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Clinton River Assessment

James T. Francis
and
Robert C. Haas

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FISHERIES DIVISION
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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 physical and biological characteristics of the Clinton 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 will provide an approach to identifying opportunities and solving problems related to aquatic resources in watersheds. It is hoped that this river assessment will increase public awareness of the Clinton River and its challenges 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 Clinton 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 Clinton River.

Geography

The Clinton River drains approximately 763 square miles of Southeast Michigan into Lake St. Clair. The mainstem is 79 miles long with 260 miles of major tributaries. Most of the watershed is included in Oakland and Macomb counties, a portion in Wayne County, with a very small section that reaches into St. Clair and Lapeer counties. Major tributaries include Sashabaw Creek, Galloway Creek, Paint Creek, Stony Creek, Red Run, Middle Branch of the Clinton River, North Branch of the Clinton River, and the Clinton River Cut-off Channel.

For the purpose of discussion, the Clinton River mainstem is divided into five sections called valley segments. Valley segments represent portions of a river that share common channel and landscape features and were identified using major changes in hydrology, channel and valley shapes, land cover, and surficial geology. The Headwater Segment is from the Clinton River's origin in north-central Oakland County to Middle Lake in Clarkston. The river in this segment is small, cool with good gradient, and fair base flow. The Upper Segment extends to Interstate-75, just south and east of the City of Pontiac. The river in this segment is wider, has less gradient, and is dominated by the large number of lakes that it passes through. The Middle Segment extends to M-59 in Utica. The river increases in gradient and water temperature cools from groundwater inflow and the influence of cool to cold water tributaries: Galloway and Paint creeks. Decreasing gradient and increasing temperature characterize the Lower Segment, which ends at the confluence with the North Branch of the Clinton

River. The Mouth Segment is the final section and is characterized as wide, with very low gradient and warm water.

History

The Clinton River watershed has a colorful history. Native Americans used the river as a transportation route and its fishes for food. Europeans originally used the river for trapping and fishing, and then built mills to harvest the rivers power. The human population increased dramatically, especially following the end of World War II. The Clinton River watershed is today the most populous watershed in the state. Rapid industrial and residential growth have had major effects.

Geology and Hydrology

The hydrology of the Clinton River is strongly influenced by glacial deposits. Surface geology of the watershed is composed of two very distinct areas. The west half of the watershed, which includes the Headwaters, Upper and Middle segments, is made up of a complex mosaic of outwash deposits and moraines which are well drained. The eastern half of the watershed is dominated by clay lake plain and sand lake plain and soils associated with these areas have low infiltration capacity.

Over its 79 miles, the Clinton River drops a total of 465 ft, or an average gradient of 5.9 ft per mile. The gradient varies among river segments; averaging 9.1 ft per mile in the Headwaters Segment, 4.6 ft per mile in the Upper Segment, 12.1 ft per mile in the Middle Segment, and 2.8 and 0.4 ft per mile in the Lower and Mouth segments. Fish and other aquatic animals are typically most diverse and productive in river sections with higher gradient and well established riffle-pool sequences with good hydraulic diversity. However, urbanization, stream channelization, filling of wetlands, and installation of drainage systems for agriculture and urban development have contributed to stream flow instability throughout portions of the watershed.

Soils and Land Use Patterns

Land use in the Clinton River watershed is split between agriculture (37%) and urban areas (32%), followed by forested (21%), wetlands (6%), and open water (4%). Channelization, drainage of wetlands, and installation of artificial drainage systems have altered stream temperature regimes and decreased flow stability. Even though a large portion of the watershed is already developed, significant growth of urban areas is anticipated. The increase in urban areas caused the growth and spread of impervious surfaces which threaten environmental quality of surface and groundwater resources. Increases in impervious surfaces cause dramatic changes in timing and volume of storm water delivered to nearby streams, causing a decrease in rate of groundwater recharge and increase in stream erosion rates.

Channel Morphology

Channel width increases as the river proceeds downstream; averaging 14.2 ft wide in the Headwaters Segment, 54.2 ft in the Upper Segment, 55.7 ft in the Middle Segment, 76.4 ft in the Lower Segment and 175.7 ft in the Mouth Segment. Gradient varied among segments, with gradient being 12.4 ft per mile in the Middle Segment, 9.1 ft per mile in the Headwaters Segment, and the other three segments ranging from 0.4 to 3.1 ft per mile. Tributaries such as Galloway and Paint creeks are small (average 16.7 to 26.3 ft wide), high gradient streams (average 16.7 to 17.7 ft per mile gradient).

Dams and Barriers

There are 79 dams in the Clinton River watershed, with 62% occurring in the Clinton River, Paint Creek, and Stony Creek subwatersheds. Most dams are private and the listed purpose is recreation. 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

Historically, the Clinton River has suffered from degraded water quality below the City of Pontiac due to unregulated discharges by industries and municipalities. Point source pollution has decreased over the past thirty years through restrictive discharge regulations and with improved water treatment technology and managerial practices. Pollution from point sources will continue to be reduced as municipal wastewater treatment plants upgrade their facilities and restrictions on industrial discharge permits are tightened. Unfortunately, many chemicals from prior industrial discharges persist in the sediments of the Clinton River.

Nonpoint source pollution is the greatest factor that degrades water quality. This type of pollution generally consists of sediments, nutrients, bacteria, organic chemicals, and inorganic chemicals from agricultural fields, livestock feedlots, construction sites, parking lots, urban streets, septic seepage, and open dumps. Implementing best management practices with farmland, construction sites, and urban development designs can significantly reduce runoff, erosion, and influxes of sediment, nutrients, and other chemicals to lakes and streams.

Increased volume and rate of runoff from impervious surfaces and concentration of pollutants in runoff are two issues associated with storm water control. Increases in flow from storm water runoff contribute to habitat modification and loss, increase flooding, decrease aquatic biological diversity, increase sedimentation and erosion. The NPDES Phase II permitting process provides a framework for addressing storm water and flow issues, with seven active subwatershed groups involving nearly 50 municipal, county, and school jurisdictions.

Special Jurisdictions

Several government agencies have regulatory responsibilities that affect the river. The Michigan Department of Natural Resources and Environmental Quality manage natural resources and state-owned lands, and enforce environmental regulations. The U.S. Fish and Wildlife Service, 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.

Biological Communities

There is little information on the Clinton River’s original fish community, although fisheries surveys show 100 species of fishes recently in the Clinton River drainage. Most species are native, although 3 species have colonized and 17 species were introduced (some intentional and others accidental). Four introduced species (coho and kokanee salmon, cutthroat trout, and lake whitefish) are no longer present because their stocking programs have stopped. Nine species have been identified as status unknown because they have not been captured during recent fisheries surveys. Although present fish species richness in the Clinton River watershed remains high, certain species have declined.

Watershed development has favored tolerant species with broad habitat requirements. Agricultural and urban development activities have reduced flow stability and increased sediment loads. 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 sea lamprey, zebra mussels, rusty crayfish, purple loosestrife, and Eurasian milfoil have had negative effects on native fishes and invertebrates.

Fish sampling was conducted by Fisheries Division at 38 sites throughout the watershed during the summer of 2001 and 2002. Sixty-one species of fish were caught, with white suckers, creek chubs, bluegills, green sunfish, largemouth bass, and johnny darters being the most frequently seen species among sites. This most recent fish sampling found that both species richness and fish densities improved dramatically from that found during an extensive survey in 1973. These findings support an improvement in water quality over the past thirty years.

The invertebrate community can provide a direct indication of water quality because they are less mobile than fish. The headwaters area and some major tributaries, such as Paint Creek and North Branch of Clinton River have good species diversity, including sensitive species that are indicators of good water quality. However, abundance of sensitive species has declined in recent samples, indicating reduced water quality. Conversely, other sections that were severely degraded, such as downstream of Pontiac, have shown recovery.

A comprehensive mussel survey was conducted throughout the watershed in 1977 and 1978. Species richness in the Clinton River was excellent (26 species). A small population of purple lilliput is the only known location of the species in the state, however recent surveys indicate its density is declining. The upper Clinton also supports what is likely the only population of rayed bean living in Michigan's streams. Many species found in the Clinton River have been extirpated from their range in eastern Michigan, and the North Branch, as of 1978, contained the finest remaining example of a large river mussel fauna in eastern Michigan. A 2004 survey duplicating the 1977 and 1978 sites and methods indicated that overall species richness had declined further, from 26 in 1978 to 14 in 2004 and this decline had occurred in all seven major tributaries of the river. In addition to decreasing species richness, mussel density declined. This recent decline is likely due to the extremes in flow instability. Flashiness results in bottom scouring and mussel displacement during high-water events as well as flow stoppage during low-water periods.

Fishery Management

Fishery management of the Clinton River ranges from low in the Headwaters and Upper segments to high in the Middle and Lower segments, and Paint Creek. Past management practices have included fish stocking, habitat improvements, fishing regulations, and chemical reclamation to reduce competitors. A number of fish species have been stocked at various times and locations. Current significant sport fisheries include a brown trout fishery on Paint Creek and a seasonal steelhead and walleye fishery on the lower portion of the Clinton River. There are also ongoing stocking efforts at various lakes.

Recreational Use

Recreational use of the Clinton River is limited in the Headwater Segment, but is high in the rest of the watershed. The abundance of lakes in the Upper Segment provides opportunities for fishing and recreational boating. Many people use the Middle, Lower, and Mouth segments, as well as tributaries and corridors for fishing, canoeing, picnicking, trapping, and hunting. The recreation value of the

Clinton River system is huge due to its proximity and accessibility to Southeast Michigan anglers. There are 1.4 million residents living in the Clinton River watershed, the state's most populous. However, the potential use of the river is limited by public access and high bacteria levels. Improved public access throughout the river and corrective action to reduce bacterial contamination will improve recreational potential.

Citizen Involvement

The Clinton River watershed has an improving public image with growing public support. Several organizations work on various aspects of the river including fishing, canoeing, and other recreational use. With decreases in government funding and personnel, public involvement through local and watershed organizations are important to ensure that habitat protection and enhancement of water quality and recreational opportunities continues to move forward in the Clinton River watershed.

Michigan Department of Natural Resources
Fisheries Special Report 39, 2006

Clinton River Assessment

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INTRODUCTION

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

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

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

River assessments are based on ten guiding principles of Fisheries Division. These are: 1) recognize the limits on productivity in the ecosystem; 2) preserve and rehabilitate fish habitat; 3) preserve native species; 4) recognize naturalized species; 5) enhance natural reproduction of native and desirable naturalized fishes; 6) prevent the unintentional introduction of 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 determine decisions. They also provide an organized reference for Fisheries Division personnel, other agencies, and citizens who need information about a particular aspect of the river system.

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

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

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

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

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

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

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

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 mammals and birds, key invertebrate animals, threatened and endangered species, and pest species are described where possible. This topic is the foundation for the rest of the assessment. Maintenance of biodiversity is an important goal of natural resource management and essential to many fishery management goals. Species occurrence, extirpation, and distribution are also important clues to the character and location of habitat problems.

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

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

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

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

Copies of the draft assessment were distributed for public review beginning August 16, 2005. Three public meetings were held October 12 in Rochester Hills City Hall Auditorium, October 19 in Washington Senior Center, and October 26 in Utica Gander Mountain. Written comments were received through November 30, 2005. Comments were either incorporated into this assessment or responded to in the Public Comment and Response section.

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

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

Michigan Department of Natural Resources
Lake St. Clair Fisheries Research Station
33135 South River Rd.
Harrison Township, MI 48045

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

RIVER ASSESSMENT

Geography

The Clinton River drains an area of 763 square miles in southeastern Michigan, just north of Detroit. The mainstem is 79 miles long, and its major tributary streams total an additional 260 miles (Figure 1). The headwaters originate in Independence Township, located in north-central Oakland County. From its origin, the river flows south and through a number of lakes just west of the City of Pontiac. Upon reaching the south side of Pontiac, it flows in a general northeast direction to Rochester, where it changes direction and flows in a southeast direction until it exits the east border of Sterling Heights. The river then flows in an easterly direction until it ultimately empties into Lake St. Clair.

Physical and biological characteristics of the Clinton River change considerably from its headwater to mouth. Therefore, for purposes of discussion in this paper, the river was split into five sections or valley segments (Figure 2). These valley segments were determined 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 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 Clinton River mainstem reaches and not the vast network of streams and rivers that are tributary to the segments. This network of tributary streams and characteristics of the land they drain were incorporated in the classification process; however, the general characteristics of a valley segment may not describe a contributing individual stream. Descriptions of river mainstem valley segments for the Clinton River follow.

Headwaters

The Headwaters Segment is 5.0 miles long and extends from the headwaters to Middle Lake in Clarkston (Figure 2). The river is small with good gradient and is a cool water stream with moderate variation in temperature that is runoff-driven, having fair base and moderate peak flows.

Upper

The Upper Segment begins at Middle Lake and continues 30.0 miles to the Auburn Court crossing, just east of Interstate-75 (Figure 2). This segment has low gradient, warm mean summer temperature with moderate diurnal variation, and is runoff-driven with moderate base flow and fair peak flow. The river is heavily influenced by the number of lakes that it passes through.

Middle

This segment begins at Auburn Court and continues 19.3 miles to where the river crosses M-59 in Utica (Figure 2). The gradient changes from low in the Upper Segment to very good in this Middle Segment as the river travels down towards the lake plain. Summer water temperatures are cool because of the influence of cool and cold water tributaries that join the mainstem, including Galloway and Paint creeks.

Lower

The Lower Segment runs 13.7 miles from the M-59 crossing in Utica to the confluence of the North Branch of the Clinton River (Figure 2). The river increases in size, the gradient decreases as it enters the clay lake plain, and water temperatures increase. Two significant tributaries, Red Run Drain and North Branch of the Clinton River enter the mainstem here.

Mouth

The final segment is 11.1 miles long encompassing the mainstem from the confluence with the North Branch of the Clinton River to the mouth where it empties into Lake St. Clair (Figure 2). The river is characterized as very low gradient and having stable warm water. Harrington Drain is the only tributary on this final segment.

History

The Clinton 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 Clinton River watershed was covered by two lobes of the Wisconsin glacier; the Saginaw lobe which advanced from the north and the Erie-Huron lobe from the southeast (Mozola 1953). The glacial retreat left varied moraine and outwash deposits that strongly influence local hydrology, channel morphology, and gradient of the mainstem and tributaries.

> The earliest evidence of occupation in the Clinton 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 [Table 1, Figure 3]. 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 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).

Indian and French settlements dotted the countryside along the Detroit and Clinton rivers and Lake St. Clair when the first settlers appeared in Macomb County. The French were fur traders and traveled the "Huron River", the name given by the Indians to the Clinton, Huron, and Rouge rivers. Following completion of the Erie Canal, the name was changed to Clinton River in 1825 to honor New York's Governor DeWitt Clinton (B. Mead, Department of State, Office of the State Archaeologist, personal communication, Willis 1987).

German Moravians founded the first European settlement on the Clinton River in 1782. Called New Gnadenhutten, it was home to 50–100 missionaries and Indian converts (B. Mead, Department of State, Office of the State Archaeologist, personal communication). During 1785, the Moravians built a twenty-three and one-half mile road from New Gnadenhutten to Tremble's Mill on Connors Creek near Detroit; the first inland road built in Michigan. In 1801, Christian Clemens established the settlement of High Banks that eventually became Mt. Clemens (Willis 1987).

Falling 465 ft over 79 miles between its headwaters and its mouth at Lake St. Clair, the swiftness of the Clinton provided many opportunities to build mills to grind farm products and to manufacture goods (Willis 1987). The areas first industrial concern was a distillery built on the banks of the river in 1797 (Willis 1987; B. Mead, Department of State, Office of the State Archaeologist, personal communication). By 1835 there were sawmills, a flour mill, an iron foundry, and a glass factory and by 1840, there were nearly 40 mills in Oakland County.

Water transportation and improved internal roads attracted more settlers to Southeast Michigan. The opening of the Erie Canal in 1825, which connected Lakes Ontario and Erie, had a great effect on the settlement of Southeast Michigan, since it provided an easy way for people from New York to migrate to Michigan (Willis 1987).

In 1838, construction began on the ill-fated Clinton-Kalamazoo canal that was to join Lake St. Clair to Lake Michigan. The canal would provide transport of new settlers and supplies to the interior, however the 20-ft wide canal was only about 12 miles long when funding ran out. A few portions of the canal can be seen today along Canal Rd. in Clinton Township and in Shelby Township (B. Mead, Department of State, Office of the State Archaeologist, personal communication). Much of the canal has been filled-in and the remainder serves mostly as a drainage ditch.

Mineral springs in the Mount Clemens area fostered a thriving health resort industry in the late nineteenth century, but the mineral baths faded from the scene during the depression. Rapid industrial growth began in World War II era. Between 1940 and 1980, the number of industries rose from about 60 to over 1,800. The southern half of the Clinton River watershed is now heavily urbanized (B. Mead, Department of State, Office of the State Archaeologist, personal communication).

Although the population continued to increase between the two World Wars, the end of World War II ushered in an explosive population expansion. Between 1950 and 1970, Macomb County's population increased from 185,000 to 625,000 people. Oakland County experienced even greater growth. During the 1950s nearly 300,000 people entered the county and another 511,870 arrived during the following 20 years (Figure 4). By 1980, its population exceeded 1 million people (Zorn and Seelbach 1992). Based on the 2000 census, there were 2 million people living in Oakland and Macomb counties.

As the population increased over time, there have been changes in land use to accommodate the growing number of people. When Europeans first arrived in the watershed, the landscape was primarily forested. Over time, the forested lands were timbered and much of the land eventually went into agricultural use. As the population continued to grow and cities expanded, agricultural land was eventually replaced with urban land use.

Rapid industrial and residential growth during the post-World War II decades had a major effect. Development (paving and rooftops) of headwater areas decreased soil permeability, causing increased flooding of areas downstream. Flooding became such a problem in Mt. Clemens that a two and one-half mile spillway was constructed between the city and Lake St. Clair in order to carry away the floodwaters (Figure 1, site 22). In 1964, Pontiac solved its flooding problems by enclosing the Clinton in concrete culverts and burying it beneath the city (Zorn and Seelbach 1992).

Historically, the Clinton River has suffered from degraded water quality below the City of Pontiac due to unregulated discharges by industries and municipalities. The passage of the Clean Water Act in 1972 initiated major municipal and industrial projects which have dramatically improved water quality in the Clinton River. The cities of Pontiac and Warren built tertiary wastewater treatment plants while other communities elected to join the regional Detroit wastewater system. Industries which discharged into the Clinton River were required to bring their effluent up to state and federal standards before discharge. Many industries chose to discharge into a municipal system instead of constructing pollution abatement systems themselves (Willis 1987).

Fisheries management has been ongoing in the watershed over the past 100 years. Stocking fish is a tool used in fisheries management to introduce new species, replace lost species, or supplement existing populations (see **Fishery Management**). There are two sites in the Clinton River watershed that have been operated as a state fish hatchery. In the 1st Biennial Report of the Michigan Fish Commission, it states that 40,000 Atlantic salmon ova were provided to N. W. Clark for incubation. His hatchery reared the first fish stocked by the government (either federal or state) in Michigan waters and his hatchery was located near Clarkston in Oakland County. These fish were stocked in 15 waters in the Lower Peninsula May 14–30, 1873. This hatchery also reared 1 million whitefish for Michigan waters in 1874 under the direction of the Michigan Fish Commission. Unfortunately, the report does not give an exact location of the hatchery. The 2nd Biennial Report indicates that the Clarkston hatchery was closed in 1874 and operations moved to the Northville Hatchery that eventually became a federal hatchery.

The location of the second hatchery is the current Drayton Plains Nature Center, located in the Upper Segment. It was operated as the Drayton Plains State Fish Hatchery from 1904 until the 1960s, when it was sold to the Drayton Plains Nature Center. Production was primarily for raising legal-sized coldwater species such as brook trout, brown trout, rainbow trout, and lake trout, but coolwater species, such as largemouth bass, bluegill, and walleye were also raised. Fish produced at Drayton Plains Hatchery were stocked statewide. Although Drayton Plains Nature Center retains ownership, MDNR Fisheries Division again began raising fish in the hatchery ponds beginning in 1970. Primarily coolwater species such as smallmouth bass, largemouth bass, northern pike, and walleye were raised and stocked statewide. Today, the ponds are used to produce fingerling walleye and northern pike for stocking in Southeast Michigan.

Geology and Hydrology

Glaciation during last ice age (Pleistocene Epoch) was the major force that structured Michigan’s landscape. Glaciers move (flow) with great force grinding up and transporting large amounts of the earth’s outer crust. Melting at a glacier margin causes the ice to thin, and ground-up rock carried in the base of the ice or dragged along beneath the glacier is deposited. When the ice margin remains in the same place for a relatively long time (tens to hundreds of years), enough rock flows to the glacier's leading edge and piles up to form a large end moraine on the landscape. End moraines produce some of the watershed’s most scenic upland landscape with excellent views of the surrounding area. The unsorted mixture of rocks, gravel, sand, and clay deposited by a glacier is called till. Most hills (end moraines) in the west half of the Clinton River watershed are thick ridges of till. A ground moraine, the relatively flat, low-lying landscape across which the melting glacier retreated, consists of a thinner layer of till. Outwash deposits are formed when sand is eroded, transported, and deposited by melt water streams from the glacier's leading edge and nearby till deposits to areas in front of the glacier. Sheet-like deposits of sand and gravel, called outwash (alluvial) plains, were left behind by numerous meltwater streams flowing away from the glacier. Outwash deposits, while made of similar materials as till, are better sorted. Till and outwash deposits have relatively high permeability allowing for relatively free flow of groundwater.

Lacustrine deposits were derived from glaciers, but were reworked and laid down in glacial lakes. Large lakes often formed from pooled meltwater at ice margins and were a major feature in the formation of the east portion of the Clinton River watershed. Lacustrine deposits range in size from fine clay to gravel and many are stratified or laminated. They tend to be composed of finer and more uniform materials than till and outwash deposits. The beds of these proglacial lakes are evident in the flat-lying, clay-rich sediments of the east part of the watershed (Figure 5). These clay-rich sediments have dramatically lower permeability than till and outwash sediments.

When glaciers are rapidly retreating, numerous blocks of ice can become detached from the main body of the glacier. If glacial till covered and insulated the ice, a depression on the surface called a kettle hole was created when the ice eventually melted. Kettle holes are commonly found on moraine and outwash plain deposits. Pitted outwash occurs when many ice blocks are separated from the snout of the glacier. When the ice melts, what might have looked like a smooth, continuous surface becomes pitted. The collapse of deposits around the melting ice blocks produces steep, ice-contact slopes bordering undrained depressions. Deep-kettle holes reaching the water table filled with water and formed lakes. Most natural lakes in the Clinton River watershed formed in this way. Some shallower kettle holes developed into wetlands such as bogs, swamps, and marshes.

Soils in the Clinton River watershed have been developing since the Laurentide ice sheet started melting back about 15,500 before present (BP) (Krist, 2001). This major glacial expansion, comprised of the Green Bay, Michigan, Saginaw, and Erie lobes in the Great Lakes region, extended south of Michigan into central Ohio, northwestern Indiana, and northeastern Illinois (Figure 6, Map 1). The last glacial retreat was primarily responsible for the topography and soil characteristics that we see in the Clinton River watershed. The glacial retreat of the Port Huron lobe and the glacial meltwater lakes, between 15,500 and 10,000 BP created most of the distinguishing terrain features found in the watershed. The maps in Figure 6 were derived from a Michigan State University, Geology Department website and depict the position of ice and other glacial features that structured the present configuration of the Clinton River watershed. During the next 5,500 years, continued glacial recession was interrupted by minor oscillations, or ice margin re-advances, that formed a series of end moraines across central Lower Michigan (Krist 2001). While retreating, a series of glacial lakes, including Lake Maumee, Lake Whittlesey, and Lake Warren, formed at the margin of the Laurentide ice sheet at locations where the land sloped toward the ice front (Figure 6, Map 4). These were constrained by the ice margin and topography of varying elevations. The lake level stabilized long enough to form successive beach ridges some of which are visible on the surface map (Figure 5). The entire eastern boundary of the watershed is likely one of these ridges. Recently uncovered land to the south of the receding glacier rose (isostatic rebound) because the weight of thousands of feet of ice was gone. The last remnants of glacial ice melted back from upper Michigan by 9,000 BP and Great Lakes drainage was easterly without any drainage connection through the Lake St. Clair-Lake Erie corridor (Figure 6, Map 3). During the next several thousand years, land across the Upper Great Lakes rose due to isostatic rebound again changing the major drainage pattern. By 5,500 BP, Great Lakes water levels (Nipissing stage) had risen as much as 50 ft above modern levels and drainage was restored through the southern outlets at Port Huron and Chicago (Krist 2001). The outlet at Port Huron was slowly down cut to bedrock around 2,200 BP, at which time the water levels in the Michigan and Huron basins lowered to their modern levels.

Geological surveys have provided information on the distribution of surface (parent soil) materials throughout the Clinton River watershed (Figure 7). The nine maps shown in Figures 8, 9, and 10, arranged in sets of three, show the distribution and areal coverage of glacial drift, alluvial, and lacustrine deposits. Lacustrine sands, gravels, clays, and silts cover almost the entire east half of the watershed and make up 48.3% of the watershed’s surface. End moraines of medium to coarse-textured till cover the majority of the western half and make up 27.9% of the watershed surface. The remaining surface in the western half is predominantly alluvial sand and gravel which makes up 18.1% of the watershed. Bedrock is not exposed at any location in the watershed.

Climate

Climatic factors determine the 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 six NOAA weather stations closest to the center of the Clinton River watershed for the period of record (Table 2). Three stations are located in, or adjacent to, the watershed and the other three are 10–20 miles outside (Figure 11 and Table 2). Daily data were combined from all stations since the historical records from individual stations were lacking substantial amounts of data.

Daily maximum and minimum air temperatures were determined for each station and then averaged across all stations to estimate historical values for the Clinton River watershed. Average maximum and minimum air temperatures for all years in the period of record (Figure 12) and for each of the 12 months (Figure 13) were calculated. Mean monthly temperatures in the basin range from a low of 23.8 °F in January to a high of 72.2 °F in July. The average frost-free period is from the first week in May to the third week in October, a total of approximately 160 days.

Daily precipitation data were combined by calculating a weighted mean based on all stations having data for that day. Means were weighted by the inverse of the distance from the weather station to the geographical center of the watershed. In this way, a mean daily precipitation database, estimated across the watershed, was created with no missing data from May 1, 1948 through December 31, 2000. This dataset was used to examine the historical extent and pattern of precipitation in the Clinton River watershed and compare it to river discharge. The estimated total annual precipitation amounts, in inches, are shown for all years in the period of record in Figure 14. The mean annual precipitation for all years was 29.9 inches, which is almost identical to 29.8 inches estimated by the Michigan Water Resources Commission for the period 1928–51, using Thiessen’s method (Michigan Water Resources Commission 1953). The highest amount of precipitation (40.4 in) fell on the Clinton River watershed in 1985. The next four highest annual precipitation years were 1950 (38.8 in), 1990 (38.8 in), 1959 (38.2 in), and 1992 (36.6 in). The least precipitation in one year (17.8 in) fell in 1999. The next four lowest annual precipitation years were 2000 (19.7 in), 1963 (20.1 in), 1958 (20.5 in), and 1971 (21.6 in). Figure 14 also displays the highest precipitation amount occurring over a consecutive 5-day period each year. These amounts ranged from a low of 1.5 inches (1953) to a high of 5.2 inches (1968). There appears to have been a change in the delivery pattern of precipitation, beginning around 1970, to spread more evenly across days, although the total annual precipitation did not appear to go down until about 1995. Mean monthly precipitation was also calculated for the period of record (Figure 15). Average monthly precipitation amounts ranged from a low of 1.6 inches in February to a high of 3.2 inches in June.

Climate Change

Long-term observations confirm that the United States climate is now changing at a rapid rate. Over the 20th century, the average annual U.S. temperature has risen by almost 1 °F and precipitation has increased nationally by 5 to 10%, mostly due to increases in heavy downpours (National Assessment Synthesis Team, 2002). These trends have been most apparent over the past few decades. Scientists indicate that the warming in the 21st century will be significantly higher than in the 20th century. Scenarios examined in this assessment, assuming no major interventions to reduce continued growth of world greenhouse gas emissions, indicate that temperatures in the U.S. will rise by about 5–9 °F (3–5 °C) on average in the next 100 years, which is more than the projected global increase. This rise will likely be associated with more extreme precipitation events and faster evaporation, leading to greater frequency of both very wet and very dry conditions.

Some meteorologists argue that one of the outcomes from global warming will be increased El Niño events. El Niño refers to the irregular increase in sea surface temperatures from the coasts of Peru and Ecuador to the equatorial central Pacific. In El Niño years, the northern U.S. tends to see a more pleasant winter with relatively milder and drier conditions. Historically, strong El Niño episodes have featured drier than normal conditions over the entire state of Michigan (70–90% of normal) during January–March, but more reliably in the southern part of the Lower Peninsula. Winter temperatures have averaged two to three degrees Fahrenheit above normal. Recent years in which El Niño events have occurred are 1951, 1953, 1957–58, 1965, 1969, 1972–73, 1976, 1982–83, 1986–87, 1991–92, 1994, and 1997 (Source: NOAA: http://www.oar.noaa.gov/k12/html/elnino2.html). Within the Clinton River watershed one of the five highest precipitation years (1992) and one of the five lowest (1958) were El Niño years. Thus, there does not appear to be a compelling relationship between El Niño events and annual precipitation amounts for this watershed. The lowest 5-day precipitation occurred in 1953 which was an El Niño year and the highest in 1968 which was not.

Annual Stream Flow

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.

We examined annual Clinton River flow by analyzing mean daily stream flow readings from 11 selected gauge stations (Figure 16) maintained by the United States Geological Survey (USGS) for their period of record (as of 2002) (Table 3). Five of the USGS gauges are located on the mainstem, three on the North Branch and its tributaries, and three on smaller, upstream tributaries to the mainstem. The most upstream gauge on the mainstem is located at Drayton Plains, with a mean discharge of 52.5 cubic ft per second (cfs) during the period of record. For reference, the mean daily flow was 23.0 cfs for the month of August. August is the month of lowest flow and gives an indication of base flow conditions (Table 3). Average annual flow rate at the Moravian Drive gauge (drainage area of 734 mi^2), the most downstream gauge on the mainstem, was 566 cfs. The Moravian Drive discharge is somewhat lower than 741 cfs reported for the downstream gauge on the River Raisin (drainage area of 1,070 mi^2) (Dodge 1998) and 757 cfs reported for the most downstream gauge on the Flint River (drainage area of 1,118 mi^2) (Leonardi and Gruhn 2001), both similar, in some respects, to the Clinton River. Average discharges for the remaining nine Clinton River watershed gauges (Table 3) range from 7.4 cfs at the Armada gauge on the East Branch of Coon Creek to 391.3 cfs at the Fraser gauge on the mainstem. The Middle Branch of the Clinton River, which has substantial flow, does not have a USGS flow gauge station.

Annual discharge of the Clinton River varied considerably across years of the period of record (Figure 14). Estimated total annual discharge ranged from a low of 20.7 billion cubic ft in 1981 to a high of 30.3 billion cubic ft in 1975, approximately 46% greater. The entire period of record for the gauge station was 1935 to 1999 (Figure 14 shows 1949 – 1999) and there was an apparent significant shift upward in discharge around 1965. The median annual discharge 1935–64 was 13.6 billion cubic ft compared to 19.7 billion cubic ft during 1965–99, a 45% increase.

We also calculated hydrologic characteristics and analyzed changes in those characteristics over time using Indicators of Hydrologic Alteration (IHA) software (version 5.2, Smythe Scientific Software

2001 (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. We used the IHA to compute and graph linear regressions on the daily flow data at the Moravian Drive gauge to assess these changes in the Clinton River watershed. We compared the flow data for the period of 1935–64 and 1965–99 (Figure 17). The program evaluates the 7-day running average divided by the annual mean, 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. The implications for these changes in flow are discussed in more detail in the **Land Use** section.

Another way of evaluating changes over time is to evaluate changes in peak and annual flows. Changes in peak flow (Figure 18) and changes in mean annual stream flow (Figure 19) at the Moravian Drive gauge station were examined. A linear regression analysis was carried out to determine the changes over time (Sinha et al. 2005). These calculations were done for each gauge station, with the exception of the Clinton River at Sterling Heights gauge because of lack of long-term data at this site (Figures 20 and 21). There was some variability in the changes in peak flow, but overall, there was a 41.8% increase in peak flow. Similarly, there was an increase in annual flow at each station, with an average increase of 47.6% over all ten sites (Sinha et al. 2005).

There are a number of possibilities that would contribute to an increase in discharge over time. At least a portion of this increase may be explained by moderate increases in precipitation over the watershed (Figure 14). Another likely contributing factor is the increase in impervious surfaces. When forests or fields, which absorb rainwater, are replaced with paved surfaces and rooftops, which prevent absorption and direct run-off to rivers, the result is an increase in discharge. Finally, it is difficult to evaluate changes in water budgets in the watershed because of importing water into and exporting it out of the watershed by sewering. Beginning in 1964, a number of communities in the Clinton River watershed began being serviced by sewers by the City of Detroit. Therefore, water that originated in the watershed was being directed out of the watershed. In 1974, the City of Detroit began operating a new water intake from Lake Huron to deal with the increasing demands of a growing population. So in this case, water was now being brought into the watershed from an outside source.

Seasonal Water Flow

Seasonal discharge of the Clinton River is quite variable. We evaluated monthly average discharge during the period of record for USGS gauge stations on the mainstem (Figure 22), North Branch station and its two tributary gauges (Figure 23), and for three gauge stations on separate tributaries to the mainstem (Figure 24). Maximum discharge occurred in March or April following the spring thaw at all gauge stations and the largest relative ranges were found at the North Branch and East Pond Creek stations where the monthly minimum discharges were only 6–8% of their maximums. Other gauge stations were characterized by minimum monthly discharges around 25–35% of maximum discharges and at all stations, monthly minimum flows occurred in August following the driest part of summer.

We constructed standardized exceedence curves for the period of record at each USGS gauge station in the Clinton 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 (our 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 at five gauge stations on the Clinton River mainstem show discharge stability, during high flows, dramatically decreases as water moves downstream in the mainstem, as is typical in southern Michigan rivers (Figure 25). Five percent standardized exceedence values ranged from 2.5 at the upper Drayton Plains gauge to 5.5 at the Moravian Drive gauge in the lower river. That means that the flood flow at Moravian Drive is 5.5 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. However, the Clinton River values are relatively low compared to 3.0 to 8.0 in the River Raisin (Dodge 1998) and 4.0 to 6.8 in the Flint River (Leonardi and Gruhn, 2001). Richards (1990) in a study of flow variability of Great Lakes tributaries found the Clinton River to be a relatively stable system and that the River Raisin was quite variable. The North Branch system was found to be much less stable under high flow conditions where 5% standardized exceedence values ranged from 4.1 at East Pond Creek to 33.0 at the North Branch gauge immediately before it enters the mainstem (Figure 26). Standardized high flow exceedence curves for the period of record at gauge stations on three tributaries to the mainstem (Figure 27) are relatively stable, indicating that the relatively unstable high flows at the lowest gauge on the mainstem are most likely due to variability in the North Branch and/or Middle Branch, which is not monitored.

Standardized low flow exceedence curves for the period of record were also constructed for each gauge station. 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 five gauge stations on the Clinton River vary from a low of 0.20 at Drayton Plains to a high of 0.44 at Sterling Heights (Figure 28). 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 South Branch of the Au Sable has a value of 0.60 (Wesley and Duffy 1999). The 95% flows for the North Branch and tributaries range from 0.10 at the North Branch gauge to 0.24 at the East Pond Creek gauge and clearly show that low flows are unstable and that groundwater does not make up a large share of their discharge (Figure 29). Zorn and Seelbach (1992) found that the lower mainstem and its tributaries, the North Branch and Red Run, had naturally unstable and low summer flows and received little groundwater because they drained areas of impermeable soils. The 95% standardized exceedence values were relatively low for three tributaries to the mainstem, indicating small contributions from groundwater sources (Figure 30). The highest of the three was 0.30 on Stony Creek where the gauge is located downstream from the dam at Stony Creek Impoundment.

Instability in flow can be seen when evaluating hydrographs of the Clinton River and tributaries (Figures 31 and 32). Absence of a large groundwater component is apparent in all hydrographs. 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 River and Au Sable River at Mio (Figure 33). 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 Clinton River and tributaries, where rain events cause a many fold increase over base flows. Thus, the extremes (low flow and high flow) are much greater in the Clinton River system.

Daily Water Flow

Mean daily discharge in the Clinton River varied considerably across period of record (Table 4). The largest daily maximum discharge at the Moravian Drive gauge was 19,200 cfs on April 6, 1947 and the smallest daily maximum was 1,400 cfs on February 23, 1948, only 7% of the largest value. Similar values exist for the other 10 gauge stations. We compared maximum and minimum flows within years. These values are given as smallest maximum flow and largest minimum flow in Table 4. Mean annual minimum discharge at the Moravian Drive gauge has ranged from 200 cfs in 1992 to 25 cfs in 1941. An inconsistency between gauge stations in years of occurrence for largest minimum and smallest maximum, demonstrates that there is a variable pattern of precipitation across the watershed.

Daily river discharge data for the Moravian Drive gauge for period of record were divided up by decade and three flow exceedence curves were constructed (Figure 34) to determine changes in flood, median, and base flows across the time period. These graphs show that the 95% (base) and 50% (median) exceedence flows have increased over time. Although the pattern is not as clear, the 5% exceedence (flood) may also have increased. The pattern of precipitation also showed some increases in two of the decades (1971–80 and 1981–90), but was not sufficiently consistent across the entire period of record to be the only factor.

We also wanted to examine how Clinton River flow responded temporally to high rain events. Heavy residential and commercial development in the watershed may have changed the rate that runoff from precipitation moves through the system. Six dates with high precipitation events, scattered through the period of record, were selected to compare daily precipitation with daily river discharge at the Moravian Drive gauge. Daily river discharge and precipitation values were plotted for 20-day periods incorporating a high rain event day (Figure 35). No major changes in the reaction time at the Moravian Drive gauge were detected at this time scale. It is likely, however, that hourly discharges would show changes over the period of record.

Consumptive Water Use and Flooding

A majority of the population in the Clinton River watershed is served by the Detroit Metro Water Department which uses Great Lakes waters as the source of supply (Schaedel and Myers 1978). The remainder of the population uses groundwater as the source of drinking water. No drinking water is known to be taken from the Clinton River (Schaedel and Myers 1978).

Modifying discharge are a number of flow-control structures on lakes in the Clinton River upstream from Pontiac. These lakes include Green Lake, Van Norman Lake, Lake Oakland, Loon Lake, Orchard Lake, Cass Lake, and Sylvan Lake/Dawson Mill Pond (Anonymous 1980). Operation schedules for these structures are not known, but they probably have a tendency to dampen high flow events.

Prior to 1950, flooding was a significant problem on the mainstem, both above and below Mt. Clemens, due to storm events and spring thaw. Above Mt. Clemens, 3,000 acres of pasture lands were flooded; in Mt. Clemens, flooding was limited to 700 acres of residential land; and below Mt. Clemens, as much as 1,000 acres were flooded dependent upon the level of Lake St. Clair (Michigan Water Resources Commission 1953). This flooding problem was alleviated in 1950–51 with the construction of a large cut-off channel by the Corps of Engineers running from Mt. Clemens, southeasterly to Lake St. Clair. This channel, while preventing flooding, created stagnant conditions in the mainstem below Mt. Clemens. In 1994, the Corps of Engineers alleviated the problem by installing an inflatable barrier at the head of the cutoff channel, directing more water down the Clinton River.

Soils and Land Use Patterns

The functioning of any "local" hydrologic system, depends upon many things including climate, geologic features (terrain, bedrock, and soils), biological communities (predominantly vegetation), and human developments operating at global, regional, and local scales. When combined, they produce what we view to be the "landscape". The hydrologic cycle in the Clinton River results from the interaction of surface and groundwater supplies within the watershed's landscape.

Local soils and groundwater supplies are inextricably linked within a watershed and critical in determining how river drainage operates. Soil formation is a dynamic process caused by weathering of surface minerals through physical, chemical, and biological processes. Surface materials may originate as bedrock exposure, aeolian (wind blown), lacustrine (from glacial lake beds), alluvium (river), and organic (peat) deposits.

Soils develop over thousands of years in response to the soil-forming forces. With time, soils generally become deeper and develop distinct layers or horizons. Soil-forming forces are physical, chemical, and biological weathering of rock (parent material) at the earth's surface. Soil is in a dynamic equilibrium always changing as a result of its interaction with the environment. As wind and water erode particles from the surface, weathering and biological activity produces more soil from the parent material. Loss of soil occurs when erosion exceeds the production of new soil. Soil, as we know it, would not exist without biological activity dissolving nutrients from the rock matrix. As soil develops, micro fauna and flora live and die in the soil constantly adding organic matter. Soil is a habitat for living things that carry out essential biological actions including addition of nutrients through decomposition, vegetative growth to bind and protect particles from erosion, and burrowing by animals to mix soil components. The kind of soil profile that develops is the result of six natural factors acting together: parent material, climate, vegetation, topography, time, and humans. Erosion (grossly magnified by human-made modifications to a landscape) is the primary source of damage to soils and rivers. Effective watershed management must include thoughtful land use practices.

Ecoregions

Management of the Clinton River watershed must take into account the types of ecosystems that it contains. In resource management, ecosystems are generally considered to be naturally integrated units of the landscape that can be identified and mapped. 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.

The most upstream ecological subsection is called Jackson Interlobate because it formed between three lobes of the Laurentide ice sheet approximately 13,000–16,000 BP and occupies 24.2% of the Clinton River watershed (Figure 5). This is the highest subsection of the watershed where land elevations range from 984 ft to 1,276 ft above sea level with an average elevation of 1,018 ft. Bedrock is covered by 250–300 ft of glacial till. Albert (1995) describes this zone as broad expanses of outwash sands surrounding sandy and gravelly end and ground moraines. Moraines are found as island-like hills surrounded by flat outwash. Numerous kettle lakes and ponds, which formed on the pitted outwash and end moraines, are clearly visible (Figure 5). There are 172 lakes in the watershed which are 10 acres or greater in size (144 are 10–100acres, 18 are 100–200 acres, 8 are 200–500 acres, and 2 are >500 acres). Soils on the moraines in this subsection are well drained. Drainage is much poorer on outwash plains and outwash channels which are composed of finer grained materials. Presettlement vegetation was highly variable because of the uneven terrain. Sandy moraines had open savannas of oak-hickory, while lower elevation outwash areas supported large wetlands and shallower kettles that were often filled with swamp or bog vegetation. This subsection contains the headwaters of the Clinton River. Most upland areas were farmed, but have more recently been developed for residential or commercial purposes. Extensive development has led to eutrophication of lakes and degradation of rivers and wetlands.

The next downstream ecological subsection, the Ann Arbor Moraines, occupies 21.1% of the watershed (Figure 5). Land elevations in this sub-section range from 673 ft to 1,142 ft with an average of 897 ft. Glacial deposits are about 200 ft thick. Albert (1995) describes this zone as a narrow band of fine and medium-textured end and ground moraines. The topography found in ground moraines is low, with relatively rounded or flat-topped hills, while end moraines are more rolling with some relatively high hills. Loam and sandy loam soils predominate in this zone with good drainage, while poorly drained mineral soils are found on lower slopes of ground moraines. The loams originally supported oak-hickory forests and swamp forest occurred on lower slopes of moraines. Almost all ground moraines were cleared for farming by 1850, but some steeper end moraines continue to be forested with oak. This subsection has relatively few lakes (Figure 5), but contains some of the watershed’s higher gradient river sections including Galloway, Paint, Stony creeks, and headwaters of the North Branch.

The Maumee and Sandusky Lakeplain subsections cover the entire eastern side of the Clinton River watershed comprising 54.7% of the watershed (Figure 5). Land elevations in the Maumee Lakeplain subsection range from 574 ft to 879 ft with an average of 661 ft. Elevations in the Sandusky Lakeplain range from 781 ft to 879 ft with an average of 817 ft. Glacial deposits over bedrock are about 100 ft thick. Albert (1995) describes this subsection as a flat, clay lake plain dissected by some glacial drainage ways of sandy soil. No lakes are present in this subsection and the river sections have very low gradient (generally less than 5 ft per mile). Lake St. Clair moderated climate and productive loamy soils resulted in early intensive agricultural development by settlers. There are several end moraines visible in the surface map (Figure 5) that were reworked by subsequent glacial meltwater. Beach ridges created by some proglacial lakes are also evident, one of which appears to form the eastern boundary of the watershed. Before European settlement, Native American settlements were common along Great Lakes shoreline, primarily upon beach ridges. The Holcombe Beach archeological site was uncovered in 1961 on one of these beach ridges, located in Sterling Heights on Dodge Park Road. It shows evidence of an early Paleo-Indian settlement about 11,000 BP. These were some of the earliest prehistoric human dwellers in the Great Lakes region. They inhabited a post-glacial lake shore and relied heavily upon woodland caribou for food. Most of the clay lake plain supported wetland or upland forest, while sandy beach ridges supported open “barrens” or oak savannas and small areas of dry prairie. Extensive marshes occurred along the coast of Lake St. Clair and probably extended for several miles up the Clinton River. Natural fluctuations in water levels of Lake St. Clair were important for maintaining marsh vegetation that extended up the Clinton River. There was extensive lakeplain wet prairie separating the eastern edge of the watershed and the shoreline of Lake St. Clair. The clay soils in this subsection were some of the first to be farmed and were artificially drained by ditching and tiling.

Land Use

Pre-historic Native Americans had significant settlements throughout the Clinton River watershed as evidenced by the distribution and frequency of archeological sites (Figure 3). A web document by Public Sector Consultants, a private Michigan corporation providing policy research, indicates that Michigan’s population of Native Americans was 6,000 to 8,000 individuals prior to the early 1600s. French explorers came through Southeast Michigan in the 1620s and Detroit was settled in 1701. Settlement of Southeast Michigan by European immigrants was legalized in 1807 and Michigan obtained statehood and counties were organized in 1837. Macomb and Oakland counties make up 92.1% of the area within the Clinton River watershed.

The growth of human population from 1900 to 2000 in Macomb and Oakland counties was incredible (Figure 4, top graph). The population grew from 78,000 in 1900 to 2 million in 2000 and there were several intervening decades when the two-county population essentially doubled. These two counties went from supporting about 3.2% of Michigan's population in 1900 to about 20% in 2000 (Figure 4, bottom graph). This expansion in the human population represents tremendous developmental pressure on the ecological framework.

To help document further environmental change, Public Sector Consultants has estimated that Michigan's land is being modified and developed 8.7 times faster than population growth. A 1999 study (Sierra Club 1999) comparing the fifty states on control of urban sprawl found that Michigan ranked 49th. A recent study by the Southeast Michigan Council of Governments SEMCOG (2003) showed that in just 10 years, 1990–2000, developed land increased by 17 percent, so that Southeast Michigan's land is now 37 percent developed. They predict another 36% increase in land development by the year 2030.

According to Barnes et al. (2002), sprawl is a pattern of land-use/land cover conversion in which the rate at which land rendered impervious by development exceeds the population growth rate over a specified time period, with a dominance of low-density impervious surfaces. Issues and problems associated with this pattern of land development are serious and often divisive, especially when efforts are directed to reining in sprawl at the local jurisdictional scale. A relatively new form of environmentally damaging development is termed "exurban" consisting of scattered non-farm residential dwellings placed in predominantly agricultural and forested areas (Barnes et al. 2002). This type of development has been occurring at a very alarming rate in northern parts of Oakland and Macomb counties.

Another significant threat to environmental resources is loss of habitat which is the greatest threat to wildlife in the United States (Doyle et al. 2001). Urbanization alters landscapes and fragments prior patterns of land use and land cover, dramatically reducing amount of habitat, size of remaining patches of habitat, and degree of connectedness among remaining patches. Land development increases distances between remaining fragments of habitat, making interactions between isolated populations of plants and animals difficult and hazardous.

Urbanization of watersheds also causes growth and spread of impervious surfaces which threaten environmental quality of surface and groundwater resources (Barnes et al. 2001). These threats include increased storm water runoff, reduced water quality, higher maximum summer temperatures, degraded and destroyed aquatic and terrestrial habitats, and diminished aesthetic appeal of streams and landscapes. Impervious surfaces are mainly constructed surfaces: rooftops, sidewalks, roads, and parking lots—covered by impenetrable materials such as asphalt, concrete, and stone. These materials effectively seal surfaces, repel water, and prevent precipitation and meltwater from infiltrating soils. Surfaces covered by such materials are hydrologically active, meaning they generate surface runoff. According to Novotny and Chesters (1981), impervious surfaces are nearly 100 percent hydrologically active, and high percentages of such surfaces occur within urbanized areas containing commercial, industrial, transportation, and medium to high density residential land uses. As watershed areas are developed for these uses, local hydrological cycles are substantially altered. Dramatic changes in timing and volumes of storm waters delivered to nearby streams follows the paving of previously vegetated areas. Changes in stream levels between storms, in heights of groundwater tables, and in rates and volumes of stream erosion are also likely outcomes of increasing watershed imperviousness. Urbanization of a watershed degrades both the shape and behavior of a downstream aquatic system, causing changes that can occur rapidly and are very difficult to avoid or correct (Booth and Jackson 1997). According to Kennen (1999) the best predictor of the presence of an unimpaired benthic community was total area of forested land located upstream from a sampling site. Kennen (1999) also found that the best indicators of the presence of a severely impaired benthic community were area of urban land in close proximity to a sampling site and total flow of municipal wastewater effluent.

A comparison of percent change in land use/cover type between pre-settlement time (circa 1800) and 1992 is presented (Table 5). The two maps in Figure 36 represent the spatial distribution of land cover in pre-settlement time and in 1992. By 1992, forested land had been nearly completely replaced by residential in the south and more than 50% replaced by agriculture and residential in the north section. Little information was located showing changes in impervious surfaces in the Clinton River watershed, but this is obviously a critical factor in degradation of the river's natural resources.

Channel Morphology

We used GIS (ArcView©) software to map, examine, and measure 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 available from the MDNR (website http://www.mcgi.state.mi.us/mgdl/). We measured stream width on 1998 aerial photographs available in MrSid© format from the same MDNR website. These photographs are digital orthorectified images (DOQQs) each covering a quarter of a standard 7.5' USGS Quadrangle map.

We also used the aerial photographs to measure the river length to calculate sinuosity. Sinuosity was calculated be dividing the stream thread length by the valley length, for each valley segment. This index provides a measure of the amount of meanders in the river. If the river were straight, with no meanders, then the Sinuosity Index would be equal to 1.0. 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.

Stream gradient is the drop in elevation over distance commonly measured in ft per mile. Predictions concerning fish communities, channel characteristics, and hydraulic diversity can be made from gradient information. Gradient classes and associated channel characteristics are listed below (G. Whelan, MDNR, Fisheries Division, personal communication).

Gradient class	Fish habitat	Channel characteristics
0.0–2.9 ft/mi	low	mostly run habitat with low hydraulic diversity
3.0–4.9 ft/mi	fair	some riffles with modest hydraulic diversity
5.0–9.9 ft/mi	good	riffle-pool sequence with good hydraulic diversity
10.0–69.9 ft/mi	excellent	well established, regular riffle-pool sequences with excellent hydraulic diversity
70.0–149.9 ft/mi	fair	chute and pool habitats with only fair hydraulic diversity
>150 ft/mi	poor	falls and rapids with poor 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.

Predicted values of spatial variation in shallow groundwater movement were extracted from the Michigan Rivers Inventory, Darcy Groundwater Movement Model, version 3. Model values are an estimate of potential groundwater velocity for fluxes from adjacent uplands to surfaces of target cells (Baker et al. 2003). These spatially referenced values were imported into Surfer software, and converted to raster image files. The "Darcy" images were draped over three-dimensional surfaces to produce terrain-based maps of potential groundwater movement connecting to surface waters in river sections. Darcy's law deals with the relationship between hydraulic head and resistance of soil material to groundwater flow. Groundwater tends to move into streams wherever the groundwater table is higher than the stream surface, alternatively in a reverse direction if the water table is lower (Winter et al. 1998). The MRI-Darcy dataset was created to predict spatial variation in potential groundwater delivery at a scale useful for stream inventory and resource assessment in lower Michigan (Baker et al. 2003). The amount of relatively cool groundwater entering stream sections is a critical factor setting conditions of base flow and temperature regime. According to Wehrly et al. (1998), water temperature is one of the most important factors affecting aquatic organisms inhabiting local stream habitats. In southern Michigan, groundwater inflows are critical in maintaining appropriate thermal habitat for cold-adapted fish and invertebrates (Wehrly et al. 1997). This type of site-specific information is needed to make fishery management plans containing reasonable expectations for fish species presence, abundance, and growth characteristics (Seelbach et al. 1997).

Headwaters

The Headwaters Segment of the Clinton River is visible in the southeast quarter (DOQQ) of the Ortonville quadrangle and the rest can be followed into the Clarkston NE DOQQ. This section runs through sizeable public park land and other areas with relatively undisturbed riparian vegetation. There is relatively little residential or commercial development adjacent to the river evident on the aerial imagery, except for the downstream end. Using GIS software, we made 78 measurements from clearly visible channel segments and they averaged 14.2 ft in width (Table 6). Elevation at the upper end of the Headwaters Segment is about 1,040 ft above sea level and ending elevation about 993 ft. Since this segment is about 5.0 miles long, the average gradient was estimated to be 9.1 ft per mile and is considered a high enough gradient to reflect good potential sport fisheries habitat (Leonardi and Gruhn 2001). Sinuosity for this segment was 1.33, ranking as moderate sinuosity. A geographic map (Figure 37) shows this river segment plus several lakes, Independence Oaks County (Oakland) Park, and some major road crossings. The outer box covers 11,014 acres surrounding this river segment. The graph in the lower part (Figure 37) shows elevation change. Drop lines were added to draw attention to approximate elevation and river distance at the road crossings. Gradient varies within a segment, especially when there are lakes along the mainstem (Figure 37). Three-dimensional maps (Figure 38) show the major terrain features and the potential shallow groundwater supply to surface waters. This segment of the Clinton River runs across glacial outwash sand and gravel and between end moraines of coarse-textured till. These glacial deposits support high water conductivity (Seelbach et al. 1997) and the Darcy image indicates significant groundwater inflows from surrounding hillsides and along the river channel.

Upper

The upper end of the Upper Segment is visible in the Clarkston NE DOQQ and it runs through Pontiac North NW, Clarkston SE, Walled Lake NE, Pontiac South NW, Pontiac South NE, Pontiac North NE, and ends in the Rochester SW DOQQ. This relatively long river segment runs through glacial outwash sand and gravel, post glacial alluvium, and end moraines of medium-textured till. The outwash deposits provided numerous kettle lakes, a number of which are directly connected to the Clinton River. We made 233 channel width measurements on aerial photos from clearly visible segments of the river channel and they averaged 54.2 ft (Table 6). Beginning elevation of the Upper Segment is about 993 ft and ending elevation about 854 ft. Since this segment is about 30.0 miles long, the average gradient was estimated to be 4.6 ft per mile and is considered to be low, reflecting only modest potential for sport fisheries habitat. Sinuosity was 1.36, ranking as moderate sinuosity. A map in Figure 39 shows this river segment plus the lakes and major road crossings. The outer box covers 72,781 acres surrounding this river segment. The graph in Figure 39 shows elevation change. Drop lines were added to draw attention to approximate elevation and river distance at the road crossings. Two three-dimensional maps (Figure 40) show major terrain features and potential shallow groundwater supply to surface waters. Glacial deposits in this segment support high water conductivity, but the Darcy image indicates significant groundwater flows into the lakes where summer conditions would tend to warm the water prior to downstream passage. This long segment of the Clinton River is heavily developed for residential and commercial purposes throughout most of its length, including the shorelines of the lakes. Many wetlands have been filled and much land cover in this area is impervious which probably interferes with natural groundwater and surface water transport.

Middle

The beginning of the Middle Segment is visible in the Rochester SW DOQQ and the rest can be viewed running through the Rochester SE, Utica SW, and ending in the Utica SE DOQQ. The upper half of this river segment runs through glacial outwash sand and gravel between end moraines of medium-textured till. The downstream half descends from end moraines onto lacustrine sand and gravel deposits crossing numerous pro-glacial beach ridges. Yates dam is located on the most western (upstream) beach ridge. We made 377 channel width measurements on aerial photos from clearly visible segments of the river channel and they averaged 55.7 ft (Table 6). The upstream segment, through the Rochester SE DOQQ, is heavily developed for residential and commercial purposes. The next portion runs through several public parks and has substantial riparian bank vegetation. The downstream half of this segment runs predominantly through publicly owned property and has good bank vegetation. The elevation at the upper end is about 854 ft above sea level and about 617 ft at the lower end. This segment is 19.3 miles long and the average gradient was estimated to be 12.4 ft per mile. This is the highest-gradient segment of the Clinton River. It is considered very good for rivers in southern Michigan, reflecting high potential for sport fisheries habitat. This segment had the highest sinuosity (1.46) compared to other segments, ranking high in sinuosity. The map in Figure 41 shows this river segment plus the lakes and major road crossings. The outer box covers 32,155 acres surrounding this river segment. Elevation change is shown in Figure 41. Drop lines were added to draw attention to approximate elevation and river distance at the road crossings. Three-dimensional maps (Figure 42) show major terrain features and the potential shallow groundwater supply to surface waters. Glacial deposits in the upper half of this segment support high groundwater conductivity and the Darcy image appears to confirm high groundwater inflow. The downstream half, flowing through lacustrine deposits, may have modest groundwater inflow, but that needs to be confirmed with an onsite field survey. The combination of high gradient, good potential for groundwater inflow, and abundant public access make this the most promising segment of the Clinton River mainstem for fisheries management.

The headwaters of Galloway Creek are visible in the Pontiac North SE DOQQ and from there the stream can be followed through the Rochester SW DOQQ. This tributary crosses glacial outwash sand and gravel and several types of moraines of medium-textured till all considered to allow good groundwater passage. Channel width averaged 16.7 ft calculated from 74 measurements on aerial photos. The upstream half runs through moderate residential development and the lower segment through moderate industrial areas. Much of the stream has good buffer zones of riparian vegetation which are clearly visible on the aerial photographs. Elevation at the beginning of Galloway Creek is about 946 ft above sea level and its ending elevation is about 808 ft. This section is about 8.3 miles long and the average gradient was estimated to be 16.7 ft per mile, higher than any stretch of the Clinton River. This gradient reflects high potential for sport fisheries habitat. A map in Figure 43 shows Galloway Creek plus major road crossings. The outer box covers 22,208 acres surrounding this river segment. The lower graph (Figure 43) shows elevation change. Drop lines were added to draw attention to approximate elevation and river distance at the road crossings. Two three-dimensional maps (Figure 44) show major terrain features and potential shallow groundwater supply to surface waters. Glacial deposits in this section support high groundwater conductivity and the Darcy image appears to confirm high groundwater inflow, especially in the uppermost reach. The downstream areas, flowing through medium-textured till deposits, may have moderate groundwater inflow, but that should be confirmed with onsite field surveys. The combination of high gradient and good potential for groundwater inflow makes this a promising tributary for future fisheries management activities.

The beginning section of Paint Creek below Lake Orion is visible in the Lake Orion SW DOQQ and the stream can be followed through the Rochester NE and Rochester SE DOQQs. Paint Creek also arises and ends in glacial outwash sand and gravel. The middle section travels through end moraines of medium-textured till. These glacial deposits are considered to allow good groundwater passage. We made 183 width measurements on aerial photos from clearly visible segments of the Paint Creek channel which averaged 26.3 ft. The catchment for the upper stream has moderate residential development, the middle has moderate residential and commercial areas, and the downstream end runs through heavy industry. Much of the stream is bordered by public land with maintained trails and has very good buffer zones of riparian vegetation clearly visible on the aerial photographs. Elevations at the upper and lower end of this section are 983 ft and 718 ft, respectively. This creek is about 15.0 miles long so the average gradient was estimated to be 17.7 ft per mile, slightly higher than Galloway Creek. This tributary also has high potential for sport fisheries habitat and there is an aggressive coldwater fish management program underway. A map (Figure 45) shows Paint Creek plus Lake Orion and major road crossings. The outer box covers 67,577 acres surrounding this river segment. The graph in the lower part (Figure 45) shows elevation change. Drop lines were added to draw attention to approximate elevation and river distance at the road crossings. Three-dimensional maps (Figure 46) show the major terrain features and the potential shallow groundwater supply to surface waters. Galloway Creek, Stony Creek, and part of the Middle Segment of the Clinton River are also visible on these two surface maps. The glacial deposits in this section also support high groundwater conductivity, especially at the upper and lower ends. The Darcy image appears to confirm high groundwater inflow, especially at the beginning and end. The middle portion, flowing through medium-textured till deposits, may have moderate to good groundwater inflow, but that should be confirmed with onsite field surveys. The combination of high gradient, good potential for groundwater inflow, and abundant public access make this one of the best river stretches in the Clinton River watershed for fisheries management activities.

The headwaters of Stony Creek are visible in the Lake Orion NE DOQQ and from there it runs through Romeo NW, Romeo SW, Utica NW, and Utica SW DOQQs. Stony Creek travels through a glacial outwash channel composed of sand, gravel, and post-glacial alluvium. The river channel is bordered on both sides by end moraines of medium-textured till. These glacial deposits have relatively high groundwater transfer capacity. We made 84 width measurements on aerial photos from clearly visible segments of the Stony Creek channel which averaged 35.1 ft. The catchment for the upper stream has recent residential and exurbanite development mixed with substantial agricultural-type land cover downstream to the Huron-Clinton Metropolitan Authority (HCMA) Stony Creek Metropark. There is significant riparian vegetation along these sections. Stony Creek Metropark is located on a large impoundment created by dams on Stony Creek. The short stretch downstream from the impoundment has moderate residential and commercial land cover and is currently under rapid urban development. Elevation at the upper end of Stony Creek is about 952 ft and the elevation at the lower end is 687 ft. Average gradient was estimated to be 15.8 ft per mile, slightly lower than Galloway and Paint creeks. Based on good gradient, this tributary has good potential for sport fisheries management, but public access is limited. A map presented in Figure 47 shows Stony Creek, Stony Creek Lake, and major road crossings. The outer box encloses an area of 94,829 acres surrounding this river segment. A graph of elevation change was not made due to inaccuracies in the elevation data and difficulty extracting information through the impoundments. Three-dimensional maps (Figure 48) show major terrain features and potential shallow groundwater supply to surface waters. Glacial deposits throughout this section should support very high groundwater conductivity and the Darcy image shows high groundwater inflow potential following the entire river channel. The combination of high gradient, good groundwater inflow, and relatively small size give this tributary moderate potential for fisheries management activities.

Lower

The beginning of the Lower Segment, visible in the Warren NE quadrangle, can be viewed running through the Mt. Clemens West NW, and Mt. Clemens West NE DOQQs. This river segment runs primarily through lacustrine sand, clay, and silt deposits. The downstream end crosses remnant end moraines (eroded by subsequent pro-glacial lakes) of medium-textured till. We made 162 width measurements from clearly visible sections and they averaged 76.4 ft. The catchment for this segment is heavily developed for residential and commercial purposes, however, the river is somewhat buffered because significant portions run through publicly owned or managed lands. There are a number of city parks and public golf courses which provide riparian vegetation and public access. Elevation at the beginning of the Lower Segment is about 617 ft and about 579 ft at the end. This segment is about 13.7 miles long so the average gradient was estimated to be only 2.8 ft per mile. This gradient is considered to be too low to supply a good variety of fish habitats. The map in Figure 49 shows this river segment plus major road crossings and Dodge Park in the city of Sterling Heights. The outer box covers 27,357 acres surrounding this river segment. The graph in the lower part (Figure 49) shows elevation change. Drop lines were added to draw attention to approximate elevation and river distance at road crossings. Three-dimensional maps (Figure 50) show major terrain features and potential shallow groundwater supply to surface waters. Lacustrine glacial deposits in this segment do not support high groundwater conductivity and the Darcy image appears to confirm low rates of groundwater inflow. From a fisheries management perspective, this segment still has modest potential based on good public access, close proximity to the Great Lakes, and being downstream of any barriers to fish migration.

Mouth

The beginning of the Mouth Segment is visible in the Mt. Clemens West NE DOQQ and can be followed through the Mt. Clemens East NW, and Mt. Clemens East NE DOQQs. This river segment runs briefly off the remnant end moraines and continues on through lacustrine clay, and silt deposits of low groundwater permeability. We made 126 channel width measurements from clearly visible sections which averaged 175.7 ft. The catchment is also heavily developed for residential and commercial purposes. Elevation at the beginning is about 579 ft and ending elevation is about 575 ft. Since this segment is 11.1 miles in length, the average gradient was estimated to be only 0.4 ft per mile. With such a low gradient, only run-type fish habitat will be supported. A map in Figure 51 shows this river segment plus major road crossings and Metro Beach Metropark in Harrison Township. The outer box covers 34,860 acres surrounding this river segment. The data in the digital elevation model was not accurate enough to extract adequate elevation data for construction of a graph showing change over distance. A three-dimensional map (Figure 51) shows major terrain features which are old beach ridges from pro-glacial lakes. Lacustrine clay and silt deposits do not support high groundwater conductivity and the Darcy data (not shown) confirms very low rates of groundwater inflow. From a fisheries management perspective, this segment only has management potential based on good public access and that it is open to fish migration from Lake St. Clair.

The map in Figure 52 shows the Middle Branch and North Branch subwatersheds and each branch drains about 35,962 acres and 68,885 acres, respectively. A graph of elevation change was not made for these segments because of the difficulty in extracting accurate data. Two three-dimensional maps (Figure 53) display major terrain features and potential shallow groundwater supply to surface waters for both the Middle and North branches.

The headwaters of the Middle Branch section are visible in the Romeo SE DOQQ and from there it can be followed through Waldenburg NW, Waldenburg SW, Waldenburg SE, and Mt. Clemens West NE DOQQs. This tributary appears to have been highly channelized, probably to drain land for agricultural purposes. The Middle Branch begins on end moraines of medium-textured till and passes through lacustrine deposits of sand, gravel, clay, and silt. These materials are relatively resistant to groundwater flow. We made 43 width measurements on aerial photos from clearly visible segments of the Middle Branch which averaged 39.5 ft. The catchment for the Middle Branch, which was predominantly agricultural, has undergone tremendous residential and commercial development over the past 30 years. Elevation at the upper end of the Middle Branch is about 879 ft and at the lower end elevation is about 579 ft. This section is about 18.1 miles long making the average gradient 16.6 ft per mile suggesting that it should provide good aquatic habitat.

The headwaters of the North Branch section are visible in the Almont SW DOQQ and from there it can be followed through Almont SE, Allenton SW, Armada NW, Armada SW, Armada SE, Waldenburg NE, Waldenburg SE, and Mt. Clemens West NE DOQQs. This tributary passes primarily through agricultural lands with several small villages and other urban developments. There are relatively large areas of public land along the North Branch, mainly associated with the HCMA Wolcott Mill Metropark. Recreational lands support significant riparian vegetation and public access. The North Branch begins on glacial outwash sand and gravel then crosses end moraines of medium-textured till before entering the lacustrine deposits of sand, clay, and silt. Glacial materials in the upper areas allow good groundwater transfer while the lacustrine deposits are resistant to groundwater flow. We made 352 width measurements on aerial photos from clearly visible segments of the North Branch which averaged 36.5 ft. Elevation at the headwaters of the North Branch is about 903 ft and about 580 ft at the downstream end. Since this section is about 41.9 miles long, the average gradient was estimated to be 7.7 ft per mile. While this is lower than the Middle Branch, it should supply adequate aquatic habitat.

The relatively fine-grained glacial deposits throughout these sections probably do not support high groundwater conductivity. The Darcy image only indicates high groundwater inflow potential in the upstream sections of both the Middle and North branches. The combination of heavy development, low rate of groundwater extrusion, and lack of public access suggest that the Middle Branch does not supply good potential for fish management. The North Branch may have good groundwater inflow in the upper stretches, but this should be confirmed with onsite surveys. Unlike the Middle Branch, the North Branch has very good potential for fisheries management because it appears to have high groundwater potential in the upper segment, moderate urban development, and good public access.

Channel Cross Sections

Channel cross section is another measurement of the quality of fish habitat. Natural channels typically provide better habitat than degraded or manipulated channels. Channel morphology is determined by channel material, stream flow and velocity, and in-channel structures. Unstable flows will create flood channels that are over wide and shallow during average-flow periods. Unusually narrow channels are produced by bulkheads or channel dredging. Abnormal sediment loads (either too much or too little) will also modify channels by causing deposition or erosion. Bridges, culverts, bank erosion, channel modifications, and armored substrates will cause deviations from expected channel form. To examine the effects of these modifying factors, more channel cross-section observations are needed in each valley segment.

Two quantitative measures of channel characteristics were determined from available data. First, channel widths were compared to the average width of rivers with the same discharge volume using relationships from Leopold and Maddock (1953) and Leopold and Wolman (1957). Channel widths were measured on the Clinton River by USGS during stream discharge studies. Cross-sections that were clear of bridges and most representative of the section were selected where possible. Expected width was calculated from measured discharge using the relation log(Width) = 0.741436 + 0.498473 * log(Mean Daily Discharge). Mean discharge measurements were taken from Drayton Plains 1994–2003, Auburn Hills 2001–03, Sterling Heights 2002–03, and Fraser 1994–2003 (Data from USGS).

Second, the hydraulic diversity of a channel can be indexed using the Shannon-Wiener information statistic (G. Whelan, MDNR Fisheries Division, personal communication). The greater the number of different velocities and depths, the larger number of species or life stages that a reach can support. Diversity indices were calculated from counts of cross-section data points in classes of velocity in intervals of 0.5 ft per second and depth in intervals of 0.5 ft. Hydraulic diversity categories and values are: Poor- 0–1.5; Fair- 1.6–2.0; Good- 2.1–2.5; and Excellent- >2.5.

Width comparisons and diversity indices for available data are presented (Table 7). The Drayton Plains site is located in the Upper Segment of the Clinton River. The expected width that was calculated (38.8 ft) came out very close to the measured width (36 ft) and the hydraulic diversity index was fair at this site. At the Auburn Hills site, located in the Middle Segment, the expected width was much wider than the observed width. This result, coupled with the poor hydraulic diversity index, indicates that channel modifications have likely taken place. The Sterling Heights site was at the lower end of the Middle Segment and had the highest diversity index of the sites evaluated. At the final site, located in the Lower Segment, hydraulic diversity declined and the expected width was wider than what was observed. Again, indicating that channel alterations likely occurred in this area.

Dams and Barriers

We were able to identify 79 dams in the Clinton River watershed from State of Michigan digital records available from the MDEQ, Land and Water Management Division, Dam Safety Unit (Table 8). In some cases, data do not appear to be very accurate (name, geographic location, purpose, and size) so there may be discrepancies regarding presence of some dams and their location. Dams are predominately located in the northwest part of the watershed (Figure 54). The Clinton River, Paint Creek, and Stony Creek subwatersheds account for 62% of all dams.

Most dams are privately owned, listed as “recreational” under purpose, and are located on very small tributaries. A number of lakes that the Clinton River flows through have water-level control structures with legally set levels controlled by Oakland County Drain Commissioner (Figure 54). These control structures may have adverse effects on river flow and temperature, especially during low flow seasons or years of below average precipitation.

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 water behind the dam is wider and slower flowing; all important considerations for fisheries management. There are a number of dams in the Clinton River watershed which should be targeted for removal because of their detrimental affect on the river; for example, Cascade Dam on the North Branch of the Clinton River (just upstream of Romeo Plank), which has failed. Although this dam does not create a reservoir and increased water warming is not an issue, it does prevent migration of native fish species. This is particularly important because there is very good fisheries habitat upstream of the dam. A second dam that is a candidate for removal is a private dam on the central portion of Paint Creek (just downstream of Gunn Road). This dam restricts movement of fish and is located on a stream that is managed for a reproducing population of brown trout.

Some discussion is warranted regarding Yates Dam, which is the first dam encountered on the Clinton River mainstem, moving upstream from Lake St. Clair. In general, Fisheries Division supports removal of dams because of their negative affects on aquatic habitat, but each dam has to be evaluated on a case-by-case basis. Yates Dam is approximately 31 miles upstream of Lake St. Clair and has an approximate head of 6 ft. The dam is a barrier to fish migration for all species except adult steelhead (potamodromous rainbow trout). Steelhead have been confirmed passing over Yates Dam, but it is unclear how efficiently they pass. There is not much depth in the pool at the base of the dam, which likely inhibits steelhead passage.

The original purpose of the dam was to operate a mill, which is no longer functional. The Clinton River behind the dam is deeper, but the dam itself does not create an impoundment. Removal of the dam would open an additional 16 miles of river before the next obstruction, where the Clinton River is piped under Pontiac. It would also open access to three important tributaries; lower Stony, Paint, and Galloway creeks. Removal of Yates Dam would be positive because it would eliminate the restriction, distribution, and exchange of genetic material of fish and other aquatic organisms. Removal would also eliminate a safety hazard; there have been two drownings from 1999–2002 at Yates Dam.

Although there would be benefits created by the removal of the dam, there are also fisheries management reasons to leave the dam standing. For example, while the dam acts as a barrier for native fish migrations, it also acts as a barrier for exotic species. While sea lamprey are not a major concern, round gobies have been documented migrating up the Clinton River (see **Present Fish Community**). It would also act as a barrier to exotic species that may get established in Lake St. Clair at a later time, such as ruffe or Asian carp.

Additionally, because Yates Dam slows the migration of steelhead, it creates a significant fishery below the dam. Based on a creel survey conducted during the steelhead migration in 1986 and 1987, anglers fished 21,000 angler hours annually immediately downstream of Yates Dam. The location of Yates Dam is important because there is very good public access for a long stretch downstream of the dam (Figure 55). Thus, the dam has the dual benefit of creating a fishery and providing it in an area that has very good public access. Removal of the dam would likely significantly reduce the fishery in this area. Furthermore, public access is much more limited above Yates Dam and the fishery would be much more dispersed.

A final consideration is that steelhead would likely pass above Yates Dam and into Paint Creek. Paint Creek has been managed as a trout fishery for 50 years and is the only significant trout fishery in Southeast Michigan (see **Present Fish Community** and **Fisheries Management)**. Removal of the dam would create two problems on Paint Creek. First, Paint Creek is a Type 1 Trout Stream, meaning that anglers could not fish for steelhead in Paint Creek when they would be available in the spring, because the fishing season is closed. Second, research has shown that the introduction of steelhead to a resident brown trout population can result in a significant reduction in older age classes of brown trout (Nuhfer 2003). When steelhead were introduced to a resident brown trout population, the interaction between the juvenile steelhead and brown trout resulted in a significant decline in over-winter survival of brown trout. This decline in survival carried over and resulted in reduced abundance of older brown trout. Thus, removal of Yates Dam would allow unimpeded access for steelhead to Paint Creek, putting the current brown trout fishery at risk.

Water Quality

Overview

Stream water quality is a very important determinant affecting aquatic organisms and the health of the entire aquatic community within a watershed. The Clinton River downstream from the City of Pontiac has historically suffered from poor water quality including high fecal coliform bacteria levels, high total dissolved solids (TDS), low dissolved oxygen, and sediments contaminated with heavy metals, oil, and grease. These water quality problems resulted in degraded biological communities in the lower Clinton River. The suspected sources of these problems include municipal and industrial point sources, urban and rural nonpoint sources, combined sewer overflows (CSO), and in-place pollutants (contaminated sediments from past discharges) (RAP 1988).

Based on the Great Lakes Water Quality Agreement signed in 1972 by the governments of Canada and the United States, most of the Lower Segment of the Clinton River was designated an Area of Concern (AOC). Currently, eight beneficial uses are considered impaired including: restrictions on fish and wildlife consumption, degradation of fish and wildlife populations, degradation of benthos, restrictions on dredging activities, eutrophication and undesirable algae, beach closings, degradation of aesthetics, and loss of fish and wildlife habitat. Efforts are under way to develop delisting criteria for the beneficial use impairments of the Clinton River AOC (Opfer et al. 2005).

Water quality in the basin has improved over the past thirty years, and virtually all point source discharges are now regulated. Tougher water quality standards due to the implementation of the Clean Water Act (1972), including upgrades in municipal treatment facilities and regulation of discharges, have contributed to improvements. However, not all detriments to the Clinton River's water quality have been human-induced. For example, the clay soil type and low relief (slow flow) in the Lower Segment continues to contribute to water quality problems (i.e., unstable flows and high TDS).

Point Source Pollution

There are 521 permitted discharges to the surface waters in the Clinton River watershed (Table 9). These discharges are permitted through the National Pollution Discharge Elimination System (NPDES). NPDES permits are issued by the Water Division 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. Discharges include effluent from municipalities: wastewater treatment plants, water treatment facilities, storm sewers, and CSOs; and industrial discharges: contact and non-contact 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.

There were 27 NPDES permits listed for the Clinton River watershed in the 1988 Clinton River Remedial Action Plan (MDNR 1988), compared to 521 in 2003 (Table 9). This large increase in the number of permits is due to the expansion of the NPDES permit system to include additional types of discharges. In 1988, permits were only required for municipal and industrial discharges. The program expanded (in 1990) to include storm water discharges. Of the 521 current NPDES permits, 35 are for municipal and industrial discharges and the remaining 486 are for industrial storm water discharges. In addition, the NPDES permitting system has expanded to include permits for construction projects. These are not listed here due to the large number and more transient nature of these projects (K. Hozak, MDEQ, Water Division, personal communication).

Nonpoint Source Pollution

Nonpoint source pollution, unlike pollution from industrial and sewage treatment plants, comes from many diffuse sources. Nonpoint source pollution occurs when rainfall, snow melt, or irrigation runs over land and through the ground, picks up pollutants, and deposits them into bodies of water. Atmospheric deposition is another source of nonpoint source pollution. Examples of pollutants include excess fertilizers, herbicides, and insecticides from agricultural lands and residential areas; oil, grease, and toxic chemicals from urban runoff and energy production; sediment from improperly managed construction sites, crop and forest lands, and eroding stream banks; bacteria and nutrients from livestock, pet wastes, and faulty septic systems. Failed septic tanks in some portions of the Clinton River watershed have been cited as potentially significant contributors to bacteria problems and further investigation of these sources is ongoing. Regular inspection and maintenance is needed to ensure proper operation of these systems.

Nonpoint source pollution may be best addressed through best management practices (BMPs) (Peterson et al. 1993). BMPs are structural, vegetative, or managerial practices used to prevent, treat, or reduce negative effects on water quality. Such practices include temporary seeding on exposed soils, and detention and retention basins for storm water control.

Sites of Environmental Contamination (Part 201 Sites)

MDEQ, Remediation and Redevelopment Division, has identified 215 sites of environmental contamination within the Clinton River watershed (Table 10). These sites are regulated under Part 201 of the Natural Resources and Environmental Protection Act, 1994 PA 451. This act provides for identification of contamination, any potentially responsible parties, a risk assessment, evaluation, and clean-up of these sites. Pollutants from these sites have the potential to enter a river through surface water runoff or by groundwater contamination and may adversely affect the environment or pose public health hazards. Typical sources of these sites include manufacturing, commercial and industrial facilities, landfills, and agricultural lands with heavy pesticide and fertilizer use.

Storm Water Control

The storm water pollution problem has two components: 1) the increased volume and rate of runoff from impervious surfaces; and 2) concentration of pollutants in runoff. Both components are directly related to development in urban areas. Together, these components cause changes in hydrology and water quality that result in a variety of problems, including habitat modification and loss, increased flooding, decreased aquatic biological diversity, increased sedimentation, and increased erosion. Effective management of storm water runoff offers a multitude of possible benefits, including protection of wetlands and aquatic ecosystems, improved quality of receiving waters, conservation of water resources, protection of public health, and flood control.

The Clean Water Act regulates storm water management. As mentioned earlier, storm water discharges are required to have an NPDES permit and are regulated under what is termed Storm Water Phase I rules. These address sources of storm water runoff that have the greatest potential to negatively affect water quality. Implementation is ongoing for Phase II rules, which will expand coverage of storm water regulations. Phase II rules describe six minimum measures which will need to be implemented in order to prevent or minimize pollutants. These six measures are public education and outreach, public involvement and participation, elimination of illicit discharges, construction site storm water runoff ordinance, post-construction storm water management ordinance, and pollution prevention and good housekeeping.

Sewer Overflows

The Clinton River continues to receive both Combined Sewer Overflows (CSO) and Sanitary Sewer Overflows (SSO). CSOs and most SSO events are associated with wet weather conditions when the capacity of the sewers is exceeded and domestic sanitary sewage and industrial wastewater is released without treatment. These releases may constitute serious environmental and human health threats.

There is one CSO facility in the watershed, Twelve Towns Drain. The facility discharges to Red Run Drain, a tributary to the Lower Segment of the Clinton River. In 2001, there were 10 events that resulted in the discharge of 949 million gallon of partially treated sewage (MDEQ 2002a). This drain has been renamed the George W. Kuhn Drain and completion of construction of an expanded CSO retention treatment facility is anticipated by the end of 2005. The expanded facility will not totally eliminate CSO discharges, but the expanded storage capacity will achieve adequate treatment as defined by MDEQ.

There were three SSO events on the North Branch Clinton River in 2001 that resulted in the discharge of an unspecified volume of diluted sewage. Bear Creek had seven events in 2001, resulting in the release of 1.6 million gallons of raw or diluted sewage in 2001. The Clinton River at Pontiac had six discharges of 19.5 million gallons of raw or diluted sewage and the lower Clinton River had 19 discharges totaling 2 million gallons of raw or diluted sewage (MDEQ 2002a). Plans are being developed to address chronic SSO facilities to eliminate these discharges.

Fish Contaminants

Fish are very nutritious food, providing a high protein, low-fat diet, which is low in saturated fats. However, certain kinds and sizes of fish contain levels of toxic chemicals that may be harmful if those fish are eaten too often. Because of this, MDEQ – Surface Water Quality Division coordinates the Fish Contaminant Monitoring Program (FCMP) between several state and federal agencies and tribal organizations (MDEQ 2002b). As part of the FCMP, fish samples are collected from lakes and streams throughout Michigan and results are used to develop the Michigan Department of Community Health's (MDCHs) *Michigan Fish Advisory*. The fish advisory samples edible-portions to issue general and specific advisories against eating certain sport fish from Michigan surface waters. The MDCH establishes advisories based on "trigger levels" of contaminants (Table 11).

Sampling resulted in fish consumption advisories for specific fish species on the Clinton River below Yates Dam, on Cass Lake, Lake Orion, Loon Lake, Maceday Lake, Osmun Lake, and Terry Lake due to elevated levels of PCBs (MDCH 2002). PCBs are synthetic organic compounds that were used as insulating fluids in electrical equipment such as transformers and capacitors, carbonless copy paper, plasticizers in plastic and rubber products, and hydraulic fluids. Due to health risks associated with PCBs, its production was banned in the United States in 1977. Fish species which had advisories include walleye, smallmouth bass, carp, rock bass, white sucker, northern pike, largemouth bass, and channel catfish.

In addition, there is a special advisory on all inland lakes in Michigan due to mercury. Research shows that most people's fish consumption does not cause a health concern. However, high levels of mercury in the bloodstream of unborn babies and young children may harm the developing nervous system. Mercury is found in nature and is also released by burning wastes and coal, and improper disposal of mercury containing products such as thermometers, batteries, and older thermostats. Small amounts can dissolve in water and nearly all fish contain small amounts of mercury. Usually only large fish that eat other fish have levels too high for humans to eat (MDCH 2002).

Sediment Contamination

Another component of the FCMP is the use of caged-fish studies to identify spatial distribution and trends in contaminants and to identify potential sources of bioaccumulative chemicals. Caged fish studies are a particularly useful water quality monitoring tool because the test fish are exposed to the water column under relatively controlled conditions without possible influence of fish migration patterns. In addition, these studies are capable of detecting highly bioconcentratable chemicals in fish tissue when those chemicals are present in the water column at levels below their respective analytical levels of detection.

Caged fish studies were conducted at the mouth of the Clinton River in 1989, 1992, 1996, and 1997. In addition, in 1999, 2000, and 2001, cages were placed at 14 locations in the Clinton River between Harris Lake and the mouth (Figure 56) to identify sources of PCBs (Day 2003). Net uptake of lipid normalized total PCB concentrations was detected at 13 of 14 sampling locations (ranging from 0 to 0.086 ppm). Concentrations were generally highest at stations in the lower river. However, PCB uptake was measured six times since 1989 at the mouth and although net uptake of total PCBs measured at the mouth of the Clinton River were relatively high compared to most of the 25 Great Lakes tributary mouths sampled since 1987 (Day and Walsh 2000), no clear trend was present (Day 2003). Caged fish monitoring does not provide evidence of a major source of PCBs to the watershed and seems to indicate that the watershed is subjected to diffuse or numerous small sources of PCB.

Caged fish monitoring also revealed statistically significant uptake of both mercury and total DDT in five of six stations sampled in 1999 (Day and Walsh 2000). DDT is a banned pesticide that is bioaccumulative, persistent, and ubiquitous in the environment. Also, statistically significant uptake of total chlordane and HCB was detected in fish from all eight locations monitored in 2000 (Day and Walsh 2001). Chlordane is a pesticide that is no longer in use, while HCB was used as a pesticide and is a by-product of some industrial processes involving chlorine. Both are ubiquitous in the environment. During 2001, significant uptake of mercury was detected at one station, total chlordane at two stations, total DDT at two stations, HCB at all three sample stations and heptachlor epoxide at one station (Day 2003).

In addition to caged fish sampling, direct sediment testing has revealed the presence of contaminants. In the Clinton River, testing from 1990 to 1997 found maximum concentrations of 15 contaminants that were greater than their Probable Effect Levels (PELs) (Table 12). PELs are used to assess the effects of contaminants in surficial bed sediments on populations of aquatic macroinvertebrates. Contaminants above their PELs will result in a reduction in abundance and diversity of aquatic invertebrates. Contaminants were found throughout the study area, however, maximum concentrations were most frequently found in the lower reach and near the mouth of the Clinton River (Rheaume et al. 2001).

Bacteria

Certain types of bacteria pose a health concern to humans and animals because they cause disease. *Escherichia coli* is the bacterium usually associated with human and animal waste. The total body contact standard (head immersion) is exceeded when there are over 300 *E. coli* colonies per 100 ml of water and the partial body contact (fishing, bathing) is exceeded with counts of 1,000 colonies per 100 ml of water. Regulatory compliance is based on geometric means of three or more samples within a defined sampling area.

Bacteria sampling by the Macomb County Department of Community Health (weekly and rainfall events) found that most of the sites had high levels of bacteria (Figure 57). Many sites are on Red

Run Drain, which continues to have problems with CSO events. There has been no direct link between elevated bacteria levels in the Clinton River with bacterial levels in Lake St. Clair. Routine bacteria monitoring is not available for Oakland County.

Stream Classification

The MDNR, Fisheries Division classified streams throughout the state in 1967 (Anonymous 2000). This classification system was based on stream temperature, habitat quality, stream size, and riparian zone development. This system was developed for use in establishing water quality standards, determination of recreational values, designating “wild” and “scenic” rivers, identifying areas for stream and stream frontage improvements and preservation, identifying dam and impoundment problems, fishing and boating access programs, fishing regulations, research planning, fisheries management planning, and stream land acquisition.

Streams were mapped based on stream type and stream quality. Stream categories were identified as: 1) top-quality coldwater streams capable of supporting self-sustaining trout or salmon populations, 2) second-quality coldwater streams that contain significant trout or salmon populations, but are limited by inadequate reproduction, competition, siltation, or pollution, 3) top-quality warmwater streams that contain good self-sustaining populations of warmwater game fish, and 4) second-quality warmwater streams that contain significant populations of warmwater fish, but game fish are appreciably limited by pollution, competition, or inadequate reproduction. The Mouth, Lower, and Middle segments of the mainstem, as well as Red Run Drain were classified as second-quality warmwater, most other tributaries and the Upper and Headwaters segments of the mainstem were classified as top-quality warmwater, and lower Paint Creek was identified as second-quality coldwater (Figure 58). There were no top-quality coldwater streams identified in the Clinton River watershed. However, this classification system is outdated; for example, Paint Creek today would be classified as a top-quality coldwater stream.

More recently, a landscape-based ecological classification system has been developed for streams in lower Michigan, including the Clinton River (Seelbach et al. 1997). This system uses valley segments to describe homogenous portions of a river channel that share some common features and flow through specific landscape units (see **Geography**). This classification system is based on the influence of landscape configuration and regional climatic characteristics. This system also takes into account predictable changes in physical (discharge, flow patterns, channel morphology, water temperature, and energy sources) and biological (fish community structure) characteristics with stream size.

Special Jurisdictions

Navigability

In Michigan, riparian owners on inland waters historically had title to land under the water. Riparian owners on inland lakes and streams own the soil under the water, but they do not own the water or fish. The determination of “navigability” of the water provides the legal avenue to convey rights to provide public fishing over private lands. The rights to public use of navigable lakes and streams includes right of trespass upon submerged soil, but does not extend to the uplands of riparian owners while in the waters, or in entering or departing from them. The word “navigable” is a legal term defining a water as “public”, and the fact that a water is boatable, does not necessarily make it navigable (MDNR 1997).

