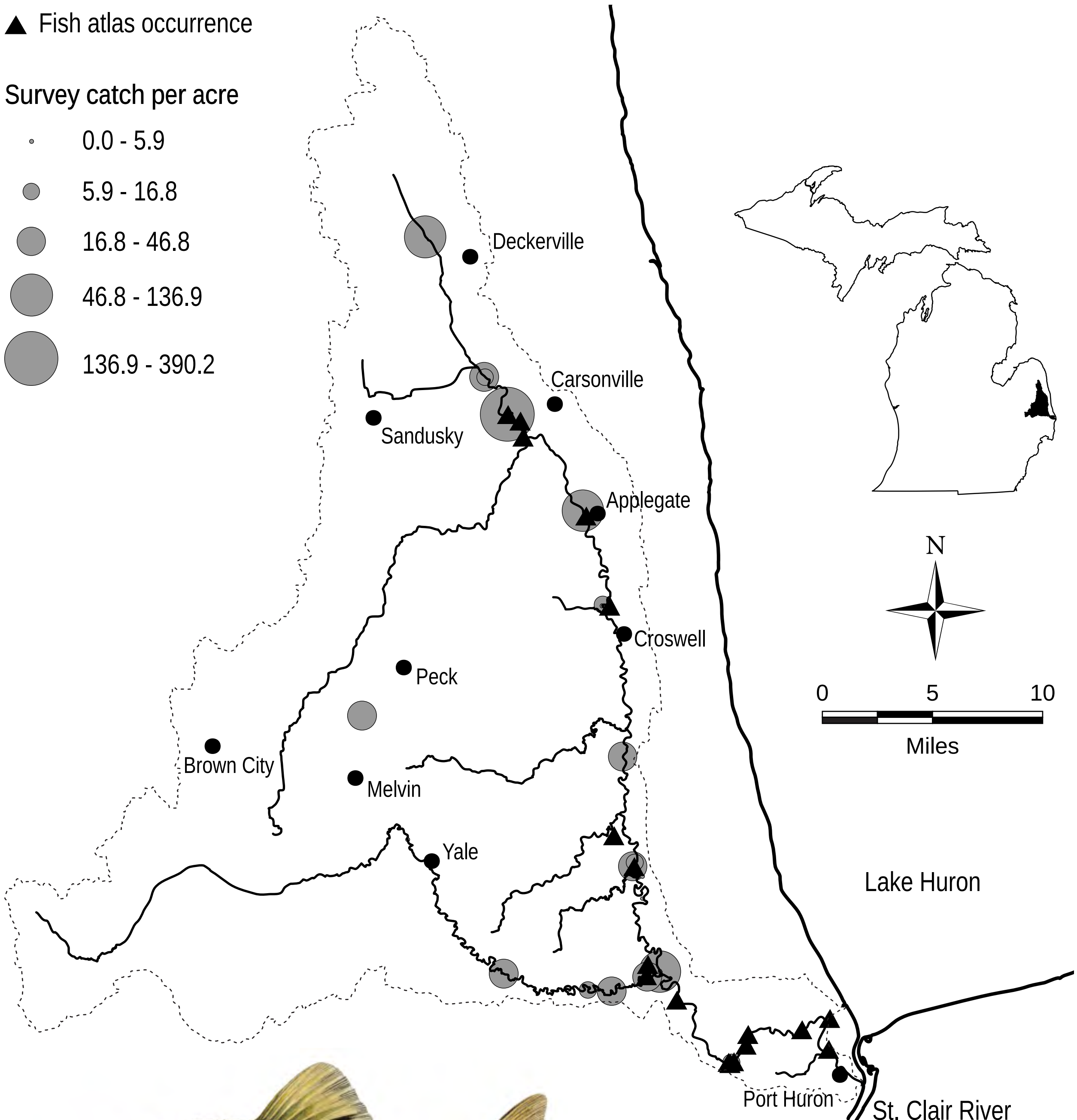


Goldfish (*Carassius auratus*)

Habitat**:**

feeding - vegetation
- low gradient, shallow, warm water streams, rivers, lakes, and impoundments
- tolerates some turbidity and siltation

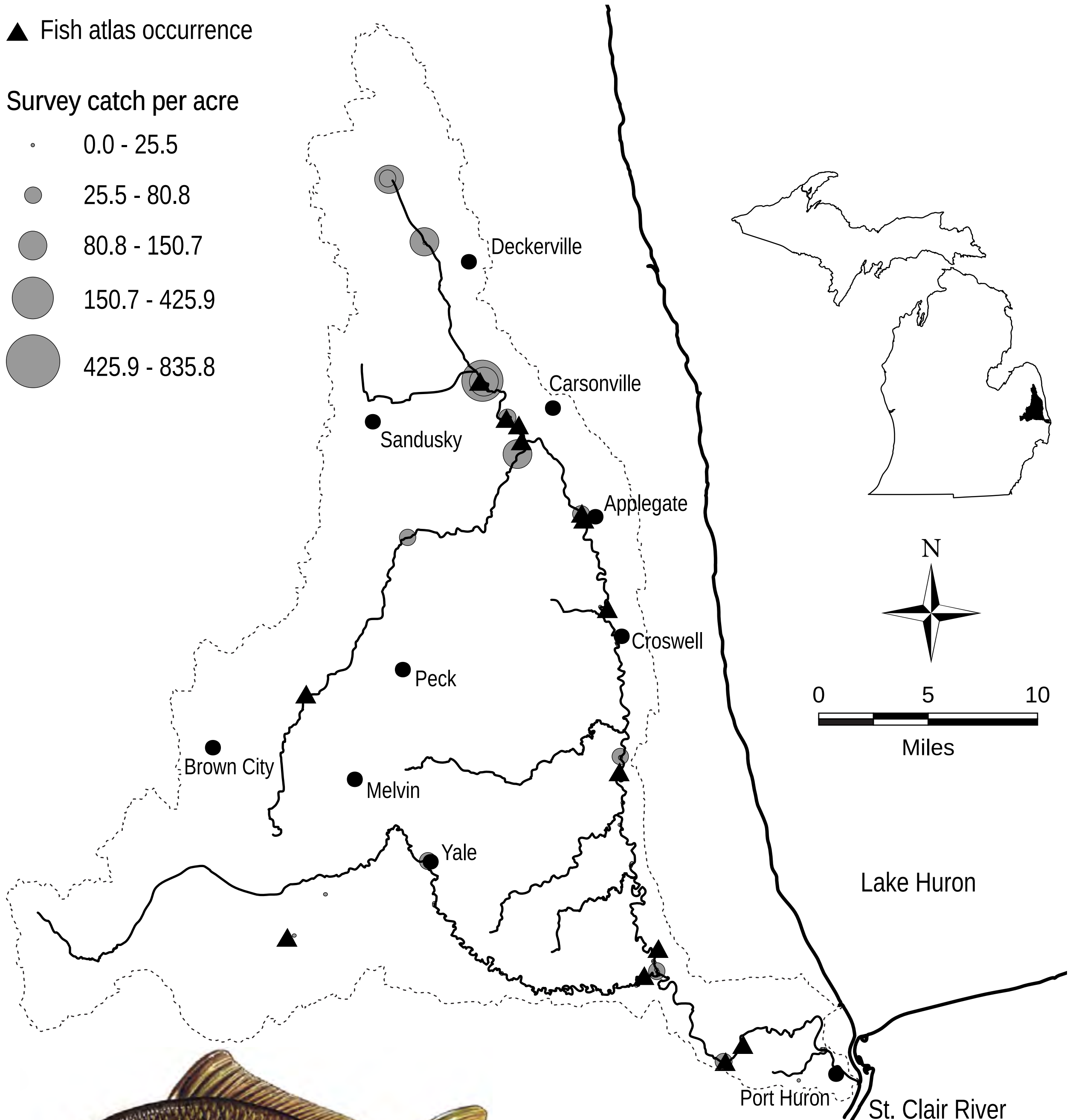
spawning - warm, weedy shallows

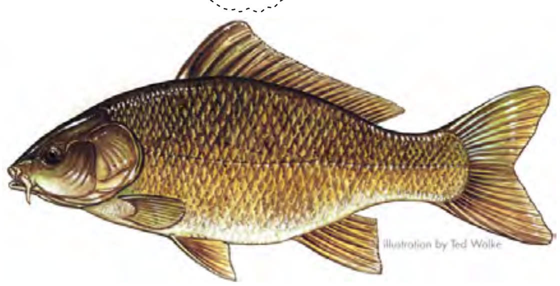


Spotfin shiner (*Cyprinella spiloptera*)

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



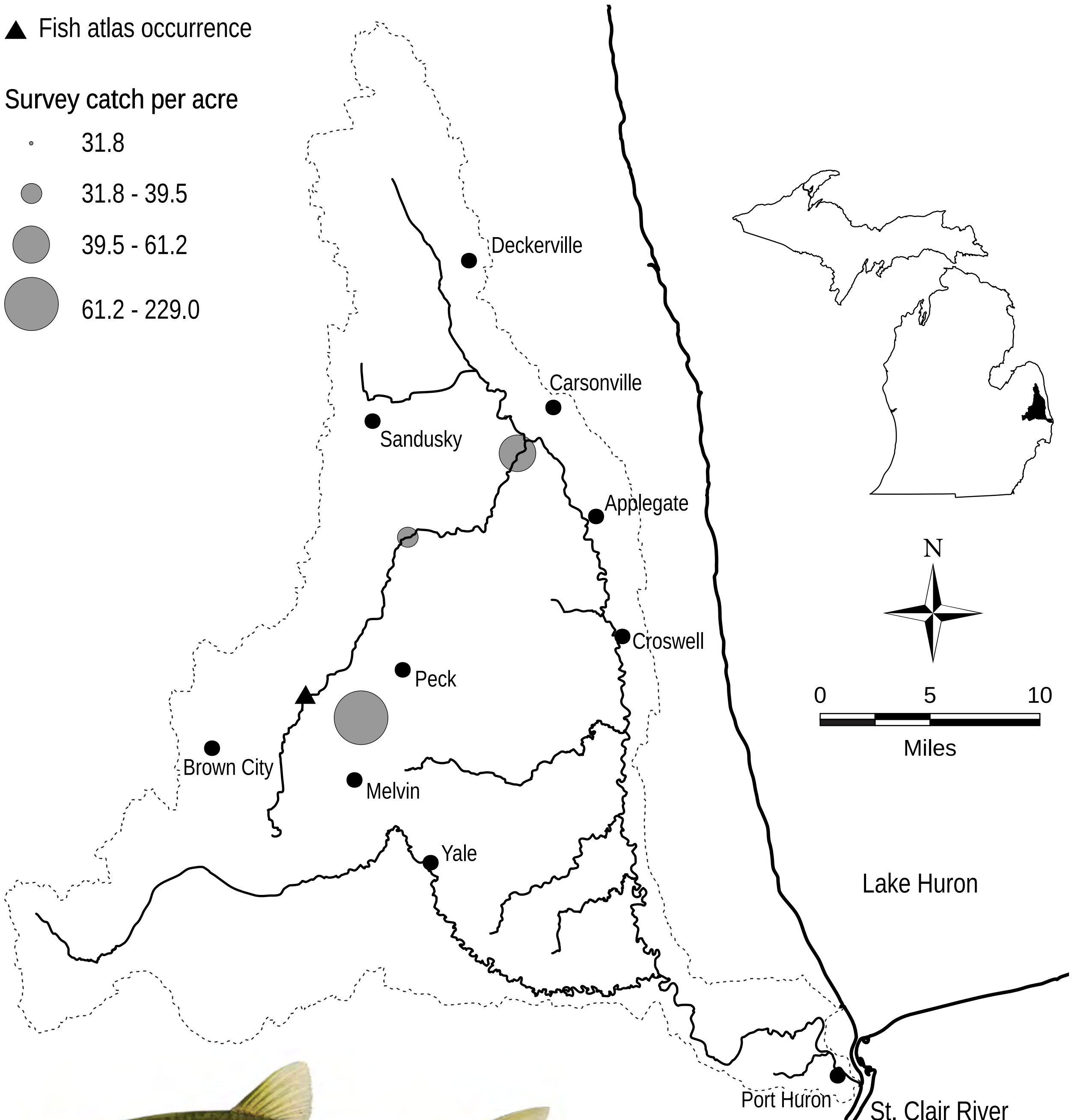


Common carp (*Cyprinus carpio*)

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

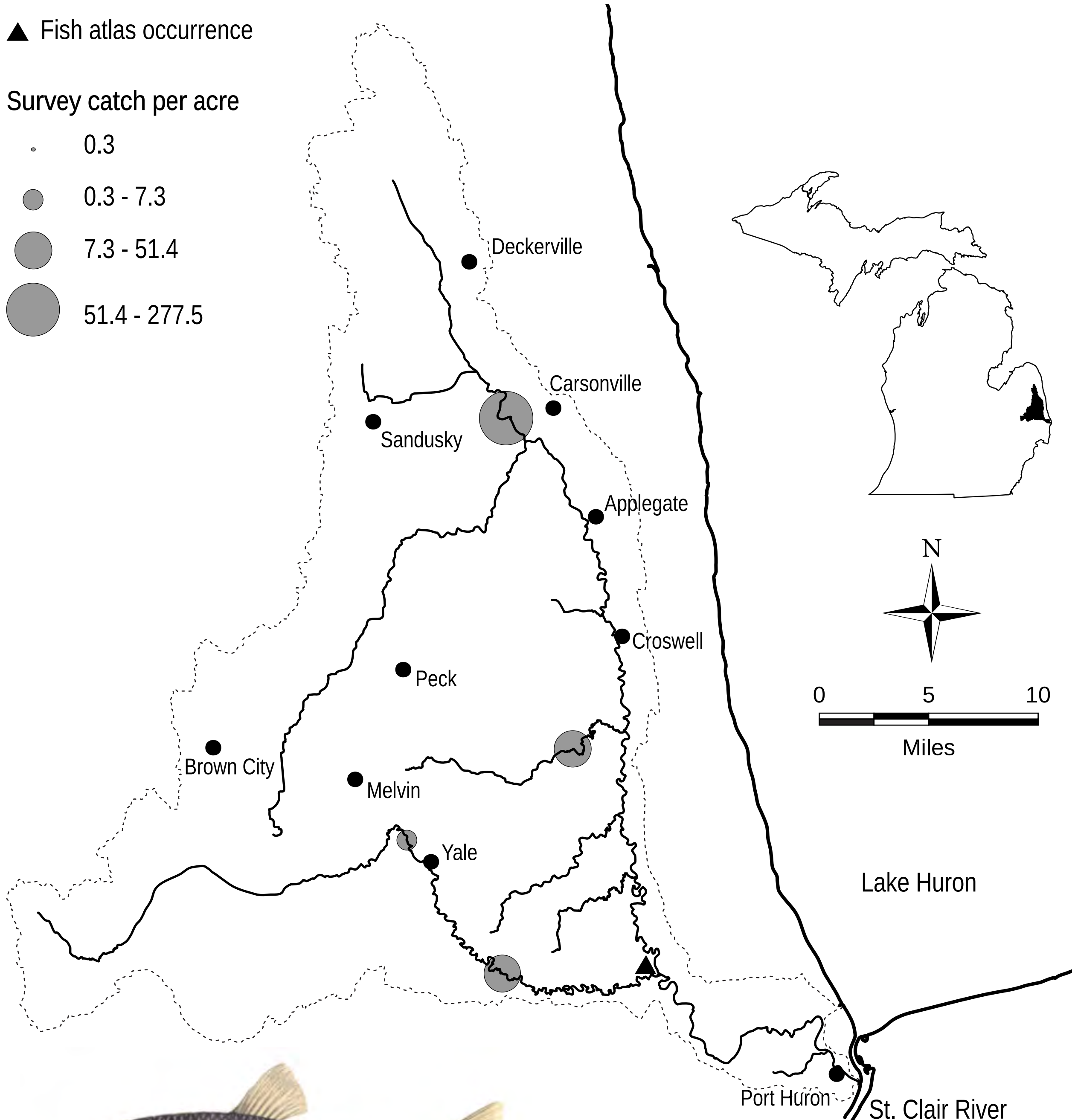
spawning - weedy or grassy shallows



Brassy minnow (*Hybognathus hankinsoni*)

Habitat**:**

feeding - cool acidic streams
- slow to moderate current
- sand or gravel substrate



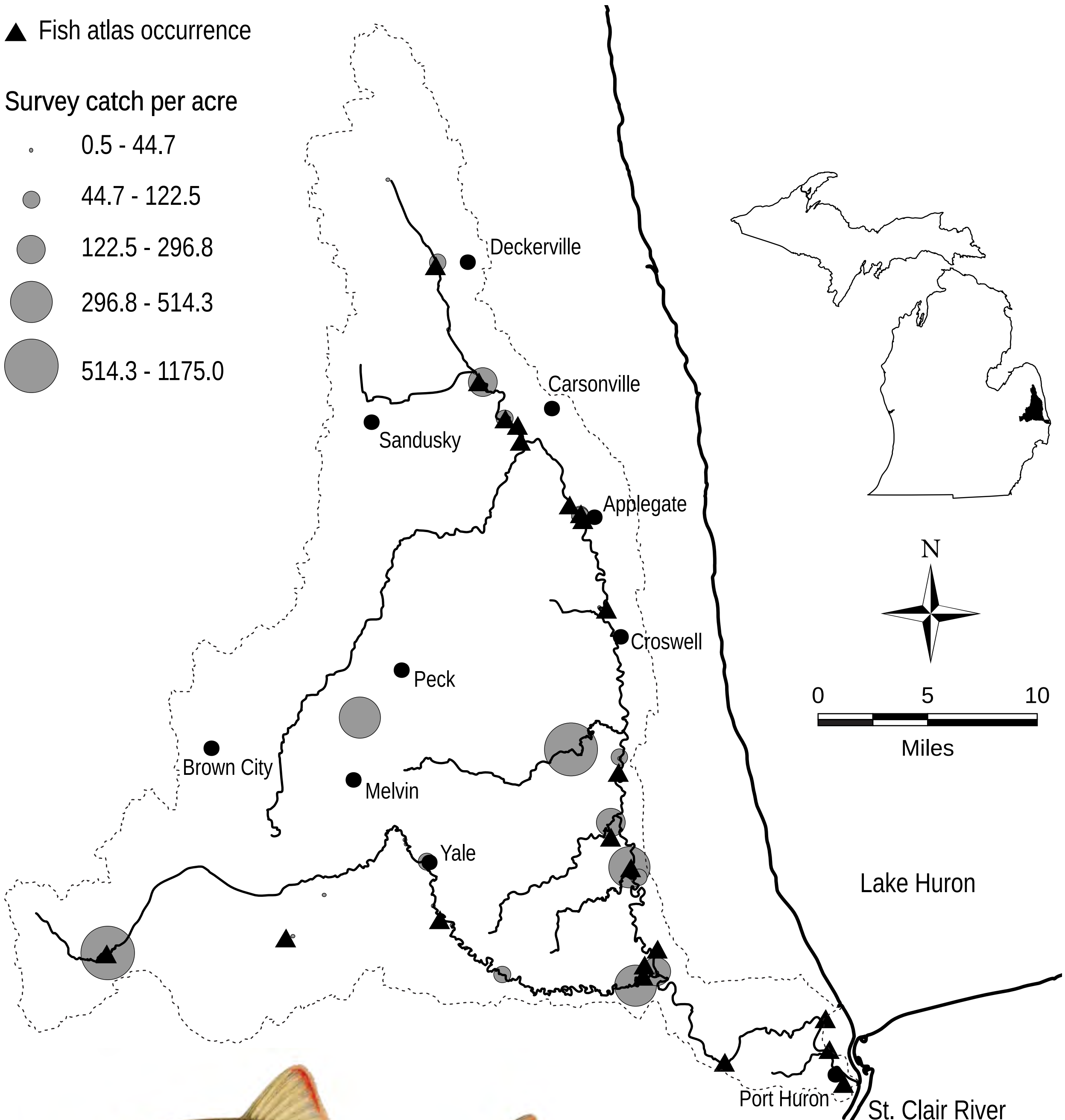
Striped shiner (*Luxilus chrysocephalus*)

Habitat:

feeding - clear to slightly turbid streams and rivers
- gravel substrate
- low gradient

spawning - gravel, boulder, bedrock, or sand substrate
- clear water in small streams with moderate to high gradient

winter refuge - in large deep pools of low gradient rivers

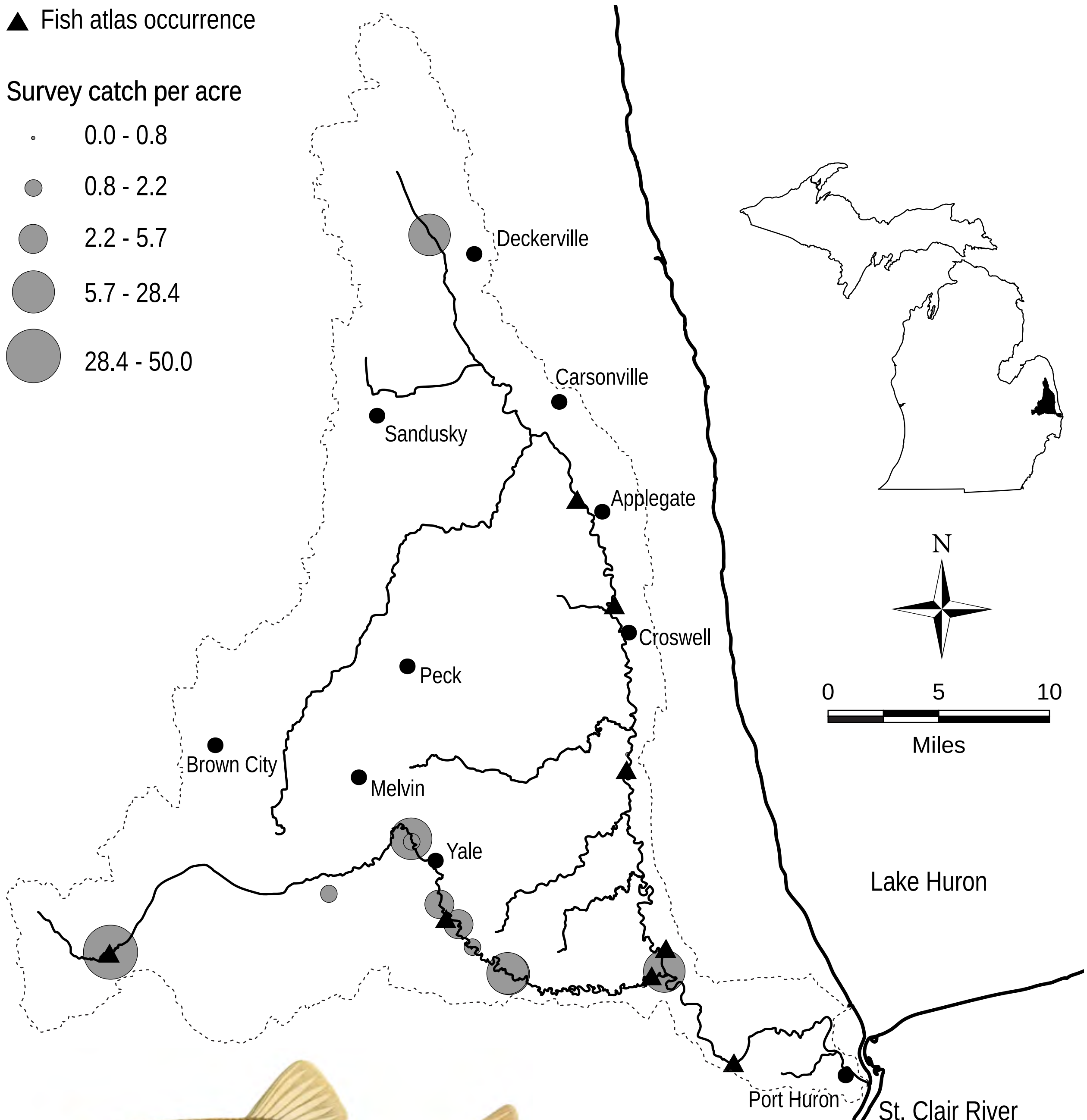


Common shiner (*Luxilus cornutus*)

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

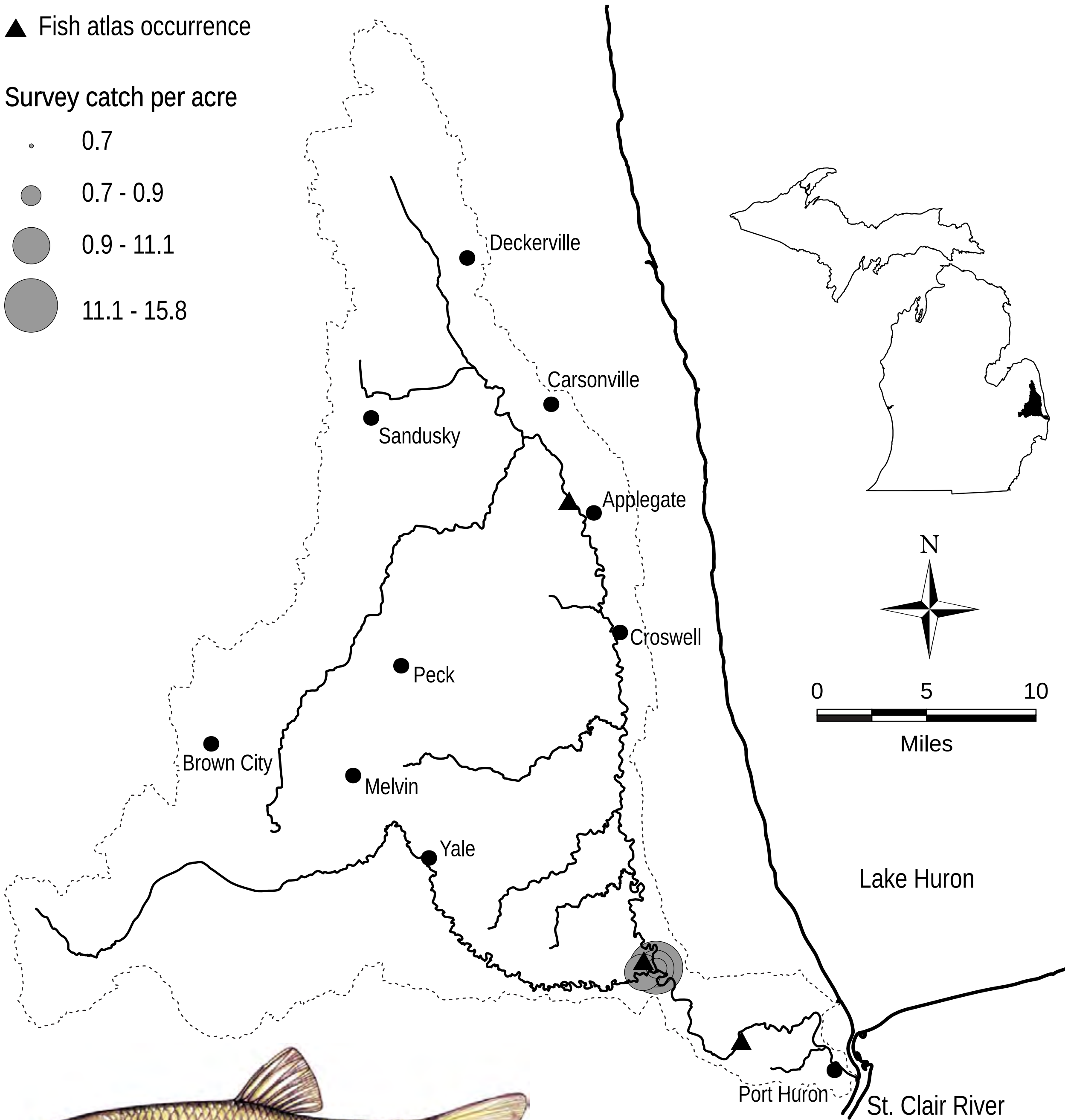
spawning - gravel nests of other fish, especially those at the head of a riffle

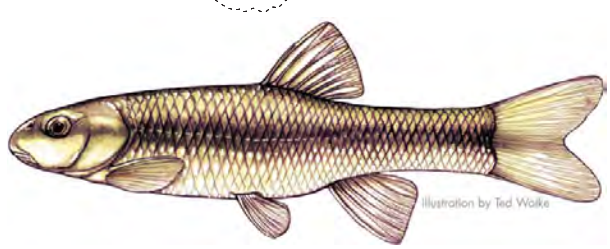


Hornyhead chub (*Nocomis biguttatus*)

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

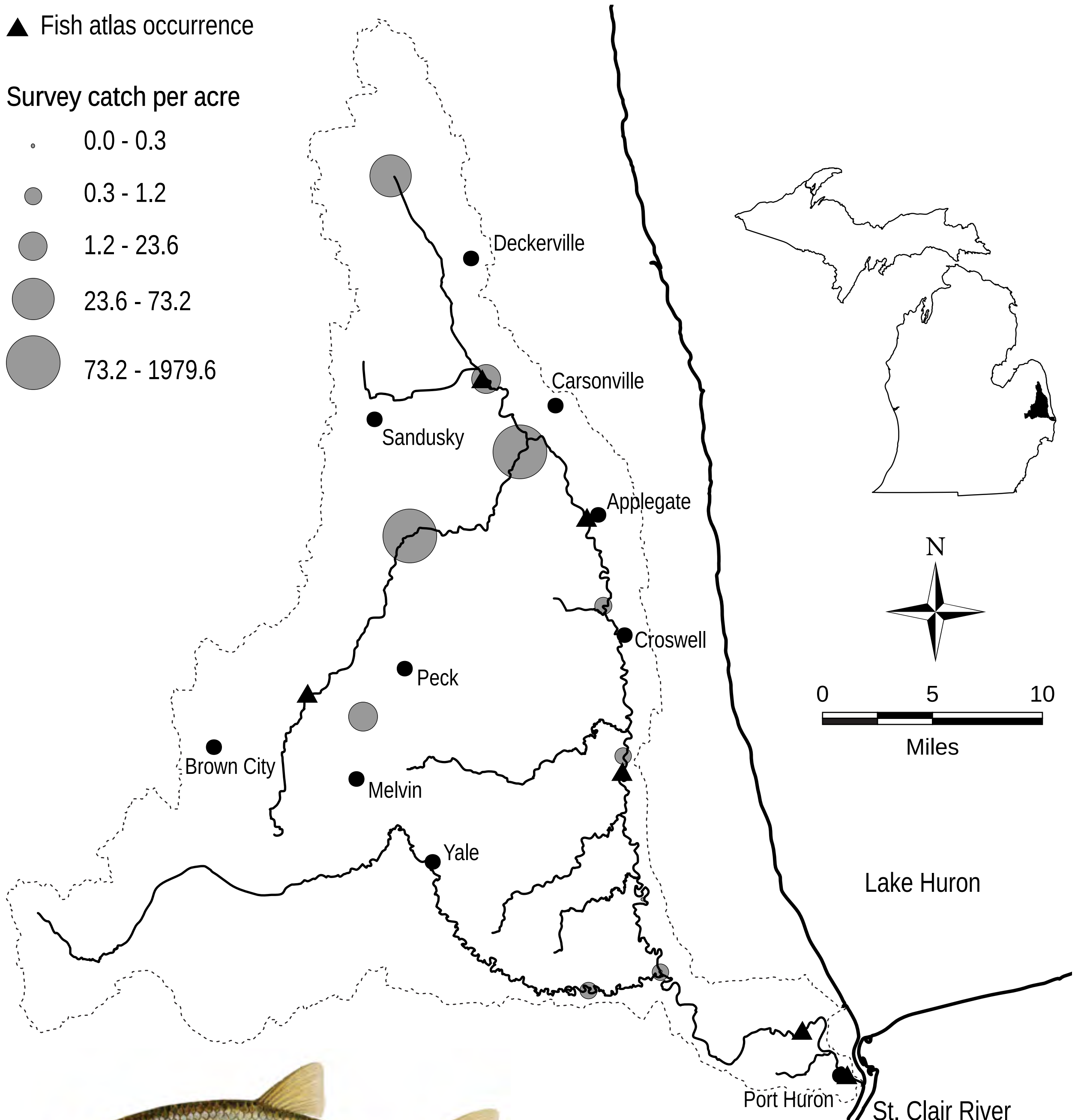




River chub (*Nocomis micropogon*)

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

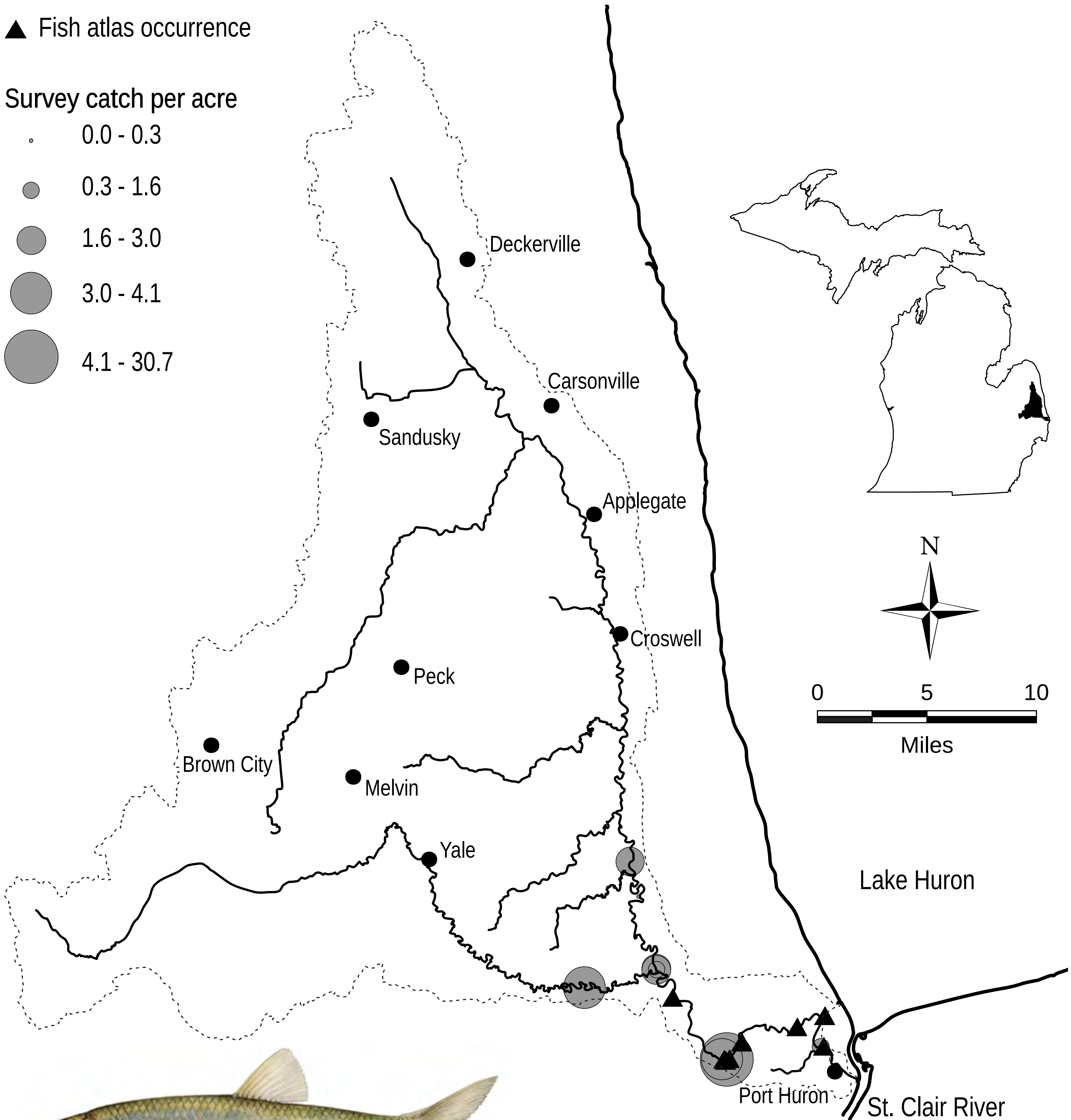


Golden shiner (*Notemigonus crysoleucas*)

Habitat**:**

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

spawning - vegetation

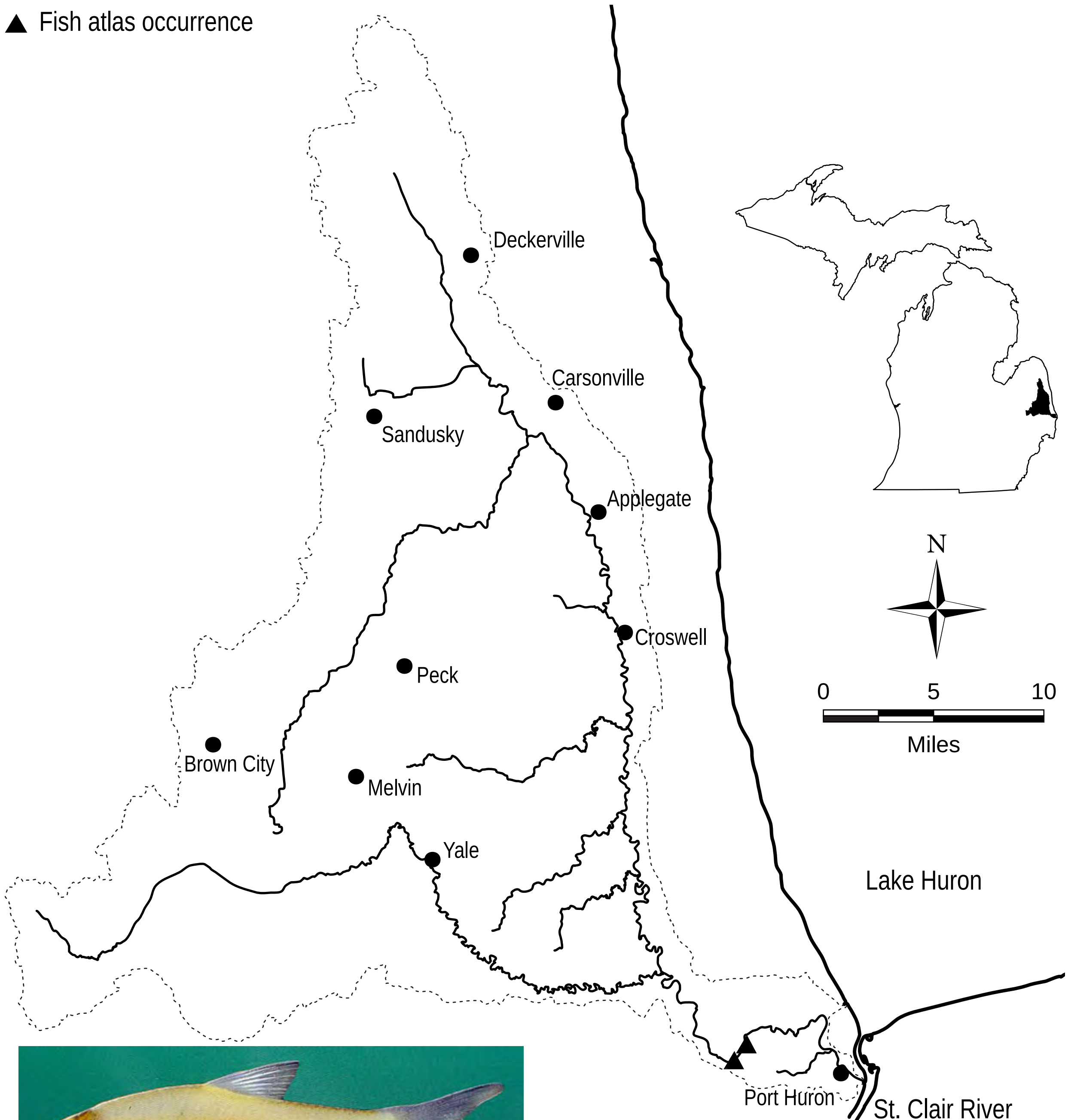


Emerald shiner (*Notropis atherinoides*)

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

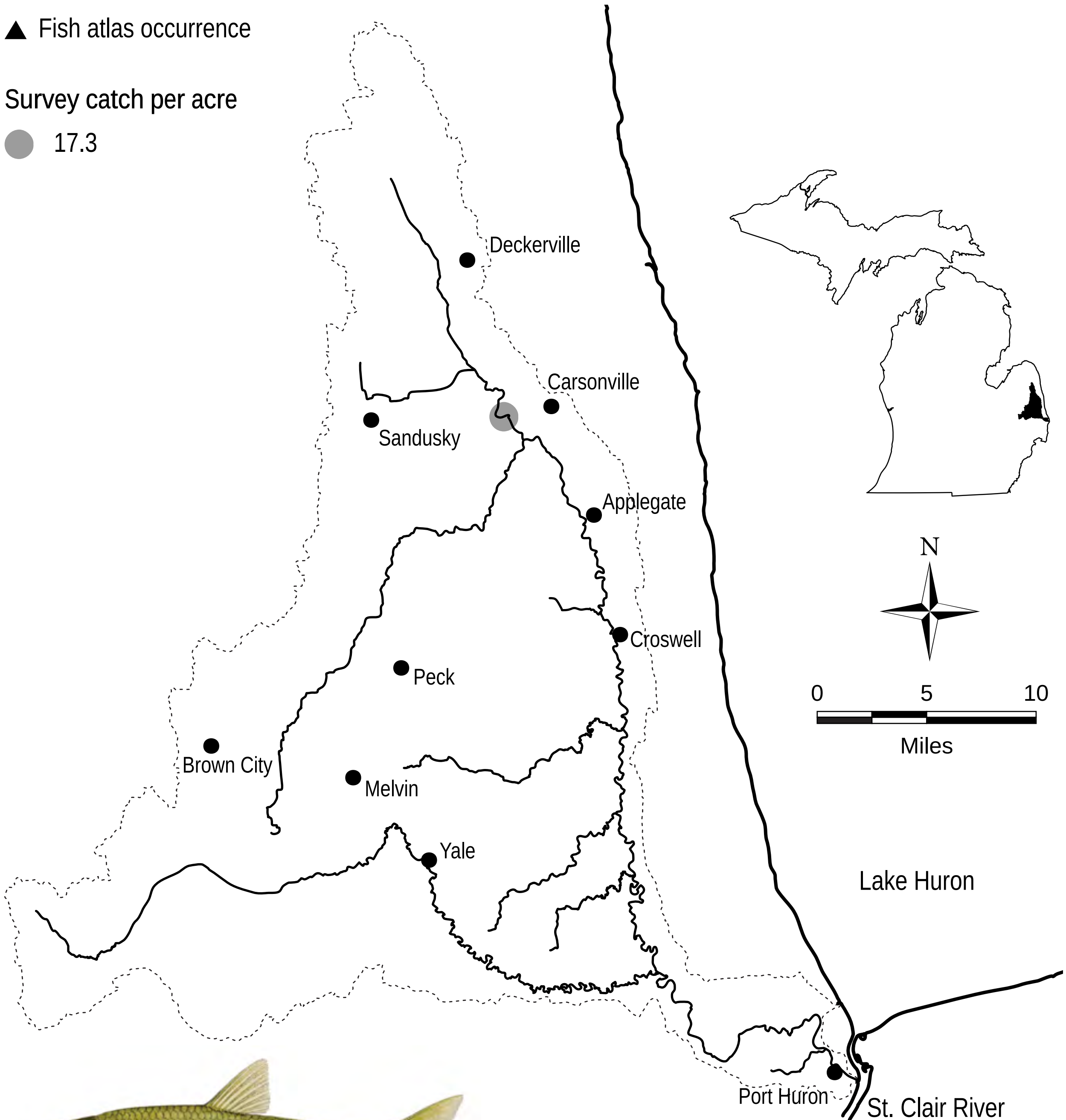
spawning - sand or firm mud substrate or gravel shoals



Ghost shiner (*Notropis buchanani*)

Habitat**:**

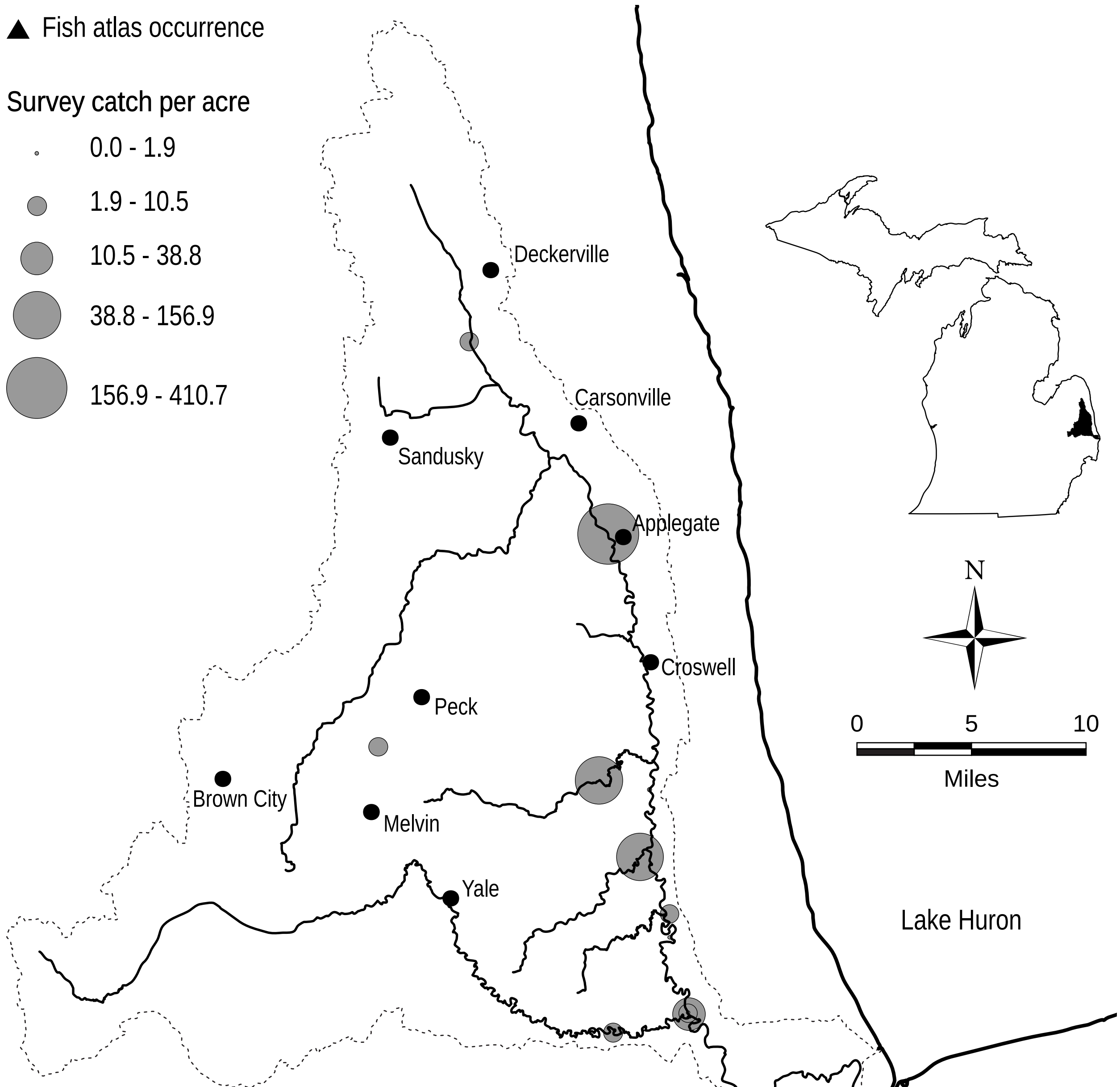
feeding - quiet waters of rivers and lakes
- clean sand, gravel bottom
- requires some aquatic vegetation



Blackchin shiner (*Notropis heterodon*)

Habitat**:**

feeding
- lakes, impoundments, and quiet pools in streams and rivers
- clear water
- clean sand, gravel, or organic debris substrate
- dense beds of submerged aquatic vegetation
- cannot tolerate turbidity, silt, or loss of aquatic vegetation

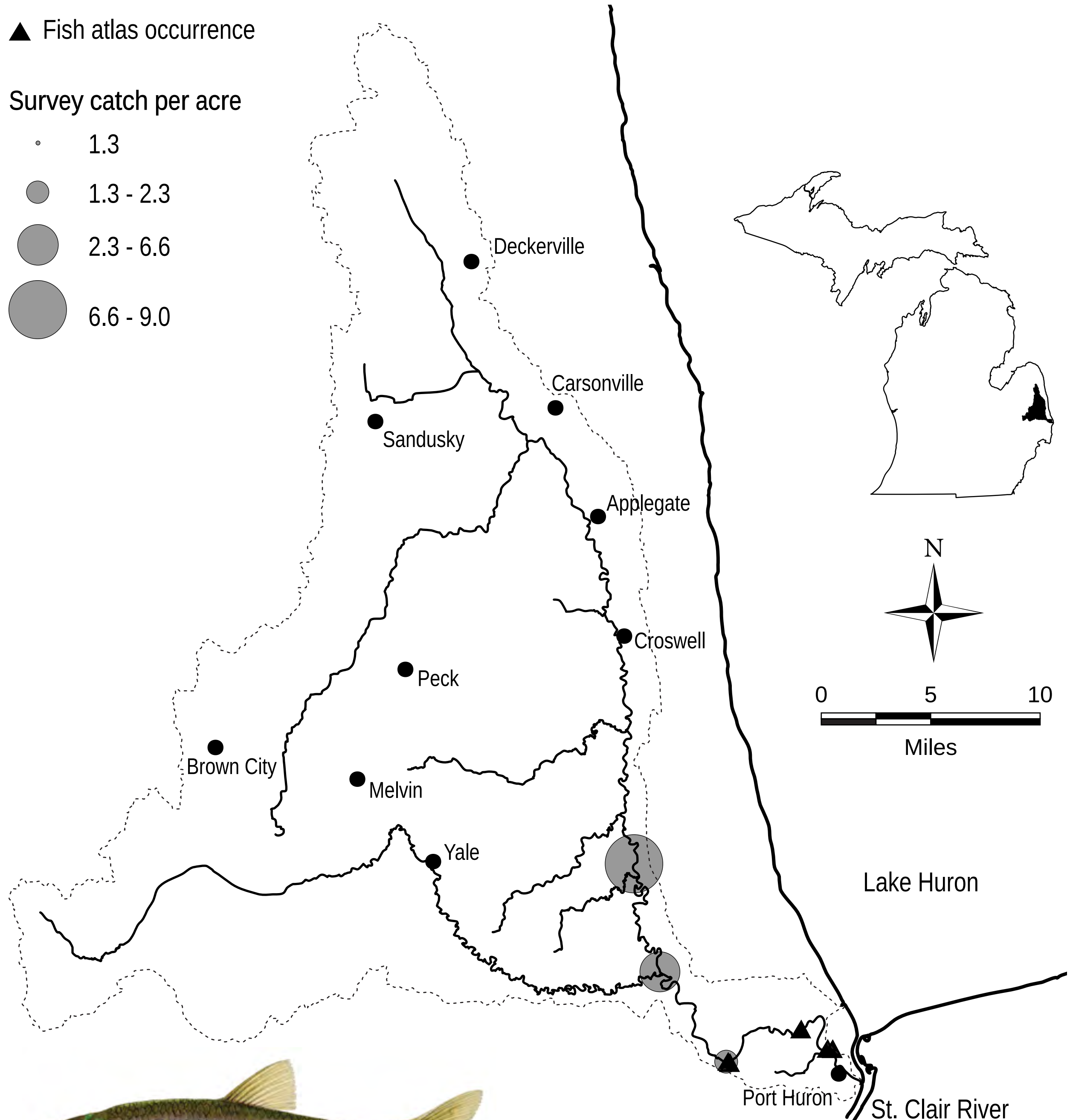


Blacknose shiner (*Notropis heterolepis*)

Habitat**:**

feeding - clear lakes, impoundments, and pools of small, clear, low-gradient streams
- aquatic vegetation
- clean sand, gravel, marl, muck, peat, or organic debris substrate
- cannot tolerate much turbidity, much siltation, or loss of aquatic vegetation

spawning - sandy substrate

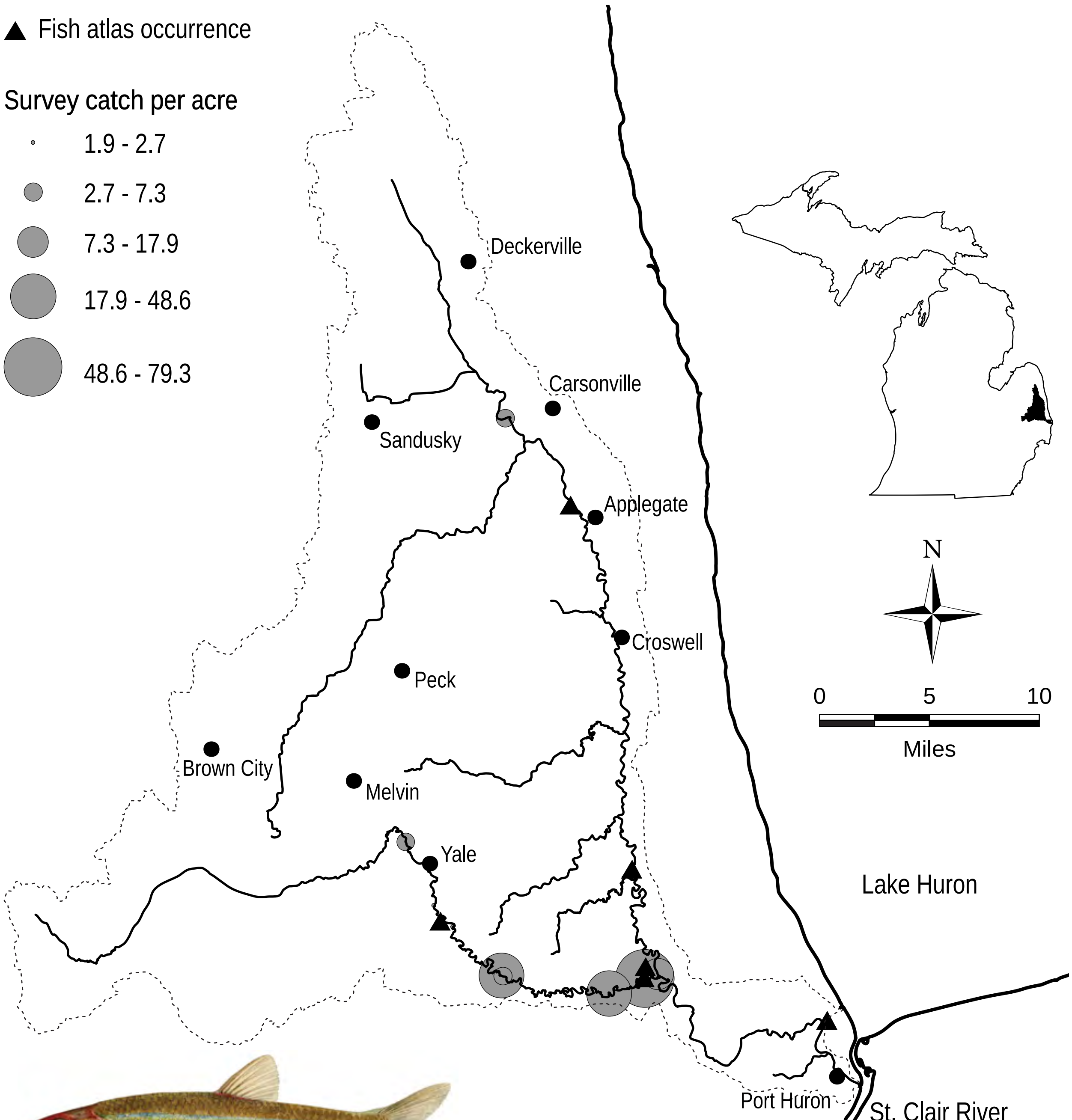


Spottail shiner (*Notropis hudsonius*)

Habitat**:**

feeding - large rivers, lakes, and impoundments
- firm sand and gravel substrate
- low current
- sparse to moderate vegetation
- avoids turbidity

spawning - over sandy shoals or gravelly riffles
- near the mouths of small streams

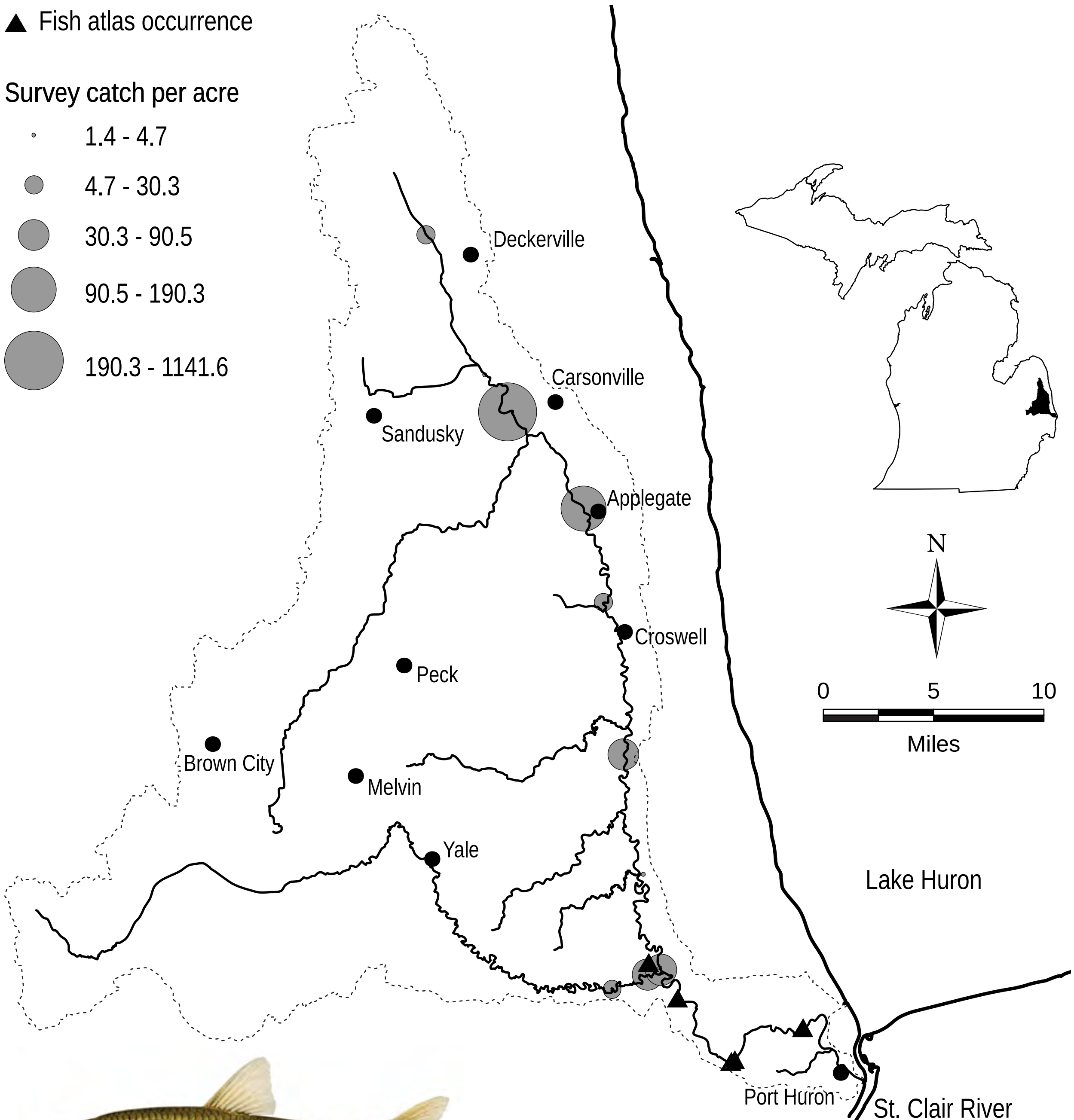


Rosyface shiner (*Notropis rubellus*)

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

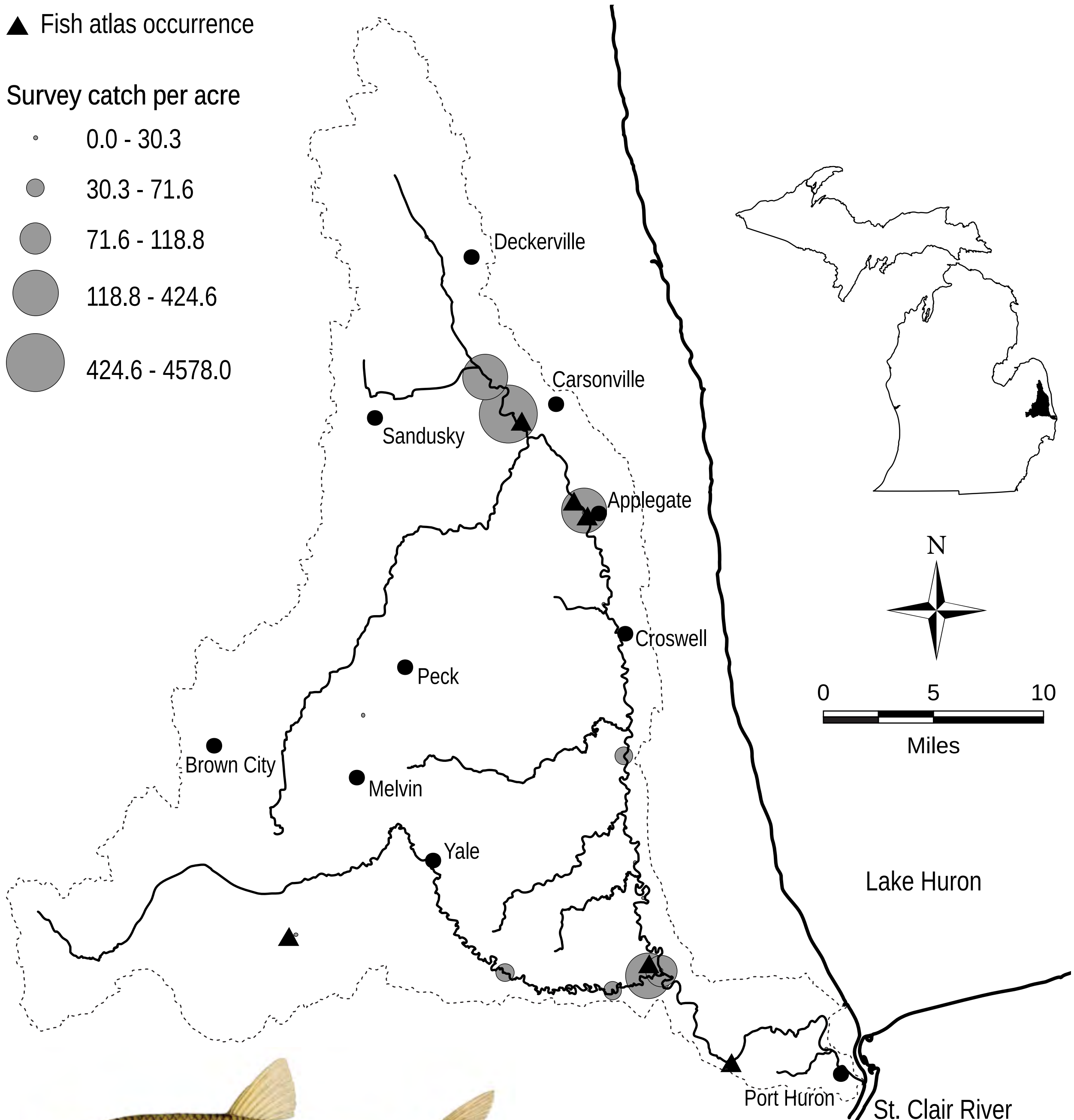


Sand shiner *(Notropis stramineus)*

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

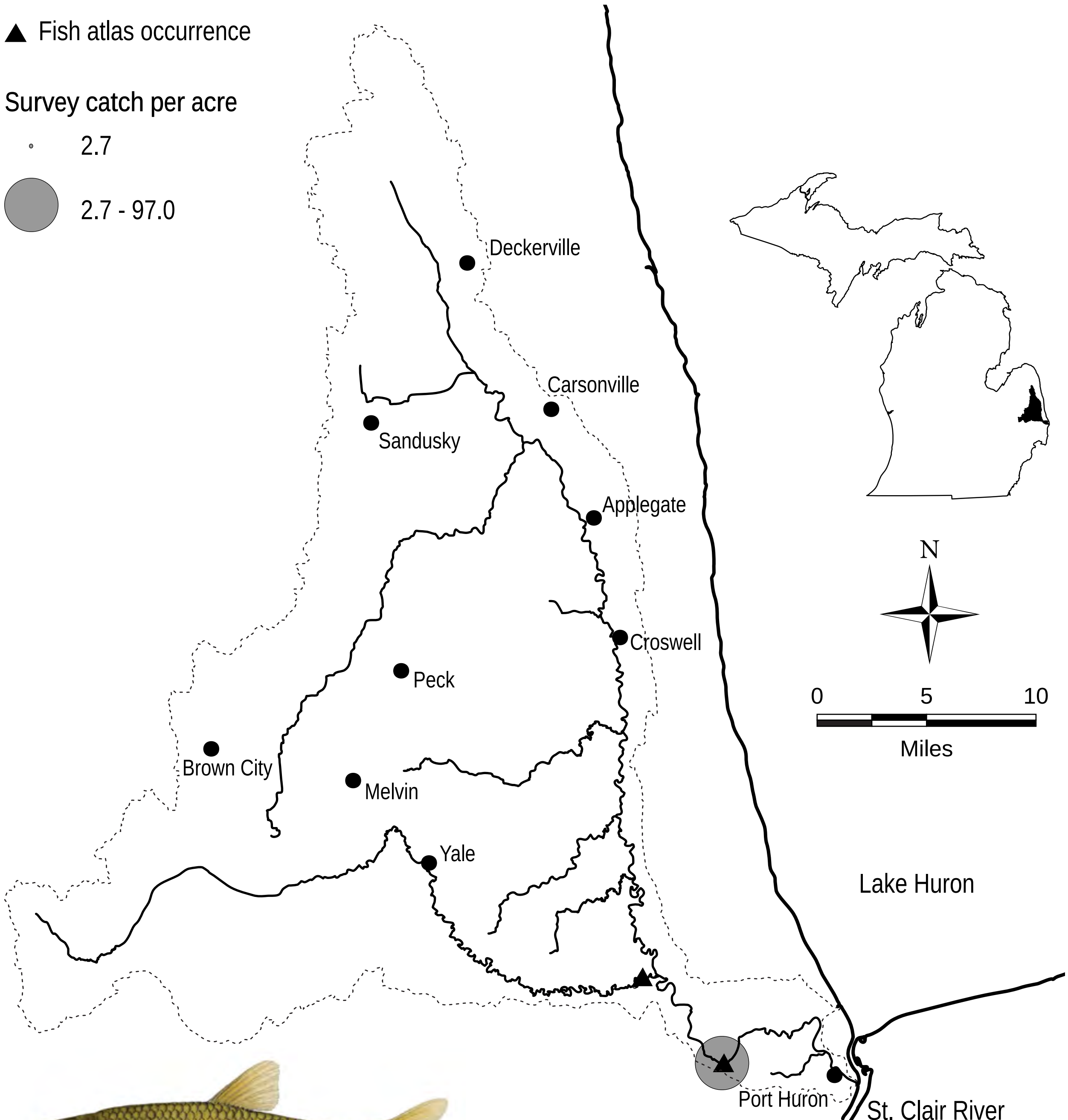


Mimic shiner (*Notropis volucellus*)

Habitat:

feeding - pools and backwater of streams, moderately weedy lakes and impoundments
- quiet or still water
- clear shallow water