The field of water law is complex and develops periodically through both legislative and judicial action. There is presently a great deal of uncertainty regarding public or private character of most of the state's streams, particularly smaller streams. Public or private status of a stream to date has been determined by judicial action. However, streams where such determinations have been made represent only an infinitesimal number of the state's total streams (MDNR 1997).

Federal or state entities have declared the following reaches of the Clinton River watershed as legally navigable (MDNR 1997):

1. United States in U.S. Army Engineering District, Detroit, 1981.
   Clinton River, from the mouth to the Gratiot Ave. bridge, Mt. Clemens.
2. Michigan Supreme Court.
   Clinton River, Macomb County, meandered upstream to Section 19, T3N, R12. (1898)
3. Michigan Legislature.
   Clinton River, Section 10, T2N, R12E, Macomb County, Laws 1849.

County Drain Commissions

County Drain Commissioners have authority to establish designated county drains under the Drain Code (P. A. 40 of 1956). This allows for construction, maintenance, inspection, and improvement of all 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 542 designated drains in the Clinton River watershed (Table 13). The characteristics of these drains can vary dramatically, ranging from water routed through an enclosed pipe to unaltered streams with good habitat and fish communities. Drains exist throughout the watershed, but the majority are in the Lower Segment, due to the less permeable soils (see **Geography**). Although Figure 59 is not exhaustive, it shows many of the open drains and smaller tributaries in the watershed. In Oakland County, there are 223 designated drains in the Clinton River watershed; 113 miles are open and 323.5 miles are enclosed drains. Similar data is not available for Macomb County.

Artificial drainage and drain maintenance activities affect the watershed in many ways. 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. In addition, some drains get enclosed in pipes, eliminating sunlight, thereby eliminating primary productivity which is the base of the food chain. These changes can significantly affect important habitat.

Drain commissioners are also responsible for maintenance and operation of many lake-level control structures, particularly those set by the Inland Lake Level Act (P.A. 146, of 1961). Methods of operation to achieve the legal established lake level are at the discretion of each Drain Commissioner. Unfortunately, the legal lake level act requires the lake level to be maintained regardless of what happens downstream. Efforts need to be made to balance the needs of downstream river users and resources with that of lake interests.

State Government

MDEQ administers statutes to protect the aquatic resources (Tables 14a and 14b). Under Part 301 of the Natural Resources and Environmental Protection Act (P. A. 451 of 1994), MDEQ is the lead agency in regulating: dredging and filling lake or stream bottoms, bridges, dams, and seawall construction, culvert installation, beach sanding, draining and filling of wetlands, placement of permanent fishing and boating piers, and boat ramp construction.

MDNR, Fisheries Division has designated sections of four streams in the Clinton River watershed as trout streams. These are: the North Branch Clinton River upstream from 32 Mile Road (Macomb County, T5N, R13E, Sec. 31); East Pond Creek, from North Branch Clinton River to East Mill Pond (T5N, R12E, Sec. 33); Paint Creek from confluence with Clinton River (T3N, R11E, Sec. 14) upstream to Lake Orion Dam (T4N, R10E, Sec.11); and Gallagher Creek (T4N, R11E, Sec. 28). This designation sets the water quality standards for that reach and governs fishing regulations.

Biological Communities

Original Fish Communities

There is a lack of information on the history of the fish community in the Clinton River watershed. However, Zorn and Seelbach (1992) reviewed historical literature and provided a good description of early conditions in the river and watershed:

> In 1835, Ludwick Weslowski, a Polish surveyor and draftsman, "…scrutinized all the Huron [presently Clinton] River and saw the river's numerous branches. Along the river route he saw majestic oaks, maples, black walnuts, and whitewood [tulip trees], mentally evaluating such timbers for construction of the [Clinton-Kalamazoo] canal" (Milostan 1976).…
>
> … The Detroit Journal and Michigan Advertiser (Anonymous 1831a) mentions that in the forests of Oakland County "…the usual variety of timber found in all parts of the [Lower] peninsula may be obtained, as pine, whitewood, oak, ash, sugar maple, hickory, black walnut, chestnut, butternut…". In 1834, Second Lieutenant A. M. Lea of the United States Topographical Bureau described the country bordering the Clinton River between Rochester and its mouth as "generally dry, level and admirably adapted to agricultural purposes; its products are wheat, flour, Indian corn, oats, pork, beef, potash, and especially lumber, having some of the finest forests of oak and walnut perhaps in the [Michigan] territory" (Lea 1834).…
>
> … Second Lieutenant A. M. Lea (1834) gives a fairly detailed description of the lower mainstem: "…From Rochester to Mt. Clemens, 6 miles above the mouth, the river gradually widens, deepens, and grows less rapid, though in this distance there is fall enough to afford water power for several mills. The least depth, in a medium stage of the water is about 2 feet, so that it may be navigated at all times by boats of light draught. From Mt. Clemens to the mouth the width is uniformly about 300 feet, and the current is barely perceptible. The channel gradually deepens, with a few slight exceptions, till within about a mile of the mouth it maintains a depth of 20 feet, thence it gradually grows more shallow, till it affords a depth of only 4 feet on the bar at the junction of the river with Lake St. Clair…There are three points in the river below Mt. Clemens, having a low water depth of only 5 feet, said to be formed by sunken logs, which would be easy to remove." …
>
> … Nearly all literature commented on the swiftness of the river's current and its potential for, or use by, mills.… "…The River Clinton which passes through the townships of Pontiac and Oakland is perhaps one of the best streams for mills in the territory. There are now seven sawmills, three gristmills, a woolen factory, and two carding machines on this stream." (Anonymous 1831b). Hagman (1970) states, "wherever water flowed

> swiftly, pioneers dammed it and erected mills", and by 1840 there were nearly 40 mills in Oakland County.…
>
> … A fairly clear picture of the Clinton River watershed emerges from these historical accounts. Nearly the entire watershed was covered with hardwood forests, which shaded much of the waters. The upper mainstem and Paint and Stony Creeks drained regions of coarse soils and high infiltration, so their flows were stable, containing a substantial proportion of groundwater. The contribution of surface runoff increased and flows became more unstable on the lower mainstem, which drained an area of glacial, lake bed soils having low infiltration.…
>
> … The upper and middle mainstem, being warmed by lakes and cooled by groundwater, contained a coolwater fish fauna which required clear waters and coarse substrates. This includes fishes such as smallmouth bass and other centrarchids, darters *Etheostoma spp.*, suckers, and minnows. The fish fauna of Paint and Stony creeks consisted of fishes such as sculpins *Cottus spp.*, dace, and chubs which require similar habitat conditions, but cold water. By the 1880s, these creeks supported brook trout *Salvelinus fontinalis* populations, which originated from hatchery plants (Westerman 1974).
>
> The lower mainstem (especially below Utica), the North Branch, and Red Run provided different conditions for fish. With their flows being dominated by runoff, these streams were warmer, had lower flow in the summer, and were more prone to flooding than other reaches. Fine substrates (silt and sand) were more common due to the extremely low gradient of these streams, and riparian wetlands were also abundant. These reaches supported pikes, smallmouth bass, largemouth bass, other sunfishes, suckers, and minnows.…
>
> … The letters of Father Pierre Dejean (1825–26) mention that in the Clinton River, one fishes for "sturgeon, trout, carp [likely suckers], and pike-this last fish is dull and tasteless" (Dejean 1986). Most mentions of fish in the historical literature were of a general nature such as, "[the streams are] well stored with fish (Anonymous 1831b) or we "caught a mess of fish" (Zeisberger 1885).

Factors Affecting Fish Communities

The Clinton River watershed has gone through tremendous change following European settlement. Human activities influenced landscape, channel characteristics, hydrology, water quality, and biological communities of the river. Following is a discussion of some activities that have changed the nature of the river.

Settlement in the watershed brought about a need for small dams to power mills. Most mills were found in the Middle Segment and on Paint and Stony creeks where gradients were highest. 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 for altering the fish biodiversity. Although, it is encouraging that dam removals have been shown to reverse this process (Kanehl et al. 1997; Bednarek 2001).

A contributing factor to stream quality is land use. Conversion of undisturbed lands to agricultural or urban land use has resulted in a loss of fish biotic integrity (Wang et al. 2001). 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. Urban land uses expand the area of impermeable land surface, which further intensifies runoff and changes in flow regimes, which in turn may result in major changes in stream morphology and flow extremes (Wang et al. 2000). Urbanization occurs when previously forested land is replaced by impervious surfaces such as rooftops and roads, and less permeable surfaces such as compacted lawns and parks. Increased imperviousness results in larger and more frequent floods, greater total surface runoff, and decreased time to produce runoff. Changes in flow due to urbanization result in channel erosion. Impervious surfaces also reduce amount of groundwater recharge by preventing infiltration. Removal of riparian vegetation is an important consequence of urbanization. Maintenance of a buffer strip helps mitigate effects of urbanization with trees that provide shade for a river to regulate stream temperature and vegetated banks that prevent channel erosion and widening (Finkenbine et al. 2000). 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).

Prior to the passage of the Clean Water Act in 1972, many rivers were seen as a dump for industrial and municipal waste, and the Clinton River was not spared from this mentality. Many aquatic organisms, such as fishes, mussels, and invertebrates, were negatively affected by pollution. 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. Although changes in laws now regulate discharges, many pollutants are extremely persistent in the environment and their effects are long term.

Present Fish Community

Based on fish sampling by MDNR, Fisheries Division (mostly from 1970 to present), MDEQ Water Division (MDEQ 1995; MDEQ 1992a; MDEQ 1992b, K. Goodwin, unpublished data), and University of Michigan Museum of Zoology records, the Clinton River basin contains 100 species of fish (Table 15). Most species are native, although 4 species have colonized and 16 were introduced (some intentional and others accidental). Four introduced species (coho and kokanee salmon, cutthroat trout, and lake whitefish) are no longer present because their stocking programs have stopped. Nine species have been identified as status unknown because they were found historically, but have not been sampled recently. Several species can be found throughout the entire watershed, but some can only be found in isolated areas as shown on the distribution maps of each species (Appendix 1).

During 2001 and 2002, the fish community was sampled at 38 sites throughout the watershed by MDNR, Fisheries Division (Figure 60). Fish were collected using electrofishing equipment during July and August. The specific type of gear used and the length of the station sampled were determined by the width of the river. River reaches that ranged in average width 4–17 ft were surveyed with a backpack electrofishing unit and station lengths ranged from 500 to 800 ft long. Intermediate river reaches that averaged 18–50 ft wide were sampled using a floating barge electrofishing unit, with stations ranging from 800 to 1,200 ft long. River reaches that averaged 50–150 ft wide were sampled using an electrofishing boat, over station lengths from 1,400 to 1,900 ft long.

A qualitative biological protocol for wadable streams was developed by the Great Lakes and Environmental Assessment Section (GLEAS) of the MDEQ, called Procedure 51 (MDEQ 2002c), and was used to evaluate fish collection data. The protocol evaluates 10 measurements of a fish community to evaluate its health. Better stream quality is normally indicated by greater fish diversity and abundance, as well as a more even distribution of individuals among taxa at one station compared with another. Conversely, poorer stream quality is indicated by a lower diversity and abundance at one station when compared to another (MDEQ 2002c).

Sixty-one species were caught during these sampling efforts (Table 15). The sampling sites were throughout the watershed and encompassed a variety of habitat. White suckers, creek chubs, bluegills, green sunfish, largemouth bass, and johnny darters were some of the most frequently seen fish among sites. The fish community has been characterized more extensively within the following valley segments below.

Headwaters

In this segment, the river is small (average 14.2 ft wide), has good gradient, cool water temperatures, and stable flows. In 2001, fish collection from one site found 14 species of fish, with rainbow darter, fantail darter, largemouth bass, and grass pickerel being the most common (Figure 60, site 1; Table 16). Darter species made up 35 percent of the total catch by number. The abundance of darters indicates that habitat quality is good. The fish community was rated excellent (not-impaired) using Procedure 51. This is the only site where blackchin shiners were found. These shiners require clear, clean, weedy waters for survival. Their range has been dramatically reduced, including being eliminated in Ohio and Iowa, presumably due to changes in water quality and habitat loss (Becker 1983; Scott and Crossman 1973). Both presence of blackchin shiners and abundance of darters are indicators that there is good water quality and habitat in the Headwaters Segment. Prior sampling is very limited (one sample in 1972), so it is not possible to make comparisons across time.

Upper

The Upper Segment has low gradient, warm water, and fairly stable natural flow. There are numerous impoundments and in-line lakes in this stretch including Middle Lake, Parke Lake, Bridge Lake, Deer Lake, Middle Lake, Dollar Lake, Greens Lake, Maceday Lake, Lotus Lake, Lester Lake, Van Norman Lake, Townsend Lake, Woodhull Lake, Eagle Lake, Lake Oakland, Lake Angelus, Mohawk Lake, Wormer Lake, Schoolhouse Lake, Loon Lake, Silver Lake, Upper Silver Lake, Cass Lake, Otter Lake, Sylvan Lake, Dawsons Mill Pond, and Crystal Lake. Especially in the upper portion of this segment, the river merely acts as a connector between lakes and is heavily influenced by these lakes. Several lakes have established lake levels and the river is manipulated to maintain levels; typically lake levels are raised in spring and lowered in fall. These manipulations have altered the natural flow of the river. The lower portion of this segment is a designated drain and is enclosed under the city of Pontiac. Substrate is variable throughout this segment; some areas have gravel and cobble present and others are mainly sand and silt. Aquatic vegetation is abundant and there is fair instream cover throughout this reach. There is good pool and run habitat, but riffles are more interspersed (Synnestvedt 1998). Sashabaw Creek is the main tributary.

In 2001, two sites were sampled on the Clinton mainstem (Figure 60, sites 2 and 3). There was good species richness, with the fish community dominated by coolwater species such as creek chubs, bluegill, largemouth bass, and yellow perch (Table 17). Abundance of bass, sunfishes, and perch is due to the large number of connected lakes interspersed throughout this reach. Banded killifish were caught at both sites, but were not caught at any of the other 36 sampling locations. This species prefers the shoal area and estuaries of large lakes and the quiet backwaters of slow current in medium- to large-sized streams (Becker 1983). This species was found here because of the large number of lakes. GLEAS Procedure 51 rated the downstream site as excellent and the upstream site as acceptable.

Fish populations were sampled at several sites in the Upper Segment throughout the 1970s and early 1980s. Survey results were very similar to those found in 2001. A species that consistently shows up, but is not found very often in other locations in the watershed is the longear sunfish. Longear sunfish usually inhabit streams of clear, shallow, nearly still, and moderately warm water, in or near areas of aquatic vegetation (Becker 1983). This habitat is consistent with that found throughout the Upper Segment. Their range in the watershed is likely restricted to this area because this species is intolerant of turbid conditions.

No river chubs were caught in the most recent survey, although this species was an uncommon catch even during earlier surveys. Some juvenile river chubs were caught at a site sampled in 1935, but it is the only record of river chubs caught in this segment. Other locations in the watershed where river chubs have been caught include Stony Creek and East Pond Creek, but they were last captured in 1978. River chubs frequent large gravel-bottomed or rocky rivers, rather than creeks, but require clean, clear water (Scott and Crossman 1973). This species has suffered a reduction in distribution throughout its range due to degradation of water quality.

An uncommon specimen that was caught in 1980 is that of a single brook silverside. This is the only record of a brook silverside caught in a river environment in the Clinton River watershed. However, this species is common in many lakes in the watershed. In addition to being found in predominantly lake environments, another factor which may have contributed to the lack of silversides caught is that they are not effectively sampled with electrofishing equipment.

In addition to the coolwater species sampled, salmon and trout were occasionally caught during prior surveys. These fish were present because of MDNR fish stocking programs to provide a trout fishery in either the Clinton River or Cass Lake (see **Fishery Management**). These fish were gone from the system shortly after the stocking programs ceased.

Sashabaw Creek was sampled in 2001 and sunfishes (76%) dominated the catch (Figure 60, site 4; Table 17). The site sampled in 2001 is the only site where lake chubsuckers were caught in the watershed. Lake chubsuckers have disappeared or decreased over much of their range. They are extirpated in Iowa and decreased in Illinois, Missouri, and Ohio (Becker 1983). The reason for the decline in this species in not clear, because they are tolerant of environmental stresses and can tolerate low oxygen thresholds. However, this species is seldom abundant and it is often disjunct in its distribution. GLEAS Procedure 51 rated the fish community at this site as acceptable. This same location was sampled by DEQ in 1999 with the same results we found in 2001. The bottom substrate in the creek is predominantly silt.

Fisheries survey data are not available on all the lakes that are on the Clinton River, because Fisheries Division manages only lakes that have public access. In general, lakes in the watershed have good coolwater fish communities dominated by bluegill, pumpkinseed, rock bass, and largemouth bass, although the quality of these fisheries may vary from lake to lake. Other game species that may be present, but their populations can vary more among lakes, include northern pike, yellow perch, and smallmouth bass. Walleye are managed in a number of lakes through stocking programs because successful walleye spawning occurs in a very limited number of inland lakes. Maceday Lake and Cass Lake both have good populations of cisco, and on Maceday Lake there is an ongoing stocking program for trout (rainbow trout and splake).

Middle

The gradient increases on this segment compared to the previous segment and is considered very good. Groundwater influence, as well as the inflow of Galloway and Paint creeks, which are cool to cold water streams, maintains cooler water temperatures. However, the temperature gradually warms as it progresses from the upper part of this segment to its lower portion. There is good substrate throughout, including gravel and cobble.

Three sites were sampled on the mainstem in this segment (Figure 60, sites 5, 6, and 7) and the number of species caught at each site ranged from 14 to 21 (Table 18). White suckers and northern hog suckers were predominant, accounting for 70% of the total catch by number. GLEAS Procedure 51 ranked the two upper sites as acceptable and the lower site as excellent. These sites had good species richness, although a low proportion of the catch was made up of species intolerant to pollution (Table 19). At the three sites, the number of intolerant taxa present ranged from 4 to 6, but there were very few numbers of these fishes present (except northern hog suckers at the lowest site).

During 2001 and 2002, mottled sculpin were caught at two of three sites, but only one other site in the watershed (Paint Creek). This species is most commonly found in cold headwater streams and large lakes. This is not consistent with the type of habitat where this species was found on the mainstem in this segment, and it is likely these fish originated from Paint Creek where they were very abundant (mottled sculpin accounted for almost half of the catch in Paint Creek).

It can be difficult to draw comparisons among survey sites over time, due to differences in sampling protocol or sampling location. For example, earlier sampling effort consisted of electrofishing a 300–600-ft section of the stream, whereas current protocol recommends sampling 800–1,200-ft sections. These differences in stream length sampled can affect the catch of less common species, because sampling larger sections increases the probability that less common species will be collected.

Even given these constraints, there have been enough data collected to note clear changes in the fish community in the past three decades. In 1973, 12 stations were sampled along this segment. Overall, catch rates were low and only three sites had species that are considered pollution intolerant. Catch rates improved from 14.1 fish/100 ft sampled in 1973 to 58.5 fish/100 ft sampled in 2001 and 2002. Not only are more fish present in recent samples, but species richness has also improved. Pollution intolerant species were not found commonly until the late 1980s. These results are not surprising given the history of pollution problems on the Clinton River downstream of Pontiac.

Galloway Creek was sampled in 2001 between Galloway Lake and the confluence with the Clinton River (Figure 60, site 8). Creek chubs and white suckers were the predominant species, but both rainbow trout and brown trout were caught (Table 18). Most of the creek above Galloway Lake is a designated county drain and portions have been ditched. The fish community was sampled in 1986 and was composed of pollution tolerant species, with no intolerant species captured.

Sargent Creek, a tributary to Paint Creek, was sampled in 2001 (Figure 60, site 9). The creek is small; averaging 8 ft wide and ½ ft deep. The substrate was made up of 50% cobble, 35% rock, and 15% silt. Almost 90% of the catch was creek chubs and blacknose dace (Table 18). The other four species that were caught all had generalist type habitat requirements and there were no pollution intolerant species caught. Based on the generalist type species caught and lack of sensitive species, there are habitat and water quality deficiencies in this creek. Sargent Creek scored a “poor” rating using Procedure 51. There is not previous fish survey data available to evaluate changes in the fish community over time.

Paint Creek below Lake Orion to the confluence with the Clinton River is a cold water tributary that is a designated trout stream. Sampling by MDNR in 2001 found mottled sculpins, creek chubs, white suckers, and brown trout as the predominant species (Figure 60, site 10; Table 18). Brown trout reproduce in Paint Creek, but are supplemented with an annual stocking by MDNR, Fisheries Division. From 1997 to 2000, the total brown trout population estimate in Paint Creek ranged from 80 to 180 trout/acre or 170 to 393 trout/mile (Braunscheidel 2002). In 1992, Thomas (1993) calculated a population estimate of 5–68 legal-sized (8 inches and larger) brown trout per mile. Juvenile rainbow trout were also caught in Paint Creek and are the result of natural reproduction from steelhead that migrate up the Clinton River from Lake St. Clair to spawn in Paint Creek.

The West Branch of Stony Creek outlets into Stony Creek Impoundment and was sampled at two locations in 2001 (Figure 60, sites 11 and 12). This is a small stream (average 9 ft wide) with good gravel and cobble bottom throughout. Species richness was good, ranging from 12 to 19 species between the two sites, with creek chubs, white sucker, rainbow darter, and common shiner the most common species present (Table 18). Some sensitive species were present at each location, but their abundance was low. Over 70% of the total catch was composed of species that are considered pollution tolerant. Both sites fell into the acceptable category under Procedure 51.

McClure Drain is also a small (average 10 ft wide) tributary to Stony Creek Impoundment. It also has good substrate; predominately gravel and cobble. Creek chubs were the most common species present (66% of catch), followed by greenside darter, johnny darter, and fantail darters during a 2001 survey (Figure 60, site 13; Table 18). McClure Drain is in close proximity to the West Branch of Stony Creek and is similar sized. However, the species richness and number of pollution intolerant taxa were lower and the percent of the total catch that is pollution tolerant was higher. Therefore, this site also scored lower on Procedure 51 ranking (acceptable–poor).

Stony Creek originates from Lakeville Lake and is impounded at the lower end to form Stony Creek Impoundment. Stony Creek is a good quality stream that was managed for trout 1982–91. Sampling did not take place in the 2001–02 survey, but occurred most recently in the late 1980s. Pumpkinseed sunfish, common shiners, hornyhead chubs, and creek chubs were found to be the most common species. However, a variety of species indicative of high water quality including American brook lamprey, northern brook lamprey, and rainbow darters were present.

Lower

The river increases in size, the gradient decreases, and the water temperatures increase in the Lower Segment. Two significant tributaries, Red Run Drain and North Branch Clinton River enter the mainstem. Due to clay soils in this area, the river is more turbid.

Three sites were sampled on the Lower Segment in 2002 (Figure 60, sites 14, 15, and 16). Round gobies were the most abundant species present, followed by northern hog sucker, white sucker, rock bass, and bluntnose minnows (Table 20). Although round gobies were the most abundant species present, they only recently colonized the Clinton River. They are an exotic species that was unintentionally introduced via ballast water from trans-oceanic vessels. They were first discovered in the late 1980s in Lake St. Clair and they quickly colonized available habitat.

Nine sites were sampled by MDNR in 1973. Similar to the Middle Segment, the total number of fish sampled, the species richness, and the number of pollution intolerant species were dramatically different than that found in 2002. The three sites sampled in 2002 ranged in length from 1,200 to 1,425 ft and species richness ranged from 9 to 19 species, with pollution intolerant species ranging from 2 to 3 per site. Total catch ranged from 50 to 706 fish per site. Contrast this to 1973 when station lengths were much longer, ranging from 1,300 to 5,200 ft. Although the station lengths were much longer, the total catch was lower per site (0 to 32 fish). Additionally, the catch was made up of very few species (0–4 per site), mostly those that can survive in a degraded environment, such as carp, suckers, and shad. These results further suggest that water quality has significantly improved over the past three decades.

Red Run Drain enters the Clinton River on the Lower Segment. It has a history of poor water quality because of discharges and problems with CSO events. The fish community was sampled at two locations in 2001 (Figure 60, sites 17 and 18). White suckers, common carp, rock bass, and fathead minnows were the predominant species present (Table 20). GLEAS Procedure 51 ranked the sites from poor to acceptable. Previous sampling to allow comparisons is not available, but anecdotal evidence indicates that water quality was very poor in the past.

Plum Brook, Gibson Drain, and Big Beaver Creek, tributaries to Red Run Drain, were all sampled in 2001. The fish community in Plum Brook was dominated by white sucker, creek chub, fathead minnow, and bluntnose minnows (Figure 60, sites 19 and 20; Table 20) and the fish community in Gibson Drain was dominated by johnny darter, blacknose dace, white sucker, and creek chubs (Figure 60, site 21; Table 20). Both communities were dominated by species tolerant of pollution. Big Beaver Creek was not adequately sampled because of the amount of refuse and debris in the creek (Figure 60, site 22). However, the low abundance of fish and the species that were caught indicated a degraded fish community (Table 20). Both Plum Brook sites scored acceptable ratings using the GLEAS Procedure 51, but Gibson Drain was ranked as poor. These fish communities are affected by the urban areas that drain into these rivers.

The Middle Branch of the Clinton River varies from a good quality stream at the upper end, to a degraded drain at the lower end. The fish community was sampled at three sites in 2001 (Figure 60, sites 23, 24, and 25). Overall, the fish community was dominated by white suckers and creek chubs, but species richness was good in the upper portion of the river (Table 20). The middle site had the greatest number of species present (24 species) compared with all 37 other sites sampled in the watershed. The two upstream sites received acceptable scores based on GLEAS Procedure 51, but the lower site scored poor.

Blackside darters were found at the most upstream site on the Middle Branch. This species was found at only one other site within the watershed during the most recent sampling. The blackside darter generally inhabits marginal cold to warm water rivers in clear to slightly turbid water. Presence of this species confirms good water quality and habitat in the upstream reach of the Middle Branch.

Coon Creek is a warm water creek that drains an area that has mainly agricultural land use. The creek has highly variable flow with low base flow and high peak flows. The bottom consists primarily of silt, with little rock or gravel. The fish community is dominated by creek chubs, johnny darters, white sucker, and brook stickleback (Table 20; Figure 60, sites 26, 27, and 28). Two of the three sites scored an acceptable rating based on GLEAS Procedure 51, and the third rated poor. There is no historical data to compare with these results.

Coon Creek was the second site where blackside darters were sampled. Another uncommon catch in Coon Creek was brassy minnow. This is the only location in the watershed that this species was caught. The brassy minnow occurs in small- to medium-sized streams of moderate to slow current. Scott and Crossman (1973) noted that wherever this species occurred in numbers, predatory fish were absent. This is consistent with our findings; no predatory fish were found at the three stations where brassy minnows were found.

East Branch of Coon Creek is a small stream that also drains a mainly agricultural area. The creek is very similar to Coon Creek, having variable flows, warm water, and poor substrate. Johnny darter, common shiner, white sucker, bluntnose minnow, and creek chubs were the most prevalent species (Table 20; Figure 60, sites 29 and 30).

The North Branch Clinton River is a cool water stream, but the headwaters are classified as cold water. Most of the catch was composed of common shiner, creek chub, gizzard shad, and central stonerollers. The most upstream site scored an excellent rating based on GLEAS Procedure 51, and the scores decreased as sampling proceeded downriver (Figure 60, sites 31, 32, and 33). The middle site had the second highest level of species richness (22 species) of all sites sampled in the watershed, and also the greatest number of pollution intolerant species (7 species). These results confirm the high quality of water and habitat in the North Branch, particularly the upper to middle section.

Apel Drain is a small designated drain in northern Macomb County that is a tributary to the North Branch of the Clinton River. This stream drains an agricultural area and has been heavily channelized. Many areas of the drain are heavily silted. Creek chubs, blacknose dace, rainbow darter, common shiner, and white suckers were the most common species (Table 20; Figure 60, site 34). Given its location in the watershed, it is likely that this stream once supported a coldwater fish community.

Kidder Creek is a small tributary to the North Branch of the Clinton River. In 2002, the species present, including brook trout, brown trout, brook stickleback, and blacknose dace, indicate a good cold water stream (Table 20; Figure 60, site 35). Given the proximity and similarities to Apel Drain, it is likely that this is more characteristic of what the fish community looked like in Apel Drain before it was channelized.

Mouth

This segment has very low gradient and mostly a silt and sand substrate. The flow is typically slow and the water is turbid. In 2002, the fish community was dominated by common carp, gizzard shad, largemouth bass, and golden shiner (Table 21; Figure 60, site 36 and 37).

Five sites were sampled in this segment in 1973. At that time, carp were even a bigger component of the fish community (85–95% of the total catch by number). In addition, there were fewer species caught in 1973 (3–6 species) compared to 2002 (10–14 species). This is consistent with what was observed on the mainstem in the Middle Segment and Upper Segment and again further supports that water quality in the lower Clinton River has improved over the past 30 years.

The Clinton River Cut-off channel is a human-made water diversion canal that is operated to control flooding. There is a weir at the top of the canal and the height is mechanically controlled. The weir is operated so that most water flow goes down the Clinton River, except during flood events. During the remainder of the year, little flow goes down the canal and it somewhat stagnates, although it does get some circulation with Lake St. Clair. In 2002 the fish community was dominated by common carp, gizzard shad, largemouth bass, golden shiner, and goldfish (Table 21; Figure 60, site 38). There was a high number of species caught at this site (19 species). Part of this is attributable to the proximity to Lake St. Clair. Due to the lack of flow except during large rain events, this channel acts more like an extension of Lake St. Clair than a part of the Clinton River.

Invertebrates

The invertebrate community of a site can provide an even more direct indication of water quality problems because of its immobility relative to fish. The 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. Other species, like most mayfly, caddisfly, and stonefly species are only found in streams with good water quality. There have been a number of biological surveys in the Clinton River watershed that have evaluated the invertebrate community. The most comprehensive survey was conducted in 1973, when 35 sites were sampled throughout the watershed (Michigan Water Resources Commission 1973). More recent survey data is available and will be cited where applicable, but these surveys investigated only specific tributaries or sections of the watershed.

Headwaters

Invertebrate sampling in the Headwaters Segment has been limited. A single site was sampled in 1973 and found good species diversity, with almost half of the species caddisfly and mayfly, representatives of good water quality. This is the only station where a very pollution intolerant stonefly species *Acroneuria arida* was found. These results indicate very good water quality existed in this segment in 1973 (Grant 1973a; MDNR 1988).

This segment was sampled most recently in 1999. Mayflies and caddisflies decreased in abundance, and midges and damselflies became the most dominant taxa (K. Goodwin, unpublished data). These results indicate that water quality has declined since it was last sampled in 1973.

Upper

A total of 14 sites were sampled in the Upper Segment at various intervals from 1972 to 1982. The upper half of this segment had macroinvertebrate communities dominated by mayflies and scuds, with moderately abundant numbers of caddisfly, indicative of good water quality. From about the midpoint to Pontiac, the invertebrate communities were dominated by scuds, although mayflies and caddisflies were still present in reduced numbers. This suggests a moderate affect on water quality; however, downstream from Pontiac, the stream quality was severely degraded. Oligochaetes, leeches, and midges dominated the invertebrate community, with no mayflies, caddisflies, or scuds present (MDNR 1988).

The upper portion of this segment was sampled at one site in 1999 and found that the community was dominated by midges, scuds, and caddisflies (K. Goodwin, unpublished data). Overall, there was a decline in abundance of both caddisflies and mayflies, indicating that water quality has declined since it was last sampled.

Middle

A total of 16 sites were sampled at various intervals from 1972 to 1982. In 1972 and 1973, the upper portion was still heavily influenced by the Pontiac wastewater treatment plant and had a severely degraded community. Moving further downstream, the invertebrate community showed signs of recovery. Before entering Rochester, there were 15 taxa, with midges, hydrosychid caddisflies, and snails indicating improvements in water quality. However, immediately below the Rochester wastewater treatment plant, degraded benthic macroinvertebrate species were present. From Yates Dam downstream, the community again improved. Species diversity improved to 10–16 taxa per station, with 1–2 of these being caddisfly or mayfly families. These taxa accounted for 14–80 percent of the total number of individuals (MDNR 1988).

Sampling in 1982 found improvements in the macroinvertebrate communities at most stations. In the upper portion, there was an increase in mayflies and caddisflies and greater species diversity, indicating improvements in water quality. The portion above Rochester was mayfly/caddisfly dominated and had 16 taxa, indicating a recovering community. The area below the Rochester wastewater treatment plant was dominated by midges, blackflies, and mayflies, indicating that the Rochester wastewater treatment plant continued to affect the invertebrate community. The area downstream of Yates Dam was dominated by mayflies, caddisflies, and blackflies, with occasional stoneflies indicating an improved condition downstream of Rochester. The most recent samplings in 1994 and 1999 found patterns in the invertebrate communities similar to the 1982 survey (MDNR 1995; K Goodwin, unpublished data).

Paint Creek, a tributary to the Clinton River, had a varied invertebrate population. Immediately downstream of the spillway from Lake Orion, benthic sampling was dominated by flatworms, scuds, heptageniid mayflies, hydrosychid caddisflies, and damselflies in 1984 (Kenaga and Crum 1987), and was basically unchanged since 1973 (Lauer and Grant 1973). However, a short distance downstream, the invertebrate population in 1984 was dominated by snails, scuds, crayfish, mayflies, caddisflies, and blackflies. These species indicate a definite improvement in stream quality since 1973 (Kenaga and Crum 1987). Two more sites were sampled further downstream in 1984 and found good diversity, with 20 to 23 taxa represented. The dominant forms were crayfish, scuds, and mayflies. This indicates a significant improvement in stream quality since 1973 due to a shift to more intolerant species and increased diversity (Kenaga and Crum 1987).

Sampling was conducted in 1991 at five sites between the Lake Orion dam and the confluence with the Clinton River (Jones 1992). The invertebrate community ranked lowest (moderately impaired) at the Lake Orion dam, increased at the three middle sites (slightly impaired), and decreased above the confluence with the Clinton River (moderately impaired). Mayflies and caddisflies were the most abundant species at the middle three sites, whereas scuds and sowbugs were the most common at the upper and lower sites. In 1999, three sites were sampled on Paint Creek. There was an increase in the abundance of blackflies and a decrease in the number of taxa of both mayflies and caddisflies at the middle stations. The site at the confluence with the Clinton River was unchanged from that seen in 1991 (K. Goodwin, unpublished data).

Trout Creek, a tributary to Paint Creek, was sampled in 1984. In its headwaters area, it was dominated by snails, clams, dragonflies, and surface dependent beetles, and slightly downstream, it was dominated by snails, scuds, and crayfish (Kenaga 1984). There was relatively good diversity with 8–10 taxa per station. These results indicate moderate stream quality.

Lower

On the mainstem above Red Run Drain, sampling in 1973 found that all stations, but one, had high productivity with good diversity, indicating increased stability in the macroinvertebrate community compared to the Middle Segment. Mayflies and caddisflies represented 14–80 percent of the total number of individuals collected (Grant 1973a). Samples in 1979 found mostly hydrosychid caddisflies, scuds, and midges with the number of taxa ranging between 9 and 13. Snails, clams, and damselflies were also present, indicating a stressed, moderate quality stream, but presence of perlid stoneflies suggested improved water quality from 1973 (MDNR 1988). Limited sampling in 1999 (one site) found a decrease in number of caddisflies, and a community dominated by midges and scuds, indicating that stream quality may have declined (K. Goodwin, unpublished data).

From Red Run Drain to the confluence with the North Branch, the macroinvertebrate community, while improved compared to earlier surveys, still rated poor in 1982. In 1973, all species were classified as facultative or pollution tolerant; mostly midges and oligochaetes. There were a few hydrosychid caddisflies and a sparse number of baetid mayflies (Grant 1973a). In 1979, the number of taxa increased and shifted to slightly more facultative rather than tolerant organisms, with one pollution intolerant mayfly present. Hydrosychid mayflies increased significantly, but midges were still dominant. In 1982, the benthic macroinvertebrate community was similar to that found in 1979 (MDNR 1988). Overall, stream quality was relatively poor.

In 1973, the benthic macroinvertebrate community in the North Branch, upstream of Almont, was dominated by caddisflies and mayflies, with 7–16% of the taxa intolerant to pollution. Downstream of the Almont wastewater treatment plant, the number of taxa sharply declined and mayflies and caddisflies were replaced by scuds and midges. Stream quality improved further downstream. At the confluence with East Pond Creek, a high quality benthic community was found with 22% of taxa intolerant to pollution. Further downstream, there was a slight decrease in stream quality near the confluence with the Clinton River mainstem. The number of taxa was slightly lower than upstream and facultative organisms were dominant (Grant 1973b).

The benthic macroinvertebrate community was sampled at five locations in East Pond Creek in 1984. The majority of the benthic community was relatively high quality; however, there did appear to be a negative affect from the Romeo wastewater treatment plant. Downstream from the plant there was an increase in leeches, aquatic worms, and midges and a decrease in the number of mayflies and caddisflies (Kenaga and Crum 1988).

Mouth

Sampling in the Mouth Segment in 1973 found a benthic macroinvertebrate community that had low species diversity (1 to 6 taxa per station) and all organisms were either facultative or pollution tolerant, dominated by oligochaetes and midges (Grant 1973a). In 1983, eight stations were sampled and the number of taxa ranged from 1 to 3 (MDNR 1988). All organisms were either facultative or pollution tolerant. Results in 1983 indicate that water quality did not improve since it was sampled in 1973.

Mussels

The earliest records of mussel collections in the Clinton River consist of a series of unpublished collections housed in the University of Michigan, Museum of Zoology. These include scattered collections from 1870 to 1925, as well as a rather thorough collection of 31 species from 11 sites in 1933. In 1977 and 1978, Strayer (1980) did a comprehensive survey of mussels in the Clinton River system and found 26 species. This is the second highest level of species diversity found in the Great Lakes drainage. However, he reported that five species (purple wartyback, round hickorynut, black sandshell, eastern pondmussel, and northern riffleshell) that were collected in earlier sampling, were likely extinct from the Clinton system. These five species were most abundant in the lower mainstem and were probably eliminated due to pollution after 1933 (Strayer 1980). The wavy-rayed lampmussel is threatened, the snuffbox, purple lilliput, and rayed bean are endangered, and the elktoe, slippershell mussel, round pigtoe, and rainbow are listed as species of special concern.

Although there was good diversity in the watershed, species distribution was not consistent throughout. Based on Strayer's (1980) work in 1977 and 1978, the Clinton River above Pontiac supported 14 species, including 4 on the state list. A small population of purple lilliput is the only known location of this species in the state, however recent surveys indicate its density is declining due to the proximity of a lake-level control structure. The upper Clinton River also supports what is likely the only population of rayed bean living in Michigan's streams (Strayer 1980). The Clinton River mainstem below Pontiac was extremely degraded. Six stations were sampled and there was no evidence of live mussels. It once supported at least 26 species, including 5 on the state list (Strayer 1980). Mussel populations in Paint Creek were largely destroyed since surveys in 1933. Only four species were found remaining in tributaries and in Paint Creek (Strayer 1980). A healthy mussel community was found in Stony Creek. Although only 10 species were found, population densities were quite high (3 adults/ m^2) (Strayer 1980). The North Branch and its tributaries contained a very diverse mussel fauna (22 species) and densities were high (>1 adult/m^2) in several locations. Only one listed species (wavy-rayed lampmussel) was found in the North Branch. Strayer concluded that many species found in the Clinton River have been extirpated from their range in eastern Michigan, and the North Branch, as of 1978, contained the finest remaining example of a large river mussel fauna in eastern Michigan (Strayer 1980).

More recent sampling for mussels has occurred in the upper Clinton River mainstem, above Pontiac, in the mid-1990s (Hunter et al. 1994, Hunter et al. 1996, Hunter et al. 1997). Hunter et al. (1994) found that species present were very similar to those found by Strayer in 1977 and 1978, although relative abundance varied. In addition, two exotic species, the Asian clam and zebra mussel, were both found in this most recent survey. These species are thought to have colonized the watershed in the early 1990s. Zebra mussels are a threat to native unionids, because they attach to native mussels and disrupt feeding, locomotion, and reproduction causing death in 2–3 years. Zebra mussels have been implicated in the severe decline in diversity and abundance of mussel populations in inland lakes and the Great Lakes.

On the Clinton River, zebra mussels are present as far upstream as Loon Lake (Hunter et al. 1994). However, densities are far less in the upper Clinton River than in the connected lakes. Thus, Hunter suggested that at most river sites, zebra mussel loads on mussels posed no immediate threat to the health and survival of unionids (Hunter et al. 1998), although long-term predictions are still unclear.

A more recent (2004) survey duplicating Strayer's sites and methods indicated that overall species richness had declined further, from 26 in 1978 to 14 in 2004 and this had occurred in all seven major tributaries of the river (R. D. Hunter, Department of Biological Sciences, Oakland University, personal communication; Morowski 2004). All regions also declined in mussel density ranging from 63% lower than in 1978 in the North Branch, to 100% lower in the Middle Branch. According to the investigators, this recent decline is likely due to extremes in flow instability. Flashiness results in bottom scouring and mussel displacement during high water events as well as flow stoppage during low water periods. The latter is especially severe below lake-level control structures. The most crucial location is at Dawson's Mill Pond outlet where the unique population of the endangered purple lilliput is especially imperiled due to frequent shutoff of all flow during drought periods (Sweet 2002). Unfortunately, growth in human population and development of the watershed will likely continue to promote flashy hydrodynamics that are detrimental to the freshwater mussel community.

Amphibians and Reptiles

Amphibians and reptiles are an important part of the fauna in the Clinton 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, one lizard, fifteen species of snakes, seven species of salamanders, and ten species of frogs and toads are known to occur in the watershed (Table 22). 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 Clinton 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).

Degradation, fragmentation, and destruction of natural habitats due to human activities are undoubtedly the greatest threat to amphibian and reptile populations. Large areas have been converted to agriculture, while urban and suburban development continues to consume more habitat. Draining and filling of wetlands has obvious deleterious implications for many species. Terrestrial and wetland habitats that are still available may be degraded by air and water pollution or bisected by roadways (Harding 1997). In addition, the widespread use of chemical pesticides is undoubtedly detrimental to insect eating species (Harding and Holman 1990).

Birds

The most comprehensive survey of breeding birds in Michigan took place 1983–88 (Brewer et al. 1991). A total of 121 species of birds have been identified to breed in the Clinton River watershed (Table 23). In addition, there are a number of species that do not breed, but seasonally may be found in the watershed as they migrate. Henslow's Sparrow, Red-shouldered Hawk, and Least Bittern are considered threatened. Cooper's Hawk, Grasshopper Sparrow, American Bittern, Black Tern, Northern Harrier, Marsh Wren, Cerulean Warbler, Prothonotary Warbler, Dickcissel, Western Meadowlark, and Hooded Warbler are listed as species of concern.

Mammals

Much of the Clinton 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 in the watershed. Burt (1957) lists 42 species of mammals that have a range in the watershed (Table 24). The least shrew is listed as threatened and the Indiana bat is 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/or 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, relict confer swamps, coastal plain marshes, and Great Lakes marshes.

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 Clinton River watershed and the effects they have on the aquatic community.

Sea lamprey are an invading species that entered the lower Great Lakes in the late 1800s and early 1900s. Sea lamprey 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 lamprey spawn in Great Lakes tributaries, including the Clinton River. The sea lamprey larvae are blind and toothless and live as filter feeders in burrows they construct in soft sediments. Sea lamprey live in the tributaries for several years before metamorphosing into free-swimming juveniles. They migrate to the Great Lakes and spend 12–20 months as predators, before becoming sexually mature and repeat the life cycle. Sea lamprey have been found in the Clinton River, but at low levels. Yates Dam is a barrier to sea lamprey migration.

Another colonized fish species in the Clinton River is the round goby. Round gobies entered Lake St. Clair in the late 1980s via ballast water discharge from trans-oceanic vessels. The most recent fisheries surveys (in 2001) found that round gobies were very abundant in the lower Clinton River, but Yates Dam provides a barrier for migration further upstream. Round gobies effect on the fish community is unknown at this point. They have displaced native fish species in Lake St. Clair, but are also preferred prey for game fishes such as smallmouth bass and yellow perch.

Zebra mussels are well established in the Clinton River and many lakes in the watershed. 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. Zebra mussels also kill native mussel species by attaching to their shells, causing suffocation and starvation. Increased water clarity and macrophyte densities often occur in the presence of high densities of zebra mussels.

Another exotic species of concern is the rusty crayfish. Their presence has been confirmed in the Clinton River watershed, but their distribution and abundance is unknown. Rusty crayfish can cause a variety of negative environmental effects when introduced to new waters. They are very aggressive and often displace native crayfish species. They are also responsible for destroying aquatic plant beds by reducing aquatic plant abundance and species diversity. It is also possible that rusty crayfish can harm fish populations by eating fish eggs.

There are four common exotic plant species that are a nuisance in the Clinton River watershed: Eurasian milfoil, curly leaf pondweed, purple loosestrife, and Phragmites. Eurasian milfoil and pondweed are both submergent aquatic plants that are widespread. These species can grow in very dense stands that out compete native macrophyte species, interfere with aquatic recreation, and reduce habitat for aquatic organisms. Control methods include chemical treatment, mechanical harvesting, or biological control of Eurasian milfoil with a species of aquatic weevil. Purple loosestrife is an exotic species that lives in wetland environments. Both purple loosestrife and Phragmites are hardy plants that rapidly degrade wetlands, diminishing their value for wildlife habitat. The best course of action currently available is to stop the spread.

Fishery Management

Fisheries management refers to management actions taken to improve the recreational fishery. MDNR, Fisheries Division has managed fisheries in the Clinton River basin since the 1920s. Management options can include fishing regulations, fish stocking, habitat enhancements, and rough fish removal. Historical and current fisheries management in each valley segment is discussed below.

Headwaters

Fisheries management has been limited in the Headwaters Segment. The river is small and shallow, with heavy vegetation along its banks in most areas. Game fish are sparse and too small in size to provide any type of fishery. There are two lakes on this stretch; the upstream lake is Upper Bushman Lake, which does not have public access, and the lower lake is Crooked Lake, previously known as Lower Bushman Lake. Crooked Lake is a 68-acre natural lake entirely within Independence Oaks Park, an Oakland County Park, established in the mid-1970s. Most shoreline remains undeveloped because of park ownership. During the 1970s, the DNR operated a pike spawning marsh on Crooked Lake, in order to stock the lake. Then, in 1981 and 1982, rainbow trout were planted, but the plantings were not successful. A public trail encircles Crooked Lake and its shore has two barrier-free fishing piers and a boat launch. Boaters are restricted to electric trolling motors only.

Many lakes throughout the watershed have been stocked with fish. Fish stocking records for the Clinton River watershed are available from 1937 through 2002 (Table 25). Records of fish plantings prior to 1937 are difficult to locate. Most stockings were done by the MDNR (or formerly the Department of Conservation). Some known private stockings were also included, as well as stocking by the United States Fish and Wildlife Service.

A number of lakes were stocked in the 1930s and 1940s with coolwater fish species such as bluegill, largemouth bass, and yellow perch (Table 25). It is uncommon for these species to be stocked today, because research has demonstrated that once established, these species are usually ubiquitous and self sustaining.

Upper

From the beginning of this segment to Loon Lake, the Clinton River merely connects various lakes together (Figure 1). Therefore, stream reaches are very small and not conducive to fisheries management on these individual stretches. The mainstem from Loon Lake to Cass Lake had historically been managed for trout. In most years, from 1938 to the late 1960s, both legal-sized rainbow and brown trout were stocked (Table 25). The stocking strategy called for equal numbers of brown and rainbow trout to be stocked prior to the fishing season. A couple of times throughout the fishing season, the original stocking was supplemented with additional rainbow trout. After the trout program ended, walleye were raised in the Drayton Plains hatchery ponds and stocked in the mainstem in 1971 and 1972. Electrofishing surveys in 1973 found only two walleye in the river, so the program did not continue. Rainbow trout were again planted from 1973 to 1977, but the program was stopped because of poor survival and growth. The poor trout survival in this section is likely the result of water temperatures being too high during summer.

In 1979, there was a one-time stocking of coho salmon in this reach. Fisheries evaluations found some coho fingerlings in spring of 1980, but the fish disappeared by May. Again, this was most likely because of high water temperatures. However, sampling in 1979 and 1980 found a few rainbow and brown trout, both which are cold water dependent species. These fish may have found an area where springs were present and localized cold water maintained a small population. Walleye were stocked again from 1990 to 1992, but a fishery failed to develop.

There are no active management efforts at this time on the Clinton mainstem in this valley segment. The upper portion is heavily influenced by impoundments and provides angling opportunities for coolwater species such as largemouth bass, bluegill, pumpkinseed, rock bass, yellow perch, and bullheads. Various management activities have been tried between Loon and Cass lakes, but a fishery has failed to develop. Summer temperatures get too warm to support a trout fishery and stocking of coolwater fish like walleye has also been unsuccessful in developing a fishery. The area downstream of the last impoundment, Crystal Lake, is not suitable for developing a fishery. A portion of it is a designated county drain that runs through a pipe under the city of Pontiac and the area below this section is channelized and the substrate heavily sedimented. A number of lakes in the Upper Segment have had past and ongoing fisheries management activities. Following is a discussion of some of the more prominent fisheries.

Deer Lake has been stocked with a variety of fish species (Table 25). It was managed for rainbow trout from 1939 to 1985 and walleye were stocked in the 1980s. However, the only public access was through a village park and access was restricted at the park in the early 1990s. Therefore, management efforts were discontinued on Deer Lake due to lack of assured public access.

Maceday and Lotus lakes are managed as a single unit because of the broad connection between them. Management history began with bluegill and largemouth bass stockings in the 1930s and 1940s. From the 1940s to present, Maceday Lake has been stocked with rainbow trout and splake from 1960s to present (Table 25). Maceday Lake is currently the best inland trout fishing lake in the metro Detroit area, although angler harvest is low, about 1 trout per acre (Waybrandt and Thomas 1988).

Maceday/Lotus Lake also provides a good fishery for coolwater species. A creel survey in 1986 found that anglers harvested an estimated 40,283 fish consisting of nine species (Waybrandt and

Thomas 1988). Bluegills accounted for 72% of the harvest, and yellow perch, black crappie, and pumpkinseed combined for 14% of the harvest. Northern pike were almost exclusively caught through the ice, while trout species, rock bass, walleye, and largemouth bass were caught mainly during open water season. Bluegills were harvested equally by the ice and open water fisheries. During the 1980s and 1990s, walleye were stocked, but failed to provide a significant fishery.

The total fishing effort and fishing success ranked high on Maceday/Lotus Lake compared to other Southeast Michigan lakes. A creel survey was done on five popular lakes in 1986 and 1987, including Maceday/Lotus, Cass, Kent, Orchard, and White lakes (Thomas 1990; Waybrandt and Thomas 1988). Maceday/Lotus Lake had the second highest catch, but was the fourth highest for total fishing effort (37,010 angler hours), even though it was the smallest of the lakes surveyed. Thus, catch rates (96 fish per acre and 1.09 fish per hour) and angler effort rates (88 hours per acre) were both second highest comparatively on Maceday/Lotus Lake (Table 26).

Woodhull Lake is a 135-acre lake on the Clinton River. Access is gained by traveling a small channel coming from Oakland Lake, where a public boat launch is located. Both lakes were stocked with bluegill, bass, and perch in the 1930s and 1940s (Table 25). Walleye were stocked into Oakland Lake most recently in the 1980s, but a fishery failed to develop. Both lakes have a reputation as providing good coolwater fisheries and being very good bass lakes.

Cass Lake, at 1,280 acres, is the largest and deepest lake in Oakland County. There are four major basins with the deepest part of the lake (121 ft) occurring in the main body. Because Cass Lake is deep and has oxygen below the thermocline, it is managed for trout. Brown trout, rainbow trout, and splake have been stocked at various times, as well as stocking lake trout when they are available (Table 25). Although trout were regularly stocked, a creel survey in 1986 found that no trout were harvested from Cass Lake during that year (Waybrandt and Thomas 1988). In addition to trout, walleye have been stocked consistently since the 1970s. A good walleye fishery is maintained through the stocking program, although the most recent fisheries survey collected walleye from year classes when stocking did not take place. Walleye in Cass Lake have access to the Clinton River, so it is possible some natural reproduction is taking place. Mark and recapture population estimates for walleye were conducted in 1992 and 1996. In general, the walleye population is being maintained at about 1 adult walleye per acre (Thomas 1992; Braunscheidel 1997).

Cass Lake was stocked with redear sunfish in 1995 and 1996 in an attempt to establish a redear sunfish population. Some redear sunfish were caught during the most recent survey, but only in low numbers. The initial stocking program was at lower levels than are typically used to establish a population. Therefore, it may take longer for redear sunfish to become better established in Cass Lake.

A creel survey was conducted on Cass Lake in 1986 to evaluate the fishery. Anglers caught an estimated 17,753 fish in 1986, composed of 10 species (Waybrandt and Thomas 1988). Bluegills accounted for 62% of the fish harvested and 24% were crappie. There were two distinct groups of anglers that fished Cass Lake. Those that fished during winter targeted northern pike, bluegill, and crappie, and those that fished open water targeted bass, walleye, and trout. Ice fishers accounted for 39% of the total annual catch. Overall, catch rates were average on Cass Lake compared to other area lakes (Table 26). However, fishing success at Cass Lake was excellent for smallmouth bass, walleye, and crappie. For example, smallmouth bass catch and harvest numbers were twice that of Orchard Lake and many times that of Maceday/Lotus Lake (Waybrandt and Thomas 1988).

Immediately south of Cass Lake is another large lake, Orchard Lake. Orchard Lake is a 788 acre lake, with a 33 acre island (Apple Island) in the middle of the lake. The lake has two deep basins, a 90-ft deep basin north and east of Apple Island and a 111-ft deep basin south and west of Apple Island. Similar to other lakes already discussed, management began with bluegill, yellow perch, walleye, and bass stockings in the 1930s and 1940s (Table 25). Because Orchard Lake is deep and contains oxygen below the thermocline, even during summer months, it is a good candidate for inland trout management. Rainbow trout were stocked most years from 1943 to 1980. It is not clear from the file records why stocking was discontinued, but it is presumed that it was stopped because it was no longer supporting a fishery. There was also a one-time stocking of Chinook salmon and rainbow smelt in 1975. No Chinook salmon or rainbow smelt were caught in subsequent surveys. Through the 1970s, fish surveys report good catches of ciscoes. More recent sampling did not find ciscoes, but sampling was not extensive. Therefore, it is not clear whether ciscoes have declined in numbers or more recent sampling was simply not successful in capturing them.

Orchard Lake has a good reputation for fishing for largemouth bass, smallmouth bass, northern pike, and panfish. A creel survey was conducted on Orchard Lake during 1986 to document fishery use. Anglers totaled 24,422 angler hours catching 8,649 fish, but nearly half of the fish caught were released (Waybrandt and Thomas 1988). Both catch and effort were low on Orchard Lake when compared to other area lakes (Table 26). Panfish such as bluegill, crappie, and pumpkinseed accounted for 70% of the total fish harvested. Ice anglers accounted for 7% of the total annual catch and 5% of the annual fishing hours. Northern pike comprised 30% of the winter catch. The low winter use may be attributed to a local ordinance that bans use of permanent ice shanties on Orchard Lake. Since this survey was completed, portable shanties have increased dramatically in popularity. Updating this survey may show that there has been a change in angler use on this lake.

Middle

The middle part of this segment was stocked with northern pike and smallmouth bass in 1975 and 1979 (Table 25) and a survey was conducted in 1980 to evaluate these stockings. No game fish were caught. The portion above Yates Dam was managed as a trout fishery from 1983 to 1994. Brown trout were stocked for the entire period at the upper end of the segment, but the lower portion above Yates Dam was only stocked for a few years. Electrofishing found that some of the planted trout were surviving and occasionally fish were caught by anglers. This confirmed at least some over winter survival. However, because of poor growth, low survival, and the lack of a fishery, the stocking program ended. Water temperature seemed to be a limiting factor for trout in this segment. Survival was adequate during cool summers, but was poor during average to warm summers.

Although the trout stocking program was unsuccessful, the steelhead program has been very successful. Steelhead have been stocked since 1985 at the lower end of this segment, below Yates Dam. The run has not been quantified, but development of a fishery has proven this program a success. A creel survey at two sites during March and April in 1996 and 1997 documented 21,000 angler hours each year, targeting steelhead (Lockwood 2000). The steelhead catch rate averaged 0.19 steelhead per hour of fishing. In addition to spring fingerling plants, since the mid-1990s, fall fingerling steelhead have been planted, primarily on an every-other-year basis. Anglers have reported catching these fish the summer following stocking. However, it is not known how many of these fish survive to contribute to the adult run of steelhead.

Yates Dam prevents some upstream migration of steelhead, but is not a complete barrier. During brown trout evaluations on Paint Creek, juvenile steelhead are often captured. This is evidence that steelhead are successfully spawning in Paint Creek, but again, it is unclear if these fish smolt, migrate downstream, and return during the spawning run.

Although Chinook salmon have not been stocked into the Clinton River, a small run of salmon has been documented since 1980. In spring of 1984, Chinook salmon fingerlings were caught below Yates Dam during a fisheries survey. Also in January of 1984, Chinook salmon eggs were removed from redds below the dam. The eggs were hatched and reared to fingerling size in an aquarium containing Clinton River water, confirming that natural reproduction is taking place. This run of salmon is likely the result of Lake Huron planted fish finding their way into the Clinton River, a small self-sustaining population, or a combination of both.

Walleye were stocked for a number of years during the 1980s and 1990s. It is unclear what contribution these fish have made to the walleye population in the Clinton River. The walleye are not resident in the river, but emigrate to Lake St. Clair and connecting waters and return during early spring to spawn in the Clinton River and other tributaries to Lake St. Clair.

There have been no fisheries management efforts on Galloway Creek, a tributary on the upper end of this segment. The portion above Galloway Lake does not offer opportunities for fisheries management due to the small stream size. Galloway Lake is an 85-acre impoundment, with few houses on the lake. One portion on the west side of the lake is a county park with a fishing pier. No active management is taking place on Galloway Lake. The portion of Galloway Creek below the lake to the confluence with the Clinton River is currently being investigated for trout management potential. The dam on Galloway Creek is an overflow dam, so discharge is warm, composed of ≥80 °F surface water during summer. However, due to groundwater inflows, the stream cools down within 2 miles of the lake and appears to be appropriate for trout management, although there are constraints on trout management potential. Two major land holders, Daimler Chrysler and Oakland University, currently restrict access. In addition, the small size of the stream would limit potential. However, this small cold water stream should be protected and can provide refuge for trout when waters get too warm on the mainstem.

Paint Creek from Lake Orion to the confluence with the Clinton River is managed as a trout stream. The stream was stocked with brown trout a couple of times before 1950, but has been stocked almost annually from 1953 to present day (Table 25). Paint Creek was treated with rotenone in 1968 and again in 1984 to remove competitors of trout, primarily creek chubs and white suckers. Effects of these removals are temporary. Other management activities included habitat restoration projects. In 1984, the Clinton Valley Chapter of Trout Unlimited did a stream bank stabilization project using log rip-rap. This same group did additional habitat improvements in 2001**,** including wing deflectors to create a plunge pool, trees cabled to shore for cover, and willow and dogwood plantings along the stream bank to provide shade and create an overhanging bank for cover. That same year, the Clinton River Watershed Council organized the installation of a lunker structure at the park just below the Lake Orion dam.

Similar to Galloway Lake, the dam on Lake Orion that feeds Paint Creek was an overspill dam prior to 1991. Therefore, the water flowing into Paint Creek often exceeded 80 degrees during summer. The water gradually cooled as it flowed downstream, influenced by cold springs and shade. However, the upper portion was marginal for trout due to high summer water temperatures. In 1991, Fisheries Division constructed a bottom draw on the dam, which included a large tube extending along the bottom of Lake Orion to deep, cold water. The tube is opened during summer to allow water to be drawn from the cold water at the bottom of Lake Orion, rather than letting the warm surface water of the lake flow over the dam. Installation of this structure has significantly cooled water temperatures and improved trout habitat in Paint Creek. Trout are now found up to the dam even during hot summer periods. These habitat enhancements have improved Paint Creek, which was once considered to be a marginal trout fishery.

Stony Creek above Stony Creek Impoundment was managed as a trout stream from 1982 to 1991 by stocking brown trout annually. Due to slow growth and an abundance of other fishes, a rotenone renovation was completed in 1986. The stocking program was discontinued due to poor trout survival and poor access for anglers.

Stony Creek Impoundment is a 500 acre impoundment created by two dams on Stony Creek. The impoundment is mostly shallow; less than 10 ft deep. Deeper water (15–22 ft deep) is only present in the central basin toward the lower dam. The lake has a good coolwater fish population predominantly made up of bluegill, yellow perch, crappie, and largemouth bass. Through MDNR stocking programs, good walleye (began in 1981) and channel catfish (began in 1996) fisheries have been developed on Stony Creek Impoundment (Table 25).

Lakeville Lake has an interesting history. Lakeville is a 460 acre impoundment, which was created when a water control structure was installed that combined 13 small lakes to create one large lake. There are several deeper basins that range in depth from 20 to 65 ft deep, but much of the lake is shallow and is conducive to abundant aquatic plant growth. Lakeville Lake has had a history of stunted (small, slow growing) panfish. A panfish control program through partial poisoning was rejected in 1957 due to opposition of the local people. A successful thinning program was done in 1978 and 1982, with the goal of improving the panfish fishery. There was a short-term benefit from the thinning project, but average size slowly declined again over the years. Walleye have been successfully used recently in Southeast Michigan as a management tool to improve the average size of panfish through predation (Schneider and Breck 1997). Walleye have been stocked into Lakeville Lake in 1999, 2001, and 2002 with this goal in mind.

Lower

The primary fisheries on this segment include the seasonal steelhead and walleye fisheries mentioned earlier. These species are accessible to anglers as they migrate from Lake St. Clair into the Clinton River to spawn.

Red Run Drain is so degraded with poor water quality and poor habitat, that it does not provided fisheries management opportunities at this time. Tributaries to Red Run Drain are either too degraded or too small to provide opportunities for fisheries management.

The headwater of the North Branch of the Clinton River (previously called Townsend Creek) was stocked with brook trout from 1949 to 1964 (Table 25). There are no records explaining why the stocking program was terminated. However, the North Branch above Almont continues to have a self-sustaining brook trout population. The small stream size and extensive private property make this fishery inaccessible to the public. The upper portion of the North Branch of the Clinton River was managed as a trout fishery with brown trout stocking taking place in most years from 1971 to 1991. Prior to trout stocking, a chemical reclamation was done in 1971, but the carp kill was incomplete. Trout survival and growth were marginal, so the program was stopped.

In 1973, the portion of the North Branch and its tributaries above 27 Mile Road was classified as a designated trout stream. In 1975, the lower limit of the designated trout stream was moved up to 32 Mile Rd. This adjustment was made due to poor trout survival in the lower area, coupled with concerns from local minnow trappers. Although the trout stocking program does not continue today, this section remains a designated coldwater stream.

Walleye were stocked in the middle area of the North Branch from 1976 to 1989. A number of sites were surveyed in early spring 1977 to 1980 to look for spawning walleye or steelhead, but none were found. The walleye stocking program was stopped because a fishery failed to develop.

A good population of smallmouth bass exists in the middle section of the North Branch. Adult bass can be caught during spring, but these are presumably bass that migrate from Lake St. Clair. Smallmouth bass can be found in good numbers throughout the remainder of the year, but legal-sized bass (14-inch minimum size limit) are typically found only during spring.

Mouth

As mentioned earlier, the Clinton River below Yates Dam is managed for a seasonal steelhead and walleye fishery. However, this area has limited public shore access. Both the lower portion of the Clinton River and the entire cut-off channel are influenced by fishes from Lake St. Clair. Seasonally, anglers fish for northern pike and yellow perch, typically during their spawning periods.

The spring spawning run of walleye was estimated for two separate periods. In 1990 and 1991, the population of walleye during the spawning run was estimated to be 8,418 ± 1,495 (95% confidence limits) and 7,406 ± 1,751 walleye, respectively (Thomas 1995). These numbers are lower than population estimates made for the spawning run in 1980 (20,307 walleye ± 5,600) (R. Julian 1981, U.S. Fish and Wildlife Service; unpublished report) and in 1981 (18,700 ± 2,205 walleye) (from R. C. Haas and K. Pearce, MDNR, Fisheries Division; unpublished report).

Tagging studies of walleye caught during spawning season in the lower Clinton River indicate that walleye migrate from throughout Lake Huron, Lake St. Clair, and even Lake Erie, as well as the St. Clair River, Detroit River and Thames River (Figure 61) (Todd and Haas 1993). A significant number of tag recoveries in the Thames River suggested that the adult walleye tagged in the Clinton River may have strayed from their natal spawning grounds in the Thames River. A genetic study of spawning walleye from the Clinton and Thames rivers (Todd and Haas 1993) showed no significant differences between the two populations. This suggests that the Thames walleye, known to be a large spawning population, did spill over or stray into the Clinton River.

Recreational Uses

The Clinton River watershed offers a variety of recreational activities, such as fishing, swimming, boating, and wildlife viewing which are accessible from a mixture of types of publicly-owned lands. A computer data base supplied by SEMCOG lists 34,710 acres of public lands within the Clinton River watershed which is approximately 7% of the 510,000 acres. According to SEMCOG, these public lands are distributed among 15 categories (Table 27). Since the watershed is heavily urbanized, municipal parks make up the largest single category (23%). Golf courses are the second largest category making up 21%. Three additional categories of state, county, and metro parks make up a combined area of 41%. Natural areas make up only 2% of the public lands or about 1/10 of 1% of the entire watershed. Very little information was located documenting the level of recreational use for any section of the Clinton River or its watershed.

From 1928 to 1968, conservation officers recorded catch and effort data from anglers at several locations in the watershed (Appendix 2). Records indicate preferred fish species sought by anglers and give some indication of species abundance. Panfish such as yellow perch, bluegill, and rock bass were popular on the Clinton River and most of its tributaries where data was collected. Other common species caught included suckers, bullhead, and northern pike. Brook trout were popular on Trout Creek and Townsend Creek (headwaters of the North Branch) and both brown trout and rainbow trout on Paint Creek.

Headwaters

The Headwaters Segment of the Clinton River only has one public parcel on the river (Figure 62), Independence Oaks County Park, but it is large (encompassing 1,132 acres) and has frontage on 36.6% of this river segment. This segment is not conducive to canoeing due to the small river size.

Upper

The Upper Segment has 14 small public parcels with frontage on or near the Clinton River of seven types covering 961 acres (Figure 63). Approximately 19.6% of the total river length (30.0 miles) is bordered by public lands. These public lands provide some public access at a number of locations. This river segment also runs through numerous lakes, most which have lake-level control structures. The Clinton River Watershed Council (CRWC) describes this segment of the river on their website at http://www.crwc.org/programs/stewardship/recreation/canoe.html as Western Oakland County canoeing water starting at Dixie Highway and ending at Cass Lake.

Middle

The Middle Segment has 11 parcels of public land with frontage on or near the Clinton River of four types covering 1,628 acres (Figure 55). Approximately 63% of the total river length (19.3 miles) is bordered by public lands. These public lands provide very good public access at a number of locations and this is one of the best stretches of the Clinton River for recreational activities. The CRWC describes canoeing this segment of the river on their website as the Auburn Hills stretch starting at Auburn Road and ending at Adams Road.

Galloway Creek has five small parcels of public land with frontage on, or near, the river comprising four types covering only 333 acres (Figure 64). Approximately 10% of the total river length (8.3 miles) is bordered by public lands. These public lands provide minimal public access, however this stretch of Galloway Creek has relatively good water quality and is being managed to improve coldwater fishing by providing cold water refuge during summer months.

Paint Creek has 10 small parcels of public land with frontage on, or near, the river comprising five types covering only 521 acres (Figure 65). Approximately 10% of the total river length (15.0 miles) is bordered by public lands. Paint Creek Hiking Trail, which runs almost the entire length of the creek, provides access to the water at numerous points. The combination of small public parcels, many road crossings, and Paint Creek Trail provide very substantial public access. Paint Creek also has relatively good water quality and is being intensively managed for coldwater fishing. This stretch of river is also as good as, or better than, any other in the watershed for hiking, biking, and nature viewing.

Stony Creek has three parcels of public land with frontage on, or near, the river comprising three types covering only 521 acres (Figure 66). Approximately 27% of the total river length (16.7 miles) is bordered by public lands. Stony Creek Metropark, which runs along a significant part of the stream, provides excellent public access to the water at numerous points. This stretch of river is also excellent for picnicking, hiking, biking, cross-country skiing, and nature viewing activities.

Lower

The Lower Segment has 10 parcels of public land with frontage on, or near, the Clinton River of two types covering a total of 780 acres (Figure 67). Approximately 62% of the total river length (13.7 miles) is bordered by public lands. These public lands also provide very good public access at a number of locations and this is a good stretch of the Clinton River for recreational purposes. The CRWC website describes canoeing this segment of the river in two stretches; the “Utica & Sterling Heights stretch” beginning at Utica City Park and ending at South Clinton River Park, and the “Clinton Township stretch” starting at Budd Park and ending at Shadyside Park.

The Middle Branch of the Clinton River and its major tributaries have four parcels of public land with frontage on, or near, the river comprising two types (three golf courses and one municipal park) covering only 794 acres (Figure 68). Approximately 4% of the total river length (37.5 miles) is bordered by public lands. This portion of the Clinton River has very limited public access and the lower portion has degraded water quality and seriously modified channel morphology, providing very little recreational opportunity.

The North Branch of the Clinton River and its major tributaries have 19 parcels of public land with frontage on, or near, the river comprising seven types covering about 4,657 acres (Figure 69). Approximately 11% of the total river length (127.7 miles) is bordered by public lands. The HCMA Metroparks, which is a regional park district serving Wayne, Oakland, Macomb, Washtenaw and Livingston counties, has been aggressively acquiring park lands along the North Branch. Largely because of this, a significant portion of the North Branch of the Clinton River has good public access, relatively good water quality, and excellent potential for providing public recreational opportunities.

Mouth

The Mouth Segment has nine small parcels of public land with frontage on, or near, the Clinton River of two types covering only 182 acres (Figure 70). Approximately 18% of the total river length (11.1 miles) is bordered by public lands. These public lands provide modest public access, but this stretch of the Clinton River has relatively low water quality so it has limited recreational value. The CRWC website describes canoeing this segment of the river as the “Mt. Clemens stretch” which begins at Shadyside Park and ends at the mouth of the Clinton River on Lake St. Clair.

There are 14 public boat-launching facilities in, or associated with, the Clinton River watershed (Figure 71). A number of them are located on natural lakes in the Clinton River system mostly within the Upper Segment of the mainstem. The CRWC, posted on their website at www.crwc.org/programs/ stewardship/recreation/launches.html, and the State of Michigan, Department of Environmental Quality, posted on their website at www.mcgi.state.mi.us/MRBIS/, have site-specific descriptions for most of these recreational facilities.

Citizen Involvement

Citizen involvement in the management of the Clinton 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 United States Fish and Wildlife Service, Army Corps of Engineers, MDNR, MDEQ, county offices such as drain commissioners, road commissioners, department of health, and local governments.

The CRWC is a non-profit organization dedicated to protecting, enhancing, and celebrating the Clinton River, its watershed, and Lake St. Clair. The council was formed in 1972 as an association of local governments under the authority of the Michigan Local Rivers Management Act of 1964. For more than 30 years, CRWC has served to coordinate the efforts of local governments, businesses, community groups, and individuals in improving water quality, promoting innovative watershed management techniques, and celebrating the river as a natural and recreational resource. In 1994, the council reorganized as a 501(c) non-profit organization, which allows CRWC to obtain funding from grants and private donors. The Council has a number of ongoing watershed management, education, and stewardship programs across the watershed.

Another active organization is Trout Unlimited. There are four separate chapters in Southeast Michigan, the Challenge Chapter, the Clinton Valley Chapter, the Paul H. Young Chapter, and the Vanguard Chapter, all of which are active in the Clinton River watershed. Recent projects include fish habitat enhancement projects on Paint Creek, fly tying and casting clinics during River Days, and youth education and mentoring. Trout Unlimited members have provided the bulk of volunteer efforts towards completion of the Clinton River Coldwater Conservation Project. This is a joint project between the four Trout Unlimited chapters, the CRWC, the City of Auburn Hills, Oakland County Planning and Economic Development Services, and Fisheries Division of MDNR.

Volunteers conducted an invertebrate and an extensive habitat survey of the Middle Segment of the Clinton River, Galloway Creek, and Paint Creek during 2003 and 2004. For the habitat survey qualitative and quantitative measurements were taken every 50 ft on Galloway Creek (approximately 5 miles), every 75 ft on Paint Creek (approximately 15 miles), and every 100 ft on the Clinton River from Yates Dam to Auburn Hills (approximately 13 miles). This was a large under taking, but produced a comprehensive view of the fisheries habitat. In addition, temperature monitors were deployed in these areas, as well as the upper North Branch, at 34 locations 2003–05. Monitors were not set out at each location during each year of sampling, but the data provides a good characterization of water temperatures in the areas surveyed. Data from these sampling efforts will be used to develop a fisheries management plan for these areas. Favorable results from survey work in 2003 on the mainstem have resulted in the re-initiation of a brown trout stocking program on the Middle Segment of the Clinton River (see **Fishery Management**).

Other organizations which play a role in watershed management include Friends of the Clinton River Trail, Friends of Bald Mountain State Park, Friends of W. C. Wetzel State Park, Macomb Land Conservancy, Oakland Land Conservancy, Friends of Macomb Orchard Trail, and North Oakland Headwaters Land Conservancy.

MANAGEMENT OPTIONS

The Clinton River system has been altered by human influences. Factors such as land use and urbanization, point and nonpoint source pollution, and dams have had a dramatic effect on the watershed. These alterations have affected water flow, quality, and temperature which have had an influence on the habitat and aquatic communities. We think the addition of water from outside the watershed has increased base flow, which results in a river that is geomorphologically dynamic. 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 Clinton River system has unstable flows throughout. Factors that contribute to the unstable flows include influx of water from outside the watershed, differences in topography and soils, and watershed development and land use changes. Storm water contributes to unstable flows in the river and will be an important issue that needs to be addressed.

Option: Protect and restore wetlands 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. Work toward zoning requirements that prevent development in floodplains.

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

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

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: Restore natural hydrologic regime of lakes and rivers by removing lake-level control structures and dams when possible.

Option: Restore run-of-river flows by operating dams and lake-level control structures as fixed-crest structures rather than by opening and closing gates.

Option: Restore summer base flows on mainstem and tributaries by establishing minimum flow requirements downstream of all dams and lake-level control structures.

Option: Support stream flow monitoring throughout the watershed. This is particularly important in this watershed due to the influence of human-based activities like lake level control structures and changes in land use, all of which will affect the hydrology of the watershed.

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, converting permeable soil surfaces to impervious surfaces, 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 riparian zones by developing a GIS-based integrated land use planning tool (i.e., ICM for Lake St. Clair, being developed by NOAA and GLC) and surveying the present riparian conditions to assist local units of government in management of riparian zones and the rest of the basin.

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.

Option: Protect the river by evaluating the amount of impervious surface and rate of change in the watershed in attempts to better manage its effects.

Channel Morphology

The channel morphology of the Clinton 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. The increase in impervious surfaces and increase in base flow in the watershed has changed the flow regime, resulting in increased stream bank erosion and altered the habitat of the river.

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. Failed dams should be evaluated on the basis of environmental and social factors to determine whether reconstruction is appropriate.

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 79 dams identified in the Clinton River watershed and many 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 used for their original purpose and dams that are a safety hazard. Failed dams should be evaluated on the basis of environmental and social factors to determine whether reconstruction is appropriate. Two dams that have a high priority for removal because of potential fisheries benefits are Cascade Dam on the North Branch immediately upstream of Romeo Plank and the dam on Paint Creek just downstream of Gunn Road.

Option: Protect habitat by opposing construction of dams and in-line detention basins.

Option: Restore flow of the river by working with lake owner groups to remove lake-level control structures to allow lakes to function naturally. If the control structure cannot be removed, operate the control structures as a fixed-crest structure to allow natural stream flow and function.

Water Quality

Water quality in the Clinton River has improved since the 1970s, after years of abuse. However, CSOs, storm sewers, NPDES discharges, and nonpoint sources continue to influence the water quality of the river. Problems such as high bacteria levels, contaminated fish, and contaminated sediments in the lower portion of the river can be attributed to past practices.

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

Option: Protect water quality by supporting Part 201 sites and Superfund clean-ups.

Option: Support programs which either eliminate CSO discharges or achieve adequate treatment of combined sewer overflows prior to discharge, consistent with NPDES permit requirements.

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

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

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

Option: Develop site-specific (AOC) delisting criteria for use in the Clinton River watershed based on the Michigan baseline delisting criteria.

Special Jurisdictions

The State of Michigan manages natural resources and environmental quality. County drain commissioners have authority over designated drains and many lake-level control structures. 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.

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

The fisheries community has improved in the middle section of the watershed since the 1970s due to improvements in water quality. However, some of the higher quality, coldwater tributaries (i.e., Gallagher and East Pond creeks) have seen declines in the quality of the fish community due to loss of habitat from sedimentation, changes in stream flow, and changes in channel morphology. 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 unstable flow as a result of watershed development. Amphibians and reptiles are on decline presumably due to loss of suitable habitat.

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. Special attention should be paid to threatened and endangered species such as massasauga rattlesnake, eastern fox snake, spotted turtle, and Blandings turtle.

Option: Survey distribution and status of species of greatest conservation need 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 Clinton River watershed and protect critical habitat.

Fishery Management

Angling opportunities on the Clinton River system vary throughout. The small size and lack of access in the Headwaters Segment limits fisheries opportunities. Opportunities in the Upper Segment are good and diverse in many impoundments and lakes. The Middle Segment provides very good fishing seasonally for steelhead, Chinook salmon, and walleye on the mainstem. There is also a very good coldwater fishery on Paint Creek. Impoundments including, Lake Orion, Stony Creek, and Lakeville Lake all have public access and provide good fishing for coolwater species. Seasonal runs of walleye and steelhead provide the primary fishing opportunities on the Lower Segment. Sections of the North

Branch provide good fishing opportunities for coolwater and coldwater species. Other tributaries in this section provide limited opportunities. Fishing in the Mouth Segment is targeted at coolwater species such as yellow perch, sunfishes, largemouth bass, and walleye.

Option: Survey the fisheries on public waters in the watershed to evaluate ongoing management efforts and look for new opportunities.

Option: Continue stocking programs that have created a successful fishery and evaluate opportunities that arise to establish new programs.

Option: Encourage sport fishing groups and conservation associations to initiate habitat improvement projects to benefit the fisheries.

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

Option: Improve access to lakes and streams by pursuing additional public access opportunities.

Option: Evaluate the appropriateness of existing fishing regulations.

Recreational Use

The watershed provides good recreational opportunities in public owned areas. Although publicly owned land is limited, a large proportion of the river length is bordered by public land. The river provides recreational opportunities for fishing, canoeing, recreational boating, picnicking, hiking, and nature watching. However, portions of the river not in public ownership have limited public access. Recreational uses could be enhanced by increased public access.

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.

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 Clinton 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 citizen involvement groups.

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

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

Option: Protect the river and its resources by promoting public education regarding issues that affect the watershed and developing stewards of the resources.

PUBLIC COMMENT AND RESPONSE

The draft of the Clinton River Assessment was distributed for public review in fall 2005. Printed copies were available from the MDNR Livonia Operation Service Center 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, printed copies were sent to: numerous local and statewide conservation organizations and fishing groups; local, state, and federal units of government; and any member of the public that requested copies. A letter explaining the purpose of the assessment and requesting review comments was enclosed with all copies.

Three public meetings were held to receive comments concerning the river assessment draft. Rochester Hills City Hall Auditorium, October 12, 2005 (9 people attended); Washington Senior Center, October 19, 2005 (2 people attended); and Utica Gander Mountain, October 26, 2005 (17 people attended).

The public comment period for the river assessment draft ended November 30, 2005. In addition to comments received during the public meetings, nine written responses were also received during the public comment period. 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 are stated in the response.

Introduction

Comment: Various comments were made supporting the river assessment process and complimenting Fisheries Division on the effort. Reviewers often requested copies of the final assessment.

> Response: These comments are acknowledged and appreciated. The final assessment will be distributed similar to the draft. Copies will also be sent to people who requested one.

Comment: A number of grammatical and typographical errors were noted.

> Response: Appropriate changes were made in the final report.

Geology and Hydrology

Comment: The 11 stream gauges analyzed in the assessment are not a comprehensive list of all stream gauge data available for the Clinton River watershed. Additionally, the period of record for the 11 gauges used went through 2002.

> Response: Both these points were clarified in the text.

Comment: Short-term stream gauge data is available for portions of 2004 and 2005 for the Middle Branch of the Clinton River which was not referenced in the assessment.

Response: Data collected at stream gauges is an ongoing process. An arbitrary cut-off point needs to be selected so that a final report can be written. Stream gauge data was evaluated through 2002 and was discussed in the assessment.

Comment: Instead of comparing mean discharge at the most downstream gauge in the Clinton River versus mean discharge at the most downstream gauges on the River Raisin and Flint River, compare discharge per square mile.

Response: Where this is discussed in the assessment, we provide both mean discharge and total drainage area for all three rivers. The information is available if the reader wishes to compare the rivers on a yield basis.

Comment: The apparent uniqueness of the stream flow of the Clinton River at the Auburn Hills gauge station (Figures 20 and 21) is interesting. Considering the location of this station with respect to watershed urbanization, the results are not surprising. Still, the amount of change at this gauge is striking.

Response: As discussed in the **Annual Stream Flow**, **Seasonal Water Flow**, and **Soils and Land Use** sections, many changes have taken place in the watershed that may contribute to this pattern. Factors include urbanization and increase in impervious surfaces, manipulation of lake levels upstream by lake-level control structures, and changes in the water budget due to water supplies and sewering. But, it is interesting to note that changes in flow were not as pronounced at upstream or downstream locations.

Comment: Use of the Moravian Road USGS gauge to assess the river's flow regime from a fisheries standpoint is misleading. It is too far downstream and is an aggregate flow parameter, which masks the unique flow regime characteristics in the river's sections and tributaries. The river's flow regime needs to be assessed in the report according to each of the river's 5 segments.

Response: Figures 14 and 17–19 focus on the Moravian gauge to evaluate changes in the watershed because it is the most downstream gauge. However, Figures 20–30 evaluate changes in stream flow at each of the stream gauges in the watershed.

Comment: Use of the "total flow" parameter is misleading in a fisheries report. From a biological/fishery health standpoint, "average daily flow for the month of August" is a better parameter. Or, "high", "mean", and "low" daily flow for the month of August. These provide a better assessment of the real flow issues as they impact a fishery potential, compared with "total flow."

Response: We agree that looking at only total flow would be misleading. Total flow is a cumulative statistic and may cover up seasonal flow issues. Evaluating flow during August, the month of lowest flow Figures 24–25, will indicate any low flow issues. Table 3 has mean daily flow in August for each stream gauge to address this issue. Furthermore, Figures 28–30 show low flow exceedence curves for each gauge station. This parameter evaluates stability of base flow conditions and illustrates the instability in flow in the Clinton River system. The comparison of hydrographs for the Clinton River (Figure 31) and selected tributaries (Figure 32) with that of two stable rivers (Figure 33) further illustrates this point.

Comment: Consider referencing Sinha et al. 2005 study on the Clinton River Geomorphology study in the Geology and Hydrology, and Channel Morphology sections. This study is the most extensive hydrologic and geomorphologic analysis of this watershed and is directly relevant to much of the assessment.

> Response: At the time that the **Geology and Hydrology** and **Channel Morphology** sections were written, this report was not yet available. We concur with the value of this document in understanding the hydrology of the Clinton River and have cited this study where appropriate.

Comment: There is support for the management option that recommends establishing a minimum flow requirement for the lake-level control structures upstream of the primary fishery management areas on the Clinton River's mainstem and on Paint Creek.

> Response: Low flow during summer appears to be one of the factors limiting fisheries production in the Clinton River. It is not known what affects the lake-level control structures upstream have on summer base flow, but this should be evaluated.

Comment: There is support for modeling the river's flow regime.

> Response: Thank you. Yes, there are many factors that affect the Clinton River and its resources. A model that integrated many of these factors in evaluating the river's flow would be very helpful in understanding the river system better.

Comment: What are the problems created by storm water runoff, especially in the southern part of the watershed?

> Response: This issue is addressed in both the **Geology and Hydrology** and **Soils and Land Use** sections of the River Assessment. Urbanizations and associated land use changes alter timing and volume of rainfall that enters the river. The increase in the amount of impervious surfaces that accompany urbanization delivers water from rain events to the river over a shorter time period. This creates problems by delivering higher loads of nonpoint source pollutants to the river and creating erosion and sedimentation issues which may limit fish use.

Comment: Are the low water levels that we have seen in the river lately a problem?

> Response: Yes. Urbanization has caused an increase in flashiness of the river (see **Geology and Hydrology** and **Soils and Land Use** sections). Flashiness means that the river experiences extended low flow and higher peak flow due to the increase in impervious surfaces and decline of wetlands that store water. This is compounded with operation of lake-level control structures that only consider lake levels, without regard for the downstream river users. These flow issues affect erosion and sedimentation, water quality, and stream temperatures, all which affect the biological community the river can support.

Soils and Land Use Patterns

Comment: Cutting grass and other vegetation on river banks to the waters edge is causing increased erosion and other problems. Education efforts should be increased to combat this problem.

Response: Removing vegetation buffers along streams does increase the delivery of nonpoint source pollutants, increases erosion, reduces fish and wildlife habitat, and can cause warming in the stream. Educational efforts need to continue to promote better land management to benefit the river.

Comment: There are several new golf courses being developed or planned along the Clinton River. Are they going to create more runoff problems, especially in light of the fact that water levels are higher now than a number of years ago? Who regulates golf course and retention pond development?

Response: The type of land use does affect runoff. There is an increase in the amount of runoff generated by a golf course versus a meadow or forested site. However, there is a bigger increase in runoff if the golf course was moved into pasture land, cultivation, residential, or commercial development. Golf courses are subject to local zoning ordinances and regulations.

Comment: There is a new shopping center being developed along the river. Why do we need another shopping center and who is permitting this to happen?

Response: Land use regulations are set through local zoning regulations.

Comment: The DNR is currently selling off surplus property. Will shoreline properties be sold to private development? The DNR should make every effort to increase public ownership and access along the Clinton River.

Response: The DNR is currently going through a land consolidation review. Each Division within the DNR has the opportunity to comment on each parcel. The DNR and Fisheries Division put a high priority on maintaining parcels that provide lake or river access for recreational use. However, it is possible that if a small waterfront lot can not be used for recreation or if there is already good access to a water body, the decision may be made to sell that parcel. The land consolidation review is taking place on a county by county basis. When the final reviews are complete, a list of properties being proposed for surplus is compiled for the entire county and a public meeting is held for the public to provide comments.

Dams and Barriers

Comment: Safety reasons were cited as a positive reason to remove Yates Dam, however, fisheries management reasons were also given as a reason to retain the dam. It is hoped that human life takes precedence.

Response: While life is to be valued and any loss of life is a tragedy, the dam does not appear to pose a chronic safety issue. Signage is provided both around and upstream of the dam, warning of its presence. Removal of Yates Dam and others around the state remains a long-term consideration.

Comment: The USGS weir identified in the dams and control structures table (Table 8) on the North Branch of the Clinton River is lower than the listed height of 6 ft.

Response: The data provided in Table 8 is from the MDEQ database and we cautioned in the text that there were accuracy issues identified with some sites listed in the table. However, this is the most comprehensive list we have available. The structure in question was measured in fall 2005 and was reported to have a head of 2.5 ft (S. Blumer, USGS, personal communication). This measured height was corrected in Table 8.

Comment: Dams have a negative impact on aquatic resources and dams that are no longer in use for their original intent should be investigated for removal. The two dams highlighted in the Management Options section, Cascade Dam on the North Branch and the private dam on Paint Creek just downstream of Gunn Road, should be investigated for removal.

Response: We agree with this comment and feel that it is covered in the **Dams and Barriers** and **Management Options** sections.

Comment: Current operation of lake-level control structures prevents much needed water flow in the Clinton River during crucial periods of the year, especially during summer. We support the recommended fixed crest operation for natural stream flow for control structures that can not be totally removed.

Response: We concur that current operation of the lake-level control structures for the benefit of the lakes with no regard for the effects on the river are unhealthy for the river and its aquatic resources. We have a management option that is directed at restoring a more natural flow of the river.

Comment: Why are the water levels of Stony Creek Impoundment and Winkler Mill Pond managed the way they are causing dramatic lowering of water for up to three weeks and "beaching" large numbers of fish?

Response: Water levels in Macomb County are regulated by the Macomb County Public Works office. Water levels on many lakes are lowered in fall to protect docks and walls from ice scour, and raised in spring to provide recreation. Lakes are filled in spring by directing water from the rivers to raise lake levels. Lake levels are typically raised as quickly as possible. However, this is often done is such a way that it is not healthy for the rivers.