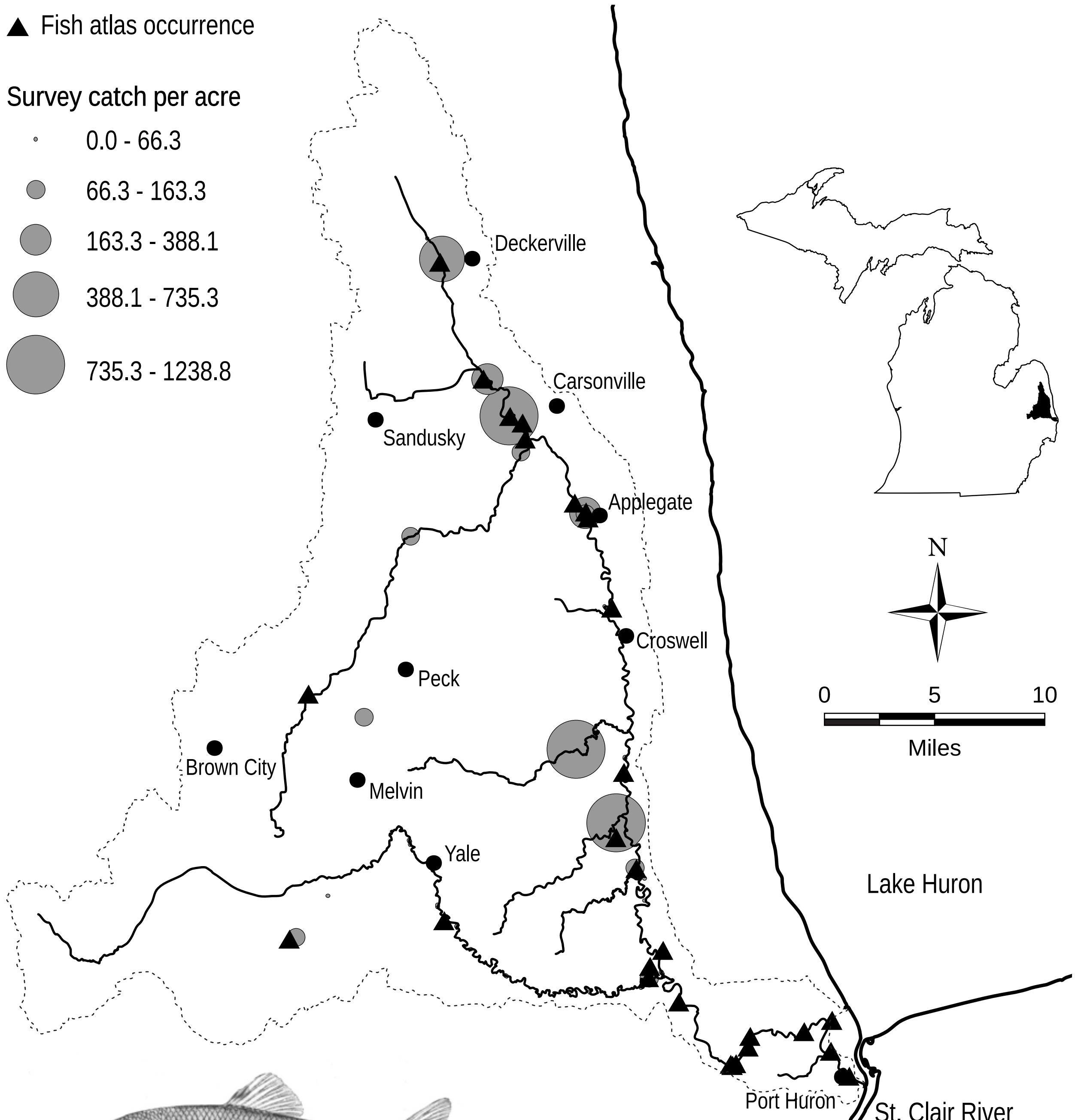
spawning - aquatic vegetation necessary



Pugnose minnow *(Opsopoeodus emiliae)* – endangered

Habitat:

feeding - clear vegetated rivers
- low current
- sand or mud substrates
- intolerant of turbidity

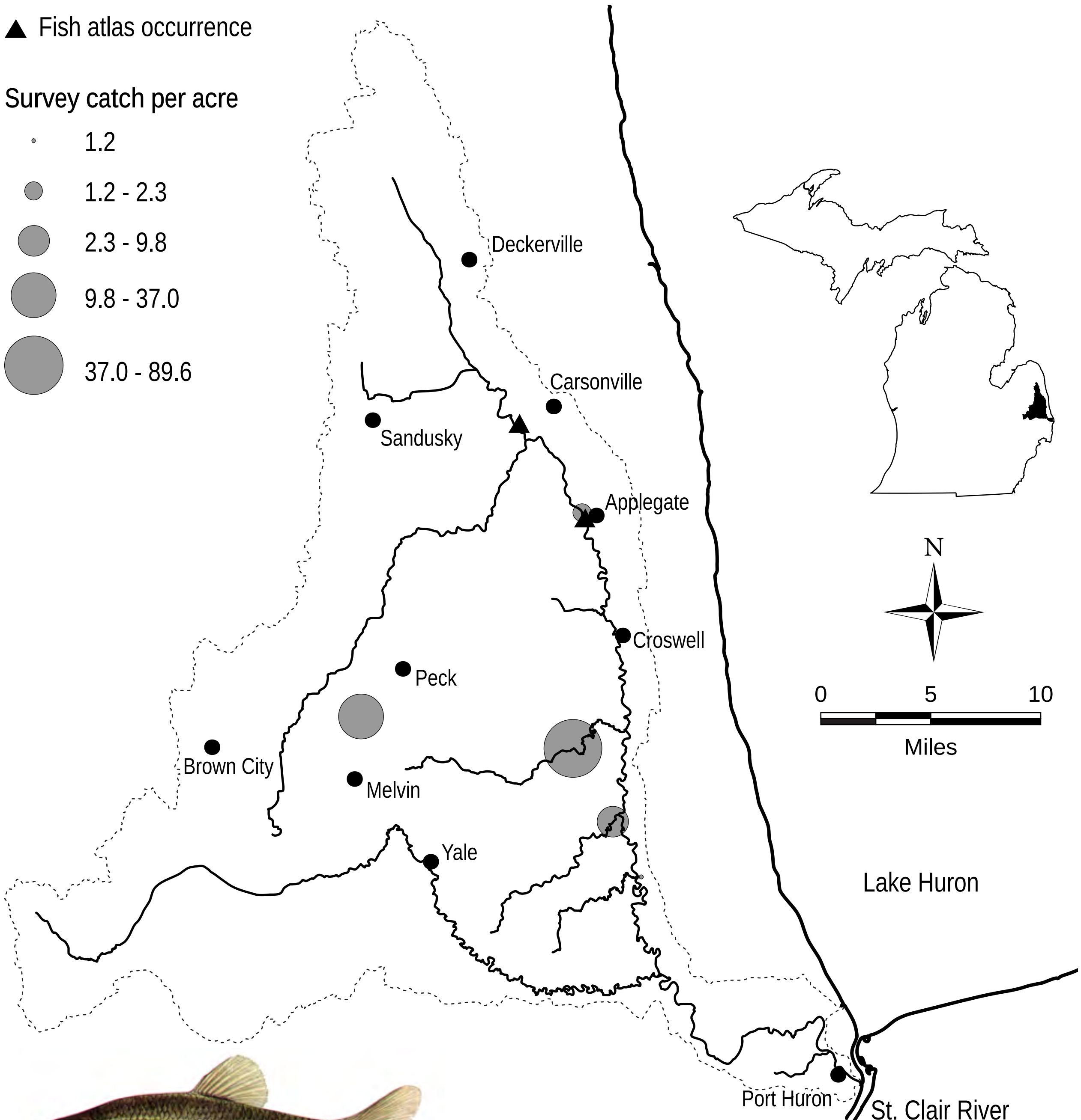


Bluntnose minnow (*Pimephales notatus*)

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

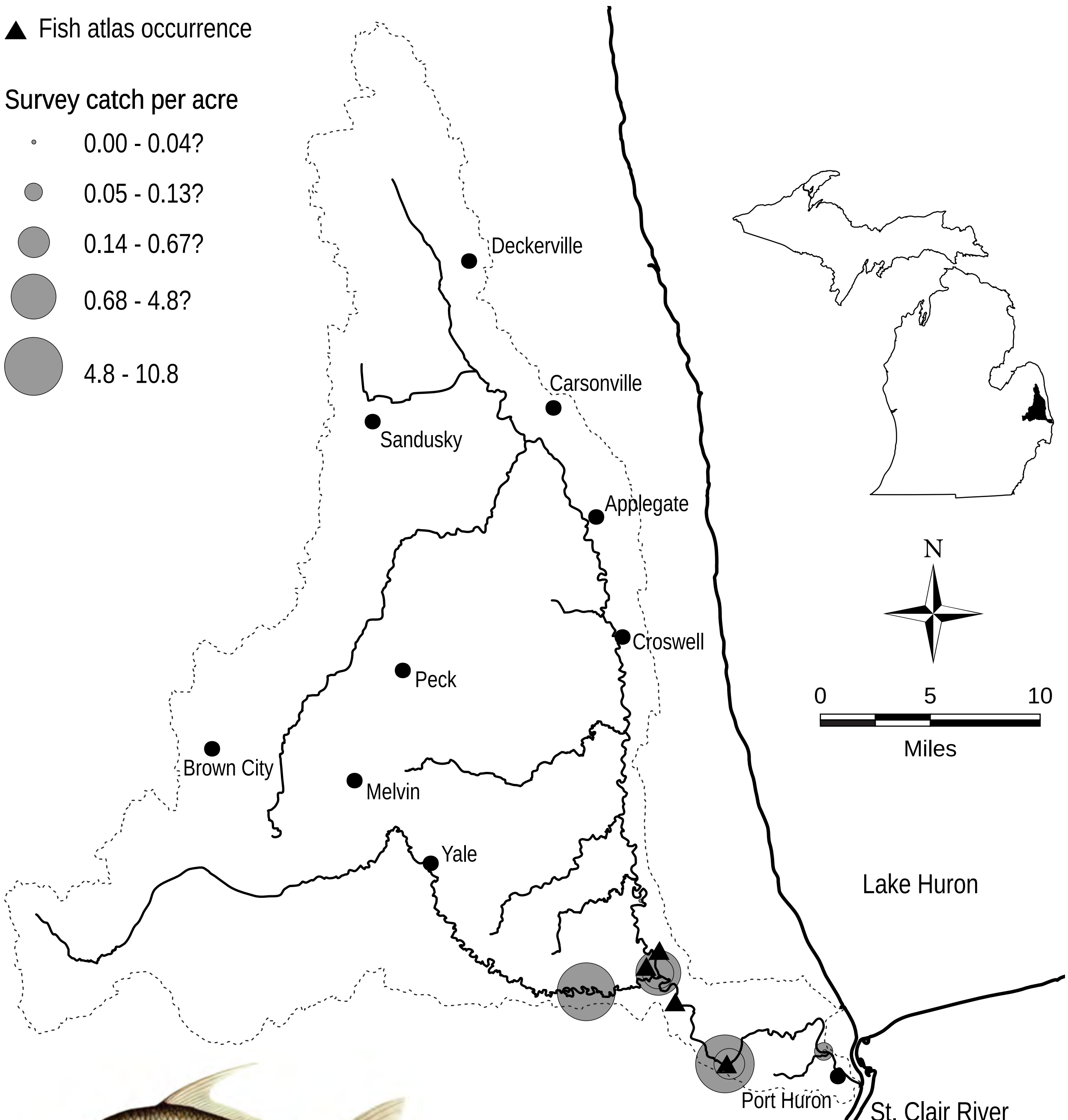
spawning
- eggs deposited on the underside of flat stones or objects
- nests in sand or gravel substrate



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

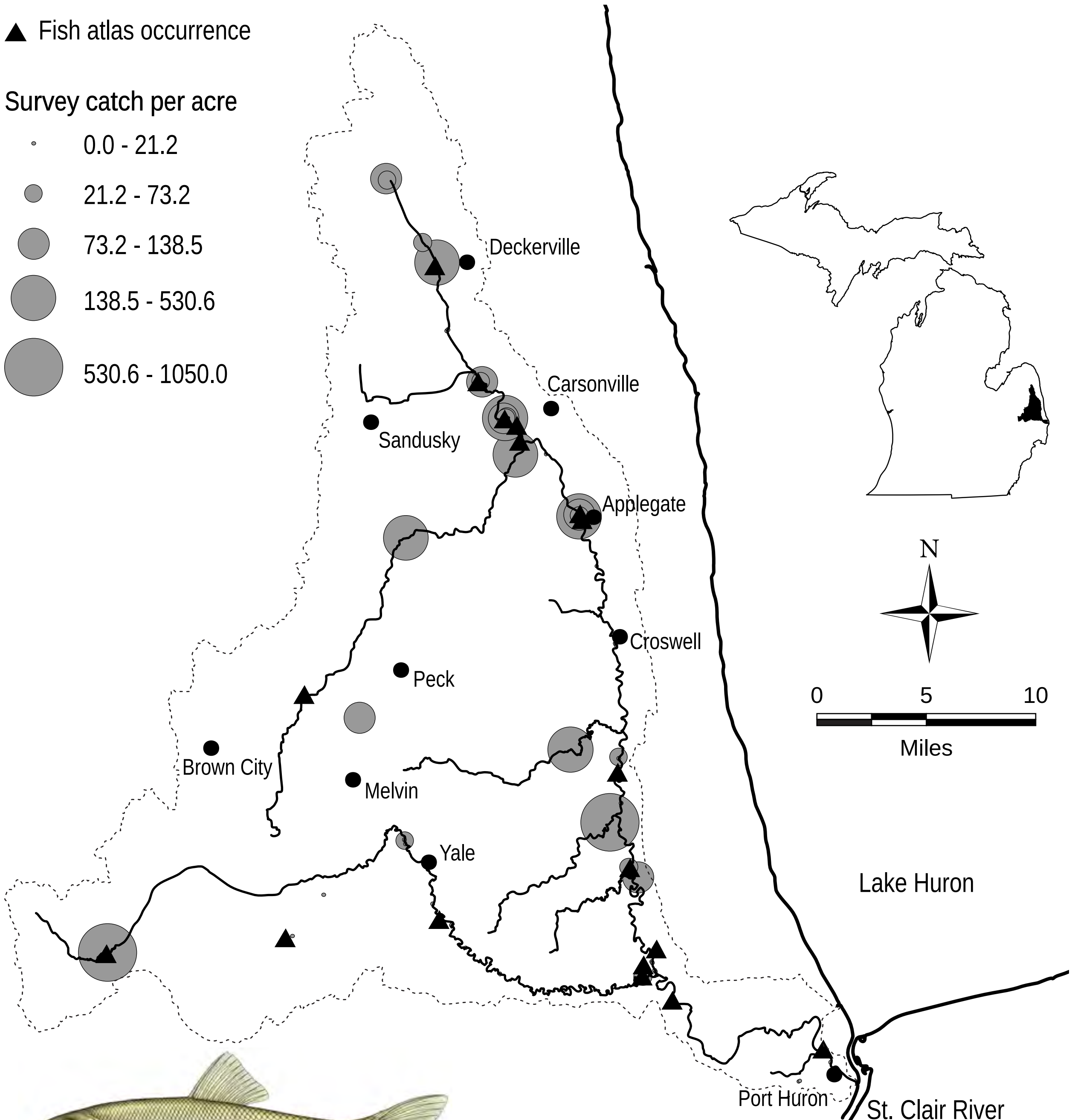


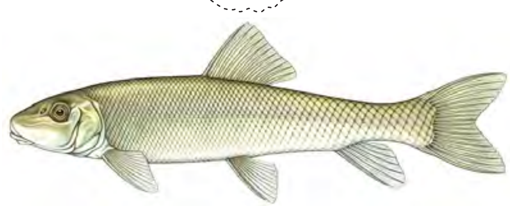
Quillback (*Carpiodes cyprinus*)

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



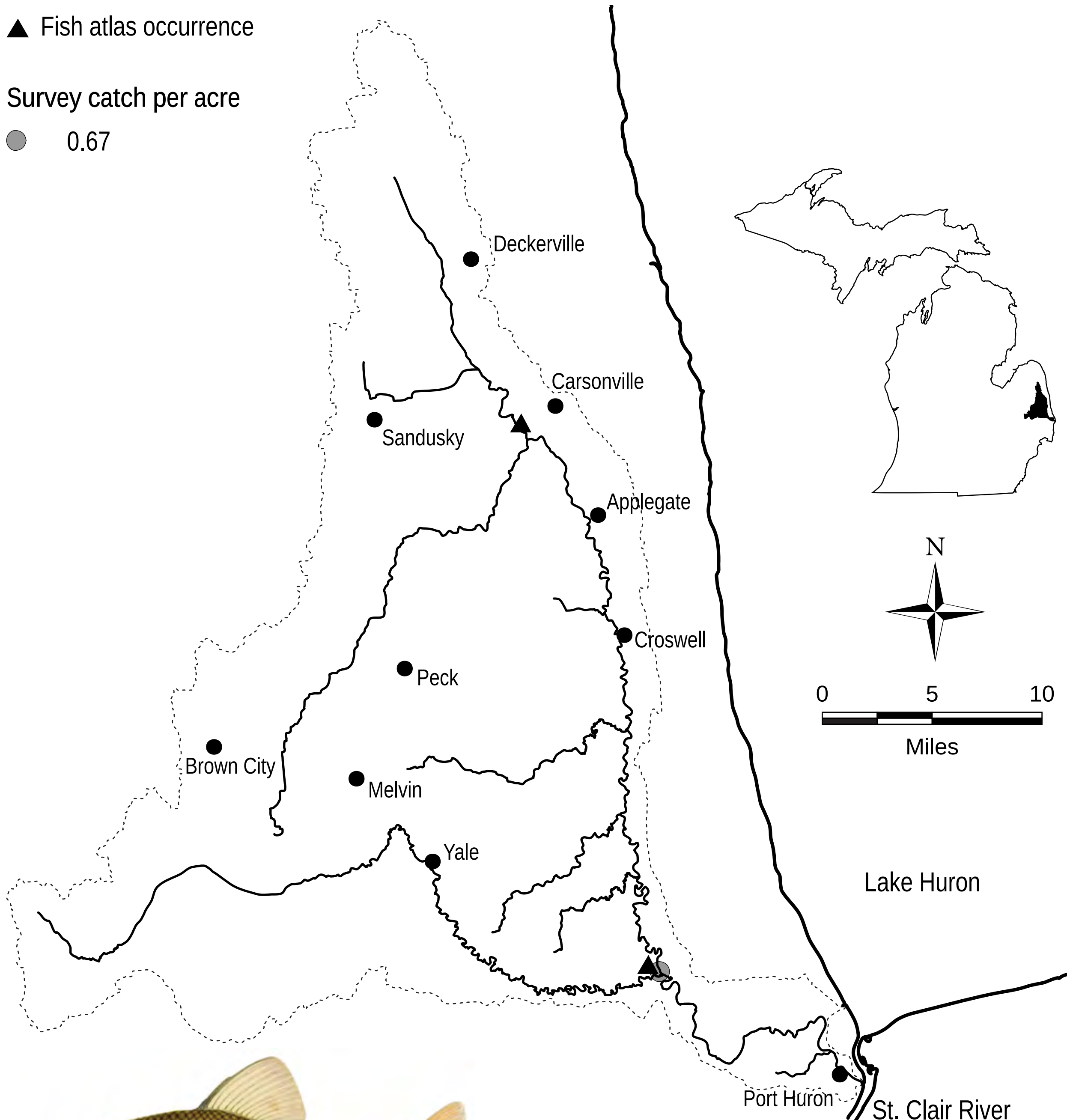


White sucker (*Catostomus commersonii*)

Habitat**:**

feeding - streams, rivers, lakes, and impoundments
- can inhabit highly turbid and polluted waters

spawning - quiet gravelly shallow areas of streams

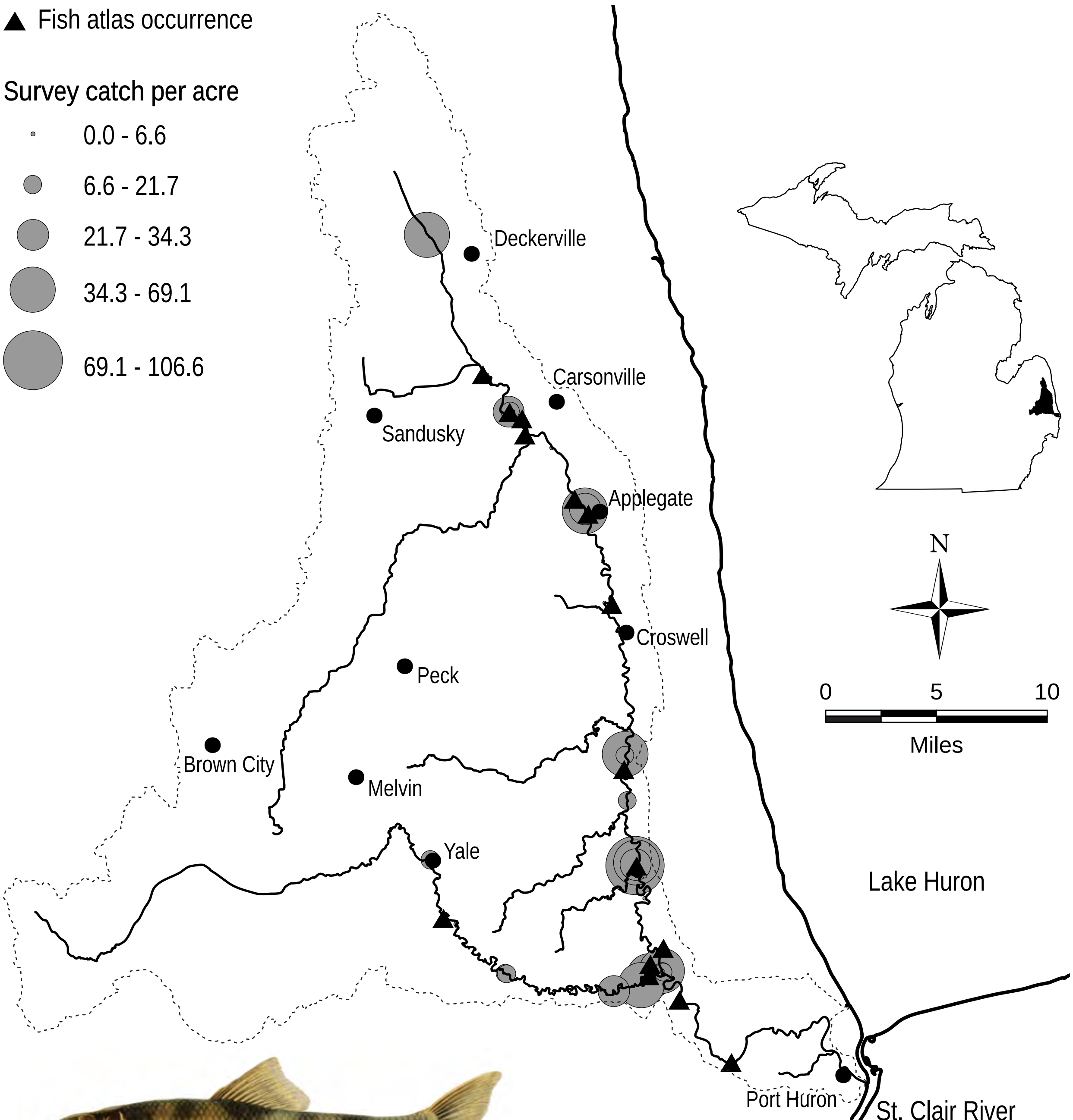


Lake chubsucker (*Erimyzon sucetta*)

Habitat**:**

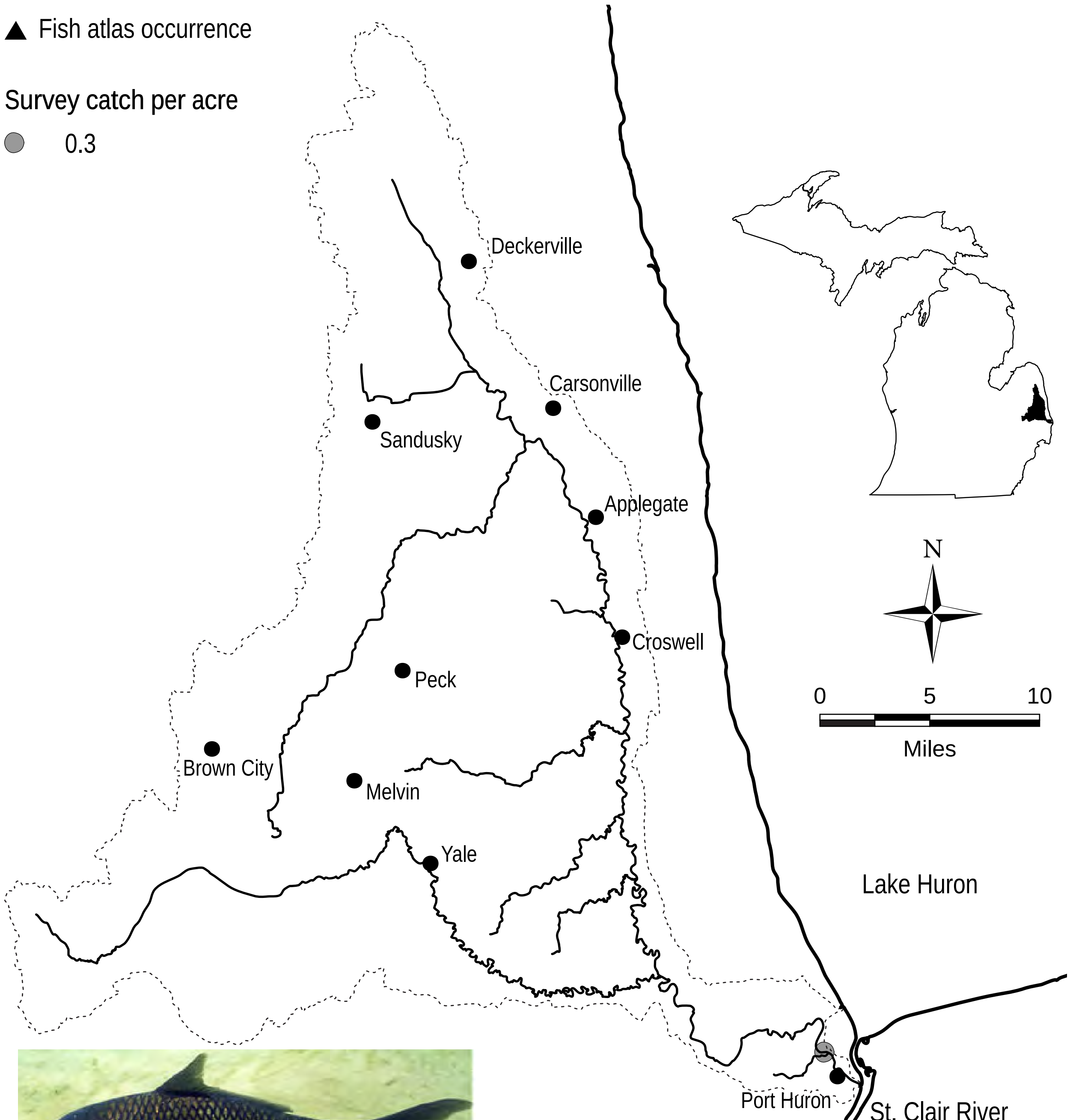
feeding - larger clear streams, rivers, lakes, and impoundments
- cannot tolerate turbid water
- low gradient
- prefers dense vegetation over substrate of sand or silt mixed with organic debris

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



Northern hog sucker (*Hypentelium nigricans*)

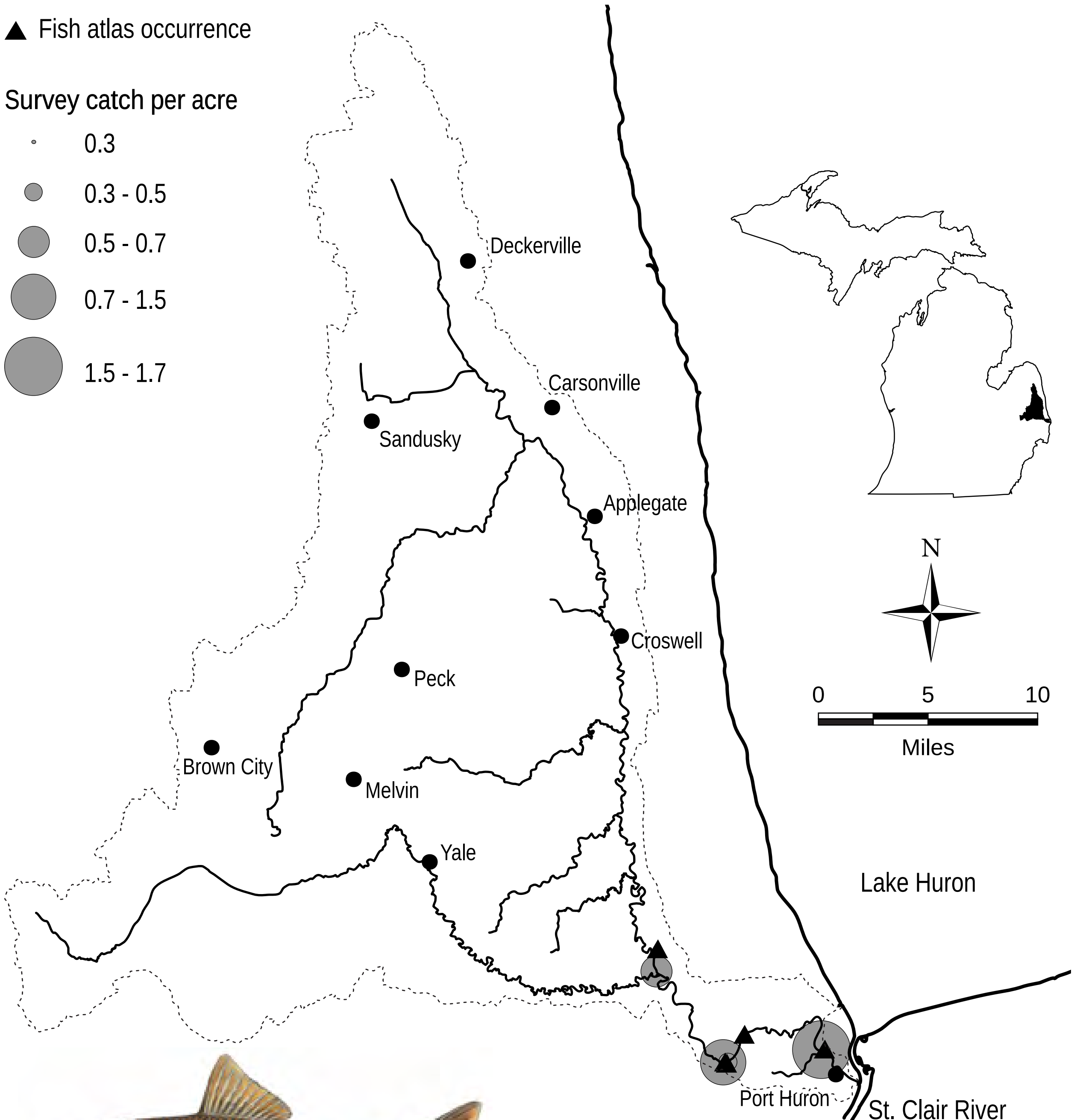
Habitat**:**	feeding	- gravel or rubble substrate
		- riffles and adjacent pools of warm shallow streams
		- clear water
		- doesn’t like turbidity or siltation
		- avoids profuse amounts of aquatic vegetation
	spawning	- riffles
		- shallow gravel substrate
		- high gradient
	winter refuge	- deeper quieter pools

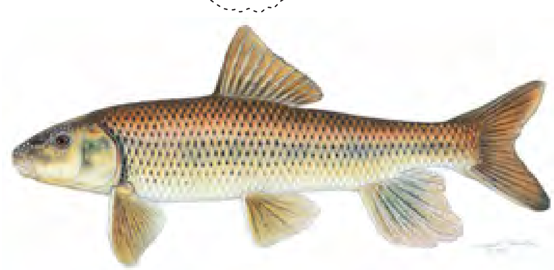


Black buffalo (*Ictiobus niger*)

Habitat:

feeding	-	large rivers
	-	deep fast riffles
	-	occasionally shallow overflow ponds and sloughs
	-	varying turbidity over various substrates
spawning	-	shallows
	-	sometimes flooded areas



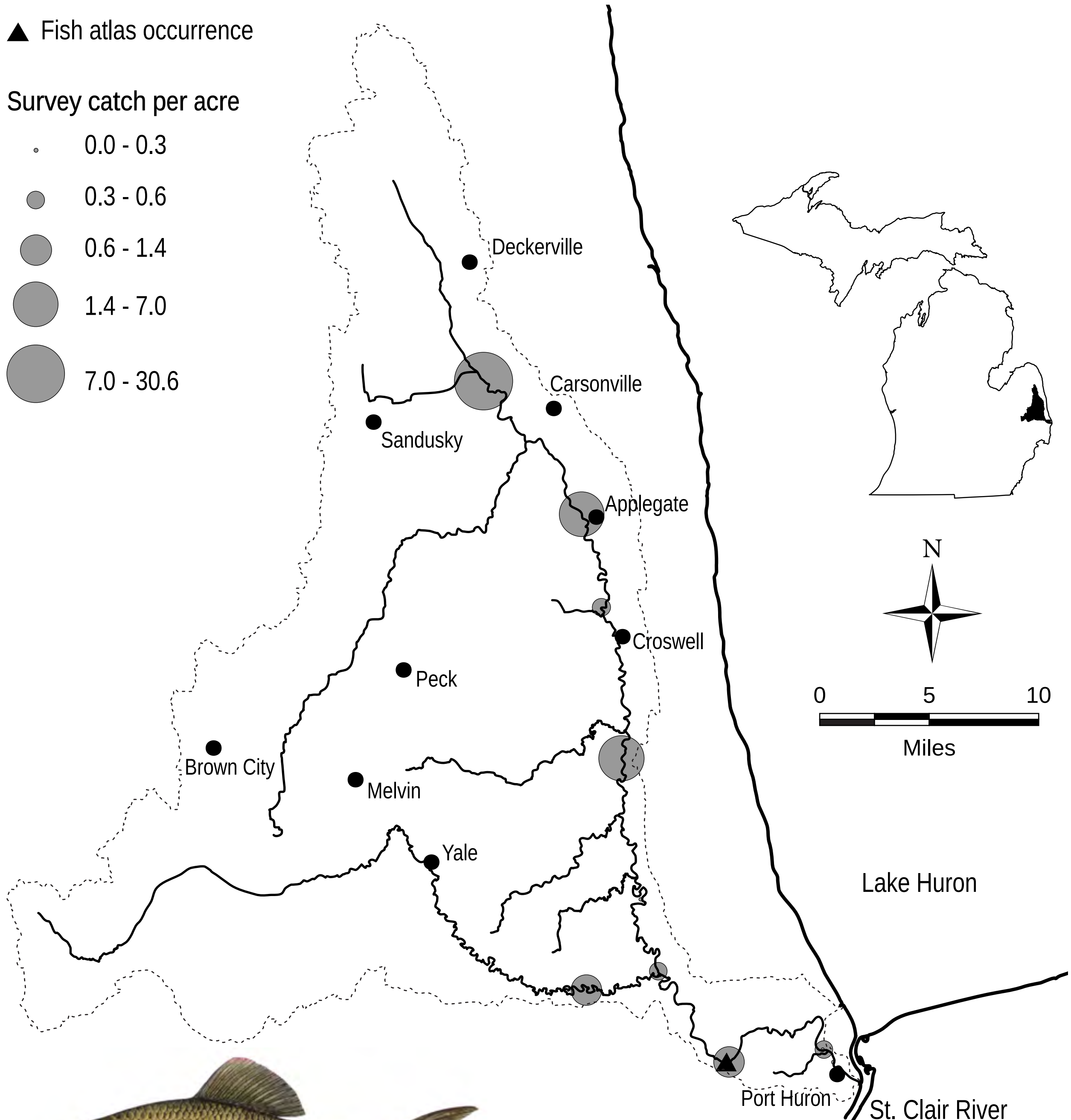


Spotted sucker (*Minytrema melanops*)

Habitat:

feeding - clear warm rivers (pools, backwaters) with little current
- abundant vegetation
- soft substrate with organic debris
- intolerant of turbidity

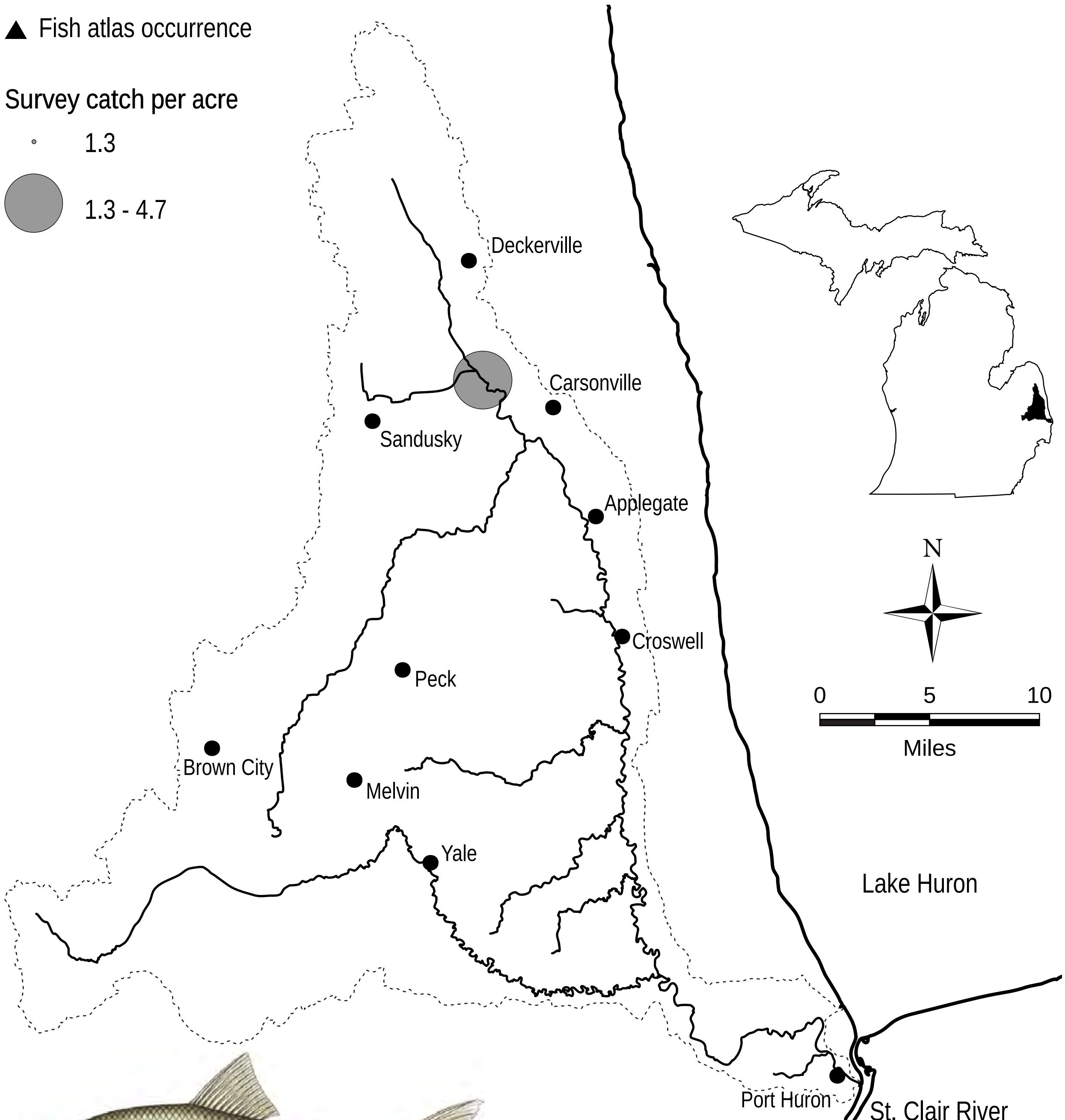
spawning - riffles

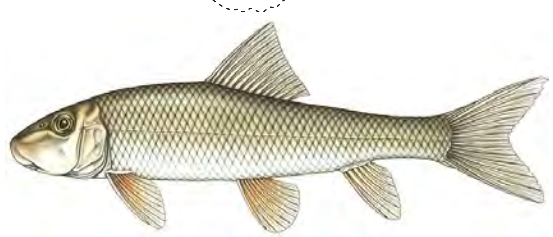


Silver redhorse (*Moxostoma anisurum*)

Habitat:

feeding	-	streams, rivers, lakes, and impoundments
	-	low current
	-	pollution and turbidity intolerant
spawning	-	swift current in rivers, do not spawn in tributaries
	-	males territorial
	-	gravel to rubble substrate

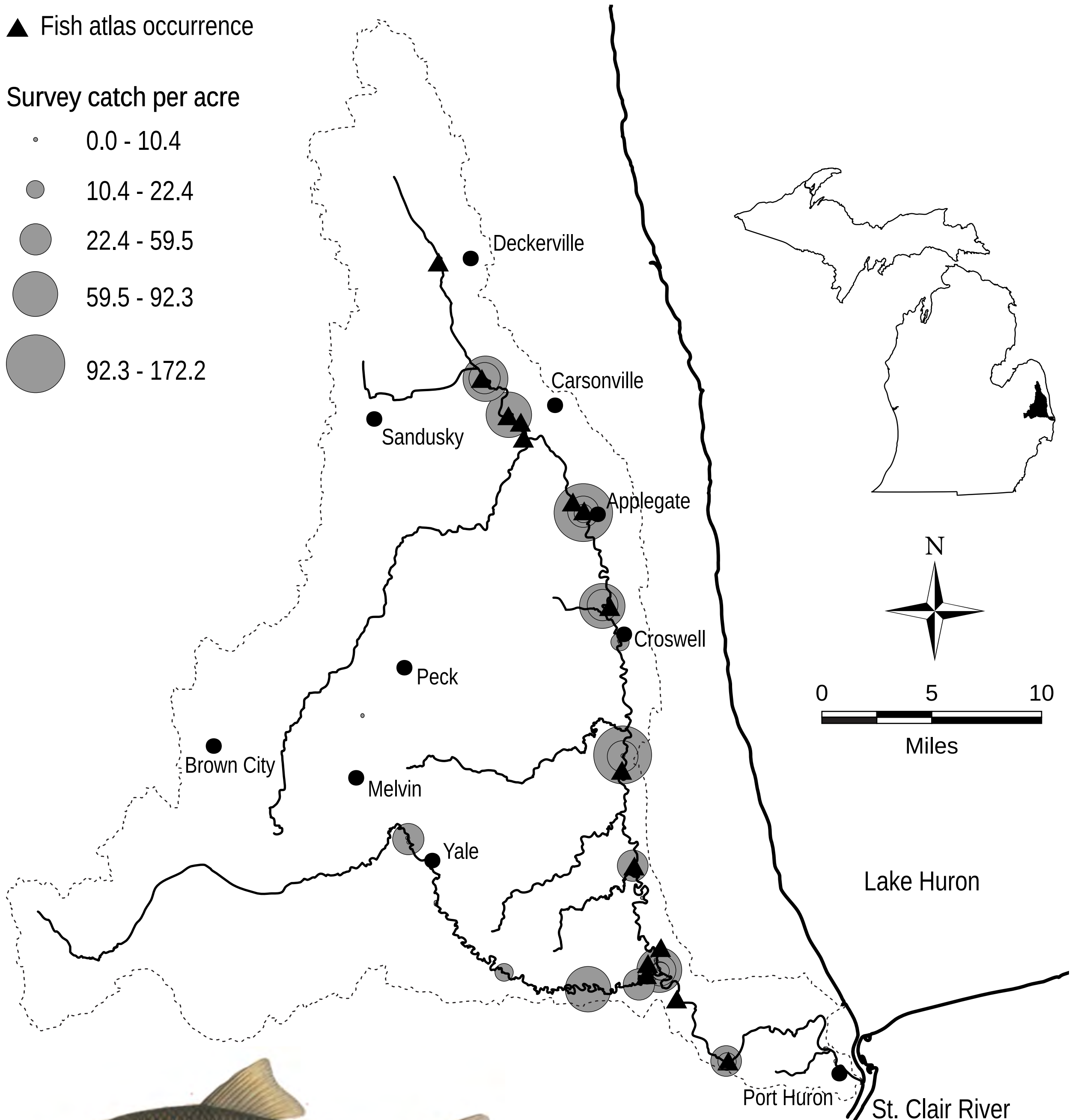




Black redhorse (*Moxostoma duquesnei*)

Habitat:

feeding	-	gravel substrate
	-	clear water, intolerant of siltation, turbidity, and low gradients
	-	medium size streams
	-	cooler swifter streams and short rocky pools with current
spawning	-	gravelly riffles
winter refuge	-	deeper holes



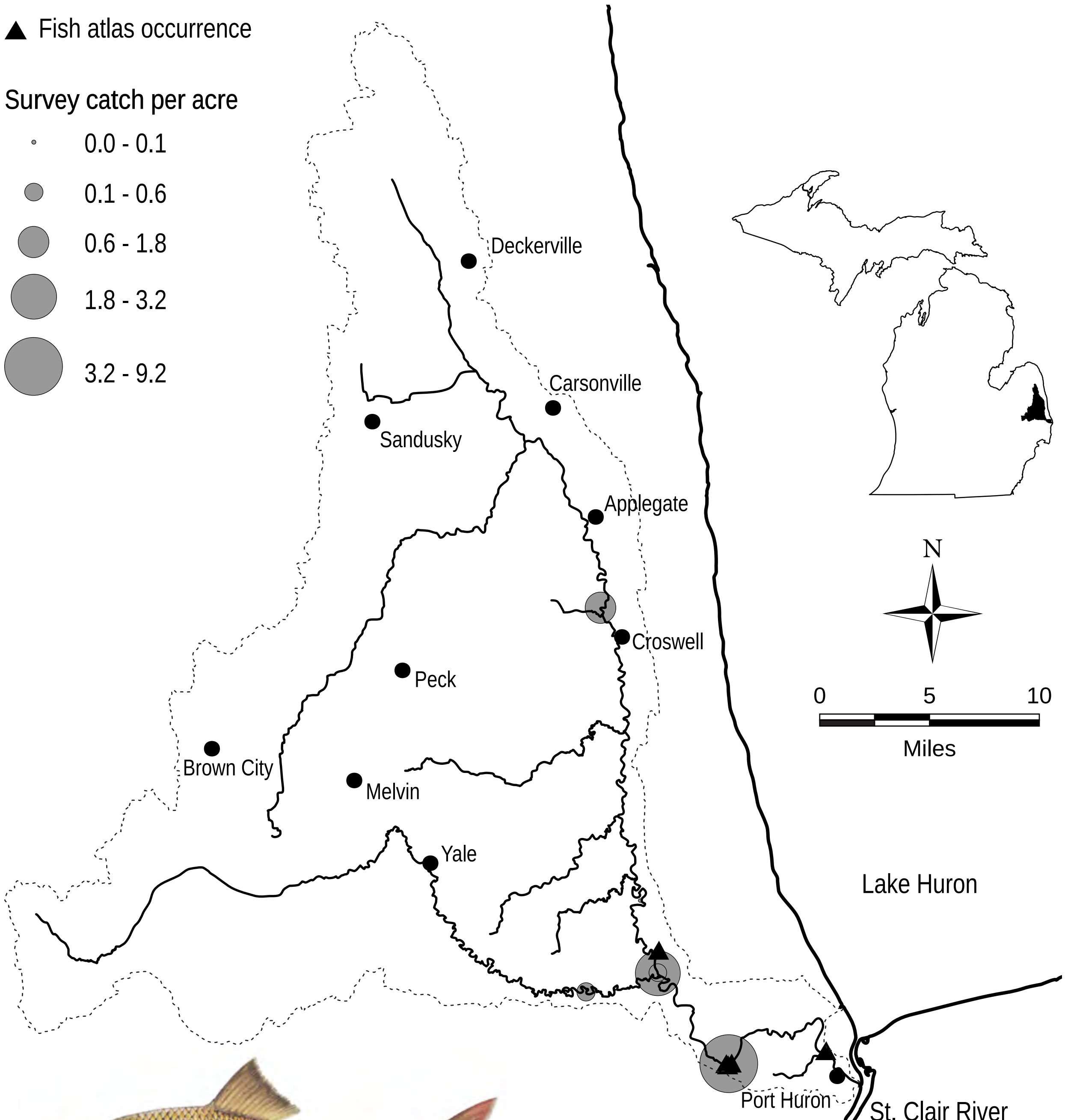
Golden redhorse (*Moxostoma erythrurum*)

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

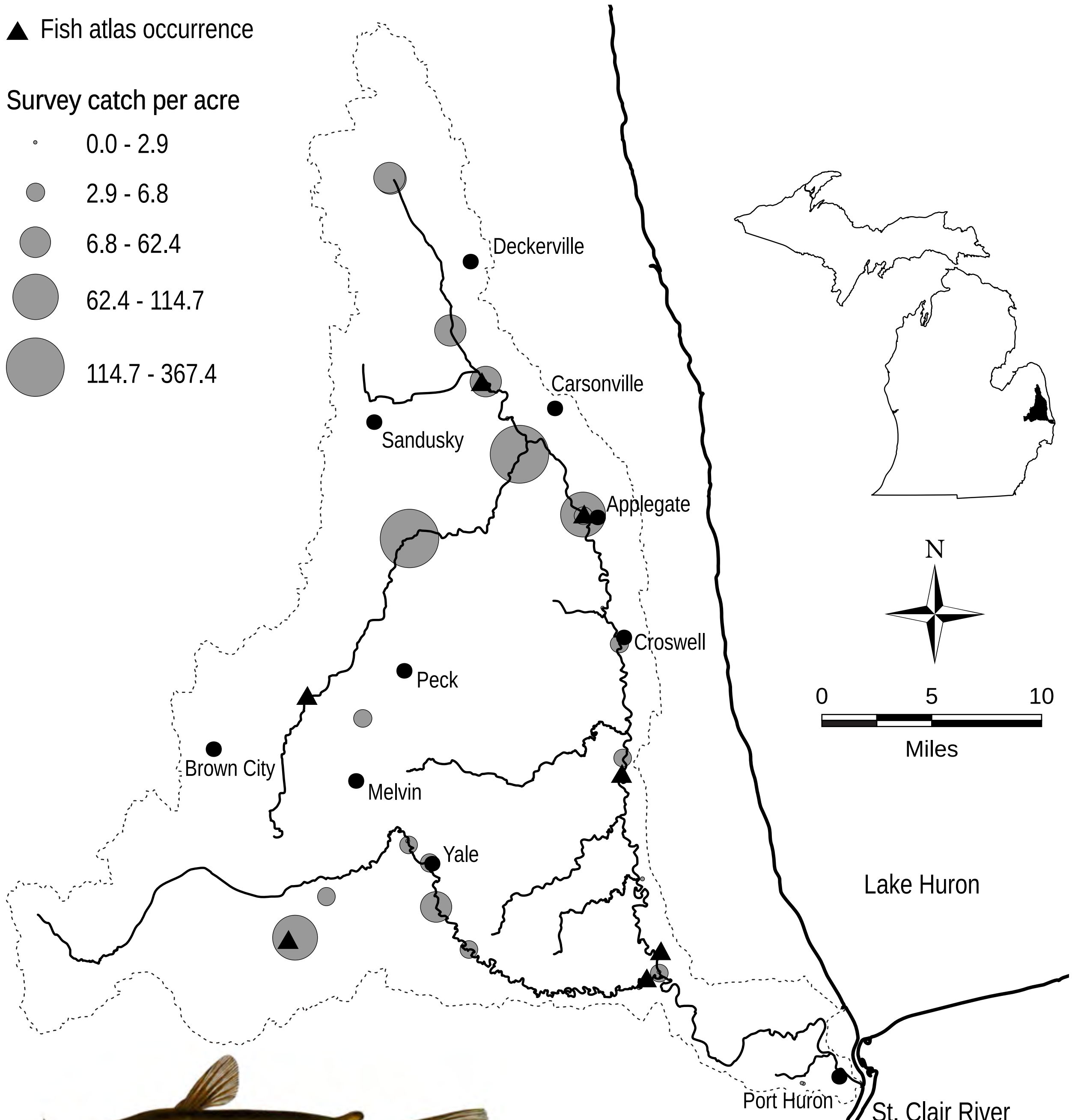
winter refuge - larger streams



Shorthead redhorse (*Moxostoma macrolepidotum*)

Habitat**:**

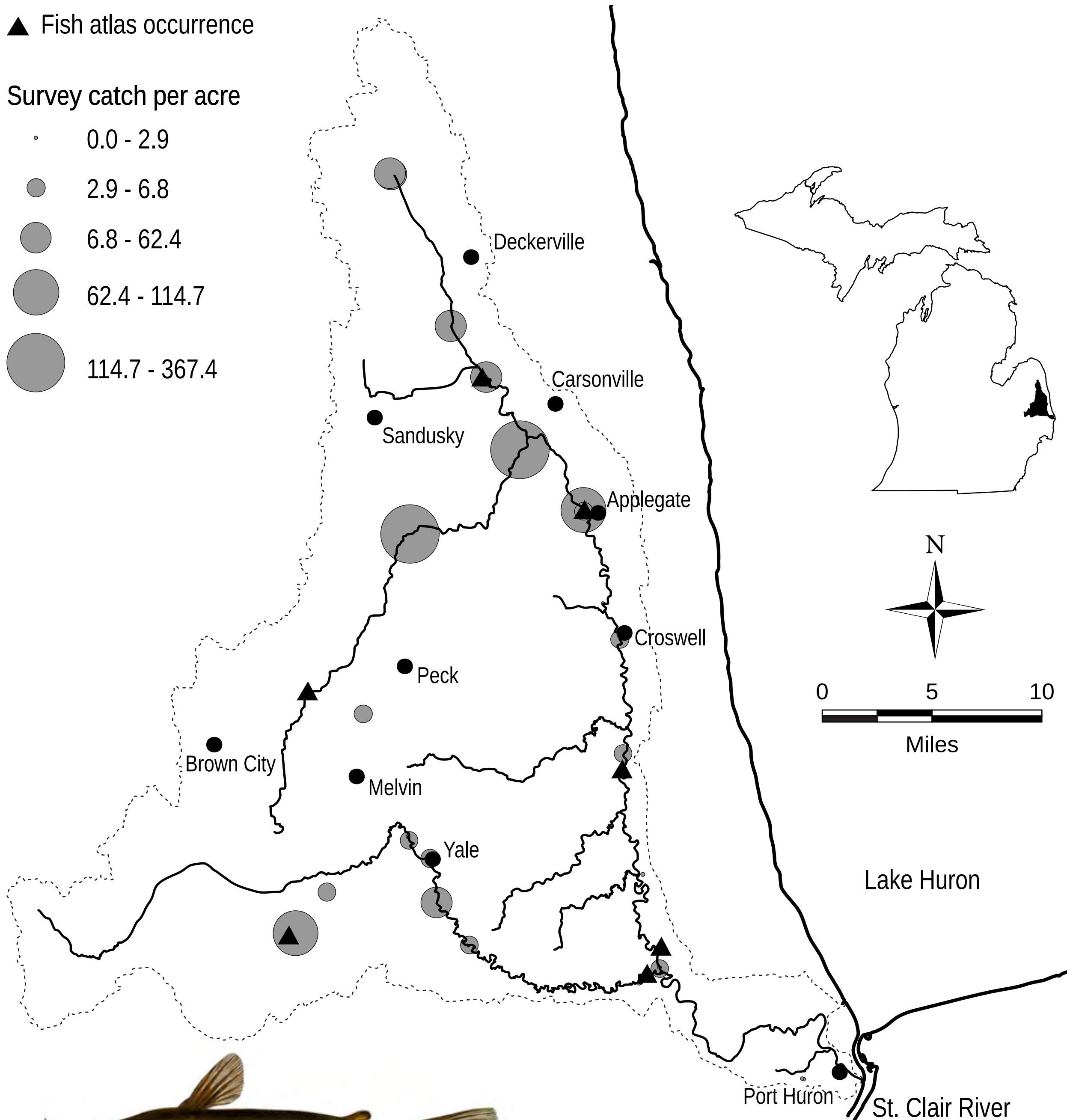
feeding	-	downstream sections of large rivers, lakes, and impoundments
	-	rocky substrates
	-	swift water near riffles
	-	clear to slightly turbid water
spawning	-	gravelly riffles in smaller feeder streams



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

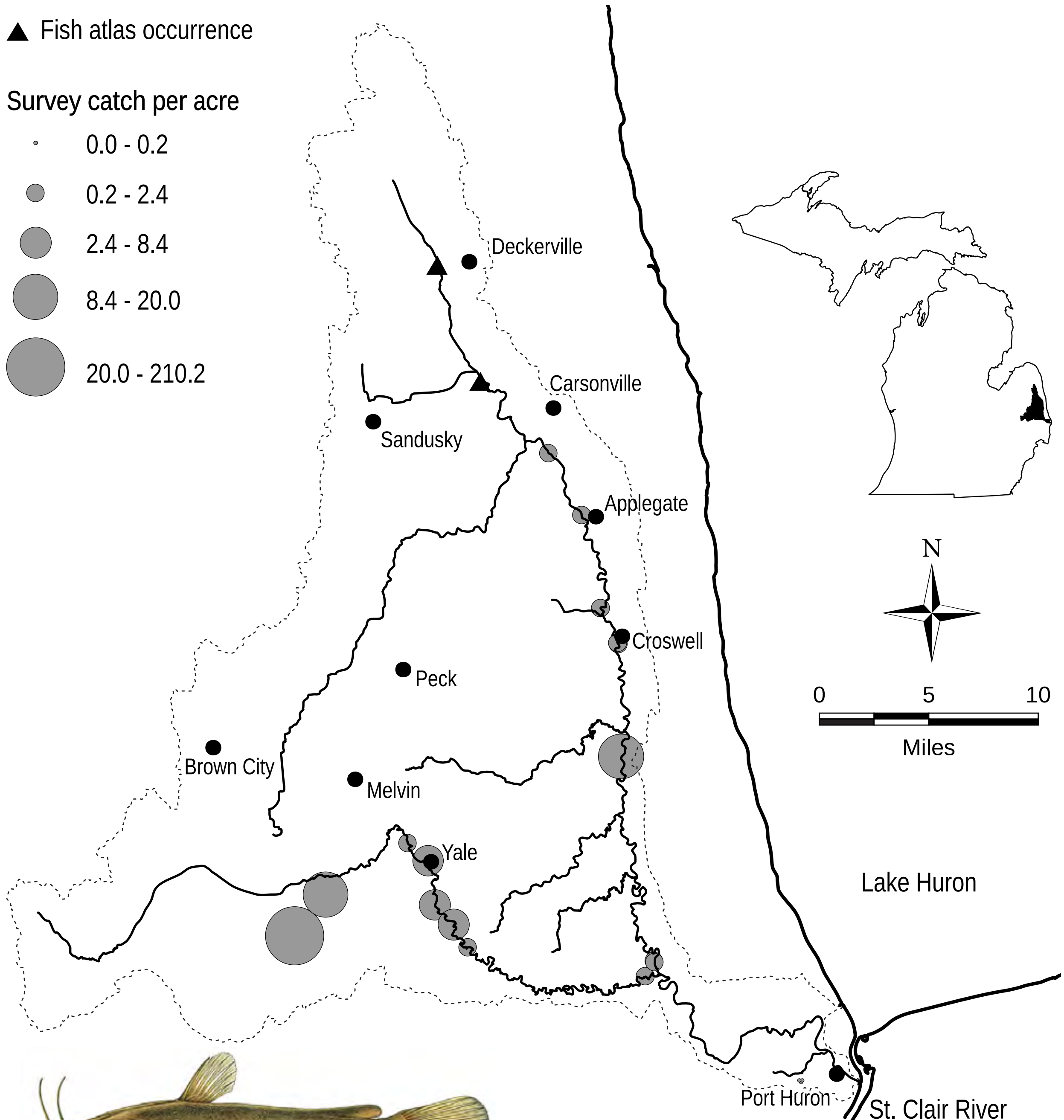


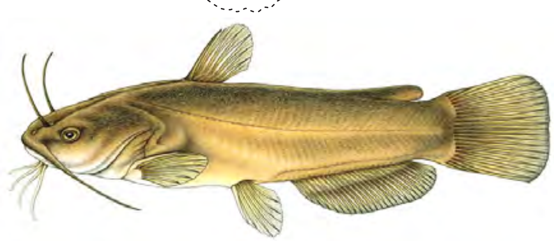
Black bullhead (*Ameiurus melas*)

Habitat:

feeding - turbid water
- silt bottom
- low gradient small to medium streams, pools, and headwaters of large rivers; also in lakes and impoundments
- can tolerate very warm water and very low dissolved oxygen

spawning - nest in moderate to heavy vegetation or woody debris and under overhanging banks

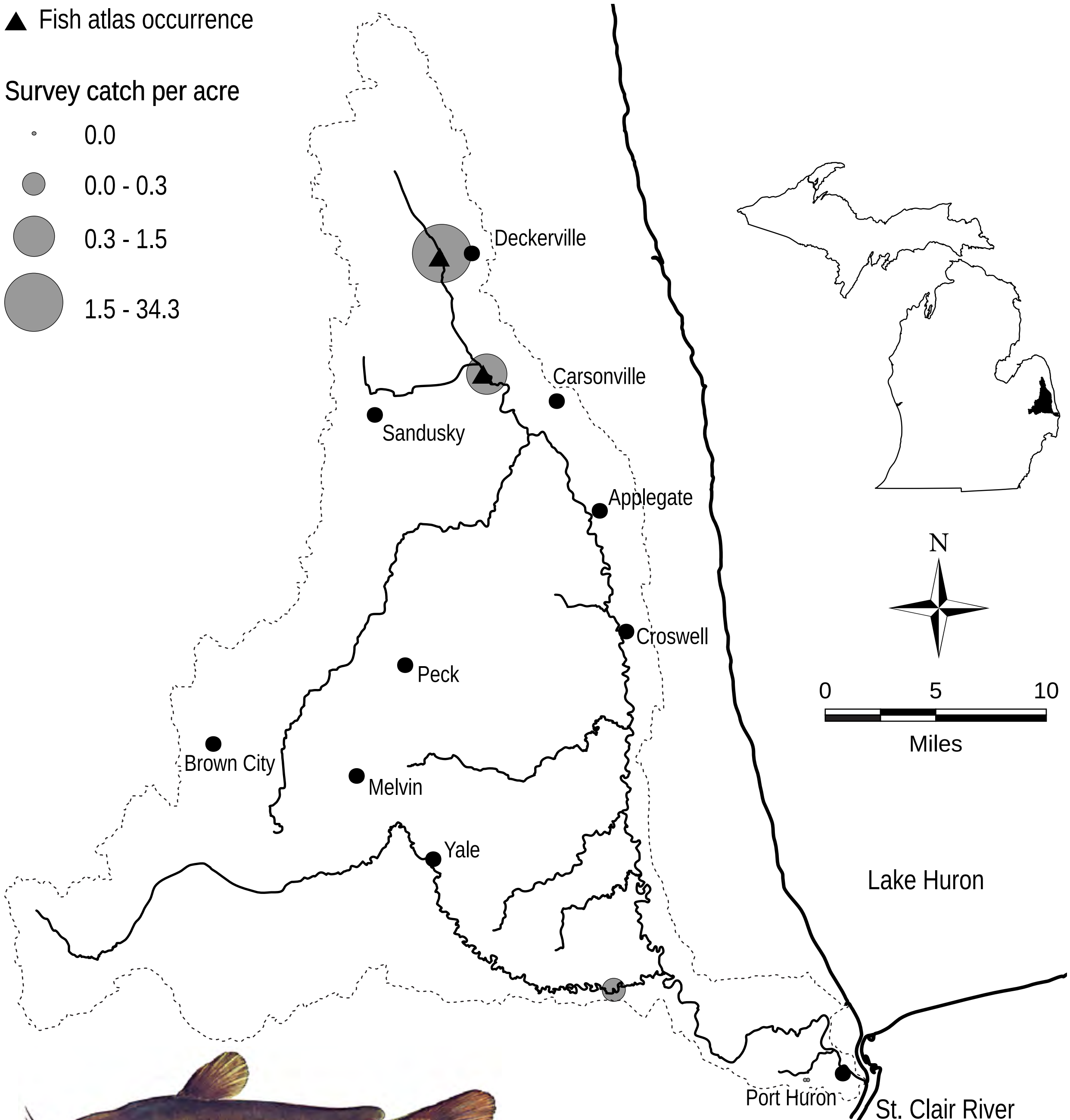




Yellow bullhead (*Ameiurus natalis*)

Habitat**:**

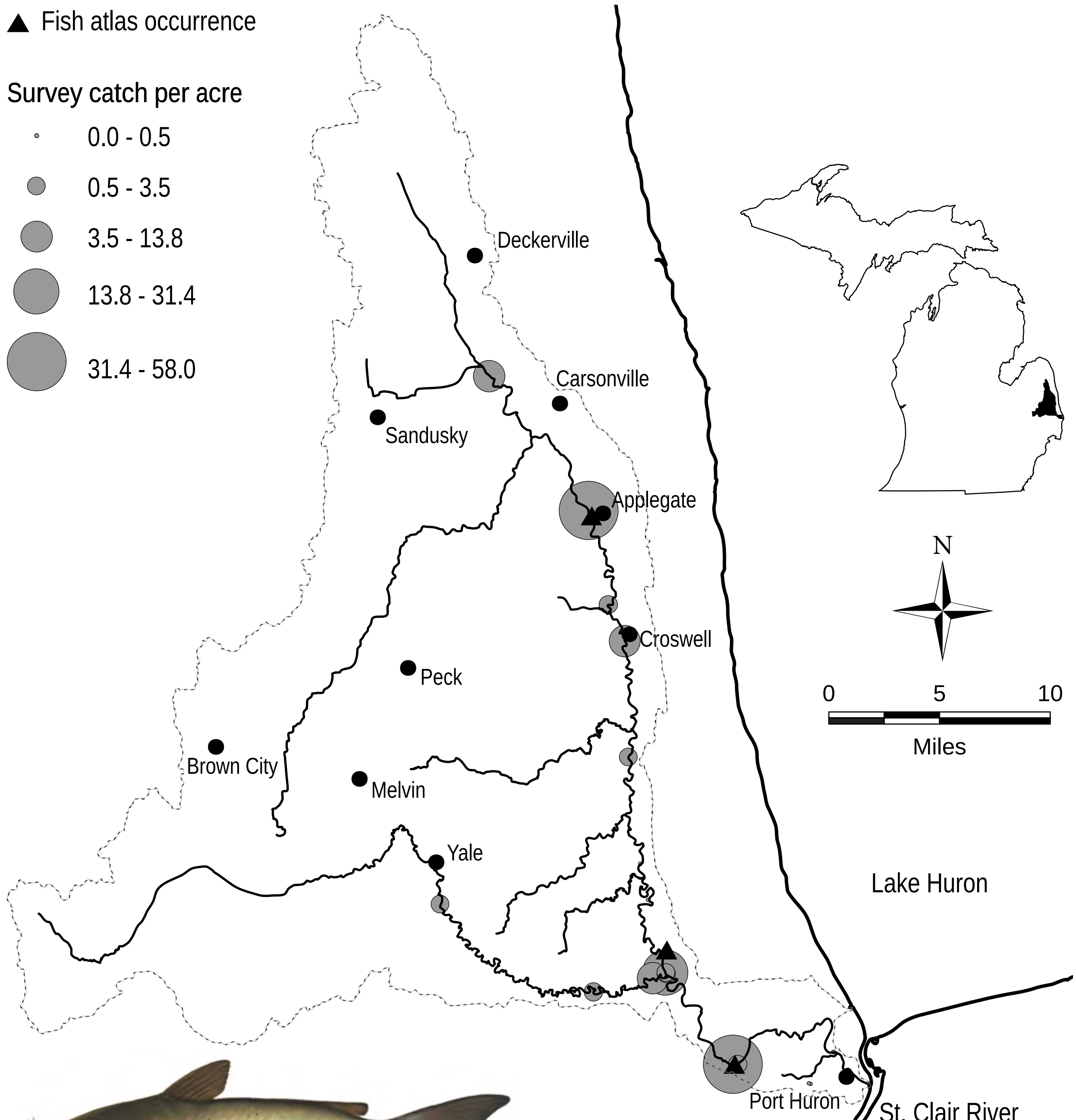
feeding	-	clear flowing water
	-	heavy vegetation
	-	low gradient streams, lakes, and impoundments
	-	tolerant of low oxygen
spawning	-	nest under a stream bank or near stones or stumps



Brown bullhead (*Ameiurus nebulosus*)

Habitat**:**

feeding	-	larger streams and rivers, lakes and impoundments
	-	clear cool water with little clayey silt
	-	moderate amounts of aquatic vegetation
	-	sand, gravel, or muck substrate
	-	not tolerant of turbid water
	-	tolerant of warm water and low oxygen
spawning	-	nest in mud or sand substrate among rooted aquatic vegetation usually near a stump, tree, or rock
winter refuge	-	in muddy bottoms