Water Quality

Comment: The Rochester Waste Treatment Plant that used to discharge to the Clinton River was decommissioned in 1993. The current Rochester Waste Treatment Plant discharges to an unnamed tributary to Paint Creek.

Response: This information was verified and the correction made in Table 9.

Comment: The GWK Drain improvement program will not totally eliminate CSO discharges, rather the upgrade will achieve adequate treatment as defined by MDEQ.

Response: The text in the Sewer Overflows section was changed to reflect this correction.

Comment: CSO events that meet "adequate treatment" and have discharges that meet NPDES effluent limits do not pose environmental or health hazards.

> Response: We agree that if NPDES effluent limits are being met, that there is not a serious environmental or health threat. There is only a potential threat to environmental and health in the event of a malfunction in a facility operation resulting in a discharge that exceeded allowable permit limits. The text in the Sewer Overflow section was modified to reflect this.

Comment: The impact of failed septic systems is a major concern, particularly in areas where inspection and maintenance programs have been given a low priority for a number of years. The Nonpoint Source section should be expanded to highlight the importance of this issue. However, the goal should be to eliminate discharge of toxic substances, including chlorine, into the environment.

> Response: We agree that failed septic systems are a concern and included some additional text in the assessment on this issue.

Comment: CSO discharges do not necessarily need to be eliminated, as long as the discharges achieve adequate treatment prior to discharge, consistent with NPDES permit requirements.

> Response: The management option recommending elimination of CSO discharges was modified by adding that programs should be supported for either elimination of CSO discharges or achieving adequate treatment prior to discharge.

Comment: Add a management option to establish a goal of properly operating and maintaining the wastewater treatment plants in the Clinton River watershed to ensure that they meet all NPDES permit requirements.

> Response: An additional management option was added under the **Water Quality** section.

Comment: Add a management option to oversee the operation of septic tanks through a regular inspection program.

> Response: An additional management option was also added to address monitoring and regulating septic tanks by County Health Department's to prevent contamination of the river.

Comment: It is appropriate to include increased stream flow from storm water as a pollutant, especially in urban environments like the Clinton River watershed. Too often stream flow from storm water is not noted as a pollutant.

> Response: We agree.

Comment: It would be helpful to identify the receiving water body in the section discussing Twelve Towns/George W. Kuhn Drain.

> Response: Information was added to this section indicating that the receiving water is Red Run Drain, a tributary to the Lower Segment of the Clinton River.

Comment: The MDNR stream classification system discussed under the Water Quality section is no longer valid. What is the implication of a new classification system? Paint Creek should no longer be listed as a "second-quality coldwater" system, it should be listed as a "top quality coldwater" stream.

> Response: This classification system is included for historical reference and is not used today. Paint Creek from the Lake Orion Dam to the Clinton River is a designated trout stream, meaning it carries a coldwater fishery designation for MDEQ permitting. This is the highest protection we can provide for a stream.

Comment: Is road salt contamination in surface water runoff one of the biggest pollution problems for the Clinton River?

> Response: Road salt is a type of nonpoint source pollution that contributes to the overall contaminant load delivered to the Clinton River and nonpoint source pollution is the biggest pollution concern for the river. However, road salt by itself is not a major threat to the health of the river. Road salt is applied to paved surfaces during snow and ice events. The salt gets introduced to the river when there is a thaw. Therefore, there is typically a large volume of water that carries the salt into the storm sewer system and the salt is relatively diluted. However, road salt has been documented to affect roadside vegetation. In addition, there may be cumulative affects of salt levels building up in inland lakes that should be investigated further.

Comment: The biggest problem for the river is that subdivision residents only think about their lawns. Too much fertilizer and other lawn chemicals are getting into the river.

> Response: Lawn fertilizers and chemicals are nonpoint sources of pollution in the watershed. There is not an inherent problem with fertilizer use, but over application is a concern and extra care needs to be taken when application is made adjacent to a river or lake.

Comment: I fish a lot in the Yates Dam area and see lots of pollution, like oil slicks and other industrial waste coming from upstream. I would like to know who is responsible for controlling that pollution and who is patrolling the river for fishing violations?

> Response: Any observed pollution in the river should be reported to the 24-hour Pollution Emergency Alerting System (1-800-292-7660) so that it can be investigated. The Clinton River is patrolled by MDNR Conservation Officers who look for fishing violations. Any observed violations should be reported to the 24-hour Report All Poaching hotline (1-800-292-7800). It is best to report violations as they are observed so officers have an opportunity to respond and investigate.

Comment: Is there more information on the two fish kills that occurred this summer (2005) in the areas where trout were stocked and where is the wastewater treatment plant located?

> Response: Dead fish were reported on June 6, 2005 in the Clinton River downstream of Auburn Road. The kill was restricted to brown trout. The cause of the fish kill was a sag in the dissolved oxygen. Hot weather was associated with this fish kill, but was not a contributing factor. The specific cause of the reduced oxygen level was not determined. The second report of dead fish came on August 18, 2005 in the same area. Reports were made of a strong chlorine smell coming from the river. A 100-meter section of the river below Auburn

Road was surveyed and a total of 133 fish were counted, mostly white suckers, creek chubs, and blacknose dace. Both incidents are still being investigated.

The Pontiac Waste Water Treatment Plant (WWTP) is located on the Clinton River approximately 4 miles above the location of the dead fish. It is unclear if the WWTP was a contributor to either fish kill.

Comment: I think that particulate matter in the river has increased and that it is the biggest pollution problem in the Clinton River. I have lived along the river for many years and it used to be clear most of the time. Is there more erosion occurring now?

Response: See also the **Soils and Land Use** section. Urbanization has resulted in a more flashy river, meaning there are longer periods of low flow and higher peak flow. The higher peak flow is very erosive which results in more sediments being carried in the river. Additionally, sediments are delivered by storm water and runoff which flow directly to the river.

Comment: Soil erosion and siltation in the river are one of the biggest problems. Currently, there is a big erosion problem at the Clarkston Road overpass of Paint Creek.

Response: We agree that this is a significant site of erosion and sedimentation for Paint Creek. We are currently working with Oakland County to address these problems.

Comment: The NPDES Phase II permitting process underway in the watershed since 2004 provides a framework for addressing the storm water and flow issues, with seven active watershed groups involving nearly 50 municipal, county, and school jurisdictions. This should be added to the Executive Summary.

Response: We agree and have added information on storm water control to the **Executive Summary**.

Comment: Galloway Creek should be added to the Designated Trout Stream list.

Response: Information is being collected on this creek to see if it warrants such listing.

Comment: What is the source of bad odor coming from the Clinton River which is not present around rivers up north?

Response: We have not heard this complaint before and do not know what might be the cause.

Special Jurisdictions

Comment: We support all management options in this section, but specifically want to see designated drains restored to a natural rivers status where such designation is no longer appropriate or where past drainage modifications have been excessive.

Response: There are many miles of streams and creeks that would benefit from such a change. Efforts should be made with the county drain commissioners to address this issue.

Comment: Navigability needs to be defined in a favorable way for public use of the resource.

Response: We agree and list a management option to address this issue.

Biological Communities

Comment: The Oakland County Road Commission should be commended for addressing the Snell Road/Orion Road/Paint Creek overpass. This is a $500,000 effort that will benefit Paint Creek and draw attention to the county's concern for Paint Creek and the environment. The resources and financial investment the county has made in decreasing soil erosion and runoff are appreciated.

Response: This particular project will remedy a chronic source of sediment input that was going into Paint Creek. We agree that this type of proactive project should be commended and encouraged.

Comment: A management option should be included to repair bridges and overpasses that contribute to accelerated soil erosion into rivers and streams. A specific priority for future repair for soil erosion and runoff control is the Clarkston Road Bridge over Paint Creek.

Response: This suggestion falls under a variety of other management options listed that are aimed at reducing erosion and sedimentation. However, we added another management option under the **Special Jurisdiction** section because we agree that bridges and road crossings should be highlighted as a separate option due to the affect they can have on streams.

Comment: In many of the state's tributaries to the Great Lakes there is a spring run of spawning smallmouth bass. Why don't I see smallmouth running into the Clinton River to spawn?

Response: We do see smallmouth bass migrating from Lake St. Clair to spawn in the North Branch. We do not see smallmouth doing this on the mainstem and that may be due to a lack of suitable habitat. The best habitat for smallmouth bass on the mainstem is above Yates Dam. It is possible there was a spawning run before this dam was built.

Comment: I have lived on the North Branch for 50 years and fishing is terrible now. I used to see many suckers and catfish moving into the river in spring, but no longer. I think that the inflatable weir in the cutoff channel prevents fish migration. I used to see many crayfish and turtles in the North Branch, but they are no longer present. Why?

Response: I can not explain your observations of reduced numbers and diversity of fisheries and aquatic life at your residence. Based on fish surveys and invertebrate sampling, the aquatic community has made a dramatic recovery over the past 40 years due to improvements in water quality. The cutoff channel and inflatable weir are not having an effect on the fish community above the weir. Shortly after installation there were some fish migration problems created by the cutoff channel, but the weir has been modified to address these issues.

Comment: The Clinton River is a river that was once in very bad shape in terms of ecological and fishery health as recently as the 1980s, yet is now showing a significant improvement in fish populations and other indicators of biological health. This should be emphasized in the Executive Summary.

> Response: We agree and added additional information in the **Executive Summary** section to illustrate this point.

Fishery Management

Comment: The Clinton River mainstem has great potential to develop a fine trout fishery. Between 800 and 900 volunteer hours have been directed at efforts to improve stream habitat in the Clinton River in 2005. The partners and the DNR should be acknowledged for their efforts.

> Response: Thank you. The DNR works closely with volunteers and organizations because it improves habitat and resources and also develops stewards of the resource.

Comment: The upper part of the North Branch needs to be reclassified. It behaves differently from the lower portion. This is not reflected throughout the report.

> Response: We agree that the North Branch transitions from a high quality, coldwater trout fishery in the headwaters to an average quality coolwater fishery at the lower end. Both **Present Fish Community** and **Fishery Management** sections are consistent with this characterization.

Comment: The angler creel survey should be included in the assessment report.

> Response: Creel data is available for the steelhead fishery for 1996 and 1997, below Yates Dam. This data is presented in the **Fishery Management** section of the assessment. This survey was conducted again in spring of 2005, but the data is not available at this time.

Comment: The Clinton River Coldwater Conservation Project (CRCCP) physical habitat data, macroinvertebrate data, and temperature data should be included in the assessment. You should document that this survey was done and the data is available.

> Response: The project was already referenced in the Citizen Involvement section of the assessment, but additional information was added to document the extent of data collected.

Comment: Add a management option to allow consideration of special fishing regulations on appropriate sections of the mainstem's midsection and on Paint Creek. These would reflect the unique coldwater habitat characteristics of these sections. This is especially important given this river systems close proximity to a large population of anglers.

> Response: A management option was added to evaluate the appropriateness of existing fishing regulations. MDNR, Fisheries Division has the authority to review fishing regulations at any time and propose changes. While special regulations could potentially provide more protection for trout, there has to be biological and social support for those changes.

Comment: A bottom-draw structure was installed on the Lake Orion Dam to improve the temperature regime in Paint Creek. What are the chances of getting bottom draws from the upper part of the Clinton River mainstem to improve water quality?

Response: Most of the Upper Segment is interrupted by numerous lakes. Due to the short distance from one lake to the next downstream lake, it is not feasible to consider bottom-draw structures because any temperature benefits would be nullified at the next lake downstream. The longest distance between impoundments is from Loon to Cass lakes and a bottom draw has not been considered at this time. The first lake encountered on the mainstem upstream from Lake St. Clair is Crystal Lake in Pontiac. It is possible a bottom-draw structure could improve water temperatures for coldwater fish in the Middle Segment and temperature data is being collected to evaluate the feasibility of this proposal.

Comment: Are there species of fish other than trout, like smallmouth bass and walleye, that could be managed for in the Clinton River above Yates Dam?

Response: Previous efforts have included stocking both smallmouth bass and walleye, but these efforts failed to develop a fishery.

Comment: What is the Fisheries Division's goal for steelhead stocking in the Clinton River?

Response: Steelhead have been stocked annually into the Clinton River since 1985. This stocking program has developed into a quality fishery and is something we wish to maintain through stocking. Recently the stocking goal has been 15,000 yearling steelhead annually. However, that number has been increased and the goal is to stock 25,000 yearling steelhead annually.

Comment: I would like to see more steelhead stocking into the Clinton River.

Response: See the reply above. Beginning in 2005, the number of steelhead stocked into the Clinton River was increased from 15,000 yearling steelhead annually to 25,000. This is a significant increase in the number of fish stocked.

Comment: Are we getting adult steelhead coming back to the Clinton River and successfully spawning and reproducing?

Response: We have documented successful steelhead reproduction in Paint Creek, but it is unclear how many of these fish contribute to the fishery. Steelhead spawn in the Clinton River mainstem as well. Redds can be observed in gravel areas downstream of Yates Dam. However, summer water temperatures get too warm to support steelhead. Conversely, steelhead that get over Yates Dam have access to water in the upper half of the Middle Segment that can support juvenile steelhead during summer at least some of the time. During hot summers, it is unlikely that steelhead are produced on the Clinton River mainstem.

Comment: What is the designated tag or clip for steelhead plants in the Clinton River?

Response: In the recent past, all steelhead that were stocked were given a fin clip for identification purposes. Unless part of a study, all steelhead stocked were given the same fin clip. Therefore, fish were not given river-specific fin clips. The purpose for clipping the fish was to identify the fish as a hatchery-produced fish. However, budget cuts have eliminated this fish marking program.

Comment: There has been a lot of discussion about trout management. I am most concerned with fish management in the shallower, downstream sections, especially the lower North Branch.

Response: The lower portion of the North Branch gets a good run of suckers and smallmouth bass.

Comment: Until the river's flow regime issues can be better managed, the success of the stocking programs will be capped. Low flow during the warm weather is a key limiting factor to the river's fishery and aquatic habitat potential.

Response: We agree that low summer flow is an impediment to fisheries populations. A number of factors, including changes in land use, filling of wetlands, water imports and exports to the watershed, and operation of lake-level control structures all contribute to reduced flows.

Comment: Would a bottom draw at Stony Creek Impoundment be feasible?

Response: No. In order for a bottom-draw structure to work, the lake needs to be deep enough to thermally stratify. Stony Creek Impoundment is too shallow for a bottom-draw structure to work properly.

Comment: Can Fisheries Division plant other species of trout in Paint Creek?

Response: Paint Creek has a long history of fish stocking, including brown, brook, and rainbow trouts. Brown trout have been stocked annually since 1972 and support a good trout fishery. Given the habitat conditions of Paint Creek and the success of the stocking program, brown trout are the most suitable species to stock.

Comment: Is there a reason why we do not want fish ladders around dams on the Clinton River? With the recent and dramatic increases in hiking trails, there is ample public access along rivers above Yates Dam, so anglers could take advantage of increased fishing opportunity.

Response: Please refer to the discussion of Yates Dam in the **Dams and Barriers** section of the River Assessment. Fish ladders are not effective for native species of interest.

Recreational Uses

Comment: Log jams are a big problem for canoes and kayaks, especially from Yates Dam upstream to Adams Road. They also cause erosion and collect human debris. Can specifications or guidelines be developed to address these problems?

Response: A Woody Debris Management Advisory Committee has developed guidelines called the "Clean and Open Method." These methods are described on the Friends of the

Rouge web page (http:/www.therouge.org/Programs/Rouge%20Rescue/woody_debris.htm). This method involves cutting a channel through the log jam in the center of the stream and does not require an MDEQ permit.

Comment: The inflatable weir on the cutoff channel prevents me from passing down the cutoff in my 16 ft boat like I used to do. Now I have to make an additional 2 hour run out of the old river channel to get to Lake St. Clair.

Response: The cutoff channel was constructed for flood control and not for recreational navigation.

Comment: I really like to fish the North Branch, but the only access available is at Wolcott Mills Metropark. Does the state have any plans to increase public access to the Clinton River, particularly along the North Branch?

Response: The DNR values lands that provide recreation potential. Although there is good public access at many points in the watershed, there are some areas that would benefit from additional access. There are management options listed to address this issue.

Comment: The recreational value of the Clinton River system is huge due to its proximity and accessibility to Southeast Michigan anglers. There are 1.4 million residents living in the Clinton River watershed, the state's most populous. This point should be made in the Executive Summary.

Response: We agree and have incorporated this point in the **Recreational Use** section of the **Executive Summary**.

Comment: The HCMA should reprint and distribute their Clinton River Canoe Map and the Oakland County Trail Network map should be made available.

Response: Both of these are good resources for information on recreational opportunities in the watershed and we encourage their availability.

Citizen Involvement

Comment: Citizen involvement should be directed towards creating some kind of volunteer committee in as many Clinton River watershed communities as possible with the intent of river stewardship.

Response: We agree that citizen involvement and river stewardship are critical to maintaining and improving the Clinton River system. The **Citizen Involvement** section currently lists a number of organizations that people can get involved with to improve conditions in the watershed.

Comment: The Clinton River Watershed Council is doing a great job of cleaning up the river.

Response: We agree. The many things the CRWC does, including education efforts, promoting stewardship, working with local government, businesses, community groups and individuals, all contribute towards a better Clinton River.

Management Options

Comment: Clarify the location of the Paint Creek dam recommended for removal in the Dams and Barriers section.

Response: Specific location was added to the assessment.

Comment: Add a management option supporting stream flow monitoring.

Response: We agree with this comment and have added a management option to address this comment.

Comment: Consider referencing the Clinton River Delisting Criteria Development project (Opfer et al. 2005) in the Management Options section.

Response: At the time that the **Management Options** section was written, this report was not yet available. We concur with the value of this document and have added appropriate management options based on this report.

GLOSSARY

alluvial – sediments carried in glacial melt waters

base flow – groundwater discharge to the river

benthic – associated with the bottom of a stream or lake

biodiversity – number and type of biological organisms in a system

BP – before present

channelize – to straighten and clean a streambed or waterway to enhance land drainage

CRCCP – Clinton River Coldwater Conservation Project

CRWC – Clinton River Watershed Council

CSO event – when a combined sewer (carrying both municipal wastewater and storm water) overflows into a waterway

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

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

extirpation – to make extinct, eliminate completely

exurban – development consisting of scattered non-farm residential dwellings placed in predominantly agricultural and forested areas

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

fauna – animals of a specific region or time

FCMP – Fish Contaminant Monitoring Program

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

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

HCMA – Huron-Clinton Metropolitan Authority

hydrology – study of water

impervious – not permitting penetration or passage

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

interlobate – within glacial moraine formations

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

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

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

macrophytes – rooted aquatic plants with stems and leaves below the surface of water (occasional exceptions have a few small floating or aerial leaves)

mainstem – primary branch of a river of stream

MDEQ – Michigan Department of Environmental Quality

MDNR – Michigan Department of Natural Resources

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

NPDES – National Pollution Discharge Elimination System

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

PCB – polychlorinated biphenyl

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

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

stratified – to form, arrange, or deposit in layers

thermocline – a layer of water between the warmer surface zone and the colder deepwater zone in a thermally stratified body of water (such as a lake), in which the temperature decreases rapidly with depth

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

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FIGURES

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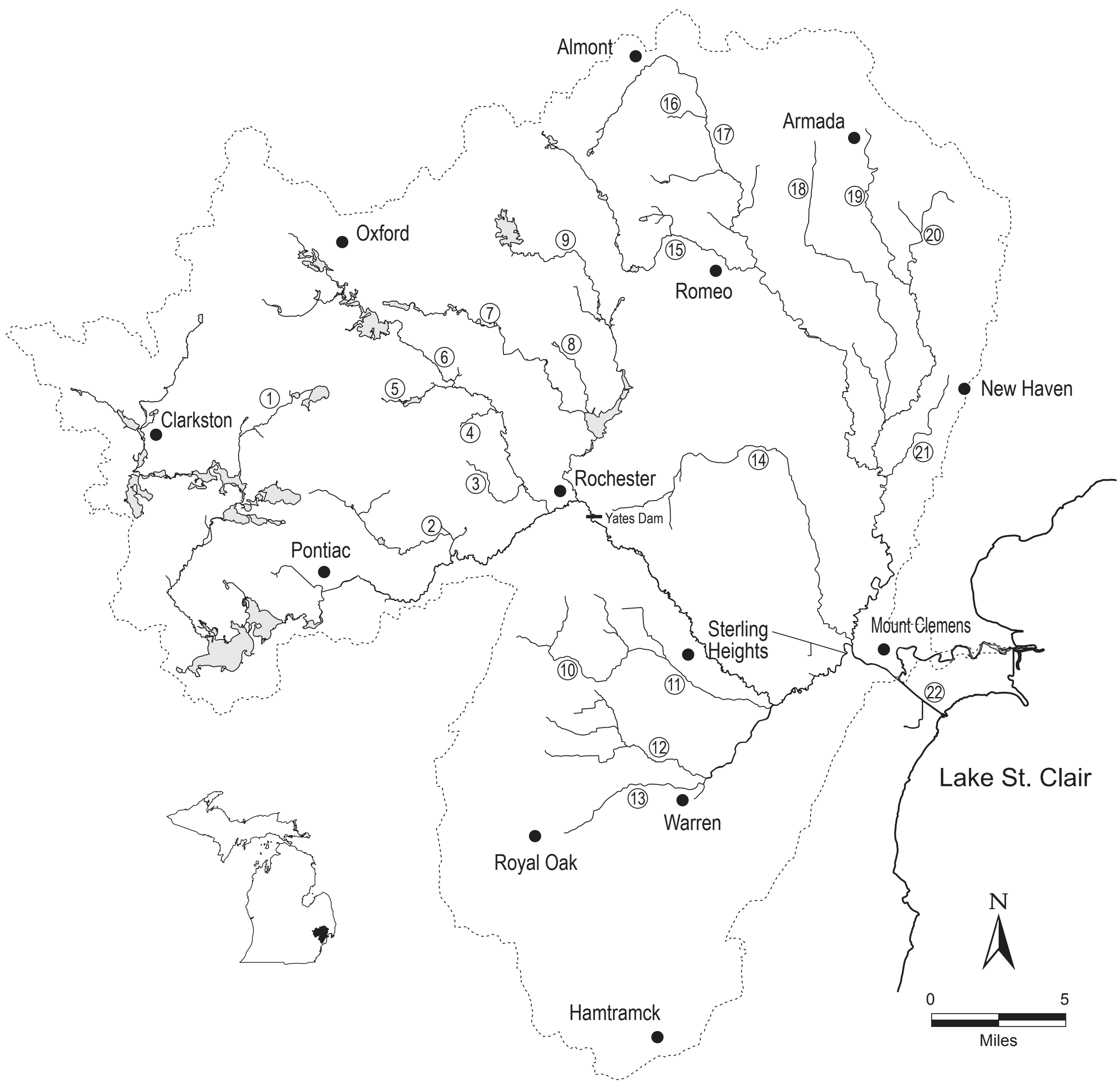


1 – Sashabaw Creek
2 – Galloway Creek
3 – Sargent Creek
4 – Gallagher Creek
5 – Trout Creek
6 – Paint Creek
7 – West Branch Stony Creek
8 – McClure Drain
9 – Stony Creek
10 – Gibson Drain
11 – Plum Brook
12 – Big Beaver Creek
13 – Red Run
14 – Middle Branch Clinton River
15 – East Pond Creek
16 – Kidder Creek
17 – North Branch Clinton River
18 – Coon Creek
19 – East Branch Coon Creek
20 – Highbank Creek
21 – Deer Creek
22 – Clinton River Cutoff Channel

Figure 1.–Major tributaries to the Clinton River.

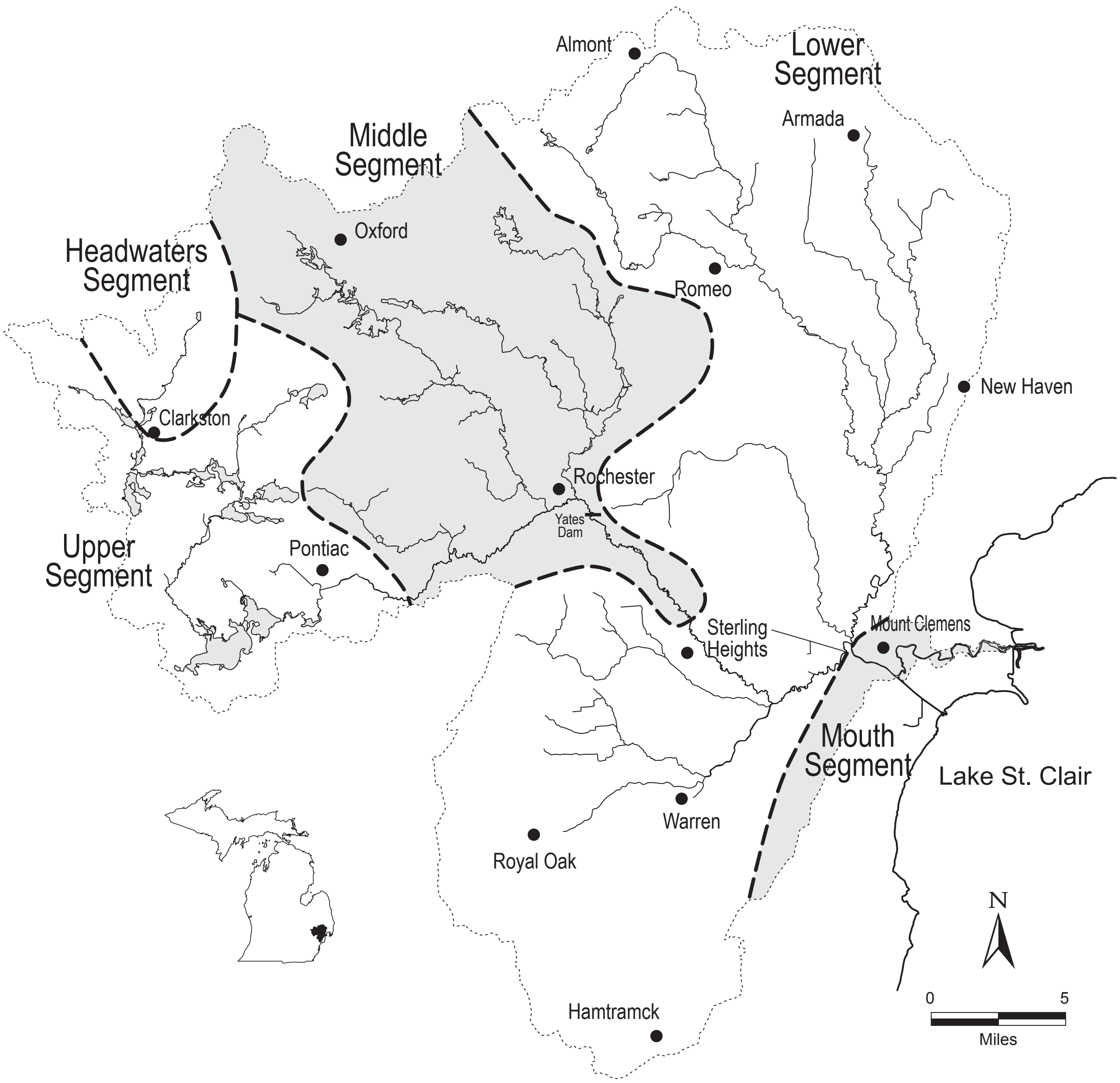


Figure 2.–Valley segments of the Clinton River mainstem.

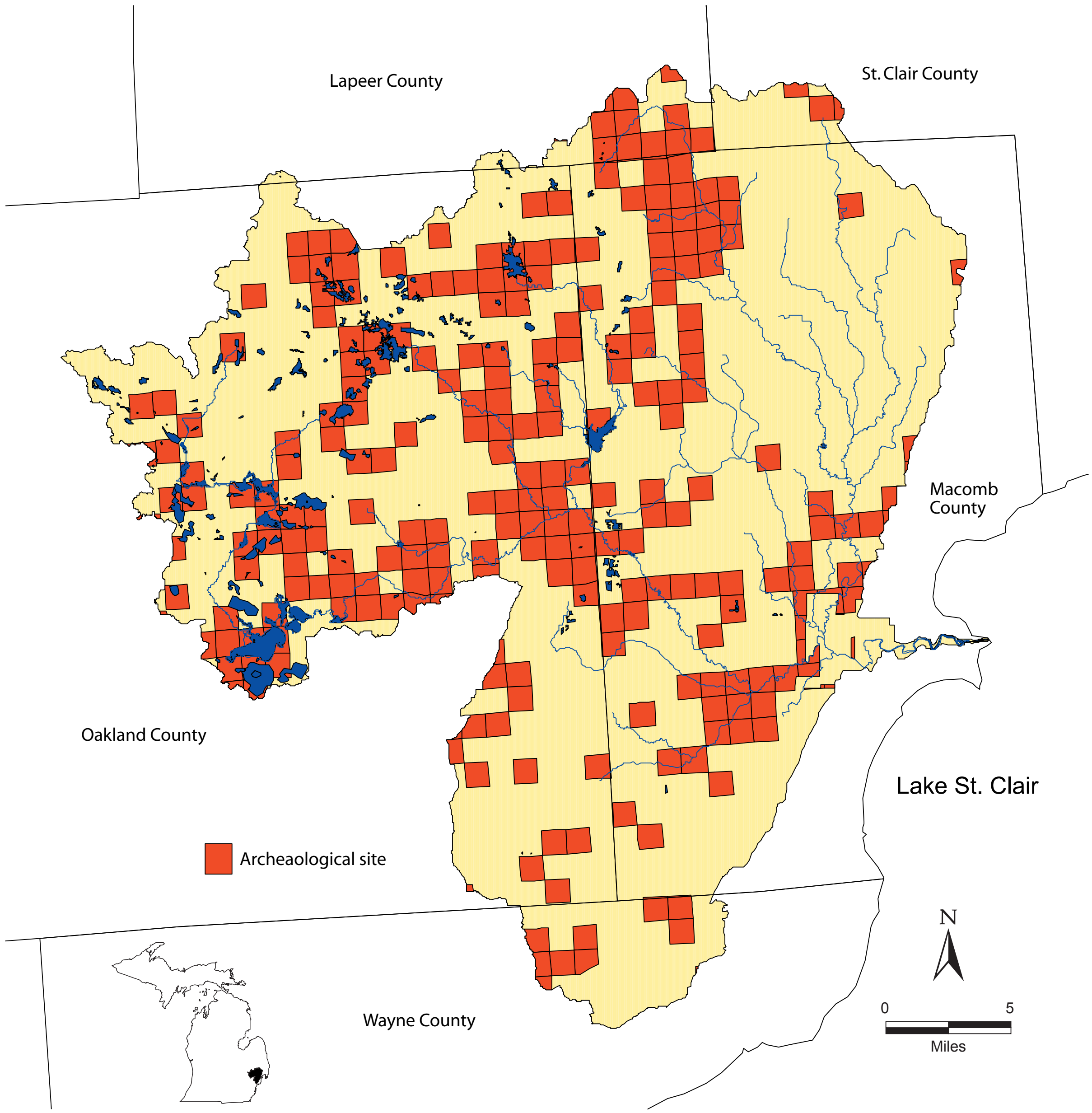


Figure 3.–Spatial distribution of archaeological sites within the Clinton River watershed indicating extensive occupation by prehistoric Native Americans.

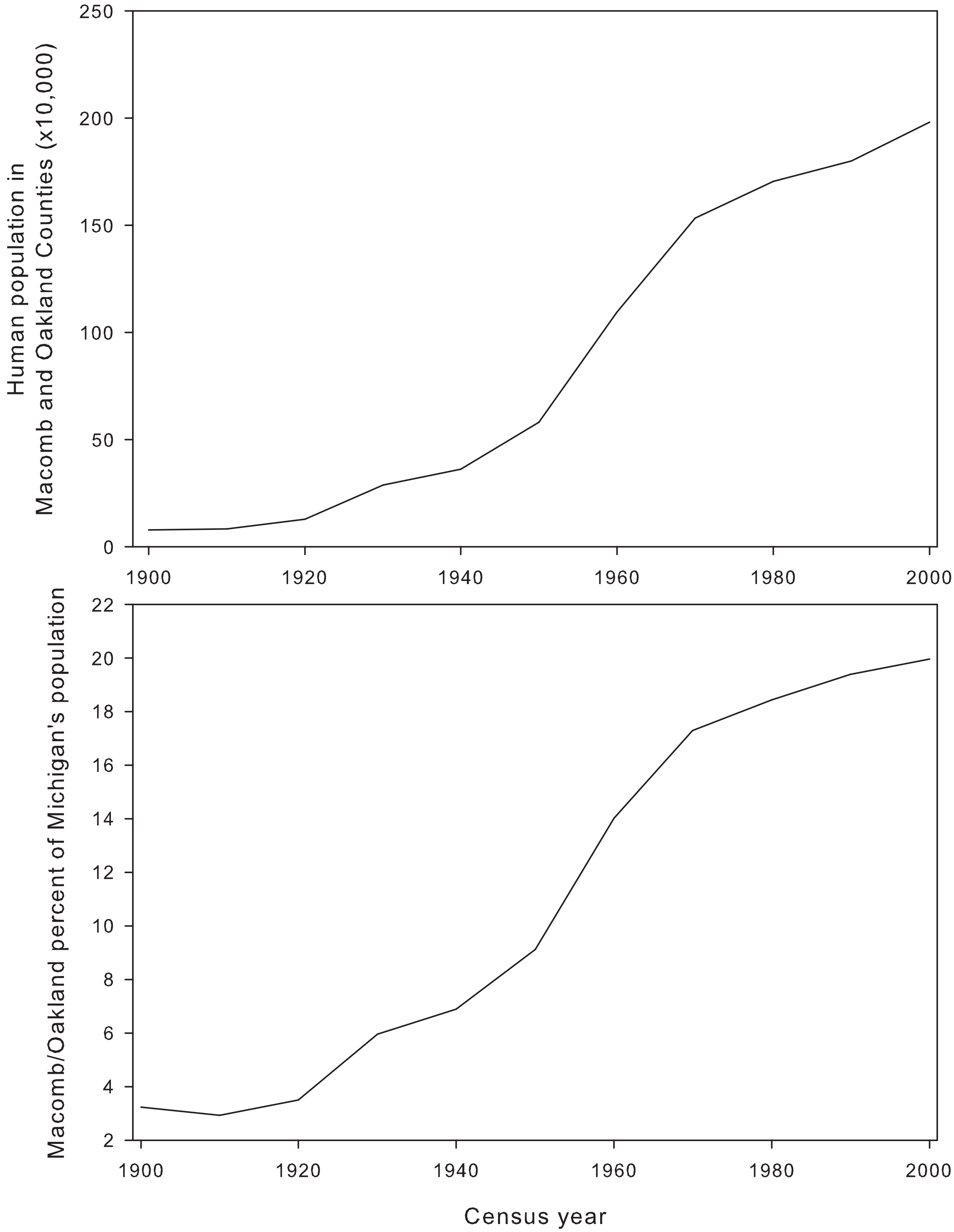


Figure 4.–Graphs of human population growth combined in Macomb and Oakland counties. The top graph shows combined population number during 11 census years from 1900 through 2000. The bottom graph shows the Oakland and Macomb population as a percentage of the total inhabitants of Michigan.

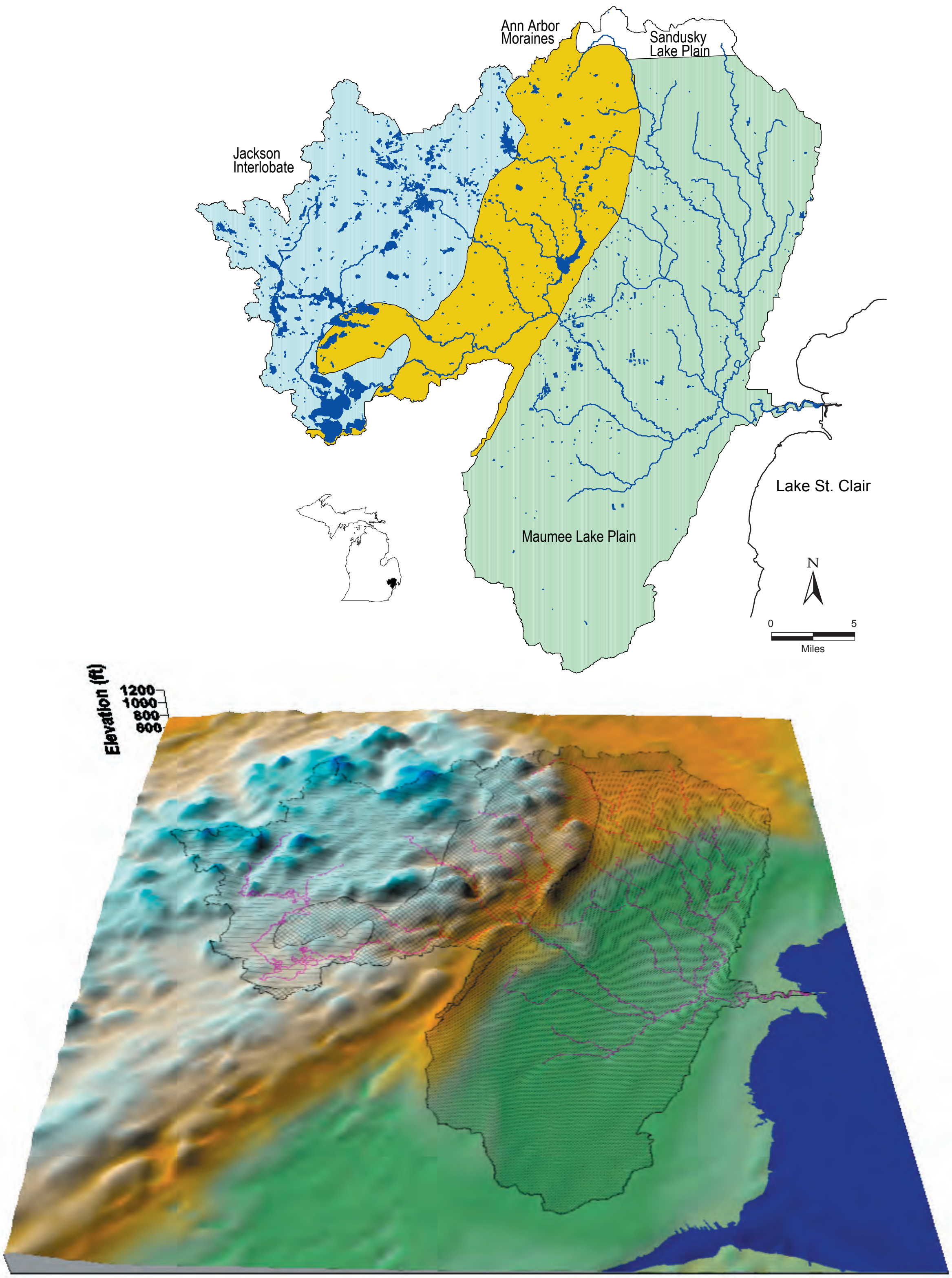
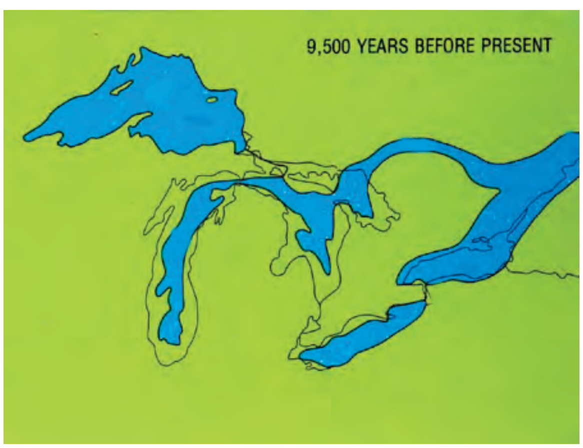


Figure 5.–Extent and classification of four landscape ecosystems (Maumee Lake Plain, Sandusky Lake Plain, Ann Arbor Moraines, and Jackson Interlobate) of the Clinton River watershed. The upper map shows lakes as well as major river segments, while the lower map shows general shape of the terrain. Ecosystem data were taken from Albert (1995).

Map 1

Map 2

Map 3



Map 4

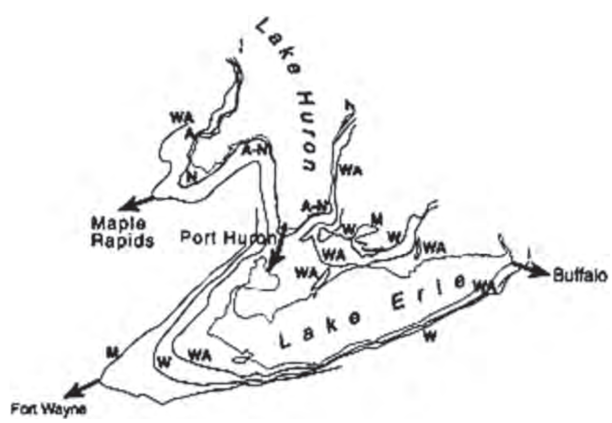


Figure 6.–Three glacial stages representing major geological forces that formed the Clinton River watershed landscape during the prehistoric (Quaternary) time period. The dark gray (or blue) areas were water, light gray (or green) land surface, and white were glaciers. The shoreline of the current Great Lakes are outlined and the watershed denoted with a black star to show geographic orientation. The fourth map shows shorelines for representative glacial lake stages. These maps were modified from images on the Michigan State University Geology Department website.

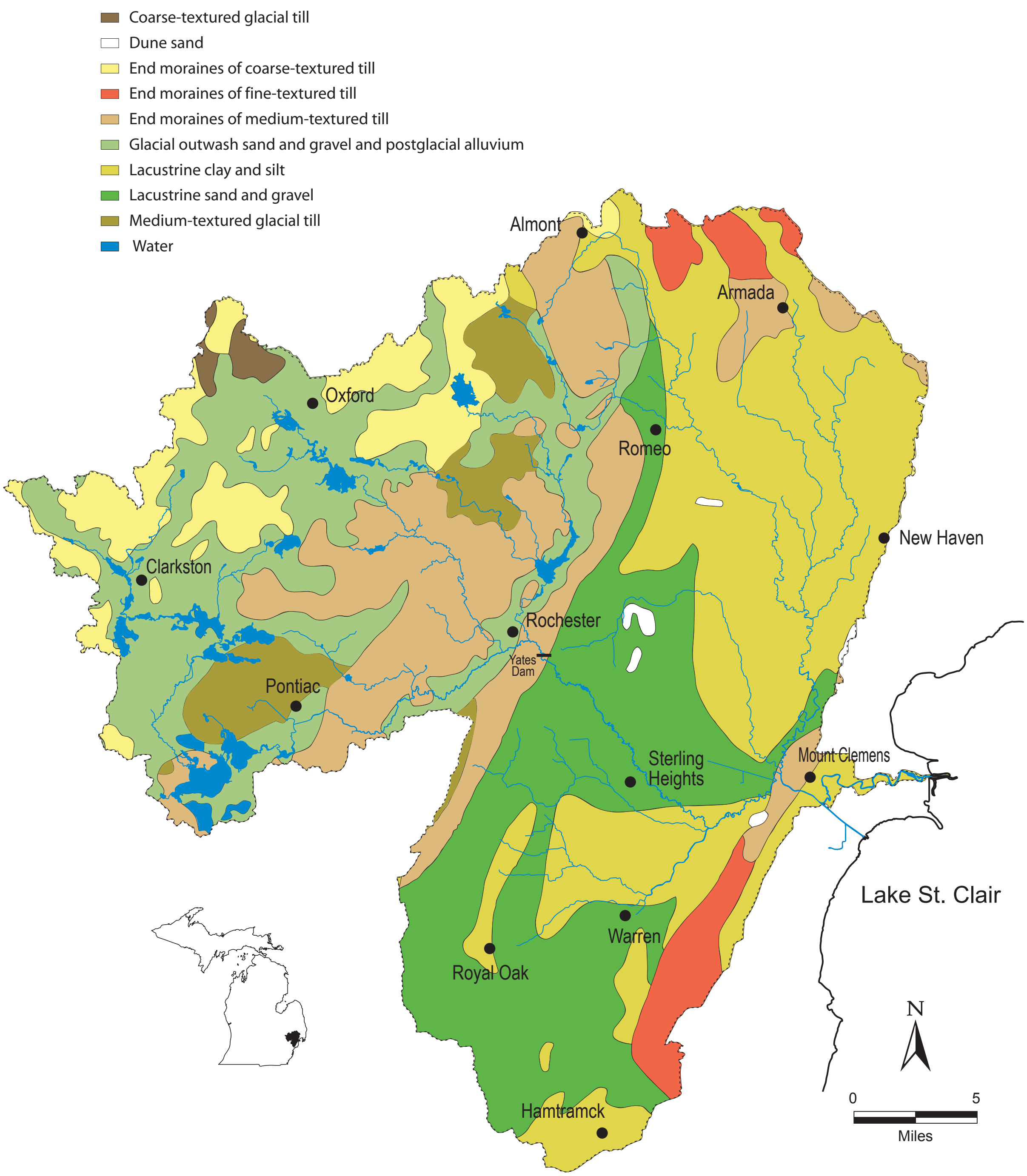


Figure 7.–Surface geology of the Clinton River watershed.

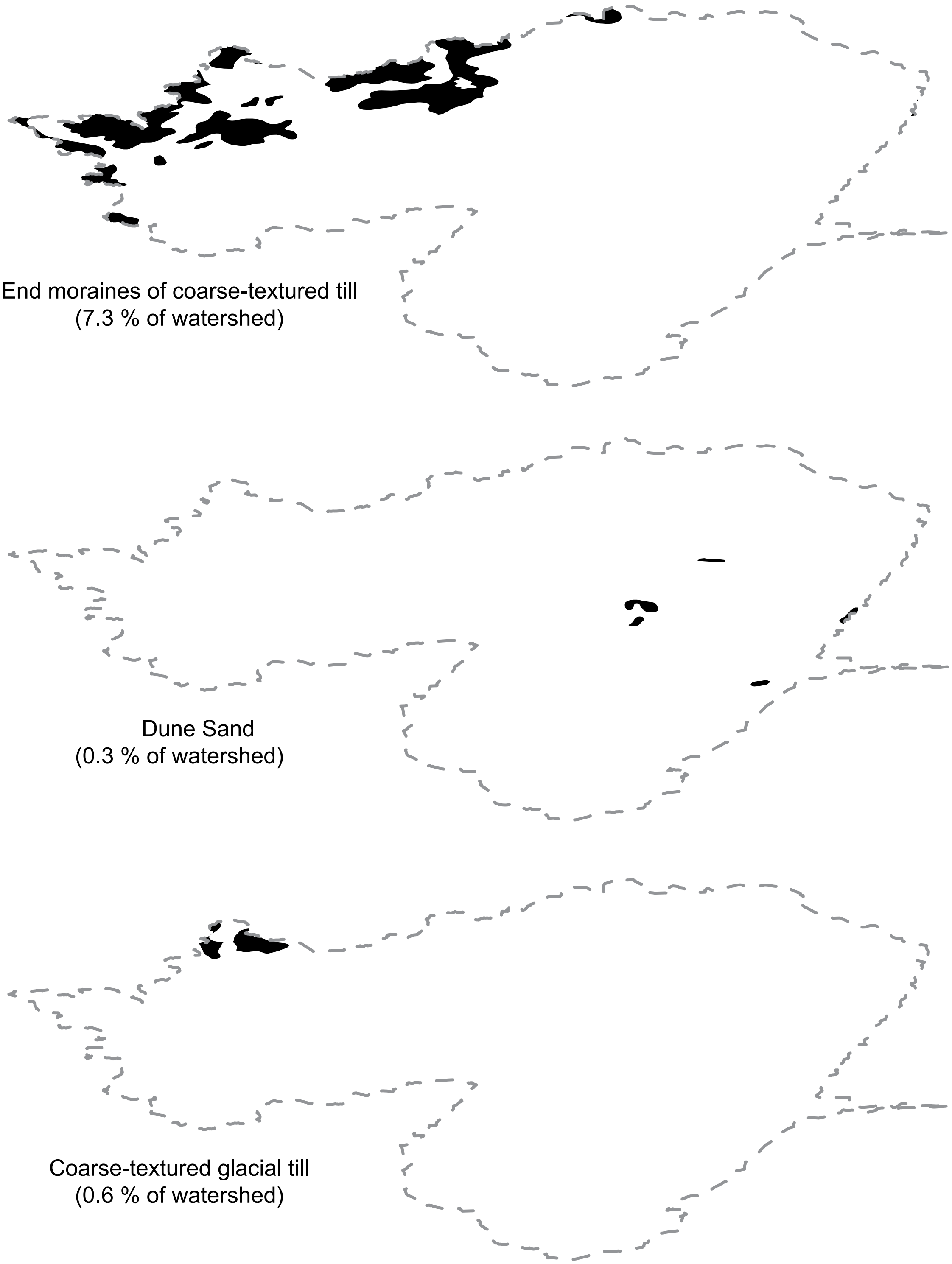


Figure 8.–Spatially aligned maps show distribution of three glacial deposits (coarse-textured glacial till, dune sand, and end moraines with coarse-textured till) within the Clinton River watershed. Numbers in parentheses show areal coverage as percent of entire watershed.

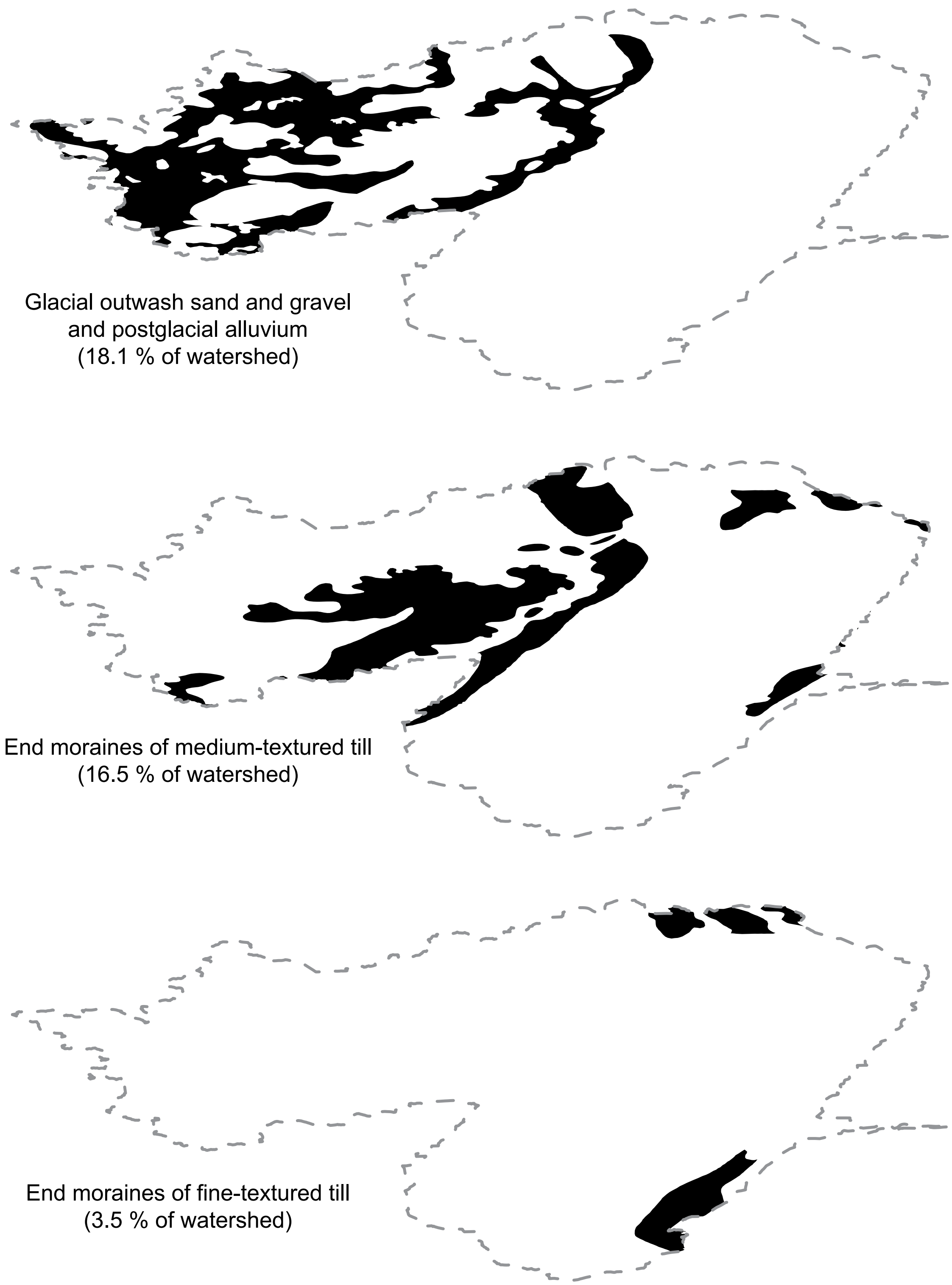


Figure 9.–Spatially aligned maps show distribution of three glacial till types (end moraines of fine-textured till, end moraines of medium-textured till, and outwash of sand and gravel) within the Clinton River watershed. Numbers in parentheses show areal coverage as percent of entire watershed.

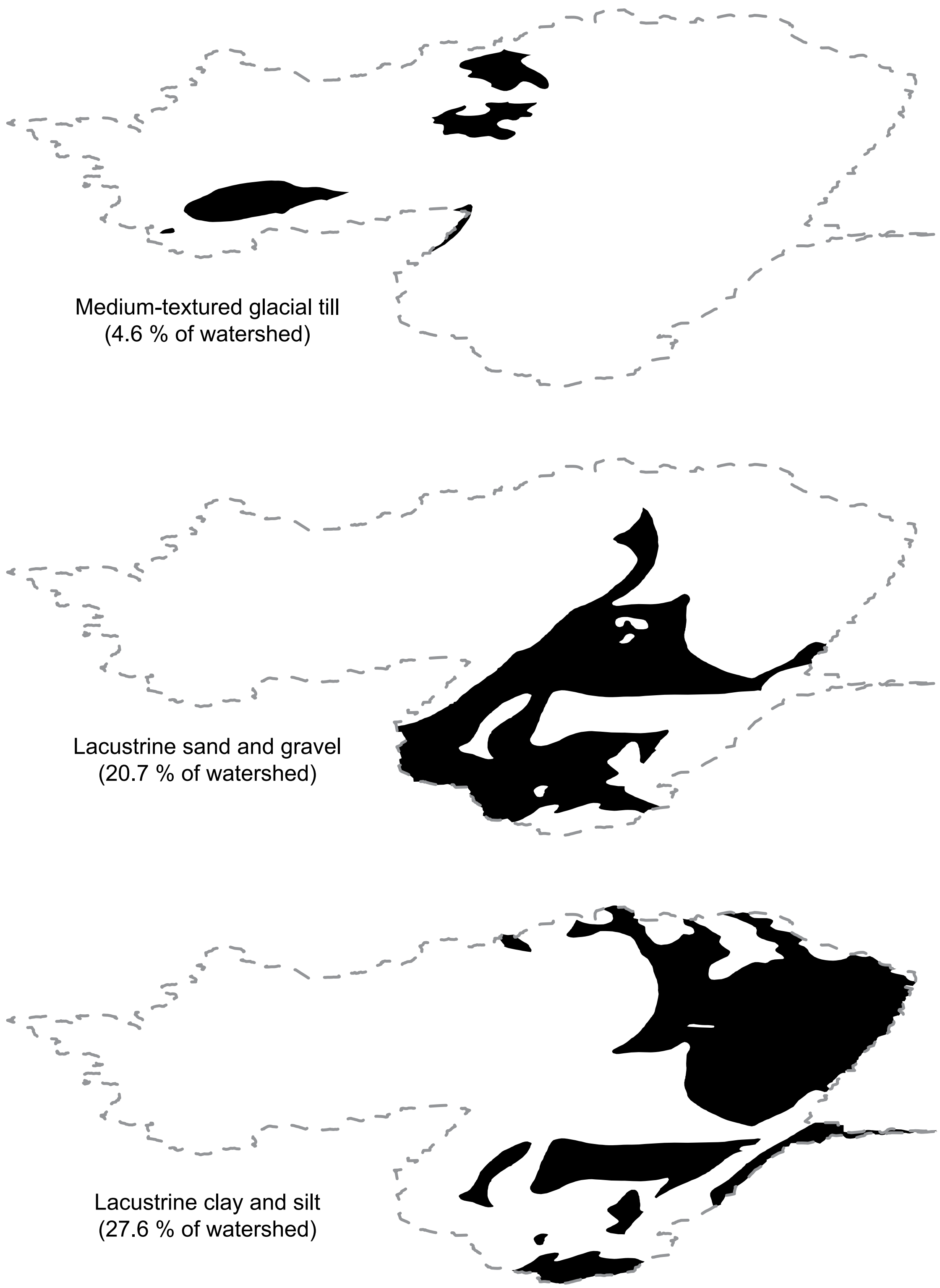


Figure 10.–Spatially aligned maps show distribution of three glacial till types (medium-textured till, lacustrine sand and gravel, and lacustrine clay and silt) within the Clinton River watershed. Numbers in parentheses show areal coverage as percent of entire watershed.

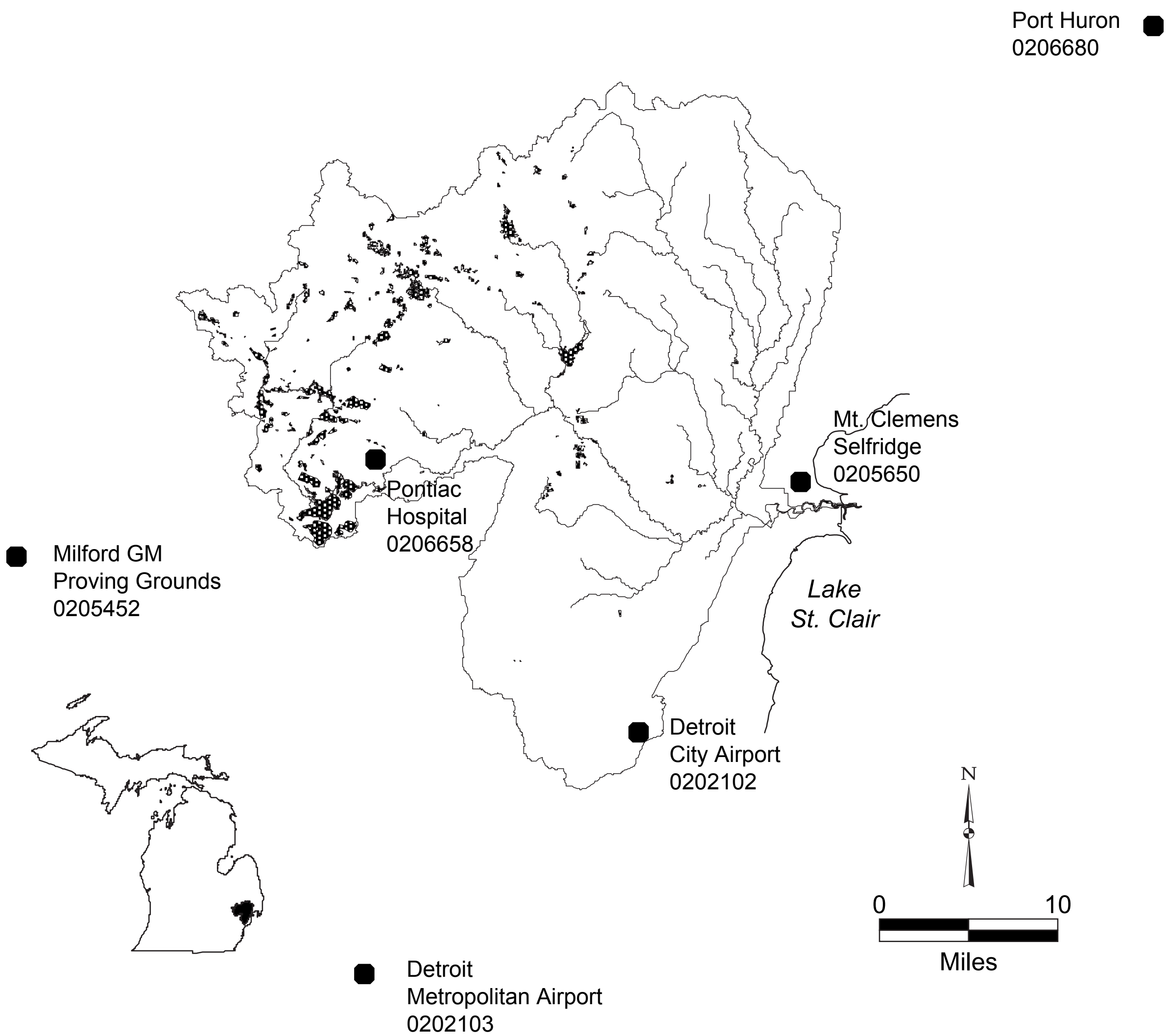


Figure 11.–Locations and National Oceanic and Atmospheric Administration identification numbers of weather stations from which data on daily precipitation, minimum, and maximum temperature were obtained for period of record (1948–2000). Data were obtained from the National Climatic Data Center which is part of the Department of Commerce, National Oceanic and Atmospheric Administration.

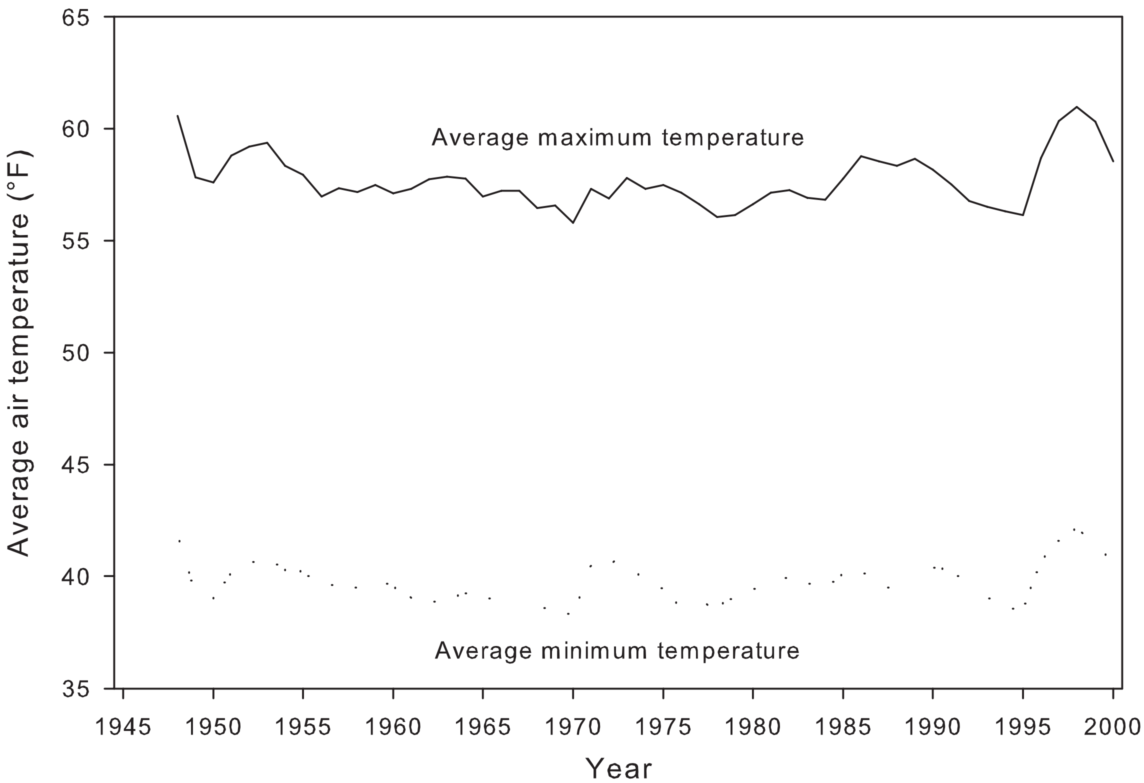


Figure 12.–Average yearly maximum and minimum air temperature in the Clinton River watershed for period of record (1948–2000). Data from the National Oceanic and Atmospheric Administration's, National Climatic Data Center.

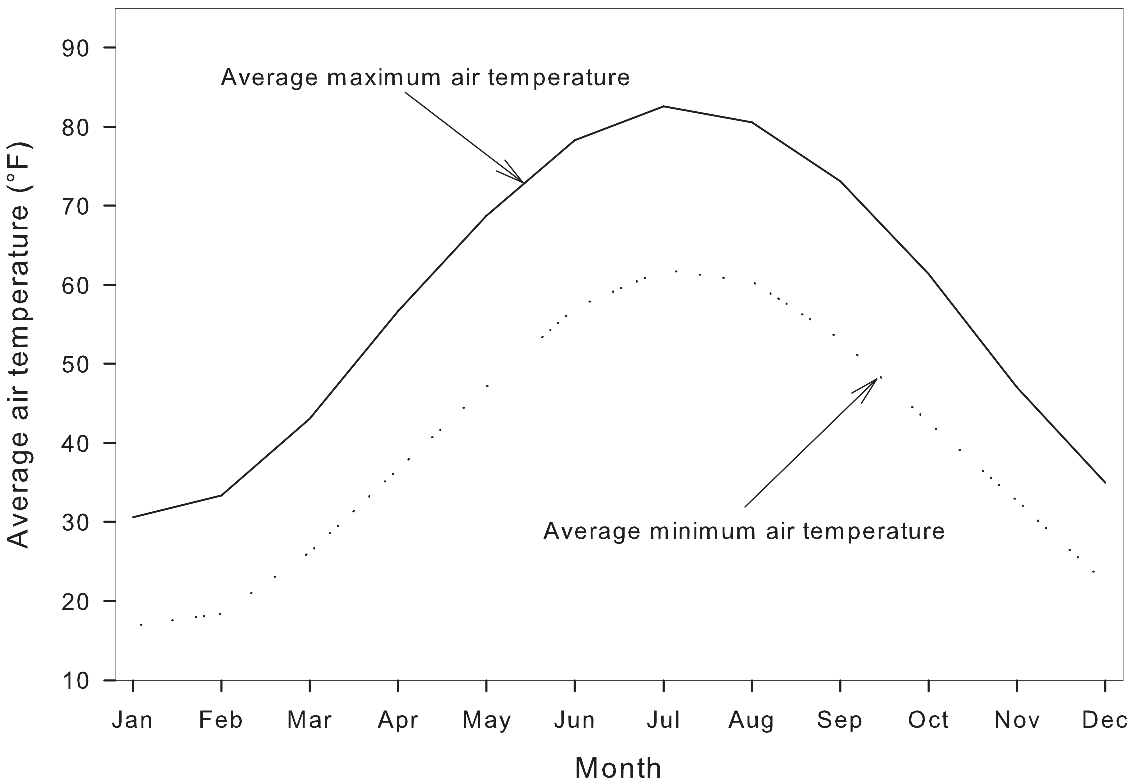


Figure 13—Average monthly maximum and minimum air temperature in the Clinton River watershed for period of record (1948–2000). Data from the National Oceanic and Atmospheric Administration's, National Climatic Data Center.

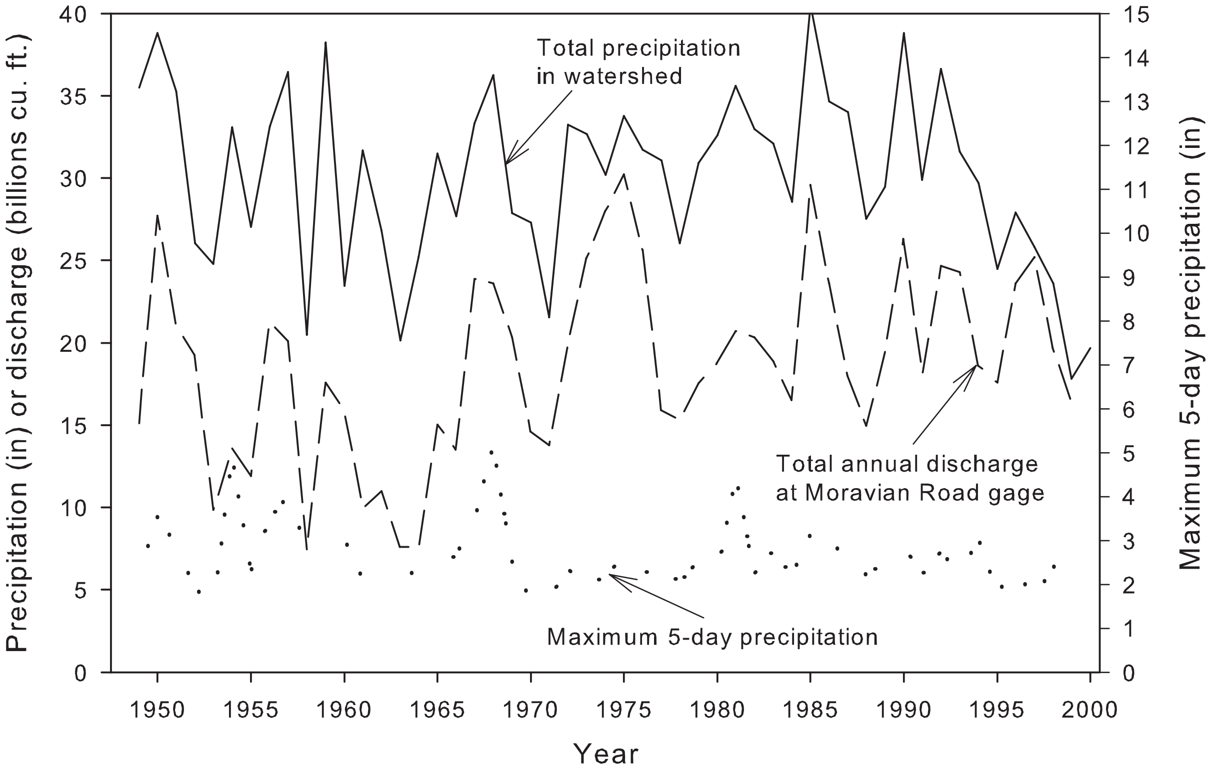


Figure 14.—Annual total precipitation (inches) and 5-day maximum (inches) in the Clinton River watershed and total annual discharge (billions of cubic feet) at the Moravian Drive gauge. Data source United States Geological Survey gauges for period of record (Table 2) and from the National Oceanic and Atmospheric Administration's, National Climatic Data Center.

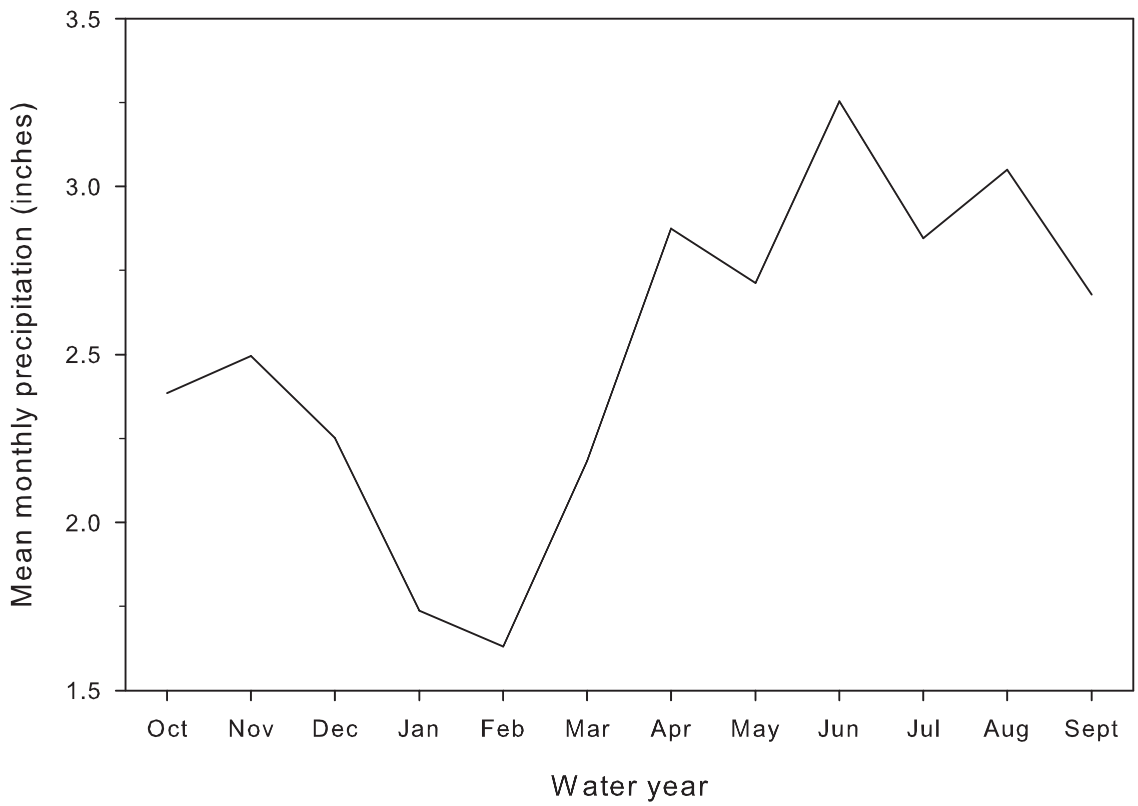


Figure 15.—Mean monthly precipitation (inches) across the Clinton River watershed for period of record (1948–2000). Values were estimated from data obtained from the National Climatic Data Center.

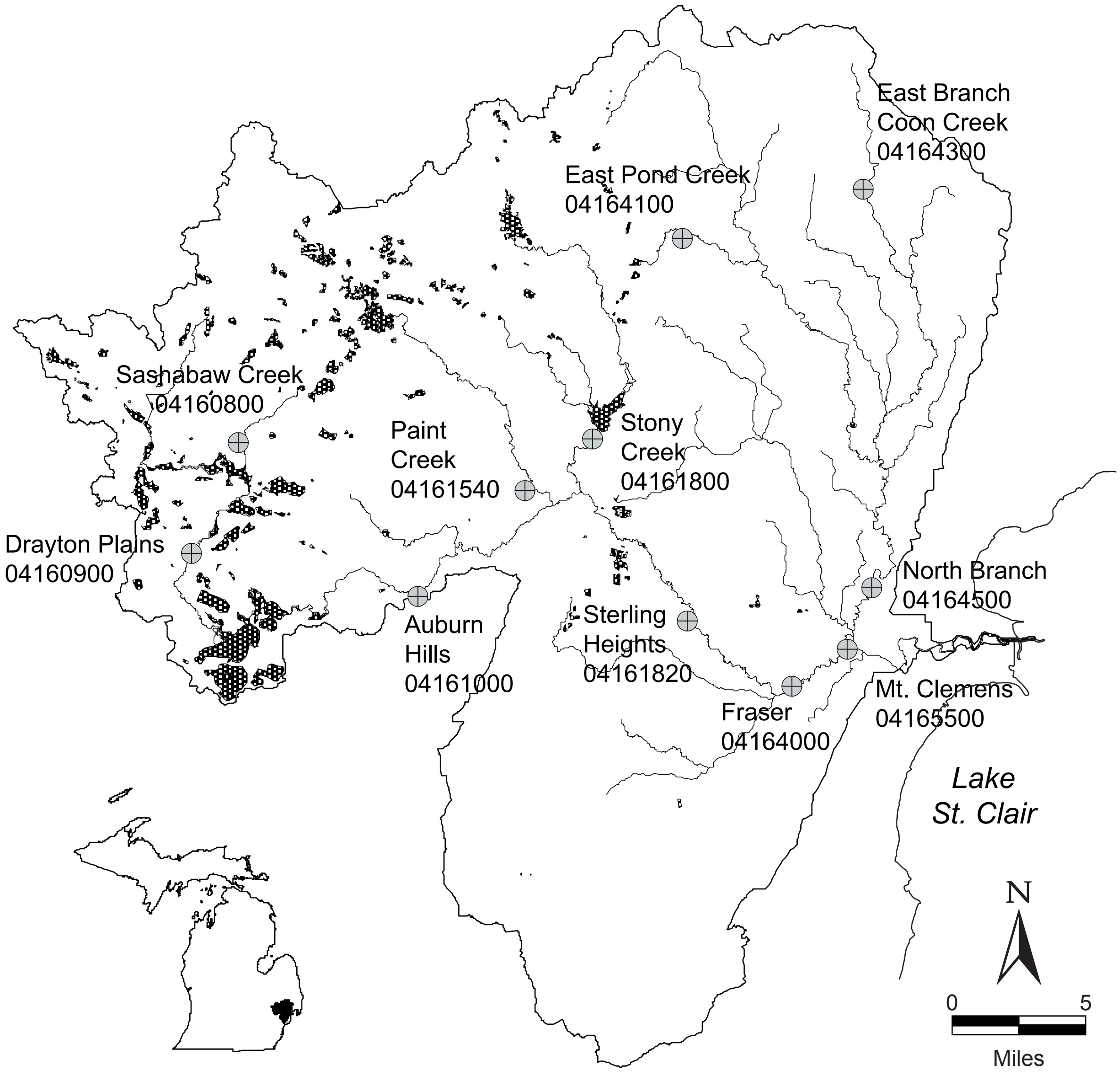


Figure 16.─Locations of selected Clinton River basin United States Geological Survey gauging stations with their name and identification number.

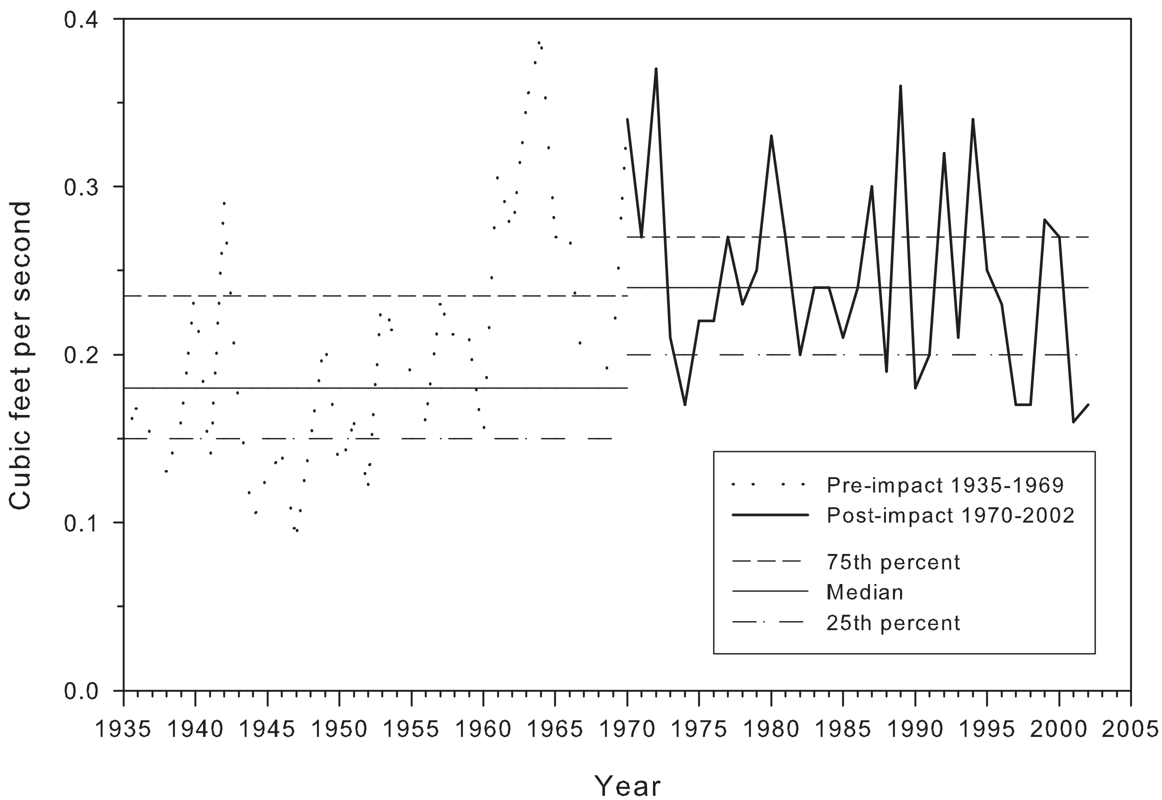


Figure 17.–Change in base flow at the Clinton River, Moravian Drive gauge, based on the Indicators of Hydrologic Alteration model.

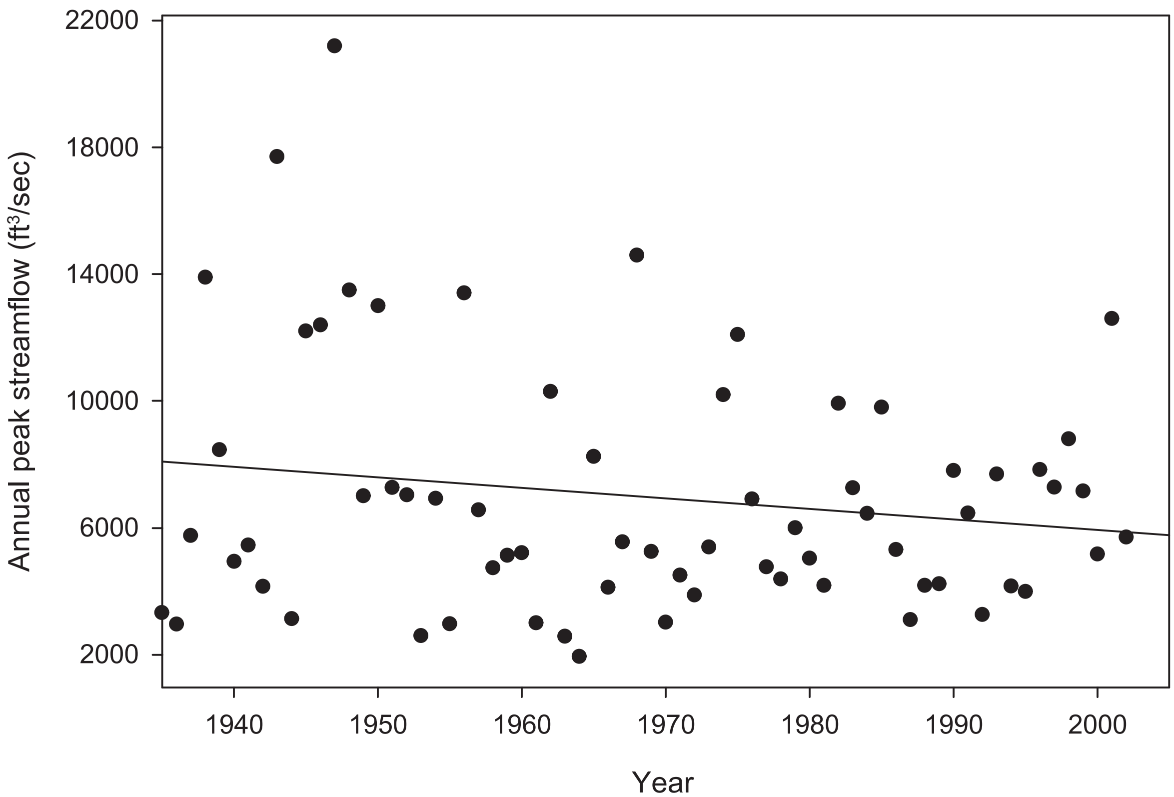


Figure 18.–Peak annual stream flow recorded at the Moravian Drive gauge station (1934–2002). Data from United States Geological Survey.

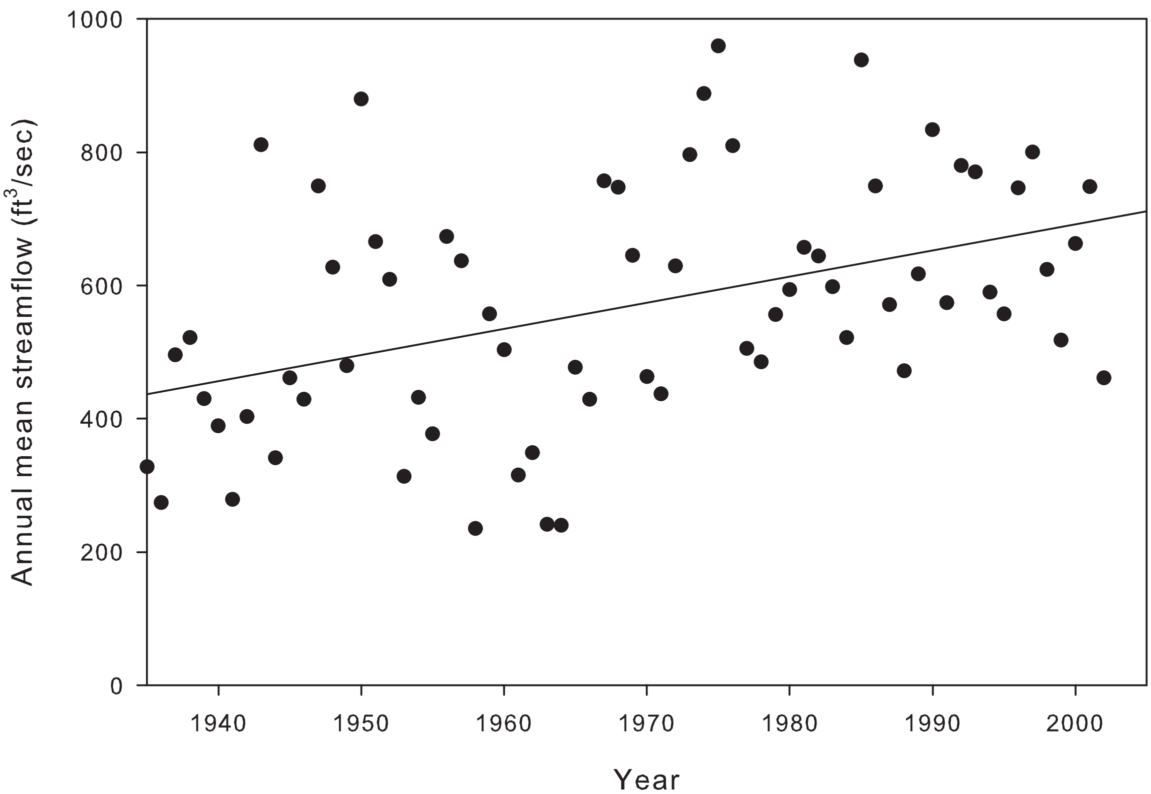


Figure 19.–Mean annual stream flow recorded at the Moravian Drive gauge station (1934–2002). Data from United States Geological Survey.

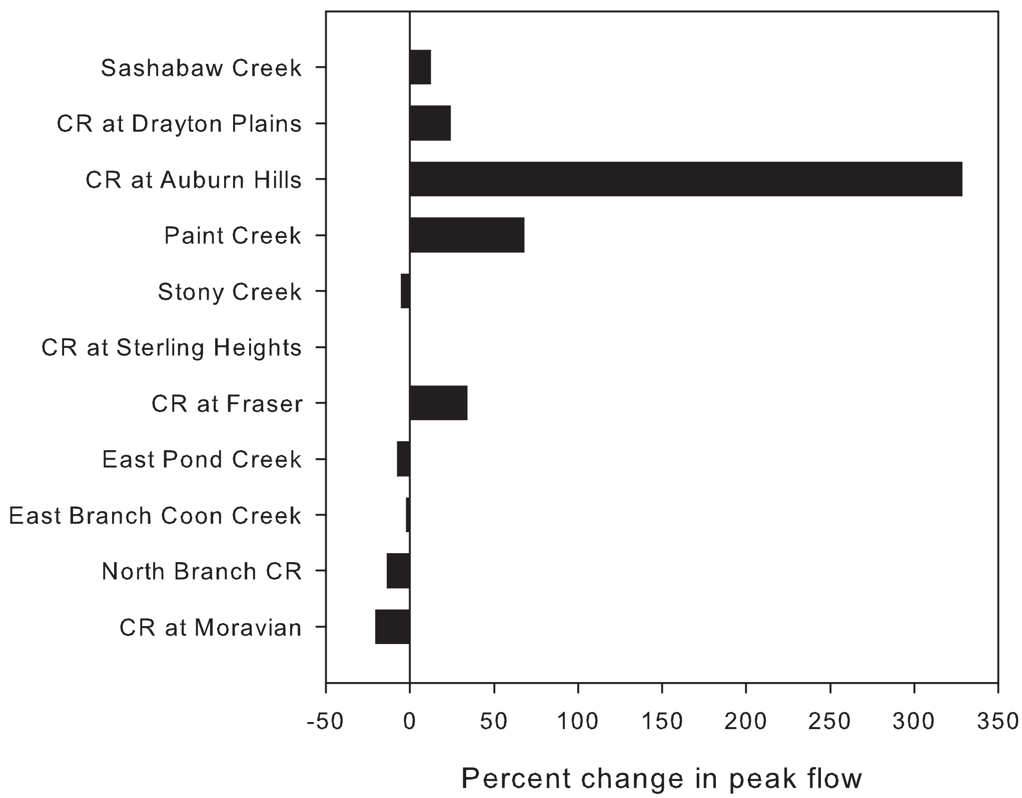


Figure 20.–Change in peak flow at each gauge station over period of record. CR in Y axis labels means Clinton River. Data from the United States Geological Survey.