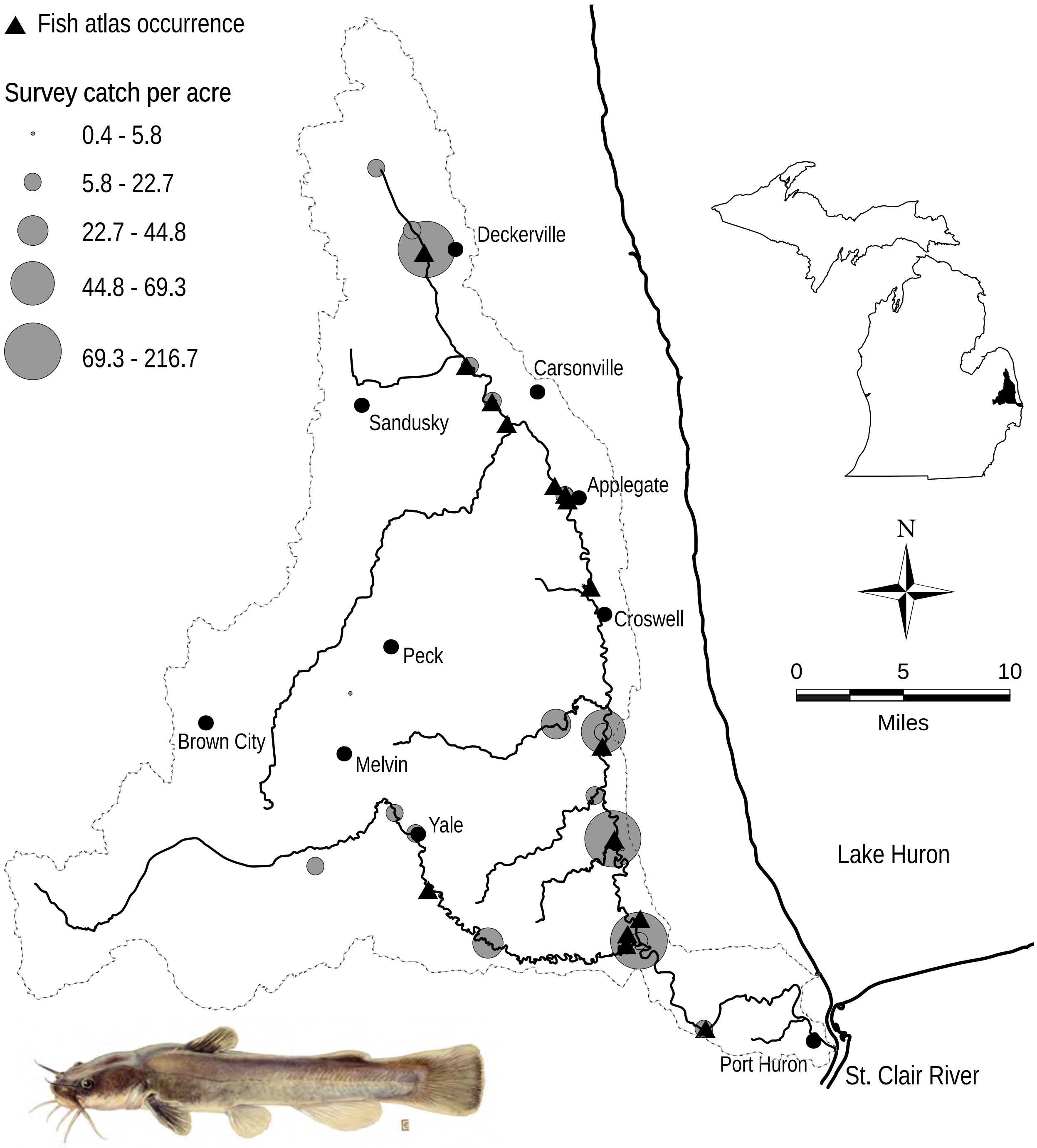


Channel catfish (*Ictalurus punctatus*)

Habitat**:**

feeding - moderately-clear, deeper waters of rivers, lakes, and impoundments
- sand, gravel, or rubble substrate
- low to moderate gradient

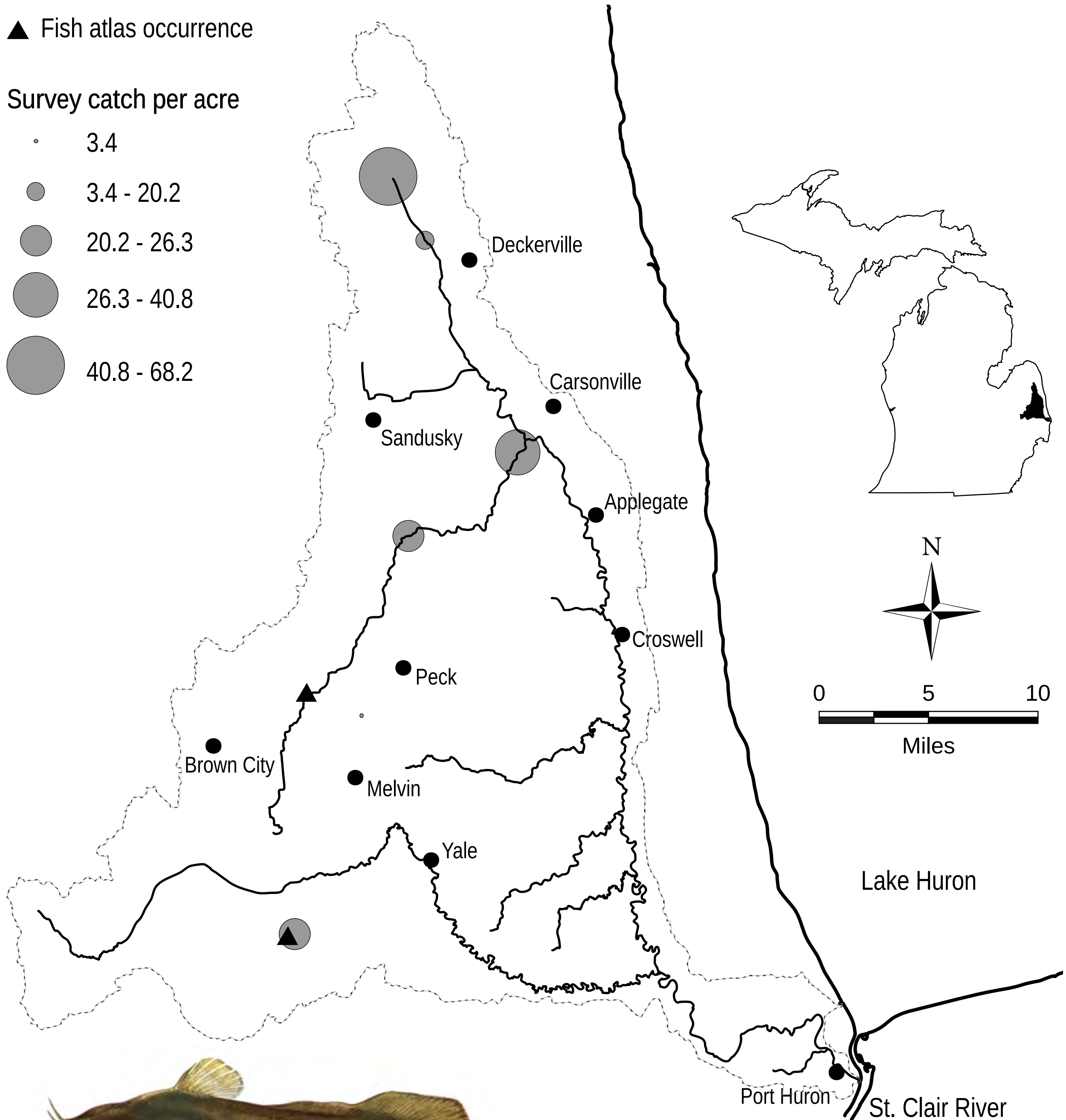
spawning - secluded semi-dark areas such as holes, under banks, log jams, or rocks



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

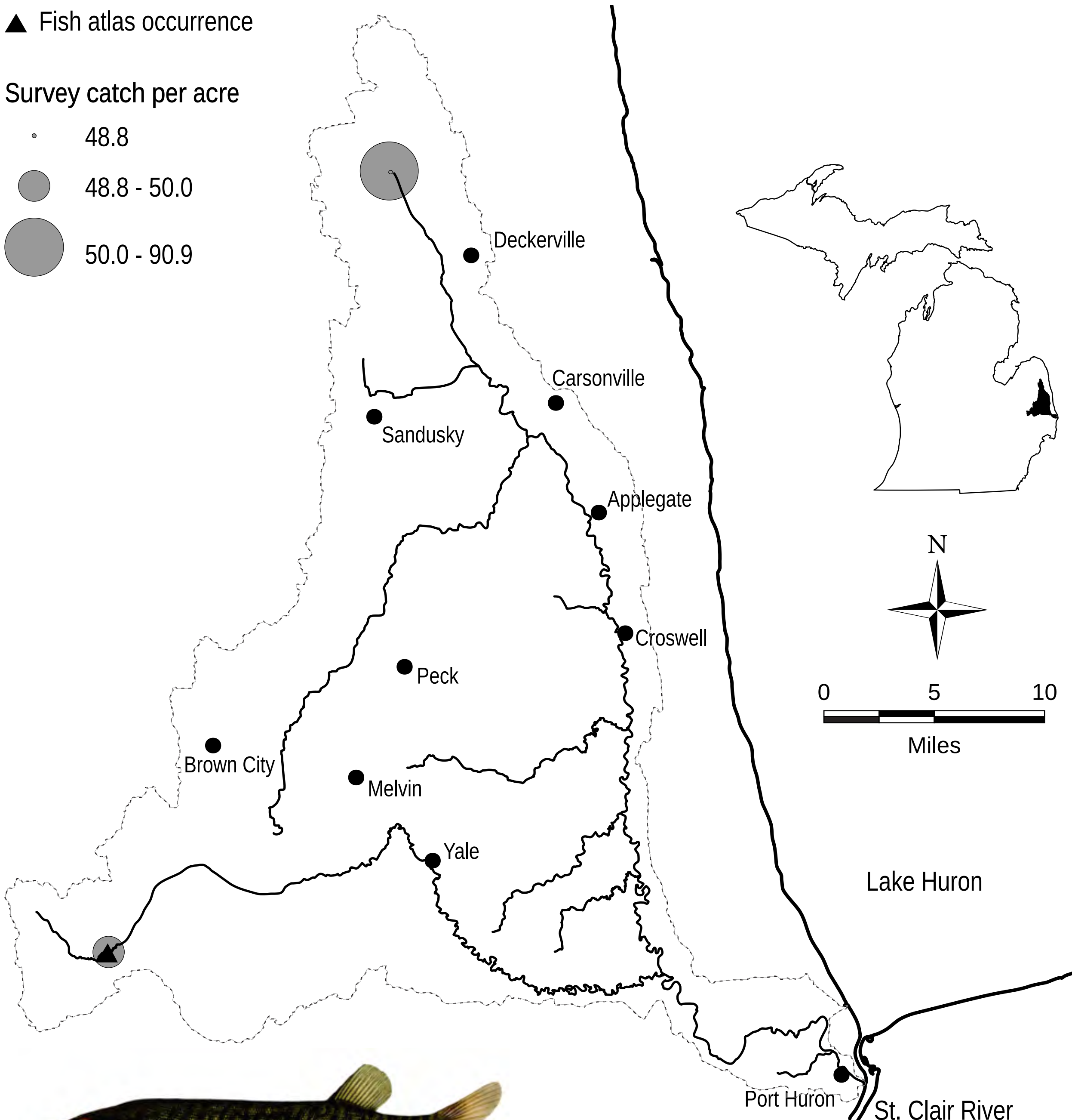


Tadpole madtom (*Noturus gyrinus*)

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)

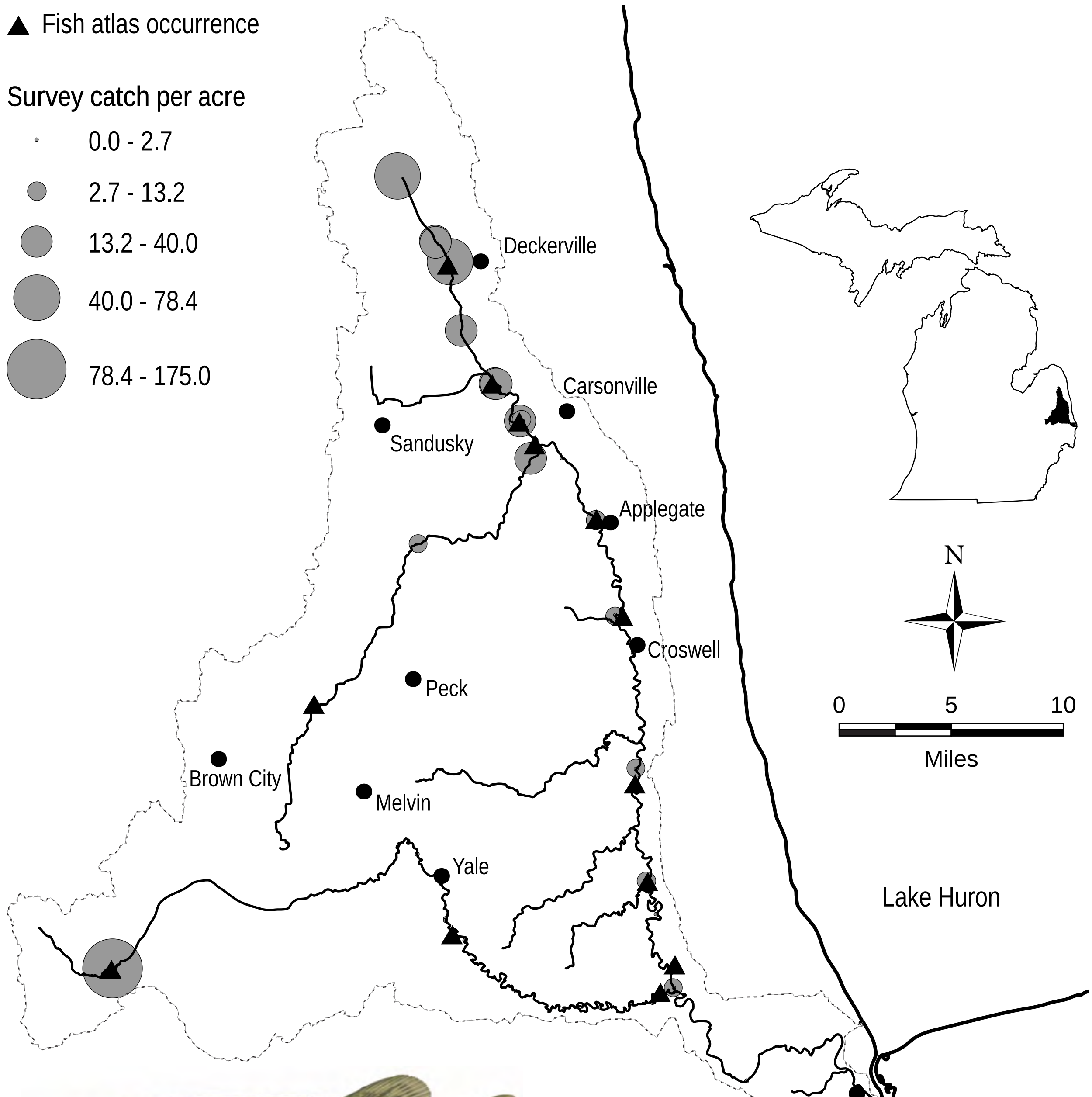


Grass pickerel (*Esox americanus vermiculatus*)

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

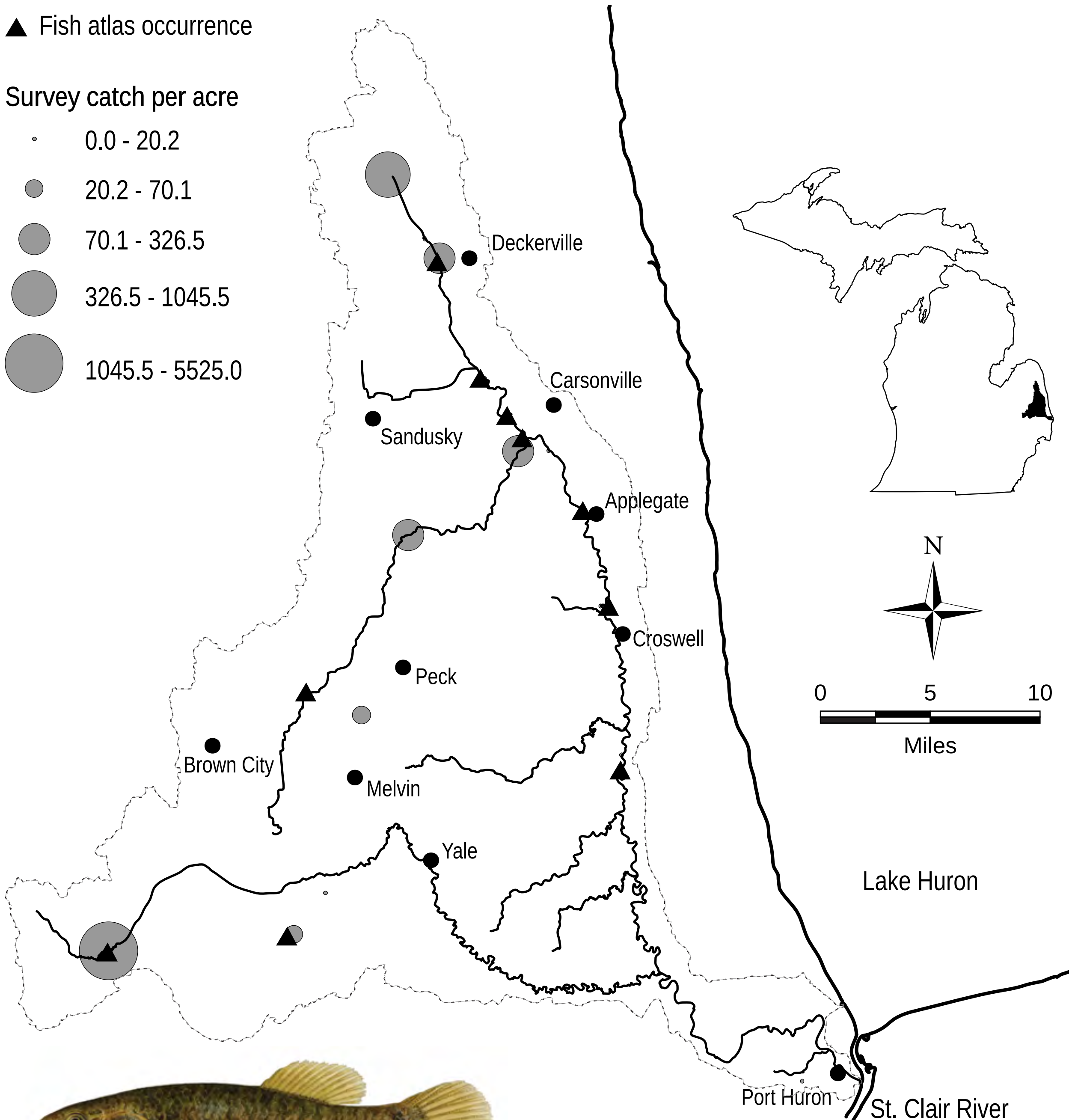


Northern pike (*Esox lucius*)

Habitat**:**

feeding - cool to moderately warm streams, rivers, lakes, and impoundments
- vegetation in slow to moderate current

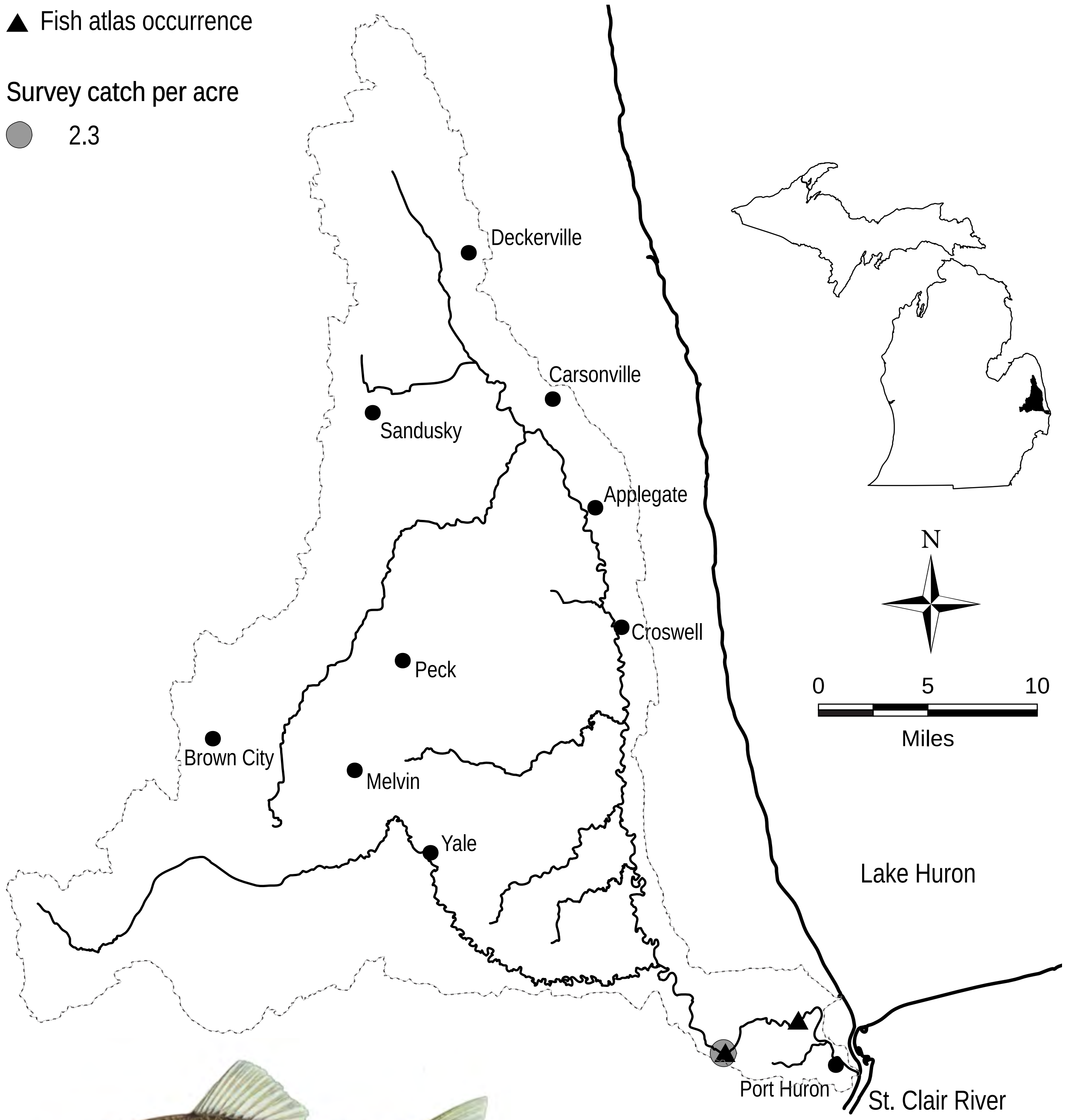
spawning - submerged vegetation with slow current in shallow water



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

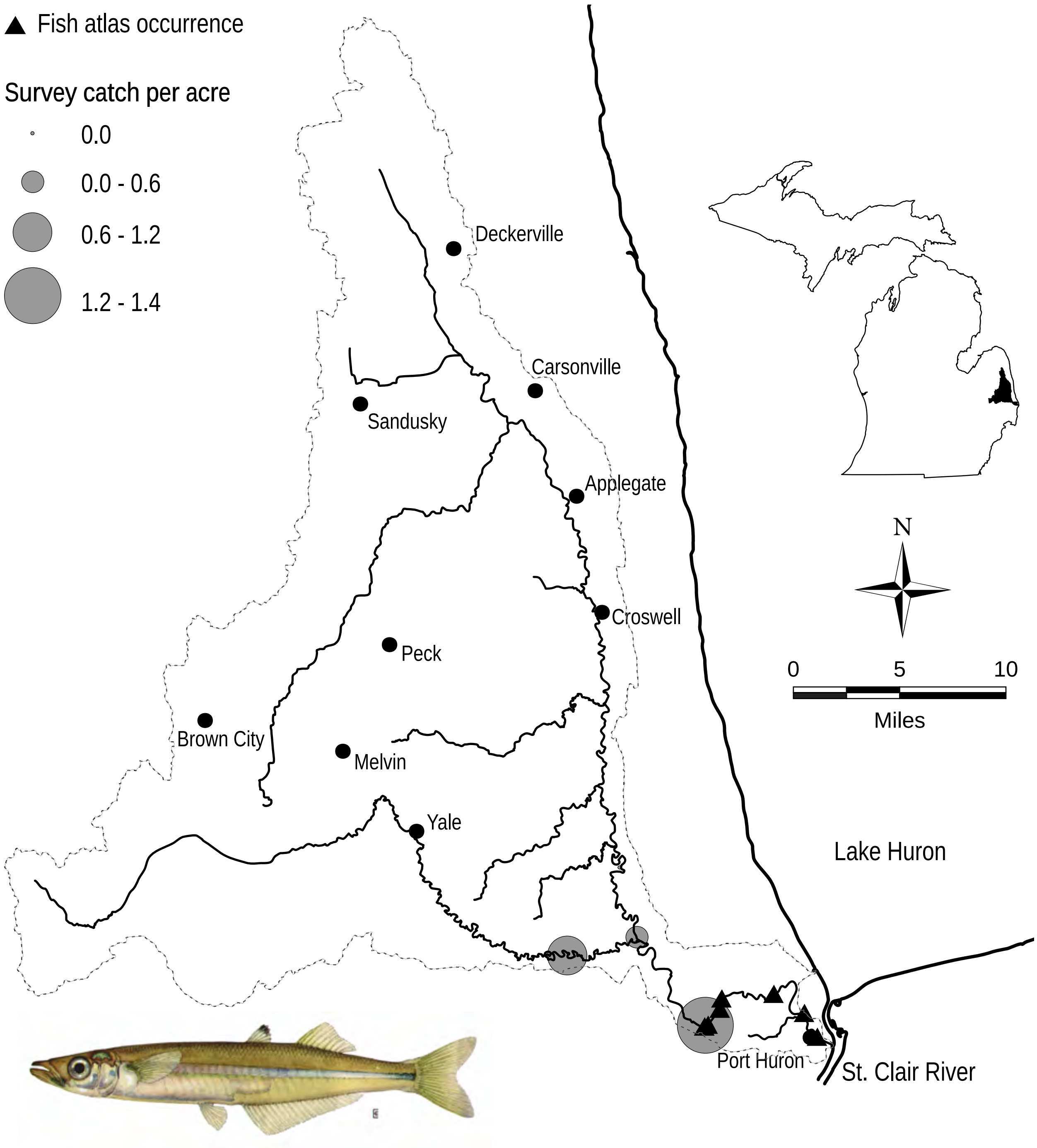


Trout-perch (*Percopsis omiscomaycus*)

Habitat**:**

feeding - clean sand or fine gravel substrate
- long deep pools in low gradient streams and Lake Michigan
- highly intolerant of clayey silts
- avoids rooted aquatic vegetation

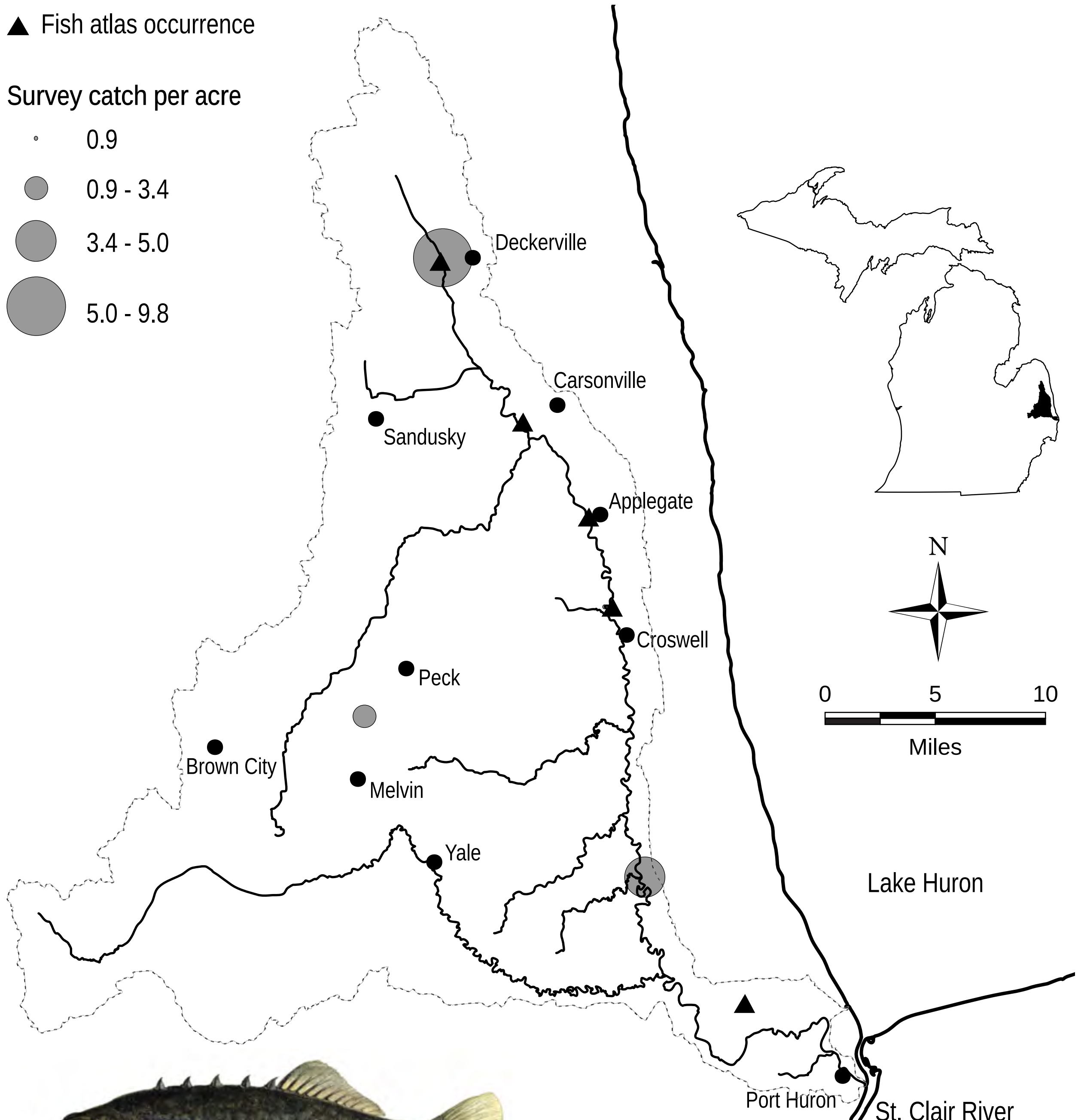
spawning - over rocks in shallows
- over sand and gravel substrates in Lake Michigan



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

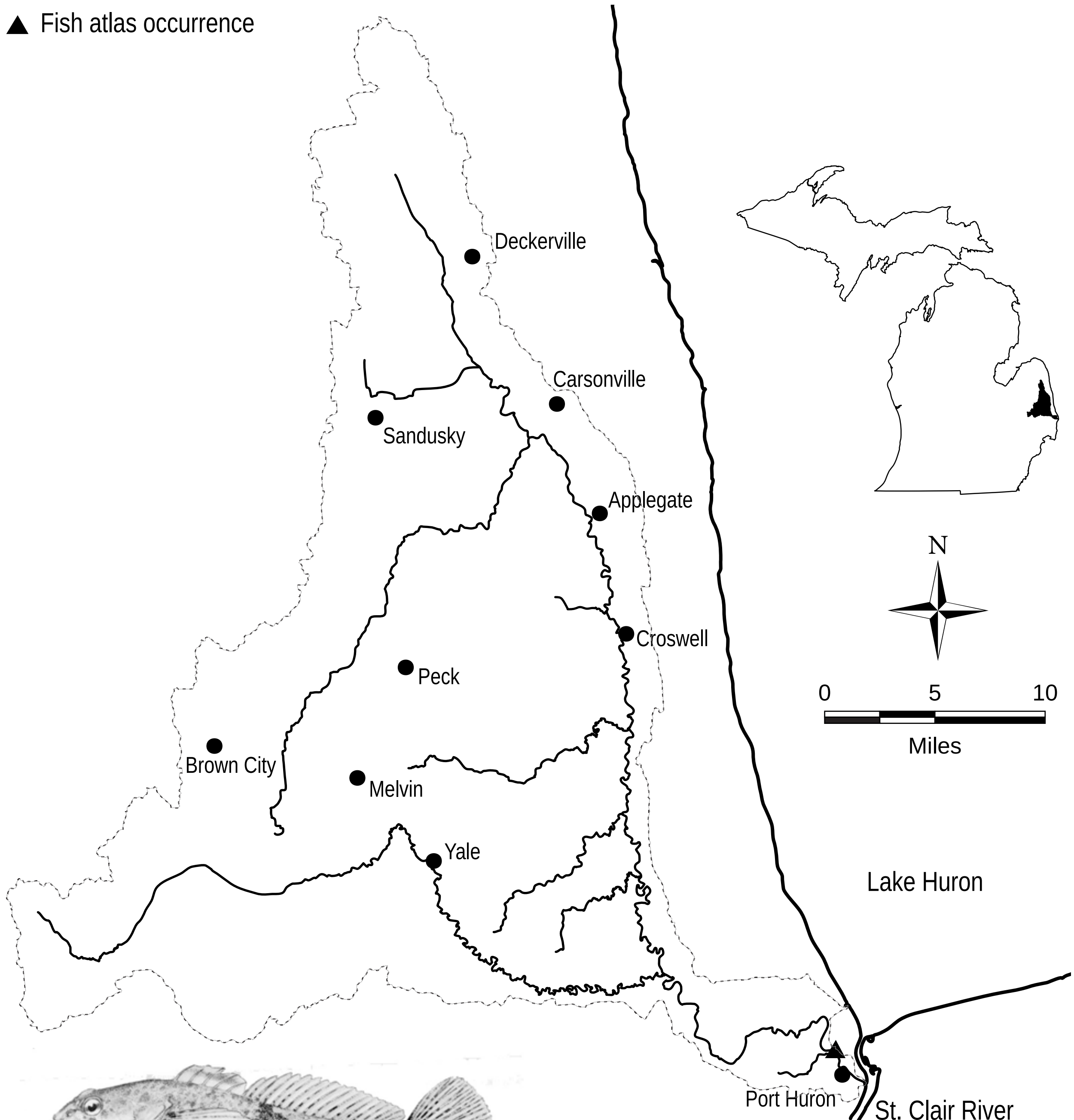


Brook stickleback (*Culaea inconstans*)

Habitat**:**

feeding
- clear, cold, densely vegetated streams, and swampy margins of lakes
- low gradient
- muck, peat, or marl substrate
- not tolerant of turbidity

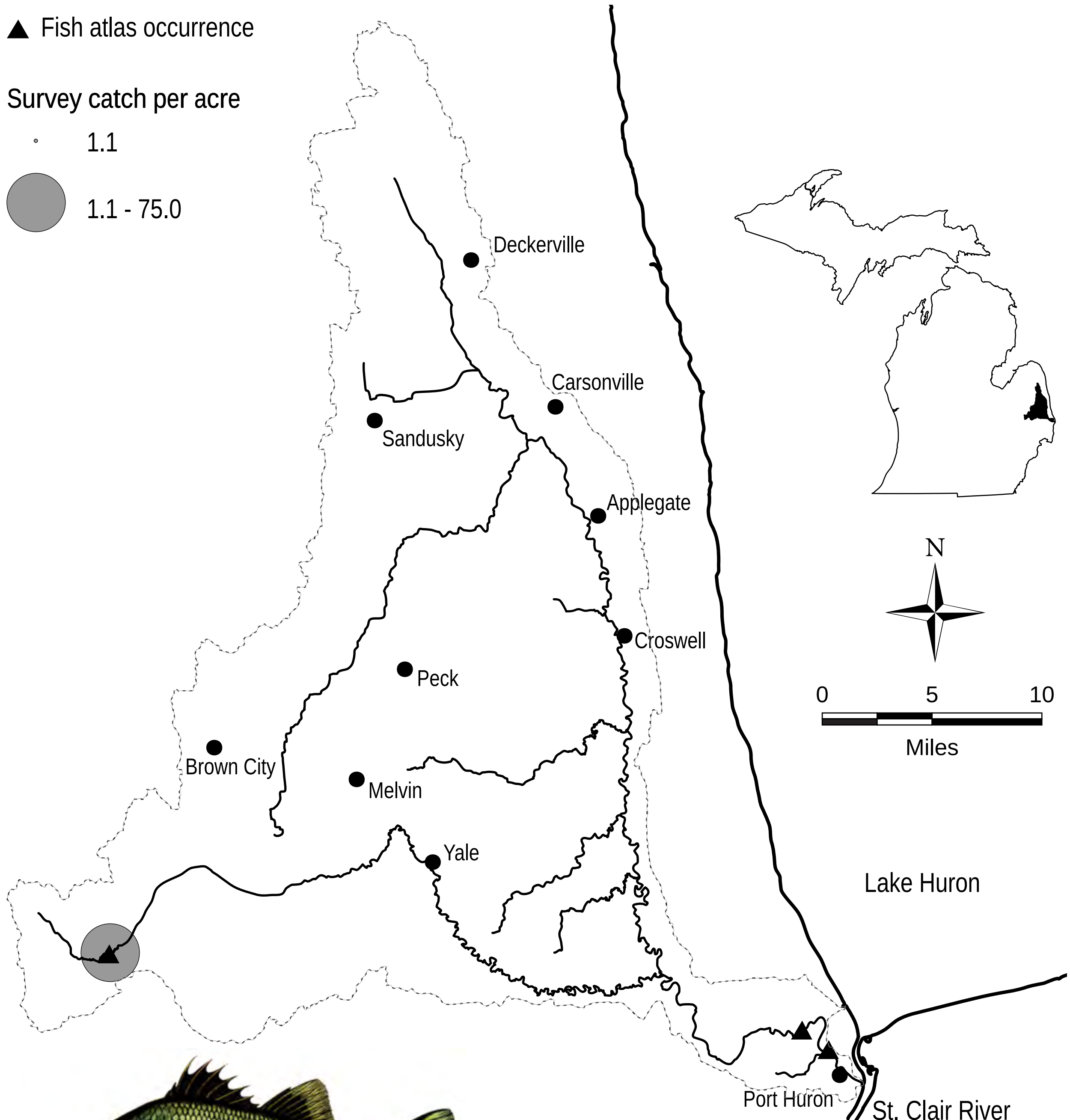
spawning
- shallow cool (<66°F) water
- aquatic reeds or grasses necessary



Mottled sculpin (*Cottus bairdii*)

Habitat**:**

feeding	-	cool to cold streams
	-	riffle and rock substrates preferred
	-	clear to slightly turbid shallow water
spawning	-	nests under logs or rock

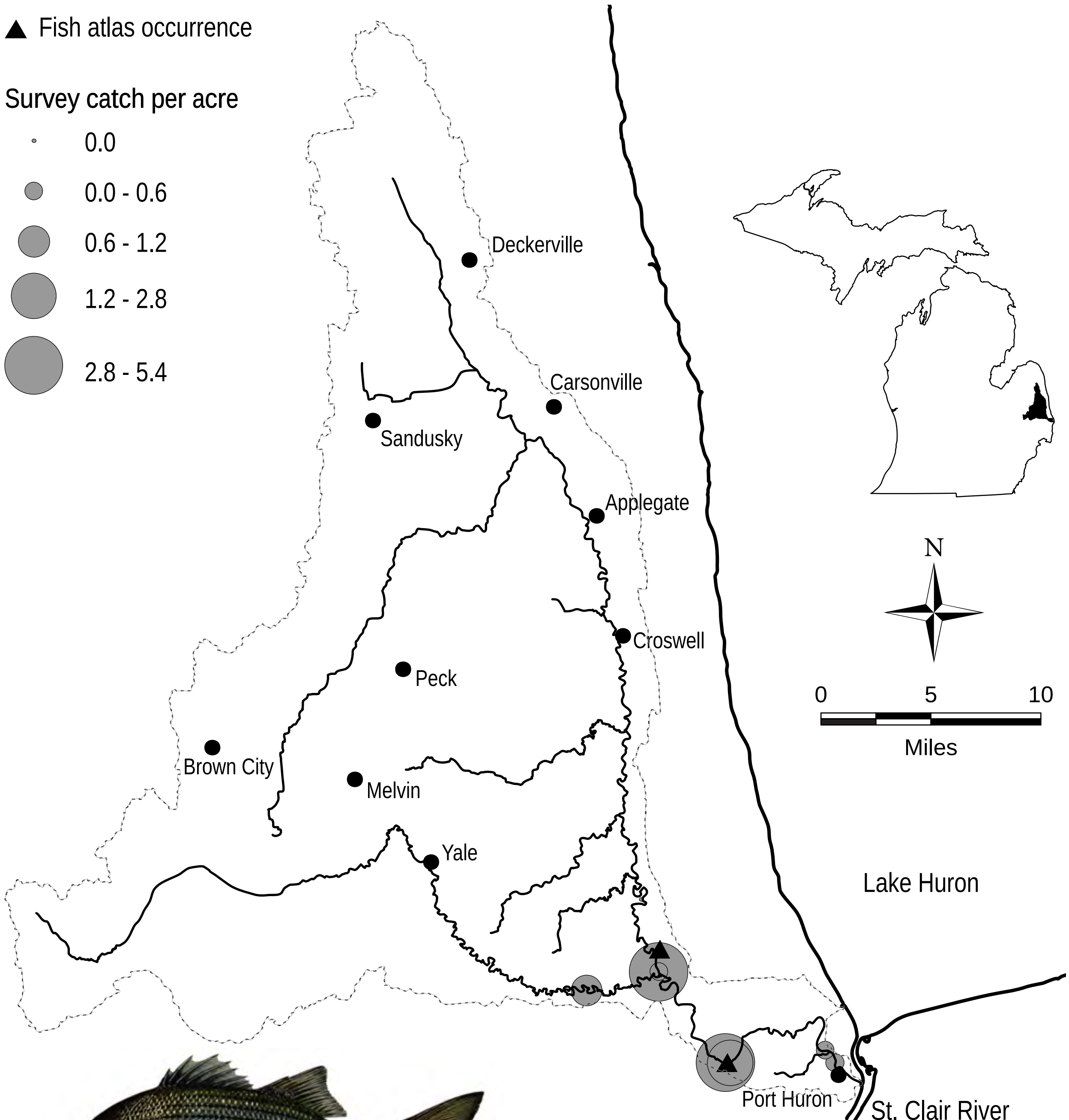


White perch (*Morone americana*)

Habitat:

feeding - clear, warm water of low-gradient streams, lakes, impoundments, and Lake Erie

spawning - shallow water over firm substrate

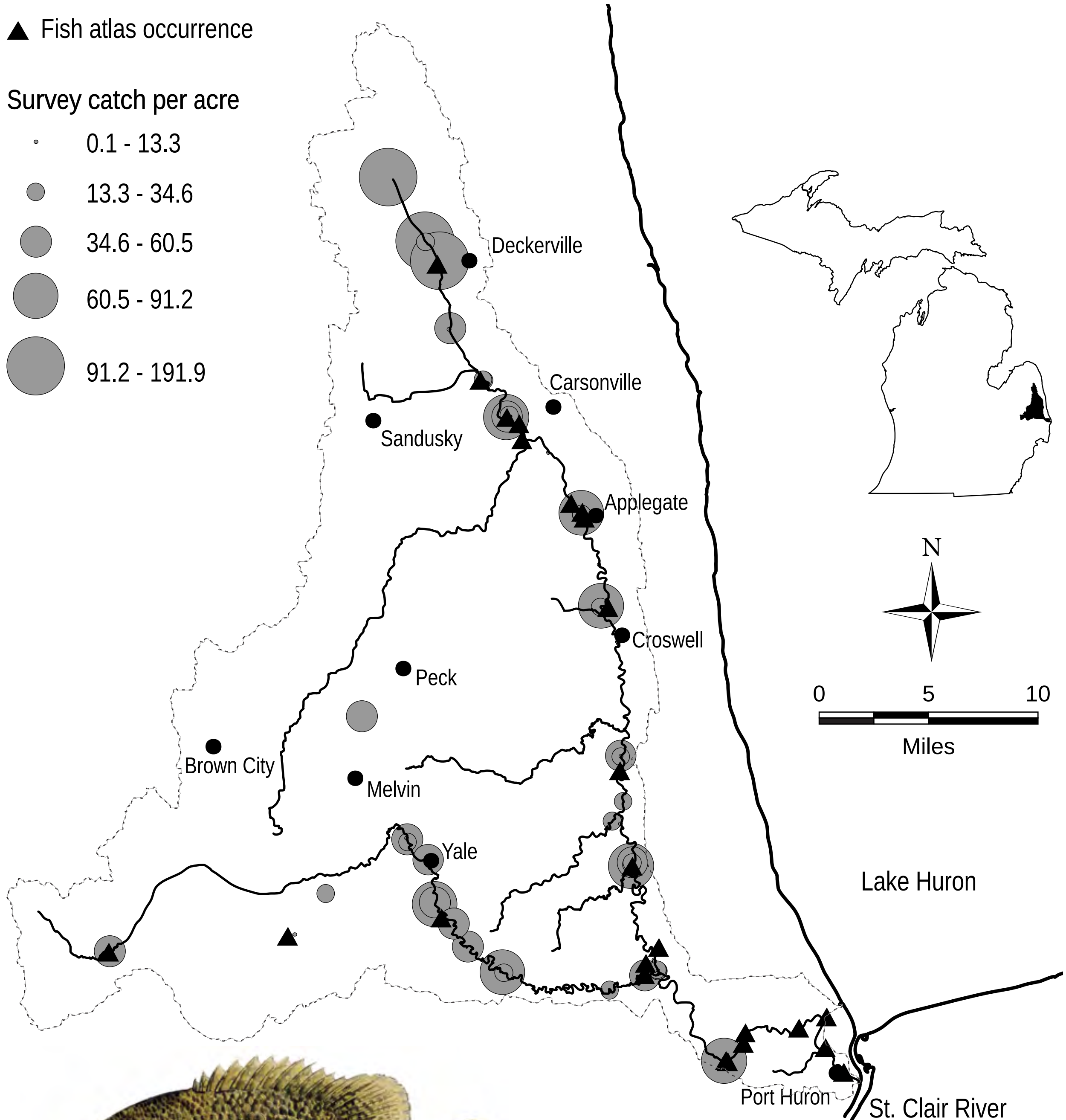


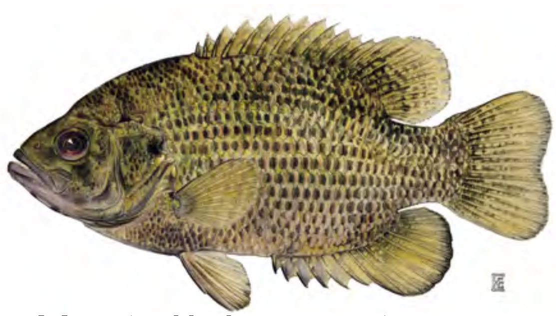
White bass (*Morone chrysops*)

Habitat:

feeding - large lakes, impoundments, and Lake Huron
- clear water of 30 feet or less depth
- firm substrate

spawning - tributary streams or shallow water of lakes
- over firm substrate

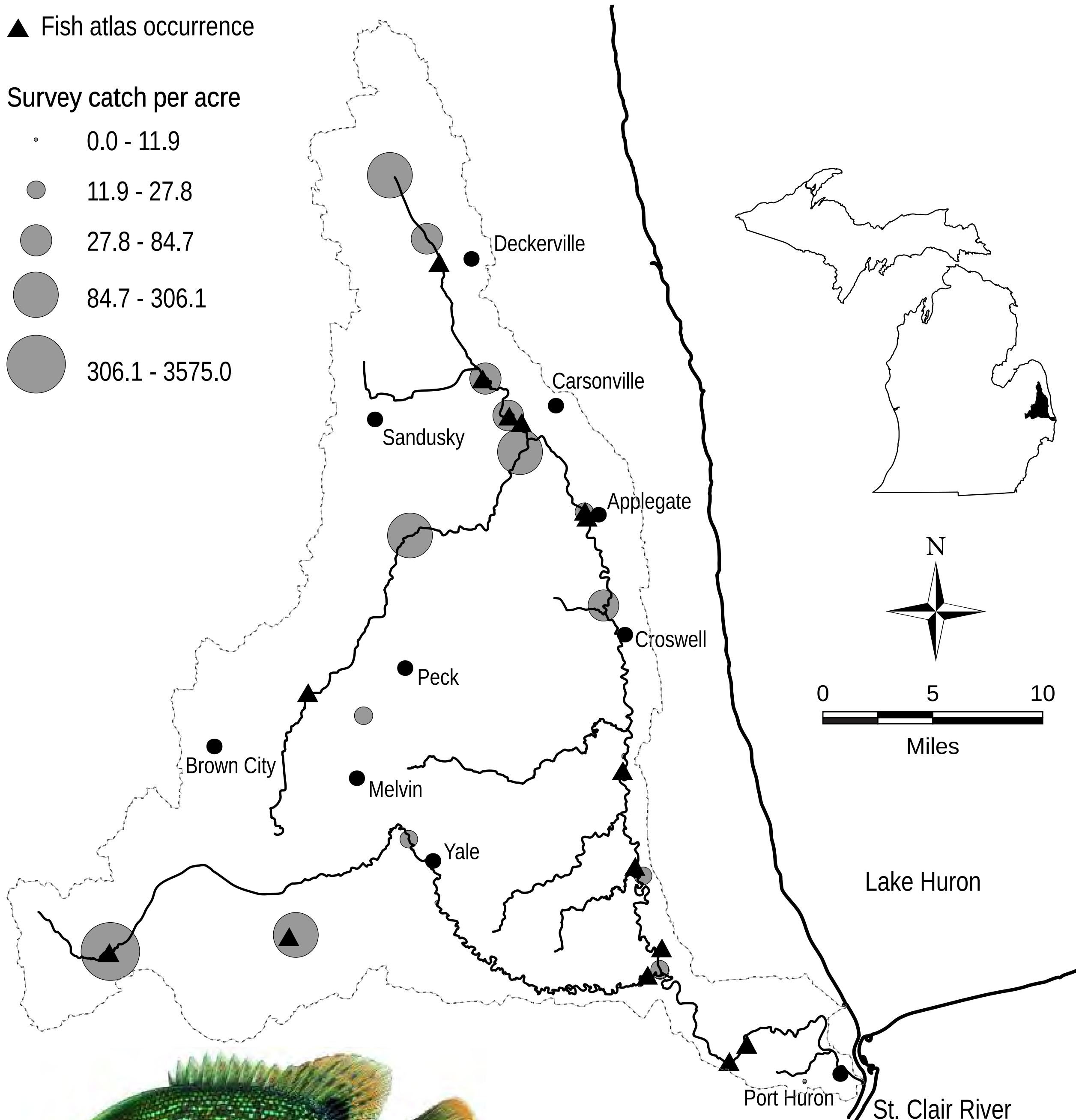




Rock bass (*Ambloplites rupestris*)

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

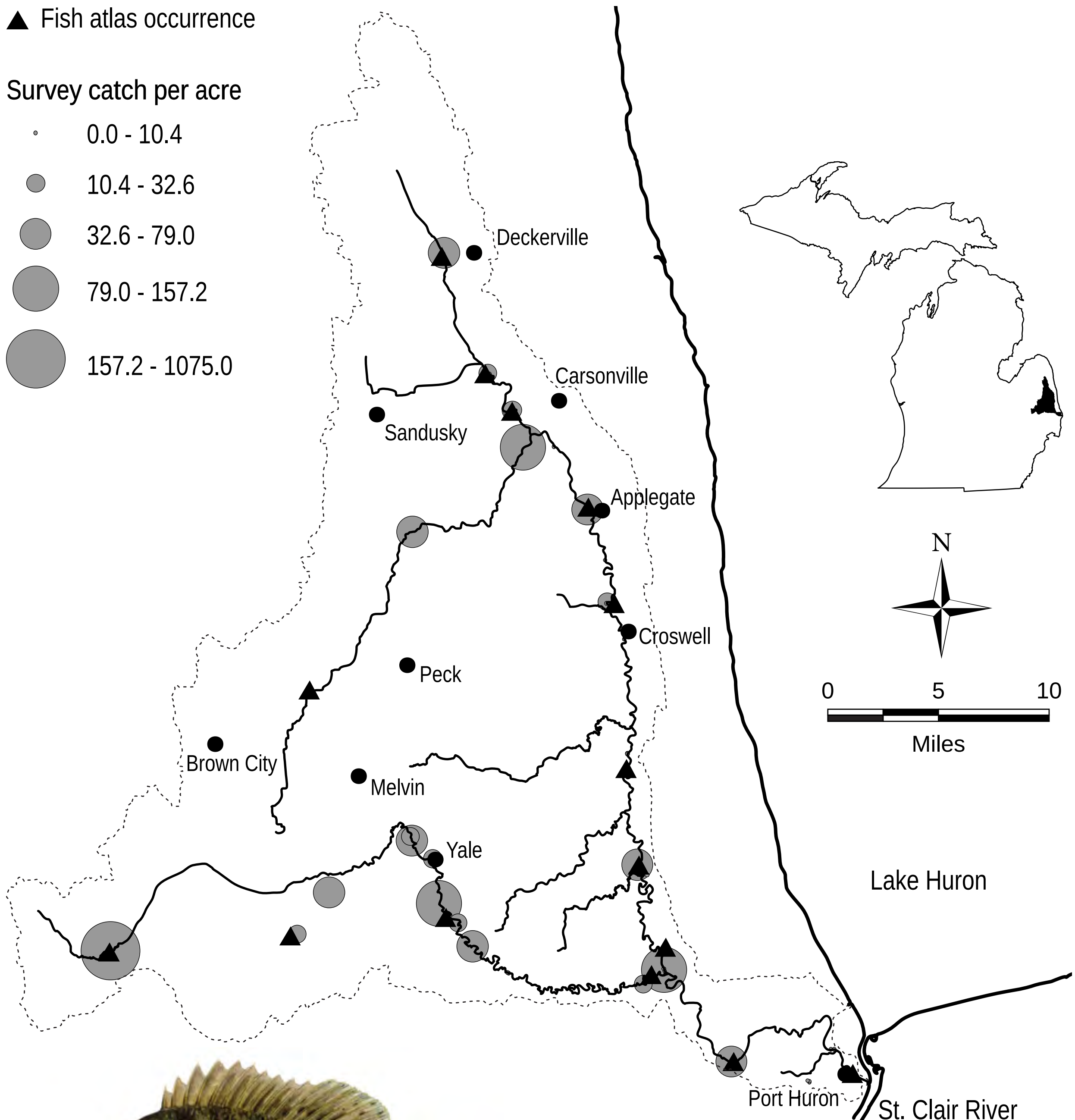


Green sunfish (*Lepomis cyanellus*)

Habitat**:**

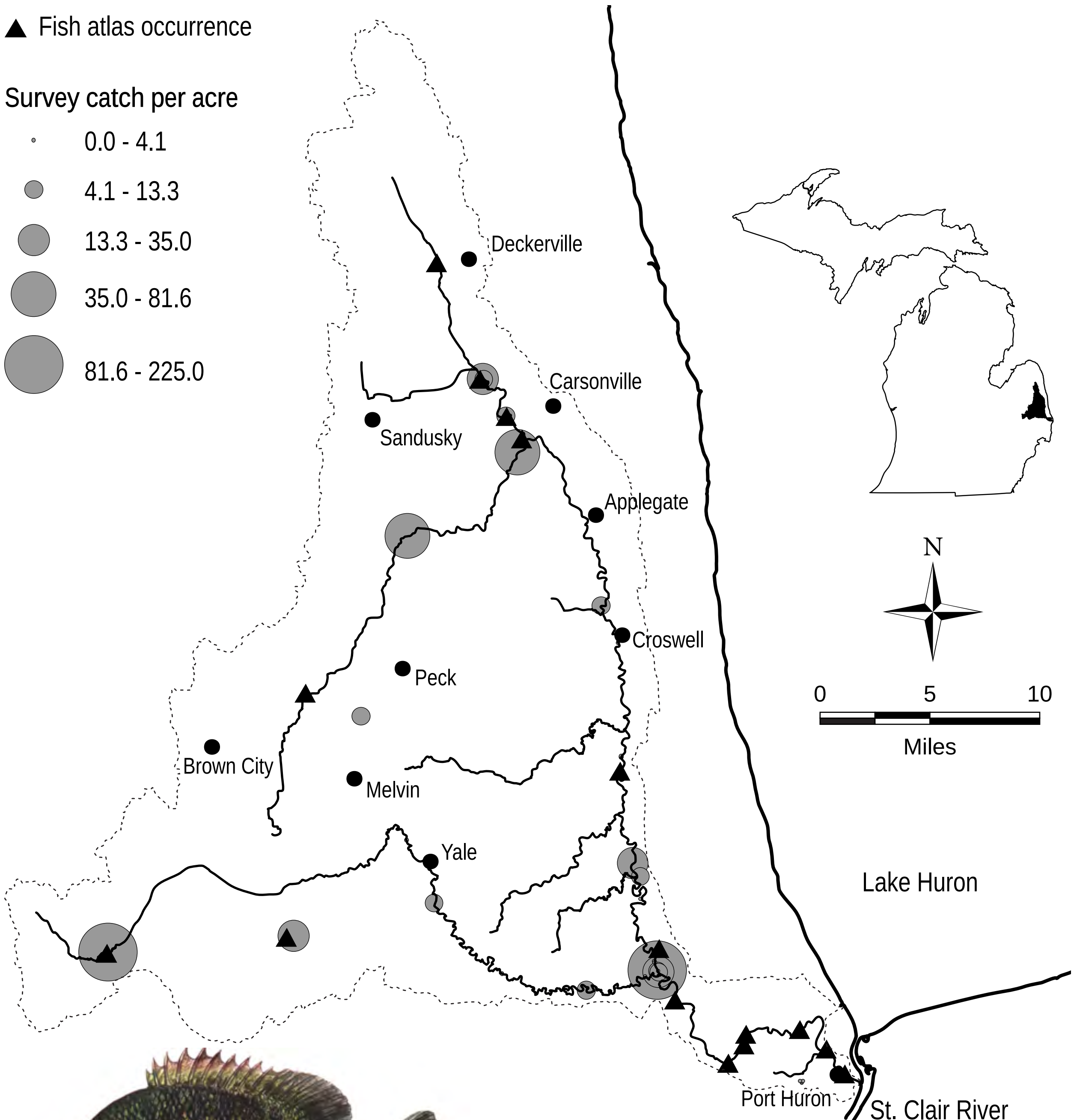
feeding - impoundments and lakes, and low-current streams and rivers
- no substrate preference

spawning - nests in shallow areas sheltered by rocks, logs, or aquatic vegetation



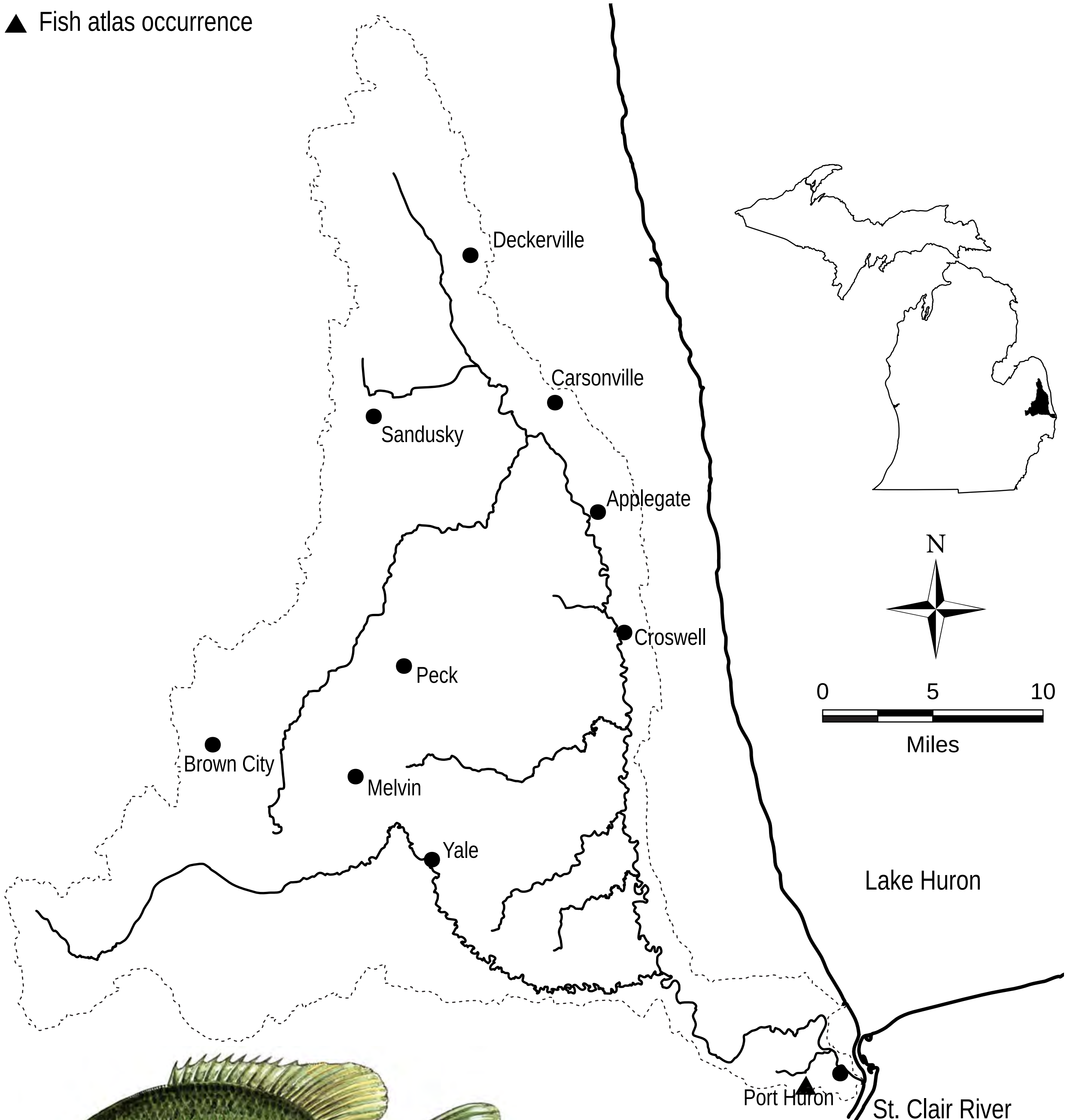
Pumpkinseed sunfish (*Lepomis gibbosus*)

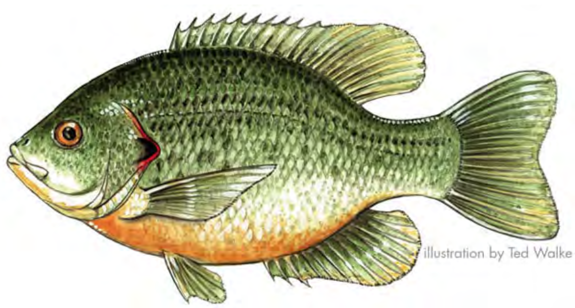
Habitat:	feeding	- non-flowing clear water in streams and rivers; also lakes and impoundments
		- muck or sand partly covered with organic debris substrate
		- dense beds of submerged aquatic vegetation
	spawning	- nest in sand, gravel, or rock substrate
		- in shallow water near submerged vegetation



Bluegill (*Lepomis macochirus*)

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

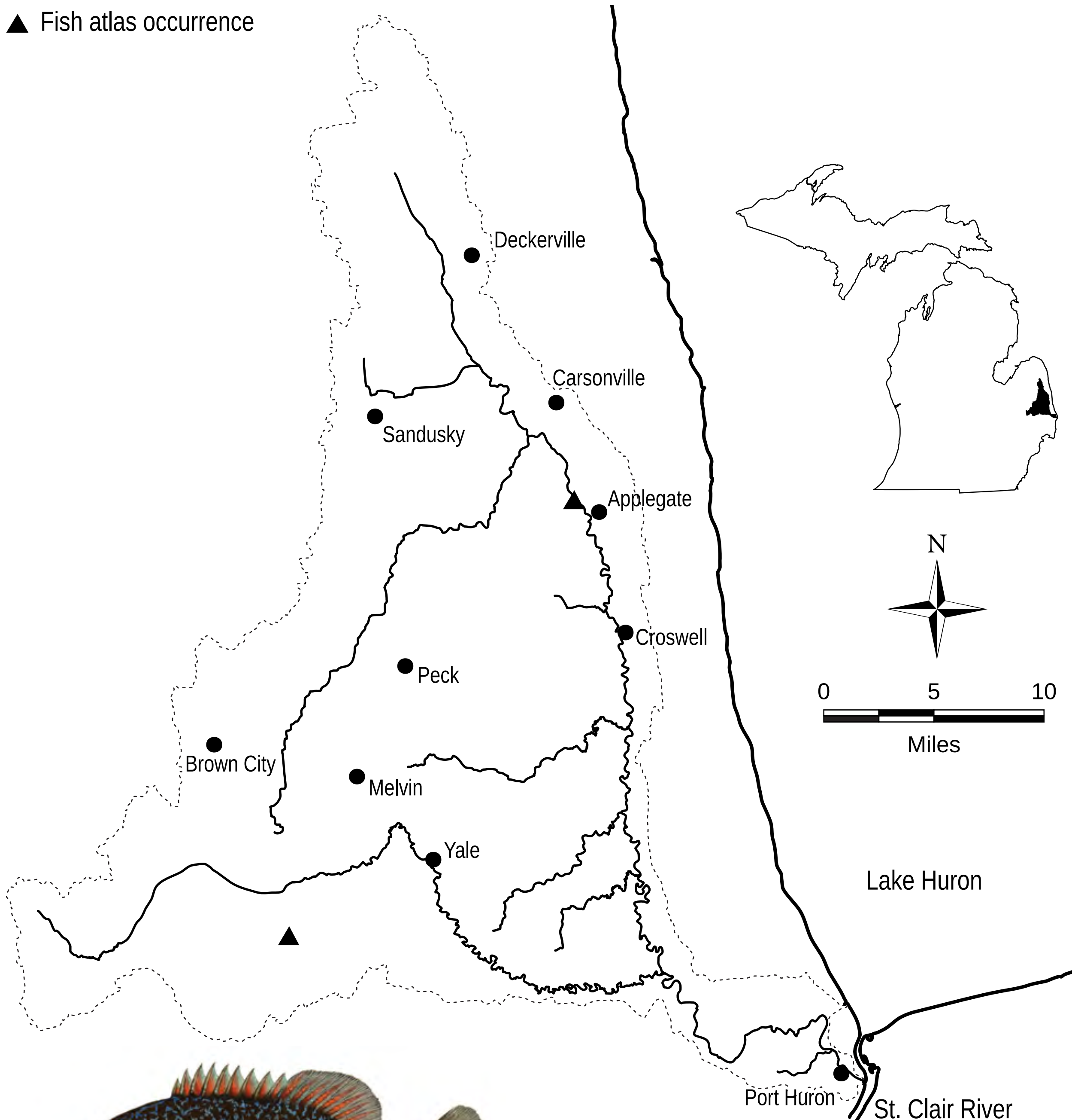




Redear sunfish (*Lepomis microlophus*)