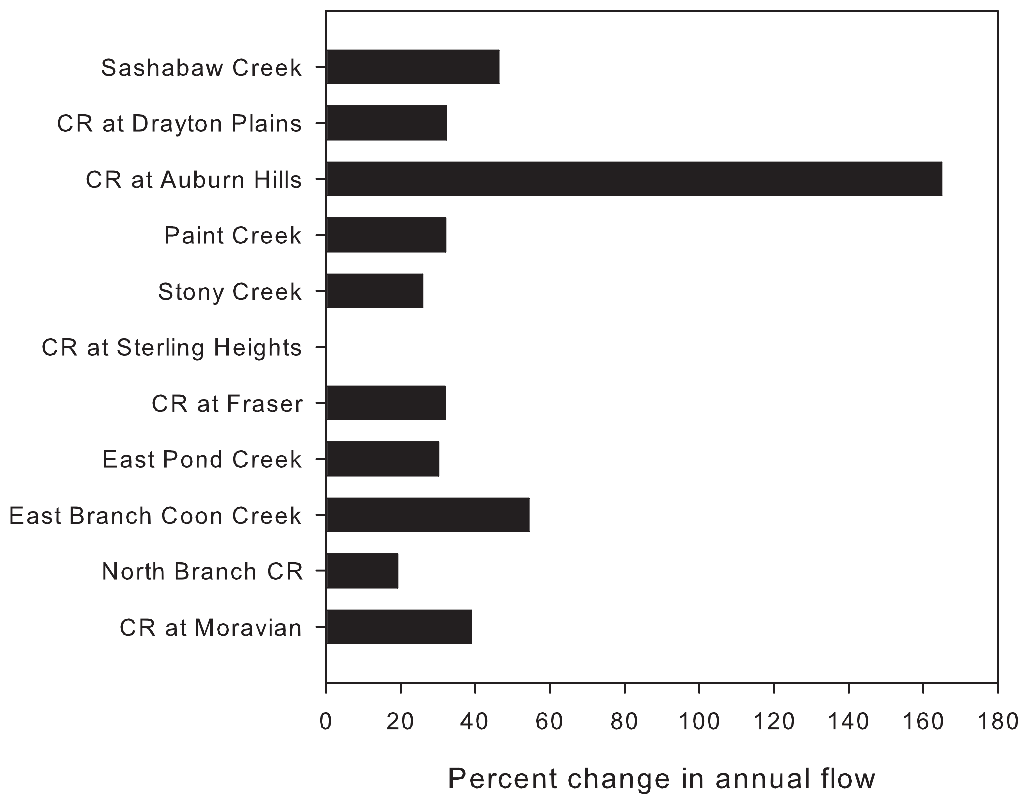


Figure 21.–Change in mean annual stream flow at each gauge station over period of record. CR in Y axis labels means Clinton River. Data from the United States Geological Survey.

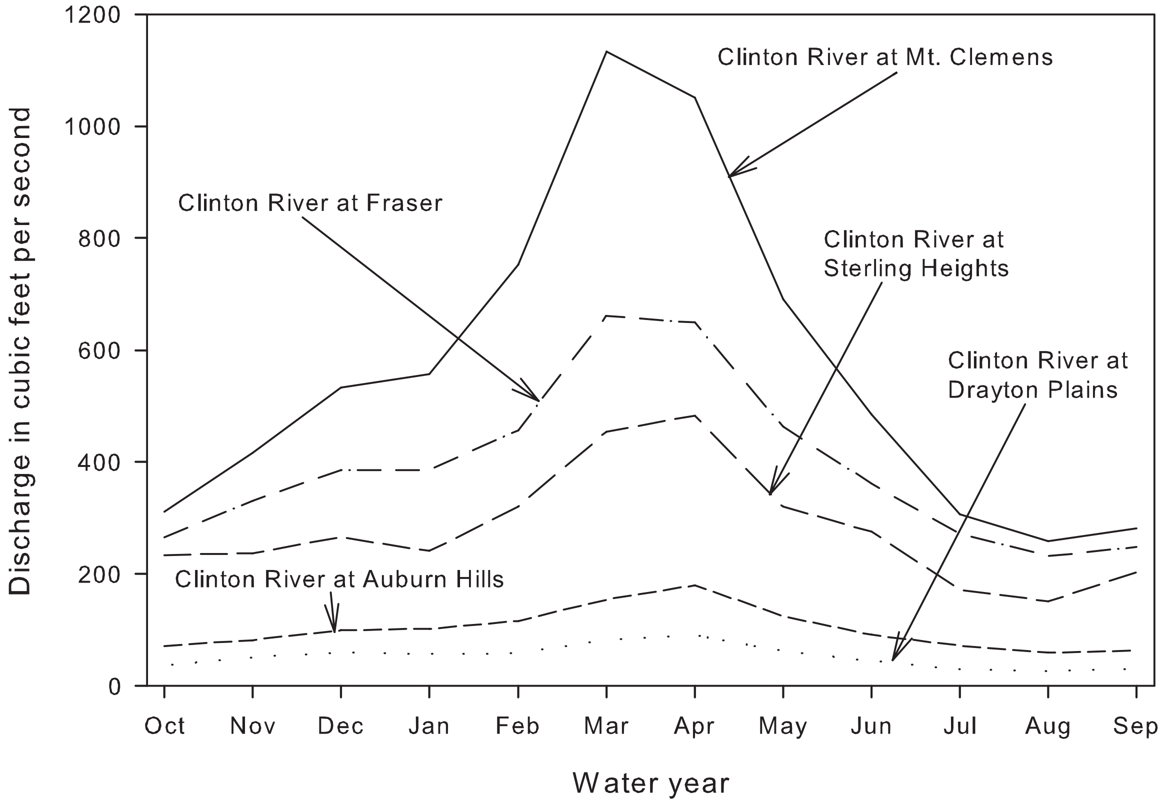


Figure 22.—Daily discharge at five locations on the main branch of the Clinton River, averaged by month. Data source United States Geological Survey gauges for period of record (Table 3).

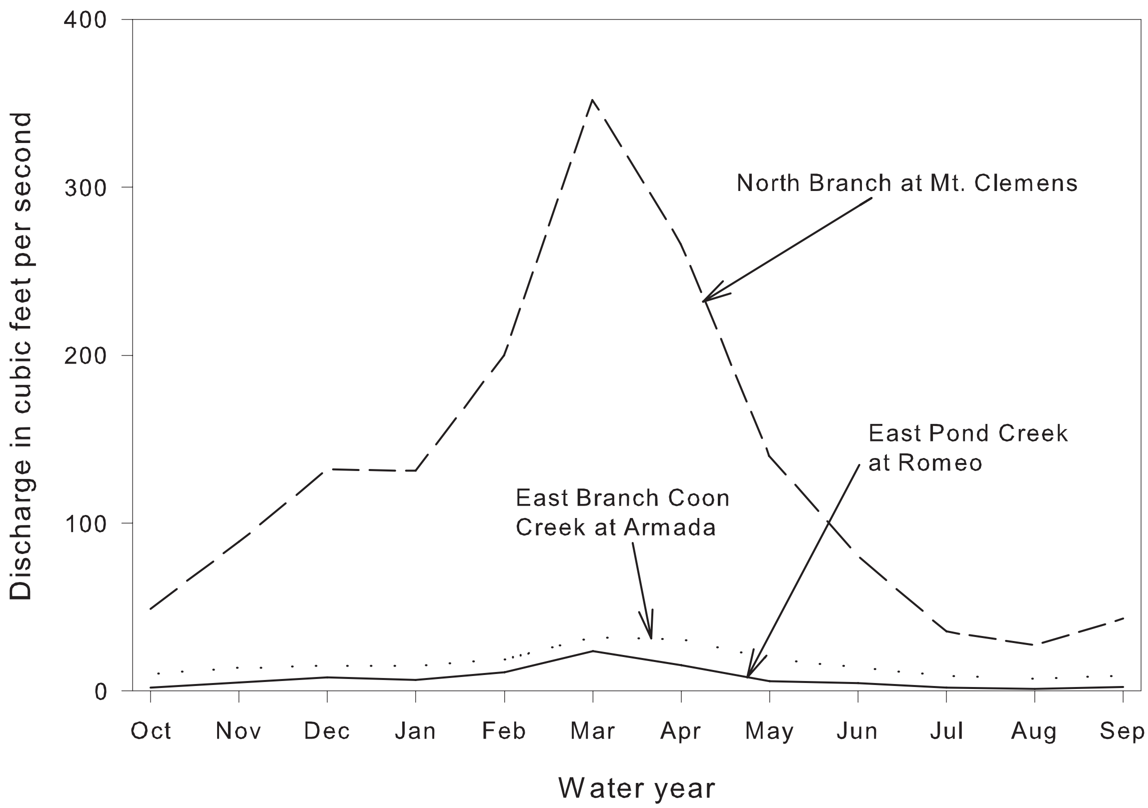


Figure 23.—Daily discharge at one location on the North Branch of the Clinton River, and two of its tributaries, averaged by month. Data source United States Geological Survey gauges for period of record (Table 3).

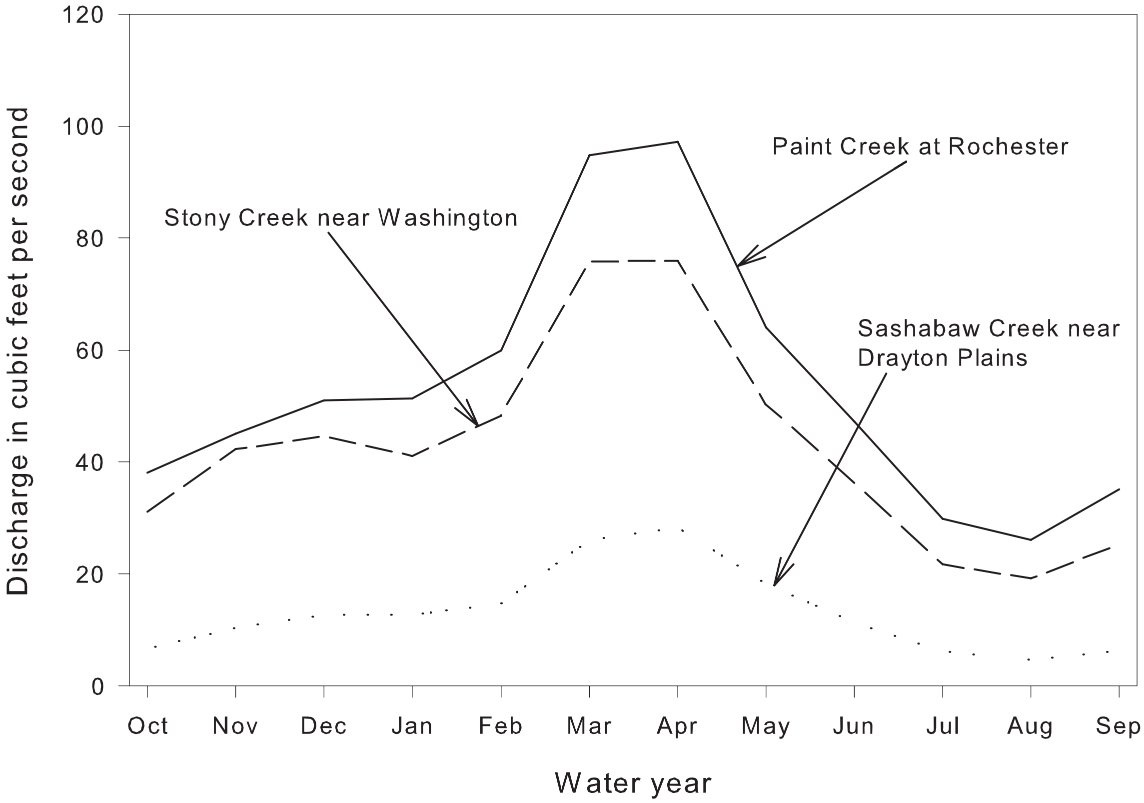


Figure 24.—Daily discharge at three locations on tributaries of the Clinton River, averaged by month. Data source United States Geological Survey gauges for period of record (Table 3).

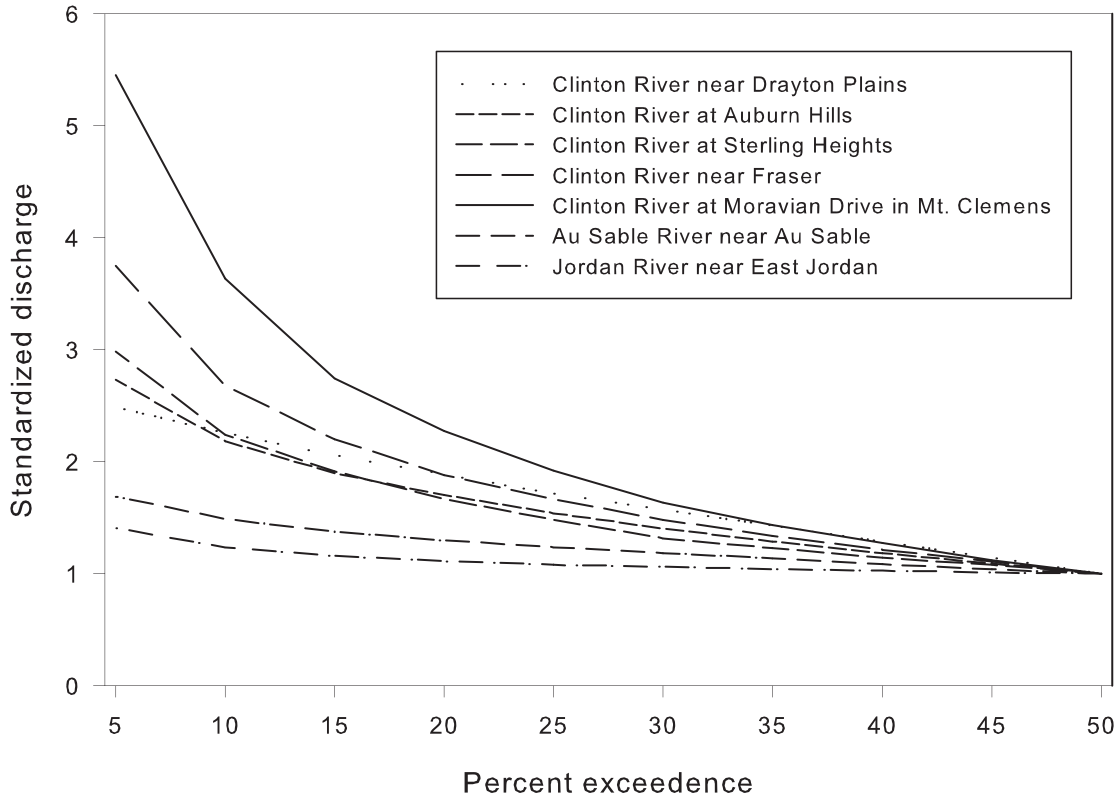


Figure 25.─Standardized high flow exceedence curves for the main branches of the Clinton River. (Standardized discharge = discharge (Q)/median discharge(50% Q)). Shown for comparison are the Au Sable and Jordan rivers, two of Michigan's most stable rivers. Data source United States Geological Survey gauges for period of record (Table 3).

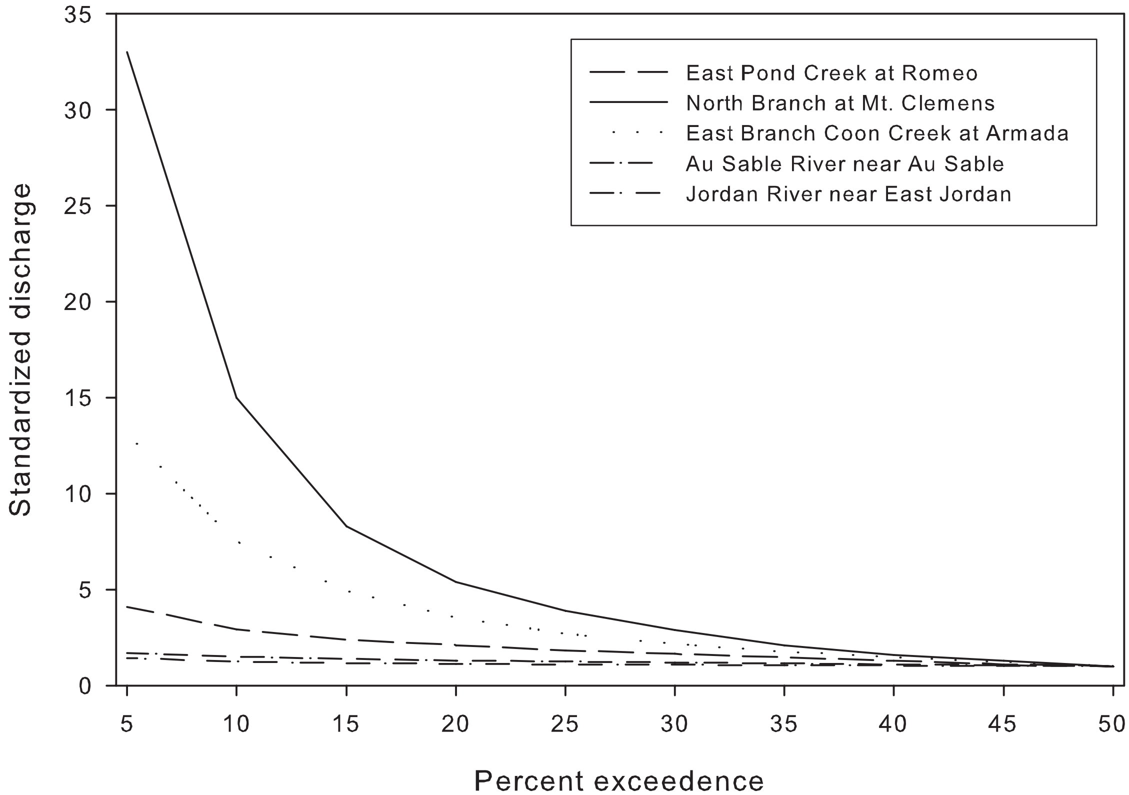


Figure 26.–Standardized high flow exceedence curves for the North Branch of the Clinton River and tributaries. (Standardized discharge = discharge (Q)/median discharge(50% Q)). Shown for comparison are the Au Sable and Jordan rivers, two of Michigan's most stable rivers. Data source United States Geological Survey gauges for period of record (Table 3).

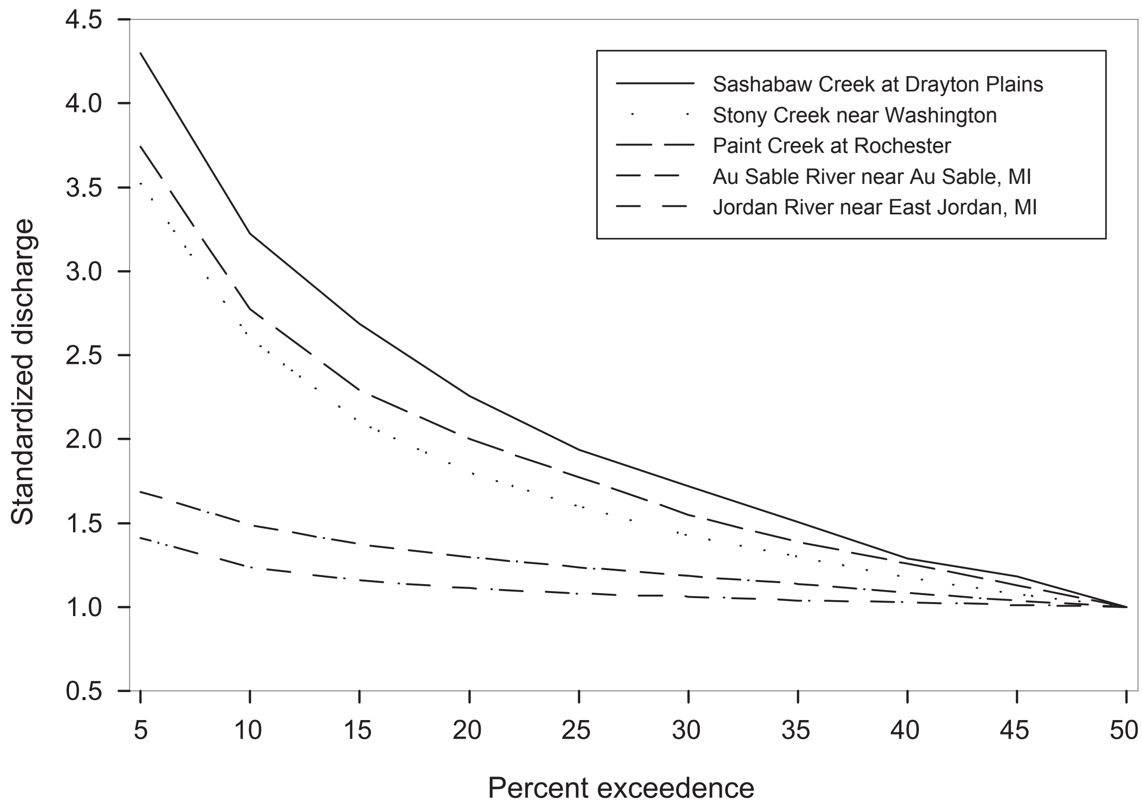


Figure 27.─Standardized high flow exceedence curves for tributaries of the Clinton River. (Standardized discharge = discharge (Q)/median discharge(50% Q)). Shown for comparison are the Au Sable and Jordan rivers, two of Michigan's most stable rivers. Data source United States Geological Survey gauges for period of record (Table 3).

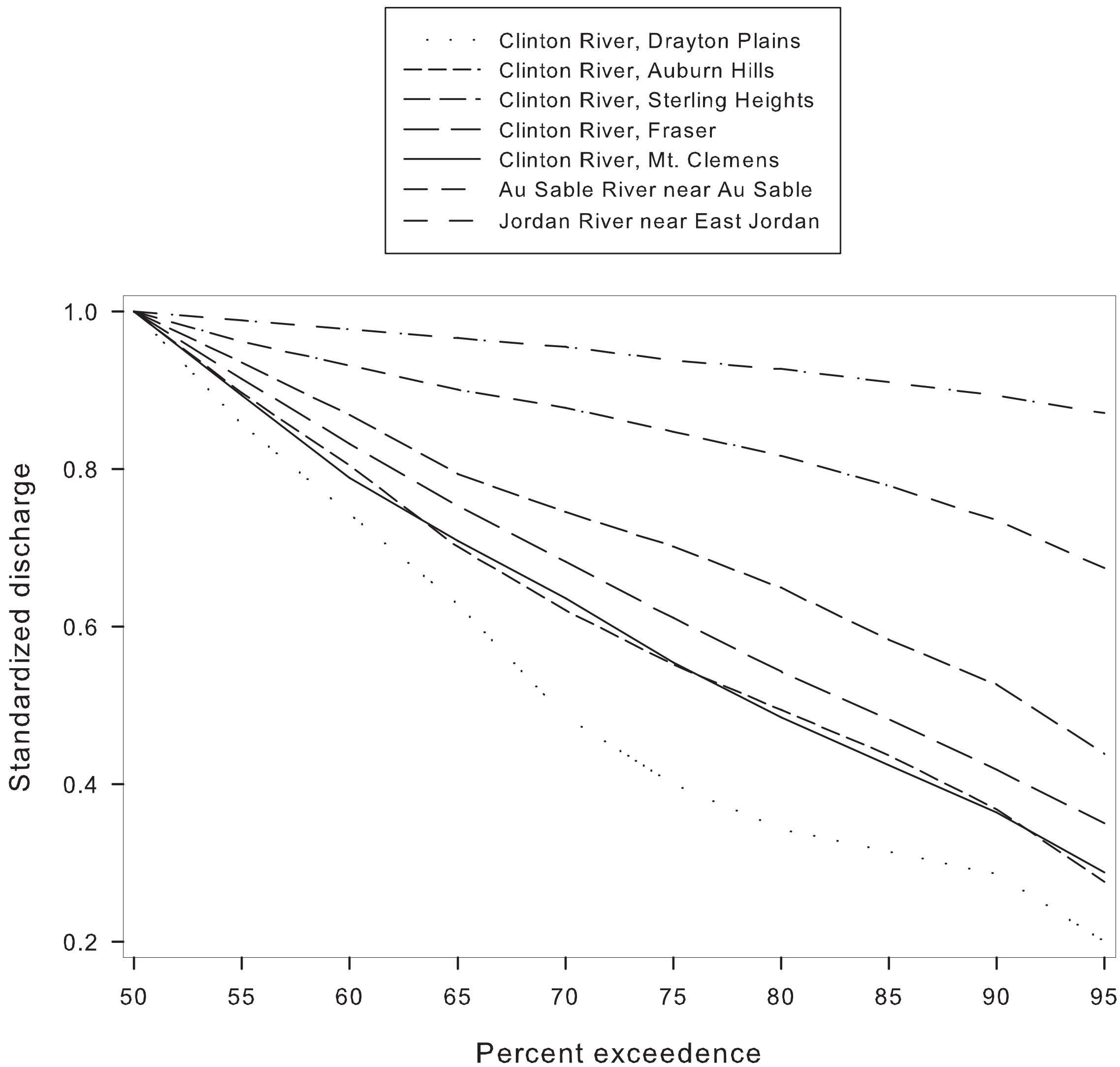


Figure 28.─Standardized low flow exceedence curves for the main branch of the Clinton River. (Standardized discharge = discharge (Q)/median discharge(50% Q)). Shown for comparison are the Au Sable and Jordan rivers, two of Michigan's most stable rivers. Data source United States Geological Survey gauges for period of record (Table 3).

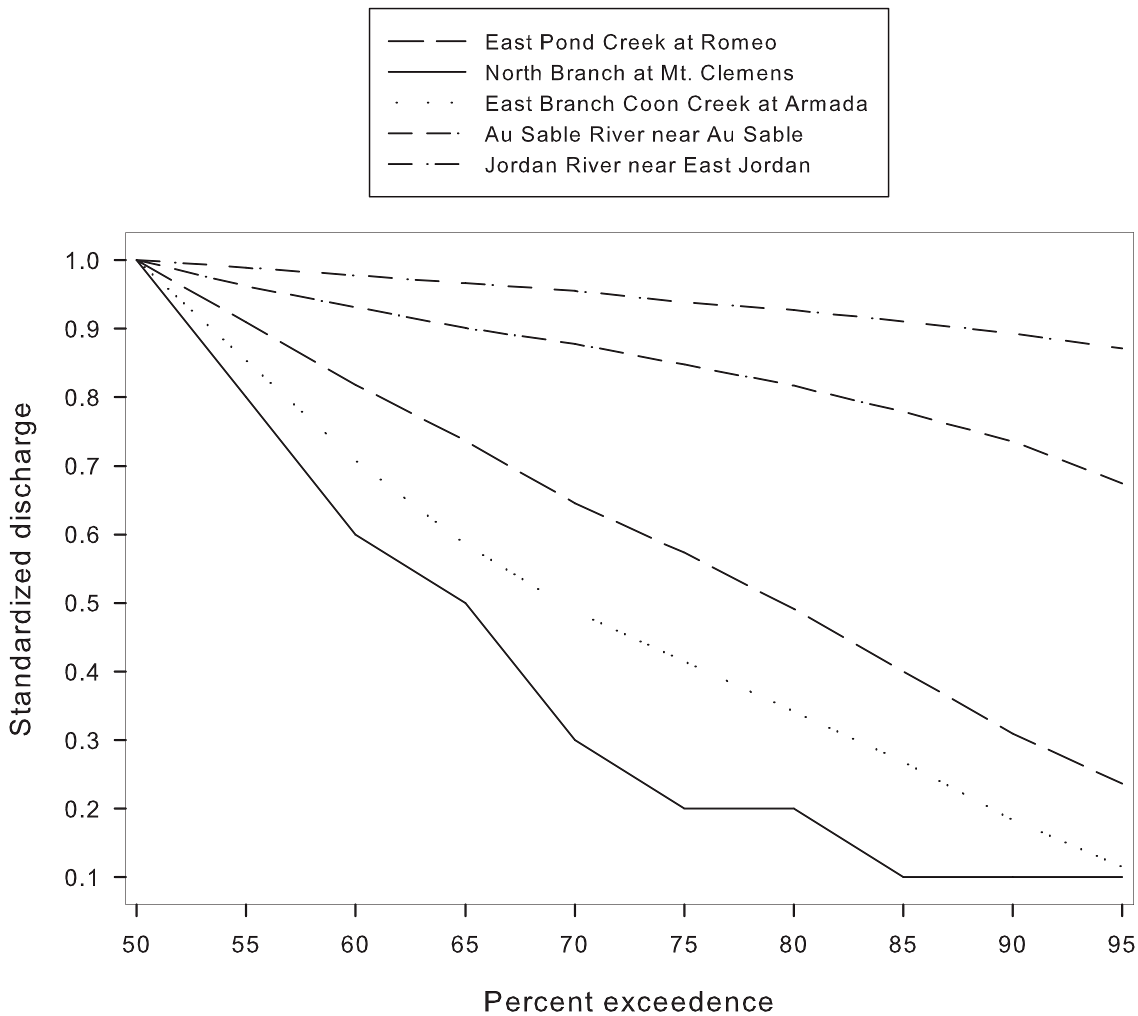


Figure 29.─Standardized low flow exceedence curves for the North Branch of the Clinton River and tributaries. (Standardized discharge = discharge (Q)/median discharge(50% Q)). Shown for comparison are the Au Sable and Jordan rivers, two of Michigan's most stable rivers. Data source United States Geological Survey gauges for period of record (Table 2).

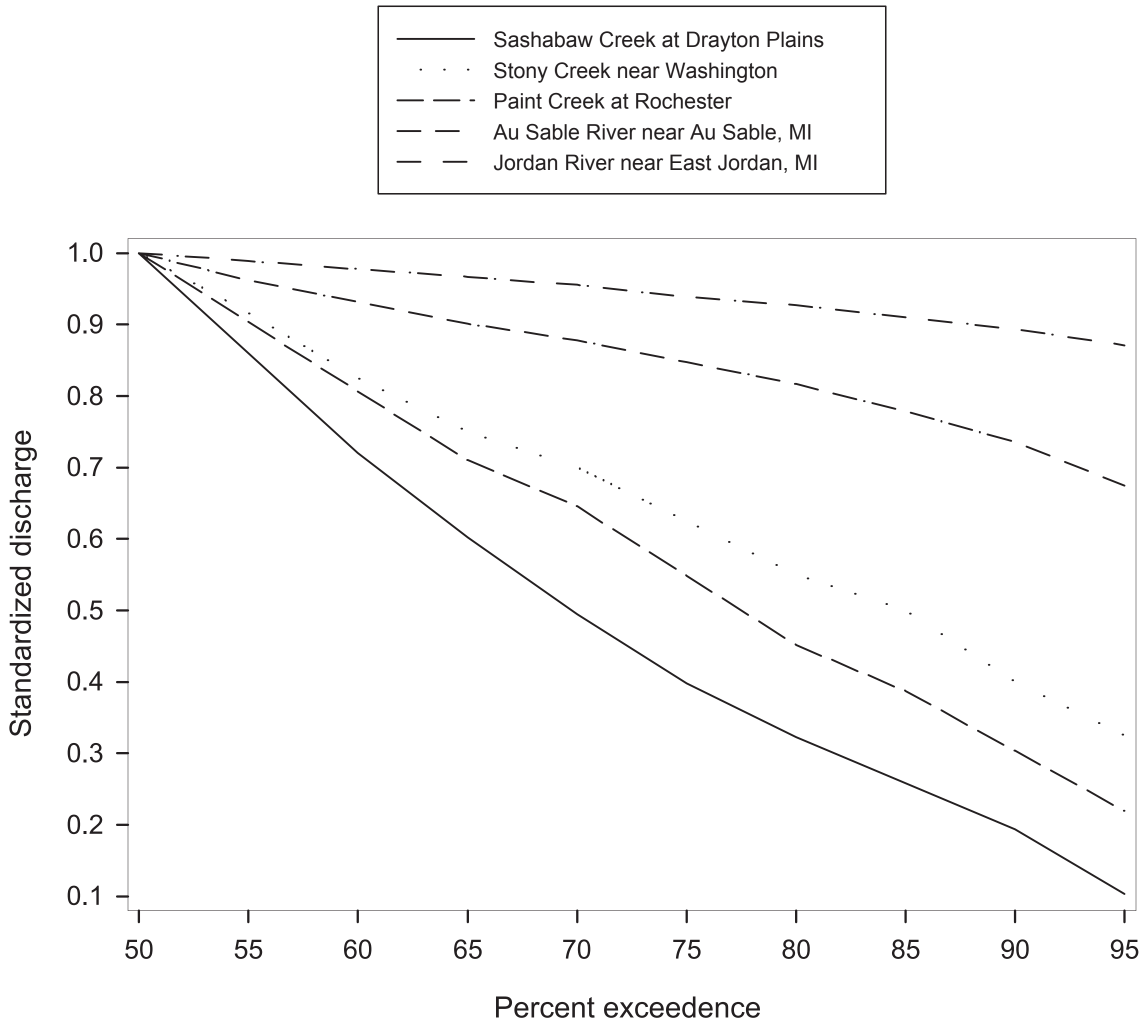


Figure 30.─Standardized low flow exceedence curves for tributaries of the Clinton River. (Standardized discharge = discharge (Q)/median discharge(50% Q)). Shown for comparison are the Au Sable and Jordan rivers, two of Michigan's most stable rivers. Data source United States Geological Survey gauges for period of record (Table 3).

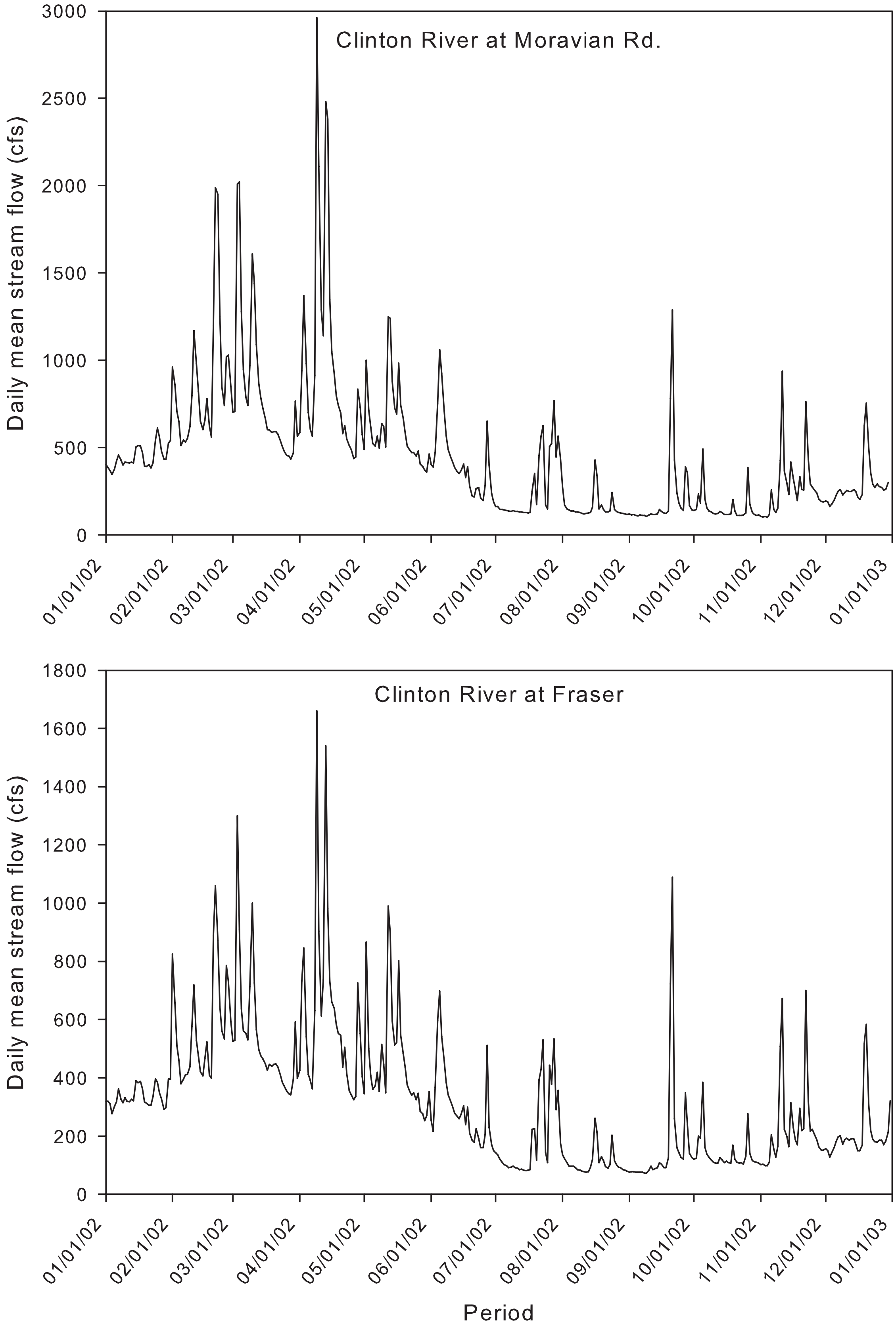


Figure 31.–Mean daily discharge at the two most downstream Clinton River gauge stations. Data from the United States Geological Survey.

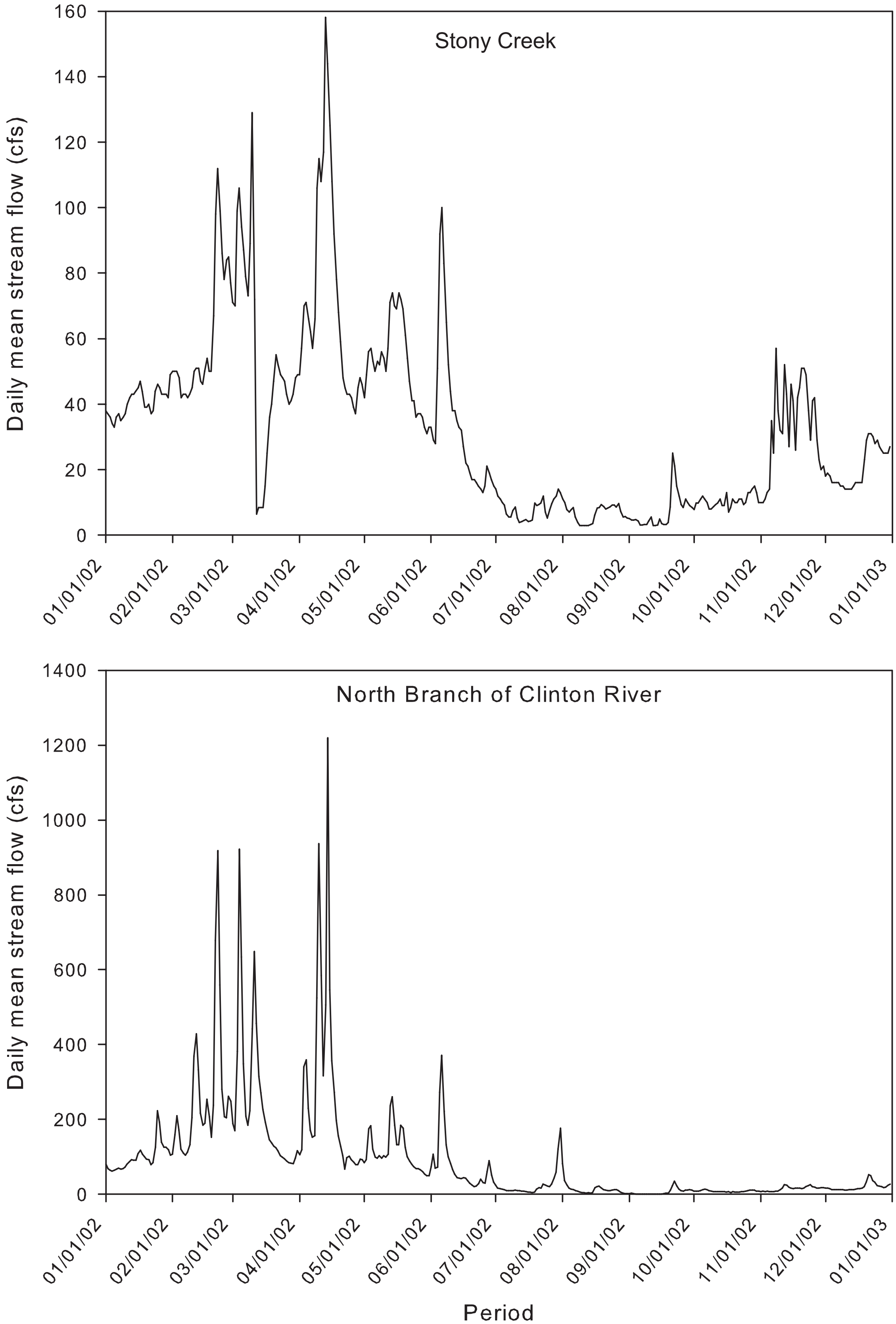


Figure 32.–Mean daily discharge at two Clinton River tributary gauge stations. Data from the United States Geological Survey.

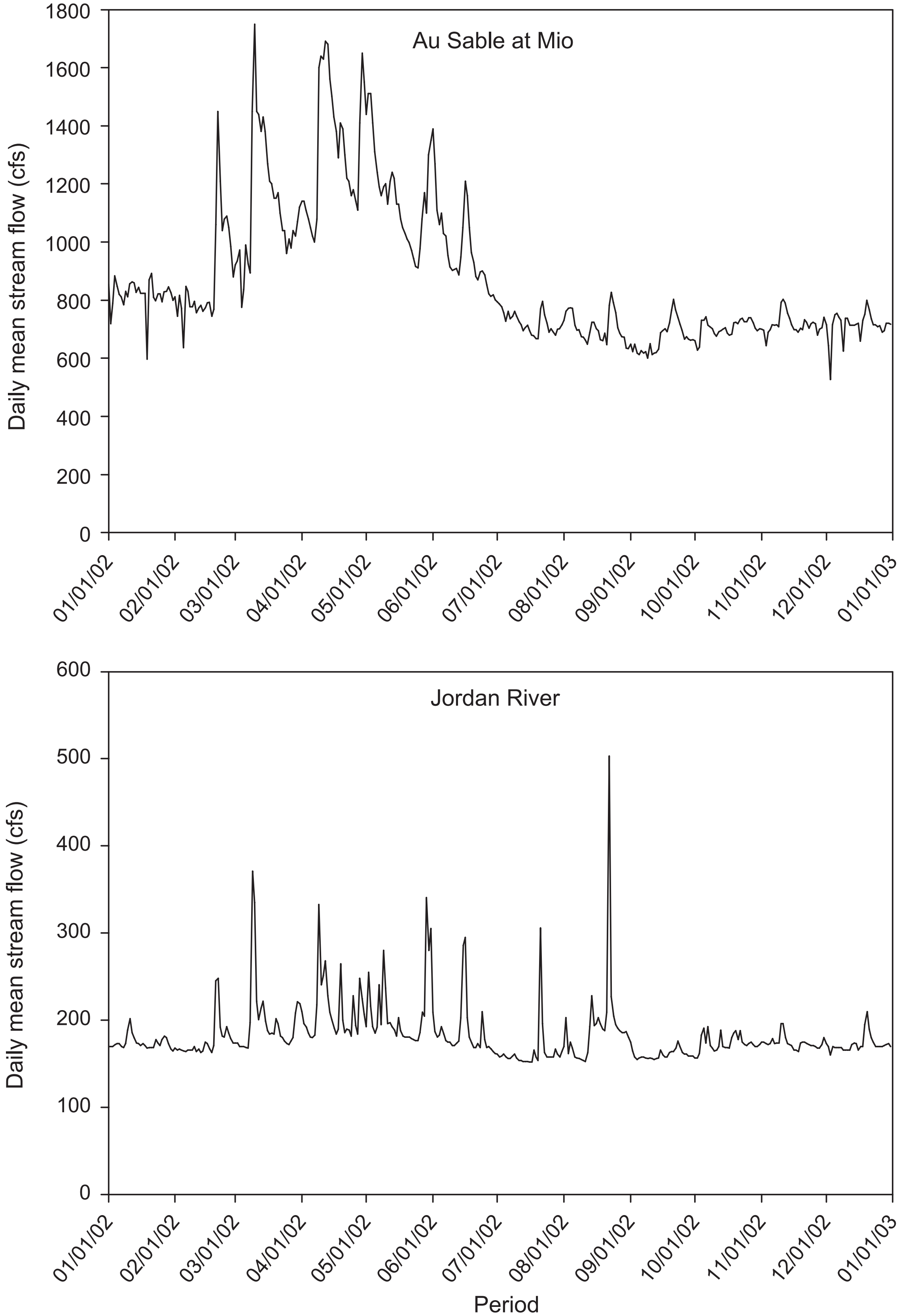


Figure 33.–Mean daily discharge on the Au Sable River near Mio and the Jordan River. Data from the United States Geological Survey.

Figure 34.─Three discharge exceedence levels for the United States Geological Survey, Moravian Drive gauge on the lower Clinton River and total precipitation on the watershed grouped by decade. Data sources United States Geological Survey gauges for period of record (Table 3) and the National Climatic Data Center for period of record (Table 2).

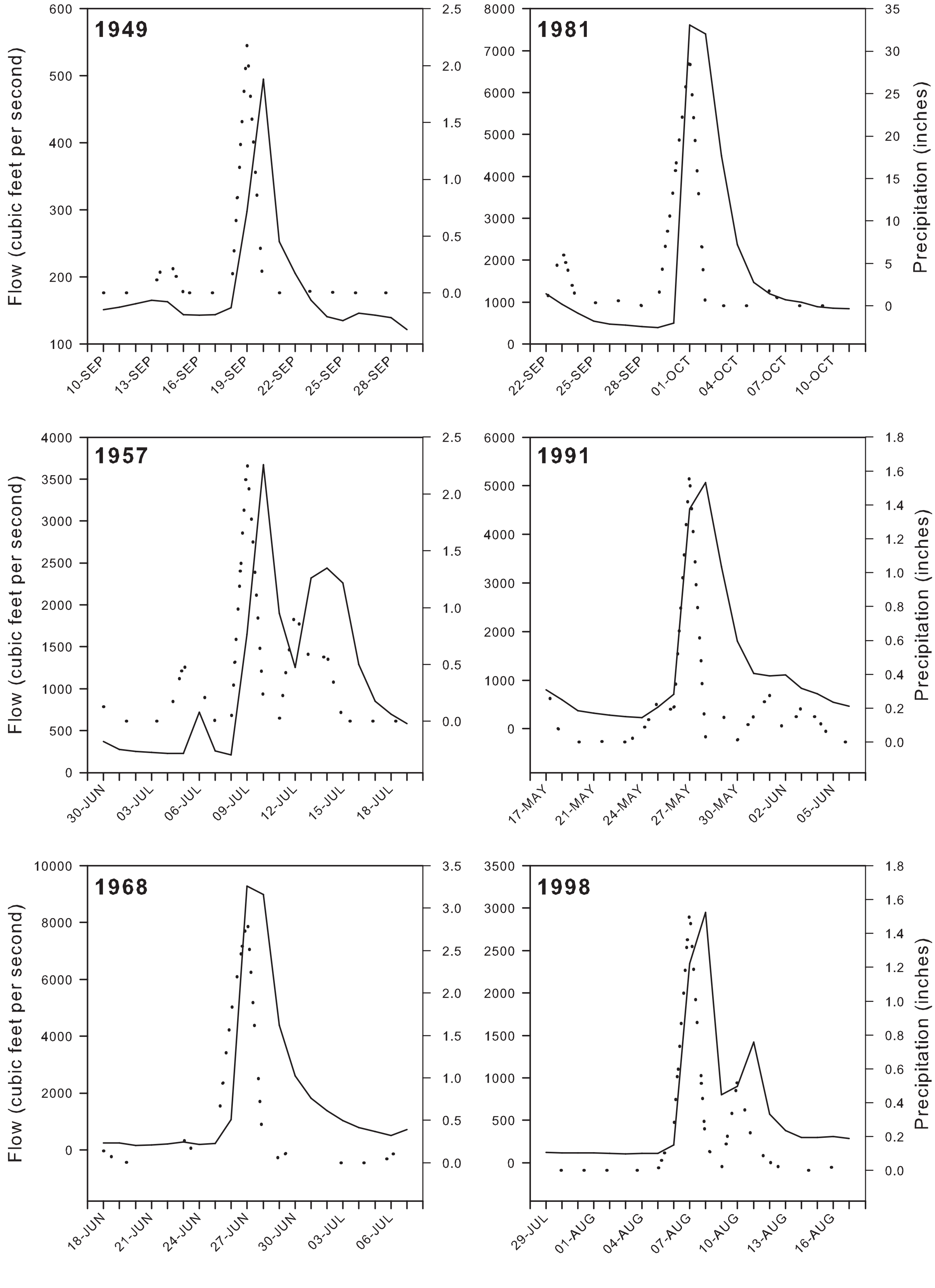


Figure 35.—Daily precipitation (dotted line) on watershed and discharge (solid line) at the Moravian Drive gauge on the main branch of the Clinton River before and after large rain events. Data sources United States Geological Survey gauges and the National Climatic Data Center.

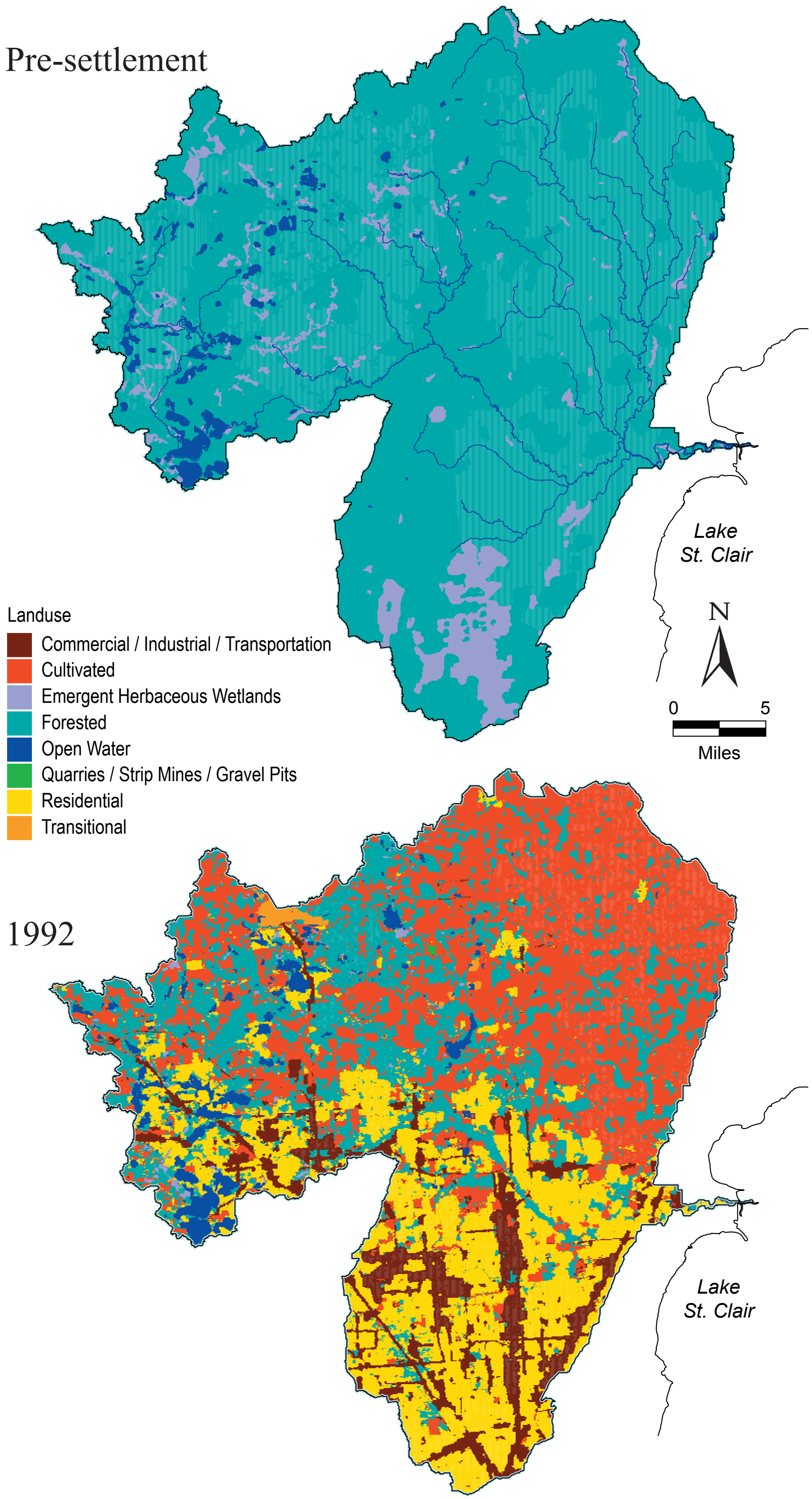


Figure 36.−Change in watershed cover type between pre-settlement times (upper) and 1992 (lower). Pre-settlement data were taken from Michigan Department of Natural Resources, Michigan Resource Inventory System. Land cover in 1992 was determined from the United States Geological Survey National Land Cover Data. Color scale applies to both maps.

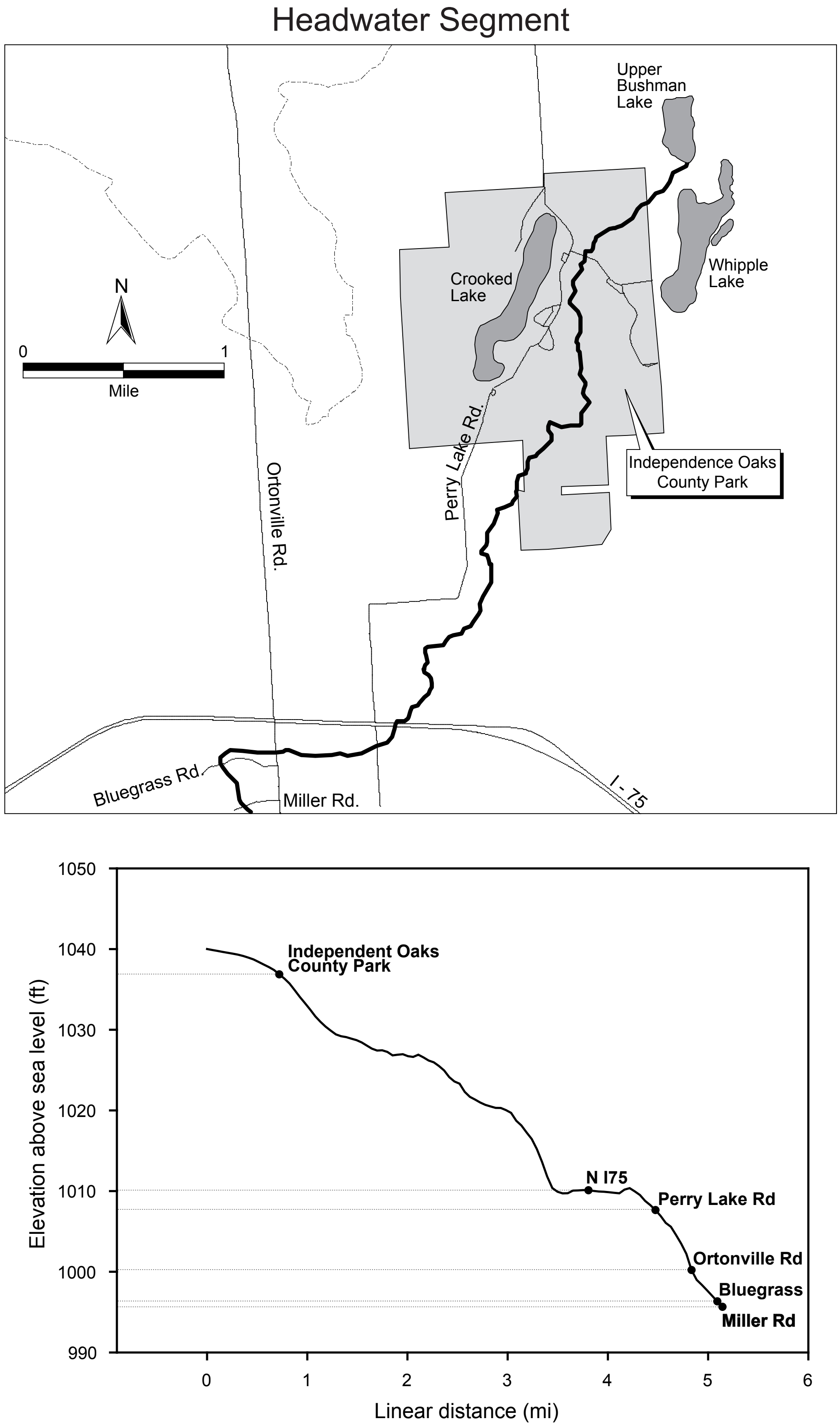


Figure 37.−Headwaters Segment of the Clinton River mainstem (upper figure) with several lakes, Independence Oaks Park, and major road crossings for geographic reference. The outer rectangle covers 9,091 acres and the river segment is 5.0 miles. River flow is southwest. Lower graph shows elevation change along this river section.

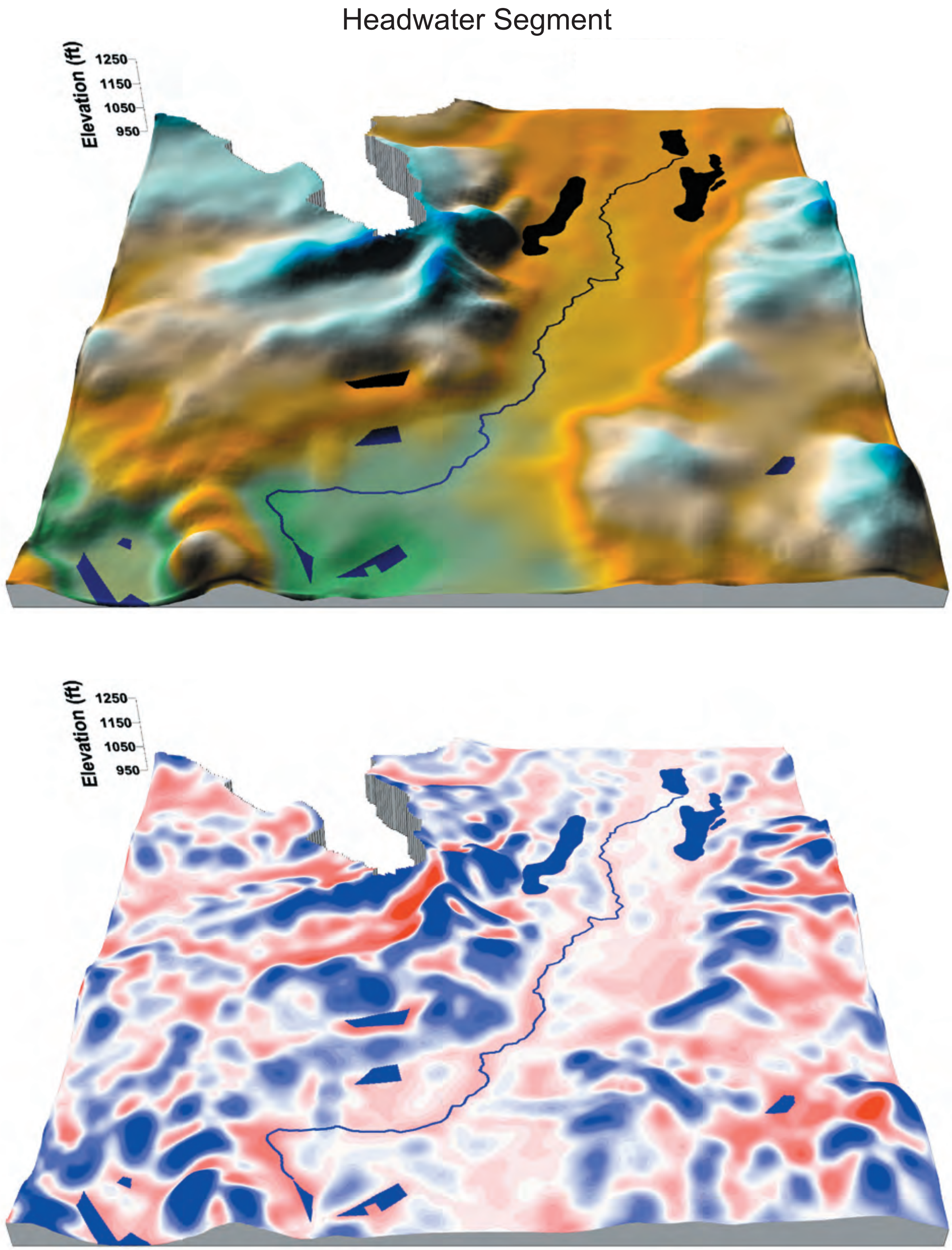


Figure 38.–Surface map (upper figure) shows general land surface features of the Headwaters Segment of the Clinton River mainstem within same area as previous figure. River flow is in a southwest direction. The lower map shows potential groundwater flux (Darcy image) draped over the surface. Red areas are considered to be discharging to surface water while blue areas are groundwater accumulation zones.

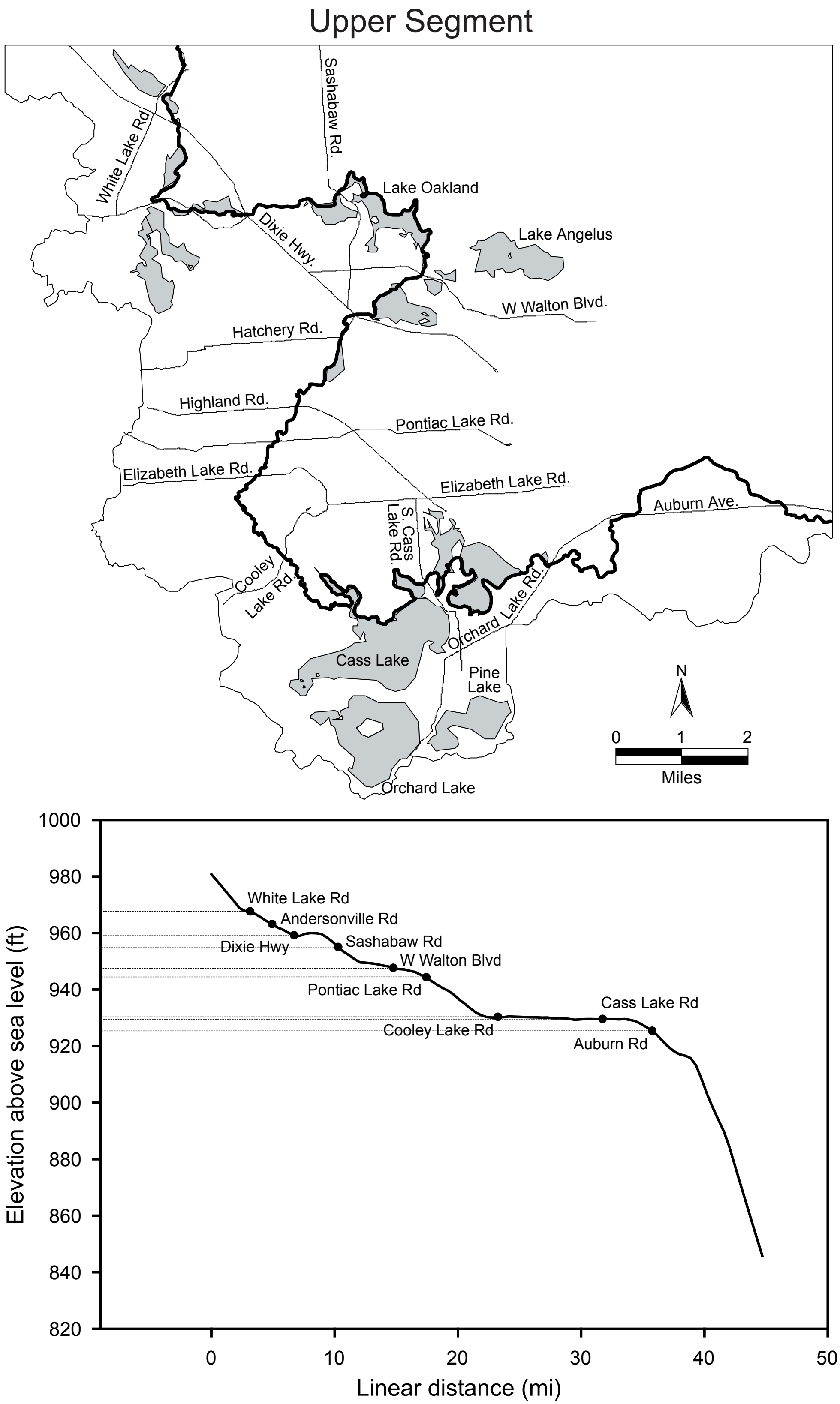


Figure 39.−Upper Segment of the Clinton River mainstem showing some lakes and major road crossings for geographic reference. The outer polygon, clipped to the watershed south boundary, covers 64,809 acres and the river segment is 30.0 miles. River flow is south and east. Lower graph shows elevation change along this river section with road crossings identified.

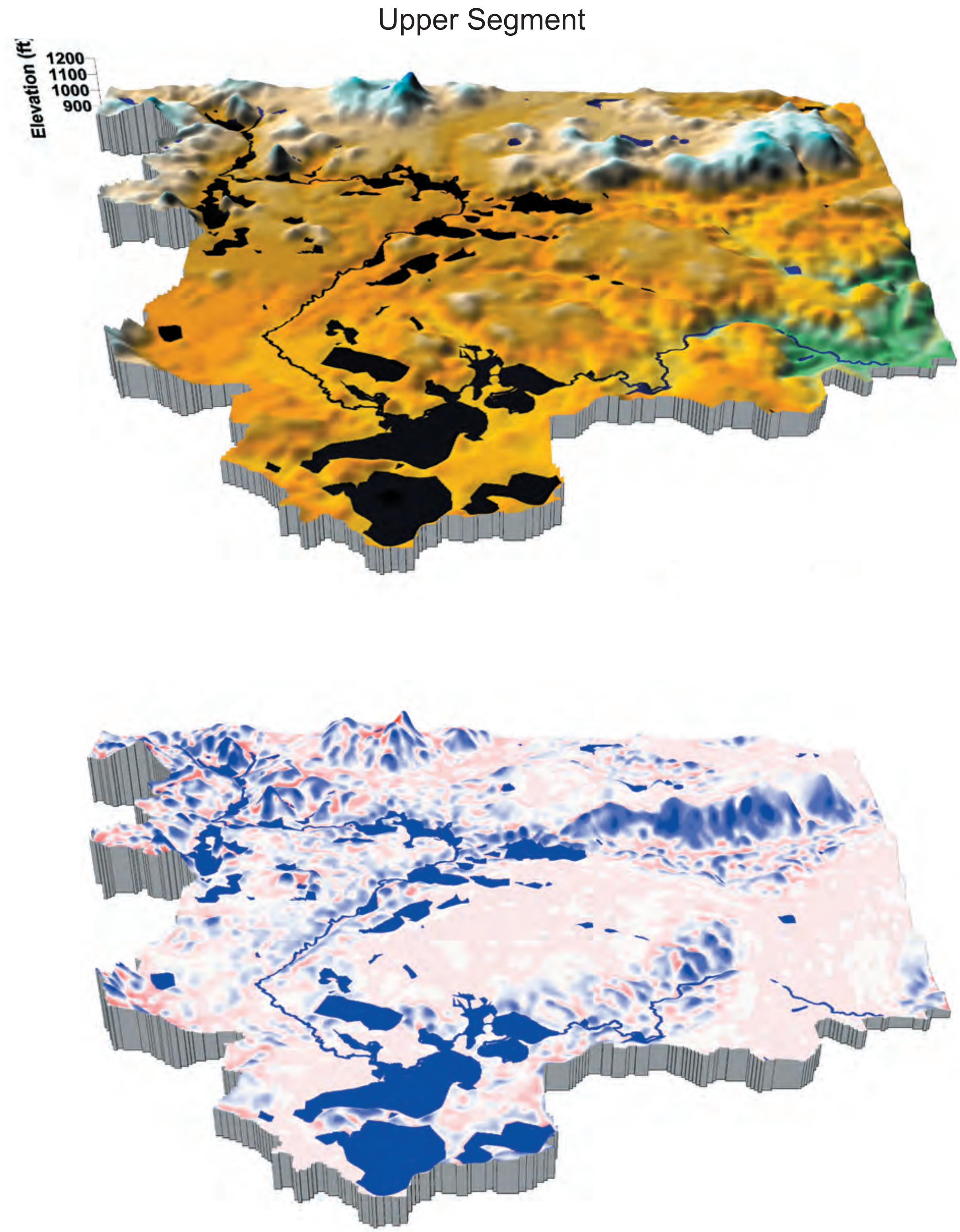


Figure 40.–Surface map (upper figure) shows general land surface features of Upper Segment of the Clinton River mainstem within same area as previous figure. River flow is in a south and east direction. The lower map shows potential groundwater flux (Darcy image) draped over the surface. Red areas are considered to be discharging to surface water while blue areas are groundwater accumulation zones. Elevation scale is the same for both maps.

Middle Segment

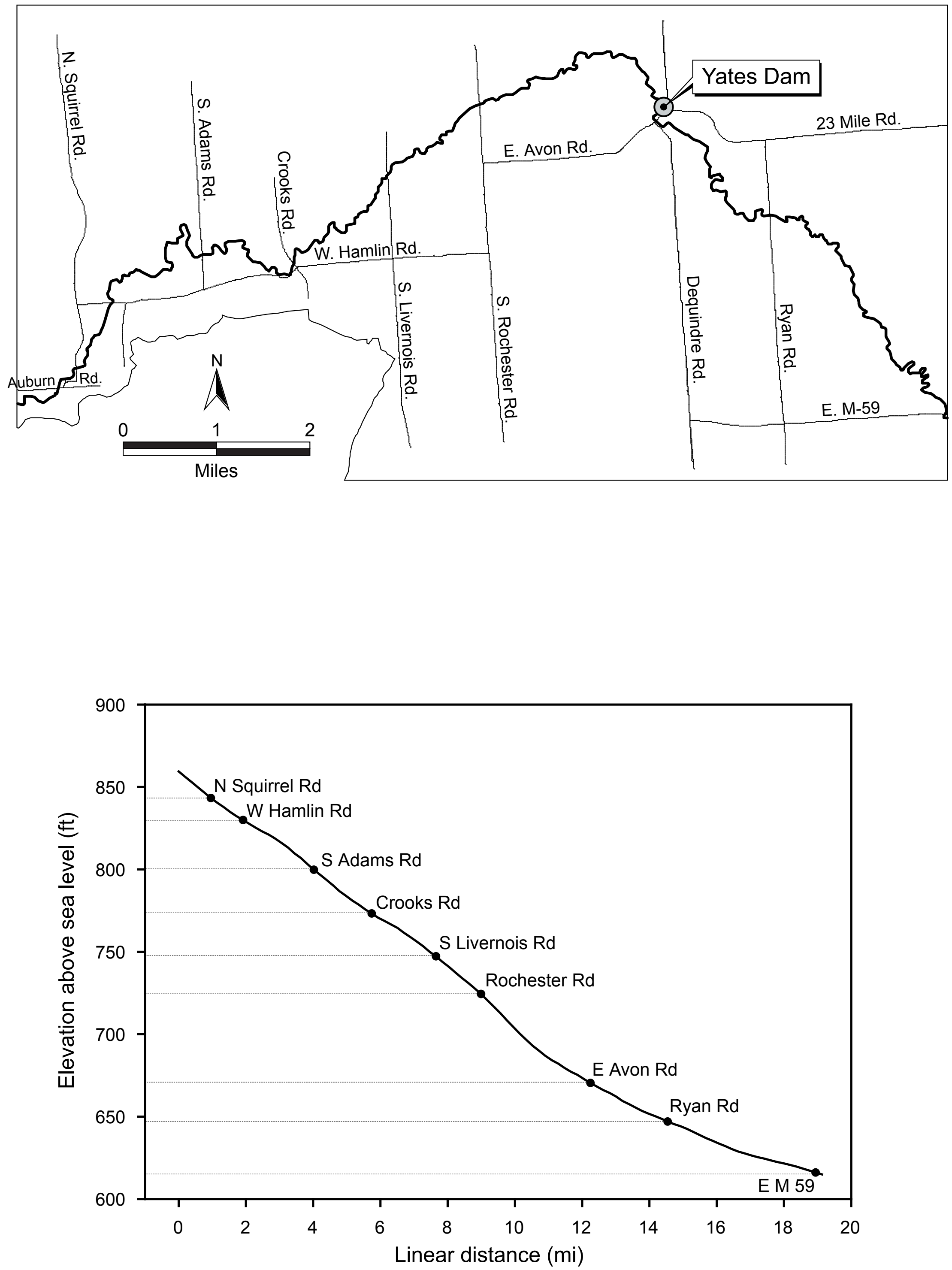
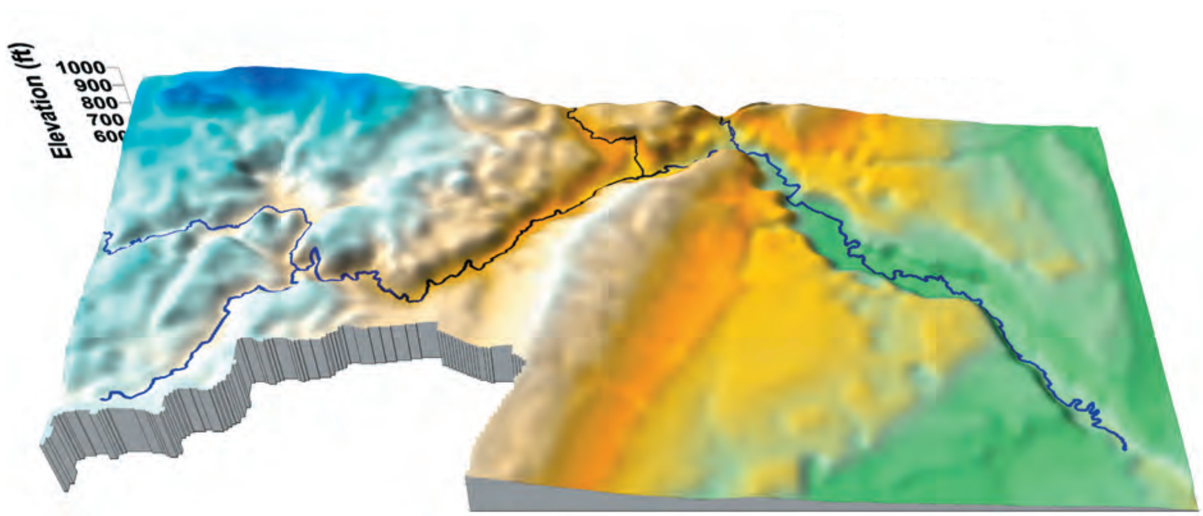


Figure 41.−Middle Segment of the Clinton River mainstem showing Yates Dam and major road crossings for geographic reference. The outer polygon covers 29,088 acres and the river segment is 19.3 miles. The boundary polygon is not rectangular because the southwest corner would fall outside the Clinton River watershed. River flow is in an easterly direction. Lower graph shows elevation change along this river section with road crossings identified.

Middle Segment



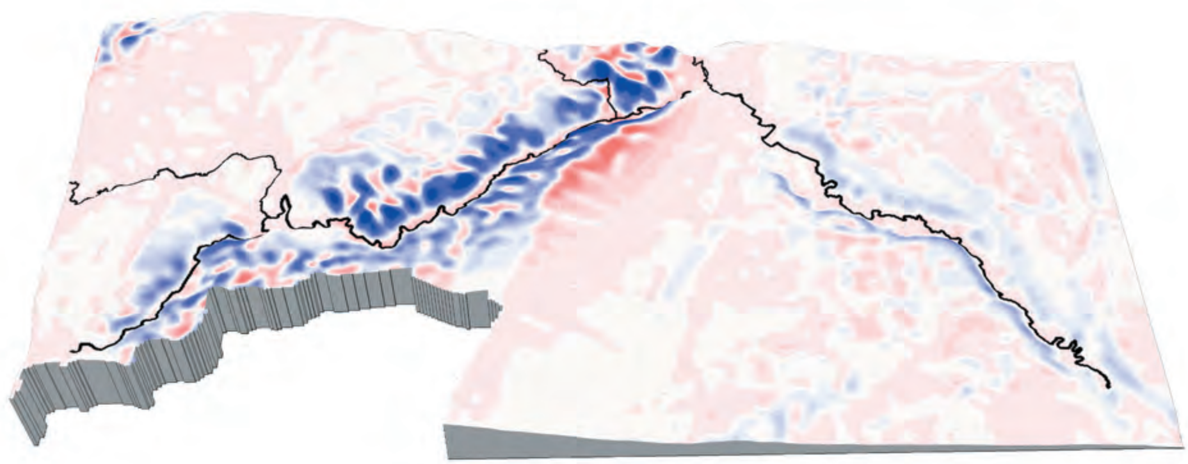
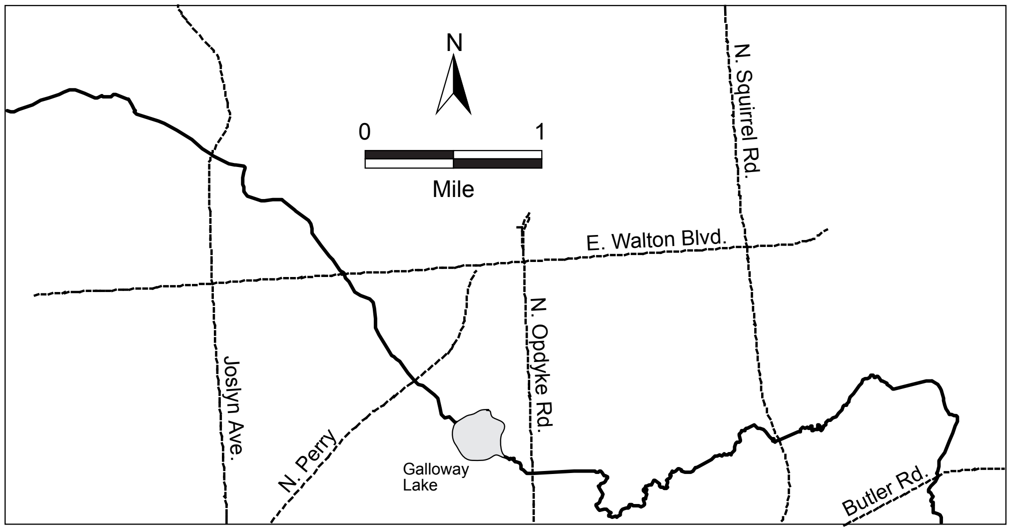


Figure 42.−Surface map (upper figure) shows general land surface features of Middle Segment of the Clinton River mainstem within same area as previous figure. River flow is in an easterly direction. The lower map shows potential groundwater flux (Darcy image) draped over the surface. Red areas are considered to be discharging to surface water while blue areas are groundwater accumulation zones. Elevation scale is the same for both maps.

Galloway Creek



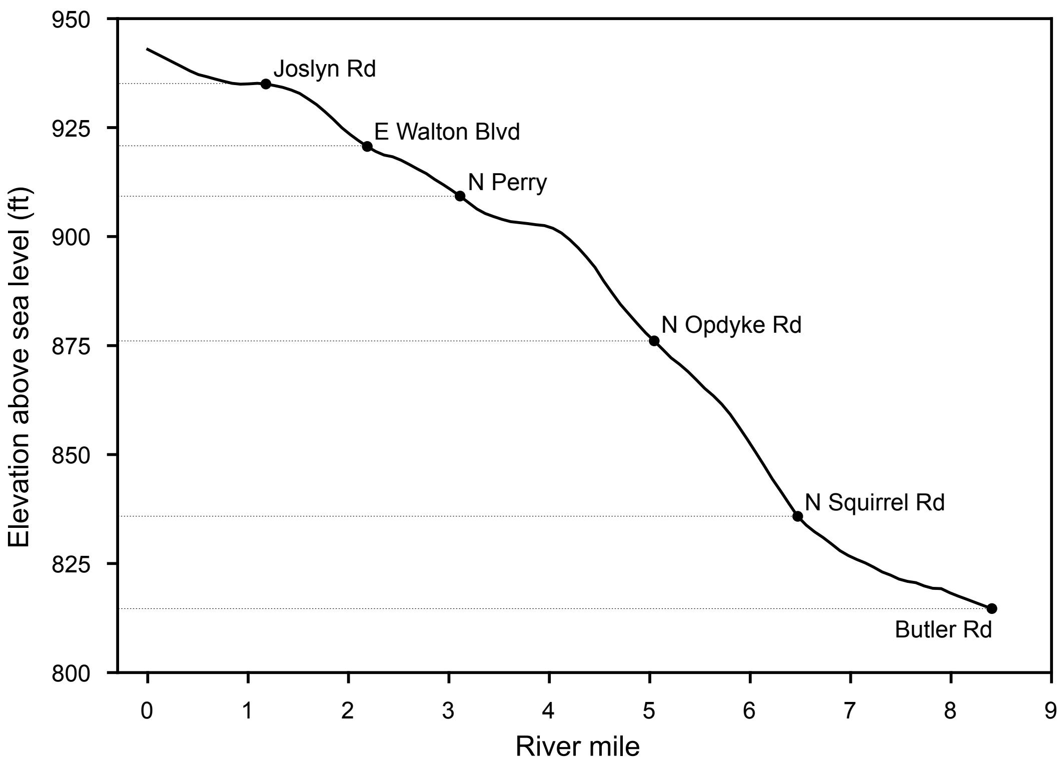


Figure 43.–Map of Galloway Creek showing major road crossings for geographic reference. The outer rectangle covers 10,507 acres and the river is 8.3 miles. River flow is southeast. Lower graph shows elevation change along Galloway Creek with road crossings identified.

Galloway Creek

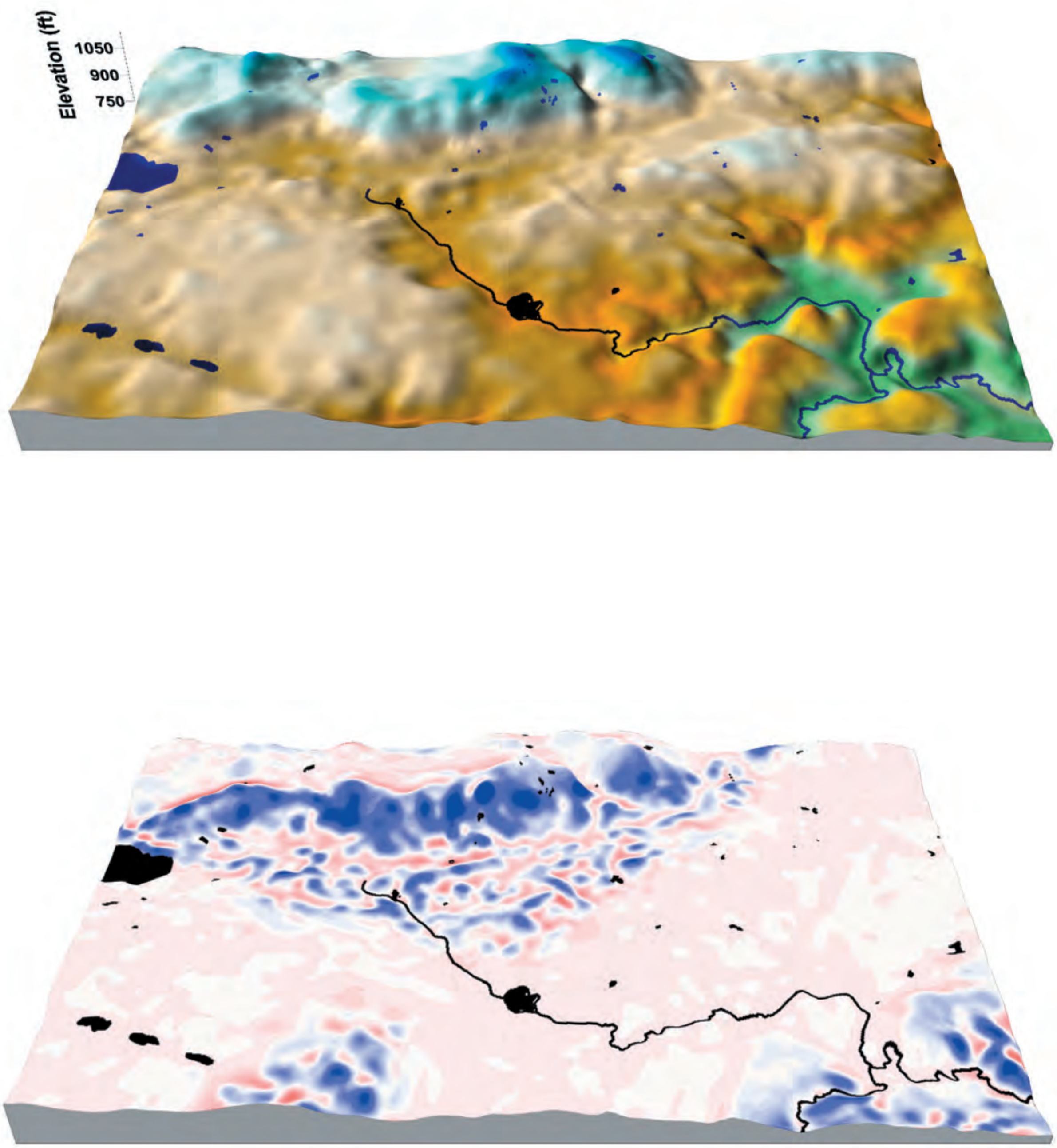
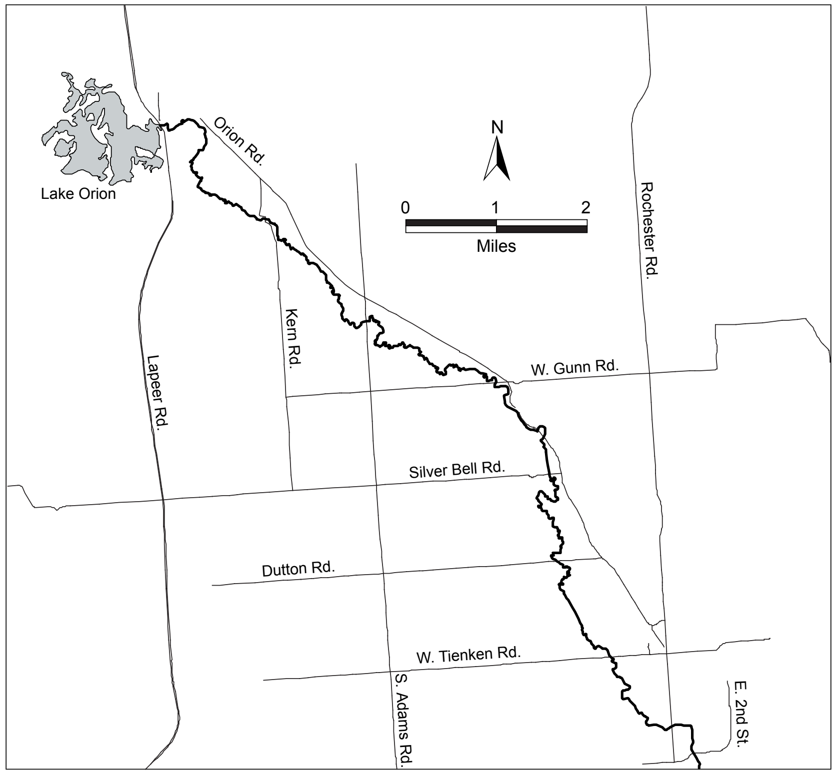


Figure 44.−Surface map (upper figure) shows general land surface features adjacent to Galloway Creek within same area as previous figure. River flow is in an southeasterly direction. The lower map shows potential groundwater flux (Darcy image) draped over the surface. Red areas are considered to be discharging to surface water while blue areas are groundwater accumulation zones. Elevation scale is the same for both maps.

Paint Creek



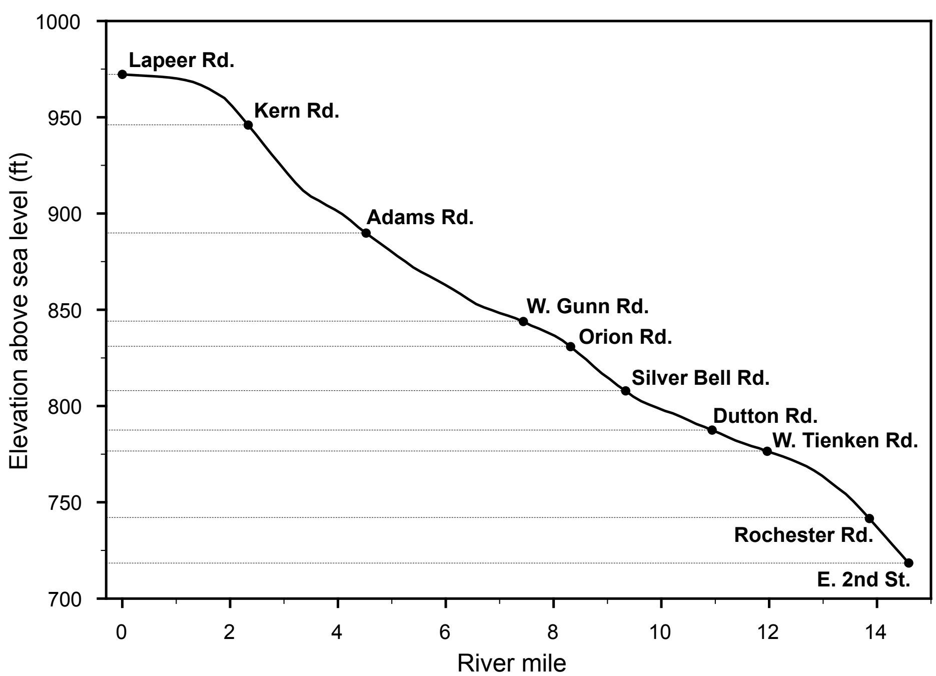


Figure 45.–Map of Paint Creek showing Lake Orion and major road crossings for geographic reference. The outer rectangle covers 48,987 acres and the river is 15.0 miles. River flow is southeast. Lower graph shows elevation change along Paint Creek with road crossings identified.