Habitat**:**

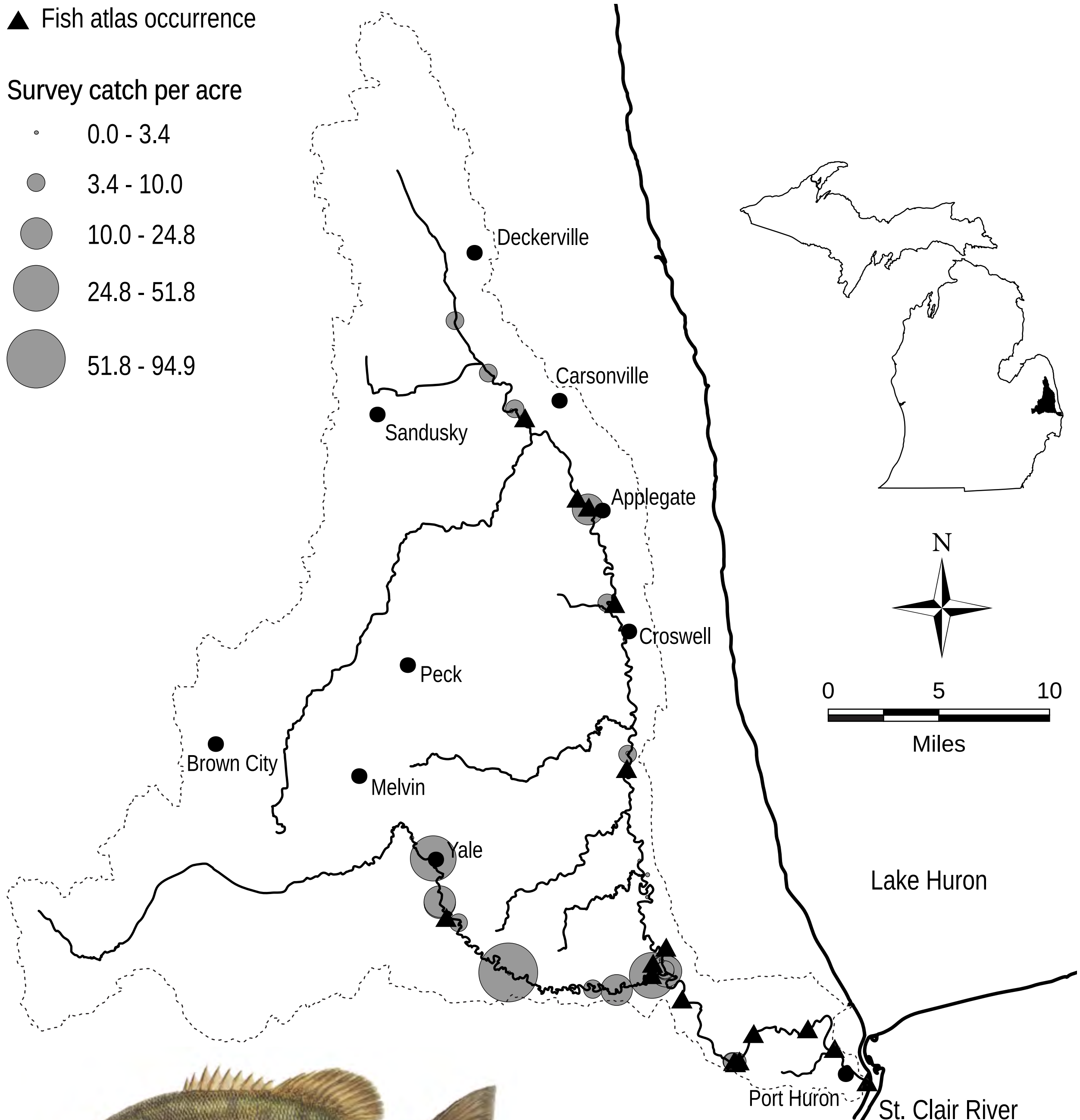
feeding	-	non-flowing clear waters of streams and lakes
	-	some aquatic vegetation
spawning	-	nest in silt or gravel substrate



Northern longear sunfish (*Lepomis peltastes*)

Habitat**:**

feeding	-	clear moderate-sized shallow streams with moderate vegetation
	-	rocky substrates
	-	little to no current
spawning	-	nests in gravel, sand, or hard rock substrate

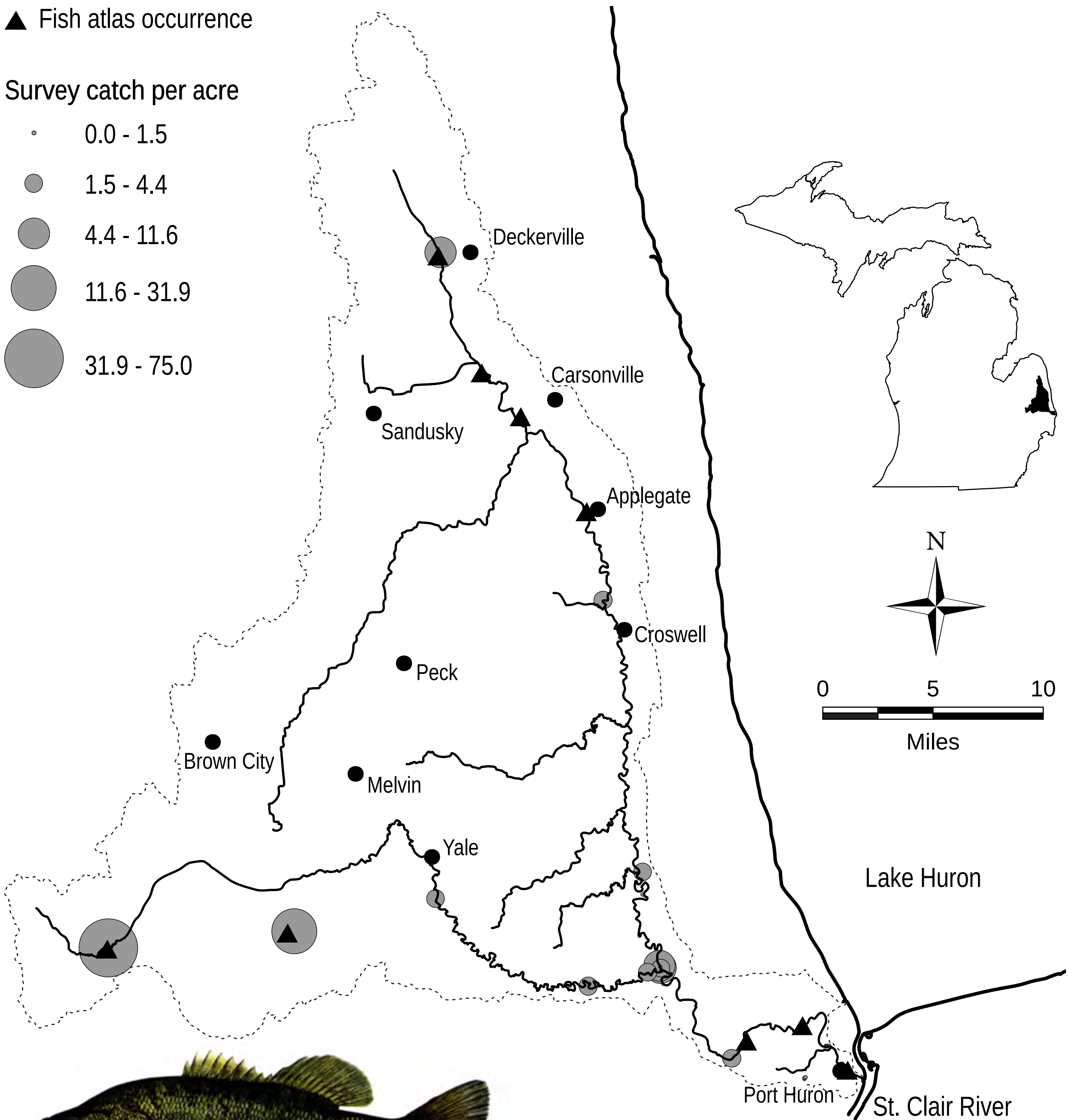


Smallmouth bass (*Micropterus dolomieu*)

Habitat: feeding
- clear, cool, deep lakes and rivers
- streams where 40% consists of riffles over clean gravel, boulder, or bedrock substrate
- in pools with a current and >4 feet of depth
- gradients between 4 and 25 feet per mile

spawning
- nest in sandy, gravel, or rocky substrate
- gradients 7 to 25 feet per mile
- streams 20 to 100 feet wide

winter refuge
- larger deeper waters with gradients between 3 to 7 feet per mile

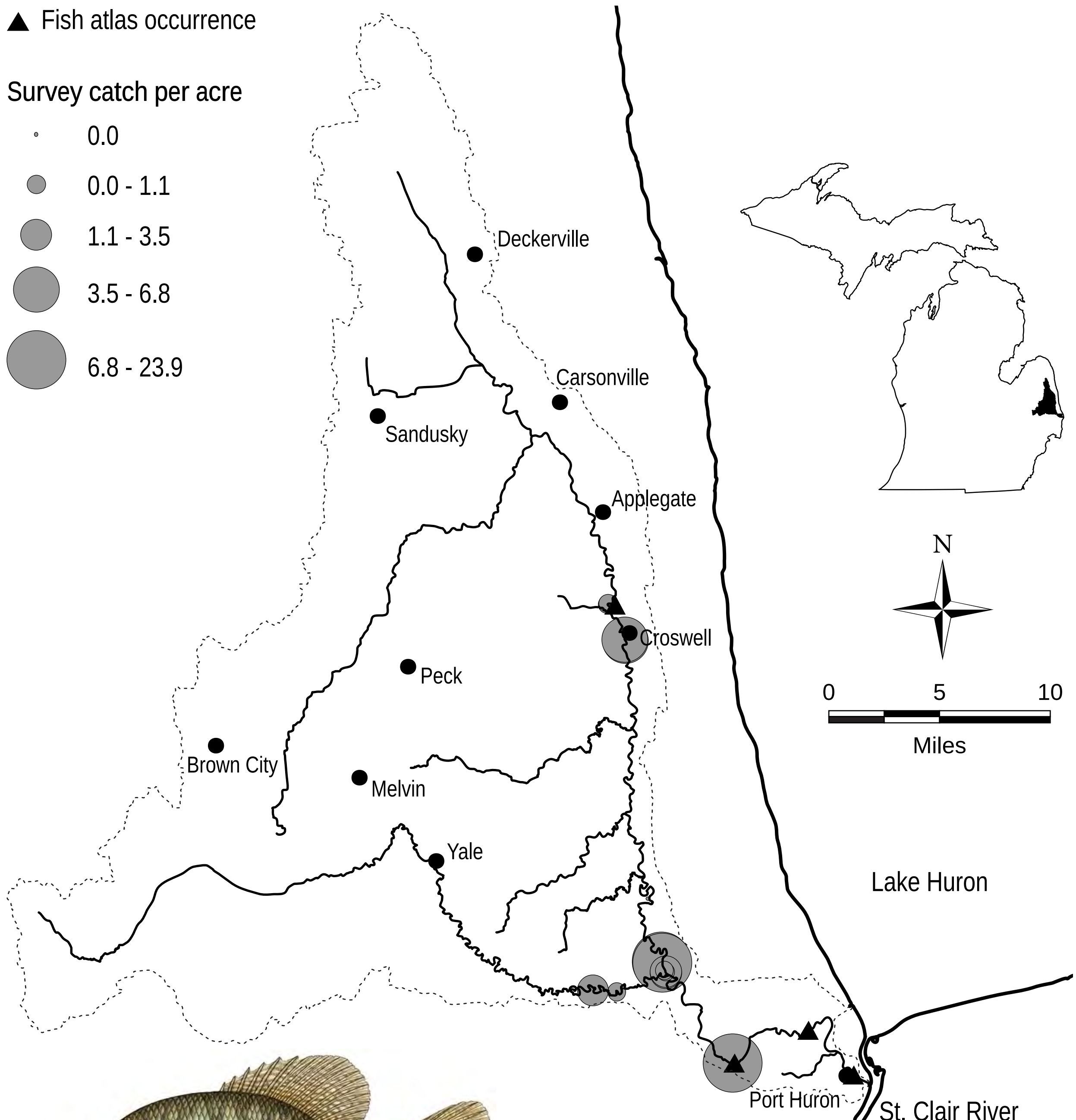


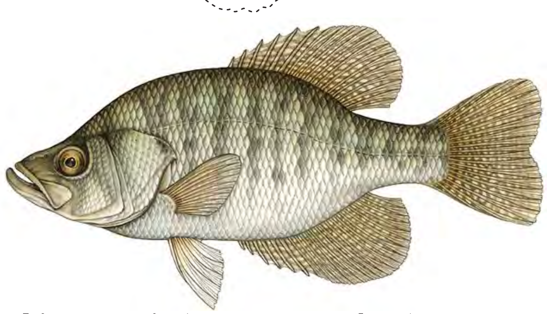
Largemouth bass (*Micropterus salmoides*)

Habitat**:**

feeding - non-flowing clear waters - lakes, impoundments, and pools of streams
- abundant aquatic vegetation
- soft muck, organic debris, gravel, sand, and hard non-flocculent clay substrates

spawning - nest in gravelly sand to marl and soft mud substrates
- emergent vegetation
- quiet shallow bays; no current



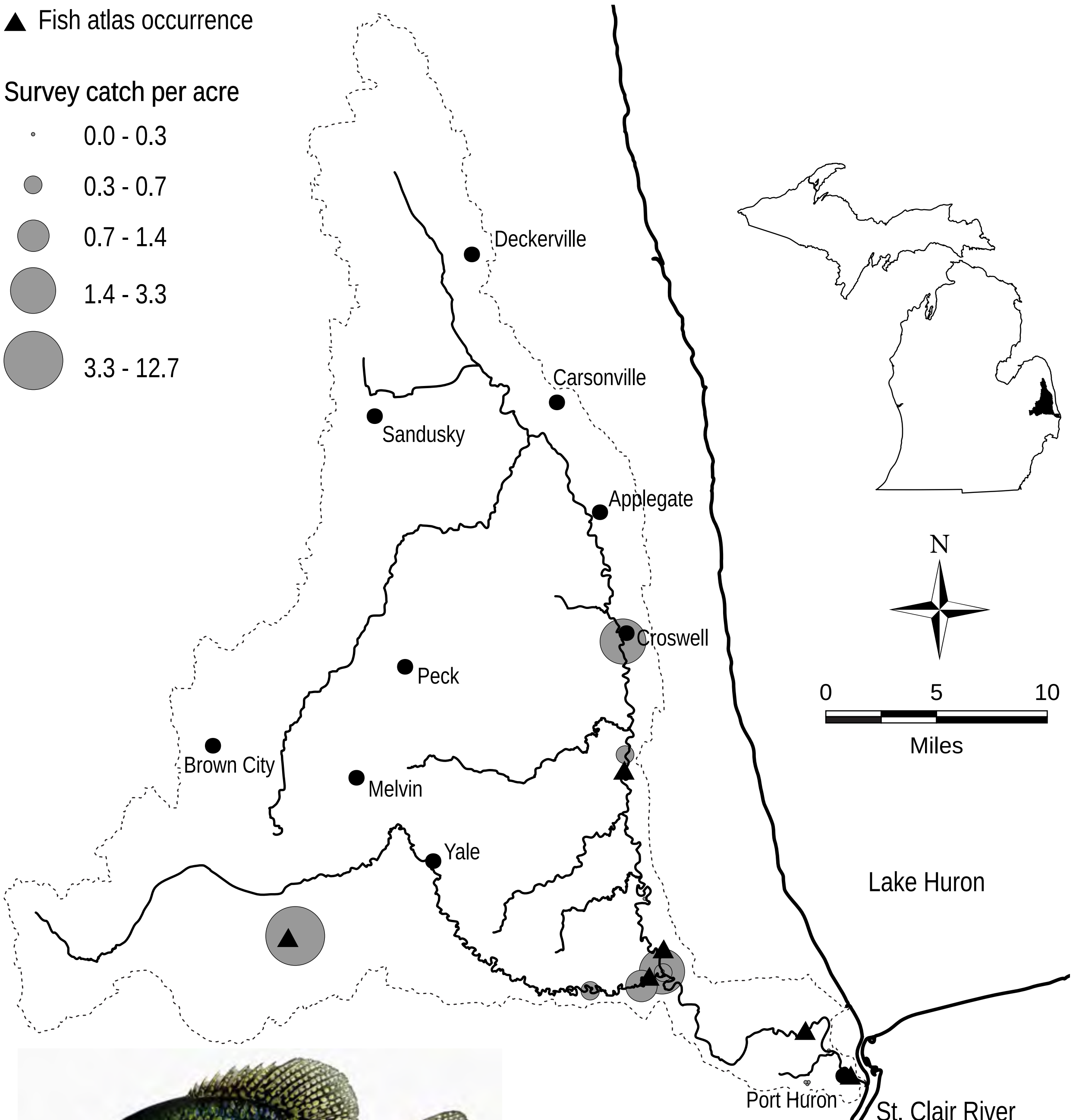


White crappie (*Pomoxis annularis*)

Habitat**:**

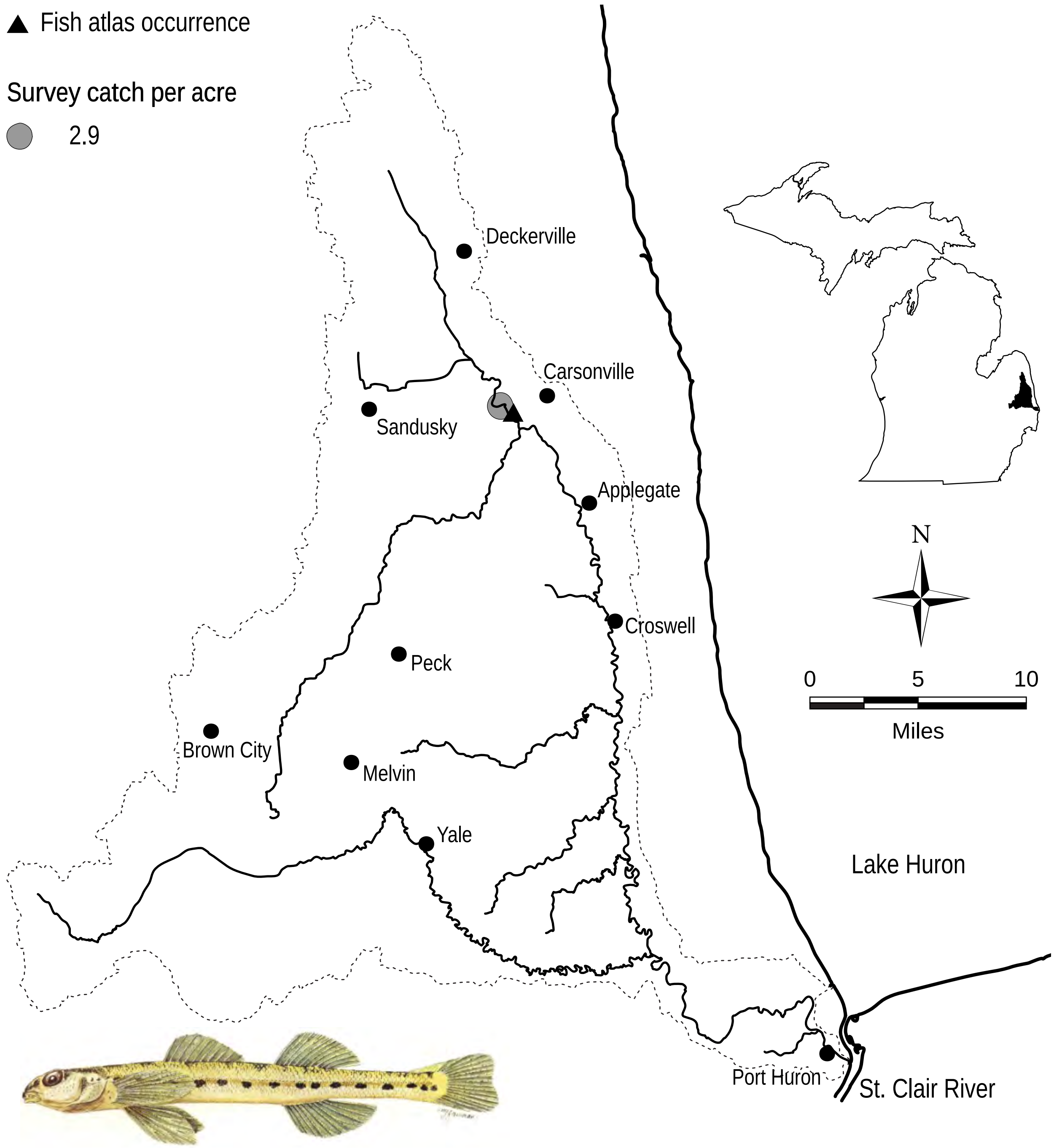
feeding
- lakes and impoundments >5 acres
- sluggish pools of moderate to large low-gradient rivers
- no substrate preference
- can tolerate severe turbidity and rapid siltation

spawning
- various substrates usually beside rooted aquatic vegetation
- sometimes under banks



Black crappie (*Pomoxis nigromaculatus*)

Habitat:	feeding	- larger clear non-silty low-gradient rivers; impoundments
		- clean sand or muck substrate
		- prefers submerged vegetation
	spawning	- nests in gravel, sand, or mud substrates
		- some vegetation must be present
		- sometimes nests under banks

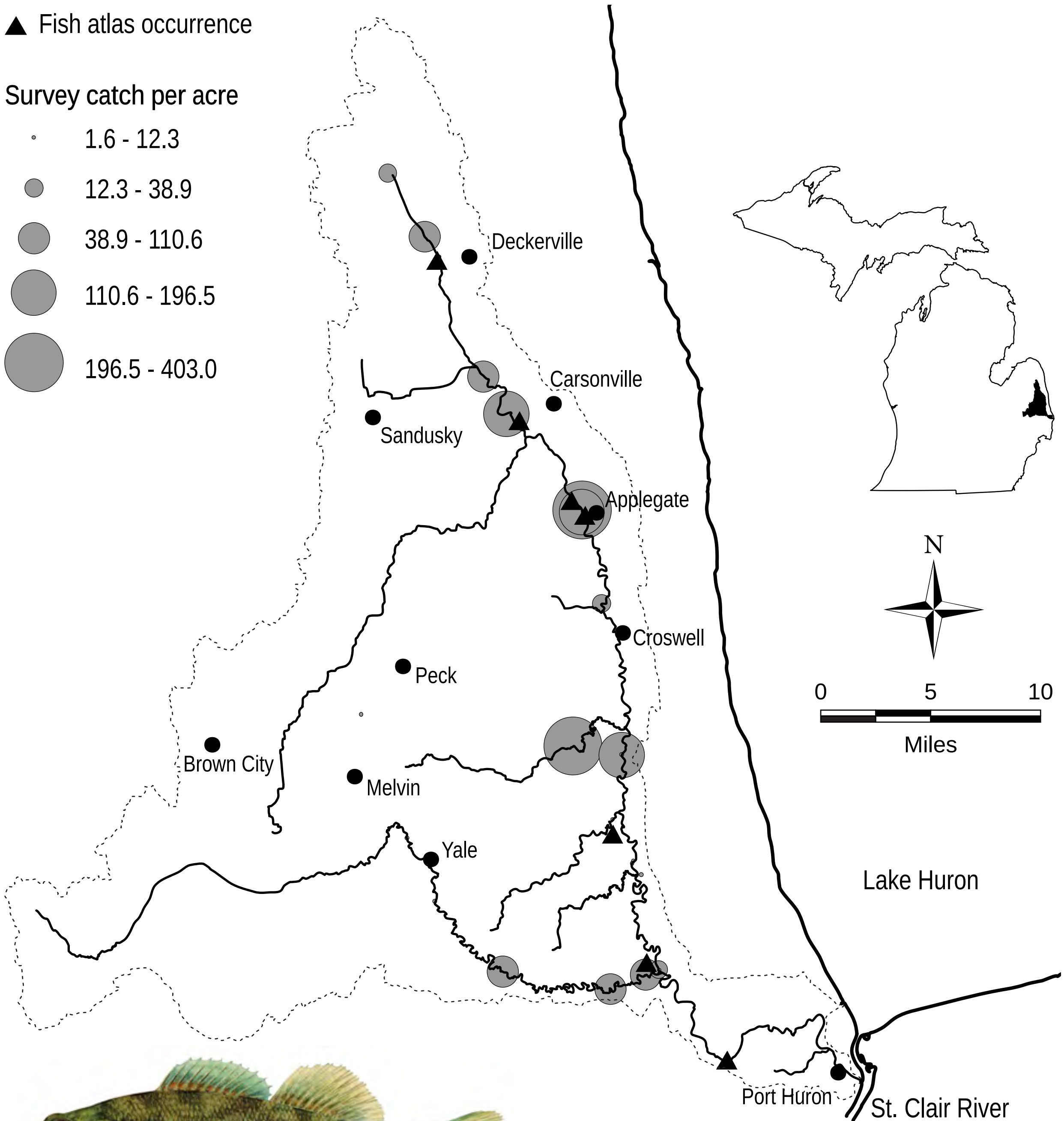


Eastern sand darter *(Ammocrypta pellucida)* – threatened

Habitat:

feeding - sandy substrate in clear streams and lakes
- does not tolerate silt well

spawning - sandy substrate

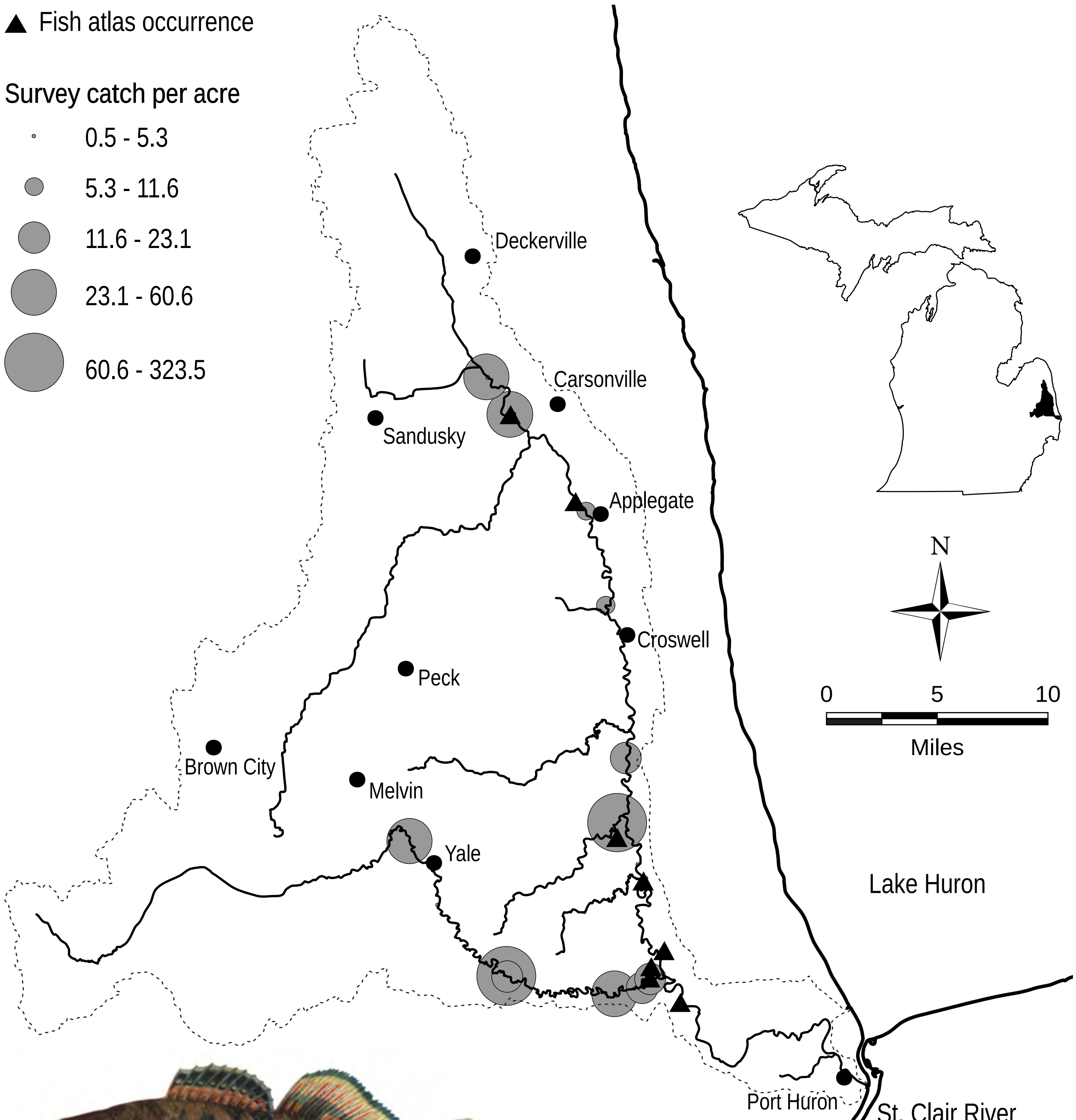


Greenside darter (*Etheostoma blennioides*)

Habitat:

feeding - young: in quiet water
- swift gravelly riffles or pools with current of streams and rivers

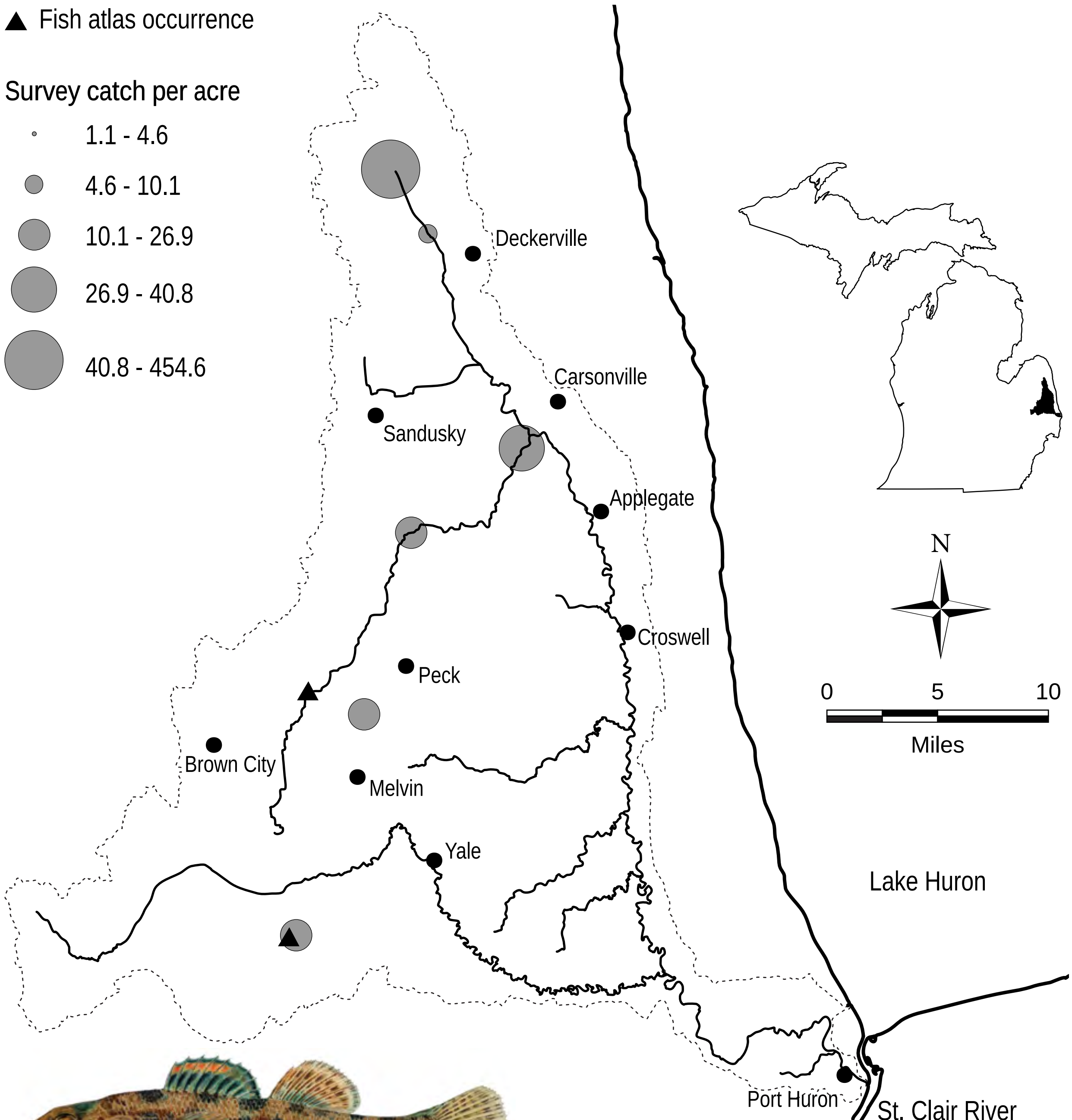
spawning - filamentous algae necessary for egg deposition