Paint Creek

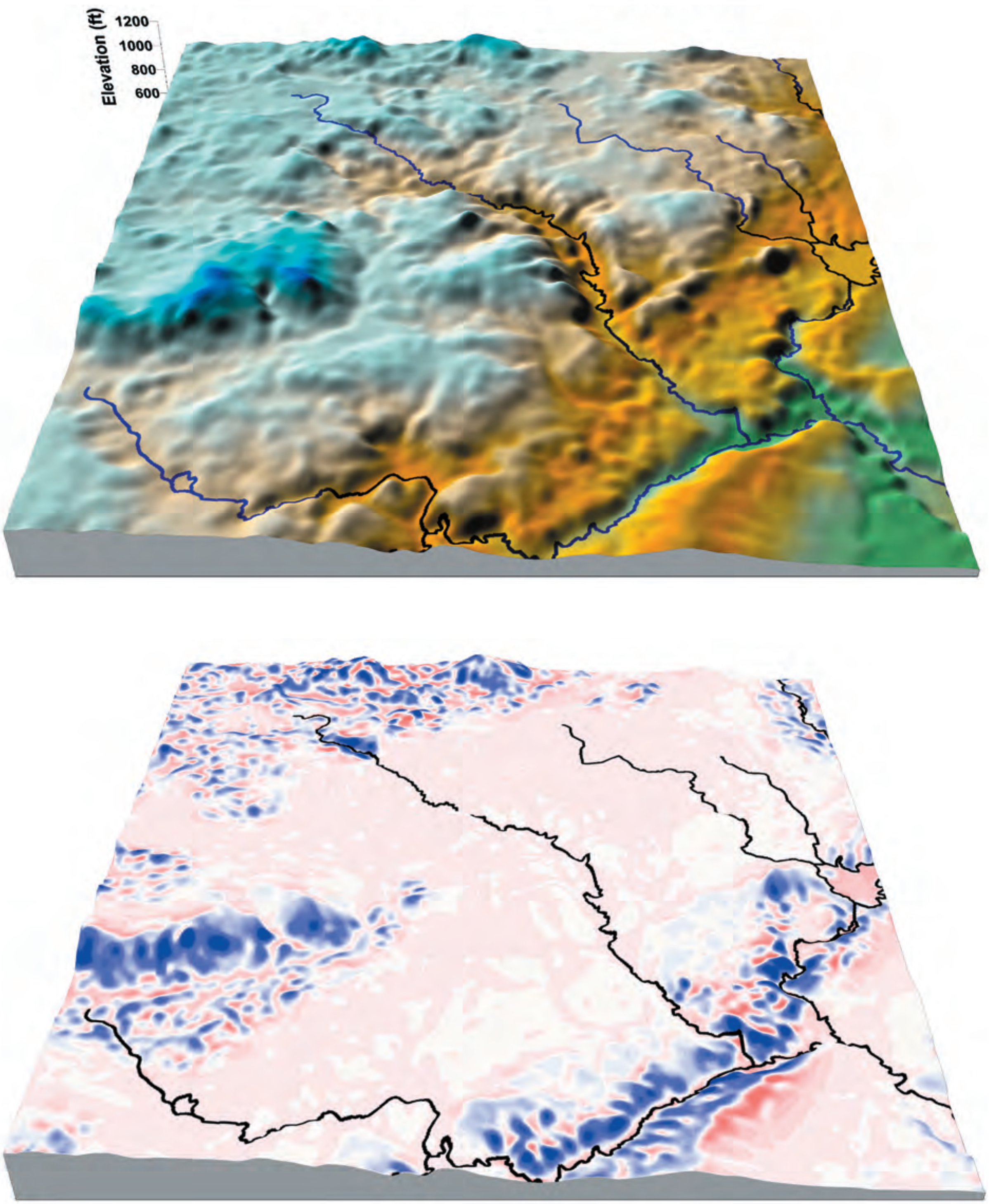


Figure 46.−Surface map (upper figure) shows general land surface features adjacent to Paint Creek within same area as previous figure. River flow is in an easterly direction. The lower map shows potential groundwater flux (Darcy image) draped over the surface. Red areas are considered to be discharging to surface water while blue areas are groundwater accumulation zones. Elevation scale is the same for both maps.

Stony Creek

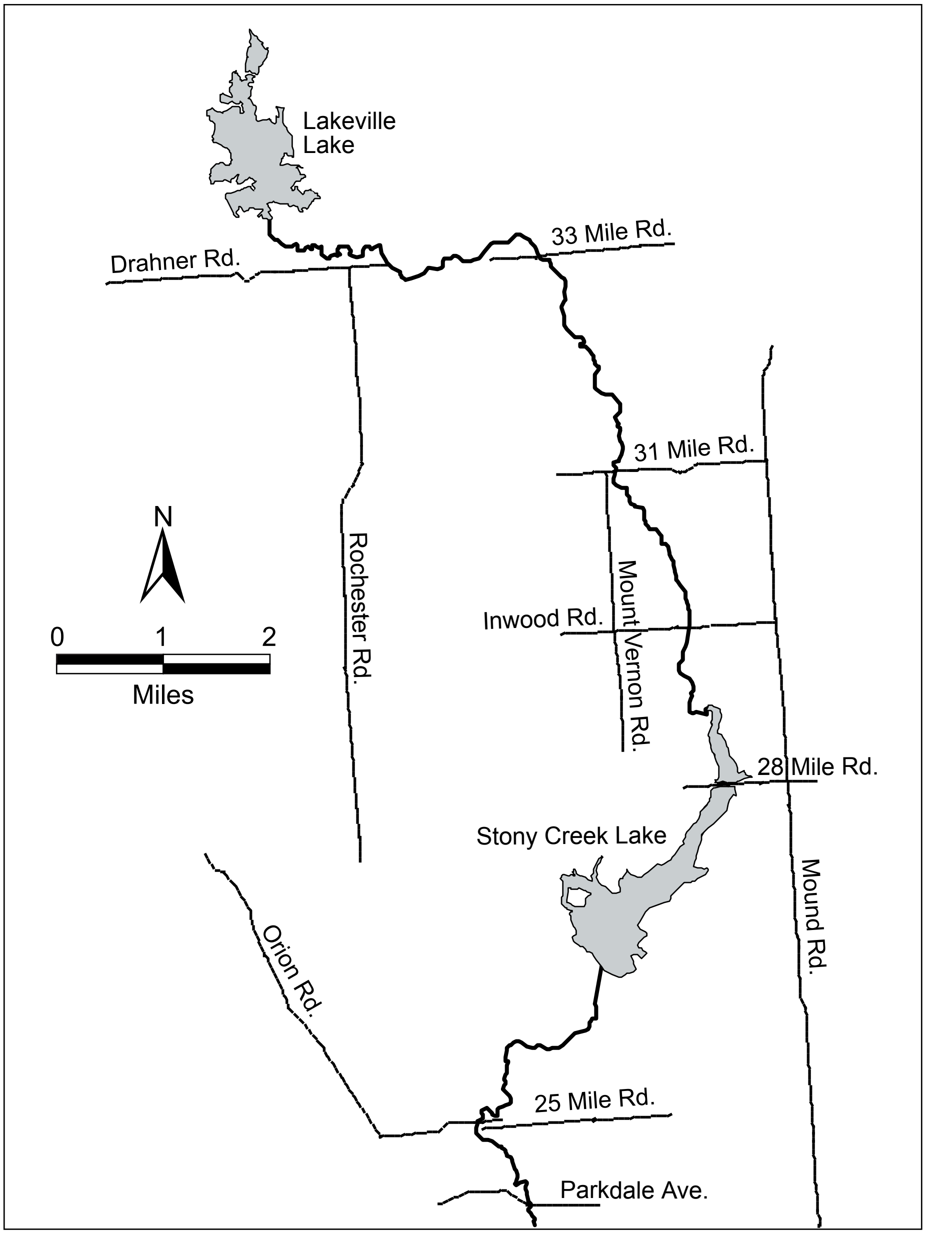


Figure 47.–Map of Stony Creek showing large impoundments and major road crossings for geographic reference. The outer rectangle covers 63,293 acres and the river is 16.7 miles. River flow is southeast.

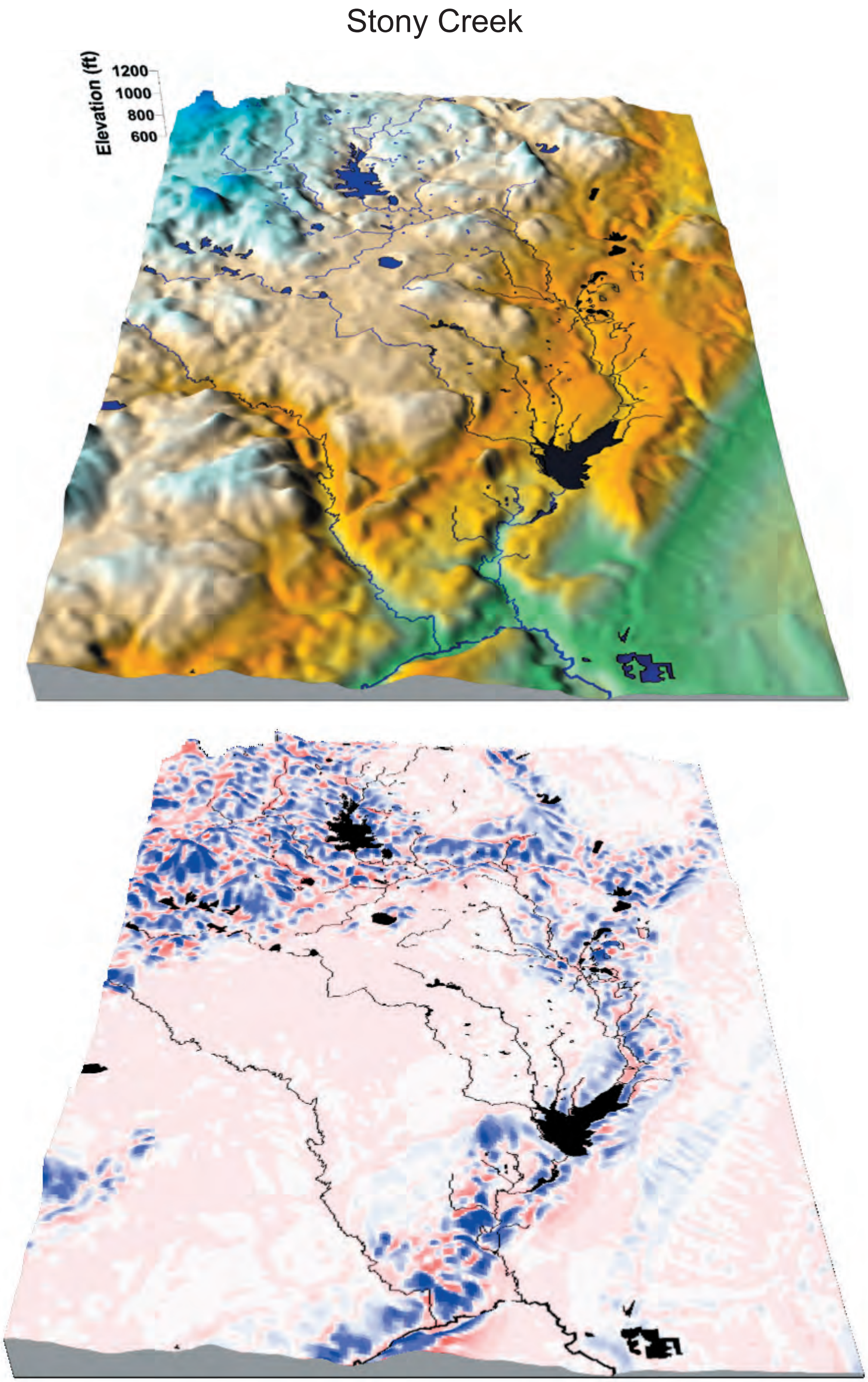


Figure 48.–Surface map (upper figure) shows general land surface features adjacent to Stony Creek within same area as previous figure. River flow is in a southerly direction. The lower map shows potential groundwater flux (Darcy image) draped over the surface. Red areas are considered to be discharging to surface water while blue areas are groundwater accumulation zones. Elevation scale is the same for both maps.

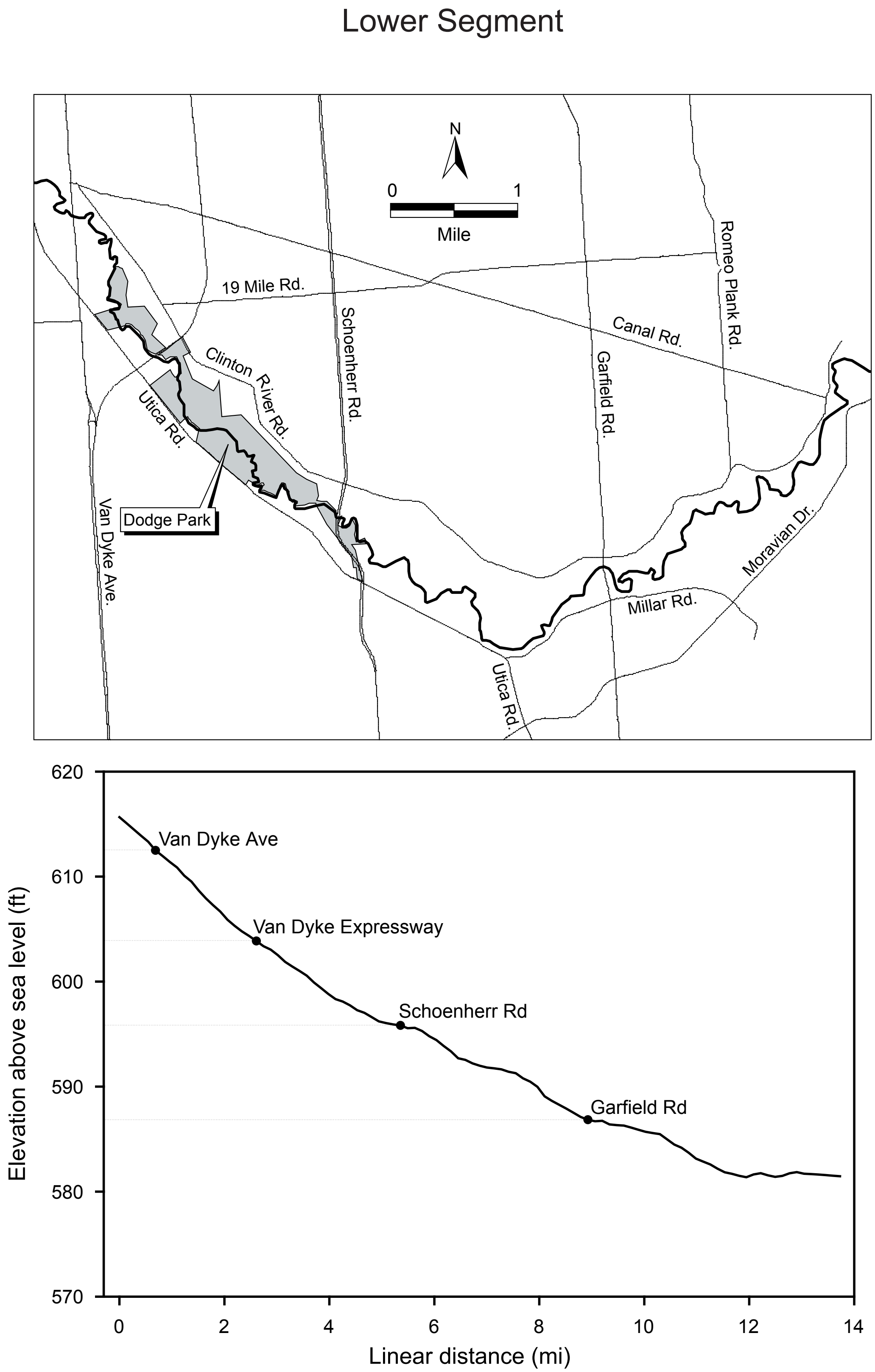


Figure 49.–Lower Segment of the Clinton River mainstem showing Dodge Park in Sterling Heights and major road crossings for geographic reference. The outer rectangle covers 21,835 acres and the river segment is 13.7 miles. River flow is in an easterly direction. Lower graph shows elevation change along this river section with road crossings identified.

Lower Segment

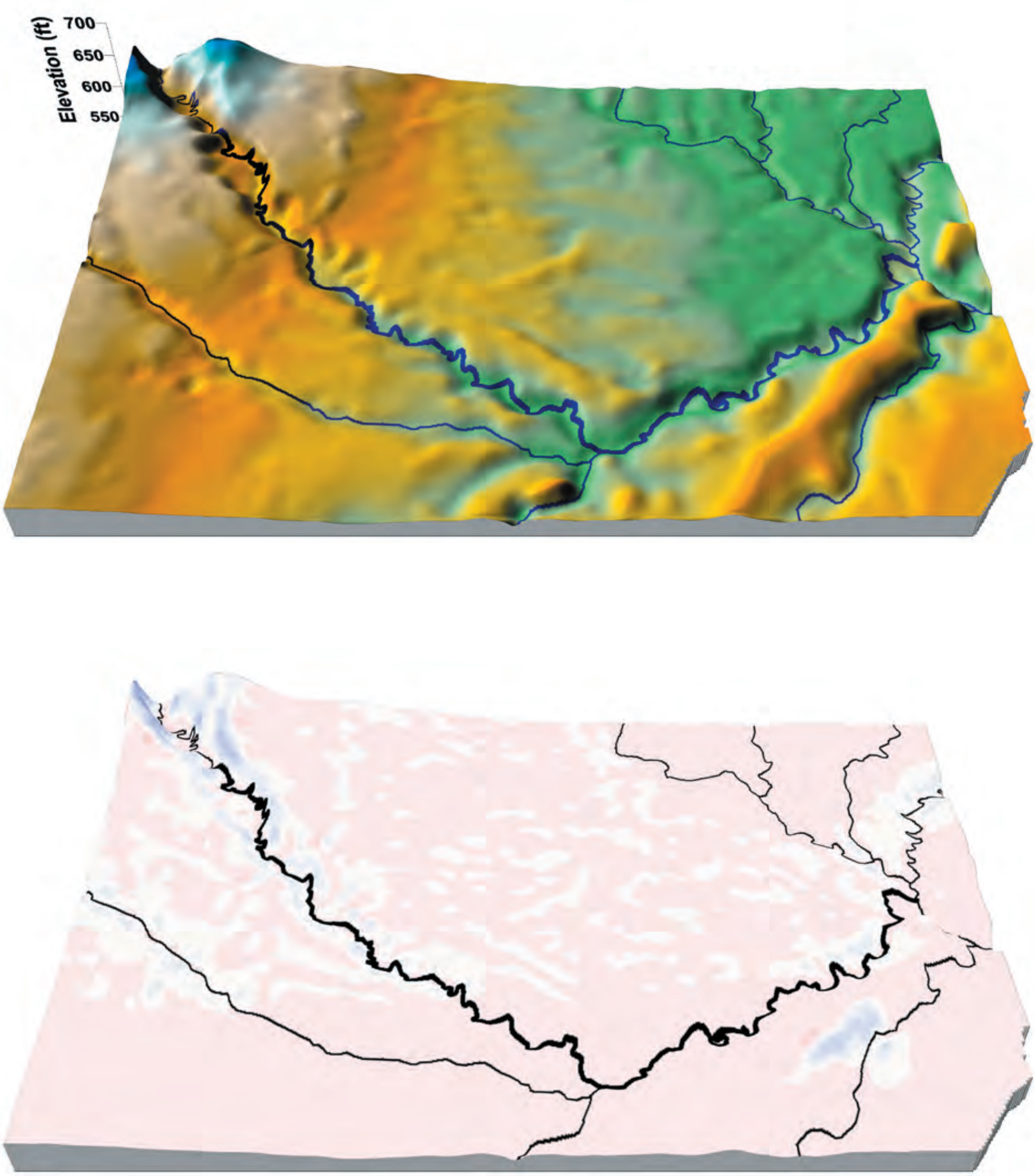
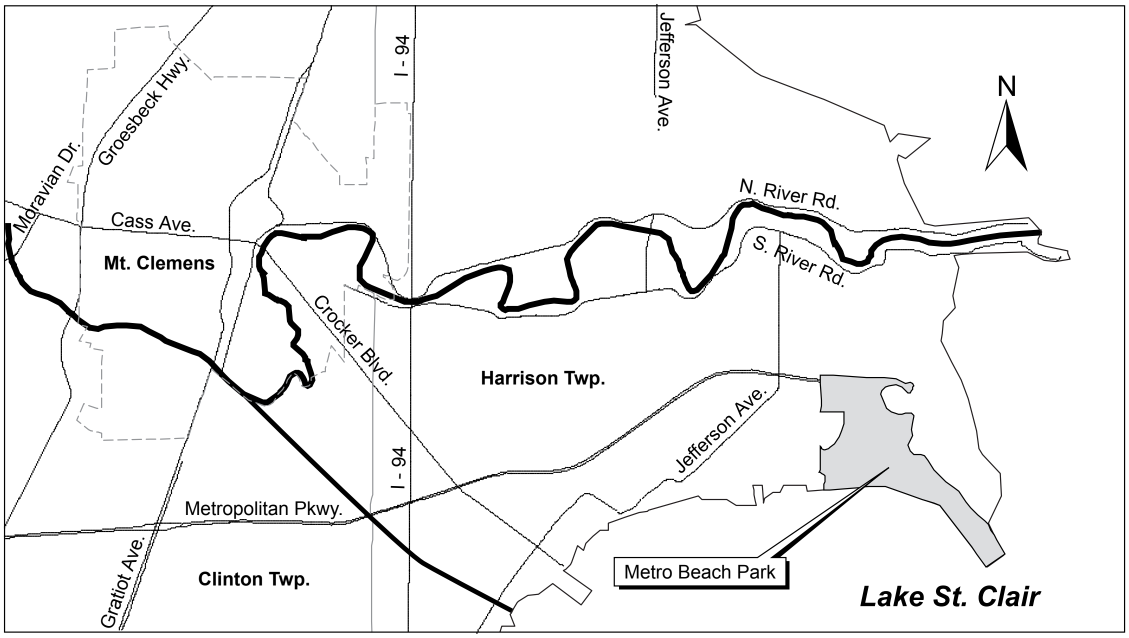


Figure 50.−Surface map (upper figure) shows general land surface features of Lower Segment of the Clinton River mainstem within same area as previous figure. River flow is in an easterly direction. The lower map shows potential groundwater flux (Darcy image) draped over the surface. Red areas are considered to be discharging to surface water while blue areas are groundwater accumulation zones. Elevation scale is the same for both maps.

Mouth Segment



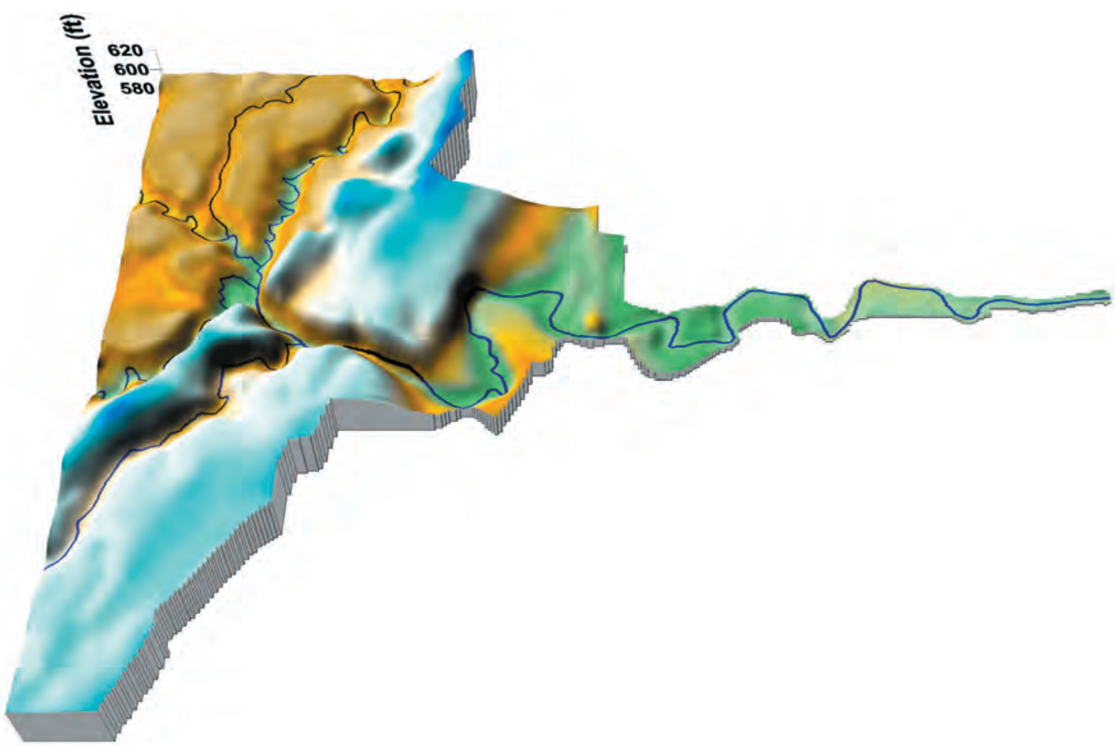


Figure 51.–The Mouth Segment of the Clinton River mainstem showing Huron-Clinton Metropark in Harrison Township and major road crossings for geographic reference. The outer rectangle covers 19,020 acres and the river segment is 11.1 miles. River flow is in an easterly direction. The lower map shows general land surface features of section 5 clipped to the watershed boundary on the east.

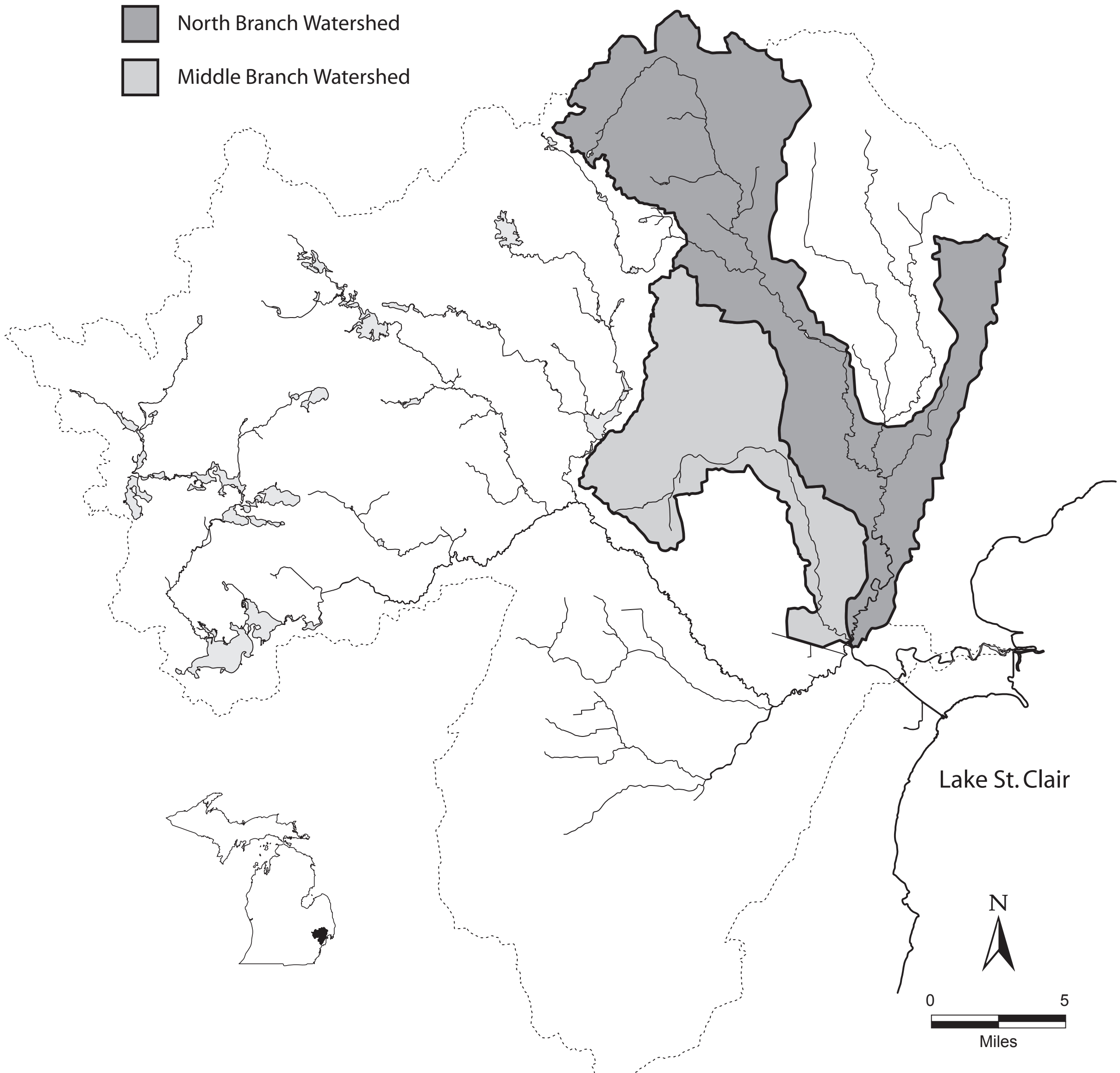
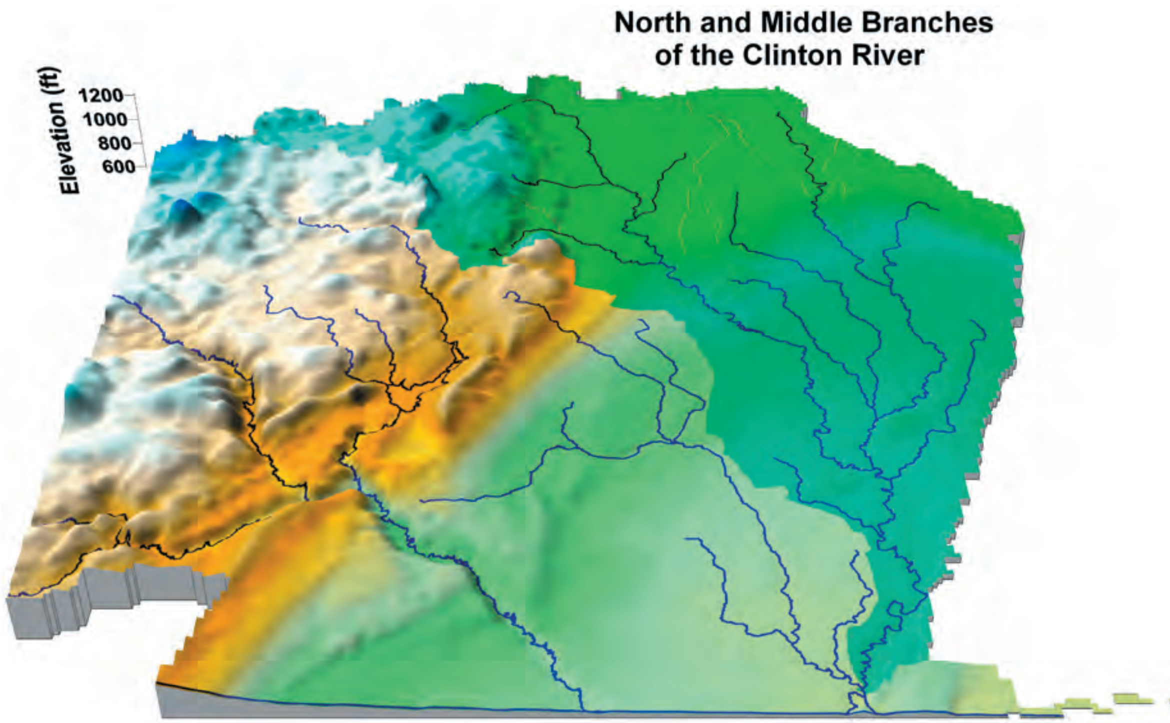


Figure 52.–Watershed for the Middle and North branches of the Clinton River. River flow is in a southerly direction.



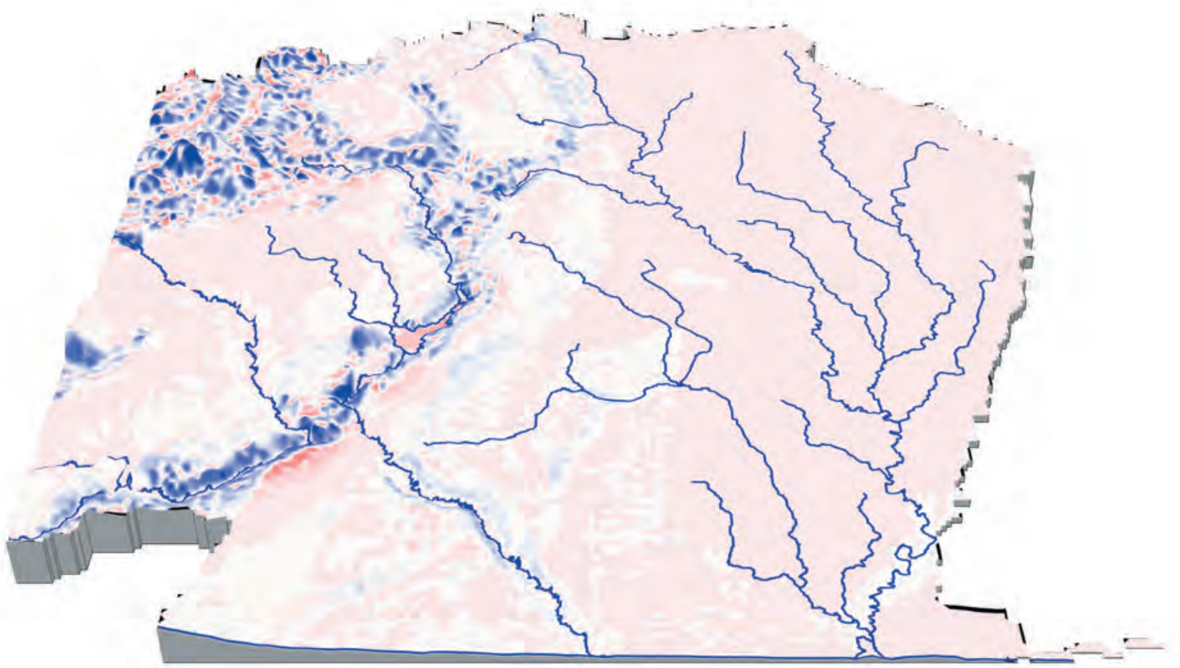


Figure 53.–Surface map (upper figure) shows general land surface features adjacent to Middle and North branches of the Clinton River watershed. River flow is in an southerly direction. The lower map shows potential groundwater flux (Darcy image) draped over the surface. Red areas are considered to be discharging to surface water while blue areas are groundwater accumulation zones.

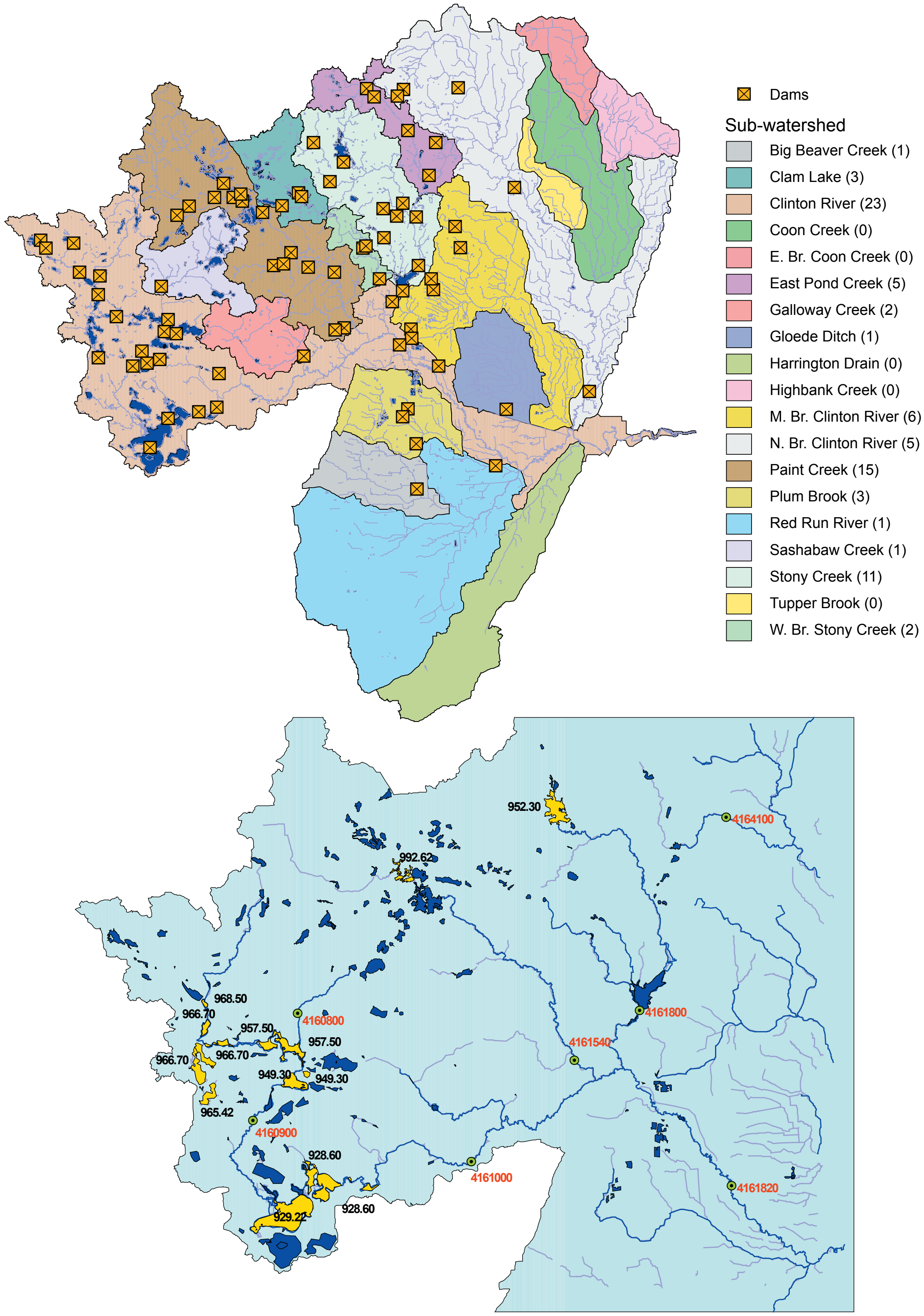


Figure 54.–Locations for 79 dams and other water control structures within the Clinton River watershed. The top map shows the location of water control structures. Lakes having water level control structures with legally set water levels are shown in yellow. Black numbers indicate the legal level in feet above sea level. Red numbers indicate United States Geological Survey gauge stations.

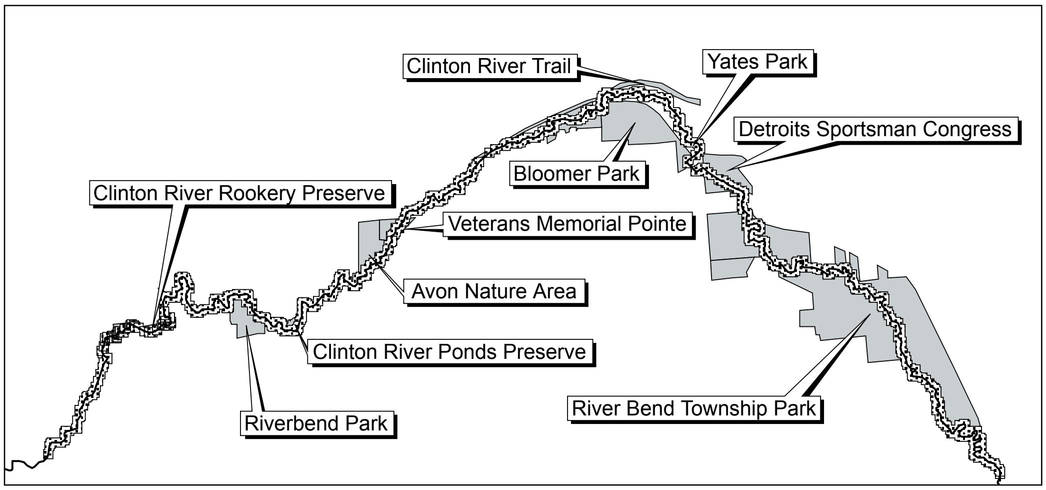


Figure 55.−Public lands (gray) located within Middle Segment of the Clinton River mainstem. This river segment is 19.1 miles long, 63% of which runs through public lands, and there are 1,628 acres of public land adjacent to the river. The Clinton River Watershed Council Recreation Guide, posted on their website at HTTP://www.crwc.org/projects/recreation/recreation.html, lists two canoeing segments in this section indicated by a light stippled buffer along the river. This website also has site-specific recreational descriptions of many of the public parcels along the river.

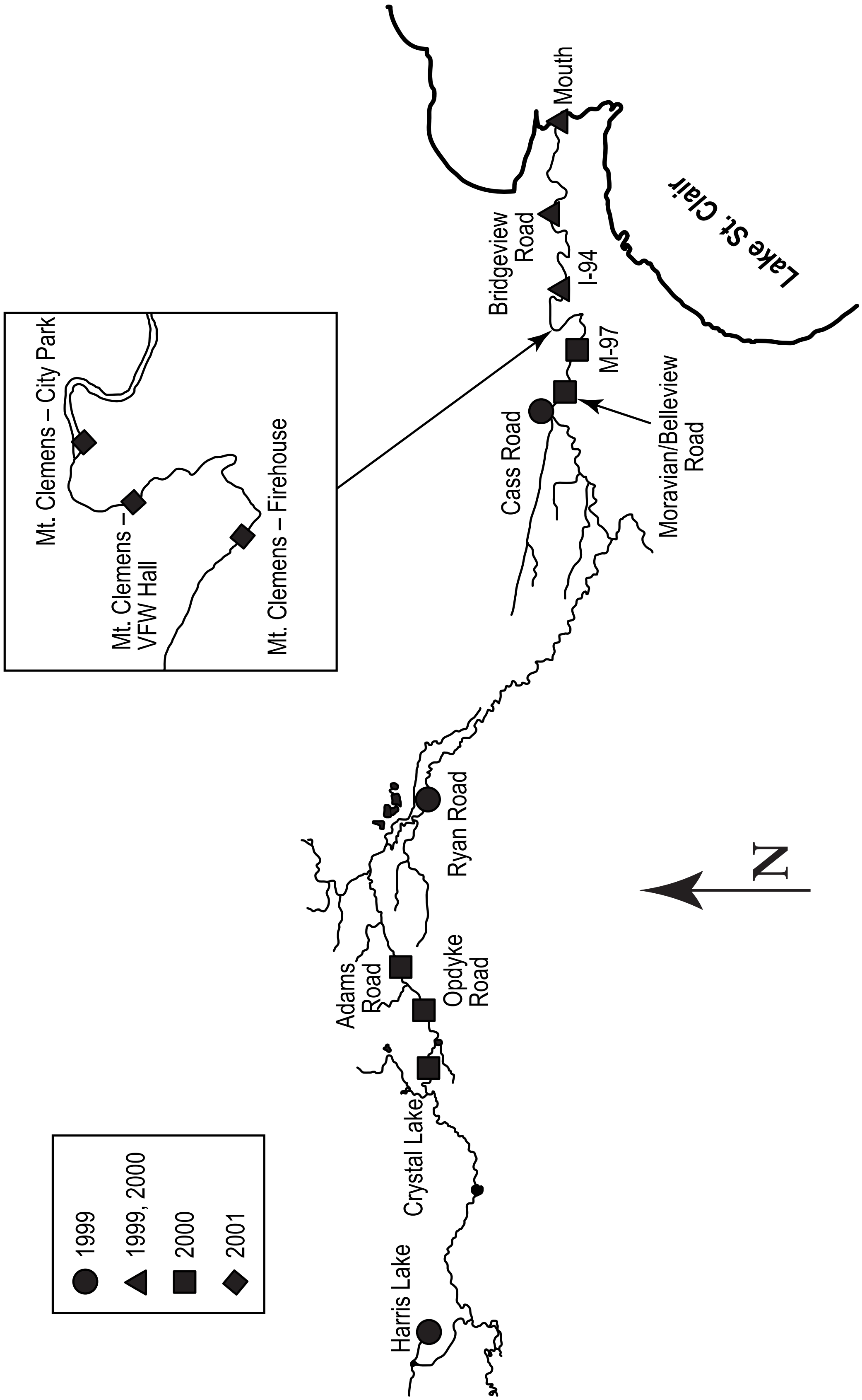
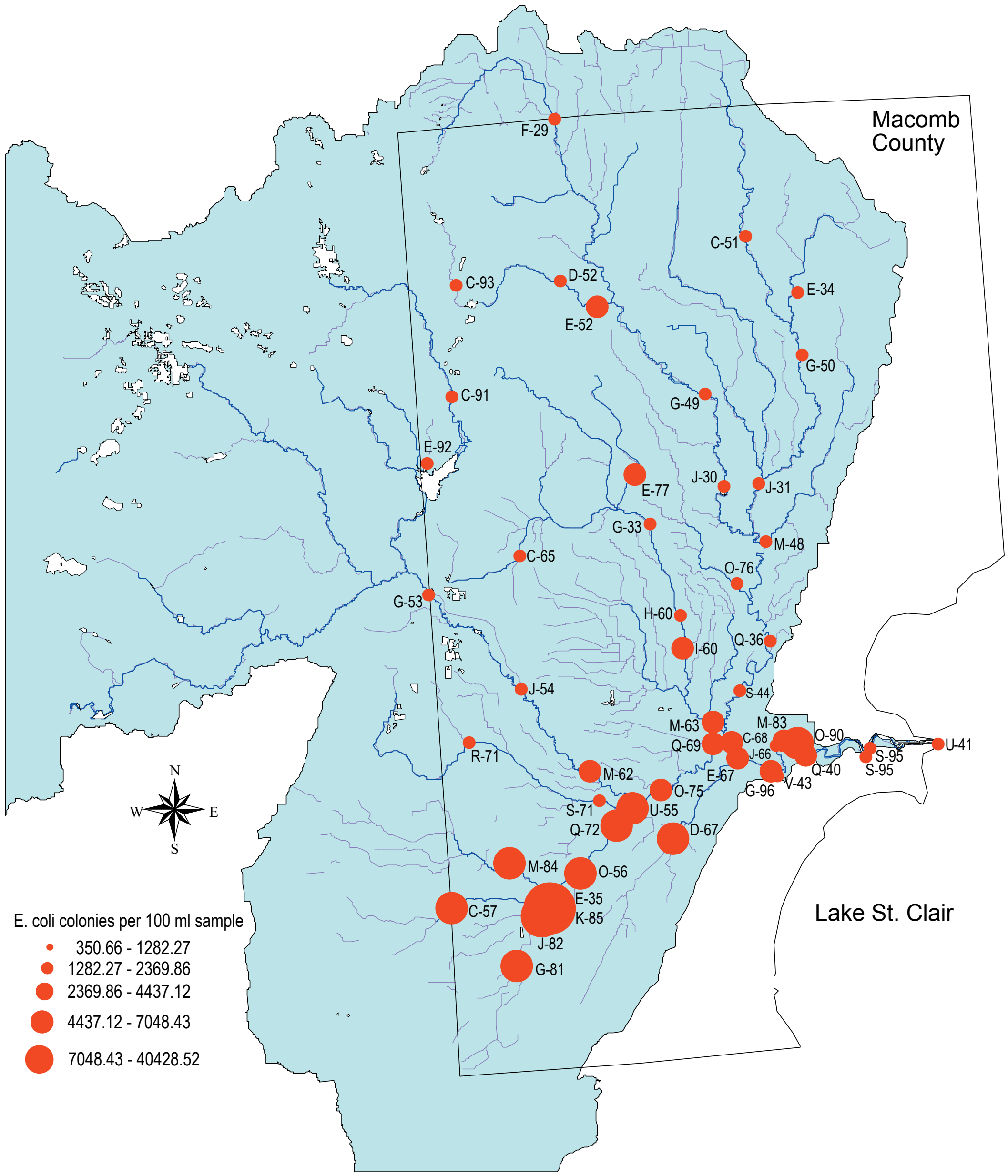


Figure 56.–Clinton River caged-fish monitoring locations. Data from Michigan Department of Environmental Quality 2003.



C-51 East Branch Coon Creek
C-57 Red Run Drain
C-65 Middle Branch Clinton River
C-68 Clinton River
C-91 Stoney Creek
C-93 Pond Creek
D-52 East Pond Creek
D-67 Sweeney Drain
E-34 Highbank Drain
E-35 Red Run Drain
E-52 North Branch Clinton River
E-67 Harrington Drain
E-77 Healy Brook Drain
E-92 Stony Creek West
F-29 North Branch Clinton River
G-33 Middle Branch Clinton River
G-49 North Branch Clinton River
G-50 East Branch Coon Creek
G-53 Clinton River
G-81 Bear Creek
G-96 Clinton River
H-60 Middle Branch Clinton River
I-60 Middle Branch Clinton River
J-30 North Branch Clinton River
J-31 East Branch Coon Creek
J-54 Clinton River
J-66 Clinton River
J-82 Bear Creek
K-85 Lorraine Drain
M-48 Deer Creek
M-62 Clinton River
M-63 Middle Branch Clinton River
M-83 Clinton River
M-84 Beaver Creek
O-56 Red Run Drain
O-75 Clinton River
O-76 McBride Drain
O-90 Clinton River
Q-36 North Branch Clinton River
Q-40 Clinton River
Q-69 Canal Drain
Q-72 Sterling Relief
R-71 Plumbrook Drain
S-44 North Branch Clinton River
S-71 Plumbrook Drain
S-95 Clinton River
S-95 Clinton River
U-41 Clinton River
U-55 Red Run Drain
V-43 Clinton River & Spillway

Figure 57.–Average bacteria load in the Clinton River, Macomb County, 1999–2003.

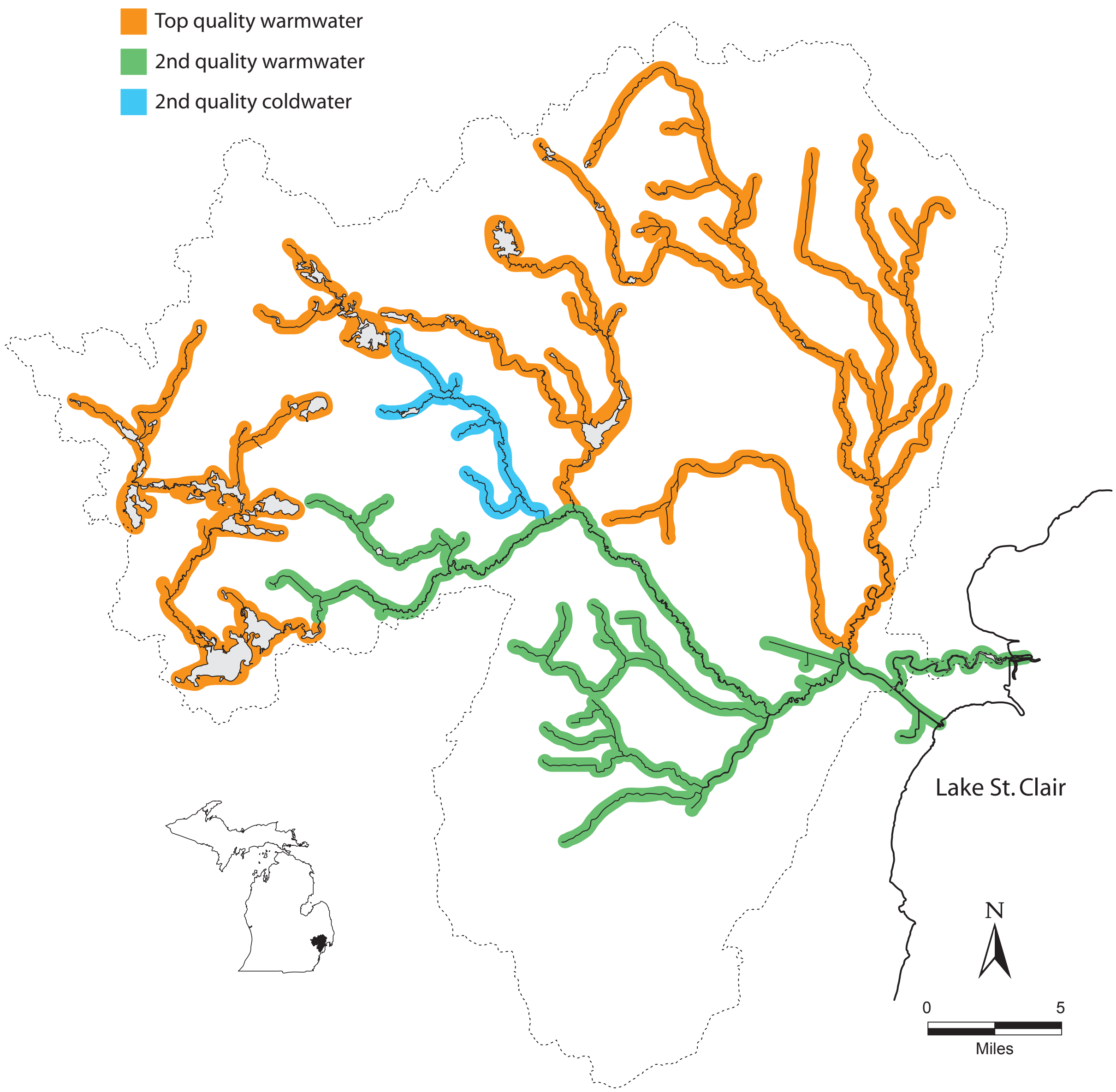


Figure 58.–Michigan Department of Natural Resources, Fisheries Division, stream classifications, 1967.

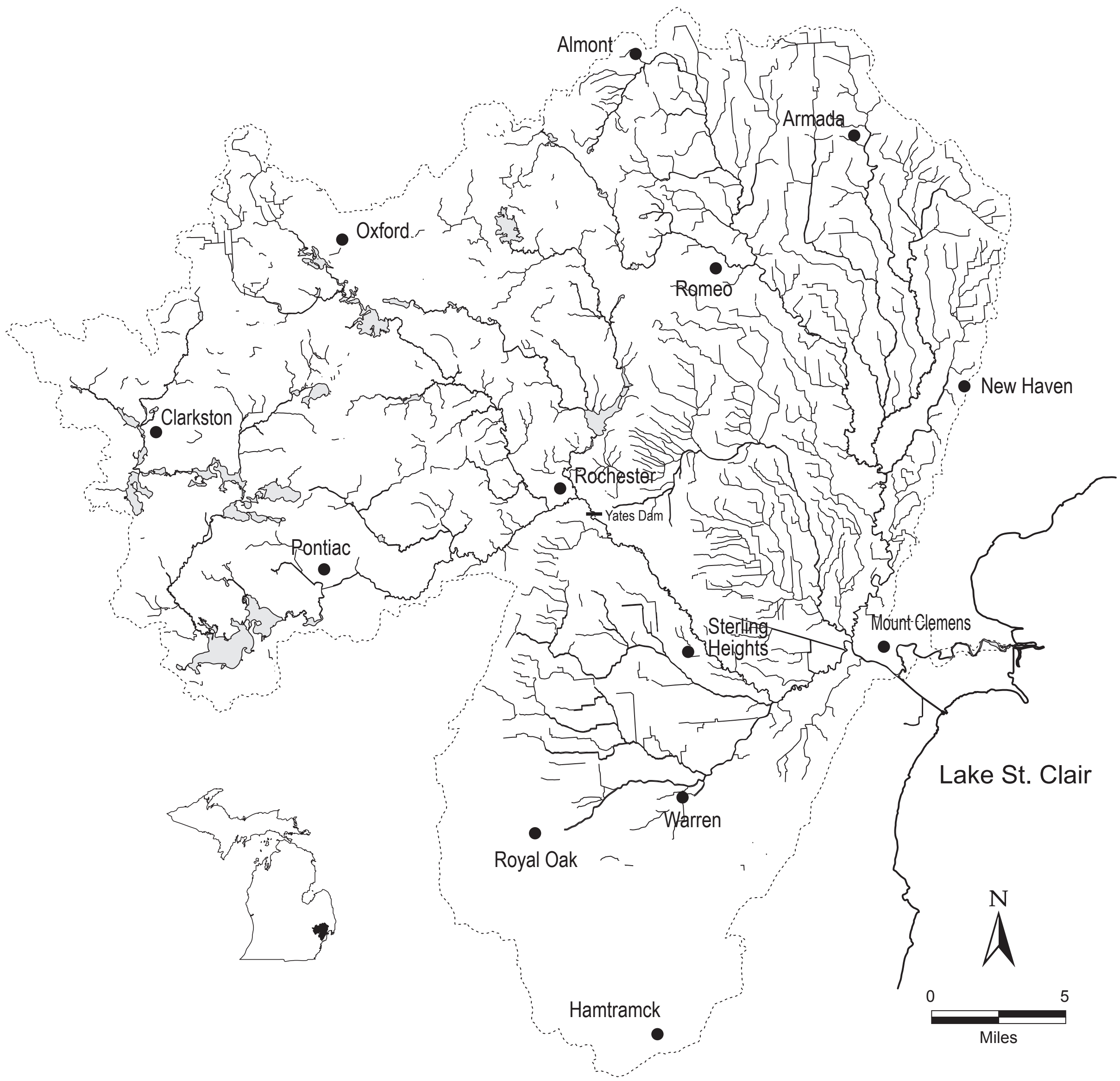
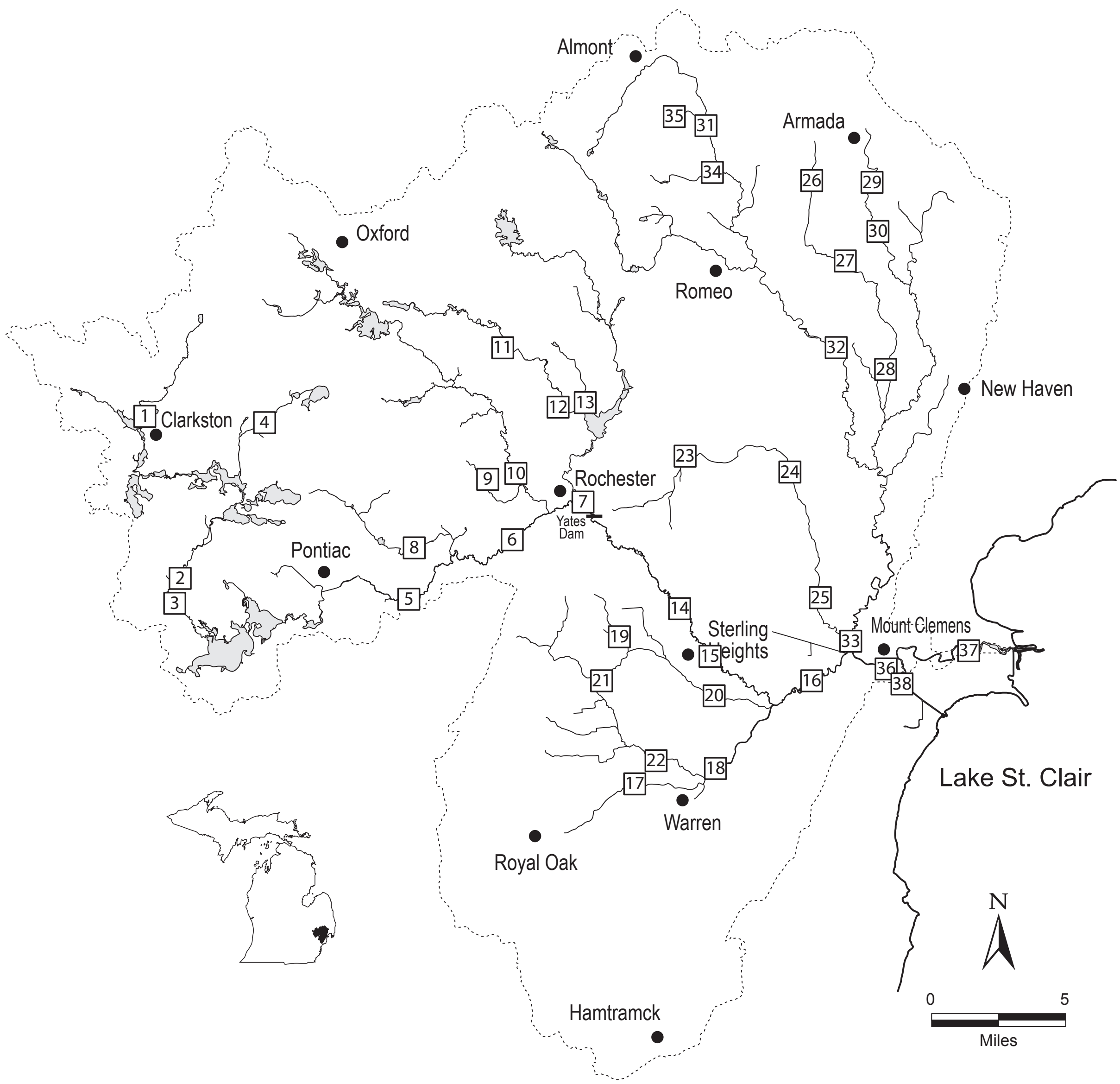
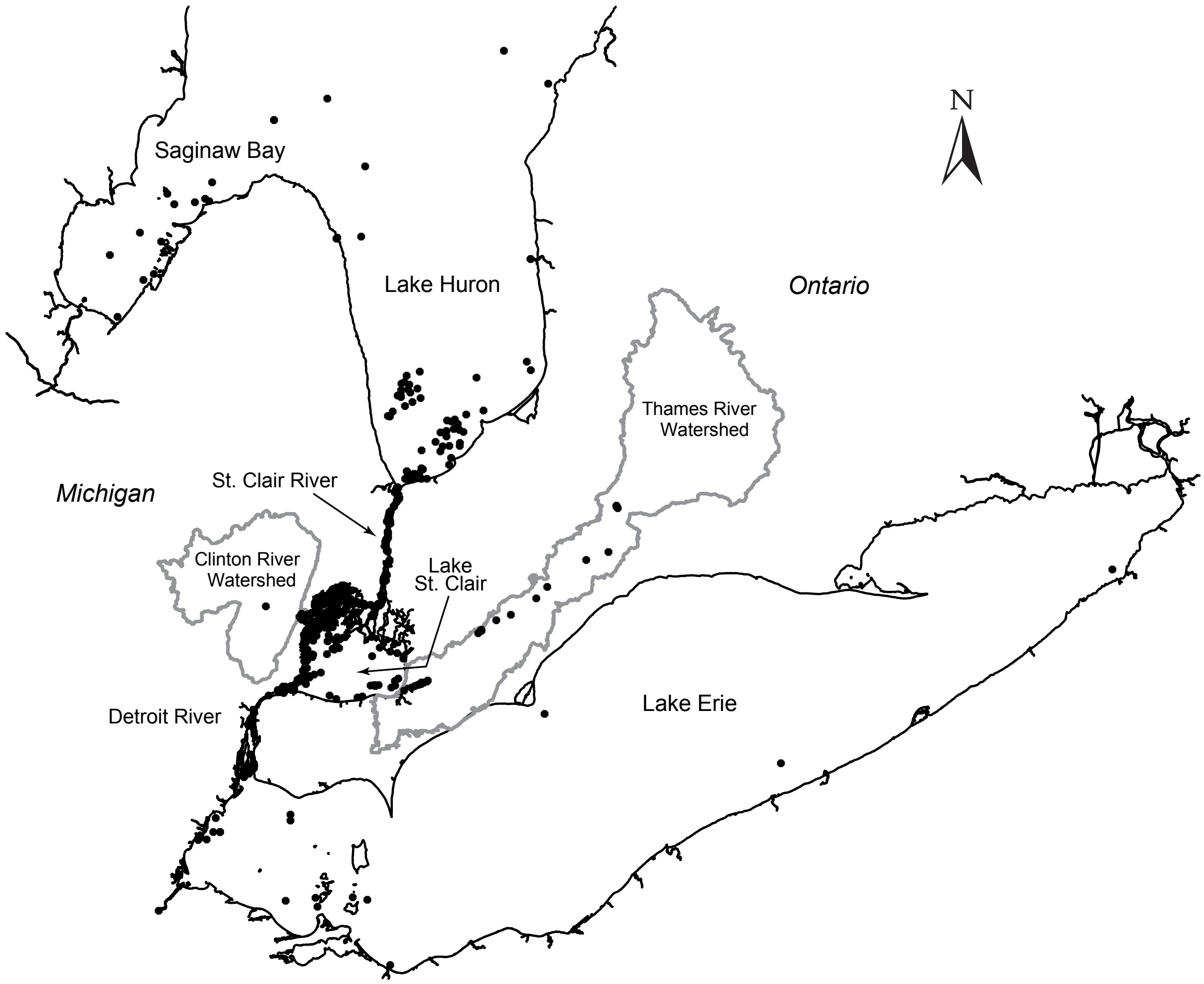


Figure 59.–Drains and smaller streams in the Clinton River watershed, in addition to the mainstem and major tributaries.



1 – Clinton River, I-75
2 – Clinton River, Pontiac Lake Rd.
3 – Clinton River, Cooley Lake Rd.
4 – Sashabaw Creek, Waldon Rd.
5 – Clinton River, Squirrel Rd.
6 – Clinton River, Livernois Rd.
7 – Clinton River, Yates Dam
8 – Galloway Creek, Squirrel Rd.
9 – Sargents Creek, Tienken Rd.
10 – Paint Creek, Tienken Rd.
11 – West Branch Stony Creek, Stony Creek Rd.
12 – West Branch Stony Creek, Snell Rd.
13 – McClure Drain, 28 Mile Rd.
14 – Clinton River, Van Dyke
15 – Clinton River, Dodge Park
16 – Clinton River, Garfield
17 – Red Run, Ryan Rd.
18 – Red Run, Maple Lane
19 – Plum Brook, 19 Mile Rd.
20 – Plum Brook, Dodge Park
21 – Gibson Drain, Dequindre Rd.
22 – Big Beaver Creek, Mound Rd.
23 – Middle Branch Clinton River, Jewel Rd.
24 – Middle Branch Clinton River, 24 Mile Rd.
25 – Middle Branch Clinton River, M-59
26 – Coon Creek, Irwin Rd.
27 – Coon Creek, 32 Mile Rd.
28 – Coon Creek, 28 Mile Rd.
29 – East Branch Coon Creek, Irwin Rd.
30 – East Branch Coon Creek, 33 Mile Rd.
31 – North Branch Clinton River, McKay Rd.
32 – North Branch Clinton River, Wolcott Mills Metro Park
33 – North Branch Clinton River, Middle Branch confluence
34 – Apel Drain, McKay Rd.
35 – Kidder Creek, Boardman Rd.
36 – Clinton River, Crocker Rd.
37 – Clinton River, Bridgeview
38 – Clinton River Spillway, Harper

Figure 60.–Location of fish sampling sites surveyed during 2001–02.



Waterbody	Percent tags recovered
Clinton River	3.4
Lake Huron	10.8
St. Clair River	26.1
Lake St. Clair	47.8
Thames River	3.5
Detroit River	6.0
Lake Erie	2.5
Total tags recovered	770

Figure 61.–Walleye tag recoveries reported by sport and commercial fishers from walleye originally tagged at spawning time, 1980–1991, in the Mouth Segment of the Clinton River.

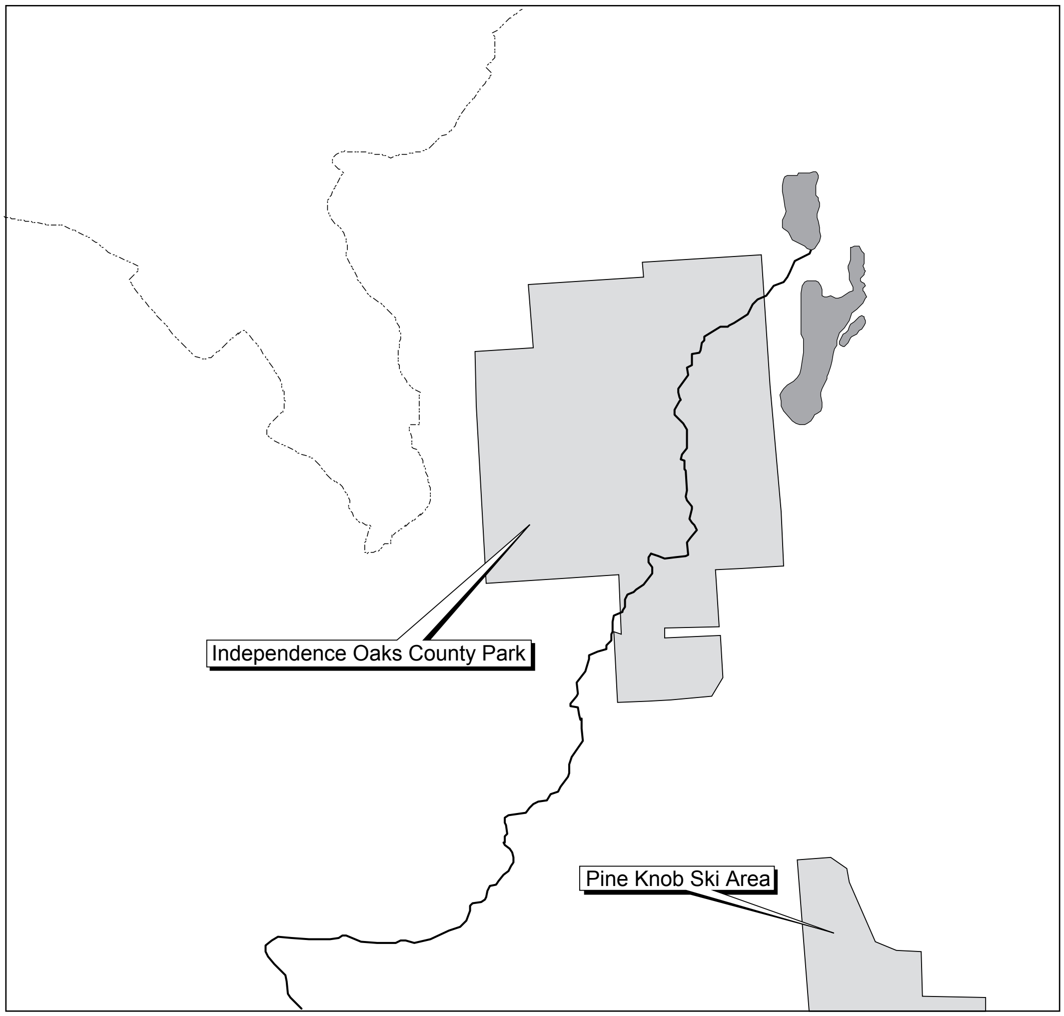


Figure 62.–Public lands (light gray) located within Headwaters Segment of the Clinton River mainstem. This river segment is 5.1 miles long, 37% of which runs through public lands, and there are 1,132 acres of public land adjacent to the river. The Clinton River Watershed Council Recreation Guide, posted on their website at HTTP://www.crwc.org/projects/recreation/recreation.html, does not recommend canoeing in this section. This website also has site-specific recreational descriptions of many of the public parcels along the river.

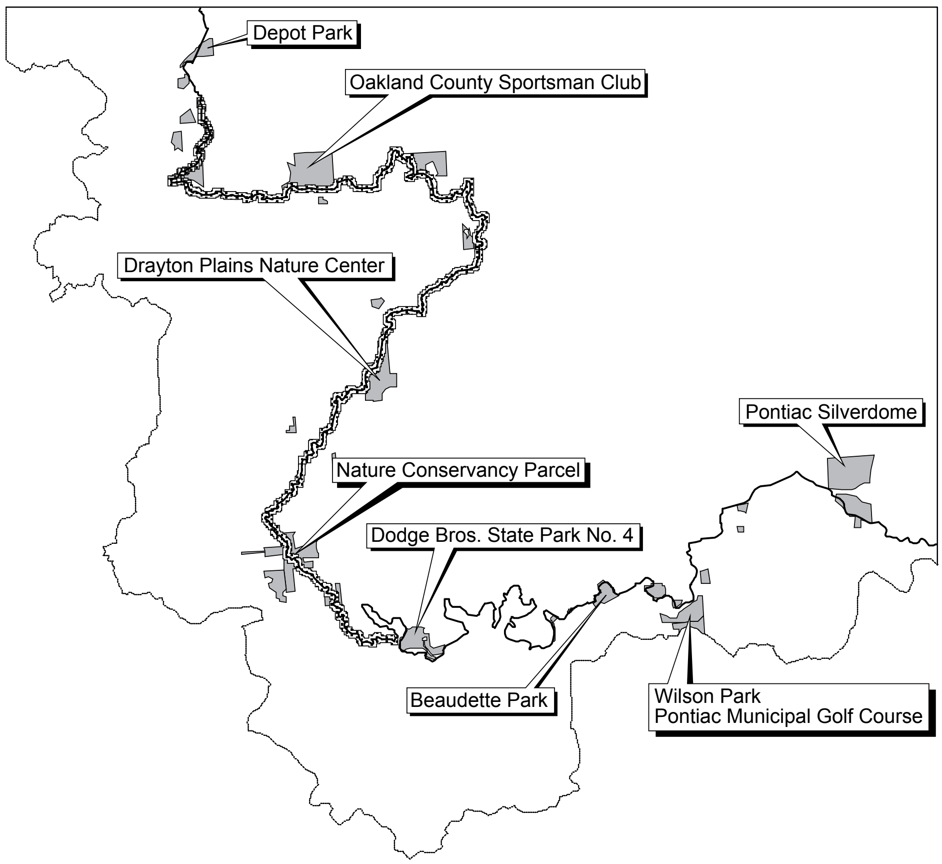


Figure 63.−Public lands (gray) located within the Upper Segment of the Clinton River mainstem. This river segment is 44.7 miles long, 20% of which runs through public lands, and there are 961 acres of public land adjacent to the river. The Clinton River Watershed Council Recreation Guide, posted on their website at HTTP://www.crwc.org/projects/recreation/recreation.html, recommends canoeing in this section as indicated by a light stippled buffer along the river. This website also has site-specific recreational descriptions of many of the public parcels along the river.

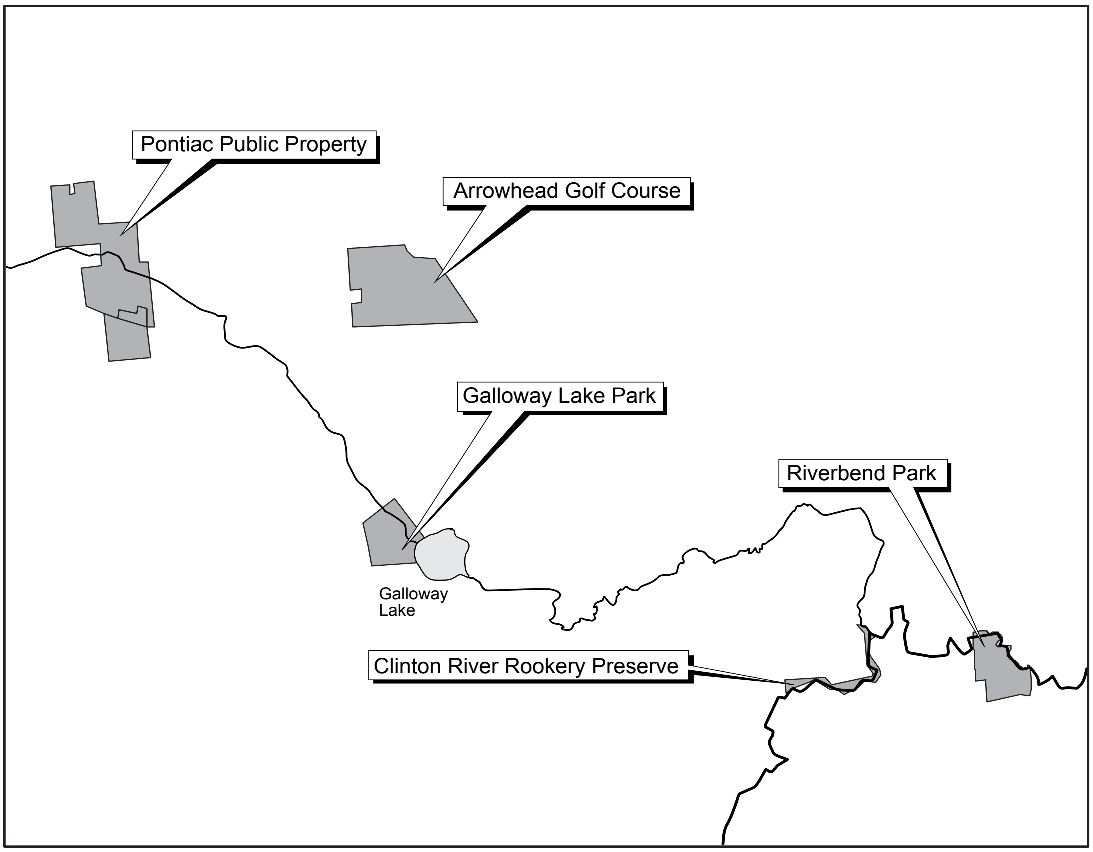


Figure 64.−Public lands (gray) located near Galloway Creek. This river segment is 8.3 miles long, 10% of which runs through public lands, and there are 333 acres of public land adjacent to the river.

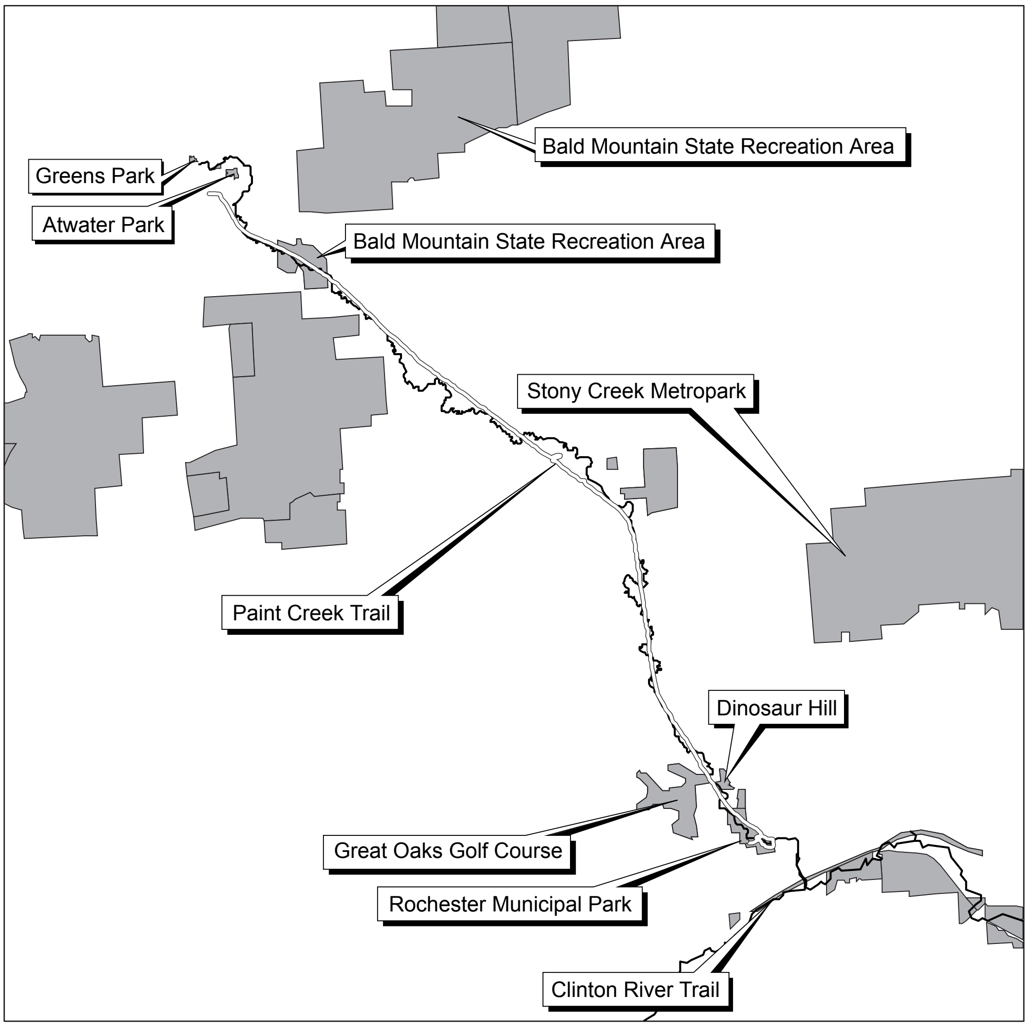


Figure 65.−Pulic lands (gray) located near Paint Creek. This river segment is 15.0 miles long, 10% of which runs through public lands, and there are 521 acres of public land adjacent to the river. Paint Creek Hiking Trail, which runs almost the entire length of the creek, provides access to the water at numerous points.

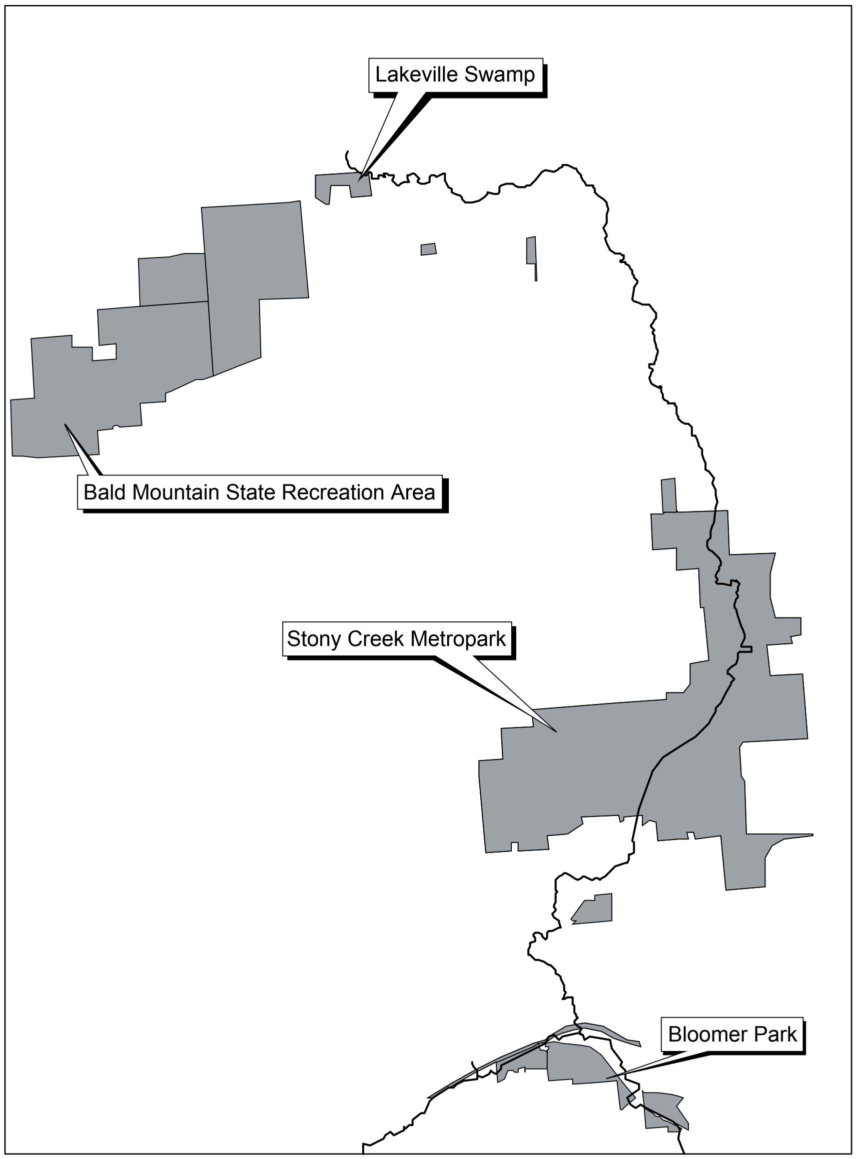


Figure 66.−Public lands (gray) located near Stony Creek. This river segment is 16.7 miles long, 27% of which runs through public lands, and there are 4,037 acres of public land adjacent to the river. Stony Creek Metropark, which runs along a significant part of the creek, provides excellent public access to the water at numerous points.

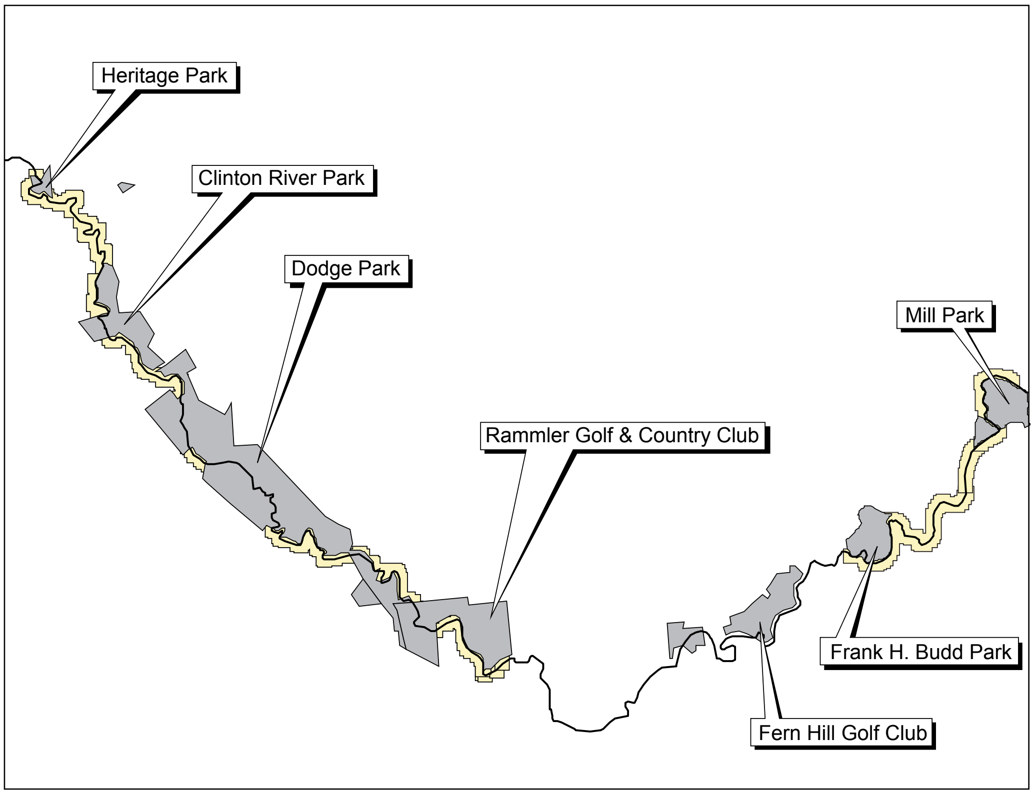


Figure 67.–Public lands (gray) located within Lower Segment of the Clinton River mainstem. This river segment is 13.7 miles long, 62% of which runs through public lands, and there are 780 acres of public land adjacent to the river. The Clinton River Watershed Council Recreation Guide, posted on their website at HTTP://www.crwc.org/projects/recreation/recreation.html, recommends canoeing in this section as indicated by a light stippled buffer along the river. This website also has site-specific recreational descriptions of many of the public parcels along the river.

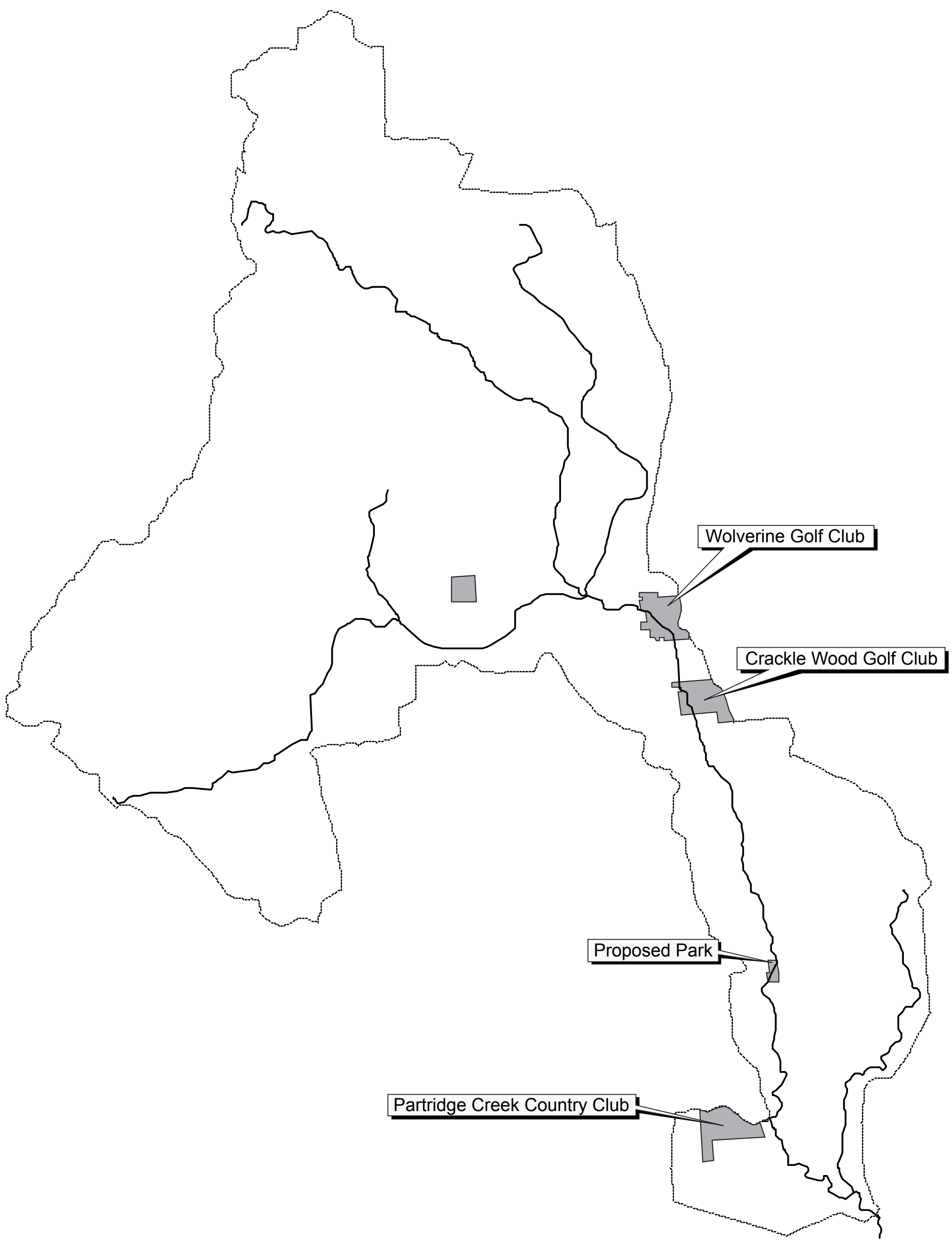


Figure 68.–Public lands (gray) located near Middle Branch of the Clinton River and major tributaries. Combined length for these river segments is 37.5 miles long, only 4% of which runs through public lands, and there are 794 acres of public land adjacent to the river. This section has very limited public access and provides little recreational opportunity.

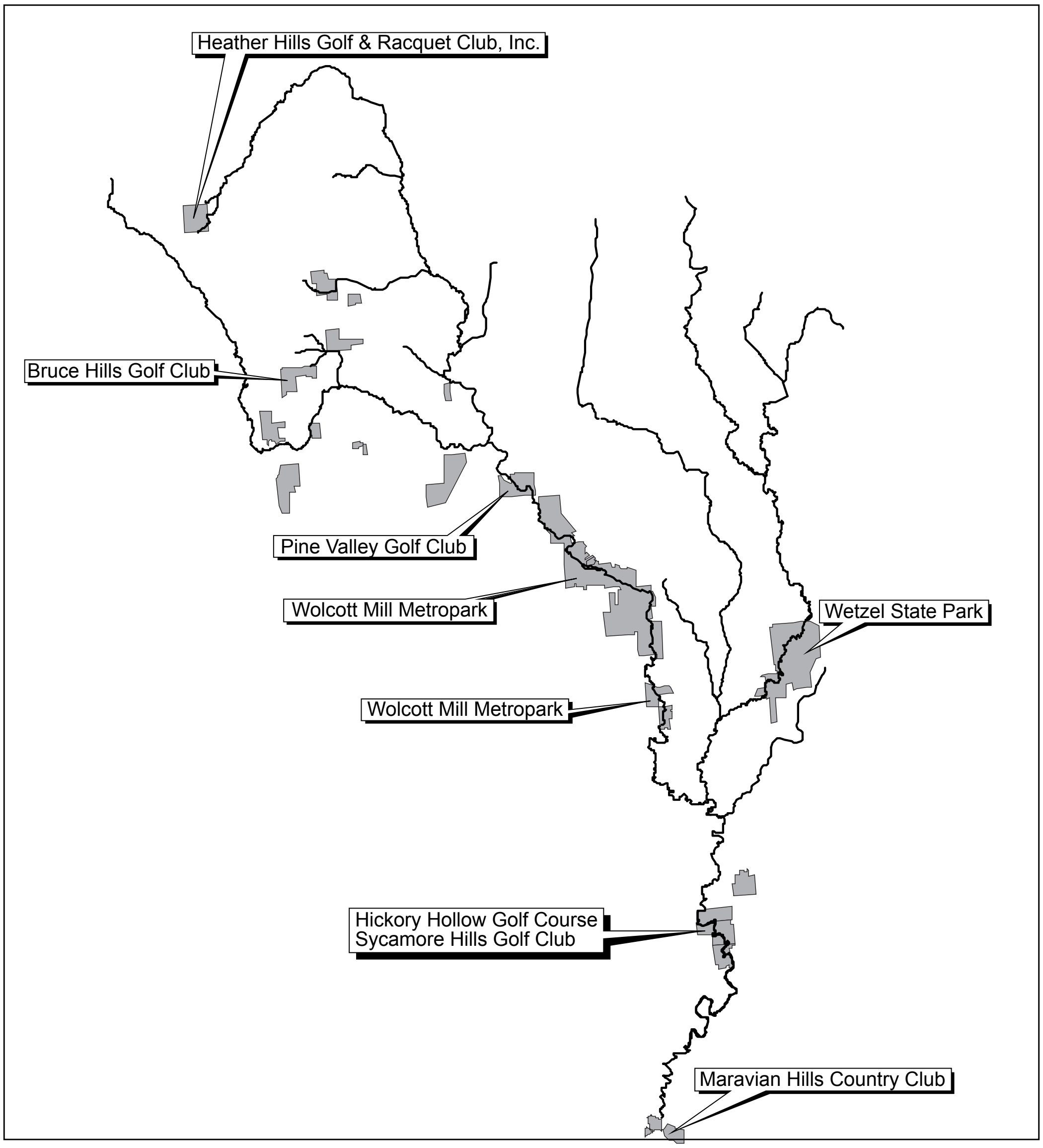


Figure 69.−Public lands (gray) located near North Branch of the Clinton River and major tributaries. Combined length for these river segments is 127.7 miles long, of which 11% of which runs through public lands, and there are 4,657 acres of public land adjacent to the river. This section has moderate to good public access providing substantial recreational opportunity.

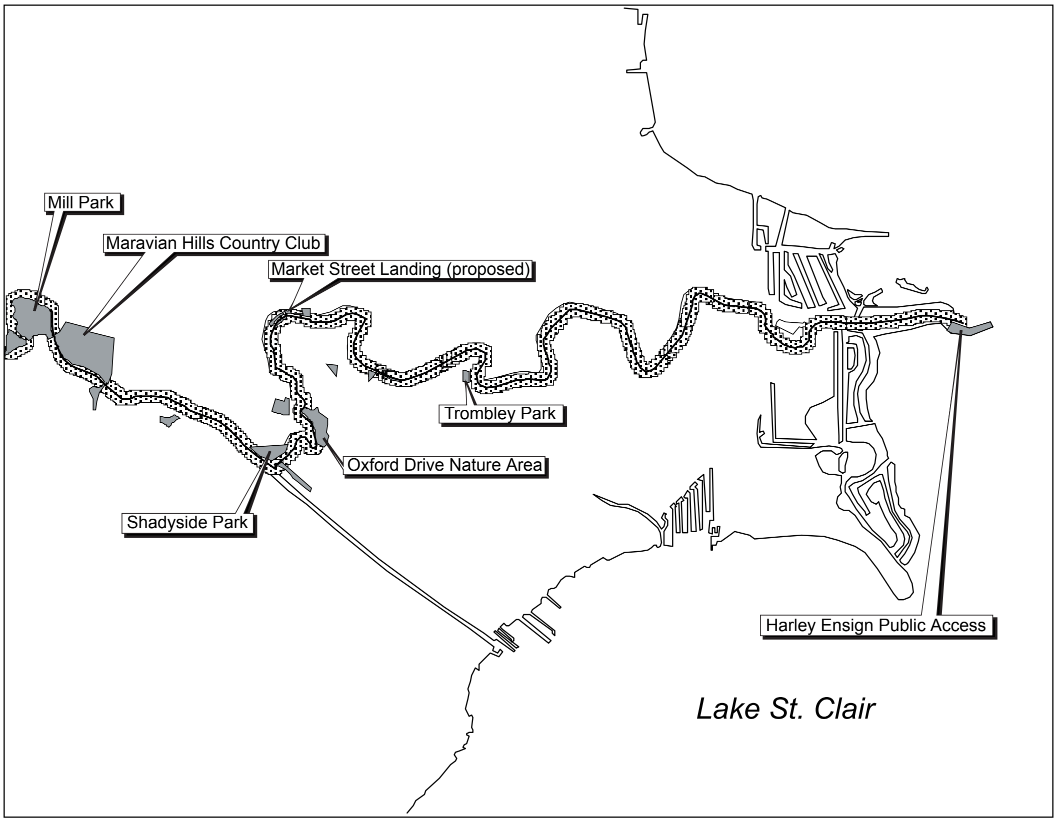


Figure 70.−Public lands (gray) located within Mouth Segment of the Clinton River mainstem. This river segment is 10.4 miles long, 18% of which runs through public lands, and there are 182 acres of public land adjacent to the river. The Clinton River Watershed Council Recreation Guide, posted on their website at HTTP://www.crwc.org/projects/recreation/recreation.html, recommends canoeing in this section as indicated by a light stippled buffer along the river. This website also has site-specific recreational descriptions of many of the public parcels along the river.

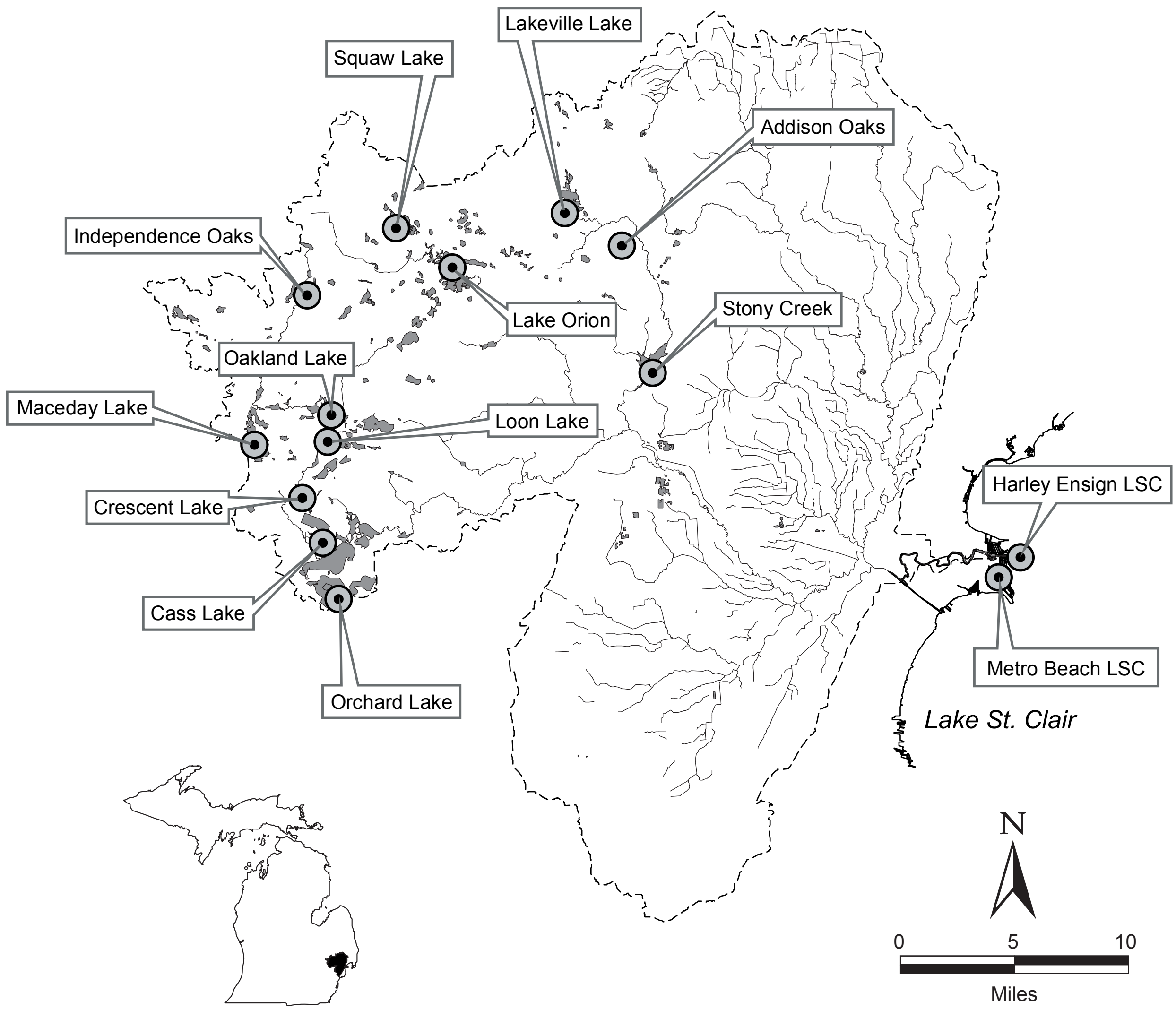


Figure 71.−Locations of major public boat launching sites in the Clinton River watershed. The Clinton River Watershed Council Recreation Guide, posted on their website at HTTP://www.crwc.org/projects/recreation/recreation.html, has site-specific recreational descriptions of many of these recreational facilities.

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TABLES

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Table 1.–Number of archaeological sites within the Clinton River drainage listed by township.

County	Township	Number of sites
Lapeer	T. 06 N, R. 12 E	25
St. Clair	T. 06 N, R. 13 E	1
Oakland	T. 05 N, R. 09 E	1
Oakland	T. 05 N, R. 10 E	15
Oakland	T. 05 N, R. 11 E	18
Macomb	T. 05 N, R. 12 E	62
Macomb	T. 05 N, R. 13 E	7
Oakland	T. 04 N, R. 08 E	2
Oakland	T. 04 N, R. 09 E	13
Oakland	T. 04 N, R. 10 E	33
Oakland	T. 04 N, R. 11 E	39
Macomb	T. 04 N, R. 12 E	22
Macomb	T. 04 N, R. 13 E	1
Oakland	T. 03 N, R. 09 E	15
Oakland	T. 03 N, R. 10 E	39
Oakland	T. 03 N, R. 11 E	46
Macomb	T. 03 N, R. 12 E	22
Macomb	T. 03 N, R. 13 E	26
Macomb	T. 03 N, R. 14 E	2
Oakland	T. 02 N, R. 10 E	1
Oakland	T. 02 N, R. 11 E	4
Macomb	T. 02 N, R. 12 E	40
Macomb	T. 02 N, R. 13 E	31
Macomb	T. 02 N, R. 14 E	12
Oakland	T. 01 N, R. 09 E	11
Oakland	T. 01 N, R. 11 E	10
Macomb	T. 01 N, R. 12 E	13
Oakland	Unknown	1
	TOTAL	512

Table 2.–Period of record for climate data at Department of Commerce, National Oceanic and Atmospheric Administration weather stations in or near the Clinton River watershed. Straight-line distance (mi) from the weather station to the geographic center of the watershed is shown. Data from NOAA's Climatic Data Center.

Station name	NCDC number	Period of record	Distance (mi)
Detroit City Airport	0202102	Jan. 1, 1948–Dec. 31, 2000	17.7
Detroit Metro Airport	0202103	Jan. 1, 1958–Dec. 31, 2000	31.1
Milford GM Proving Grounds	0205452	Jan. 1, 1948–Dec. 31, 2000	28.5
Mt. Clemens Selfridge	0205650	Jan. 1, 1948–Dec. 31, 2000	16.5
Pontiac State Hospital	0206658	Jan. 1, 1948–Jan. 31, 1999	7.8
Port Huron	0206680	Jan. 1, 1948–Dec. 31, 2000	43.3

Table 3.–Period of record mean annual discharge at selected United States Geological Survey gauging stations on the Clinton River. Data from United States Geological Survey.

Gauge site	Gauge number	Period of record	Drainage area (mi^2)	Mean annual discharge (cfs)	Yield (cfs/mi^2)	Mean daily flow in August
Sashabaw Creek near Drayton Plains	04160800	1959–02	20.9	13.1	0.63	4.7
Clinton River near Drayton Plains	04160900	1959–02	79.2	52.5	0.66	23.0
Clinton River at Auburn Hills	04161000	1935–39 1956–82 2001–02	123.0	103.4	0.84	59.1
Paint Creek at Rochester	04161540	1959–02	70.9	53.1	0.75	26.1
Stony Creek near Washington	04161800	1958–02	68.2	43.0	0.63	19.2
Clinton River at Sterling Heights	04161820	1978–82 1996–97 2001–02	309.0	277.2	0.90	129.0
Clinton River near Fraser	04164000	1947–02	444.0	391.3	0.88	231.9
East Pond Creek at Romeo	04164100	1958–02	21.8	16.2	0.74	7.2
East Branch Coon Creek at Armada	04164300	1958–02	13.0	7.4	0.57	1.4
North Branch Clinton River near Mt. Clemens	04164500	1947–02	199.0	128.1	0.64	27.1
Clinton River at Moravian Drive	04165500	1934–02	734.0	565.9	0.77	259.0

Table 4.–Period of record maximum and minimum daily discharges at selected United States Geological Survey gauging stations on the Clinton River. Data were grouped by year to determine smallest annual maximum and largest annual minimum flows. Data from United States Geological Survey.

		Maximum flow				Minimum flow				Full years
	Gauge	largest		smallest annual		largest annual		smallest		of data
Gauge site	number	cfs	year	cfs	year	cfs	year	cfs	year	in record
Sashabaw Creek near Drayton Plains	04160800	146	1981	39	1961	4.0	1980	0.1	1984	40
Clinton River near Drayton Plains	04160900	99	1962	82	1964	17.0	1972	3.0	1963	40
Clinton River at Auburn Hills	04161000	970	1974	181	1958	49.0	1981	5.5	1936	29
Paint Creek at Rochester	04161540	660	1968	107	1964	22.0	1986	6.8	1988	40
Stony Creek near Washington	04161800	407	1968	33	1963	14.0	1980	1.3	1964	41
Clinton River at Sterling Heights	04161820	2,000	1997	1,110	1980	110.0	1980	55.0	1996	6
Clinton River near Fraser	04164000	6,930	1948	781	1958	168.0	1968	49.0	1955	52
East Pond Creek at Romeo	04164100	302	1968	36	1961	6.6	1997	0.9	1964	41
East Branch Coon Creek at Armada	04164300	497	1975	30	1964	0.3	1992	0.0	1976	41
North Branch Clinton River near Mt. Clemens	04164500	5,040	1975	450	1958	14.0	1968	0.1	1988	52
Clinton River at Moravian Drive in Mt. Clemens	04165500	19,200	1947	1,400	1958	200.0	1992	25.0	1934	65

Table 5.–Cover type in the Clinton 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).

	Presettlement (*c*. 1800)		Current 1992	
Cover type	Acres	Percent of total	Acres	Percent of total
Agriculture	0	(0)	187,972	(36.5)
Forested	466,605	(91.5)	108,650	(21.3)
Urban and built up	0	(0)	164,970	(32.4)
Wetlands	41,065	(8.1)	32,541	(6.3)
Open water	2,200	(0.4)	15,737	(3.1)

Table 6.–Beginning and ending elevations and gradient for principal segments of the Clinton River. Elevation and segment length data were extracted from the Michigan Department of Natural Resources, Michigan Resource Inventory System digital elevation and framework datasets. Width measurements were taken from orthorectified aerial images available from same source.

River segment	Elevation at upper end (ft)	Elevation at lower end (ft)	Segment length (mi)	Gradient (ft/mi)	Average width (ft)	Stand. dev. of width	Number measures	Sinuousity index
Clinton River								
Headwaters	1,039.8	992.9	5.0	9.1	14.2	4.1	78	1.33
Upper	992.9	854.1	30.0	4.6	54.2	28.8	233	1.37
Middle	854.1	616.6	19.3	12.4	55.7	13.7	377	1.46
Lower	616.6	578.6	13.7	2.8	76.4	21.1	162	1.42
Mouth	578.6	574.6	11.1	0.4	175.7	51.8	126	1.26
Galloway Creek	945.9	807.6	8.3	16.7	16.7	4.6	74	1.18
Paint Creek	983.1	717.9	15.0	17.7	26.3	23.8	183	1.34
Stony Creek	951.8	687.4	16.7	15.8	35.1	19.6	84	1.15
North Branch	903.2	579.7	41.9	7.7	36.5	5.3	352	1.29
Middle Branch	879.3	578.7	18.1	16.6	39.5	9.8	43	1.04

Table 7.–Clinton River cross-section data summary. Expected width was calculated using average width of rivers with the same discharge volume (equations from Leopold and Maddock 1953, Leopold and Wolman 1957). Mean discharge measurements were taken from Drayton Plains 1994–2003, Auburn Hills 2001–2003, Sterling Heights 2002–2003, and Fraser 1994–2003 (data from United States Geological Survey). Hydraulic diversity index was calculated using the Shannon-Weiner information statistic.

Location	Actual width (ft)	Median daily discharge (cfs)	Expected width (ft)	Hydraulic diversity index
Drayton Plains	36	50.2	39	1.80
Auburn Hills	33	116.0	51	1.45
Sterling Heights	75	177.5	73	2.38
Fraser	83	400.7	109	1.75

Table 8.–Dams and water control structures in the Clinton River watershed, arranged by subwatershed. Data from Department of Environmental Quality, Land and Water Management Division, Dams Safety Unit. Data codes: P=private, F=federal, S=state, LG=local government. Hazard type: 1=high, 2=significant, 3=low. High hazard — loss of life would occur; significant hazard — large amounts of property damage would occur. Blank indicates no data available.

Dam name	Water body	Year built	Owner	Type	Height (ft)	Surface acreage	Storage capacity (acre-ft)	Use	Hazard type
Clinton River									
Dixie Lake Dam		1940	P	earth	4	61	300	lake-level	3
Susin Lake			P	earth	10	50	0	recreation	3
Wau-Me-Gah Lake Dam	Clinton River	1930	P	earth	8	115	600	recreation	2
Tody Lake Dam	Mill Creek	1965	P	earth	12	23	0	recreation	3
Clarkston Dam	Clinton River	1900	P	earth; gravity	34	10	90	retired hydro	1
Williams Lake Control Structure		1972			5	175	0		3
Cemetary & Dollar Lake Dam	Clinton River		P	other	1	28	0		3
Waterford Multi-Lakes Level Control	Clinton River	1973	P	earth; gravity	12	417	3,800	lake-level	2
Eagle Lake Dam	Eagle Lake outlet	1978	LG	earth;	3	20	25	recreation	3
Clintonville Dam	Clinton River	1915	P	earth	14	370	3,900	recreation	2
Lake Angelus Level Control Structure	Lake Angelus outlet	1979	LG	earth; gravity	3	413	520		3
Loon Lake Dam	Clinton River	1936	P	earth; gravity	8	467	3,800	recreation	2
Scott Lake Control Structure					0	77	0		
Watkins Lake Dam	Clinton River				3	244	0		3
Lower Hatchery Dams	Clinton River		P	concrete; gravity	9	43	3	recreation	3
Orchard Lake Dam		1968	LG	earth	8	850	0	lake-level	3
Cass Lake Control Structures 1 and 2	Clinton River	1968	P	other; gravity	6	1,280	0	recreation	3
Pontiac Motor Division Detention Basin	Montcalm Storm Sewer	1982	P	other	12	1	10	lake-level	2
Dawson Millpond Dam	Clinton River	1915	P	concrete	9	567	3,447	retired hydro	1
Walter Moore Dam	Clinton River	1989	LG		0	83	0		3
Winkler Pond Dam	Stony Creek	1917	P	earth; gravity	13	18	200	recreation	2
Yates Mill Dam	Clinton River		P	gravity	10	4	20	other	3
Ford Motor Company Drain Dam	Clinton River		P	gravity	8	2	0	recreation	3
Sashabaw Creek									
Sashabaw Creek Dam	Sashabaw Creek		P	gravity	4	1	0	recreation	3

Table 8.–Continued.

Dam name	Water body	Year built	Owner	Type	Height (ft)	Surface acreage	Storage capacity (acre-ft)	Use	Hazard type
				Galloway Creek					
Galloway Lake Dam									
Galloway Creek USGS Control	Galloway Creek	1960	F	other	6	0	0	other	3
				Paint Creek					
Hillview Lake Dam	Tributary to Paint Creek		P	gravity	9	4	0	recreation	3
Pungs Dam	Paint Creek Drain	1923	P	earth; gravity	16	19	160	recreation	2
Lake Araho Dam	Paint Creek Drain		P	earth; gravity	10	28	140		3
Oxford Multi-lakes	N. Br. Paint Creek	1975	P	earth; gravity	12	76	1,175	recreation	3
Duck Lake Dam	Paint Creek Drain	1920	P	earth; gravity	15	49	350	recreation	3
Manito Lake Dam		1950	LG	earth	6	25	60	recreation	3
Indianwood Lake Dam	Paint Creek	1920	P	earth; gravity	13	122	465	recreation	3
Lake Orion Dam	Paint Creek	1829	LG	gravity	18	470	3,600	lake-level	2
Upper Trout Lake Dam	Trout Creek	1963	S	earth	11	3	57	recreation	3
Lower Trout Lake Dam	Trout Creek	1963	S	earth; other	25	68	660	recreation	3
Bald Mountain Pond Dam	Spring Creek	1946	S	earth; gravity	12	6	30	recreation	3
Warstler Dam	Tributary to Paint Creek		P	earth	0	3	0		3
Paint Creek Cider Mill Dam	Paint Creek		P	gravity	8	1	0		3
Sargent Creek Dam	Sargent Creek		P	earth; gravity	9	4	0	recreation	3
Rochester City Park Dam	Paint Creek	1934	LG	other; gravity	6	1	0	recreation	3
				Clam Lake					
Indian Lake Dam	Tributary W. Br. Stony Creek	1928	P	buttress	20	58	900	recreation	3
Prince Lake Dam	Tributary W. Br. Stony Creek	1963	S	earth	20	28	310	recreation	3
Bunny Run Dam	W. Br. Stony Creek	1926	P	earth	11	11	40	recreation	3
				West Branch Stony Creek					
Buell Road Dam	W. Br. Stony Creek		P	gravity	5	5	0	recreation	3
Eggleston Dam	W. Br. Stony Creek	1953	P	gravity	0	1	0	recreation	3

Table 8.–Continued.

Dam name	Water body	Year built	Owner	Type	Height (ft)	Surface acreage	Storage capacity (acre-ft)	Use	Hazard type
Stony Creek									
Gehrke Dam	Tributary Stony Creek	1913	P	earth; gravity	18	3	60	other	2
Shoup Pond	Clark Drain		LG	gravity	8	1	6	recreation	3
Lakeville Lake Dam	Stony Creek	1913	P	other	10	460	2,200	lake-level	3
Addison Oaks Dam	Krohn Drain	1976	LG	earth	6	37	90	recreation	3
Misuaraca Dam	Tributary Stony Creek		P		0	3	0	recreation	3
Clifton Mill Pond Dam	Stony Creek	1937	P	earth; gravity	12	9	50	recreation	3
Afton Dam	Tributary Stony Creek		P	earth	0	1	0	recreation	3
Thorington Lake Dam	Tributary Stony Creek		P		3	11	0		3
Traxler Dam	Mcclure Drain		P	gravity	0	1	0	recreation	3
Upper Stony Lake Dam	Stony Creek	1961	LG	earth; gravity	24	90	2,500	recreation	1
Lower Stony Lake Dam	Stony Creek	1961	LG	gravity earth	32	590	13,000	recreation	1
East Pond Creek									
Baldwin Pond Dam	East Pond Creek		P	gravity	6	3	2	recreation	3
Secord Lake Dam	East Pond Creek		P	gravity	7	55	130	recreation	3
Fisher Dam	Tributary East Pond Creek	1920	P	earth	15	43	290	recreation	3
Hidden Lake Dam	Tributary East Pond Creek	1968	P	earth	8	16	70	recreation	3
East Mill Lake Dam	Tributary East Pond Creek	1926	P	earth	15	31	440	recreation	3
Middle Branch Clinton River									
Mather Dam	Price Brook		P		0	1	0		3
Lefever Dam	Tributary Yates Drain		P		0	1	0		3
Cory Lake Dam	Tributary Yates Drain		P	earth	8	7	32	recreation	2
Crystal Creek Detention Dam No 1	TR–Clinton River	1989	P	earth	12	4	8	lake-level	3
Huntington Lake Level			LG	other	0	0	0	recreation	3
Chestnut Lake Dam	Middle Br. Clinton River	1968	LG	gravity	16	10	100	recreation	3
Gloede Ditch									
Sterling Mall Dam	Utica Drain	1977	LG	earth	9	16	234	lake-level	3

Table 8.–Continued.

Dam name	Water body	Year built	Owner	Type	Height (ft)	Surface acreage	Storage capacity (acre-ft)	Use	Hazard type
				North Branch Clinton River					
Bishop Dam	North Branch Clinton River	1964	P	earth	5	1	0	recreation	3
Centennial Lake Dam	North Branch Clinton River		P		6	30	0		3
Woodland Waters Dam	North Branch Clinton River	1962	P	earth	6	25	0	recreation	3
Cascade Dam	North Branch Clinton River		P	buttress	9	1	0	other	3
North Branch Clinton USGS Control	North Branch Clinton River	1961	F	other	2.5	1	0	other	3
				Plumb Brook					
Andries Dam	Plumbrook Drain		P	earth	6	1	0	recreation	3
Troy Lakes Estates Dam	Gibson Drain	1993	P	earth	19	6	30	lake-level	3
Gibson Drain Detention Dam	Gibson Drain				9	16	0		3
Big Beaver Creek									
Autumn Ridge Detention Dam	Shanahan Drain	1982	LG	earth	11	1	23	other	2
				Red Run River					
Plumbrook Golf Course Dam	Plumbrook Drain		P	gravity	4	1	0	irrigation	3

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

Valley segment City	Receiving water	Designated name	Permit type
Upper			
Auburn Hills	Carpenter Lake	Oakland Hts Development	industrial stormwater
Orion	Carpenter Lake	GM Orion Assembly	industrial stormwater
Waterford	Cass Lake	Cass Lake Dry Dock Marina	industrial stormwater
Auburn Hills	Clinton River	Foamade Ind	processed wastewater
Clarkston	Clinton River	Springfield Metal Works	industrial stormwater
		Thompson–McCully–Clarkston	industrial stormwater
Pontiac	Clinton River	Clawson Concrete–Plt 7	industrial stormwater
		FedEx Ground–Pontiac	industrial stormwater
		GM Truck Product Center–West	industrial stormwater
		GM–Pontiac East Assembly	industrial stormwater
		Grand Trunk WRR–Pontiac	processed wastewater
		Heat Treating Services–Pontiac	industrial stormwater
		Pontiac WWTP	non-industrial sanitary wastewater
		Seniors Unlimited Garage	industrial stormwater
Waterford	Clinton River	Midwest Millwork–Waterford	industrial stormwater
		Oakland–Pontiac Airport	industrial stormwater
		SPS Waterford Co–Waterford	industrial stormwater
		TTX Corp–Draco Div–Waterford	industrial stormwater
Clarkston	Greens Lake	LDM Technologies–Clarkston	industrial stormwater
Orion	Judah Lake	Corban Industries–Orion	industrial stormwater
Clarkston	Lotus Lake	Premarc Corp	industrial stormwater
Pontiac	Orange Lake	ABF Freight–Friendly Rd	industrial stormwater
Waterford	Osum Lake	Schram Auto Parts–Waterford	industrial stormwater
	Otter Lake	US Postal Service–Waterford	industrial stormwater
Pontiac	Pontaic Creek	Amtrak Station–Pontiac	industrial stormwater
		Automotive Component Carrier	industrial stormwater
		First Student–Pontiac	industrial stormwater
		Grand Truck WRR–Pontiac Car	industrial stormwater
		Grand Trunk WRR–Pontiac Loco	industrial stormwater
		Smart–Pontiac	industrial stormwater
		UPS–Pontiac	industrial stormwater
Waterford	Pontiac Creek	City Aluminum Foundry	industrial stormwater
		Simpsons Towing–Waterford	industrial stormwater
Waterford	various	Six-S Inc–MO-4502	industrial stormwater
		Six-S Inc–MO-3238	industrial stormwater
		Six-S Inc–MO-4485	industrial stormwater
		Six-S Inc–Ross Bandit AT-173	industrial stormwater
Middle			
Auburn Hills	Clinton River	Corrigan–Auburn Hills	industrial stormwater
		Jamco Mfg–Auburn Hills	industrial stormwater
		Peninsula Plastics Co Inc	industrial stormwater
		Phase II Ind–Auburn Hills	industrial stormwater

Table 9.–Continued.

Valley segment City	Receiving water	Designated name	Permit type
Auburn Hills	Clinton River	Ralco Industries	industrial stormwater
		Superior Materials and Redi Mix	industrial stormwater
Pontiac	Clinton River	Akzo Nobel Coatings–Pontiac	industrial stormwater
		Akzo Nobel–30 Brush St	industrial stormwater; processed wastewater
		GM Truck Prod Ctr–Validation	industrial stormwater
Rochester	Clinton River	Fibermark–Rochester	industrial stormwater
		Parkedale Pharmaceuticals Inc	industrial stormwater
		Premix Concrete–Rochester	industrial stormwater
		Rochester WTP	processed wastewater
		Solaronics–Rochester	industrial stormwater
Rochester Hills	Clinton River	Angelos Crushed Con #6–R Hills	industrial stormwater
		Eagle Ottawa–Rochester Hills	industrial stormwater
		Eaton Corporation	industrial stormwater
		Hamlin Tool and Machine Co	industrial stormwater
		Long Mfg–Rochester Hills	industrial stormwater
		Pulte, Arthur	processed wastewater
		Su-Dan–Rochester Hills	industrial stormwater
		Yates Cider Mill Inc	industrial stormwater
Utica	Clinton River	Jolico-JB Tool Inc	industrial stormwater
Shelby Twp	Clinton River	Liquid Disposal Inc–SF Site	processed wastewater
	Unammed trib to Clinton River	G and H LF PRP Group	processed wastewater
Clinton Twp	Cottrell Drain	Venture Ind–Harper Pit	industrial stormwater
Auburn Hills	Galloway Creek	C and D Enterprises	industrial stormwater
		DaimlerChrys Tech Center	industrial stormwater
		Inalfa Roof Syst–Auburn Hills	industrial stormwater
Orion	Galloway Creek	Eagle Valley Recycle and Dispos	industrial stormwater
Pontiac	Galloway Creek	City Waste Systems–Pontiac	industrial stormwater
		Detroit Steel Treating–Pontiac	industrial stormwater
		FPT–Pontiac Division	industrial stormwater
		Great Lakes Waste–Highwood	industrial stormwater
		Highwood Die and Engineering	industrial stormwater
		USF Holland–Pontiac	industrial stormwater
Auburn Hills	Unnamed trib of Galloway Creek	Delta Tooling Co.	industrial stormwater; processed wastewater
	Galloway Ditch	Ajax Materials–Plt 2	industrial stormwater
		Automotive Products–Auburn Hills	industrial stormwater
		Cole Specialty Systems	industrial stormwater
		Roadway Express–Auburn T264	industrial stormwater

Table 9.–Continued.

Valley segment City	Receiving water	Designated name	Permit type
Orion	Galloway Ditch	Lymtal International–Orion	industrial stormwater
		Schenck Turner–Orion	industrial stormwater
Auburn Hills	Galloway Drain	ABB Inc–Auburn Hills	industrial stormwater
		Recticel–Auburn Hills	industrial stormwater
Rochester Hills	Honeywell Ditch	Avon Broach and Production Co	industrial stormwater
Auburn Hills	Johnson Drain	Johann A Krause Inc	industrial stormwater
Pontiac	Joslyn Drain	GM–Pontiac North Campus	processed wastewater
Leonard	Lakeville Lake	ITT Industries	industrial stormwater
Utica	Old Clinton River Channel	Visteon Corp–Utica Fac	industrial stormwater
Oxford	Oxford Lake	TKMS Ltd–Oxford	industrial stormwater
Lake Orion	Paint Creek	Lamb–Lake Orion	industrial stormwater
Washington	Stony Creek	American Aggregates–812	industrial stormwater
		Natural Aggregates–Washington	processed wastewater
Oxford	Stony Lake	American Aggregates–817	industrial stormwater
		RLM Industries–Oxford	industrial stormwater
Lower			
Center Line	Bear Creek	BAE Industries–Center line	industrial stormwater
		Juklin Industries–Center line	industrial stormwater
		Wico Metal Products–Center line	industrial stormwater
Hazel Park	Bear Creek	AMCOL Corp–Hazel Park	industrial stormwater
		National Induction Heating	industrial stormwater
		Red Industries–Hazel Park	industrial stormwater
Madison Hts	Bear Creek	Universal Trim–Madison Hts	industrial stormwater
Warren	Bear Creek	Acco Systems–Warren	industrial stormwater
		Adams United Corp–Warren	industrial stormwater
		Ajax Metal Processing–Cold	industrial stormwater
		Almo Manifold and Tool–Warren	industrial stormwater
		Angelos Crushed Con #4	industrial stormwater
		AZ Automotive–Mound Rd.	industrial stormwater
		Cape Industries–Warren	industrial stormwater
		Commodore Cartage Co.–Warren	industrial stormwater
		Cook Industries–Warren	industrial stormwater
		CPS Process Systems Inc	industrial stormwater
		Everfresh/LaCroix Beverages	industrial stormwater
		Fini Finish Products–Warren	industrial stormwater
		Flex-N-Gate–Stamping 2	industrial stormwater
		GM-Powertrain Div–Warren	industrial stormwater
		Hayden Twist Drill and Tool	industrial stormwater
		Henkel Surface Technologies	industrial stormwater
		Hercules Welding Products	industrial stormwater
		Hoover Steel Treating–Warren	industrial stormwater
		Induction Engineering–Warren	industrial stormwater
		InveCast Corp–Dodge St–Warren	industrial stormwater
		Invecast Corp–Warren	industrial stormwater

Table 9.–Continued.

Valley segment City	Receiving water	Designated name	Permit type
Warren	Bear Creek	J and J Buring and Fabricating	industrial stormwater
		Macomb Auto Salvage–Warren	industrial stormwater
		Metallurgical Processing Co	industrial stormwater
		Mich Metal Fabricators–Warren	industrial stormwater
		Milco Manufacturing Co–Warren	industrial stormwater
		Modern Broaching Serv–Warren	industrial stormwater
		Nitro-Vac Heat Treat–Warren	industrial stormwater
		Noble Metal Processing Inc	industrial stormwater
		Nor-Cote Inc–Warren	industrial stormwater
		Plymouth Shafting Corp–Nagel	industrial stormwater
		Precision Mold and Engineering	industrial stormwater
		Ring Screw Works–Screw Div	industrial stormwater
		Royce Corp–Warren	industrial stormwater
		Schwab Foundry Co–Warren	industrial stormwater
		Schwartz Machine Co–Warren	industrial stormwater
		SET Enterprise Inc	industrial stormwater
		SLC Recycling Industries Inc	industrial stormwater
		Soramatic Precision Machining	industrial stormwater
		Tank Truck Mfg–Warren	industrial stormwater
		Tool Dex Inc	industrial stormwater
		Tractech–Warren	industrial stormwater
		Tuff Machine Co–Warren	industrial stormwater
		Warner Elect Formsprag Clutch	industrial stormwater
		Weldaloy Products Company	industrial stormwater
		Welform Electrodes Inc–Warren	industrial stormwater
		Wico Metal Products–Ryan Rd	industrial stormwater
		Wico Metal Products–Warren	industrial stormwater
		Wolverine Die Cast–Nagel Ave	industrial stormwater
Sterling Hts	Beaver Creek	A G Simpson Inc	industrial stormwater; processed wastewater
		Ex-Cell-O Machine Tools Inc	industrial stormwater
		Tesma Sterling Hts	industrial stormwater
	Big Beaver Creek	Automotive Plastic Tech	industrial stormwater
		Cadillac Products–Auto Div	industrial stormwater
		Deluxe Stamping and Die Co	industrial stormwater
		Detroit Hoist and Crane	industrial stormwater
		Luckmarr Plastics Inc	industrial stormwater
		Orlandi Gear–Sterling Hts	industrial stormwater
		PPG Industries–Sterling Hts	industrial stormwater
		Proficient Products Inc	industrial stormwater
		TRW–Sterling Hts	industrial stormwater
		Valiant Industries Inc	industrial stormwater
Chesterfield	Bowman Ditch	Visteon Corp–Chesterfield Pl2	industrial stormwater
	Brandenburg Drain	Motor City Stamping	industrial stormwater
Armada	Cemetery Creek	Armada Rubber Mfg	industrial stormwater
Sterling Hts	Chrissman Drain	AZ Automotive–Sterling Hts	industrial stormwater
		Continental Light–Sterling Hts	industrial stormwater

Table 9.–Continued.

Valley segment City	Receiving water	Designated name	Permit type
Sterling Hts	Chrissman Drain	J G Kern Enterprises Inc	industrial stormwater
		Mark Engineering Co	industrial stormwater
		Venture Corp–Mound Facility	industrial stormwater
Almont	Clinton River	Aristo-Cast Inc–Almont	industrial stormwater
Center Line	Clinton River	AZ Automotive–Center line	industrial stormwater
Clinton Twp	Clinton River	A and M Industries	industrial stormwater
		Collins and Aikman–Clinton	industrial stormwater
Madison Hts	Clinton River	Advanced Assembly–Madison Hts	industrial stormwater
		Valley Industries–Madison Hts	industrial stormwater
Mt. Clemens	Clinton River	DuPont–Mt. Clemens	industrial stormwater
Rochester	Clinton River	Baxter Hyland Immuno–Rochester	industrial stormwater
Rochester Hills	Clinton River	Avon Plastic Products	industrial stormwater
Roseville	Clinton River	Lincoln Die Casting–Roseville	industrial stormwater
Sterling Hts	Clinton River	Amplas Compounding Inc	industrial stormwater
		Automotive Composites Co	industrial stormwater
		Casadei Structural Steel Inc	industrial stormwater
		IMPCO	industrial stormwater
		John R Fuel and Supply–Van Dyke	industrial stormwater
		Regal Prototypes Inc	industrial stormwater
		Shuert Industries–Sterling Hts	industrial stormwater
		Thread-Craft–Sterling Hts	industrial stormwater
		Ultimate Hydroforming Inc	industrial stormwater
		Warhoops Auto and Truck Parts	industrial stormwater
Utica	Clinton River	MNP Corporation–Utica	industrial stormwater
Warren	Clinton River	Guardian Automotive Company	industrial stormwater
		M and W Manufacturing Co	industrial stormwater
		Super Steel Treating Co–Warren	industrial stormwater
Armada	Coon Creek	Park Electric–Armada	industrial stormwater
Macomb	Crittenden Drain	Michigan Production Machining	industrial stormwater
		PICO East–Macomb Twp	industrial stormwater
Shelby Twp	Decker Drain	SND Steel Fabrication Inc	industrial stormwater
Armada	East Branch of Coon Creek	Armada WWTP	non-industrial sanitary wastewater
Romeo	East Pond Creek	Armada Ind Park	processed wastewater
		Aristo-Craft–Romeo	industrial stormwater
		D and N Bending–Romeo	industrial stormwater
		Ford–Michigan Proving Grounds	processed wastewater
		Kriewall Enterprises Inc	industrial stormwater
		Romeo Expeditors Inc	industrial stormwater
		Romeo WWTP	non-industrial sanitary wastewater
		Twentieth Century Machine Co	industrial stormwater
New Baltimore	Fuller Drain	Emhart Automotive–Chesterfield	industrial stormwater
		Emhart Automotive–Gratiot	industrial stormwater

Table 9.–Continued.

Valley segment City	Receiving water	Designated name	Permit type
Sterling Hts	Gamble Drain	Hi-Tech Tool–Sterling Hts	industrial stormwater
		Proto Gauge Inc	industrial stormwater
Troy	Gibson Drain	Versatube Corp–Troy	industrial stormwater
Macomb	Gloede Ditch	Berz–Macomb Airport	industrial stormwater
		Jam Prototype–Macomb	industrial stormwater
	Harris Drain	ACR Industries–Macomb	industrial stormwater
		Dimension Machine Tool	industrial stormwater
		Joint Production Technology	industrial stormwater
Troy	Hawthorn Drain	Birmingham Hydraulics–Troy	industrial stormwater
Richmond	Highbanks Creek	Armada Products–Richmond	industrial stormwater
Madison Hts	Lawson Drain	Henze Stamping and Manufacturing	industrial stormwater
Shelby Twp	Longstaff Drain	JAC Products Inc Rollform	industrial stormwater
		Nat Asphalt Products Inc	industrial stormwater
		Ski Industries–Shelby Twp	industrial stormwater
		Utica-Craft Industries	industrial stormwater
	Longstaff Drain #2	AV Technology–14920 23 Mile	industrial stormwater
		Fori Automation–Shelby Twp	industrial stormwater
		Shelby Precast Concrete Co	industrial stormwater
		Utica Products–Shelby Twp	industrial stormwater
Romeo	Mahaffy Drain	L and L Products Inc–Deep South	industrial stormwater
		Shelby Enterprises–Romeo	industrial stormwater
Madison Hts	McCoy Drain	Eleven Mile Truck Frame and Axle	industrial stormwater
Clinton Twp	Middle Branch of Clinton River	John Carlo Inc–2828 Rex	industrial stormwater
		John Carlo Inc–Johnson Plt225	industrial stormwater
		John Carlo Inc–Plt2721	industrial stormwater
		John Carlo–Rex Models S 2017	industrial stormwater
Shelby Twp	Middle Branch of Clinton River	Arlington Transit Mix	industrial stormwater
Clinton Twp	Miller Drain	Electroplating Ind–Clinton Twp	industrial stormwater
Sterling Hts	Moore Drain	Becker Tooling–Sterling	industrial stormwater
		Classic Tool and Boring Inc	industrial stormwater
		Consolidated Rail–Sterling Hts	industrial stormwater
		DaimlerChrysler–Sterling Hts	industrial stormwater
		Experi-Metal–Sterling Hts	industrial stormwater
		Fettes Mfg–Sterling Hts	industrial stormwater
		Sterling Concrete–Sterling Hts	industrial stormwater
		Visteon Corp–Sterling	industrial stormwater
Almont	North Branch of Clinton River	Almont WWTP	non-industrial sanitary wastewater
Clinton Twp	North Branch of Clinton River	Blue Water Fabricators	industrial stormwater
		Columbia Tool and Die Co	industrial stormwater

Table 9.–Continued.

Valley segment City	Receiving water	Designated name	Permit type
Clinton Twp	North Branch of Clinton River	D and B Polishing–Clinton Twp	industrial stormwater
		Fred J Breiten Lumber–Clinton	industrial stormwater
		Norgren Automotive–Clinton Twp	industrial stormwater
		Tower Automotive–Clinton Twp	industrial stormwater
Romeo	North Branch of Clinton River	Ford–Romeo Engine Plant	industrial stormwater
Almont	Unnamed trib to North Branch	Almont Meadows MHP	non-industrial sanitary wastewater
Chesterfield	Pitts Drain	Profile Mfg–Chesterfield	industrial stormwater
		Visteon Corp–Chesterfield Pl1	industrial stormwater
Sterling Hts	Plum Brook	American and Import Auto Parts	industrial stormwater
		Atlas Copco AFS Inc	industrial stormwater
		Curtis Metal Finishing	industrial stormwater
		Ford-Van Dyke–Sterling Hts	industrial stormwater
		McClain Industries	industrial stormwater
		Norbert Industries Inc	industrial stormwater
		Troy Aggregate–Sterling Hgts	industrial stormwater
	Plum Brook Creek	Levy-Clawson Concrete–Plt 16	industrial stormwater
		Mayco Plastics–Sterling Hts	industrial stormwater
		Mich Tile and Marble Co	industrial stormwater
		Moore Flame Cutting	industrial stormwater
	Plumbrook Drain	Nisshinbo Automotive Corp	industrial stormwater
		Ran-Shel Inc	industrial stormwater
		Shamrock Fasterner Tech	industrial stormwater
		Wyatt Services–Sterling Hts	industrial stormwater
Center Line	Red Run Drain	Aetna Industries–Center line	industrial stormwater
		Emerald Steel–Center Line	industrial stormwater
Hazel Park	Red Run Drain	KC Jones Plating–Hazel Park	industrial stormwater
Madison Hts	Red Run Drain	Ajax Paving–M-400	industrial stormwater
		Ajax Paving–M-430	industrial stormwater
		Ajax Paving–M-482	industrial stormwater
		Ajax Paving–M-522	industrial stormwater
		Ajax Paving–M-524	industrial stormwater
		Ajax Paving–M-604	industrial stormwater
		Atlas Gear–Madison Hts	industrial stormwater
		Bokum Tool–Madison Hts	industrial stormwater
		Central Gear–Madison Hgts	industrial stormwater
		H and L Tool–Madison Hgts	industrial stormwater
		Howard Finishing–Madison Hts	industrial stormwater
		Inland Diamond Products Co	industrial stormwater
		Kerr Screw Products Co	industrial stormwater
		Meridian Automotive Systems	industrial stormwater
		Oakland Co SOCSDS 12 Towns RTF	non-industrial sanitary wastewater

Table 9.–Continued.

Valley segment City	Receiving water	Designated name	Permit type
Madison Hts	Red Run Drain	Ogura Corp–Madison Hgts	industrial stormwater
		Park Precision–Madison Hgts	industrial stormwater
		Plating Specialties	industrial stormwater
		Ross Controls	industrial stormwater
		Stanhope Tool–Madison Hts	industrial stormwater
		UPS–Madison Hts	industrial stormwater
		Zimmerman Handling Systems	industrial stormwater
Roseville	Red Run Drain	Angelos Crushed Con #1	industrial stormwater
		Spartan Grinding–Roseville	industrial stormwater
		Sphere Industries–Roseville	industrial stormwater
Sterling Hts	Red Run Drain	DaimlerChrysler–Sterling Stamp	industrial stormwater
Warren	Red Run Drain	A and T Auto Parts–Warren	industrial stormwater
		Ace Finishing–Warren	industrial stormwater
		Anchor Tool and Die–Warren	industrial stormwater
		Apex Broaching Systems–Warren	industrial stormwater
		AZ Automotive–Plants 6 and 9	industrial stormwater
		Best Block Co–Warren	industrial stormwater
		Bilco Tool Corp–Warren	industrial stormwater
		Borg Warner Automotive–Warren	processed wastewater
		Cadillac Plating–Warren	industrial stormwater
		Capri Tube Inc–Warren	industrial stormwater
		Caratron Industries–Warren	industrial stormwater
		Carboloy Inc	industrial stormwater; processed wastewater
		Central Metal Products–Warren	industrial stormwater
		Cerametal Mich–Warren	industrial stormwater; processed wastewater
		Comtrex LLC–Warren	industrial stormwater
		Contrail–Warren	industrial stormwater
		Conway Central Express–xpn	industrial stormwater
		DaimlerChrysler–Dodge City	industrial stormwater; processed wastewater
		Distel Tool and Machine–Warren	industrial stormwater
		Duramic Abrasive Product	industrial stormwater
		E and E Engineering–Warren	industrial stormwater
		Ernst Concrete–Warren Plt	industrial stormwater
		Express Coat Corp–Warren	industrial stormwater
		Flex-N-Gate–Forming Tech	industrial stormwater
		Flex-N-Gate–Stamping 1	industrial stormwater
		FOHA North America–Warren	industrial stormwater
		Gentz Industries–Warren	industrial stormwater
		GM-Technical Center–Warren	industrial stormwater
		Grosse Tool and Machine–Warren	industrial stormwater
		Hahn Elastomers–Warren Div	industrial stormwater
		Hi-Tech Coatings Inc	industrial stormwater
		Inalfa/SSI Roof Syst–Warren	industrial stormwater
		J and N Fabrication–Warren	industrial stormwater
		Keo Cutters–Warren	industrial stormwater

Table 9.–Continued.

Valley segment City	Receiving water	Designated name	Permit type
Warren	Red Run Drain	Leonard Tool and Die–Warren	industrial stormwater
		Machining Enterprises Inc	industrial stormwater
		Manufacturers Products Co	industrial stormwater
		Michigan Rivet Corp–Warren	industrial stormwater
		Midwest Gear and Tool Inc	industrial stormwater
		Modern Hard Chrome Service Co	industrial stormwater
		Parton and Preble Mix–Warren	industrial stormwater
		Paslin Co–Warren	industrial stormwater
		PK Fabricating Inc–Warren	industrial stormwater
		Plymouth Shafting Corp–Hoover	industrial stormwater
		Punchcraft Co–Warren	industrial stormwater
		Rajason International	industrial stormwater
		Reska Spline Products–Warren	industrial stormwater
		Sheridan Auto Parts–Edorn	industrial stormwater
		Sheridan Auto Parts–Groesbeck	industrial stormwater
		Sturdy Broaching Service	industrial stormwater
		TI Group–Warren	industrial stormwater
		Tool-Dex Inc–Warren	industrial stormwater
		Tri County Precision Grinding	industrial stormwater
		Vac-Met Inc–Warren	industrial stormwater
		Venture Corp–Warehouse	industrial stormwater
		Warren Abrasives Inc	industrial stormwater
		Warren Recycling Center	industrial stormwater
		Warren WWTP	non-industrial sanitary wastewater; industrial stormwater
		Weyerhaeuser Co–Warren	industrial stormwater; processed wastewater
		Wolverine Die Cast–Hoover Rd	industrial stormwater; processed wastewater
		Wear-Ever Surface Treating	industrial stormwater
Troy	Shanahan Drain	Clark Refining–Troy	processed wastewater
	Spencer Drain	Adaptive Technologies–Troy	industrial stormwater
		Airborne Express–Troy	industrial stormwater
		AL-Craft–Troy	industrial stormwater
		Angel Trucking	industrial stormwater
		Barrett Paving Materials–Troy	industrial stormwater
		Big Beaver Specialty Co	process wastewater
		Castall Products–Troy	industrial stormwater
		CNI Inc–Troy	industrial stormwater
		Compound Technologies–Troy	industrial stormwater
		Controlled Power–Troy	industrial stormwater
		DuPont–Troy	industrial stormwater
		Federal Express–Troy	industrial stormwater
		FedEx Freight East–Troy	industrial stormwater
		Fisher Corp–Troy	industrial stormwater
		FJ Manufacturing–Troy	industrial stormwater
		Lebow Products Inc	processed wastewater

Table 9.–Continued.

Valley segment City	Receiving water	Designated name	Permit type
Troy	Spencer Drain	Magna International Inc–Vehma	industrial stormwater
		Metaldyne–Troy	industrial stormwater
		Mich Timber and Truss–Troy	industrial stormwater
		Modern Prototype Div–Troy	industrial stormwater
		ND Industries–Troy	industrial stormwater
		Ring Screw Textron–Troy	industrial stormwater
		Scott Specialty Gases–Troy	industrial stormwater
		Smart–Troy	industrial stormwater
		Solvay Automotive–Troy	industrial stormwater
		Sterling Industries–Troy	industrial stormwater
		Sulzer Metco–Troy	industrial stormwater
		Tiechon Industries–Troy	industrial stormwater
		Troy Aggregate–Troy	industrial stormwater
		Vehma International Amer	industrial stormwater
		Venture Mold and Eng–Troy	industrial stormwater
		Yarema Die and Engineering	industrial stormwater
		Yarema Die and Engineering–Troy	industrial stormwater
	Sturgis Drain	Metro Technologies–Troy	industrial stormwater
		PPG Industries–Chemfil	industrial stormwater
		USPS–Royal Oak Processing	industrial stormwater
Sterling Hts	Vokes Drain	Utica Transit Mix and Supply Co	industrial stormwater
Romeo	Wilson Drain	L and L Products Inc–Romeo North	industrial stormwater
		Theut Products Inc–Mich Block	industrial stormwater
		Theut Products Inc–Romeo	industrial stormwater
Washington	Yates Drain	Sterling Concrete–Washington	industrial stormwater
Mouth			
Clinton Twp	Clinton River	Warren Industries Inc–Clinton	industrial stormwater
Fraser	Clinton River	A-V-R Mfg–Fraser	industrial stormwater
		Turchi Cut Stone–Fraser	industrial stormwater
Harrison Twp	Clinton River	Barcoa Manufacturing	industrial stormwater
		Ernies Auto Parts	industrial stormwater
		Mega Thrust–Harrison Twp	industrial stormwater
		Northern Industrial Mfg	industrial stormwater
		Par-Kut International	industrial stormwater
		Selfridge Plating–Mt Clemens	industrial stormwater
Mt. Clemens	Clinton River	A-1 Roll Co–Mt Clemens	industrial stormwater
		Barrett Paving–Mt Clemens	industrial stormwater
		Caterpillar Inc–Mt Clemens	industrial stormwater
		Concord Tool and Mfg–Mt Clemens	industrial stormwater
		Enmanco Inc–Mt Clemens	industrial stormwater
		Johnson Controls–Mt Clemens	industrial stormwater
		LeRoys Auto Parts–Mt Clemens	industrial stormwater

Table 9.–Continued.

Valley segment City	Receiving water	Designated name	Permit type
Mt. Clemens	Clinton River	Mt. Clemems WWTP	non-industrial sanitary wastewater
		TM Smith Tool Intl Corp	industrial stormwater
Pontiac	Clinton River	Hydra-Lock–Mt Clemens	industrial stormwater
Roseville	Clinton River	AZ Automotive–Roseville	industrial stormwater
Selfridge ANGB	Clinton River	Selfridge ANGB	processed wastewater
Clinton Twp	Harrington Drain	American Auto–Clinton Twp	industrial stormwater
		Austemper–Clinton Twp	industrial stormwater
		Auto-Con Corp–Clinton Twp	industrial stormwater
		Burkard Industries Inc	industrial stormwater
		Mini Mix Supply–Clinton Twp	industrial stormwater
		RW Mfg–Orion Industries	industrial stormwater
		Superior Heat Treat LLC	industrial stormwater
		Van Loon Ind–Clinton Twp	industrial stormwater
		Venture Ind–Groesbeck Plt	industrial stormwater
Fraser	Harrington Drain	JJJ Inc	industrial stormwater
		Metaldyne–Fraser	industrial stormwater
Roseville	Harrington Drain	Moon Roof Corp of America	industrial stormwater
		Phalanx Inc–Roseville	industrial stormwater
		Piper Industries–Roseville	industrial stormwater
		QMC Die Technology	industrial stormwater
		Radar Industries–Roseville	industrial stormwater
		RCO Engineering Inc–Roseville	industrial stormwater
		UPS–Roseville	industrial stormwater
		Wolverine Bronze Co–Roseville	industrial stormwater
		Wolverine Plating–Roseville	industrial stormwater
Warren	Harrington Drain	Radar Industries Inc–Warren	industrial stormwater
		Roadway Express–Warren T262	industrial stormwater
Clinton Twp	Peltier Drain	Waste Management–East	industrial stormwater
Warren	Schoenherr Drain	Chemtech Finishing Systems	industrial stormwater
Eastpointe	Sweeney Drain	Hydra-Fab–Eastpointe	industrial stormwater
Fraser	Sweeney Drain	K and K Stamping–Fraser	industrial stormwater
		Middleton Auto Parts–Fraser	industrial stormwater
		Vac-Met Inc–Fraser	industrial stormwater
		CBS Boring and Machine Co Plt2	industrial stormwater
		Christy Industries	industrial stormwater
		Oakland Tool and Mfg–Fraser	industrial stormwater
		Shane Steel Processing–Fraser	industrial stormwater
		Specialty Steel–Fraser	industrial stormwater
		TBL Trailer Inc–Fraser	industrial stormwater
		US Mfg Corp–Fraser	industrial stormwater
		Venture Ind–Commerce Plt	industrial stormwater
		Venture Ind–Malyn Plt1	industrial stormwater
		Venture Ind–Malyn Plt3	industrial stormwater
		Venture Ind–Malyn Warehouse	industrial stormwater
		Venture Ind–Masonic Plt	industrial stormwater

Table 9.–Continued.

Valley segment City	Receiving water	Designated name	Permit type
Roseville	Sweeney Drain	Aero Grinding Inc–Roseville	industrial stormwater
		Apollo Plating–Roseville	industrial stormwater
		Regal Plastics–Roseville	industrial stormwater
		Advance Precision Grinding	industrial stormwater
		Albert Webster–Engineering	industrial stormwater
		Crown Boring–Roseville	industrial stormwater
		Don and Hanks Highway Auto Parts	industrial stormwater
		Gilco–Roseville	industrial stormwater
		Great Lakes Paper Stock Corp	industrial stormwater
		Grippe Machining and Mfg Co	industrial stormwater
		H and M Machining Inc–Roseville	industrial stormwater
		Hofley Manufacturing–Roseville	industrial stormwater
		Industrial Stamping and Mfg	industrial stormwater
		Roberts and Sons–Roseville	industrial stormwater
		Westgood Mfg–15211 11 Mile	industrial stormwater
Warren	Sweeney Drain	Midwest Brake	industrial stormwater
		Harry and Sons Auto Parts–Warren	industrial stormwater
		Sur-Flo Plastics–Warren	industrial stormwater
		Technical Rotary Services	industrial stormwater
		Tonys Die and Machine–Warren	industrial stormwater
Clinton Twp	Tesk Drain	Lunar Industries–Clinton Twp	industrial stormwater
		Press-Way–Clinton Twp	industrial stormwater
Fraser	Tesk Drain	A-1 Stamping–Fraser	industrial stormwater
		Automated Production–Fraser	industrial stormwater
		Berg Tool–Fraser	industrial stormwater
		CBS Boring and Machine Co Plt 3	industrial stormwater
		CBS Boring and Machining–Fraser	industrial stormwater
		Continental Plastics	industrial stormwater
		Crawford Technologies Inc	industrial stormwater
		Diversified Fabricators–Fraser	industrial stormwater
		Edrich Products–Fraser	industrial stormwater
		Falcon Cold Forming Inc	industrial stormwater
		G and F Prototype Plasters	industrial stormwater
		Grossel Tool–Fraser	industrial stormwater
		Inter-Lakes Bases–Fraser	industrial stormwater
		ISO Plus Inc–Fraser	industrial stormwater
		Jason Tool and Engineering	industrial stormwater
		Kinde II	industrial stormwater
		Prototype Tooling and Mfg–Fraser	industrial stormwater
		Stampings Inc–Fraser	industrial stormwater
		Sur-Flo Plastics–Fraser	industrial stormwater
		Venture Corp–Advanced	industrial stormwater
		Venture Ind–Tech Center	industrial stormwater

Table 10.–Contamination sites in the Clinton River watershed, as of 2003 (Department of Environmental Quality, Remediation and Redevelopment Division). Acronyms: BHC=benzenehexachloride; BTEX=benzene, toluene, ethylbenzene, and xylene; BTX=benzene, toluene, and xylene; DCA=dichloroethane; 1,1 DCA=isomer of dichloroethane; 1,2 DCA=isomer of dichloroethane; cis-1,2-DCE=isomer of dichloroethylene; tran-1,2-DCE=isomer of dichloroethylene; DDE=dichloro-diphenyl-dichloroethylene; DDT=Dichloro-diphenyl-trichloroethane; MEK=methyl ethyl ketone; MTBE=methyl tertiary butyl ether; PCBs=polychlorinated biphenyls; PCE=perchloroethylene; PNAs=polynuclear aromatic hydrocarbons; SVOCs=semi-volatile organic compounds; TCA=trichloroethane; 1,1,1 TCA=isomer of trichloroethane; TCE=trichloroethylene; VC=vinyl chloride; VOCs=volatile organic compounds.

Site location common site name	Pollutant
Headwaters	
Oakland County	
Former Texaco – Clarkston	Gasoline, BTEX, MTBE
Salem Sand and Gravel	VOCs
Upper	
Oakland County	
Clarkston Rd. Area	Arsenic, Lead
Camp Pontiac Correctional Facility	PNAs
Colombiere Center	PNAs
Main Street Residential Wells	1,2 DCA, Benzene, 1,1 DCA, Xylenes
Oakland Co. Rd. Comm. Dixie Lake	Sodium, Chloride
Woodhull Lake	Inorganics, PNAs
Buckeye Pipeline	BTEX
Maybee and Sashabaw Rd. Residential Well	BTEX
Clinton Valley Center	VOCs
W.C. Warner Petroleum	No data
Dandy Oil	1,1,1 TCA
Pontiac Steel (former)	Boron, iron, lead
Sashabaw Rd. Area Residential Wells	BTEX, TCE, TCA
Emma Milner	Gasoline, BTEX, MTBE, cadmium, cyanide, lead, napthalene
Fisher Cleaners and Laundry	PCE
Safety Kleen	PCE, TCE
Oakland County Fuels Inc.	VOCs, SVOCs
One Hour Martinizing Cleaners	PCE, TCE
Oakland County Central Power House	VOCs, PNAs
Drayton Rd. Well	1, 1, 1 TCA
Rockcroft St. Residential Wells	VC, PCE, TCE
Cooley Lake Rd. Residential Well	BTX, DCA
Kayo Oil Co.	BTEX
Hoight Oil	VOCs, SVOCs
Pontiac Manufactured Gas Plant	PNAs
Saltarelli Landfill	Metals, PNAs, TCE, PCBs, Acenephylene
West Bloomfield School Bus Garage	No data
Shell Dry Well 1 Telegraph	Pseudocumene, Phenols, mesitylene, benzene
Nu Kar Products	BTX
G.M. Truck and Bus – Pontiac Central	BTEX, PNAs, lead
G.M. Truck and Bus Pontiac Central	Cyanide

Table 10.–Continued.

Site location common site name	Pollutant
George W. Auch Co.	SVOCs
Kennett Rd. Landfill	Chlorobenzene, xylenes, fluoranthene, lead
Wide Track and Wesson	Arsenic
Wide Track and Saginaw	VOCs, arsenic, lead
City of Pontiac, Lot 9 Brownfield	SVOCs, inorganics
City of Pontiac 94-32	VOCs, SVOCs, inorganics
Branch and Gillespie Street	Inorgancis
GM CPC Pontiac	PCBs, 1,2 DCA, VOCs, PNAs, Metals
Grand Trunk R.R. Ojista Rd.	Diesel Fuel
AKZO Coatings	Benzene
Paddock and M-59 Drums	VOCs
Architectural Stone International	VOCs, SVOCs
Goddard Coatings	PNAs, Metals
Goddard Coatings	SVOCs
Middle	
Oakland County	
Auburn Court Associates	BTEX, PNAs
Adams and Auburn Rd. Development	PCE, TCE, Xylenes, Cis-1,2-DCE
Christianson Adam Rd. Dumpsite	TCE, Toluene, Chromium, Lead, Manganese, Xylene
Former A and A Asphalt	TCA, Toluene, Methylene, Chloride
Auburn Hills Specialty Crews Complex	No data
Great Lakes Container Corp.	Toluene, Dieldrin, Lead, Cadmium, Nickel
Royal Auto Parts	Inorganics
Collier Rd. Landfisll Pontiac	Zinc, TCE, VC, Asbestos
Collier Rd. N. of Galloway Creek	SVOC, inorganics
Joslyn Collier Property	Diethylether, methane, iron, chromium
Joslyn Road Oil Spill	Petroleum Products
Industrial Services of America	Phenols, Napthalene, Chloroethane
Michigan Dust Control	Oil
Oakland Co. Rd. Comm. Sanitary Landfill	4,4 DDT, Cadmium, Chromium, arsenic
Oakland Co. Rd. Comm. Lake Orion	Chloride
ITT Automotive	TCE, PNAs, Lead, Copper, Mercury, Chlorinated Hydrocarbons
Upland and Joslyn Landfill	Arsenic
Sanicem Landfill J Fons Co.	Chromium, Copper, Cadmium, Lead
Kingston Development	Nickel, Chromium, Toluene, Xylene, Acetone
Lakeview and Tienken Creek	PCBs
Sandfill Landfill No. 1	Inorganics, VOCs, SVOCs
Stans Trucking	Lead, Chromium, Lead, Zinc, copper, dichlorobenzene
Stan’s Trucking Landfill Outlot A	Methane, PCBs, VOCs
Sun Pipeline Livernois Rd.	VOCs, SVOCs
Sandfill Landfill No.2	Inorganics, VOCs, SVOCs
J and L Landfill	Copper, Nickel, Lead, Chromium, TCE, Toluene, Manganese, Cadmium

Table 10.–Continued.

Site location common site name	Pollutant
Warner Lambert GSA	Inorganics
Collins and Orion Roads Residential Wells	VOCs
House of Imports	Chromium, Nickel
Former GP Plastics	VOCs, metals
Former Oxford Township Firing Range	Lead
Bald Mountain Rec Area Dump	Inorganics, SVOCs
Bald Mountain Shooting Range	Inorganics, PNAs
Lanthier Foundry and Machine	Ethyl Alcohol, PCE, TCE
Lapeer Road Residential Well	TCE, 1,2 DCE, PCE, VC, Vinylidene Chloride
Stadium Dr. Elementary School	No data
Micholson Lake Lot #10	No data
MSP Brazeway	TCE
Macomb County	
G and H Landfill	PCBs, TCE, BTEX
Hamlin Rd. Landfill East	Lead, chromium
Ramona Park Landfill	Phenols
Spring Lake Subdivision	BTEX, Napthalene, PCBs
Liquid Disposal, Inc.	PCBs, TCE, PCE, Phthalates, chloroform
North Oxford Area GW Contam.	TCE, VC
Lower	
Macomb County	
Carolee St. Area	Chloride
Utica Site Cardinal Land Corp.	No data
DPW Public Service Facility	No data
Art Van Furniture	Lead, arsenic
Former Wellhasen General Store	No data
Washington Township Sec 8 Landfill	Benzene, VC, TCA
Warhoops Junkyard	PNAs, lead
Clinton River Rd. Disposal Area	Phenols
BBC Holdings, LLC	TCA, tetrachloroethene, SVOCs
Koch Rd. Dump	Lead, hydrocarbons
Maidstone Automotive	No data
Stony Creek Liquor Store	Motor oil
Bear Creek Drain Commission	Lead, barium, chromium
Card Rd. Residential Wells	Benzene
Ryan and 23 Mile Rd.	TCE, cis-1,2-DCE
26 Mile Rd. and Romeo Plank Residential	Phenanthrene
Red Run Drain Baumgartner	Lead, barium, zinc
Red Run Drain Maple Lane	Lead, barium, zinc
Red Run Drain Fostoria Freedom	Methylene chloride, VC, lead, acetone
Red Run Drain (Old Detroit Landfill)	Lead, arsenic, chromium
Detroit Arsenal	Chromium, lead, 1,1 DCA, 1,1,1 TCA
Cedargrove Rd. Residential Wells	Benzene, 1,2 DCA
Foss Road Residential Well	PCE
Mt. Clemens Coatings and Plastics	Lead, phthalates, MEK, tetrahydrofuran

Table 10.–Continued.

Site location common site name	Pollutant
Equipment Mfg.	TCE, metals
Fini Finish Products	Chromium, cyanide
First State Bank Property	BTEX
Gibbs Machinery	PCBs, lead, phenanthrene
TRW 28 Mile Road Stamping	Arsenic
Kor-Tech Stamping, Inc.	Naphthalene
Local 909 UAW	No data
Nutrax Inc.	Gasoline
Performance Automotive	oil
Rockyanos Azza	No data
Robbins CPR, Inc.	Oil
Mold Tech	VOCs
Superior Polishing	Hexavalent chromium
Vorelco Property	Metals, PNAs, VOAs
Warren Alloy	Methylnaphthalene, nitrosodiphenylamine, arsenic
Village Fair Plaza Shopping Center	VOCs
Veet Industries	Fluorene, BTEX, Napthalene
Weyerhauser Paper Company	Dichlorobenzene, trichlorobenzene
Former Warren State Police Post	BTEX, TMBs, Napthalene
Sherwood Lime Pit	PNAs, PCBs, TCE
Shell Utica and Moravian	Phenols, MTBE, PNAs
A and J Insulation Company	No data
Former Romeo State Police Post	BTEX, TMB, Napthalene
Ring Screw Works	Phenanthrene
Anthony’s Florist	Kerosene
Walker Landfill	TCA
South Macomb Disposal (LF 9 and 9A)	MEK, Benzene
Michigan Casting Corporation	Metals, oils
32 Mile Rd. Residential Wells	Brine, chlorides
Lakehead Pipeline	Crude oil
Park Electric	Lead
Armada Times	BTEX
Macomb Road Commission Dump	Inorganics, SVOCs
Oakland County	
Beaumont Hospital – Troy	PNAs
Beaver Precision Products	TCE
21721 Wyoming–Royal Oak Twp.	No data
8521 Northend–Royal Oak Twp.	No data
Davis Mtg. – Clawson	TCA, 1,2-DCA, Vinyl Chloride
Eaton Corporation	TCE, Vinyl Chloride, Trans-1,2-DCE
Ford New Holland Inc.	VOCs, SVOCs, metals
Electroplating Service Inc.	Metals
H L Blachford	TCE, DCA
NCKS Associates	PNAs, HVO
Eleven Mile Truck Frame and Axle	Lead, PNAs, PCBs

Table 10.–Continued.

Site location common site name	Pollutant
Royal Oak Project	TCE, PCE, DCA, Toluene, Xylenes, Ethylbenzene
TCF Bank	Benzene, toluene, ethyl benzene
Wayne Oakland Oil Company	BTEX
Wesley Drugs	No data
Advanced Friction Materials	TCE
Howard Gas and Oil	BTX
Rose Exterminator	Pesticides–chlordane, DDE, DDT, Endrin, heptachlor, diazinon, BHC
Test Systems Simulations Inc.	Xylenes, TCA, Carbon tetrachloride
SOCRRA John R and 12 Mile	Lead, BTEX, TCE, DCA
Randolph Tool and Manufacturing Co.	Vinyl chloride
Reichhold Chemicals	TCE, xylenes, ethylbenzene, styrene, 1,2-DCE
Venture Rim Products	No data
Ferndale Laboratories	Heating oil
West Side Woodward	PNAs
Royal Oak Mini Storage LLC	BTX, phenanthrene, fluorine, naphthalene
Powerfone	Lead, PNAs, BTEX
Shane Steel Property – Hazel Park	No data
Sentry Steel	Heating oil
Gauge Products Company	PCBs, BTEX, Chlorobenzene
Ethyl Corp.	Lead, Chromium, Tetrahydrofuran, Cloroform
Sam’s Auto Parts	Oil, Transmission Fluid
Colonial Village Cleaners	No data
East Milton and Dequindre Residence	Lead
Wayne County	
Celanese Plastics Specialties Co.	BTX
Plating Equipment Used Inc.	Cyanide, cadmium, lead
General Die Casting	Chromium, lead, cyanide
U S Industries	Benzopyrene, phenanthrene, benzo (a) anthancene
Enterprise Oil	Waste oil
McNichols E North Sector	PNAs, metals
McNichols E South Sector	Lead
Southland Corp E McNichols	BTEX
Chemcentral Farr Avenue	PCE, TCE, BTEX, Carbon tetrachloride
Helen Avenue Vacant Lot, 13535	Lead
Daimler Chrysler Lynch Rd. Marshalling	PNAs, lead
Master Metals	Lead, Arsenic
Edgeton	Lead
30 Glynn Court	1,2,4 tremethyl benzene
BASF Bourke Avenue	Hexyl acetate
Freezer Services–St. Aubin	Lead, Oils
Peloquin Enterprises Detroit	Lead, Oil
Michigan Industrial Finishes	Paint wastes
Wayne Co. Detention Center	TCE, PCE, DCE
BASF Hamtramck Plant	VOCs, HVOCs, PNAs, heavy metals

Table 10.–Continued.

Site location common site name	Pollutant
Cook Family Foods	No data
Grand Haven Residential Development	Lead
WITCO	Chromium, nickel
M and G Convoy Property	Lead
Sears Former	Arsenic, PNAs
Highland Park Hospital (power plant)	BTEX, PNAs
Lapeer County	
Almont Manufacturing Co. (frmr)	TCE, metals
Mouth	
Macomb County	
Bryer Cleaner	PCE, TCE
Clinton River	Lead, Chromium, PCB
Pulse Oil	BTEX, PNAs
Giddings and Lewis	PCB, 1,1 DCE
Orion Industries	PNAs, metals
Vanderbush Industrial (former)	PCE, TCE, DCE
Stramaglia Construction Inc.	No data
Zendts Landscaping	Oil

Table 11.–Trigger levels used by the Michigan Department of Community Health to establish sport fish consumption advisories (MDEQ 2003). (ppm=parts per million; ppt=parts per trillion)

Chemical	MDCH Trigger Level
Total Chlordane	0.3 ppm
Total DDT	5.0 ppm
Dieldrin	0.3 ppm
Dioxin Toxic Equivalents	10.0 ppt
Heptachlor (+Heptachlor Epoxide)	0.3 ppm
Mercury	
Restrict Consumption	0.5 ppm
No Consumption	1.5 ppm
Mirex	0.1 ppm
Total PCB	
General Population	2.0 ppm
Women of Child Bearing Age and Children Under 15 years	
1 Meal per week	0.05 ppm
1 Meal per month	0.2 ppm
6 Meal per year	1.0 ppm
No Consumption	1.9 ppm
Toxaphene	5.0 ppm

Table 12.–Contaminants of concern that had concentrations in at least one sample that exceeded the contaminants Probable Effect Level in the Clinton River 1990–97 (Rheaume et al. 2001).

Anthracene
Total PAH
Phenanthrene
Total PCB
Benz[a]anthracene
Chrysene
Benzo[a]pyrene
Total chlordane
Mercury
Lindane
Lead
Zinc
Cadmium
Arsenic
Total DDT

Table 13.–Designated drains in the Clinton River watershed by valley segment, county, and township.

Headwaters

Oakland County

- *Brandon Township*
  - Allen

Oakland County – continued

- *Independence Township*
  - Cranberry Lake

Upper

Oakland County

- *Bloomfield Township*
  - Waldron
  - Ward Orchards
- *Independence Township*
  - Kelly
  - M-15
- *Orion Township*
  - Ballard
  - Brown
  - Dry Run
  - Reid and Branch
- *Pontiac Township*
  - Augusta
  - Bartlett
  - Brewer
  - Brooklyn
  - David L. Moffit
  - Earlmoor
  - Holland
  - Jewel
- *Pontiac Township – continued*
  - Wilmont Relief
  - Johnson
  - Joseph Jones
  - Joslyn
  - Mainland
  - Moore
  - Pontiac Clinton River #1
  - Pontiac Clinton River #2
  - Pontiac Clinton River #3
  - Pontiac Creek Extension
  - Richton Relief
  - Rowland
  - Birdsland
  - Drayton Plains and Extension
  - Guyer
  - Lochaven
  - McIvor
  - Otter
  - Silvercrest Extension
  - Tillden
- *Waterford Township – continued*
  - Turtle
  - West End
- *West Bloomfield Township*
  - Beechmont
  - Drakeshire Condominium
  - Estates of West Bloomfield
  - Four Towns
  - Keego Harbor
  - Meadowridge Estates
  - Mission Springs County
  - Orchard Lake Woods
  - Perrytown Estates County
  - Pilgrim Hills of West Bloomfield Twp
  - Pine Lake North
  - Skae
  - Wellington Woods
  - Willow Woods
  - Windrift Pond
  - Woodslands

Middle

Macomb County

- *Washington Township*
  - Mt. Vernon
- *Shelby Township*
  - Gravel Ridge
  - Greens M-59 Relief
  - Shelby Consolidated N.W.
  - Woodland Tile

Oakland County

- *Addison Township*
  - Clark
  - Krohn
  - Leonard
- *Avon Township*
  - Bishop
  - Chester
  - Fessler
  - Fred D. Houghten
  - Gabler
  - Greenacre
  - Hamilton
- *Avon Township*
  - Hampton
  - Honeywell
  - Hoot
  - Ireland-Varner
  - Jensen
  - Karas
  - Ladd
  - Lueders
  - Ramiro
  - Rewold Phase 1
  - Sue Ann Douglas
  - Van Maele
- *Brandon Township*
  - Big Meadows
  - Cowden
  - Perry
  - Weir
- *Oakland Township*
  - Carrollton
  - Century Woods
- *Oakland Township – continued*
  - Chamberlin Farms
  - Claremont
  - Cloisters
  - Cornerstone Condominium
  - County Creek
  - Crossings
  - Deer Point
  - Delta Kelly
  - Dutton
  - Five Points
  - Frost
  - Goodison Glen
  - Goodison Place
  - Gosling
  - Guardian Angel
  - High Meadows
  - Hills of Kings Pointe
  - Hills of Oakland County
  - Kingsridge
  - Kirklands

Table 13.–Continued.

Middle, *Oakland County* – continued		
• *Oakland Township – continued*	• *Oakland Township – continued*	• *Oxford Township – continued*
Knorrwood Pines West	Twin Lakes Branch No. 1	Drahner
Maple Park Office Center	Twin Lakes Branch No. 2	Prince
Oakland Crest	Twin Lakes	Sanders
Oakland Farm County	Wellington	• *Pontiac Township*
Oakland Knolls	Woodcliff on the Lake	Galloway
Oakland Meadows	Wyndgate Pointe	Galloway Lake Farms
Orchard Ridge	Wyndridge Estates	Hobart
Paint Creek Estates	• *Orion Township*	Joachim
Plum Creek	Axford	Kasper
Pond Vallee	Osgood	Maplehurst
Ramsgate Farms	Paint Creek	Palmer
Royal View	• *Oxford Township*	Sinking Bridge
Shoup	Brandon-Oxford	Skaritt
Lower		
Macomb County	• *Clinton Township*	• *Lenox Township – continued*
• *Armada Township*	Bousson	Ray Lenox
Armada-Ray	Bridgewood Basin	Rubarth
Chase	Canal-Kukuk Relief	Smith
Coon Creek	Cranberry Marsh	• *Macomb Township*
Crawford	Crooked Brook	Ahrens
Crawford No. 2	Daus	Alwardt
Farley	Doescher	Arndt
Hullett	Eberts	Bowman
Jacobs	Greiner	Burk
Kruger	Groth	Card
Mills	Kerner	Crittenden
Milton	Kukuk	Coates
Morton	Luedke	Conklin
Newland Branch	Meitz	Gloede
Newland	Millar	Denryter
Townline	Moravian	Dunn
Wakefield	Schroeder	Eckert
Wilson	Stadler	Fieblecorn
Woodbeck	Utica	Green
• *Bruce Township*	• *Lenox Township*	Hafel
Apel	Anderson	Hahn
Bruce	Bark	Hall
Clinton River Romeo Relief	Deer Creek	Hammon
Hosner	Dixon	Harder
Lucking	Dryer	Hart
Mahaffy	Hardscrabble	Heydenreich
McKay	Harrison	Howard
Rood	Hill	Jersey Branch
Townline	Jaques	Jersey
Trieloff	Neiman	Jones
Wakefield	Norton	Kath

Table 13.–Continued.

Lower, *Macomb County* – continued

• *Macomb Township – continued*
Kitley
Klockow
Kruth
Lewis
Luchtman
Macomb
McBride
Miller
Nicol
Peters
Pingle
Rabe
Rose
Steinbrink
Stein
Stern
Thoel
Tilch
Wallasch
Zander

• *Ray Township*
Corey
Eaton
Five Points
Gass
Knust
McBride Branch
Priest
Stark
Wyman

• *Richmond Township*
Anderson East Branch
Clay
Jaques West Branch
Ward
Wheeler

• *Shelby Township*
Bannister
Brown
Cannon
Decker
Disco
Dunn Branch B
Dunn Brach C
Dunn Branch D
Dunn
Foley
Franklin Branch

• *Shelby Township – continued*
Hawald
Harris
Kaflic
Ketcham
Kingsbury
Lawson
Longstaff
Longstaff No. 2
Middle Branch Clinton River
Preston
Ruby
Runyan
Schocke
Shelby Conservation
Shoemaker
Stokes
Utica Improvement and Encourse
Westlake
Wilcox
Vineyard

• *Sterling Heights Township*
16-1/2 Mile
17 Mile Road and Branches
18 Mile Rd.
Belmont Retention
Berger
Bliesath
Brieholz
Briston Heights Retention No. 1
Bristol Heights Retention No. 2
Burr
Burr Relief No. 2
Busch
Cady
Cady Enclosure
Cady Extension
Canal
Cook
Country Club Estates Retention
Crissman
Daus
Diener
Diener Enclosure No. 2
Fisher
Foley
Gamble
Gamble Impounment
Georgian Mansion Retention

• *Sterling Heights Township – continued*
Gibson
Greens Enclosure
Hawken Enclosure
Hildebrandt Basin
Hildebrandt
Kleino Relief Canal Rd. Branch
Kleino Relief Enclosure
Lakeside Lake
Lateral 1A
Lateral 1B
Lateral 2A
Lateral 2B
Lateral 3A
Lateral 3B
Lateral 4A
Lateral 4B
Lateral 5A
Lateral 5B
Lateral 6B
Lateral 12B
Lateral 13A
Lateral 15A
Lateral 15B
Lateral 16A
Lateral 16B
Lateral 19B
Lockwood
L.R.W. Retention Basin
McInerney
Merrill
Moore
Newth
Phiel
Plumbrook
Puls
Red Run
Rickabus
Robinhood Retention
Robinson
Schuer
Shanahan Enclosure
Shell Heights Retention
Spencer
Sterling Relief
Sterling Relief Extension
Union
Utica Gardens Tile
Vokes Relief Branch No. 2

Table 13.–Continued.

Lower, *Macomb County* – continued

• *Sterling Heights Township – continued*
- Vokes Relief Branch No. 3
- Vokes Relief

• *Warren Township*
- Bear Creek
- Bear Creek
- Bear Creek Warren Branch 2
- Bear Creek Warren Branch North
- Buckland
- Center line Branch
- Center line Relief
- Center line Relief Branch No. 1
- Cramer Relief
- Edman
- Fogg
- Frazho East Branch
- Grobbel Relief and Brs.
- Grobbel Relief Branch No. 2
- Harrington East
- Harrington West
- Hartsig Relief
- Kutchey Relief
- Kutchey Relief Brs.
- Kutchey Thomas Relief
- Lorraine Storm Branch No. 1
- Lorraine Storm Branch No. 2
- Lorraine Storm
- Martin Rd. Branch West
- Masonic Lateral
- Masonic Rd. Branch E
- McCoy Relief and Brs.
- Meckler
- Meirow
- Murthum Relief
- Red Run Branch A
- Red Run Branch B
- Red Run Branch D
- Red Run Branch E
- Red Run Branch F
- Rinke Branch
- Schoenherr Relief Branch No. 1
- Schoenherr-14 Mile Relief
- Schoenherr Relief
- Schroeder-Szabo-Otto
- Schroeder Relief
- Schroeder North Branch
- Schroeder South Branch
- Sharkey Relief
- Smith

• *Warren Township – continued*
- Springer
- Stevens East Branch
- Stephens West Branch
- Ten Mile Branch East Lateral
- Ten Mile Branch West Lateral
- Walker Relief
- Warren Branch No. 2
- Warren Branch South

• *Washington Township*
- Balch
- Brown
- Gaskill
- Gould Tile
- Healy Brook Branch
- Healy Brook
- Heide
- King
- Nims
- Nims Extension
- See
- Taft
- Washington
- Yates Branch
- Yates

Oakland County

• *Royal Oak Township*
- Acacia Park Triple
- Batavia
- Campbell No. 2
- Clawson
- Coolidge
- Dequindre Interceptor
- Dunleavy
- East-Clawson
- George W. Kuhn – Contract 1
- George W. Kuhn – Contract 2
- George W. Kuhn
- Glendale
- Henry-Graham
- John Garfield and Garfield
- Kaczmar
- Lawson
- North Arm Relief
- Marshall
- McClain
- Murray
- Red Run
- Red Run Federal

• *Royal Oak Township – continued*
- Red Run Imp and Campbell Road
- Red Run Warren Branch
- Schubiner
- Shaberman
- Triple
- Twelve Towns
- Vickers
- Wilson

• *Southfield Township*
- Barry
- Calhoun
- Clarkston
- Horton Relief
- Lilly
- McClelland
- Pemberton
- Royal Oak
- Southfield No. 1
- Southfield No. 2
- Southfield No. 6

• *Troy Township*
- Barnard
- Boyd
- Brotherton
- Crake
- Dennis Murphy
- Douglas
- Elliott
- Ferry
- Fetterly
- Fredericks
- Gibson
- Gorsline
- Halfpenny
- Hawthorne
- Houghten
- Hugh Dohany
- Jackson
- King
- Lane
- Lane Extension
- Lanni
- Mastin
- McConnell
- McDonald
- McIntyre
- Moxley
- Nelson-Phase I

Table 13.–Continued.