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

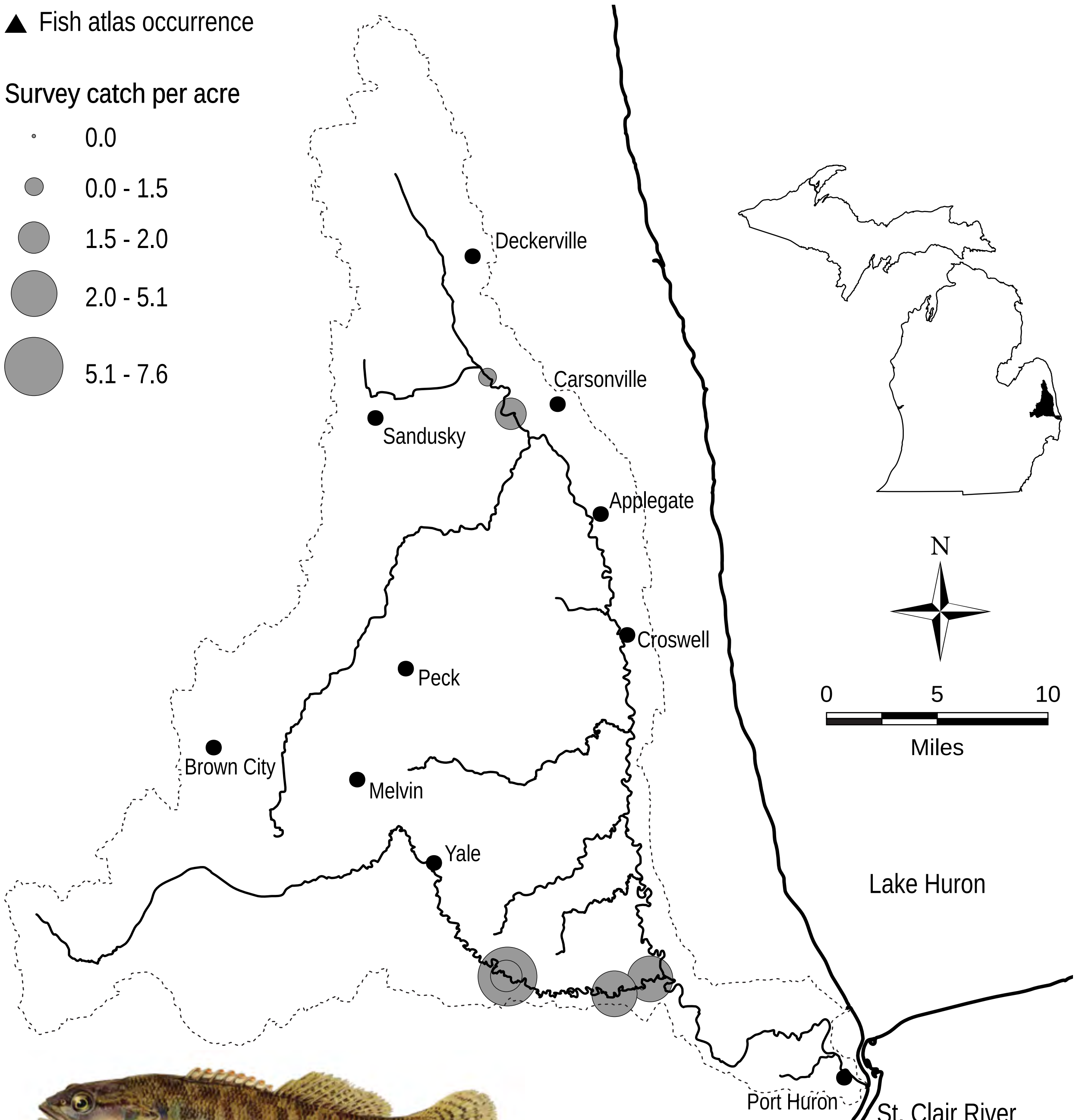


Iowa darter (*Etheostoma exile*)

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

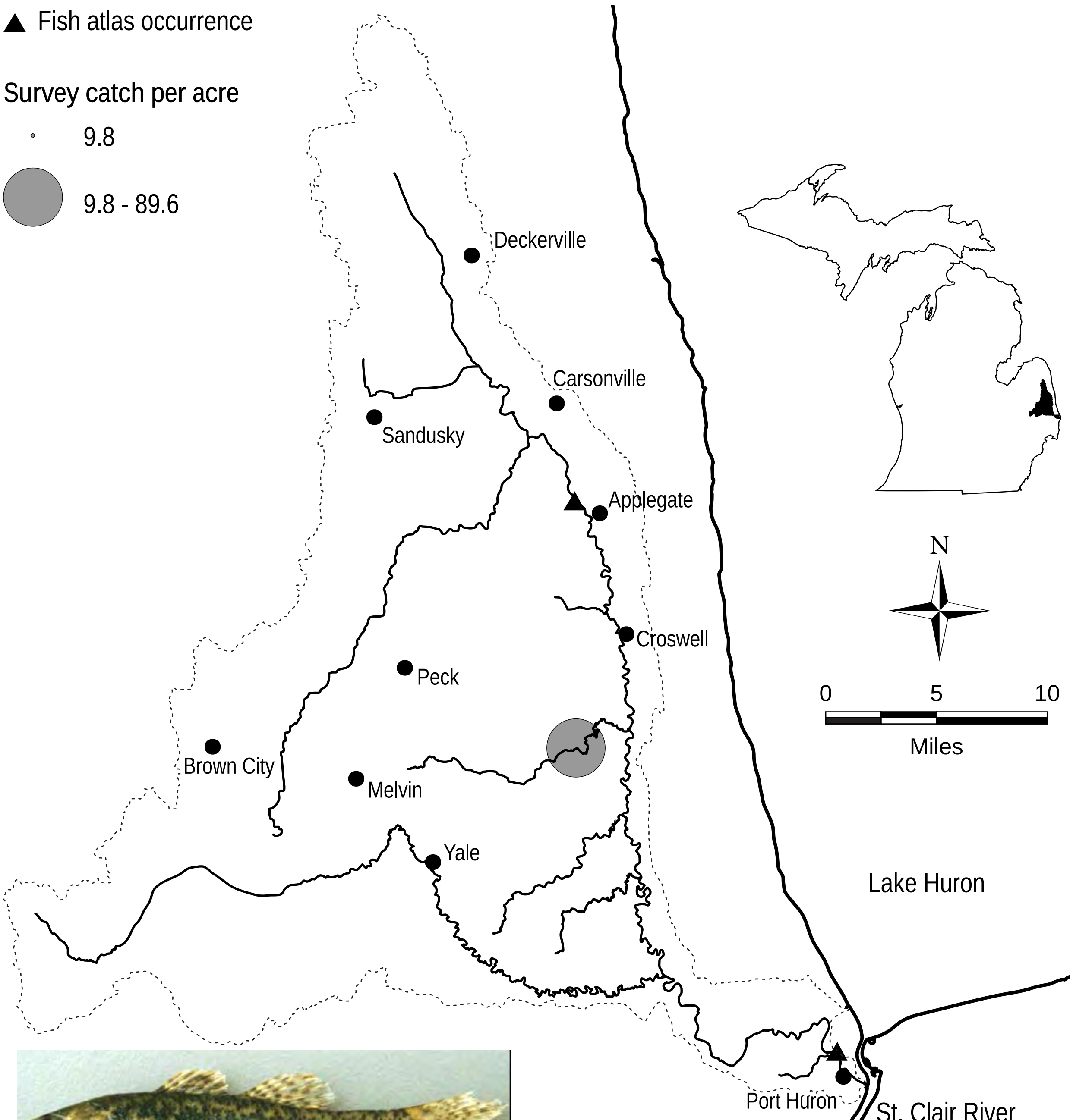


Fantail darter *Etheostoma flabellare*

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

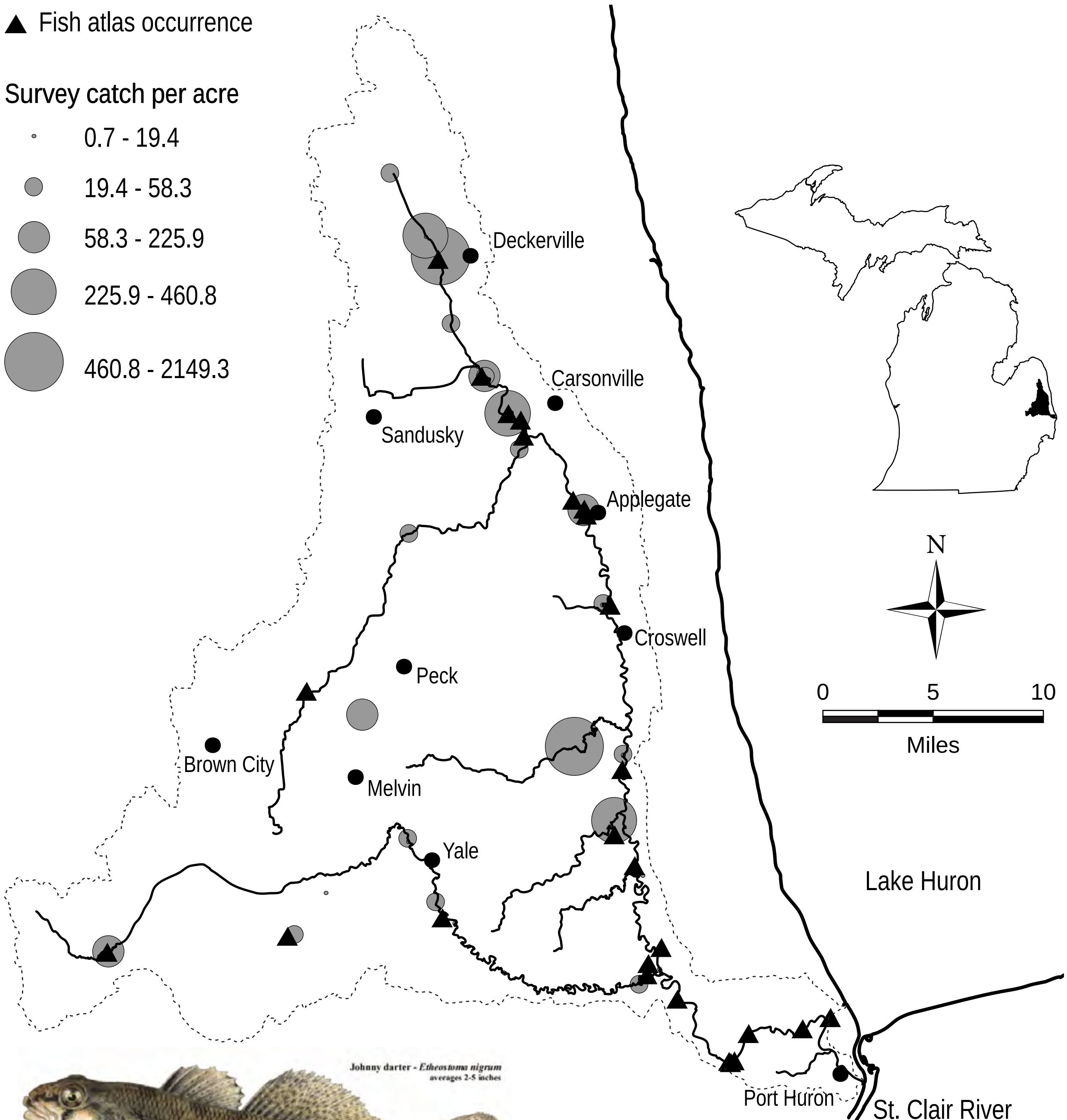


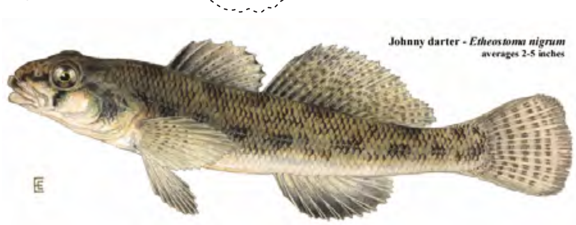
Least darter (*Etheostoma microperca*)

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

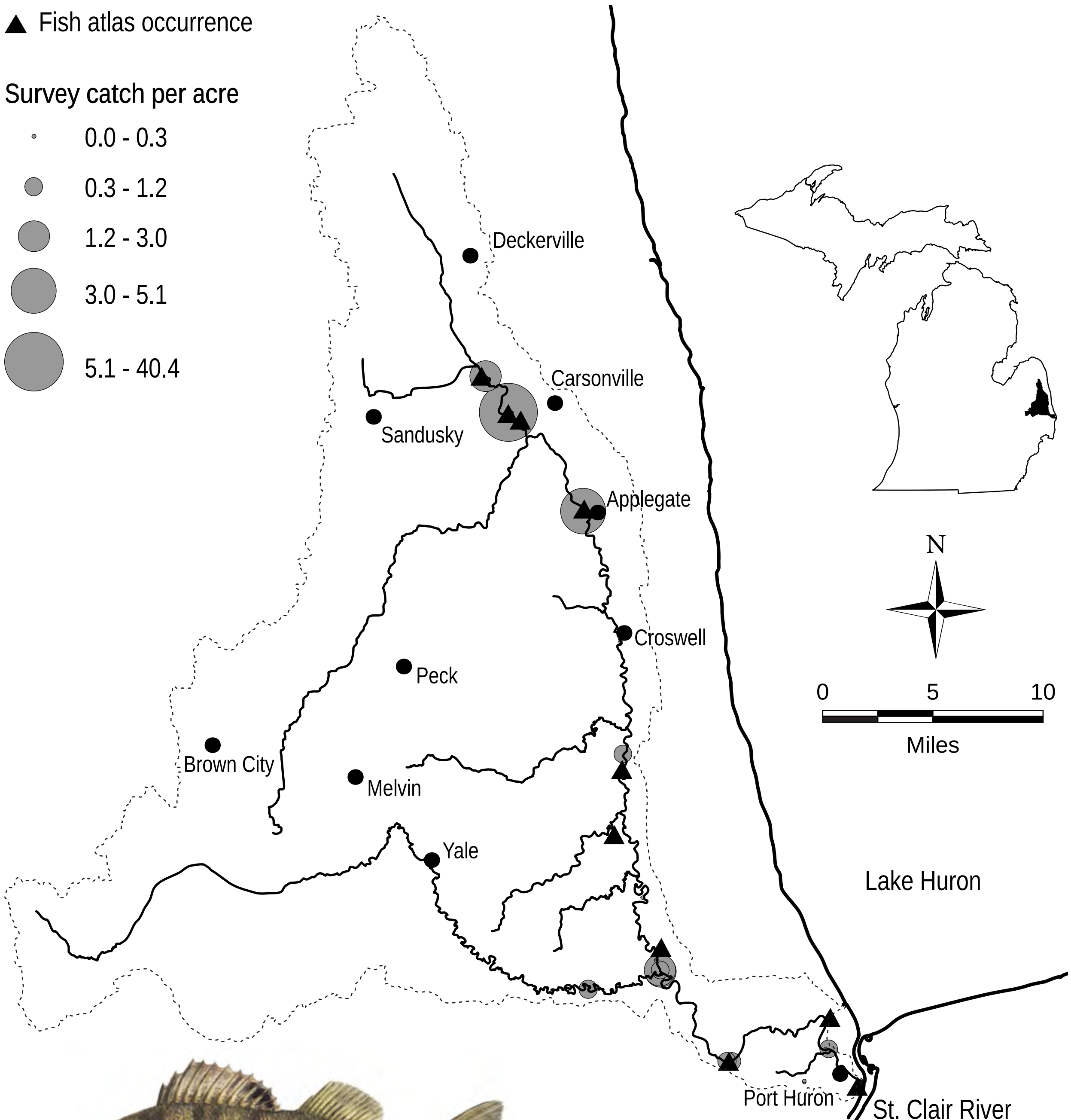




Johnny darter (*Etheostoma nigrum*)

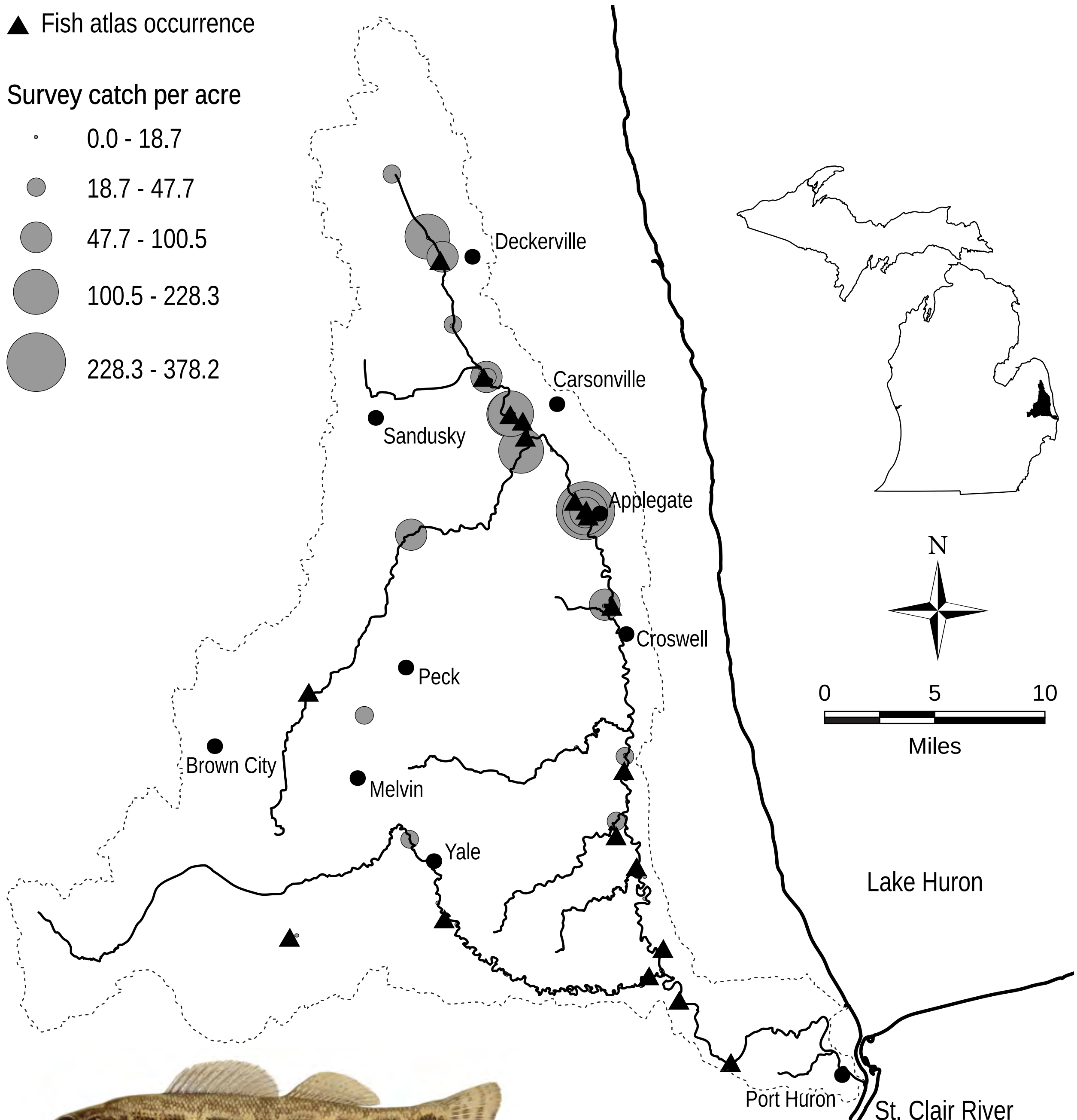
Habitat**:**

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*)

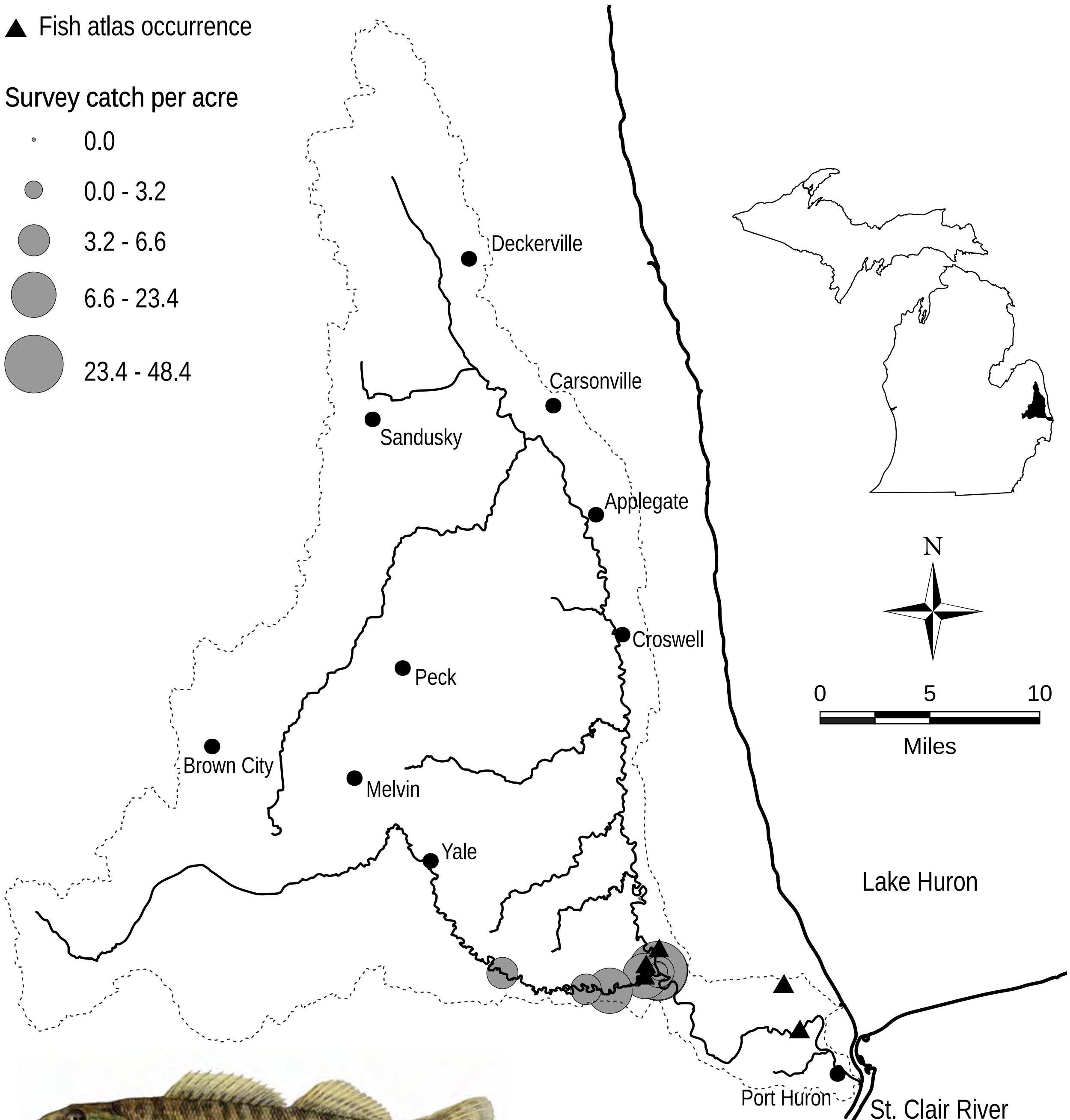
Habitat:	feeding	- clear lakes and impoundments; also Lake Michigan
		- low gradient rivers
		- abundance of rooted aquatics
		- muck, organic debris, sand, or gravel substrate
		- does not tolerate turbidity and siltation
	spawning	- shallows of lakes, tributaries of streams
		- occurs over rooted vegetation, submerged brush, fallen trees
		- may occur over sand or gravel



Blackside darter (*Percina maculata*)

Habitat:

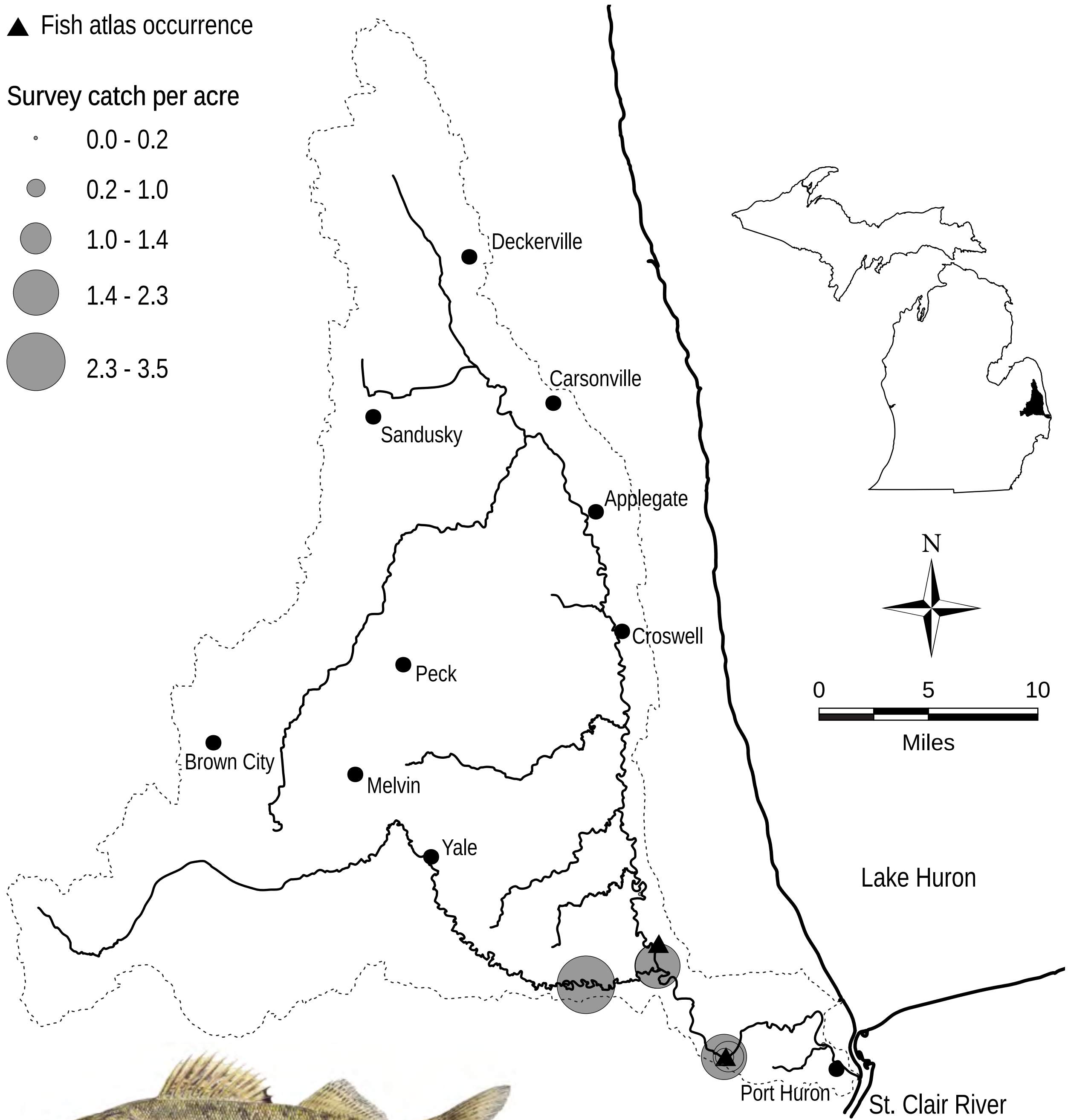
feeding	-	small to medium streams
	-	low to medium gradient
	-	gravel and sand substrate
	-	tolerate some turbidity
spawning	-	gravel and sand substrate



Northern logperch *Percina caprodes semifasciata*

Habitat**:**

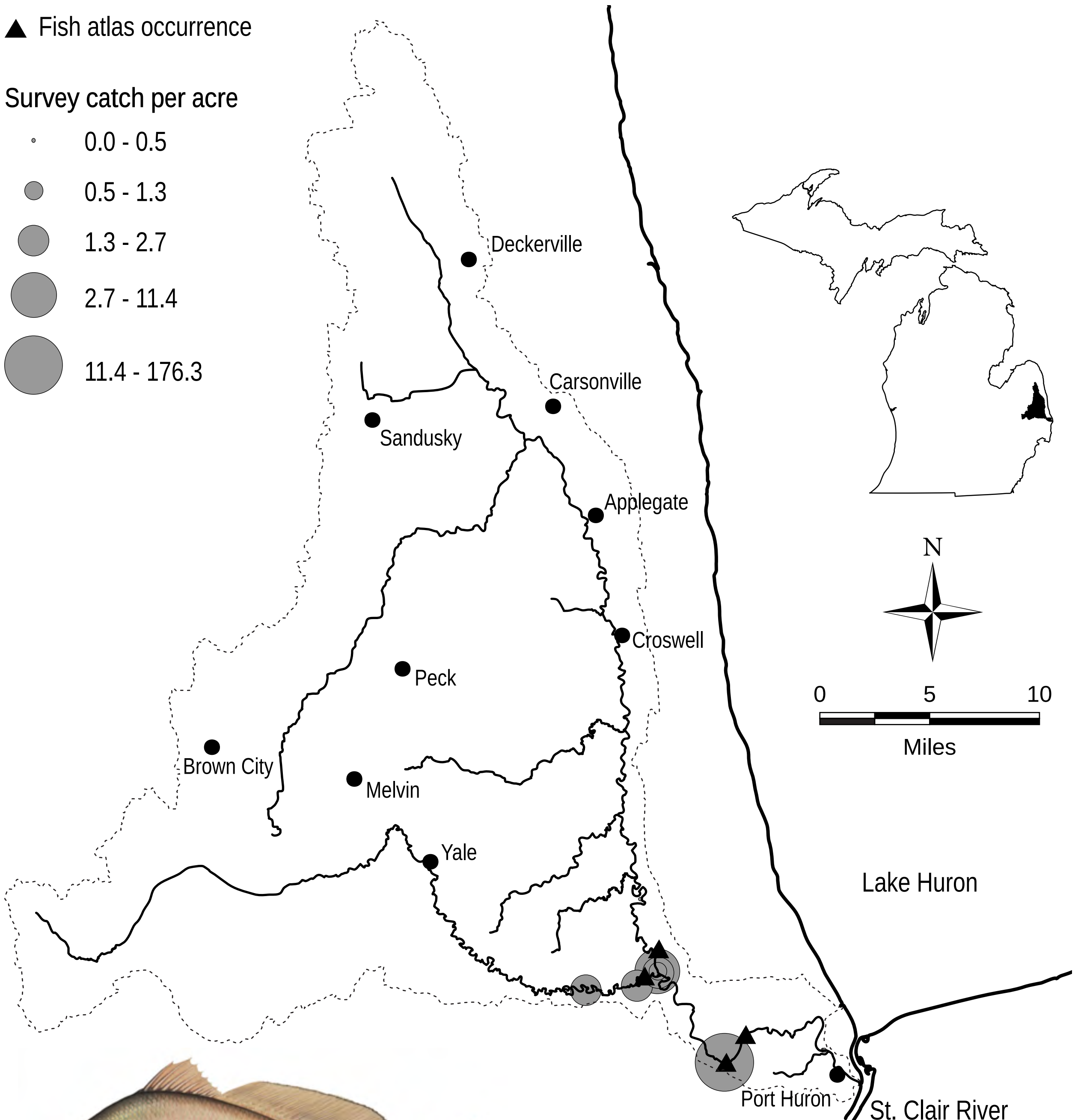
feeding	-	gravel riffles, deeper slower sections of rivers
	-	medium size streams; also lakes, impoundments
	-	sand, gravel, or rock substrate
	-	avoids turbidity and silt
spawning	-	riffles or sandy in-shore shallows



Walleye (*Sander vitreus*)

Habitat**:**

feeding	-	larger, deeper streams and in large, shallow, turbid lakes and impoundments; also Lake Michigan
	-	gravel, bedrock, and firm substrates preferred
	-	does not tolerate a lot of turbidity or low oxygen
spawning	-	rocky substrates in high gradient water in rivers
	-	boulder to coarse gravel shoals in lakes
winter refuge	-	avoids strong currents

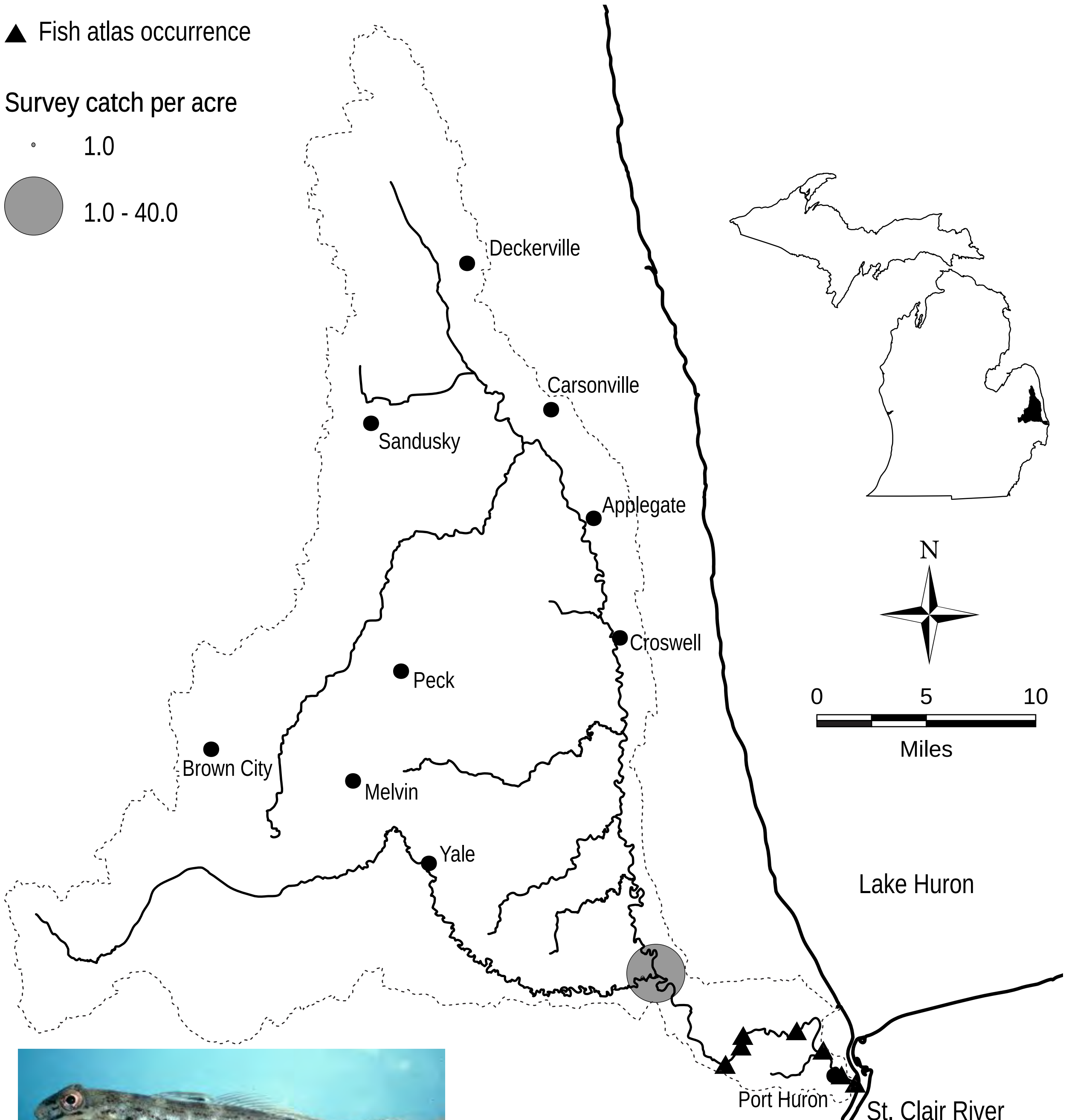


Freshwater drum (*Aplodinotus grunniens*)

Habitat**:**

feeding - deeper pools of rivers and Lake Michigan
- 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