Lower, *Oakland County* – continued		
• *Troy Township – continued*	• *Troy Township – continued*	• *Troy Township – continued*
Nelson-Phase II	Renshaw	Spencer
Neslon-Phase III	Richardson	Sturgis
Olson	Robert Huber	Swan
Page	Roth	Wrey
Quinn	Shanahan	
Mouth		
Macomb County	• *Clinton Township – continued*	• *Roseville Township*
• *Clinton Township*	Spruce Street	Callahan
Cass Avenue West Lateral	Strevel Heights	Erin Clinton Townline
Charter Oaks	Sweeney	Fraser Tile
Faulman	Teske	Priest
Harrington	Vermander	Rohrbeck-Sweeney Relief
		Winkleman Tile

Table 14a.–Statutes administered by Michigan Department of Environmental Quality, that protect aquatic resources. N.R.E.P Act=Natural Resources and Environmental Protection Act (1994 PA 451).

State of Michigan Acts	Description of Acts
Public Health Code (1978 PA 368, as amended)	Aquatic Nuisance Control: regulates the use of any substances for the treatment of swimmer's itch, and excexcessive aquatic plants and algae.
Part 31 N.R.E.P. Act	Water Resource Protection: regulates discharge to surface waters according to set water quality standards.
Part 41 N.R.E.P. Act	Sewerage Systems: regulates wastewater or sewer system facilities.
Part 91 N.R.E.P. Act	Soil Erosion and Sedimentation Control: regulates any earth change that disturbs one or more acres, or is within 500 feet of a lake or stream.
Part 301 N.R.E.P Act	Inland Lakes and Streams: this part regulates structure placement or removal, dredging, filling below the ordinary high water mark, and operating or constructing a marina in lakes and streams.
Part 303 N.R.E.P. Act	Wetland Protection: regulates dredging, filling, and structure placement within wetlands.
Part 307 N.R.E.P. Act	Inland Lake Level: regulates the establishment of legal lake levels and lake level control structures.
Part 309 N.R.E.P. Act	Inland Improvement: regulates the establishment of lake boards and revolving funds to protect and improve lakes.
Part 315 N.R.E.P. Act	Dam Safety: establishes a program to maintain a statewide inventory of dams, and provides staff to inspect dams to evaluate the integrity of the structures.

Table 14b.–Federal statutes, administered by Michigan Department of Environmental Quality, that protect aquatic resources.

Federal Water Pollution Control Act, Section 314 (as amended 2002, PL 107-303)
Federal Water Pollution Control Act, Section 402 (as amended 2002, PL 107-303)
Federal Water Pollution Control Act, Section 404 (as amended 2002, PL 107-303)
Coastal Zone Management Act (as amended 1996, PL 104-150)
River and Harbor Act, Section 10 (1899)

Table 15.–Fish species historically found in the Clinton River watershed. Origin: N=Native, C=Colonized, I=Introduced; Status: P=Present, O=Extirpated, U=Unknown (followed by year it was last collected in the watershed); 2001/2002: an X indicates the species was caught in the most recent fisheries survey during 2001 and 2002.

Common name	Scientific name	Origin	Status	2001/2002
Lampreys	Petromyzontidae			
chestnut lamprey	*Ichthyomyzon castaneus*	N	P	
northern brook lamprey	*Ichthyomyzon fossor*	N	P	
silver lamprey	*Ichthyomyzon unicuspis*	N	P	
American brook lamprey	*Lampetra appendix*	N	U (1915)	
sea lamprey	*Petromyzon marinus*	C	P	
Sturgeons	Acipenseridae			
lake sturgeon **(threatened)**	*Acipenser fulvescens*	N	U	
Gars	Lepisosteidae			
longnose gar	*Lepisosteus osseus*	N	P	X
Bowfins	Amiidae			
bowfin	*Amia calva*	N	P	X
Herrings	Clupeidae			
alewife	*Alosa pseudoharengus*	C	P	
gizzard shad	*Dorosoma cepedianum*	N	P	X
Carps and minnows	Cyprinidae			
central stoneroller	*Campostoma anomalum*	N	P	X
goldfish	*Carassius auratus*	I	P	X
spotfin shiner	*Cyprinella spiloptera*	N	P	X
common carp	*Cyprinus carpio*	I	P	X
brassy minnow	*Hybognathus hankinsoni*	N	P	X
striped shiner	*Luxilus chrysocephalus*	N	U (1929)	
common shiner	*Luxilus cornutus*	N	P	X
redfin shiner	*Lythrurus umbratilis*	N	P	
hornyhead chub	*Nocomis biguttatus*	N	P	X
river chub	*Nocomis micropogon*	N	U (1978)	
golden shiner	*Notemigonus crysoleucas*	N	P	X
pugnose shiner	*Notropis anogenus*	N	U (1927)	
emerald shiner	*Notropis atherinoides*	N	P	X
bigmouth shiner	*Notropis dorsalis*	N	U (1978)	
blackchin shiner	*Notropis heterodon*	N	P	X
blacknose shiner	*Notropis heterolepis*	N	U (1935)	
spottail shiner	*Notropis hudsonius*	N	P	X
rosyface shiner	*Notropis rubellus*	N	P	X
sand shiner	*Notropis stramineus*	N	P	
mimic shiner	*Notropis volucellus*	N	P	
northern redbelly dace	*Phoxinus eos*	N	P	
bluntnose minnow	*Pimephales notatus*	N	P	X
fathead minnow	*Pimephales promelas*	N	P	X
western blacknose dace	*Rhinichthys obtusus*	N	P	X
creek chub	*Semotilus atromaculatus*	N	P	X

Table 15.–Continued.

Common name	Scientific name	Origin	Status	2001/2002
Suckers	Catostomidae			
quillback	*Carpiodes cyprinus*	N	P	
white sucker	*Catostomus commersonii*	N	P	X
lake chubsucker	*Erimyzon sucetta*	N	P	X
northern hog sucker	*Hypentelium nigricans*	N	P	X
spotted sucker	*Minytrema melanops*	N	P	X
silver redhorse	*Moxostoma anisurum*	N	P	
black redhorse	*Moxostoma duquesnei*	N	U (1924)	
golden redhorse	*Moxostoma erythrurum*	N	P	X
shorthead redhorse	*Moxostoma macrolepidotum*	N	P	
Bullhead catfishes	Ictaluridae			
black bullhead	*Ameiurus melas*	N	P	X
yellow bullhead	*Ameiurus natalis*	N	P	X
brown bullhead	*Ameiurus nebulosus*	N	P	X
channel catfish	*Ictalurus punctatus*	N	P	X
stonecat	*Noturus flavus*	N	P	X
tadpole madtom	*Noturus gyrinus*	N	P	X
brindled madtom **(special concern)**	*Noturus miurus*	N	P	
northern madtom	*Noturus stigmosus*	N	P	X
Pikes	Esocidae			
grass pickerel	*Esox americanus*	N	P	X
northern pike	*Esox lucius*	N	P	X
muskellunge	*Esox masquinongy*	I	O	
Mudminnows	Umbridae			
central mudminnow	*Umbra limi*	N	P	X
Smelts				
rainbow smelt	*Osmerus mordax*	I	P	
Trouts	Salmonidae			
cisco (lake herring) **(threatened)**	*Coregonus artedi*	N	P	
lake whitefish	*Coregonus clupeaformis*	I	O	
kokanee salmon	*Oncorhynchus nerka*	I	O	
coho salmon	*Oncorhynchus kisutch*	I	O	
rainbow trout	*Oncorhynchus mykiss*	I	P	X
Chinook salmon	*Oncorhynchus tshawytscha*	I	P	
cutthroat Trout	*Salmo clarki*			
brown trout	*Salmo trutta*	I	P	X
brook trout	*Salvelinus fontinalis*	I	P	X
splake	*Salvelinus fontinalis x S. namaycush*	I	P	
lake trout	*Salvelinus namaycush*	I	P	
Killifishes	Fundulidae			
western banded killifish	*Fundulus diaphanous*	N	P	X
Silversides	Atherinidae			
brook silverside	*Labidesthes sicculus*	N	P	
Sticklebacks	Gasterosteidae			
brook stickleback	*Culaea inconstans*	N	P	X
ninespine stickleback	*Pungitius pungitius*	N	U (1939)	

Table 15.–Continued.

Common name	Scientific name	Origin	Status	2001/2002
Sculpins	Cottidae			
mottled sculpin	*Cottus bairdii*	I	P	X
Striped basses	Moronidae			
white perch	*Morone americana*	C	P	
white bass	*Morone chrysops*	N	P	
Sunfishes	Centrarchidae			
rock bass	*Ambloplites rupestris*	N	P	X
green sunfish	*Lepomis cyanellus*	N	P	X
pumpkinseed	*Lepomis gibbosus*	N	P	X
warmouth	*Lepomis gulosus*	N	P	
bluegill	*Lepomis macrochirus*	N	P	X
redear sunfish	*Lepomis microlophus*	I	P	
longear sunfish	*Lepomis peltastes*	N	P	X
smallmouth bass	*Micropterus dolomieu*	N	P	X
largemouth bass	*Micropterus salmoides*	N	P	X
white crappie	*Pomoxis annularis*	N	P	X
black crappie	*Pomoxis nigromaculatus*	N	P	X
Perches	Percidae			
greenside darter	*Etheostoma blennioides*	N	P	X
rainbow darter	*Etheostoma caeruleum*	N	P	X
Iowa darter	*Etheostoma exile*	N	P	X
faintail darter	*Etheostoma flabellare*	N	P	X
least darter	*Etheostoma microperca*	N	P	X
johnny darter	*Etheostoma nigrum*	N	P	X
orangethroat darter	*Etheostoma spectabile*	N	P	
yellow perch	*Perca flavescens*	N	P	X
logperch	*Percina caprodes*	N	P	X
channel darter **(endangered)**	*Percina copelandi*	N	P	
blackside darter	*Percina maculata*	N	P	X
walleye	*Sander vitreus*	N	P	X
Drums	Sciaenidae			
freshwater drum	*Aplodinotus grunniens*	N	P	X
Gobies	Gobiidae			
round goby	*Neogobius melanostomus*	I	P	X

Table 16.–Relative abundance of fish species (percent of total) found in Headwaters Segment of the Clinton River in 2001. Dash (–) indicates species not collected. Number of collection sites per stream is indicated in parentheses, at the top of the column.

Fish species	Clinton River (1 site)
longnose gar	–
bowfin	–
gizzard shad	–
central stoneroller	–
goldfish	–
spotfin shiner	–
common carp	–
brassy minnow	–
common shiner	–
horneyhead chub	–
golden shiner	–
emerald shiner	–
blackchin shiner	6.2
spottail shiner	–
rosyface shiner	–
bluntnose minnow	–
fathead minnow	–
blacknose dace	–
creek chub	1.2
white sucker	10.5
lake chubsucker	–
northern hog sucker	–
spotted sucker	–
golden redhorse	–
black bullhead	–
yellow bullhead	–
brown bullhead	0.6
channel catfish	–
stonecat	–
tadple madtom	–
northern madtom	–
grass pickerel	12.3
northern pike	–
central mudminnow	3.1
rainbow trout	–

Table 16.–Continued.

Fish species	Clinton River (1 site)
brown trout	–
brook trout	–
banded killifish	–
brook stickleback	–
mottled sculpin	–
rock bass	2.5
green sunfish	3.7
pumpkinseed	5.6
bluegill	4.9
longear sunfish	–
smallmouth bass	–
largemouth bass	14.2
white crappie	–
black crappie	–
greenside darter	–
rainbow darter	20.4
Iowa darter	–
fantail darter	14.2
least darter	0.6
johnny darter	–
yellow perch	–
logperch	–
blackside darter	–
walleye	–
freshwater drum	–
round goby	–
Total catch	162
Total number of species	14
Total length sampled (ft)	1,176
Total time sampled (hrs)	1.6

Table 17.–Relative abundance of fish species (percent of total) found in Upper Segment of the Clinton River in 2001. Dash (–) indicates species not collected. Number of collection sites per stream is indicated in parentheses, at the top of the column.

Fish species	Clinton River (2 sites)	Sashabaw Creek (1 site)
longnose gar	–	–
bowfin	–	–
gizzard shad	–	–
central stoneroller	–	–
goldfish	–	–
spotfin shiner	0.1	–
common carp	0.4	–
brassy minnow	–	–
common shiner	0.4	–
horneyhead chub	–	–
golden shiner	–	–
emerald shiner	–	–
blackchin shiner	–	–
spottail shiner	–	–
rosyface shiner	–	–
bluntnose minnow	1.3	–
fathead minnow	–	–
blacknose dace	–	–
creek chub	26.1	1.5
white sucker	0.3	–
lake chubsucker	–	0.4
northern hog sucker	7.1	–
spotted sucker	–	–
golden redhorse	–	–
black bullhead	0.4	–
yellow bullhead	0.6	2.7
brown bullhead	0.1	–
channel catfish	–	–
stonecat	0.1	–
tadple madtom	–	–
northern madtom	–	–
grass pickerel	0.7	1.9
northern pike	1.1	0.4
central mudminnow	0.4	9.1
rainbow trout	–	–
brown trout	–	–

Table 17.–Continued.

Fish species	Clinton River (2 sites)	Sashabaw Creek (1 site)
brook trout	–	–
banded killifish	3.2	–
brook stickleback	–	–
mottled sculpin	–	–
rock bass	4.5	9.8
green sunfish	0.6	3.0
pumpkinseed	3.4	3.4
bluegill	19.1	58.7
longear sunfish	0.6	–
smallmouth bass	0.4	–
largemouth bass	11.8	1.5
white crappie	–	–
black crappie	–	–
greenside darter	0.8	–
rainbow darter	–	7.6
Iowa darter	–	–
fantail darter	0.1	–
least darter	–	–
johnny darter	6.0	–
yellow perch	6.4	–
logperch	4.0	–
blackside darter	–	–
walleye	–	–
freshwater drum	–	–
round goby	–	–
Total catch	1,412	264
Total number of species	27	12
Total length sampled (ft)	2,400	1,200
Total time sampled (hrs)	4.0	2.3

Table 18.–Relative abundance of fish species (percent of total) found in Middle Segment of the Clinton River in 2001 and 2002. Dash (–) indicates species not collected. Number of collection sites per stream is indicated in parentheses, at the top of the column.

Fish species	Clinton River (3)	Galloway Creek (1)	Sargents Creek (1)	Paint Creek (1)	West Branch Stony Creek (2)	McClure Drain (1)
longnose gar	–	–	–	–	–	–
bowfin	–	–	–	–	–	–
gizzard shad	–	–	–	–	–	–
central stoneroller	–	2.7	6.5	–	0.7	–
goldfish	–	–	–	–	–	–
spotfin shiner	–	–	–	–	–	–
common carp	0.5	–	–	–	–	–
brassy minnow	–	–	–	–	–	–
common shiner	–	0.4	–	–	6.5	–
horneyhead chub	0.7	–	–	–	5.1	–
golden shiner	–	–	–	–	–	–
emerald shiner	0.1	–	–	–	–	–
blackchin shiner	–	–	–	–	–	–
spottail shiner	0.1	–	–	–	–	–
rosyface shiner	–	–	–	–	–	–
bluntnose minnow	0.2	–	–	–	0.1	–
fathead minnow	0.1	0.4	–	0.5	–	–
blacknose dace	4.3	4.9	20.8	1.1	2.3	–
creek chub	11.6	64.6	68.5	22.1	44.4	66.0
white sucker	40.8	17.9	2.3	13.4	10.8	3.0
lake chubsucker	–	–	–	–	–	–
northern hog sucker	29.1	–	–	2.5	1.0	–
spotted sucker	–	–	–	–	–	–
golden redhorse	–	–	–	–	–	–
black bullhead	–	–	–	–	0.1	–
yellow bullhead	–	–	–	–	2.7	–
brown bullhead	–	–	–	–	–	–
channel catfish	0.1	–	–	–	–	–
stonecat	–	–	–	–	–	–
tadple madtom	–	–	–	–	0.4	–
northern madtom	–	–	–	–	–	–
grass pickerel	–	–	–	–	0.9	–
northern pike	–	–	–	–	–	–
central mudminnow	–	1.5	–	–	6.3	–
rainbow trout	0.4	2.3	–	0.8	–	–
brown trout	–	0.4	–	7.9	–	–

Table 18.–Continued.

Fish species	Clinton River (3)	Galloway Creek (1)	Sargents Creek (1)	Paint Creek (1)	West Branch Stony Creek (2)	McClure Drain (1)
brook trout	–	–	–	–	–	–
banded killifish	–	–	–	–	–	–
brook stickleback	0.5	0.8	–	–	0.1	–
mottled sculpin	0.2	–	–	46.7	–	–
rock bass	0.5	–	–	–	0.9	–
green sunfish	1.1	0.4	–	0.1	0.4	–
pumpkinseed	0.1	–	–	–	0.2	–
bluegill	2.5	–	1.1	0.4	0.7	1.0
longear sunfish	–	–	–	–	–	–
smallmouth bass	0.1	–	–	–	–	–
largemouth bass	1.1	0.4	0.8	1.3	2.5	–
white crappie	–	–	–	–	–	–
black crappie	0.1	–	–	–	–	–
greenside darter	0.5	–	–	–	0.1	11.0
rainbow darter	2.0	1.9	–	3.0	10.2	3.0
Iowa darter	0.1	–	–	–	–	–
fantail darter	0.5	–	–	–	–	8.0
least darter	–	–	–	–	–	–
johnny darter	3.0	1.5	–	–	1.7	8.0
yellow perch	–	–	–	–	–	–
logperch	–	–	–	–	–	–
blackside darter	–	–	–	–	–	–
walleye	–	–	–	–	–	–
freshwater drum	–	–	–	–	–	–
round goby	–	–	–	–	–	–
Total catch	1,909	263	355	798	1,156	100
Total number of species	26	14	6	12	22	7
Total length sampled (ft)	3,200	610	500	1,200	1,020	800
Total time sampled (hrs)	5.7	1.7	1.0	2.9	3.5	1.1

Table 19.–List of Michigan fish species classified as intolerant to pollution (MDEQ 2002b).

Common name
Lampreys
sea lamprey (ammocete)
silver lamprey (ammocete and adult)
northern brook lamprey (ammocete and adult)
chestnut lamprey (ammocete and adult)
American brook lamprey (ammocete and adult)
Sturgeons
lake sturgeon
Paddlefish
paddlefish
Mooneyes
mooneye
Trouts
rainbow trout
brown trout
brook trout
coho salmon
Chinook salmon
pink salmon
cisco
lake whitefish
bloater
deepwater cisco
kiyi
blackfin cisco
shortnose cisco
shortjaw cisco
pygmy whitefish
round whitefish
Atlantic salmon
lake trout
Arctic grayling
Pikes
muskellunge
Minnows and carp
bigeye chub
river chub
pugnose shiner
bigeye shiner
ironcolor shiner
weed shiner
blackchin shiner
blacknose shiner
spottail shiner

Table 19.–Continued

Common name
Minnows and carp – continued.
silver shiner
rosyface shiner
southern redbelly dace
longnose dace
redside dace
pearl dace
silver chub
pugnose minnow
Sculpins
mottled sculpin
slimy sculpin
spoonhead sculpin
deepwater sculpin
Suckers
longnose sucker
creek chubsucker
northern hog sucker
black buffalo
spotted sucker
silver redhorse
river redhorse
black redhorse
shorthead redhorse
greater redhorse
Bullhead, catfish
stonecat
Topminnows
banded killifish
Sticklebacks
ninespine stickleback
Sunfish
rock bass
smallmouth bass
Perch
eastern sand darter
rainbow darter
Iowa darter
least darter
orangethroat darter
banded darter
channel darter

Table 20.–Relative abundance of fish species (percent of total) found in Lower Segment in 2001 and 2002. Dash (–) indicates species not collected. Number of collection sites per stream is shown in parentheses, at the top of the column.

Fish species	Clinton River (3)	Red Run Drain (2)	Plum Brook (2)	Gibson Drain (1)	Big Beaver Creek (1)	Middle Branch Clinton River (3)	Coon Creek (3)	East Branch Coon Creek (2)	North Branch (3)	Apel Drain (1)	Kidder Creek (1)
longnose gar	–	–	–	–	–	–	–	–	–	–	–
bowfin	–	–	–	–	–	–	–	–	–	–	–
gizzard shad	0.6	0.1	0.2	–	–	0.3	–	–	11.8	–	–
central stoneroller	–	–	0.5	7.8	–	1.3	5.7	7.2	6.8	0.9	–
goldfish	–	0.1	–	–	–	–	–	–	–	–	–
spotfin shiner	6.1	0.1	–	–	–	–	–	–	0.1	–	–
common carp	1.7	13.0	6.7	0.2	42.9	0.1	–	–	–	–	–
brassy minnow	–	–	–	–	–	–	0.5	–	–	–	–
common shiner	–	2.1	2.3	–	–	0.1	1.5	13.1	31.9	9.6	–
horneyhead chub	0.2	–	–	–	–	–	0.1	–	6.4	–	–
golden shiner	–	0.1	–	–	–	–	–	–	–	–	–
emerald shiner	–	–	–	–	–	0.1	–	–	0.3	–	–
blackchin shiner	–	–	–	–	–	–	–	–	–	–	–
spottail shiner	0.1	0.9	–	–	–	–	–	–	0.1	–	–
rosyface shiner	–	–	–	–	–	–	–	–	0.2	–	–
bluntnose minnow	8.5	0.7	14.1	5.0	–	0.5	0.2	11.5	0.4	–	–
fathead minnow	0.1	6.3	14.6	0.2	14.3	0.1	0.2	–	–	–	–
blacknose dace	–	–	12.0	18.1	42.9	0.8	4.2	0.4	1.2	17.9	12.9
creek chub	2.1	0.1	17.7	9.1	–	34.6	36.8	10.5	15.6	35.7	4.3
white sucker	10.9	54.7	29.1	10.8	–	43.0	8.9	12.3	6.7	6.7	–
lake chubsucker	–	–	–	–	–	–	–	–	–	–	–
northern hog sucker	14.4	–	–	–	–	1.5	–	–	2.3	–	–
spotted sucker	0.1	–	–	–	–	–	–	–	0.1	–	–
golden redhorse	0.9	–	–	–	–	0.2	–	–	0.4	–	–
black bullhead	–	–	–	–	–	0.2	–	–	–	–	–
yellow bullhead	–	–	0.2	–	–	–	–	–	–	–	–

Table 20.–Continued.

Fish species	Clinton River (3)	Red Run Drain (2)	Plum Brook (2)	Gibson Drain (1)	Big Beaver Creek (1)	Middle Branch Clinton River (3)	Coon Creek (3)	East Branch Coon Creek (2)	North Branch (3)	Apel Drain (1)	Kidder Creek (1)
brown bullhead	–	0.3	–	–	–	–	–	–	–	–	–
channel catfish	–	–	–	–	–	–	–	–	–	–	–
stonecat	–	–	–	–	–	–	–	–	0.1	–	–
tadple madtom	–	–	–	–	–	–	–	0.1	–	–	–
northern madtom	–	–	–	–	–	–	–	–	–	–	–
grass pickerel	–	–	–	–	–	–	–	0.3	–	–	–
northern pike	–	–	–	–	–	0.2	–	–	0.4	–	–
central mudminnow	–	–	–	0.8	–	2.8	1.5	0.1	0.3	–	42.9
rainbow trout	0.1	–	–	–	–	–	–	–	–	–	–
brown trout	–		–	–	–	–	–	–	–	–	1.4
brook trout	–	–	–	–	–	–	–	–	–	–	8.6
banded killifish	–	–	–	–	–	–	–	–	–	–	–
brook stickleback	–	–	–	–	–	0.1	7.0	0.7	–	0.2	7.1
mottled sculpin	–	–		–	–	–	–	–	–	–	–
rock bass	10.3	10.9	–	–	–	2.0	–	0.3	3.1	–	–
green sunfish	–	5.2	1.3	0.8	–	1.8	0.7	0.2	0.1	0.7	–
pumpkinseed	1.2	3.7	1.1	0.2	–	0.8	–	1.2	–	–	–
bluegill	3.5	1.6	–	–	–	4.5	–	–	0.7	8.0	–
longear sunfish	–	–	–	–	–	–	–	0.1	–	–	–
smallmouth bass	0.1	–	–	–	–	–	–	–	0.8	–	–
largemouth bass	3.1	–	–	–	–	0.2	–	–	0.6	0.2	–
white crappie	–	–	–	–	–	–	–	–	–	–	–
black crappie	0.1	–	–	–	–	0.1	–	–	–	–	–
greenside darter	7.4	–	–	–	–	0.6	4.5	–	3.2	0.2	–
rainbow darter	–	–	–	–	–	–	0.6	6.0	4.5	12.9	–
Iowa darter	–	–	–	–	–	–	–	–	–	0.9	12.9

Table 20.–Continued.

Fish species	Clinton River (3)	Red Run Drain (2)	Plum Brook (2)	Gibson Drain (1)	Big Beaver Creek (1)	Middle Branch Clinton River (3)	Coon Creek (3)	East Branch Coon Creek (2)	North Branch (3)	Apel Drain (1)	Kidder Creek (1)
fantail darter	–	–	–	–	–	–	0.8	–	–	–	–
least darter	–	–	–	–	–	–	1.2	0.4	–	–	–
johnny darter	7.2	–	0.3	47.1	–	1.0	24.9	35.8	1.7	6.0	10.0
yellow perch	0.3	–	–	–	–	2.6	–	–	0.2	–	–
logperch	0.2	–	–	–	–	0.7	0.5	0.1	0.1	–	–
blackside darter	–	–	–	–	–	0.1	0.1	–	–	–	–
walleye	0.1	–	–	–	–	–	–	–	–	–	–
freshwater drum	0.1	–	–	–	–	–	–	–	0.1	–	–
round goby	20.8	–	–	–	–	–	–	–	–	–	–
Total catch	1,009	763	618	603	7	1,050	1,276	1,132	1,816	448	70
Total number of species	26	16	13	11	3	27	19	18	29	13	8
Total length sampled (ft)	3,825	2,500	1,594	800	430	2,430	1,500	1,400	3,500	500	550
Total time sampled (hrs)	4.3	3.5	2.6	1.8	0.5	4.7	7.8	4.2	3.8	2.0	1.0

Table 21.–Relative abundance of fish species (percent of total) found in Mouth Segment in 2002. Dash (–) indicates species not collected. Number of collection sites per stream is shown in parentheses, at the top of the column.

Fish species	Clinton River (2)	Clinton River Cut–off channel (1)
longnose gar	0.4	1.8
bowfin	1.5	0.9
gizzard shad	16.3	16.0
central stoneroller	–	–
goldfish	–	9.1
spotfin shiner	–	–
common carp	47.1	26.9
brassy minnow	–	–
common shiner	–	0.5
horneyhead chub	–	–
golden shiner	7.6	10.0
emerald shiner	1.5	–
blackchin shiner	–	–
spottail shiner	0.8	–
rosyface shiner	–	–
bluntnose minnow	–	1.4
fathead minnow	–	–
blacknose dace	–	–
creek chub	–	–
white sucker	–	0.9
lake chubsucker	–	–
northern hog sucker	–	–
spotted sucker	0.4	1.4
golden redhorse	–	–
black bullhead	–	–
yellow bullhead	–	–
brown bullhead	0.4	–
channel catfish	–	–
stonecat	–	–
tadple madtom	–	–
northern madtom	–	–
grass pickerel	–	–
northern pike	0.4	0.9
central mudminnow	–	–
rainbow trout	–	–

Table 21.–Continued.

Fish species	Clinton River (2)	Clinton River Cut–off channel (1)
brown trout	–	–
brook trout	–	–
banded killifish	–	–
brook stickleback	–	–
mottled sculpin	–	–
rock bass	0.4	–
green sunfish	–	–
pumpkinseed	6.5	3.7
bluegill	3.4	7.3
longear sunfish	–	–
smallmouth bass	–	–
largemouth bass	11.8	11.4
white crappie	–	0.5
black crappie	–	0.9
greenside darter	–	–
rainbow darter	–	–
Iowa darter	–	–
fantail darter	–	–
least darter	–	–
johnny darter	–	–
yellow perch	1.1	0.9
logperch	–	–
blackside darter	–	–
walleye	–	0.9
freshwater drum	–	4.6
round goby	–	–
Total catch	263	219
Total number of species	15	19
Total length sampled (ft)	2,985	1,585
Total time sampled (hrs)	2.0	1.5

Table 22.–Reptiles and amphibians found in the Clinton River watershed (Harding 1997).

Common name	Scientific name
Turtles	
snapping turtle	*Chelydra serpentine*
common musk turtle	*Sternotherus odoratus*
spotted turtle **(threatened)**	*Clemmys guttata*
eastern box turtle **(special concern)**	*Terrapene carolina Carolina*
Blandings turtle **(special concern)**	*Emydoidea blandingii*
common map turtle	*Graptemys geographica*
painted turtle	*Chrysemys picta*
red-eared slider	*Trachemys scripta elegans*
spiny softshell	*Apalone spinifera*
Lizards	
five-lined skink	*Eumeces fasciatus*
Snakes	
northern water snake	*Nerodia sipedon 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 platyrhinos*
blue racer	*Coluber constrictor foxi*
black rat snake **(special concern)**	*Elaphe obsolete obsolete*
eastern fox snake **(threatened)**	*Elaphe gloydi*
eastern milk snake	*Lampropeltis triangulum triangulum*
eastern smooth green snake	*Opheodrys vernalis vernalis*
eastern massasauga rattlesnake **(special concern)**	*Sistrurus catenatus catenatus*
Salamanders	
mudpuppy	*Necturus maculosus maculosus*
eastern newt	*Notophthalmus viridescens*
spotted salamander	*Ambystoma maculatum*
blue-spotted salamander	*Ambystoma laterale*
eastern tiger salamander	*Ambystoma tigrinum tigrinum*
red-backed salamander	*Plethodon cinereus*
four-toed salamander	*Hemidactylium scutatum*
Frogs and Toads	
eastern American toad	*Bufo americanus americanus*
Blanchard’s cricket frog **(special concern)**	*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 23.–Breeding birds in the Clinton River watershed (Brewer et al. 1991).

Common name	Scientific name
Pied-billed Grebe	*Podilymbus podiceps*
American Bittern	*Botaurus lentiginosus*
Least Bittern	*Ixobrychus exilis*
Great Blue Heron	*Ardea herodias*
Great Egret	*Casmerodius albus*
Green-backed Heron	*Butorides striatus*
Mute Swan	*Cygnus olor*
Canada Goose	*Branta canadensis*
Wood Duck	*Aix sponsa*
American Black Duck	*Anas rubripes*
Mallard	*Anas platyrhynchos*
Blue-winged Teal	*Anas discors*
Turkey Vulture	*Cathartes aura*
Northern Harrier	*Circus cyaneus*
Cooper’s Hawk	*Accipiter cooperii*
Red-shouldered Hawk	*Buteo lineatus*
Broad-winged Hawk	*Buteo platypterus*
Red-tailed Hawk	*Buteo jamaicensis*
American Kestrel	*Falco sparverius*
Ring-necked Pheasant	*Phasianus colchicus*
Ruffed Grouse	*Bonasa umbellus*
Wild Turkey	*Meleagris gallopavo*
Northern Bobwhite	*Colinus virginianus*
Sora	*Porzana carolina*
American Coot	*Fulica americana*
Killdeer	*Charadrius vociferus*
Spotted Sandpiper	*Actitis macularia*
Common Snipe	*Gallinago gallinago*
American Woodcock	*Scolopax minor*
Black Tern	*Chlidonias niger*
Rock Dove	*Columba livia*
Mourning Dove	*Zenaida macroura*
Black-billed Cuckoo	*Coccyzus erythropthalmus*
Yellow-billed Cuckoo	*Coccyzus americanus*
Eastern Screech-owl	*Otus asio*
Great Horned Owl	*Bubo virginianus*
Barred Owl	*Strix varia*
Common Nighthawk	*Chordeiles minor*
Chimney Swift	*Chaetura pelagica*
Ruby-throated Hummingbird	*Archilochus colubris*
Belted Kingfisher	*Ceryle alcyon*
Red-headed Woodpecker	*Melanerpes erythrocephalus*
Red-bellied Woodpecker	*Melanerpes carolinus*
Downy Woodpecker	*Picoides pubescens*
Hairy Woodpecker	*Picoides villosus*
Northern Flicker	*Colaptes auratus*

Table 23.–Continued.

Common name	Scientific name
Eastern Wood-pewee	*Contopus virens*
Acadian Flycatcher	*Empidonax virescens*
Alder Flycatcher	*Empidonax alnorum*
Willow Flycatcher	*Empidonax traillii*
Least Flycatcher	*Empidonax minimus*
Eastern Phoebe	*Sayornis phoebe*
Great Crested Flycatcher	*Myiarchus crinitus*
Eastern Kingbird	*Tyrannus tyrannus*
Horned Lark	*Eremophila alpestris*
Purple Martin	*Progne subis*
Tree Swallow	*Tachycineata bicolor*
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*
Bank Swallow	*Riparia riparia*
Barn Swallow	*Hirundo rustica*
Blue Jay	*Cyanocitta cristata*
American Crow	*Corvus brachyrhynchos*
Black-capped Chickadee	*Parus atricapillus*
Tufted Titmouse	*Parus bicolor*
White-breasted Nuthatch	*Sitta carolinensis*
Brown Creeper	*Certhia americana*
House Wren	*Troglodytes aedon*
Marsh Wren	*Cistothorus palustris*
Blue-gray Gnatcatcher	*Polioptila caerulea*
Eastern Bluebird	*Sialia sialis*
Veery	*Catharus fuscescens*
Wood Thrush	*Hylocichla mustelina*
American Robin	*Turdus migratorius*
Gray Catbird	*Dumetella carolinensis*
Brown Thrasher	*Toxostoma rufum*
Cedar Waxwing	*Bombycilla cedrorum*
European Starling	*Sturnus vulgaris*
White-eyed Vireo	*Vireo griseus*
Yellow-throated Vireo	*Vireo flavifrons*
Warbling Vireo	*Vireo gilvus*
Red-eyed Vireo	*Vireo olivaceus*
Blue-winged Warbler	*Vermivora pinus*
Golden-winged Warbler	*Vermivora chrysoptera*
Yellow Warbler	*Dendroica petechia*
Chestnut-sided Warbler	*Dendroica pensylvanica*
Black-throated Green Warbler	*Dendroica virens*
Cerulean Warbler	*Dendroica cerulean*
Black-and-white Warbler	*Mniotilta varia*
American Redstart	*Setophaga ruticilla*
Prothonotary Warbler	*Protonotaria citrea*
Ovenbird	*Seiurus aurocapillus*
Northern Waterthrush	*Seiurus noveboracensis*

Table 23.–Continued.

Common name	Scientific name
Common Yellowthroat	*Geothlypis trichas*
Hooded Warbler	*Wilsonia citrine*
Yellow-breasted Chat	*Icteria virens*
Scarlet Tanager	*Piranga olivacea*
Northern Cardinal	*Cardinalis cardinalis*
Rose-breasted Grosbeak	*Pheucticus ludovicianus*
Indigo Bunting	*Passerina cyanea*
Dickcissel	*Spiza americana*
Rufous-sided Towhee	*Pipilo erythrophthalmus*
Chipping Sparrow	*Spizella passerine*
Field Sparrow	*Spizella pusilla*
Vesper Sparrow	*Pooecetes gramineus*
Savannah Sparrow	*Passerculus sandwichensis*
Grasshopper Sparrow	*Ammodramus savannarum*
Henslow's Sparrow **(threatened)**	*Ammodramus henslowii*
Song Sparrow	*Melospiza melodia*
Swamp Sparrow	*Melospiza georgiana*
Bobolink	*Dolichonyx oryzivorus*
Red-winged Blackbird	*Agelaius phoeniceus*
Eastern Meadowlark	*Sturnella magna*
Western Meadowlark	*Sturnella neglecta*
Common Grackle	*Quiscalus quiscula*
Brown-headed Cowbird	*Molothrus ater*
Orchard Oriole	*Icterus spurius*
Northern Oriole	*Icterus galbula*
House Finch	*Carpodacus mexicanus*
Pine Siskin	*Cardeulis pinus*
American Goldfinch	*Cardeulis tristis*
House Sparrow	*Passer domesticus*

Table 24.–Mammals found in the Clinton River watershed (Burt 1957).

Common name	Scientific name
opossum	*Didelphis marsupialis*
eastern mole	*Scalopus aquaticus*
starnose mole	*Condylura cristata*
masked shrew	*Sorex cinereus*
least shrew **(threatened)**	*Cryptotis parva*
shorttail shrew	*Blarina brevicauda*
little brown bat	*Myotis lucifugus*
Indiana bat **(endangered)**	*Myotis sodalist*
keen myotis	*Myotis keeni*
silver-haired bat	*Lasionycteris noctivagans*
big brown bat	*Eptesicus fuscus*
red bat	*Lasiurus borealis*
hoary bat	*Lasiurus cinereus*
raccoon	*Procyon lotor*
longtail weasel	*Mustela frenata*
least weasel	*Mustela rixosa*
mink	*Mustela vison*
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*
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 25.–Fish stocked in the Clinton River watershed, 1934–2002.

Segment Township Water body	Species	Years	Number stocked in period
Headwater			
Independence Twp.			
Cranberry Lake	bluegill	1934–37, 1939–45	59,900
	largemouth bass	1934, 1934, 1937–39, 1943–45	3,250
	yellow perch	1934, 1935, 1937, 1939, 1941	20,600
Crooked Lake	northern pike	1973, 1974, 1976–80	9,700
	rainbow trout	1981, 1982	11,400
Round Lake	bluegill	1944, 1945	4,400
	largemouth bass	1944, 1945	600
	yellow perch	1935	2,000
Brandon Twp.			
Seymour Lake	bluegill	1934, 1936–43, 1945	83,000
	largemouth bass	1937–39, 1941, 1943, 1945	2,500
	yellow perch	1934, 1937, 1939, 1940	13,000
Upper			
Independence Twp.			
Bridge Lake	bluegill	1940	10,000
Cemetery Lake	bluegill	1934–43, 1945	69,000
	brown trout	1968	2,000
	largemouth bass	1935, 1937–39, 1944, 1945	4,250
	rainbow trout	1948, 1950–56, 1958–64, 1966, 1967	25,800
	yellow perch	1934, 1935, 1937	6,800
Clinton River	rainbow trout	1943	100
Deer Lake	bluegill	1934–45	115,800
	brown trout	1968	6,500
	crayfish	1937	1,429
	cutthroat trout	1939	400
	rainbow trout	1939, 1947, 1948, 1950–56, 1958–67, 1977–80, 1983–85	118,152
	smallmouth bass	1937, 1942–44	4,000
	splake	1971–74	52,007
	walleye	1935–37, 1983, 1985, 1989, 1991	450,473
	yellow perch	1934, 1937, 1939, 1941	20,600
Dollar Lake	bluegill	1934–37, 1939	12,500
	largemouth bass	1935	500
	yellow perch	1934, 1937	2,800
Clarkston Pond	bluegill	1942, 1943	14,000
	largemouth bass	1940, 1943	800
	yellow perch	1941	10,000

Table 25.–Continued.

Segment Township Water body	Species	Years	Number stocked in period
Greens Lake	bluegill	1934, 1936, 1937–45	80,200
	largemouth bass	1935, 1936, 1939–41, 1943–45	4,075
	smallmouth bass	1940	175
	yellow perch	1934, 1939, 1940	7,950
Park Lake	bluegill	1938–39	8,000
	largemouth bass	1938–39	700
	yellow perch	1939	1,500
Sashebaw Creek	rainbow trout	1943	350
Townsend Lake	largemouth bass	1935	500
	northern pike	1969, 1970	55,000
	rainbow trout	1947, 1948, 1950, 1951	3,500
Waterford Mill Pond	bluegill	1944, 1945	3,000
	largemouth bass	1945	320
Orion Twp.			
Mill Lake	bluegill	1940–43, 1945	16,200
	largemouth bass	1942, 1945	900
	yellow perch	1940	5,000
Pontiac Twp.			
Crystal Lake	bluegill	1979	213
	crappie	1979	70
	largemouth bass	1979, 1980	18,216
	rainbow trout	1980–82	16,000
Springfield Twp.			
Bridge Lake	bluegill	1934, 1939, 1942, 1943	24,000
	largemouth bass	1935, 1944	1,000
	rainbow trout	1949–52, 1958–60	5,500
	smallmouth bass	1943	1,060
Waterford Twp.			
Chillman Pond	bluegill	1944	1,350
	largemouth bass	1944	140
Clinton River	brown trout	1938, 1941, 1944, 1953, 1955–58, 1960–68	20,907
	coho salmon	1979	50,000
	rainbow trout	1939–41, 1943–64, 1973–77	168,970
	walleye	1975, 1980, 1990–92	123,329
Crescent Lake	bluegill	1935–45, 1976	120,200
	crayfish	1939	11,250
	largemouth bass	1936, 1938–41, 1943, 1945, 1976–76	12,787
	rainbow trout	1967–69, 1975–80	63,001
	walleye	1937, 1985, 1990, 1997–99, 2001	242,518
	yellow perch	1934, 1934, 1937	6,000

Table 25.–Continued.

Segment Township Water body	Species	Years	Number stocked in period
Eagle Lake	bluegill	1944, 1945	2,100
	largemouth bass	1943–45	1,000
Elizabeth Lake	bluegill	1934–45	225,850
	brown trout	1968	7,820
	crayfish	1939	11,250
	largemouth bass	1936–41, 1944, 1945	10,650
	rainbow trout	1954–58, 1960–69	112,800
	smallmouth bass	1934–37, 1041–44	9,000
	walleye	1935, 1937, 1938	498,000
	yellow perch	1934–37, 1939	29,700
Geneva Lake	bluegill	1944	2,000
	largemouth bass	1944, 1945	600
Huntoon Lake	bluegill	1934–38, 1940–45	45,650
	largemouth bass	1935, 1937, 1939, 1943, 1945	2,570
	yellow perch	1936, 1941	9,000
Lake Oakland	bluegill	1934–45	158,300
	crappie	1939	500
	crayfish	1937	1,429
	largemouth bass	1935–42, 1945	18,650
	smallmouth bass	1942–44	3,600
	walleye	1955, 1956, 1983, 1984, 1986	917,790
	yellow perch	193437, 1939	26,100
Loon Lake	bluegill	1934–45	202,800
	brown trout	1973, 1974	16,000
	crappie	1938, 1939	2,600
	crayfish	1937, 1939, 1941	12,929
	largemouth bass	1935, 1937, 1939–41, 1945	6,450
	northern pike	1956, 1982, 1995–97, 2001	13,128
	rainbow trout	1973–74	32,000
	smallmouth bass	1942–44	5,500
	walleye	1935, 1937, 1938, 1944, 1946, 1953, 1955, 1983, 1984, 1986, 1990, 1992	768,388
	yellow perch	1934, 1935, 1937, 1939–41	24,800
Lotus Lake	bluegill	1937, 1939–42, 1945	41,250
	largemouth bass	1939–41, 1945	1,780
	rainbow trout	1948	1,000
	yellow perch	1935	4,000
Maceday Lake	bluegill	1934, 1935, 1937–45	169,650
	brown trout	1991	10,287
	lake trout	1949–56, 1969–72, 1994–96	48,776
	largemouth bass	1935–41, 1944	8,900

Table 25.–Continued.

Segment Township Water body	Species	Years	Number stocked in period
Maceday Lake – continued	rainbow trout	1947, 1948, 1950–64, 1968–70, 1972, 1976–79, 1981–2002	489,415
	smallmouth bass	1936, 1942–44	5,300
	splake	1966, 1968–72, 1975–77, 1981–88, 1990, 1992–2002	331,326
	steelhead	1968, 1975, 1980	29,469
	walleye	1937, 1938, 1983, 1984, 1986, 1989, 1991, 1993, 1995	349,387
	yellow perch	1934–36, 1939	18,000
Mohawk Lake	rainbow trout	1947, 1948, 1950, 1958–60	5,000
Schoolhouse Lake	bluegill	1934–45	80,500
	largemouth bass	1935–37, 1939–41, 1943–45	6,400
	rainbow trout	1948, 1950, 1958–60, 1964–67	11,800
	yellow perch	1934, 1936, 1937, 1939	9,800
Scott Lake	bluegill	1934, 1935, 1937–45	86,200
	largemouth bass	1934–41, 1943–45	10,050
	yellow perch	1934, 1935, 1937, 1939, 1941	18,500
Silver Lake (upper and lower)	bluegill	1935–45, 1977	184,100
	brown trout	1968, 1971, 1981, 1982	6,620
	crappie	1939	900
	largemouth bass	1935, 1937, 1939–41, 1944, 1945, 1976–78	24,636
	rainbow trout	1948–52, 1958–60, 1964–67, 1969, 1977–80	29,115
	smallmouth bass	1942, 1943	1,500
	yellow perch	1934, 1937, 1939, 1941	20,500
Van Norman Lake	bluegill	1939	4,000
	largemouth bass	1939	1,000
Watkins Lake	bluegill	1934, 1935, 1937–45	147,300
	largemouth bass	1935–41, 1945	5,350
	smallmouth bass	1935–37, 1942–44	7,050
	walleye	1937, 1938	328,000
	yellow perch	1934, 1937, 1939, 1941	19,500
Williams Lake	bluegill	1934, 1935, 1937–45	121,050
	largemouth bass	1934–41, 1944, 1945	13,650
	northern pike	1974, 1975	4,000
	smallmouth bass	1942, 1943	2,500
	walleye	1937, 1938	168,000
	yellow perch	1934–36, 1939, 1941	21,500

Table 25.–Continued.

Segment Township Water body	Species	Years	Number stocked in period
Woodhull Lake	bluegill	1934–45	91,159
	crappie	1939	300
	crayfish	1937, 1939	15,679
	largemouth bass	1935–37, 1939–41, 1943–45	8,250
	yellow perch	1934, 1937, 1939	13,100
Wormer Lake	bluegill	1934–43, 1945	58,500
	largemouth bass	1935–37, 1939–41, 1943, 1945	4,450
	yellow perch	1934, 1937, 1939	6,800
W. Bloomfield Twp.			
Cass Lake	bluegill	1934, 1936–45	213,200
	brown trout	1968, 1983–86	118,700
	crayfish	1938–1940	9,825
	kokanee salmon	1969–71, 1976	738,947
	Lake trout	1954, 1955, 1972–74, 1976, 1979, 1996–98	108,114
	Lake whitefish	1973	275
	largemouth bass	1935–42, 1944, 1945	24,450
	northern pike	1978	1,000
	rainbow trout	1972, 1978, 1980	60,327
	redear sunfish	1995–96	71,017
	smallmouth bass	1942–44	9,000
	splake	1964–66, 1981, 1982, 1984, 1985	206,180
	walleye	1934, 1937, 1938, 1972, 1973, 1982, 1983, 1985, 1990, 1992, 1994, 1995, 1997, 1999, 2001	1,400,844
	yellow perch	1934–37, 1939	42,200
Orchard Lake	bluegill	1934, 1935, 1937–40, 1942	158,500
	brown trout	1981–83	57,000
	Chinook salmon	1975	51,800
	crayfish	1939–40	5,825
	largemouth bass	1935, 1937–40	5,875
	rainbow trout	1943–48, 1950–58, 1960–72, 1975, 1979–80	329,292
	smallmouth bass	1935, 1939, 1942	2,550
	rainbow smelt	1975	3,600
	walleye	1934, 1937–38	706,000
	yellow perch	1934–35, 1937, 1939	37,200
Pine Lake	bluegill	1934–39, 1941, 1942, 1944, 1945	132,250
	largemouth bass	1935–39, 1941, 1944, 1945	10,050
	rainbow trout	1965, 1966	23,000
	smallmouth bass	1944	1,000
	walleye	1934, 1937, 1938	736,000
	yellow perch	1934–37, 1939	36,100

Table 25.–Continued.

Segment Township Water body	Species	Years	Number stocked in period
Sylvan Lake	bluegill	1934–45	170,500
	crayfish	1939, 1940	12,875
	largemouth bass	1935–37, 1939–41, 1944, 1945	12,250
	rainbow trout	1951	2,000
	smallmouth bass	1942, 1943	4,000
	walleye	1937, 1938	220,000
	yellow perch	1934, 1935, 1937, 1939	25,000
Middle			
Addison Twp.			
Echo Lake	yellow perch	1934	2,000
Indian Lake	bluegill	1937	4,000
	largemouth bass	1937	450
Lakeville Lake	bluegill	1934–45	135,600
	largemouth bass	1934–45	14,150
	northern pike	1956, 1982, 1999, 2000, 2002	12,776
	walleye	1937, 1999, 2001, 2002	280,472
	yellow perch	1934–37, 1939, 1940	42,100
Stony Creek	brown trout	1987–91	3,890
	walleye	1989	2,301
Avon Twp.			
Maxon Pond	smallmouth bass	1946	250
Paint Creek (Avon and Oakland twps.)	brook trout	1941	250
	brown trout	1938, 1949, 1953, 1954, 1956–70, 1972–2002	299,684
	crayfish	1940, 1941	21,200
	rainbow trout	1941–64, 1986, 1987	23,250
Rochester Pond	bluegill	1969	242
	largemouth bass	1969	10
	pumpkinseed	1969	382
Bruce Twp.			
Stony Creek	brown trout	1982–91	8,211
Independence Twp.			
Walters Lake	bluegill	1934–45	66,300
	largemouth bass	1934–41, 1943–45	4,530
	smallmouth bass	1936	350
	walleye	1935, 1937	430,000
	yellow perch	1934, 1935, 1937, 1939, 1941	31,000
Oakland Twp.			
Chamberlain Lake	rainbow trout	1962–66	3,300
Graham Lake	northern pike	1960	1,400
	rainbow trout	1962–66	9,225

Table 25.–Continued.

Segment Township Water body	Species	Years	Number stocked in period
Hart Lake	largemouth bass	1964	800
Shoe Lake	rainbow trout	1962–66	1,850
Bald Mountain Pond	brook trout	1964, 1965	125
	brown trout	1965, 1966, 1968	5,512
	rainbow trout	1947, 1948, 1950–55, 1957–67, 1969–71	28,473
	redear x green sunfish	1969	5,000
Orion Twp.			
Buckhorn Lake	bluegill	1936	1,500
Clam Lake	bluegill	1940	5,000
Elkhorn Lake	bluegill	1934, 1935, 1937–45	47,700
	largemouth bass	1935, 1939–45	3,100
	smallmouth bass	1939	300
	yellow perch	1934, 1937, 1939, 1940	14,300
Heather or Dennis Lake	northern pike	1959	200
Indianwood Lake	bluegill	1939	1,500
	largemouth bass	1939, 1940, 1943	1,825
Lake Orion	bluegill	1934–45	200,100
	largemouth bass	1934–42, 1945	13,700
	northern pike	1956, 1984	16,000
	smallmouth bass	1943, 1944	2,200
	yellow perch	1934–37, 1939, 1940	46,800
	walleye	1935, 1937, 1996–98, 2000, 2002	1,031,276
Long Lake	bluegill	1934–37, 1939–41, 1943–45	60,500
	largemouth bass	1935, 1936, 1939, 1944, 1945	2,450
	smallmouth bass	1943	500
	yellow perch	1935–37, 1939	25,000
Square Lake	bluegill	1936, 1939–45	46,750
	largemouth bass	1939, 1940, 1942–45	3,000
	northern pike	1960	2,300
	yellow perch	1939, 1940	7,000
Taylor Lake	bluegill	1934–45	60,200
	largemouth bass	1934–45	6,300
	yellow perch	1934–36, 1939, 1940	19,300
Trout Creek	brook trout	1941–64	26,500
	brown trout	1974–79, 1982–93	34,356
Upper Trout Lake	brook trout	1964	1,000
	brown trout	1968	2,000
	rainbow trout	1965, 1967, 1969,1971	8,825
Lower Trout Lake	rainbow trout	1964–66	21,500

Table 25.–Continued.

Segment Township Water body	Species	Years	Number stocked in period
Oxford Twp.			
Bailey Lake	smallmouth bass	1941	500
	largemouth bass	1936	350
Little Fish Lake	bluegill	1941, 1942	4,000
	largemouth bass	1942	1,000
	yellow perch	1940	5,000
Long Lake	bluegill	1943–45	7,900
	largemouth bass	1934, 1935, 1944	800
	smallmouth bass	1934, 1935, 1944	1,400
	yellow perch	1934, 1936	4,400
Stoney Lake	bluegill	1934–45	73,900
	largemouth bass	1935–42, 1945	6,150
	rainbow trout	1961–63	8,650
	smallmouth bass	1939, 1943, 1944	1,100
	walleye	1937	130,000
	yellow perch	1934–37, 1939, 1940	29,900
Clinton River (Pontiac and Avon twps.)	brown trout	1983–94	41,091
	channel catfish	1975	100,000
	northern pike	1975, 1980	229,999
	smallmouth bass	1975, 1980	6,110
	steelhead	1998, 2000, 2002	292,035
	walleye	1975, 1983, 1984	136,463
Pontiac Twp.			
Galloway Lake	largemouth bass	1940	500
Shelby Twp.			
Clinton River	brown trout	1983–86, 1990	6,523
	steelhead	1985–02	1,039,276
	walleye	1982–85, 1994, 1995, 1997	1,006,380
Handsome Lake (OC)	largemouth bass	1939	375
Washington Twp.			
Stony Creek	brown trout	1943, 1982–91	16,358
Stony Creek Impoundment	bluegill	1999	40,082
	channel catfish	1996, 2001	10,212
	muskellunge	1964	18,986
	northern pike	1980	4,000
	walleye	1981, 1983, 1985, 1987–89, 1991, 1993, 1995, 2001	185,638

Table 25.–Continued.

Segment Township Water body	Species	Years	Number stocked in period
W. Bloomfield			
Pine Lake	bluegill	1940, 1943	59,000
	crayfish	1940	1,625
	largemouth bass	1935, 1940	1,500
	rainbow trout	1964	3,000
	smallmouth bass	1942, 1943	4,000
Lower			
Bruce Twp.			
East Pond Creek	brown trout	1971–91	51,143
Frantz Lake	bluegill	1937	5,000
Hidden Lake	smallmouth bass	1939, 1942	790
Kidder Creek	brown trout	1972	500
Nolan Lake	bluegill	1939–41	14,000
	largemouth bass	1939–41	3,000
Ray Twp.			
Cascade Lake	bluegill	1939–41	17,500
	largemouth bass	1939, 1940	3,500
Shelby Twp.			
Bowman Lake	largemouth bass	1946	126
Dufty Pond	largemouth bass	1946	500
Sterling Heights Twp.			
Clinton River	walleye	1990–92	67,751
Washington Twp.			
Cusik Lake	bluegill	1934, 1937, 1939, 1940	28,000
	largemouth bass	1934, 1939, 1940, 1941	3,600
	rainbow trout	1948, 1949	2,500

Table 26.–Comparison of angler catch rates, pressure, and success at select Oakland County lakes (two standard errors in parentheses) (Waybrant and Thomas 1988, Thomas 1990).

Lake	Acres	Year surveyed	Total catch	Total effort	Catch per acre	Angler hours per acre	Catch per hour
Cass	1,280	1986	17,753	39,205	13.9 (2.9)	30.6 (3.8)	0.45 (0.11)
Kent	1,000	1987	276,906	231,000	282.2 (42.7)	231.0 (23.0)	1.22 (0.22)
Orchard	788	1986	8,649	24,422	11.0 (2.5)	31.0 (5.3)	0.35 (0.10)
White	540	1987	15,692	40,257	33.4 (9.5)	74.5 (10.0)	0.45 (0.14)
Maceday/Lotus	419	1986	40,283	37,010	96.1 (16.0)	88.3 (10.0)	1.09 (0.22)

Table 27.–Public lands in the Clinton River watershed listed by 15 categories sorted from largest land area to least. Data from Southeast Michigan Council of Governments.

Public land category	Number of parcels	Total land area (acres)	Percent of all public land	Cumulative percent
Municipal park	334	8,030	23.1	23.1
Golf course	48	6,884	19.8	43.0
Metro park	4	5,724	16.5	59.5
State recreation area	5	5,163	14.9	74.3
County park	6	2,375	6.8	81.2
Open public	30	1,955	5.6	86.8
State Park	4	1,014	2.9	89.7
Camp or campground	5	740	2.1	91.9
Nature preserve	15	690	2.0	93.8
Private recreation	11	680	2.0	95.8
Unknown	10	484	1.4	97.2
Ski area	3	413	1.2	98.4
Hunt club	6	398	1.1	99.5
Dedicated open space	3	106	0.3	99.8
Nature trail	1	55	0.2	100.0
Total acreage	485	34,710		

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Clinton River Assessment Appendix

James T. Francis
and
Robert C. Haas

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Appendix 1

Distribution Maps of Fish Species

This appendix contains known past and present fish distributions in the Clinton River system. Distribution of fishes were compiled from records located at the University of Michigan Museum of Zoology, Michigan Department of Natural Resources Institute for Fisheries Research, Michigan Department of Natural Resources Lake Erie Management Unit, and from the Michigan Department of Environmental Quality. Specific locations were plotted and extrapolated by the authors.

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

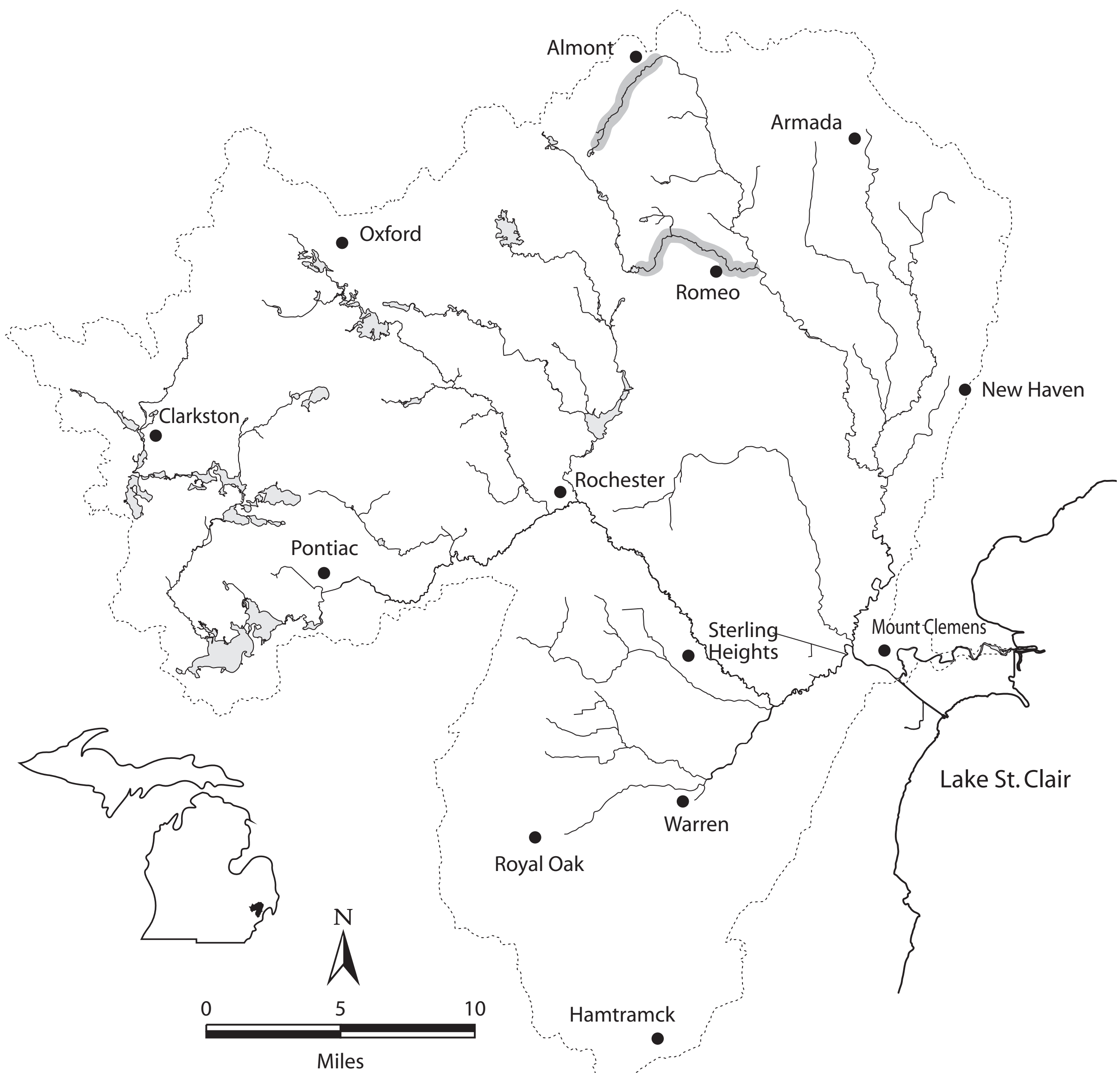
APPENDIX 1 INDEX

Chestnut lamprey *Ichthyomyzon castaneus*

Habitat:

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

spawning - moderate-size stream
- nest builder

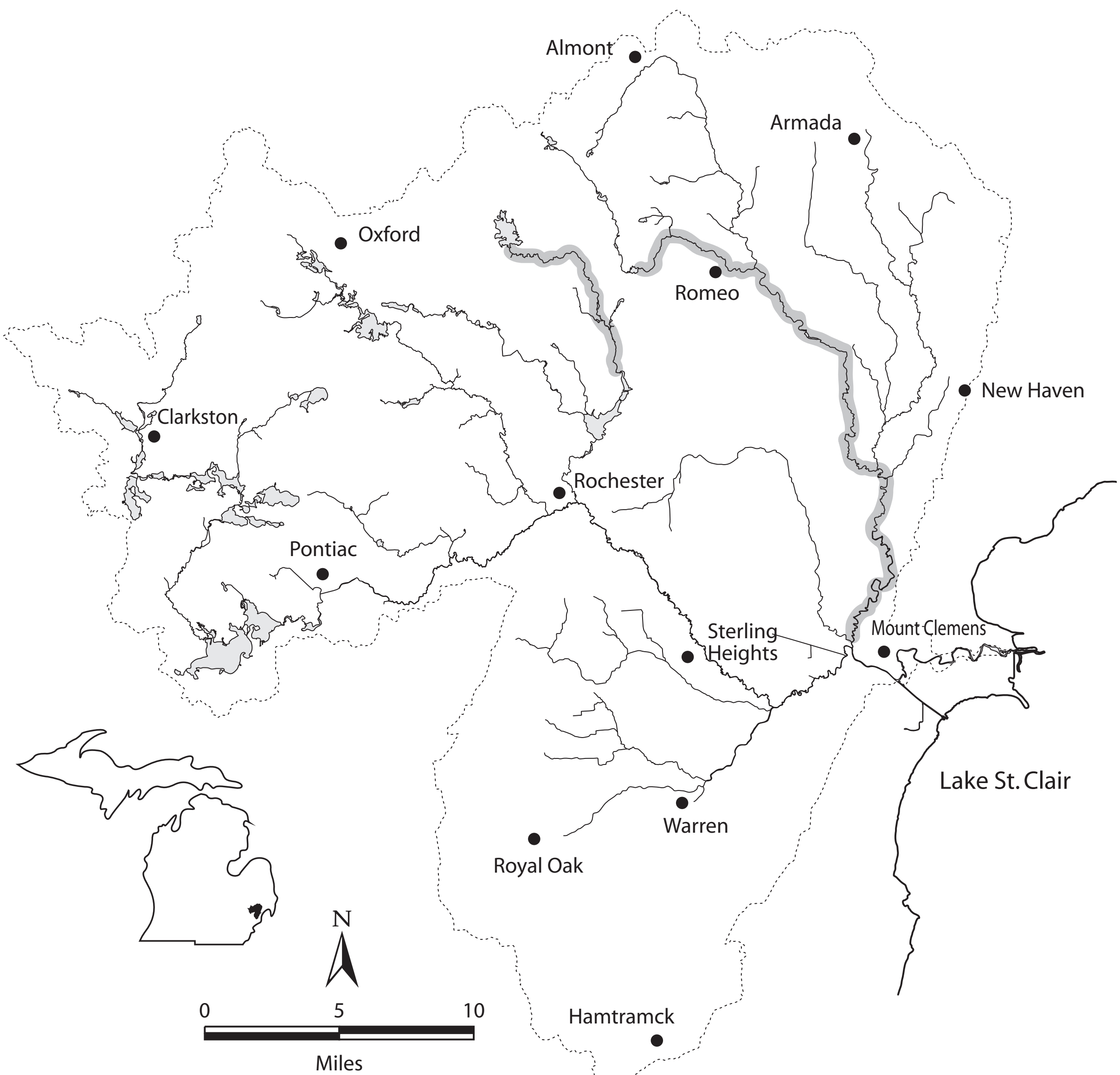


Northern brook lamprey *Ichthyomyzon fossor*

Habitat:

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

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



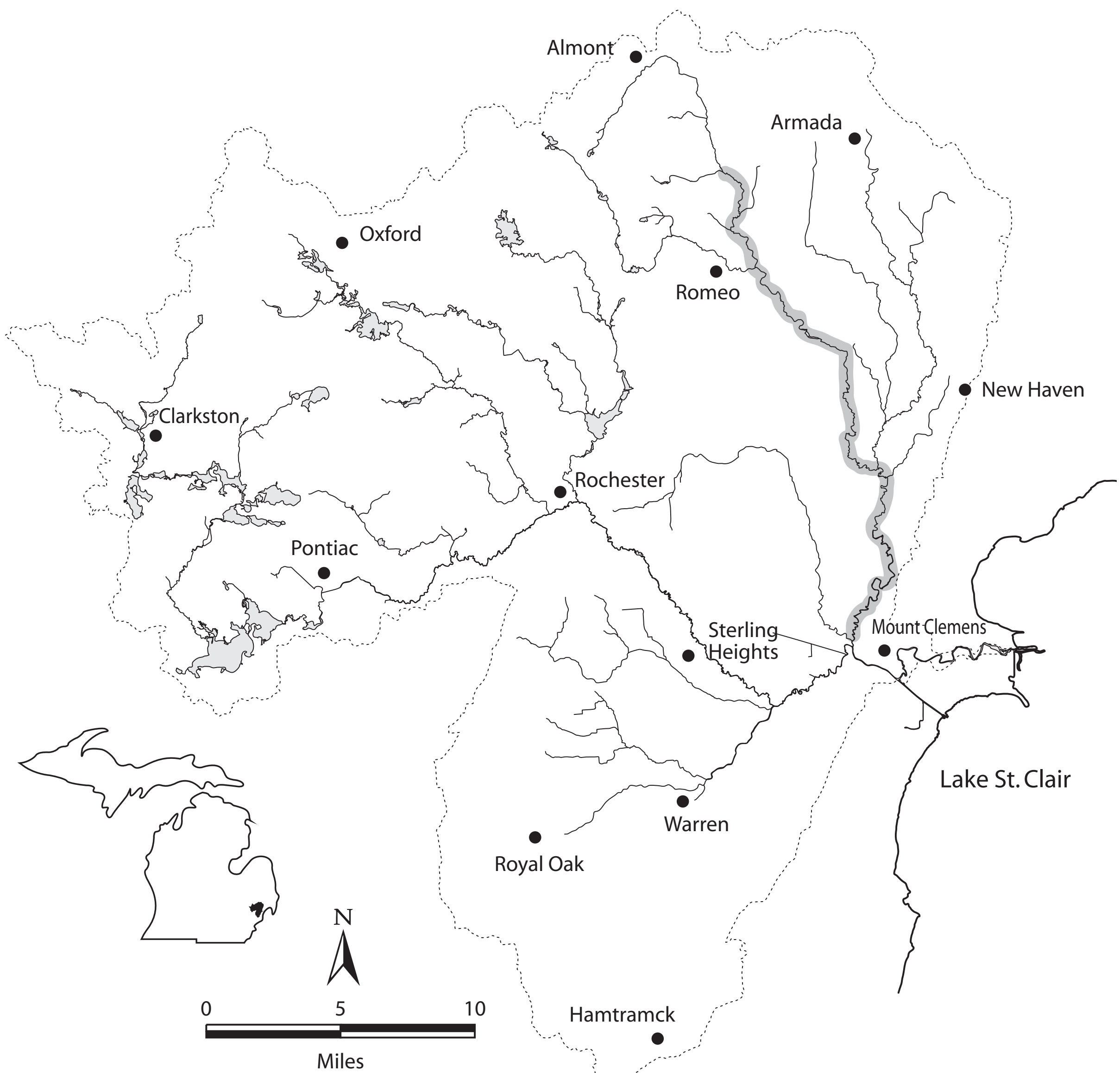
Silver lamprey *Ichthyomyzon unicuspis*

Habitat:

feeding - young:sand,muck,or organic debris substrate
- adults:clear river water with prey species

spawning - gravel and sand substrate
- moderate gradient
- moderate size stream
- cannot tolerate silt
- no dams

winter refuge - ammocetes burrow for 4 to7 years in mud and silt at river margins



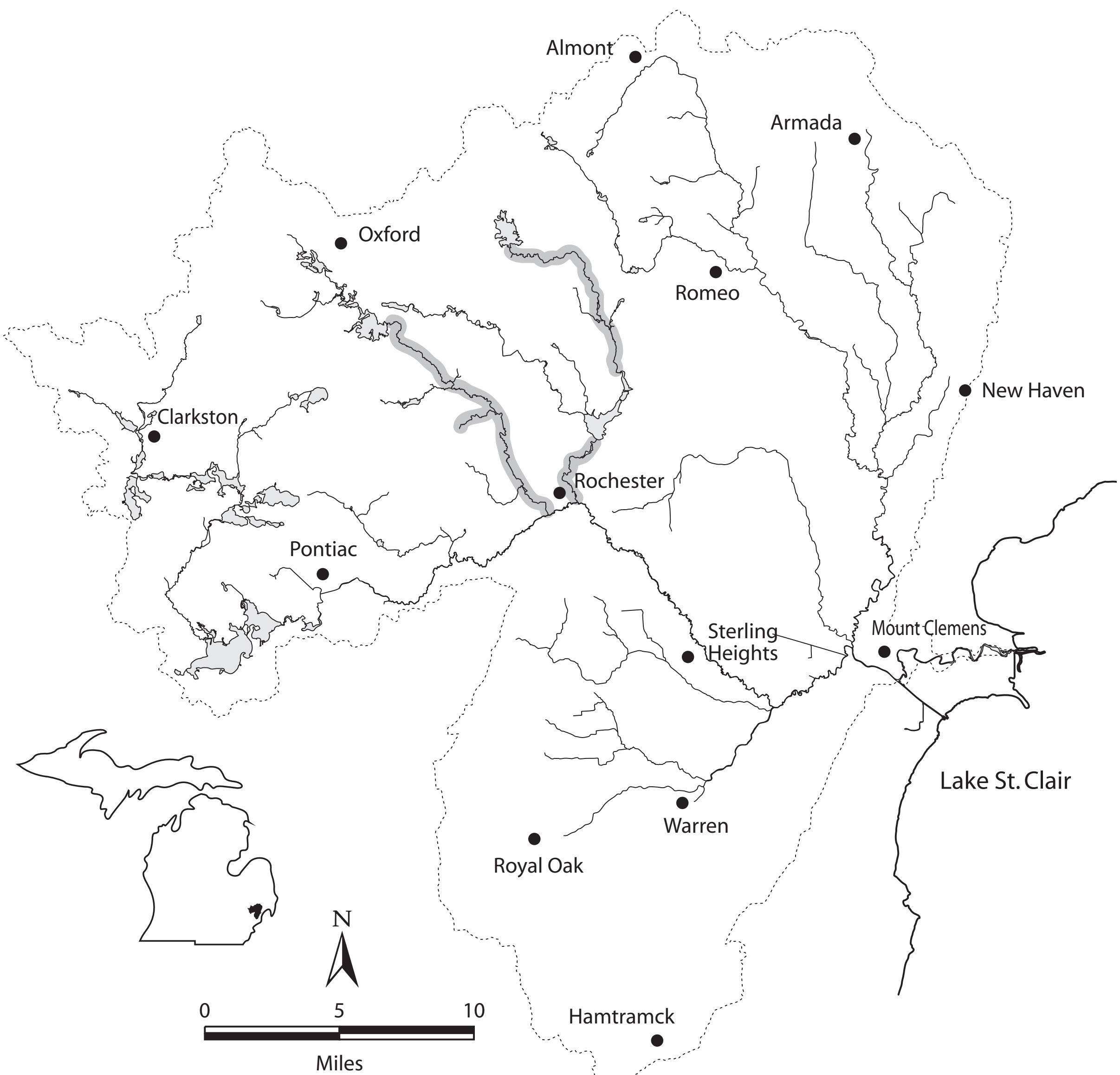
American brook lamprey *Lampetra appendix*

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 ammocetes

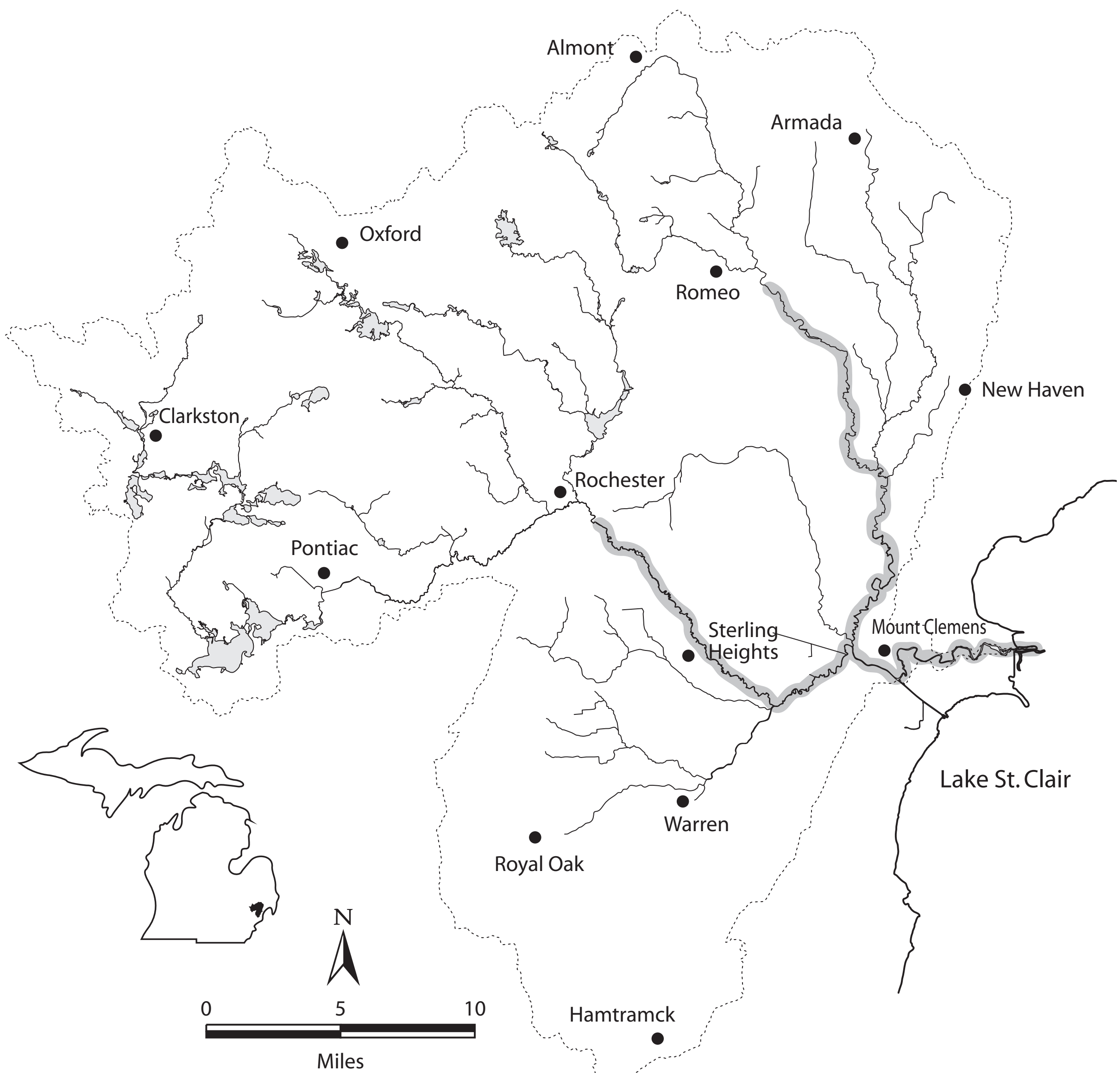


Sea lamprey *Petromyzon marinus*

Habitat:

feeding - young: substrate with beds of sand mixed with organic debris
- cannot tolerate silt
- adults: clear cool water

spawning - no dams
- riffles with sand and gravel substrates

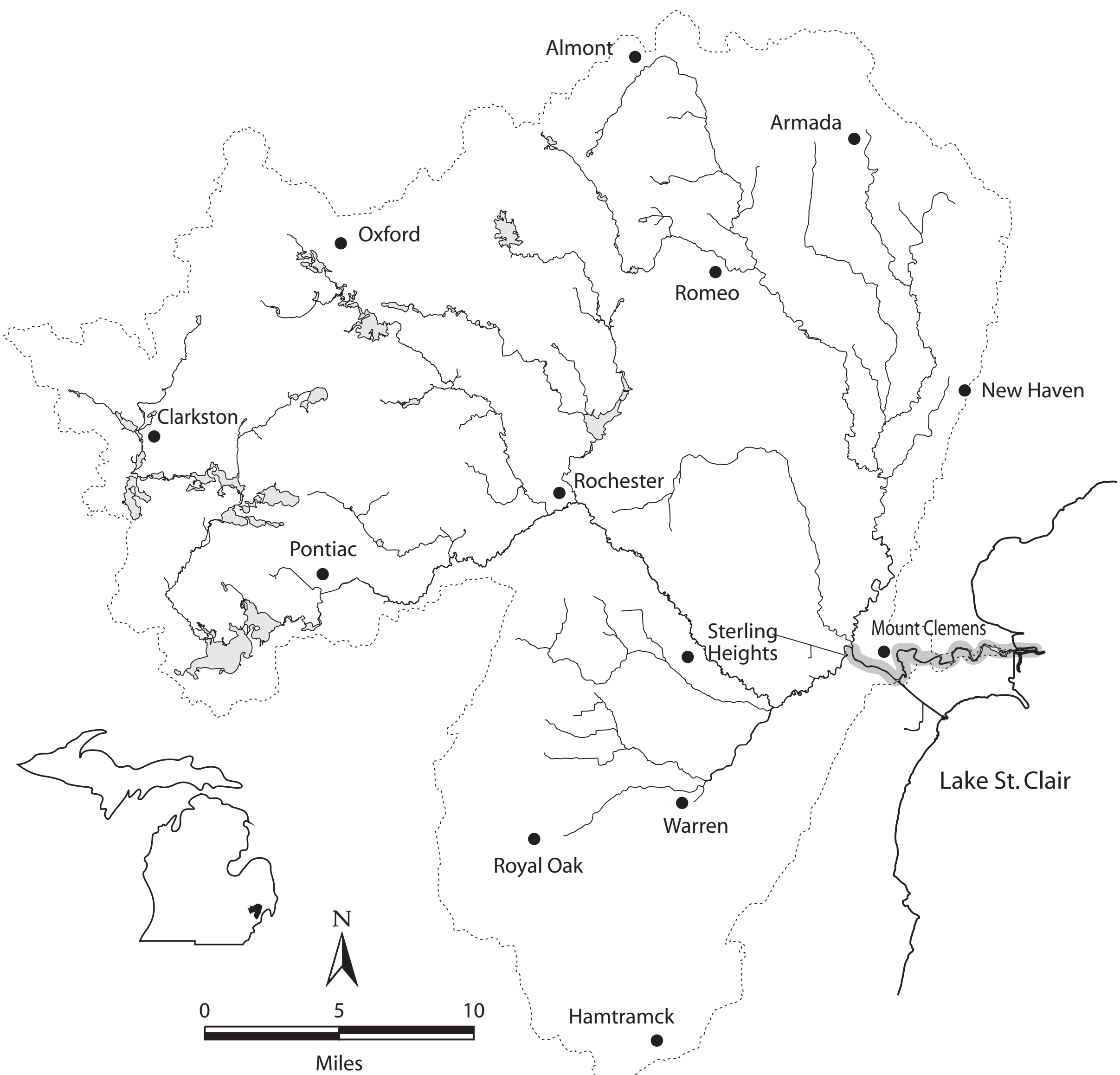


Lake sturgeon *Acipenser fulvescens* – **threatened**

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

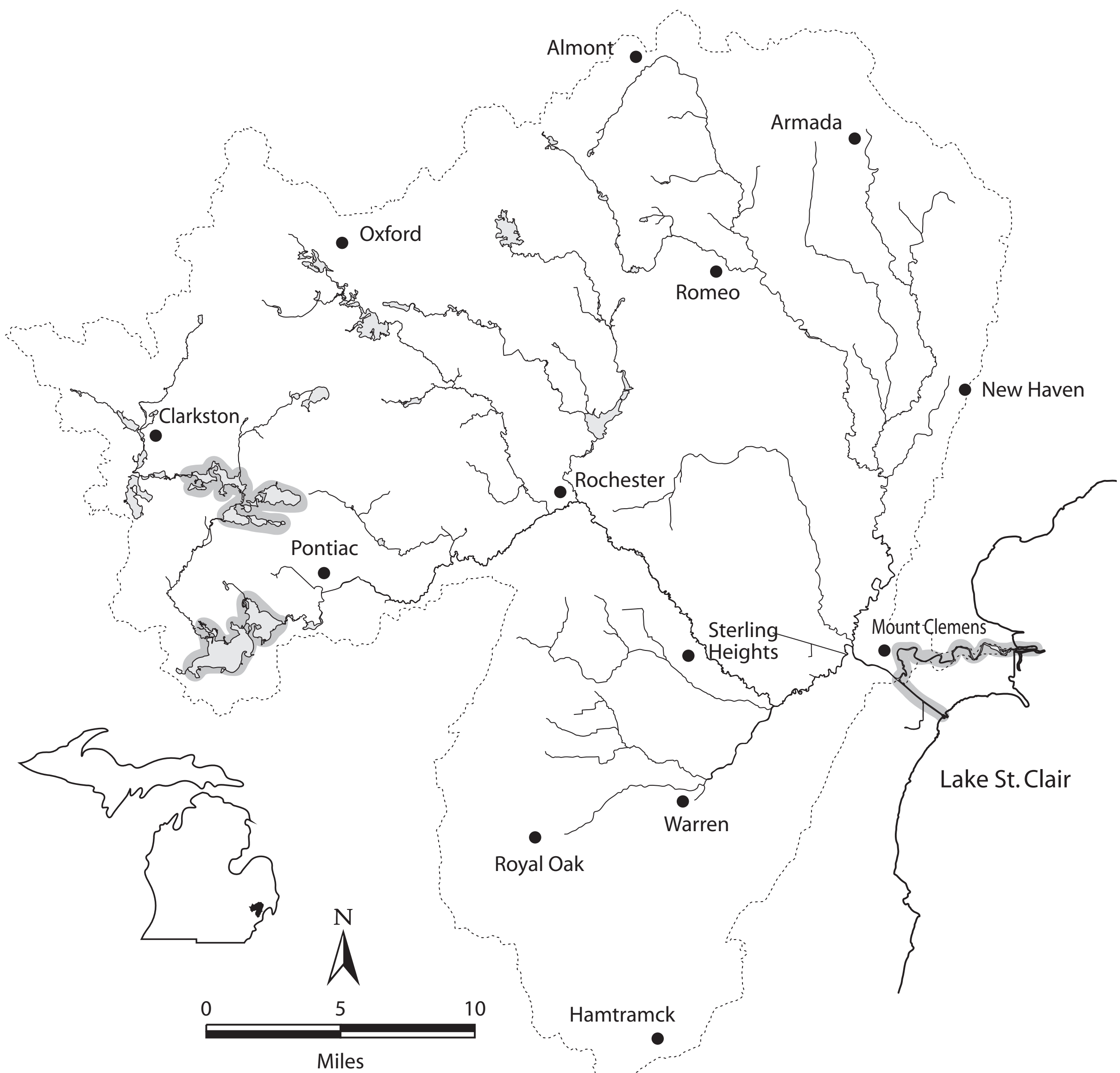


Longnose gar *Lepisosteus osseus*

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



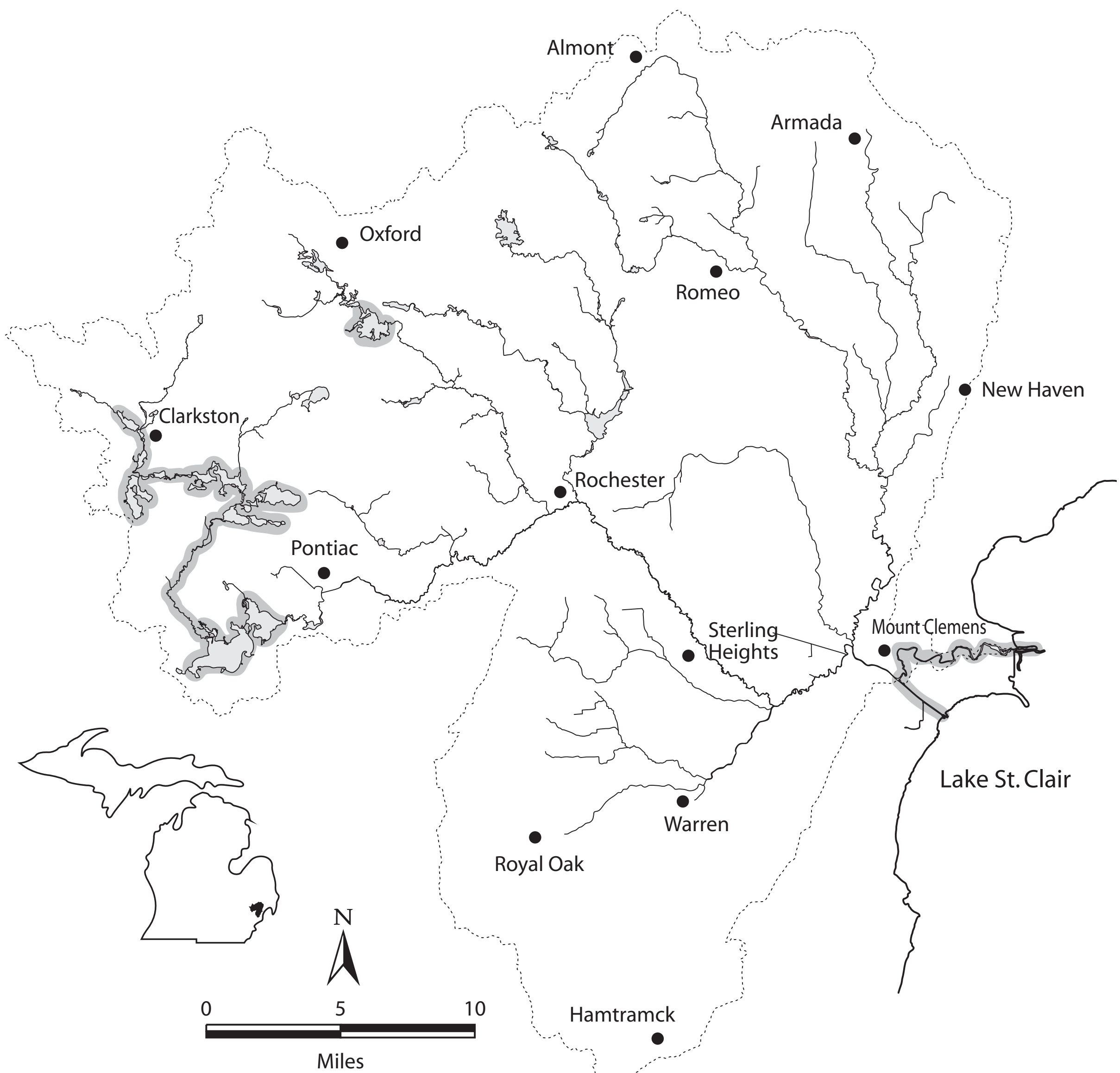
Bowfin *Amia calva*

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

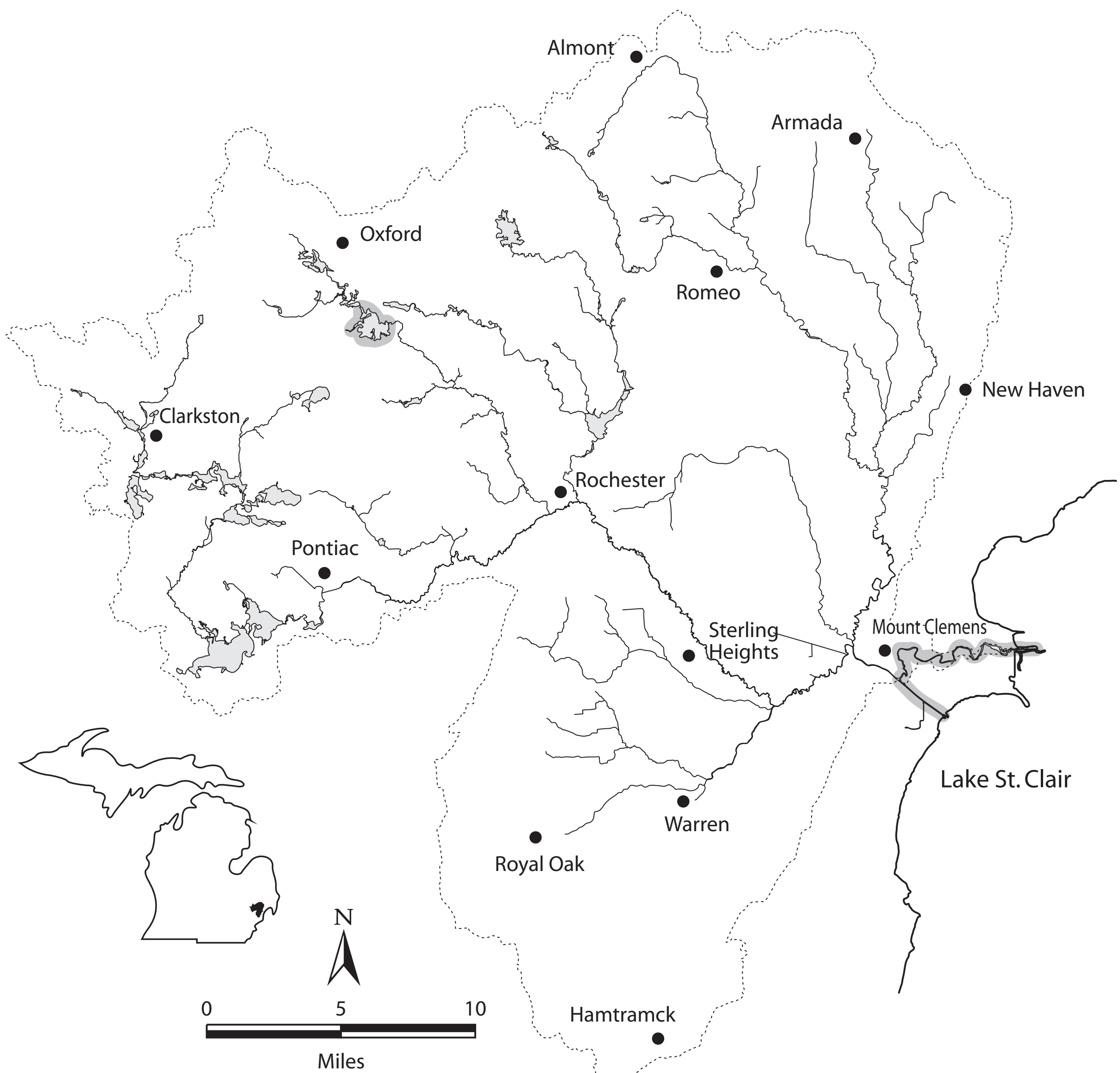
winter refuge - gravelly pockets among aquatic vegetation



Alewife *Alosa pseudoharengus*

Habitat:

feeding	- Lake St. Clair
	- prefers warmer waters
spawning	- streams or shallow beaches of lake
	- sand or gravelly substrate
winter refuge	- deep water

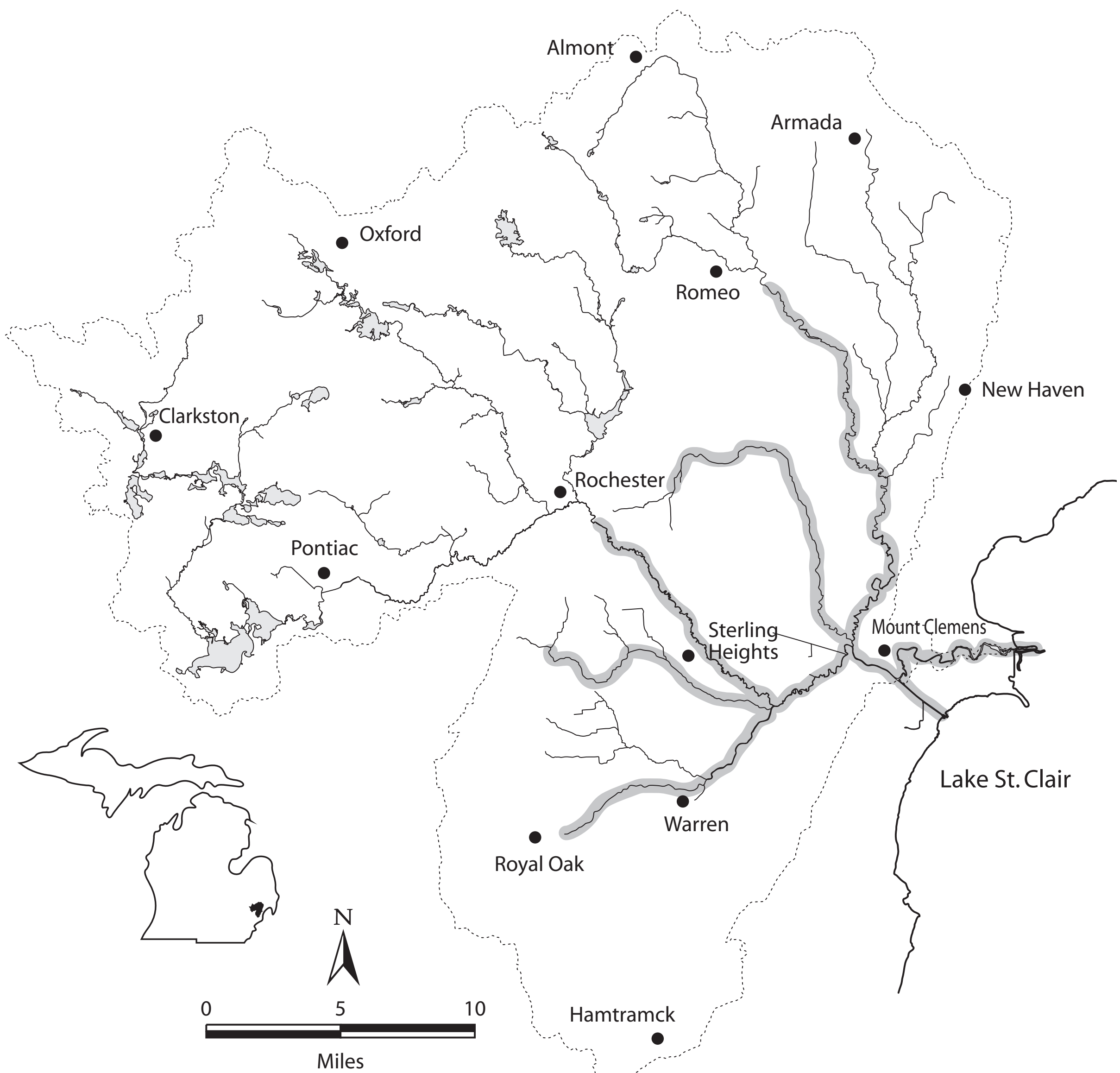


Gizzard shad *Dorosoma cepedianum*

Habitat:

feeding - large streams with low gradient, impoundments, and Lake St. Clair
- tolerant of clear and turbid water

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

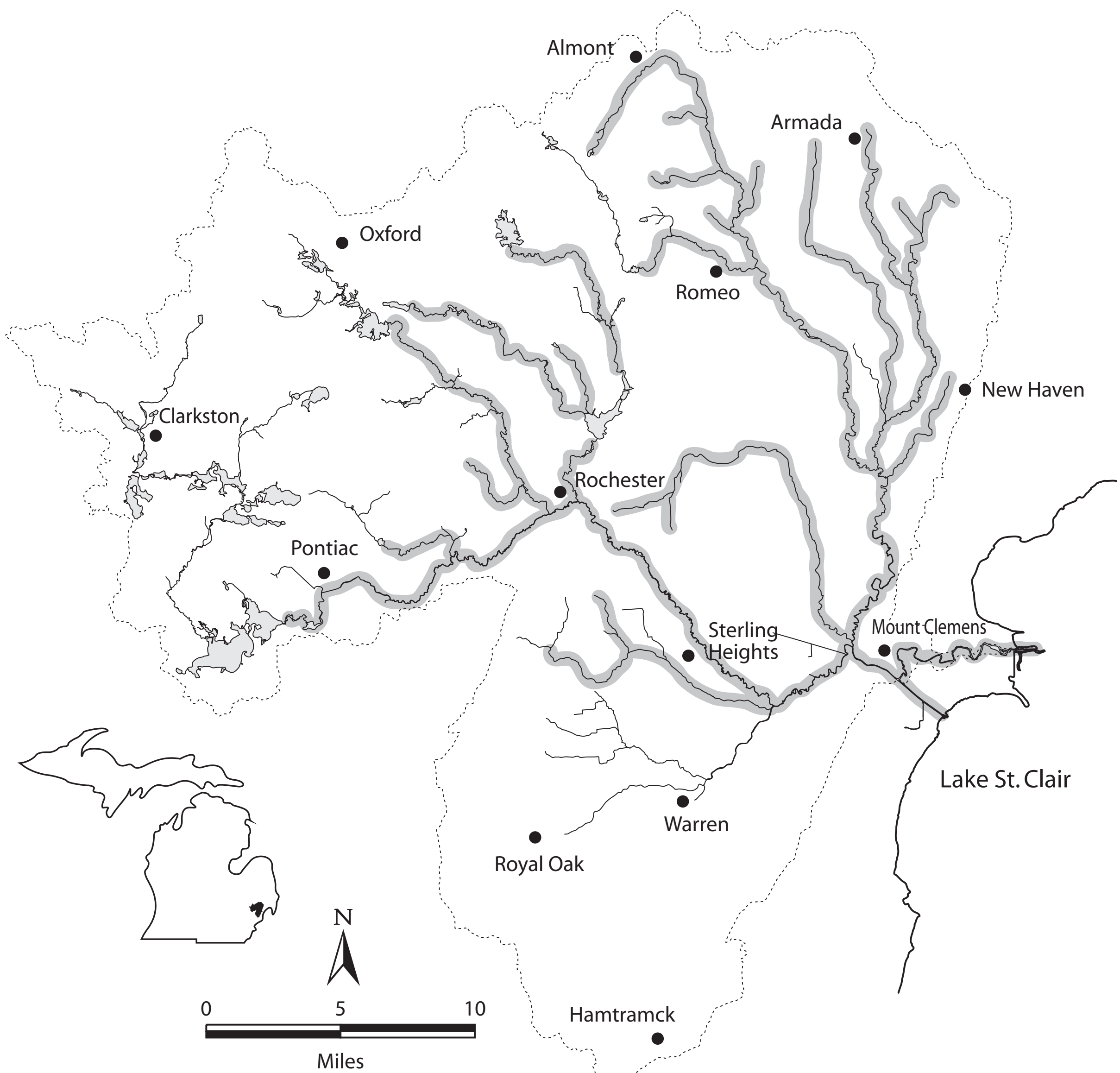


Central stoneroller *Campostoma anomalum*

Habitat:

feeding
- moderate to high gradients
- rocky riffles
- somewhat tolerant of turbidity
- riffles and adjacent pools of warm, clear, shallow streams
- gravel or cobble substrate

spawning
- riffles, nest with a deep pool or bank overhang

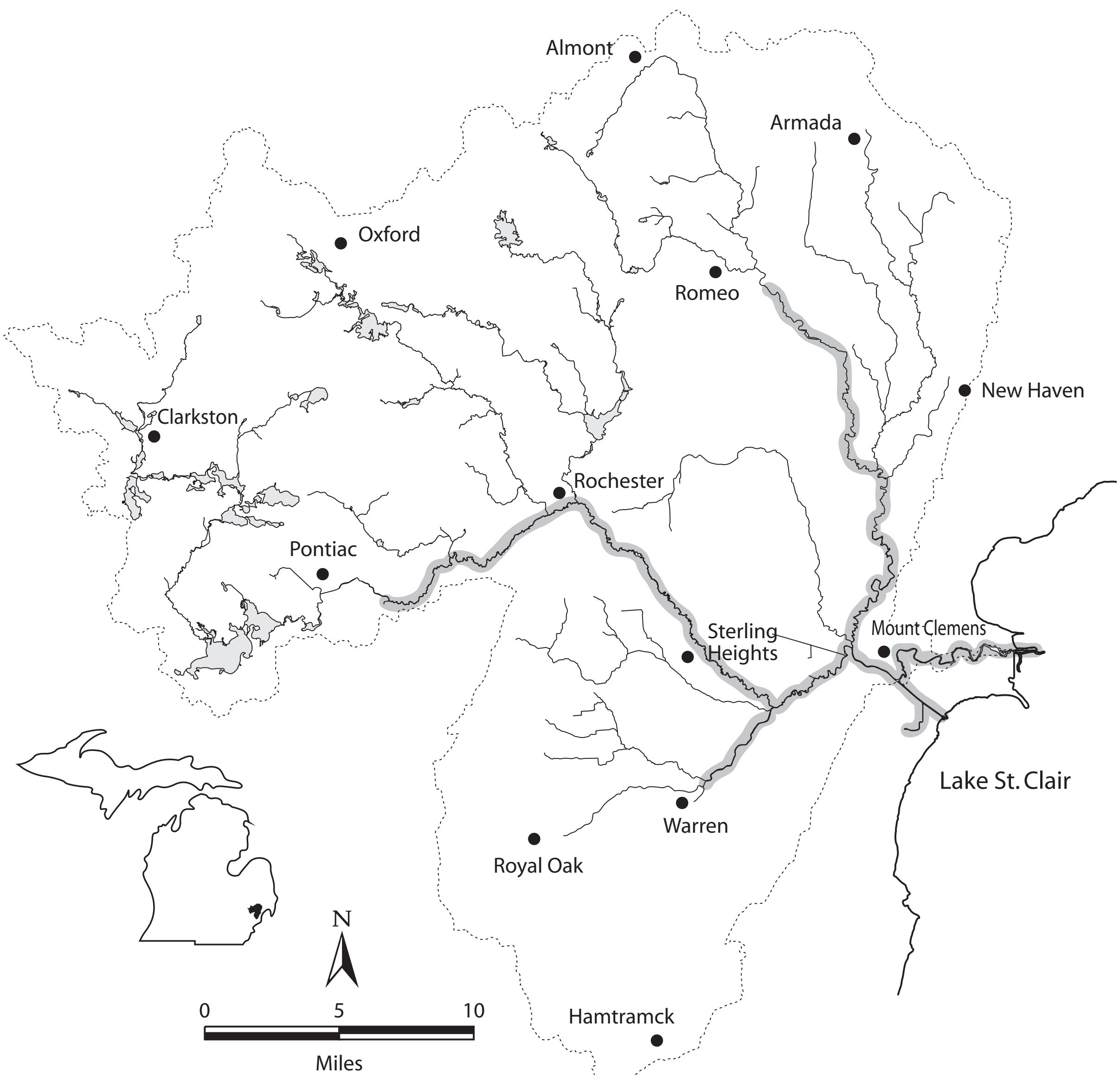


Goldfish *Carassius auratus*

Habitat:

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

spawning - warm, weedy shallows

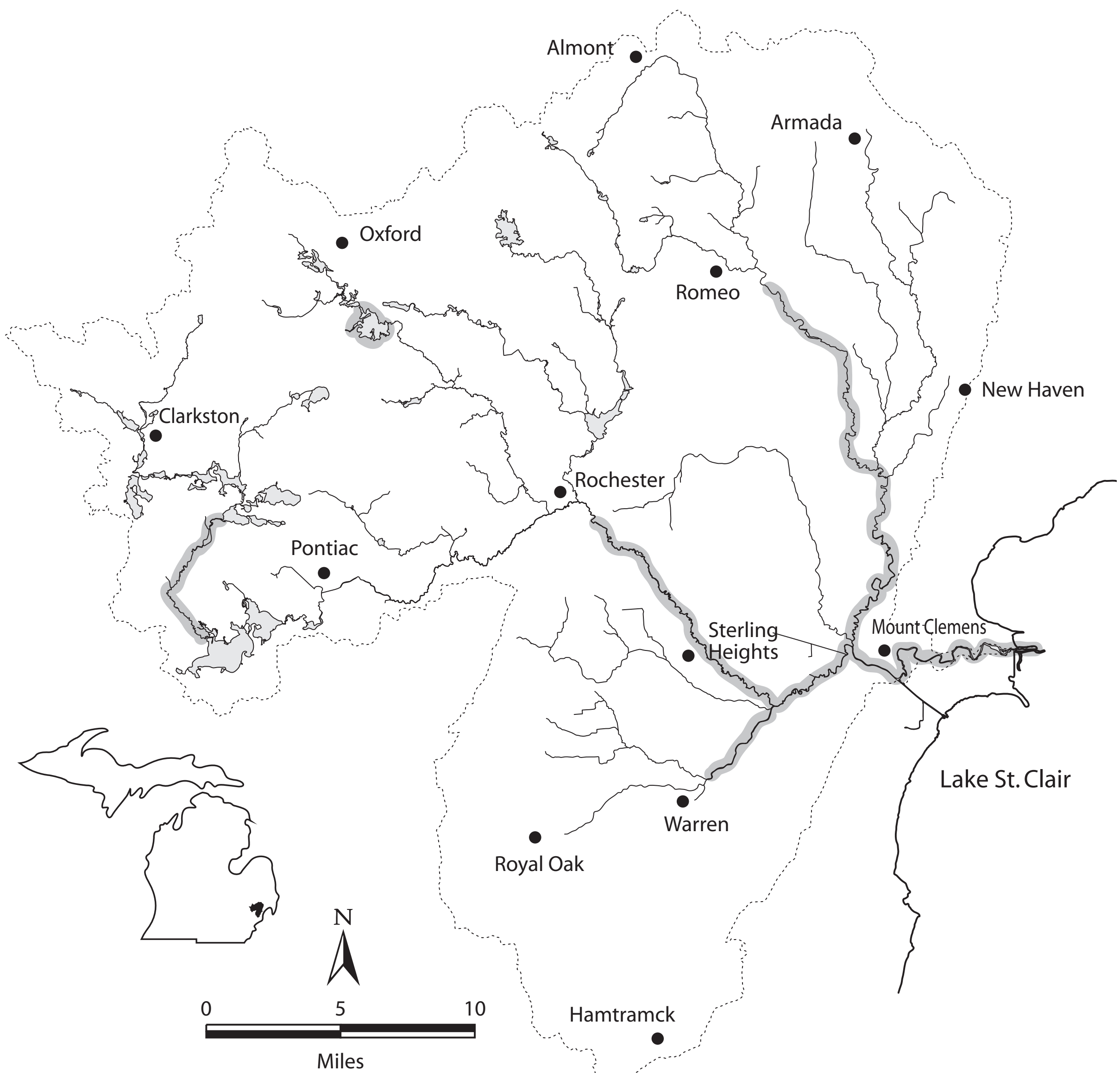


Spotfin shiner *Cyprinella spiloptera*

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

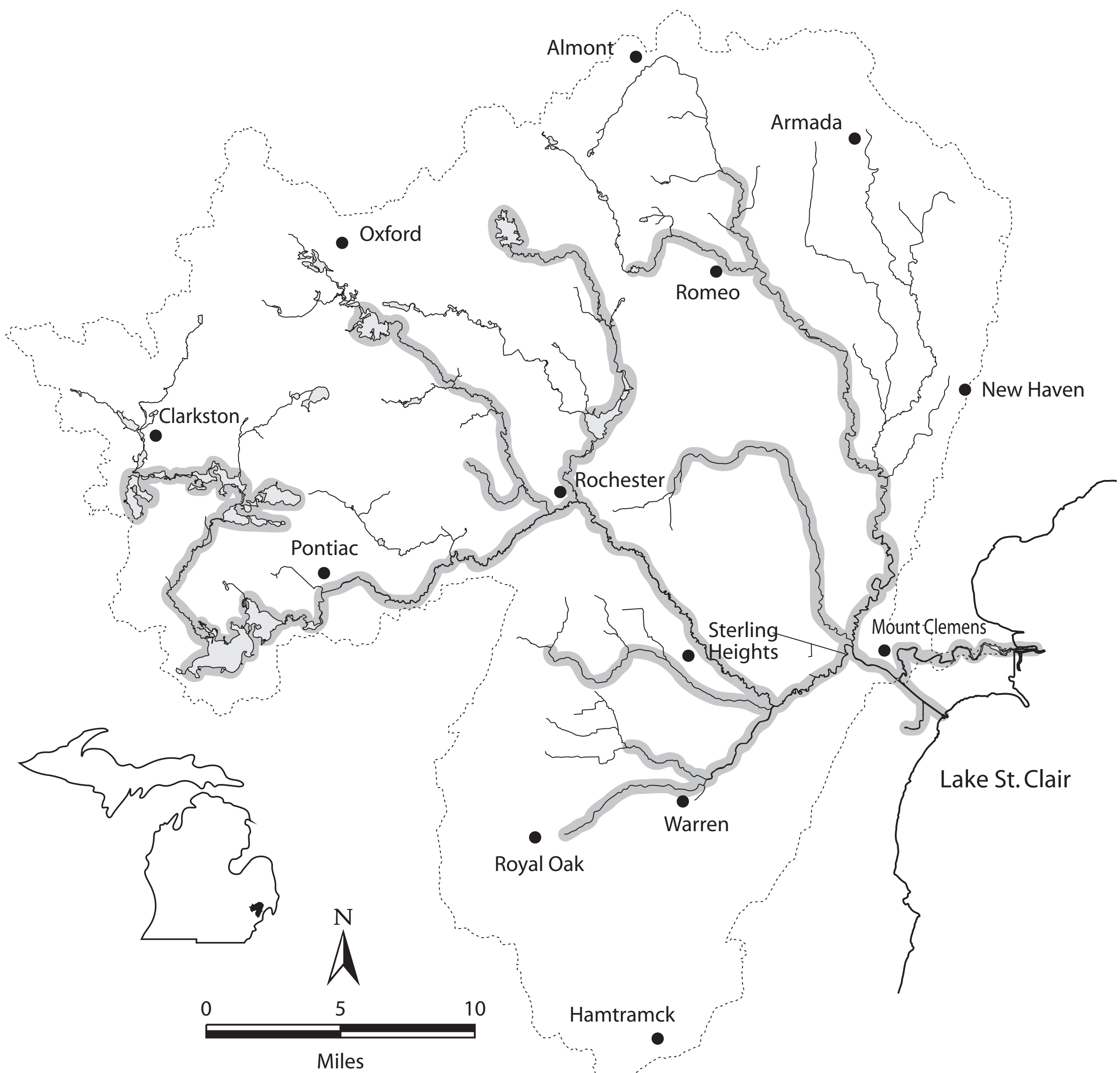


Common carp *Cyprinus carpio*

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

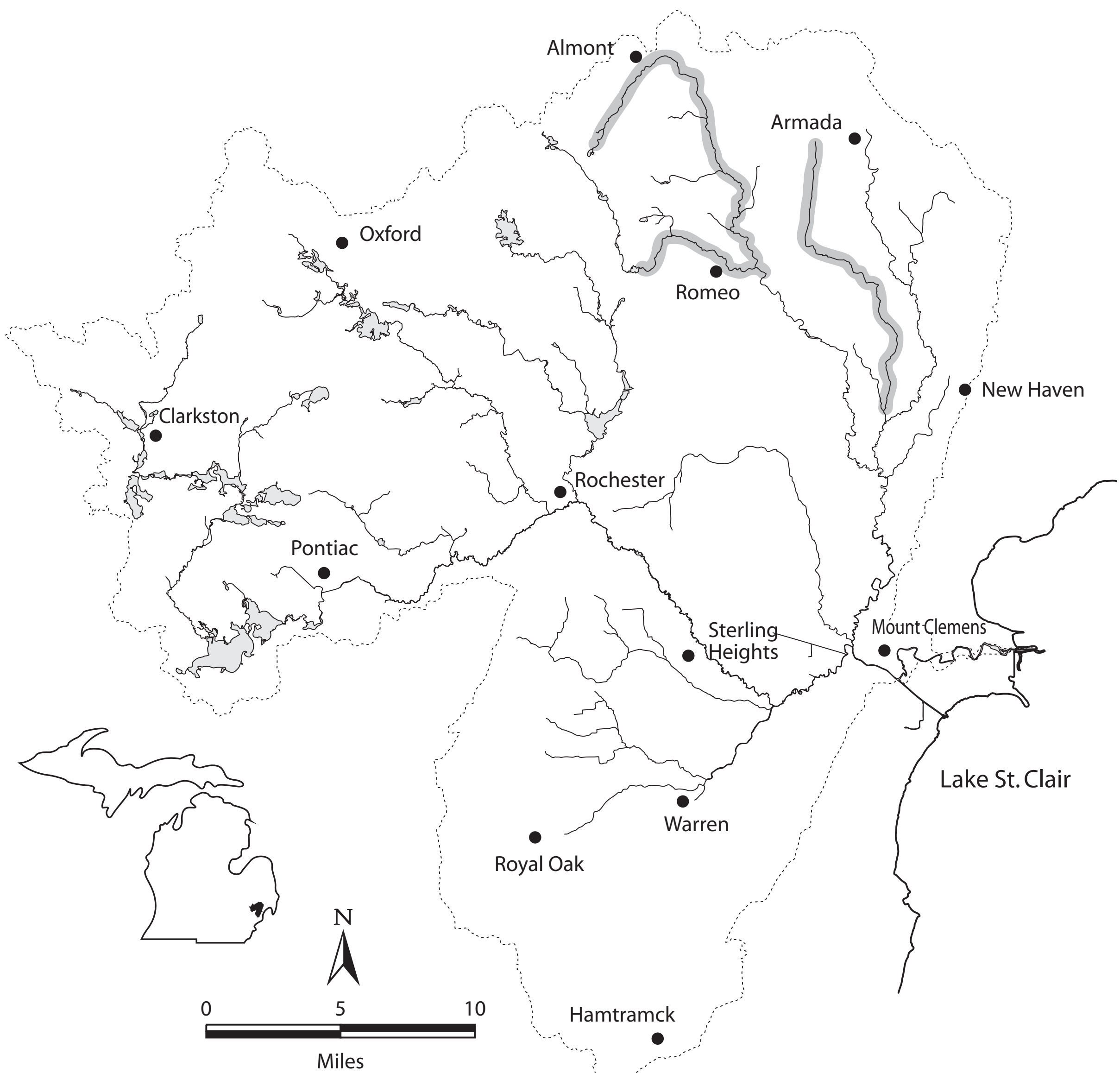
spawning - weedy or grassy shallows



Brassy minnow *Hybognathus hankinsoni*

Habitat:

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



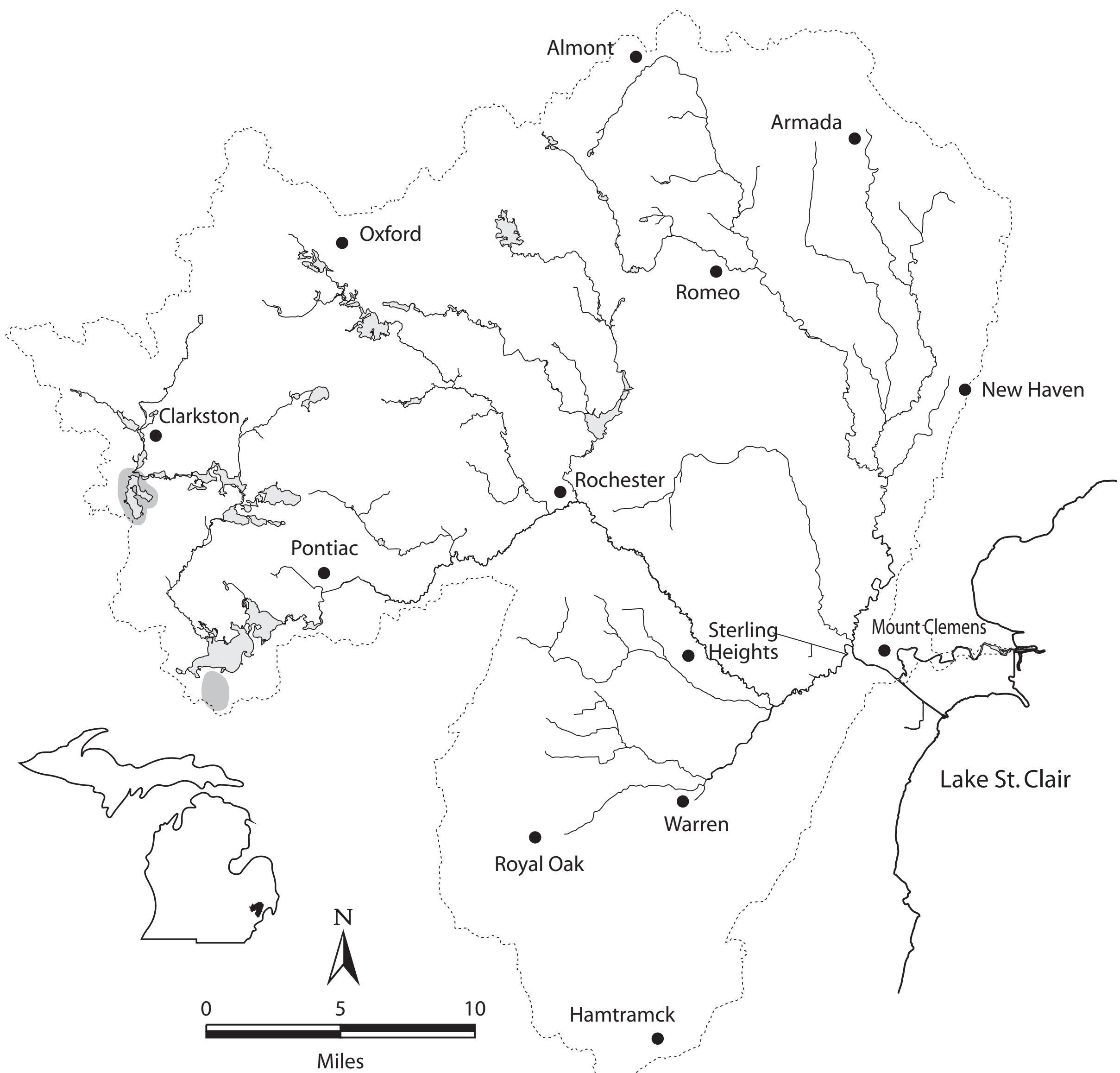
Striped shiner *Luxilus chrysocephalus*

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

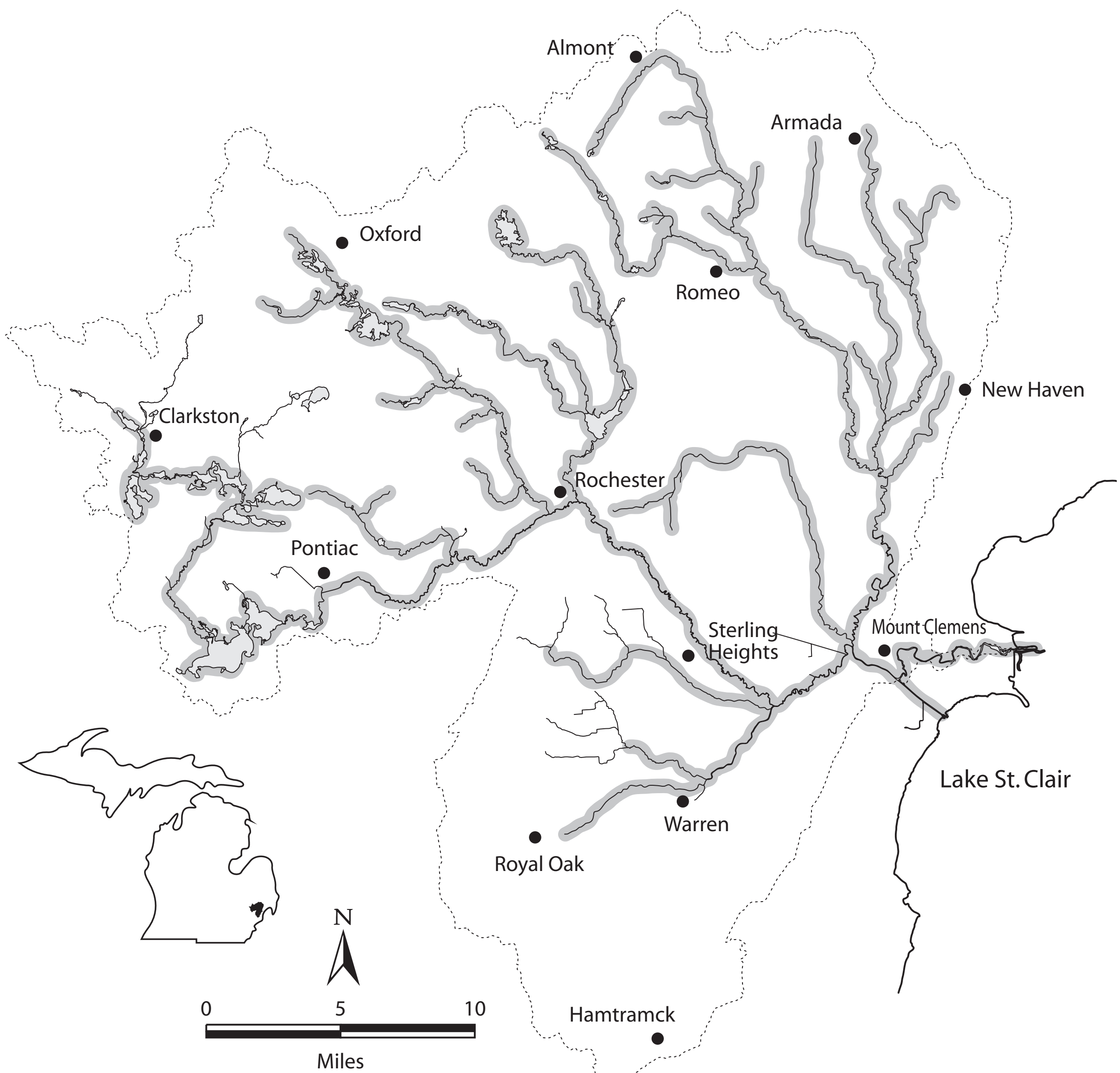


Common shiner *Luxilus cornutus*

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

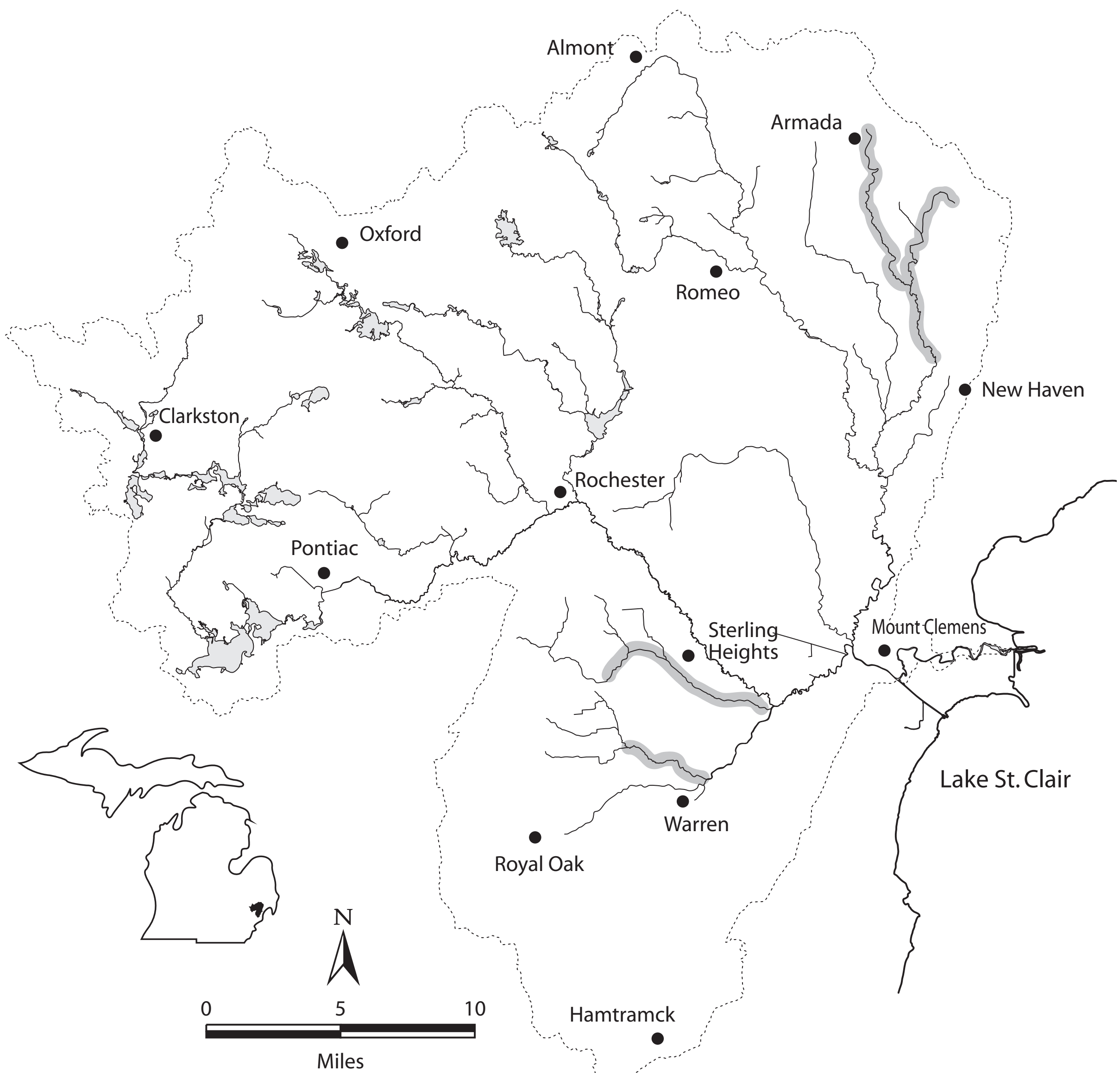


Redfin shiner *Lythrurus umbratilis*

Habitat:

feeding - clear, quiet warm rivers in weedy pools
- little to no current
- abundant submerged and emergent vegetation

spawning - over sand and gravel substrate in slow moving sections of streams

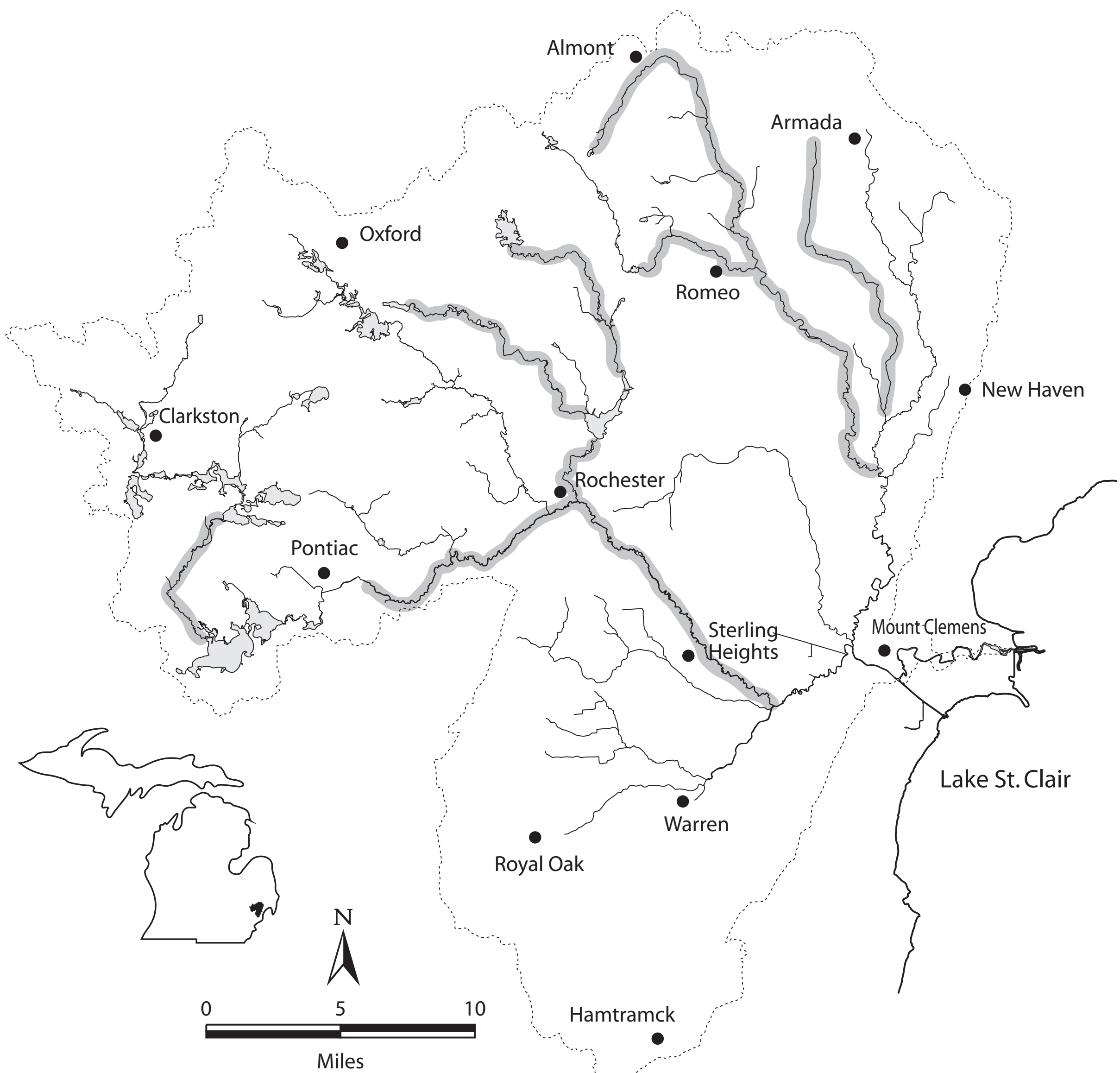


Hornyhead chub *Nocomis biguttatus*

Habitat:

feeding
- adults: near riffles
- young: near vegetation
- clear water, does not tolerate turbidity
- gravel substrate
- low gradient streams that are tributaries to large streams

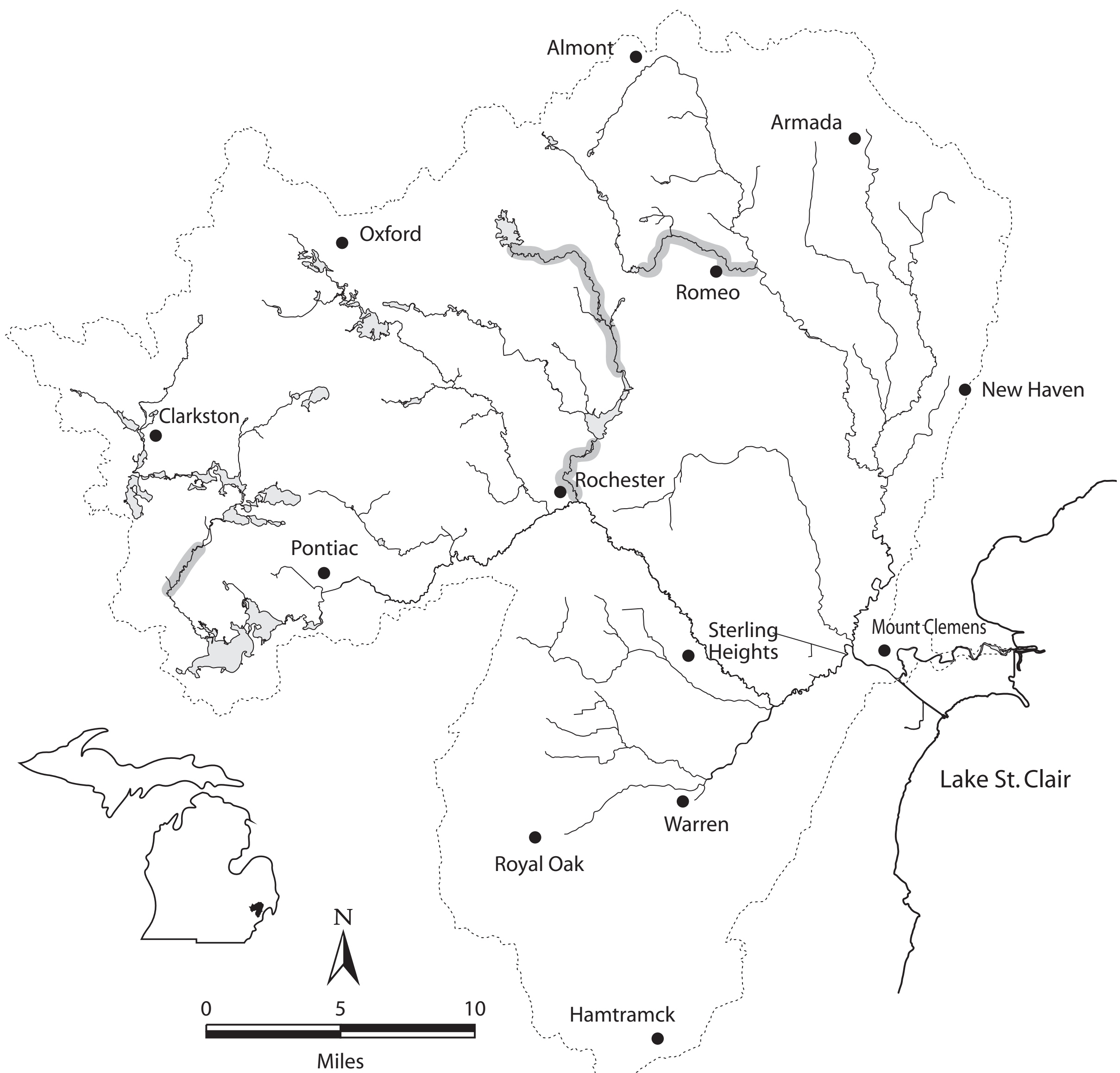
spawning
- large stones and pebbles present
- often below a riffle in shallow water
- gravel substrate



River chub *Nocomis micropogon*

Habitat:

feeding - moderate to large streams
- moderate to high gradient
- gravel, boulder, or bedrock substrate
- little to no aquatic vegetation
- cannot tolerate turbidity or siltation

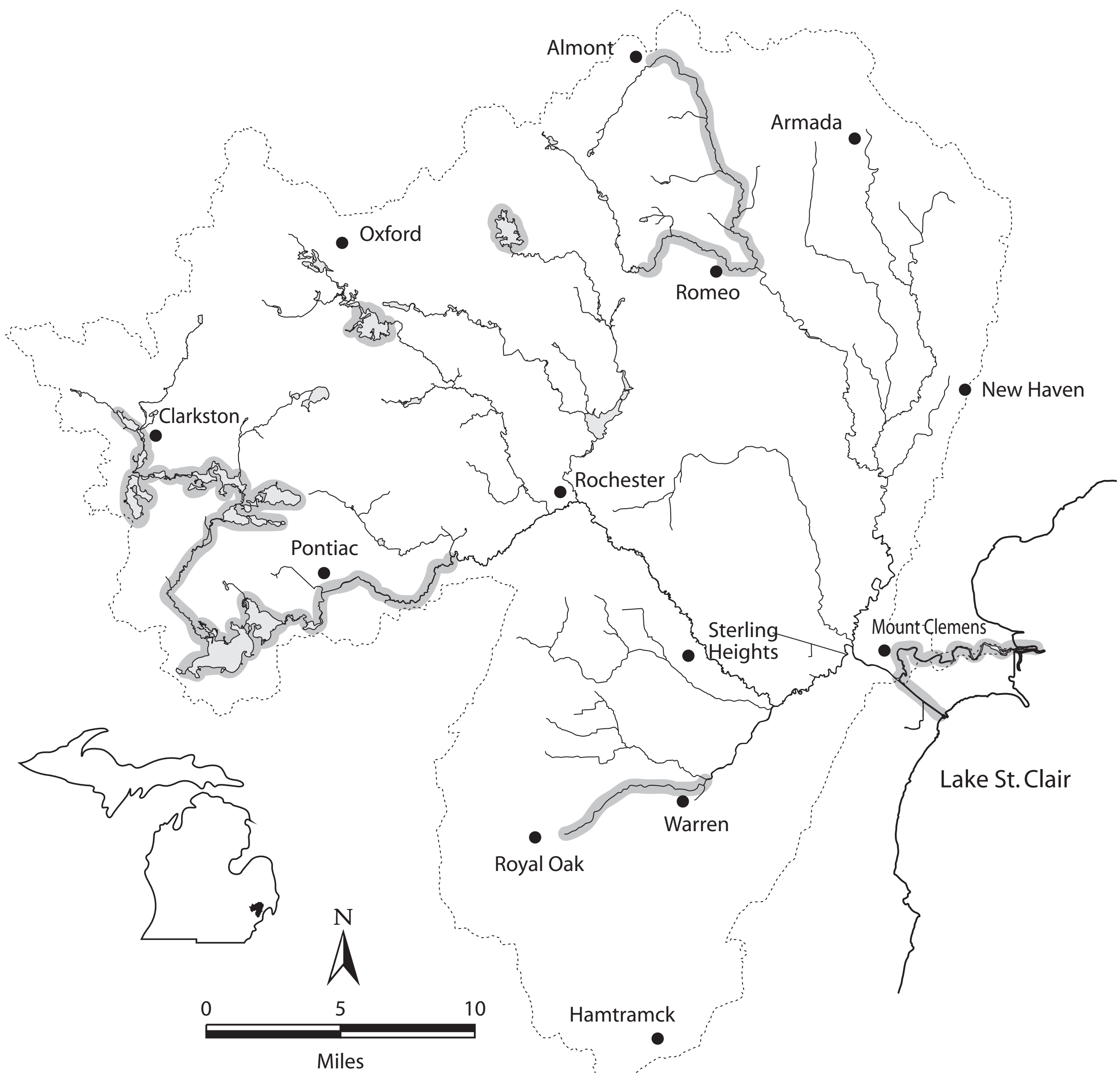


Golden shiner *Notemigonus crysoleucas*

Habitat:

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

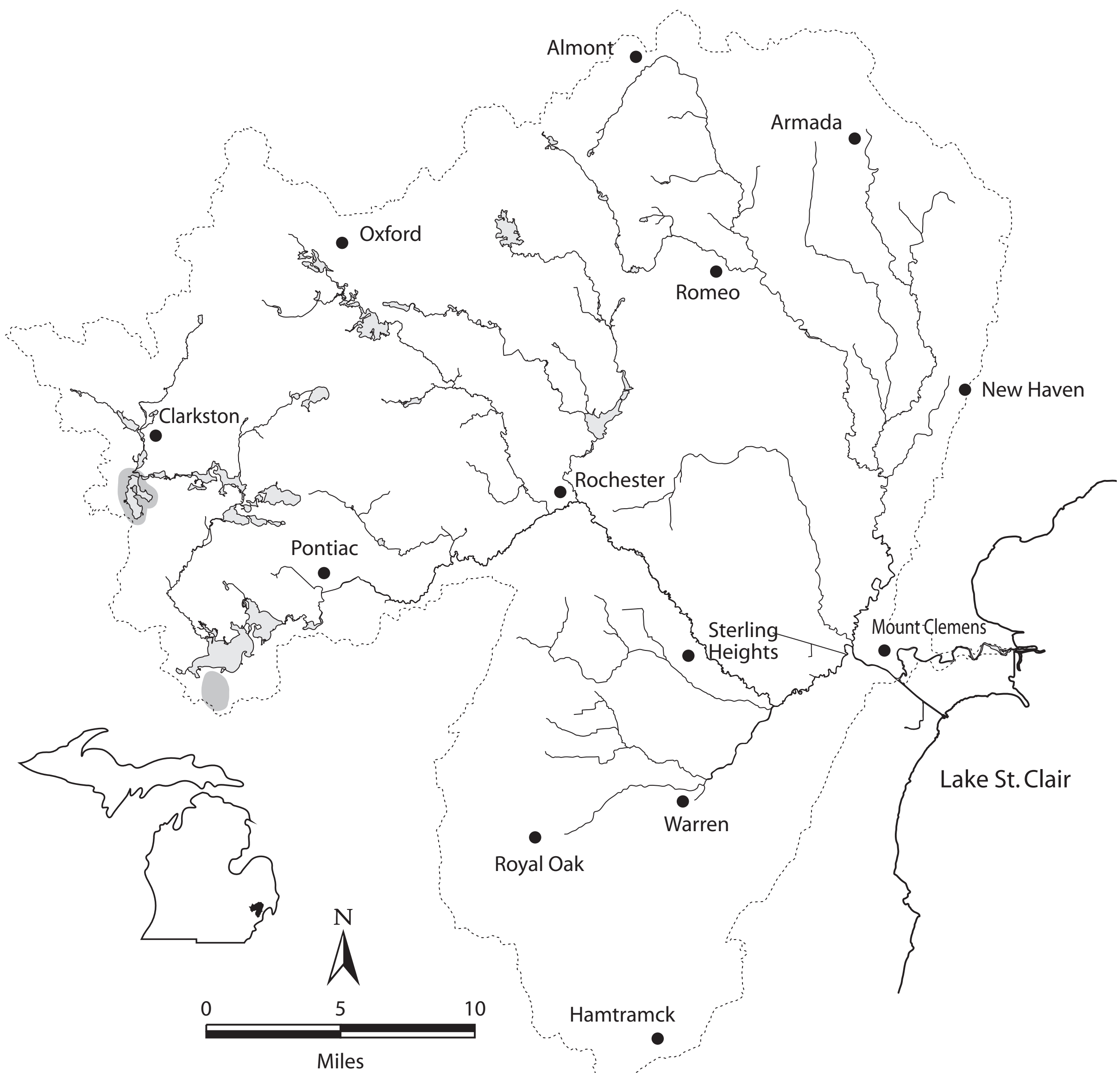
spawning - vegetation



Pugnose shiner *Notropis anogenus*

Habitat:

feeding - very clear water of lakes, impoundments, and low-gradient streams
- aquatic vegetation
- clean sand, marl, or organic debris substrate
- extremely intolerant of turbidity

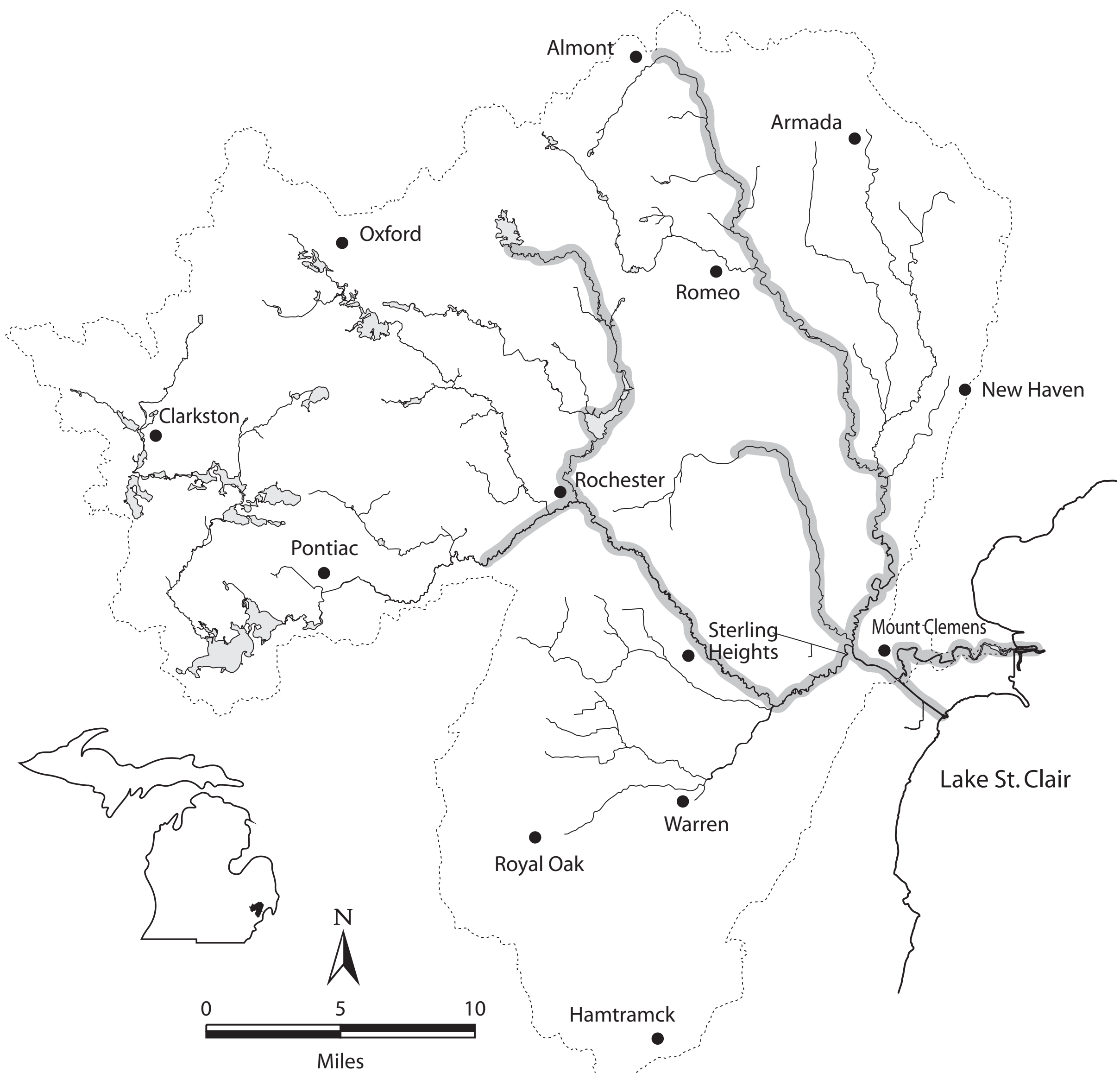


Emerald shiner *Notropis atherinoides*

Habitat:

feeding
- open-large stream channels and lake
- low to moderate gradient
- range of turbidities and bottom types
- midwater or surface preferred, substrate of little importance
- avoids rooted vegetation

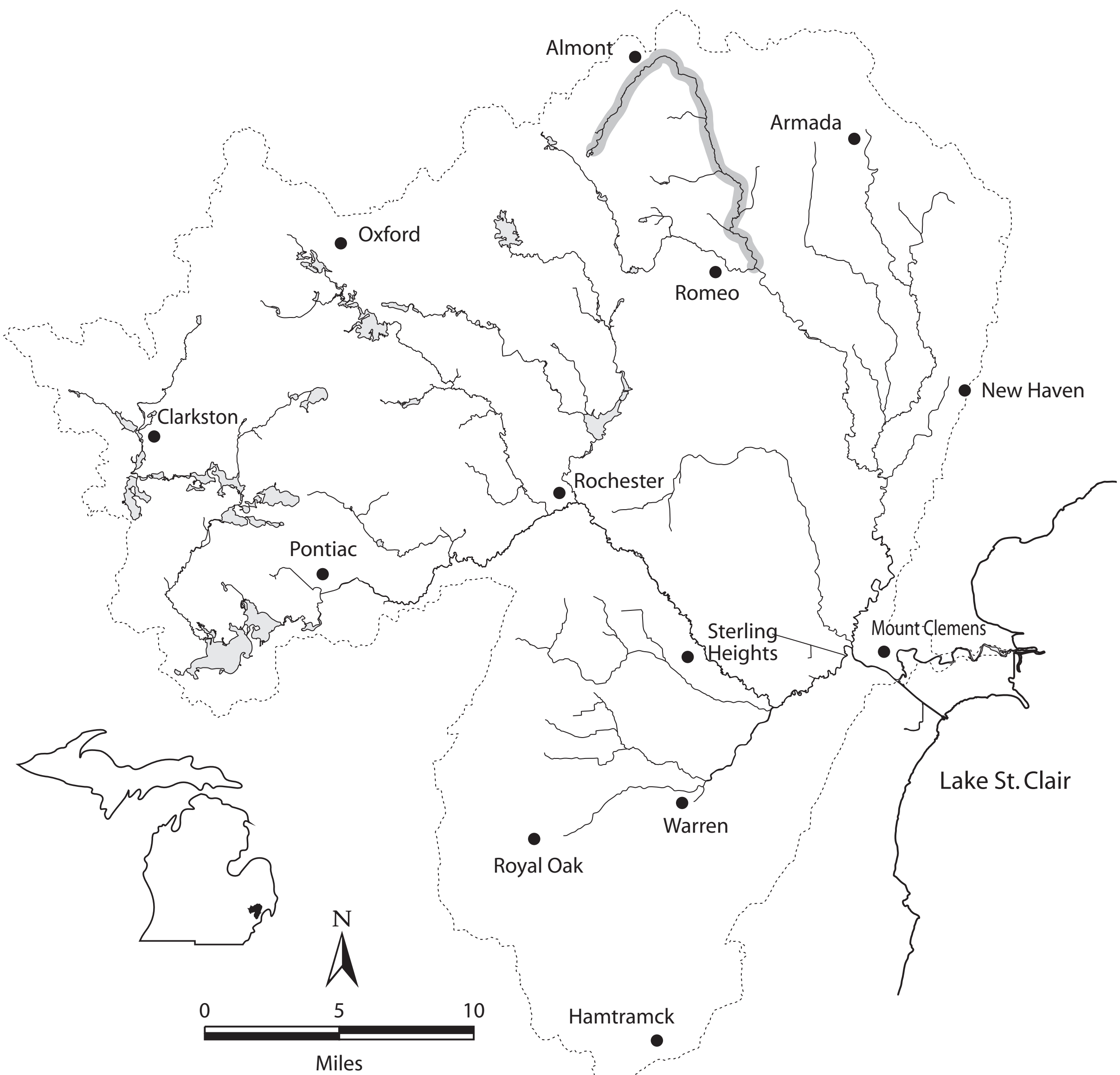
spawning
- sand or firm mud substrate or gravel shoals



Bigmouth shiner *Notropis dorsalis*

Habitat:

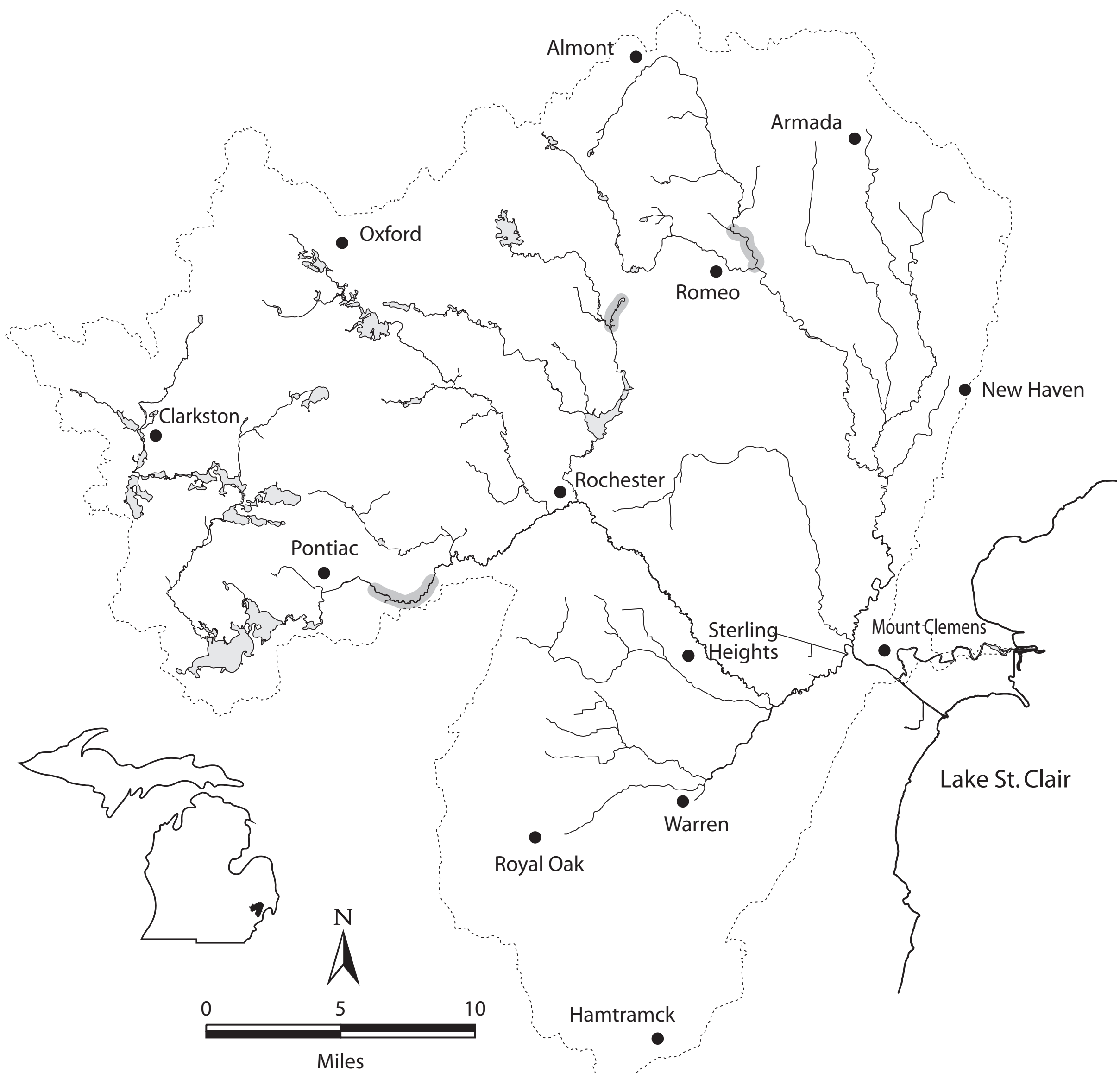
feeding
- small clear streams
- good flows
- sand or gravel substrate
- open water, free from vegetation



Blackchin shiner *Notropis heterodon*

Habitat:

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

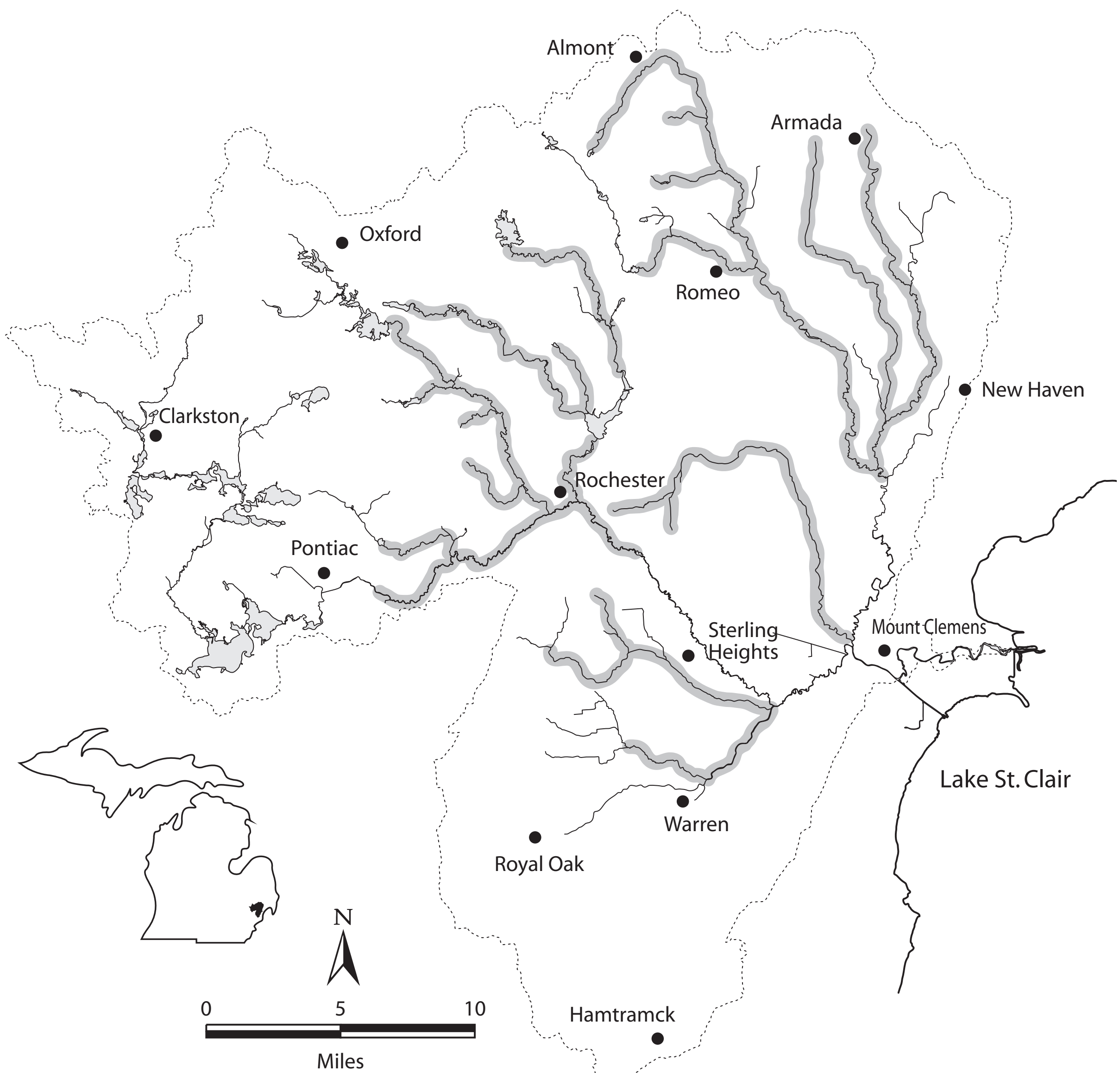


Blacknose shiner *Notropis heterolepis*

Habitat:

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

spawning
- sandy substrate

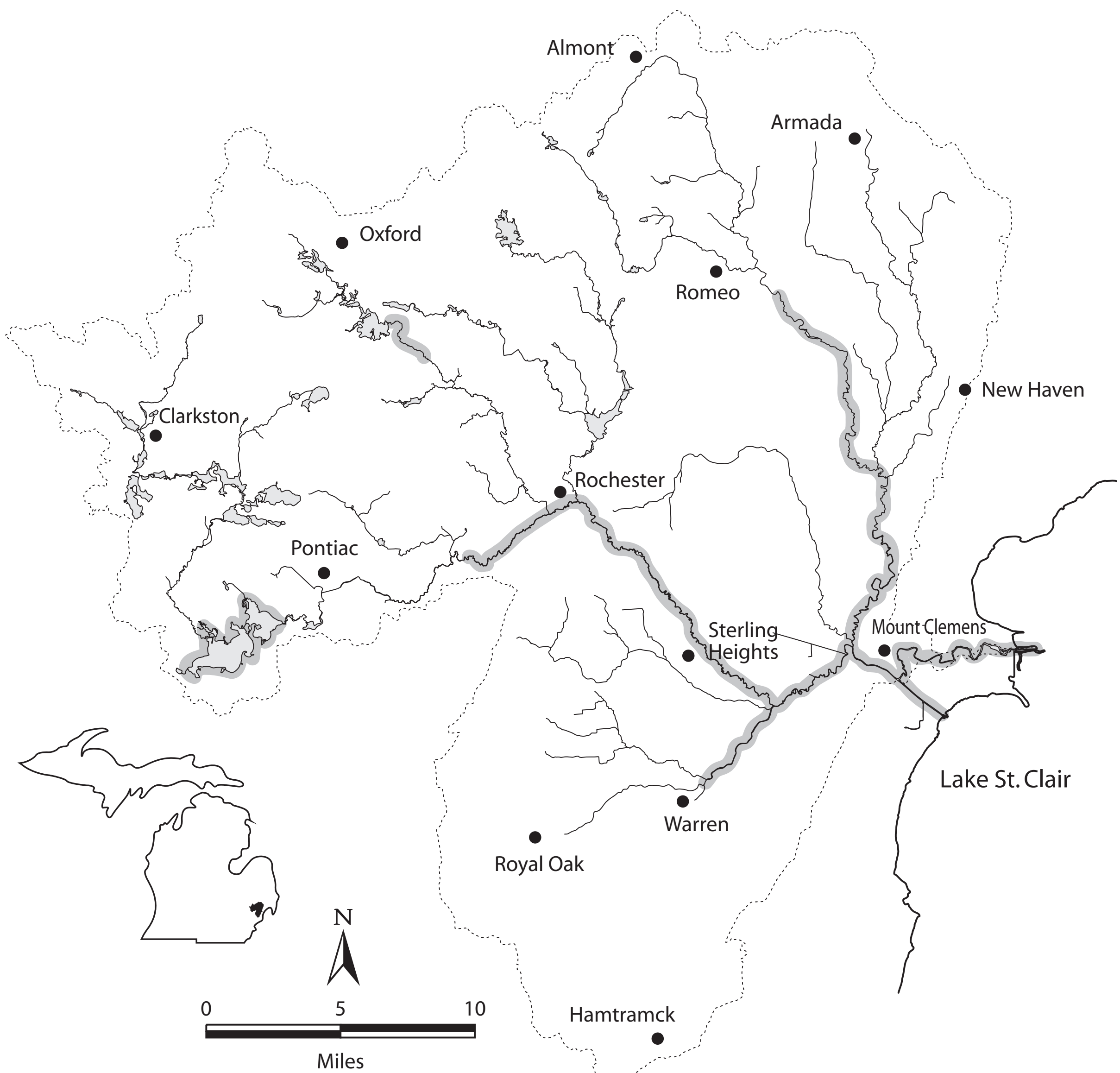


Spottail shiner *Notropis hudsonius*

Habitat:

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

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

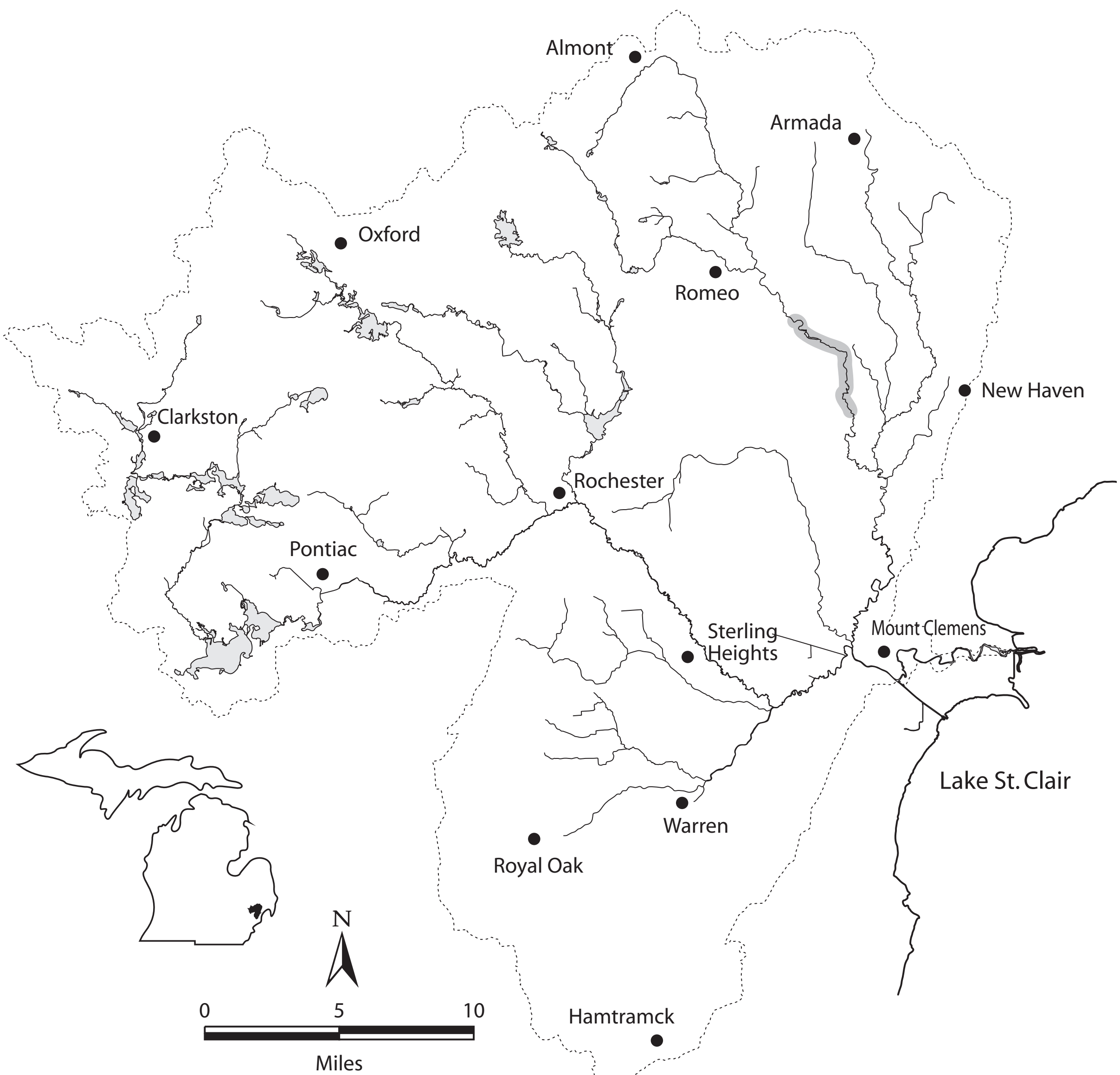


Rosyface shiner *Notropis rubellus*

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 hornyhead chub, chestnut lamprey, and redhorses
- sandy-gravel, gravel or bedrock substrate
- shallow high gradient water

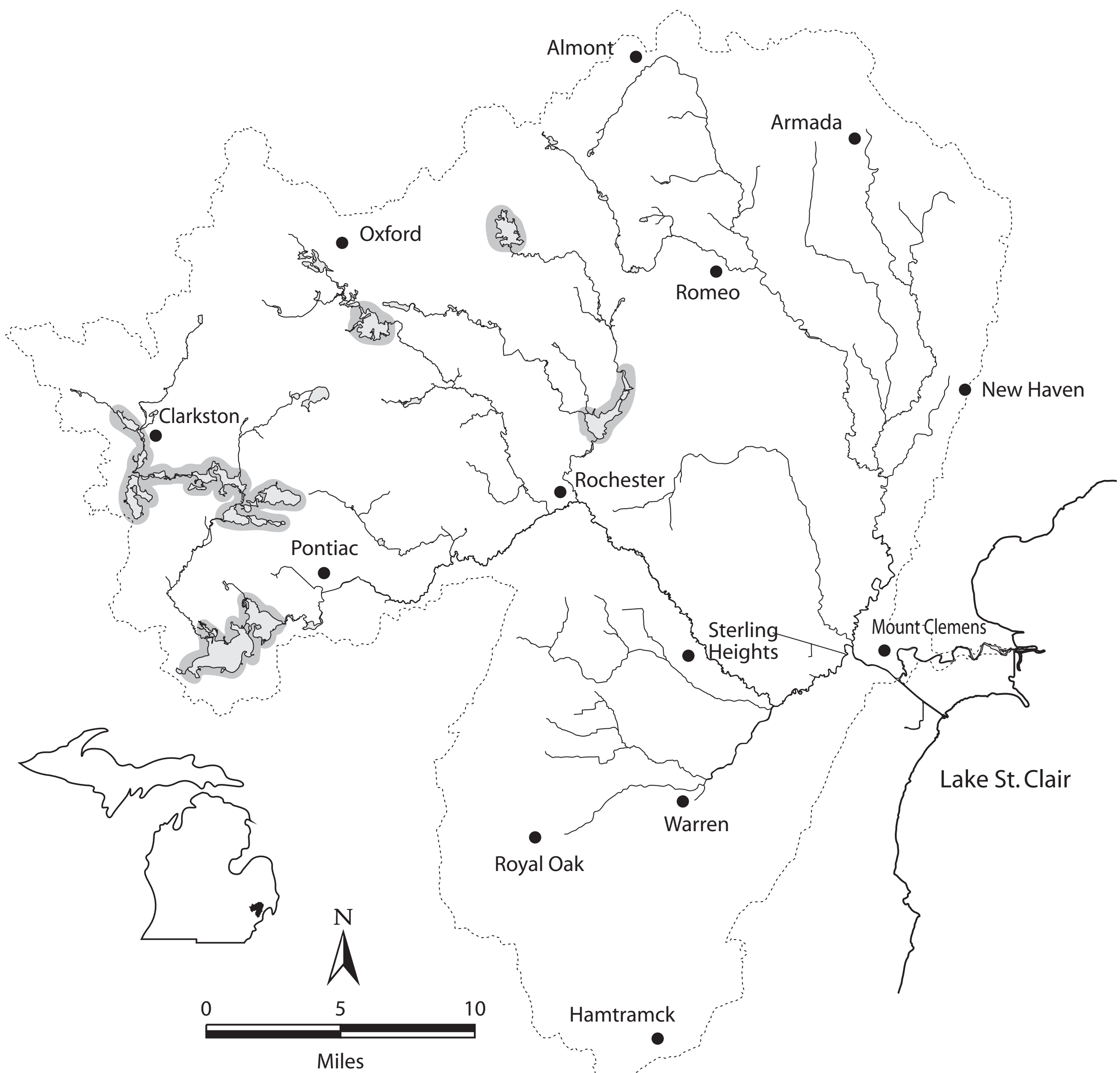


Sand shiner *Notropis stramineus*

Habitat:

feeding - sand and gravel substrate
- shallow pools in medium size streams, lakes, and impoundments
- clear water and low gradient
- rooted aquatic vegetation preferred
- tolerant of some inorganic pollutants provided substrate is not covered

spawning - clean gravel or sand substrate

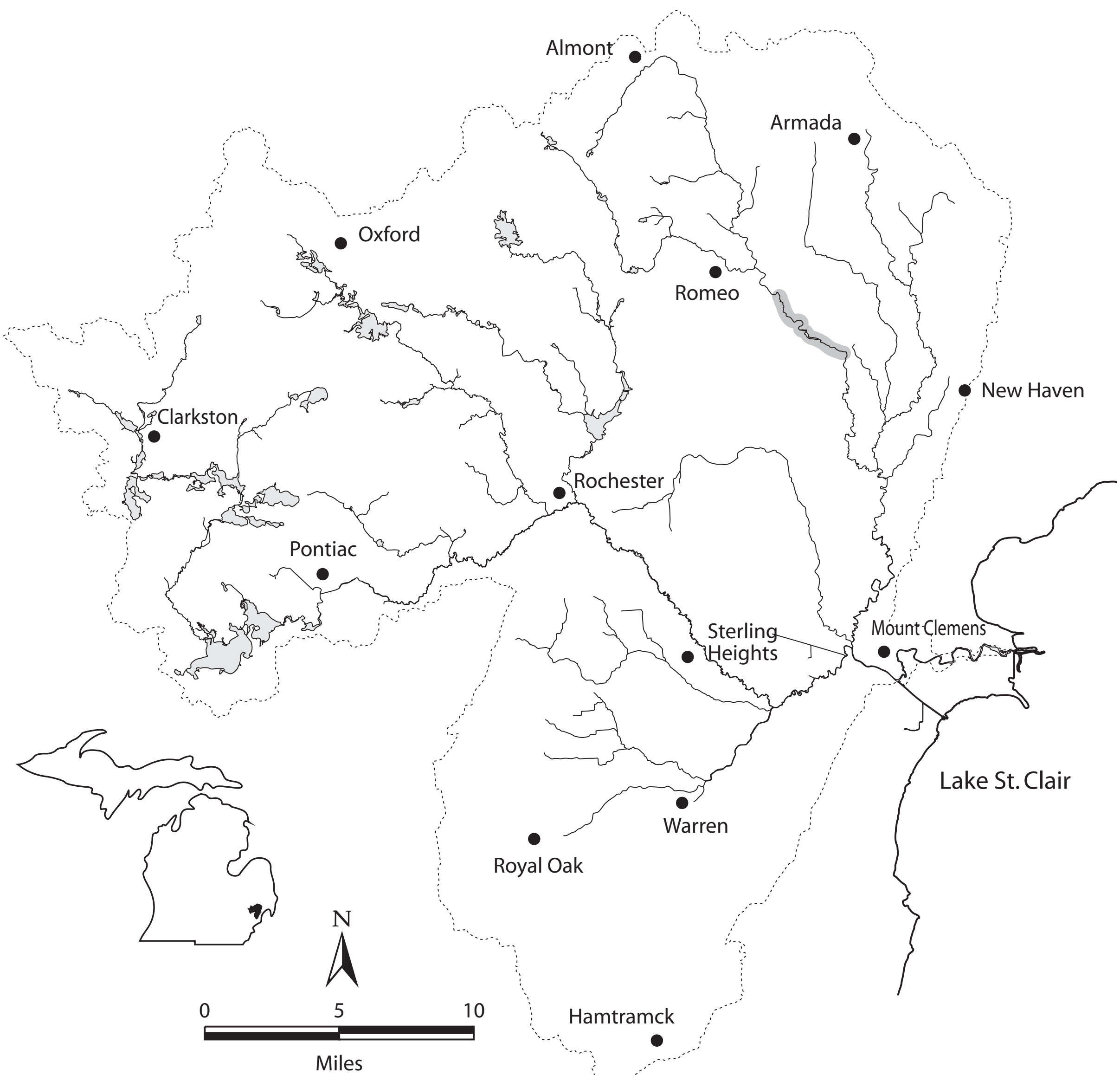


Mimic shiner *Notropis volucellus*

Habitat:

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

spawning - aquatic vegetation necessary

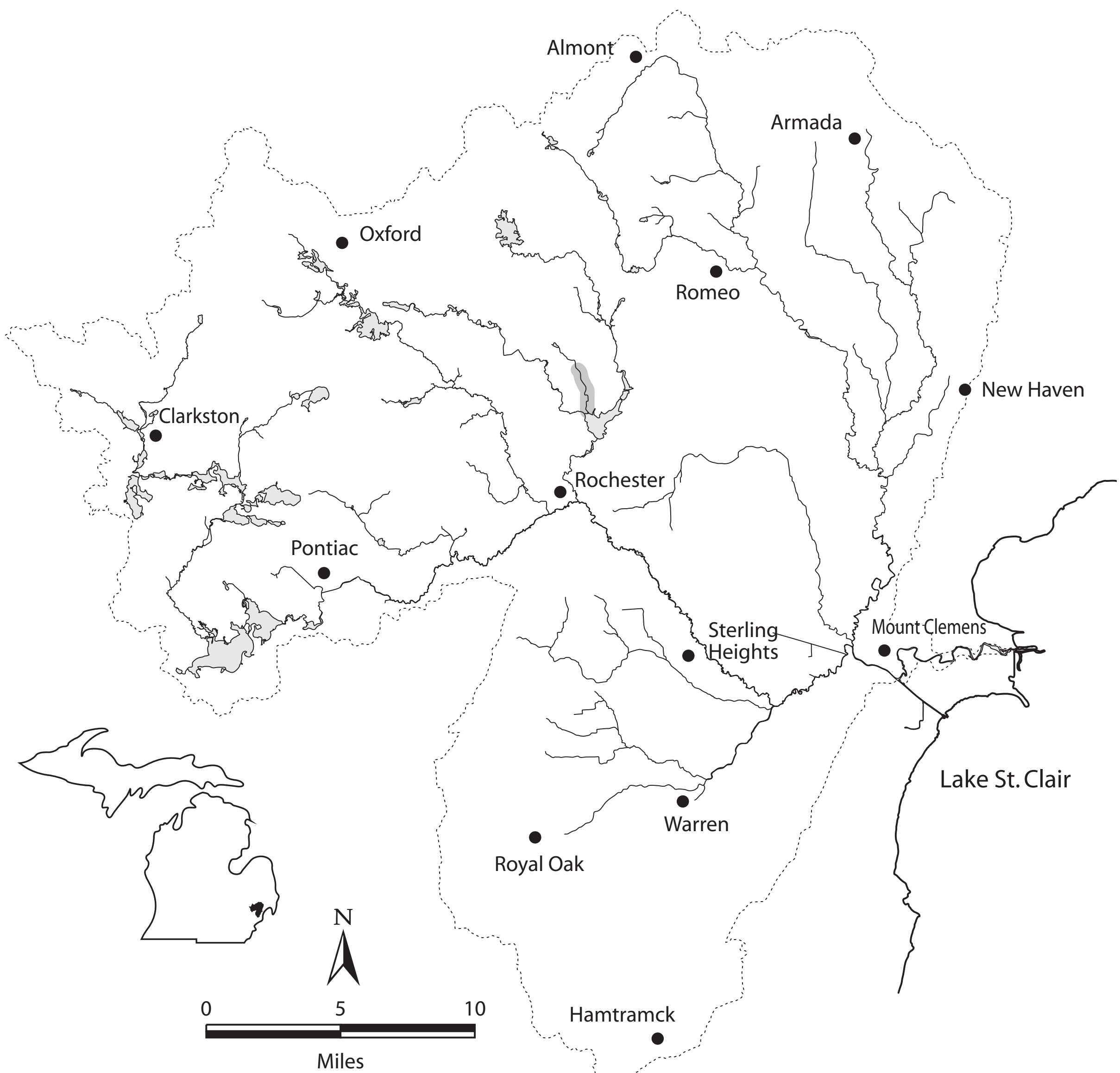


Northern redbelly dace *Phoxinus eos*

Habitat:

feeding - slow current
- in boggy lakes and streams
- detritus or silt substrate
- clear to slightly turbid water

spawning - filamentous algae needed for egg deposition

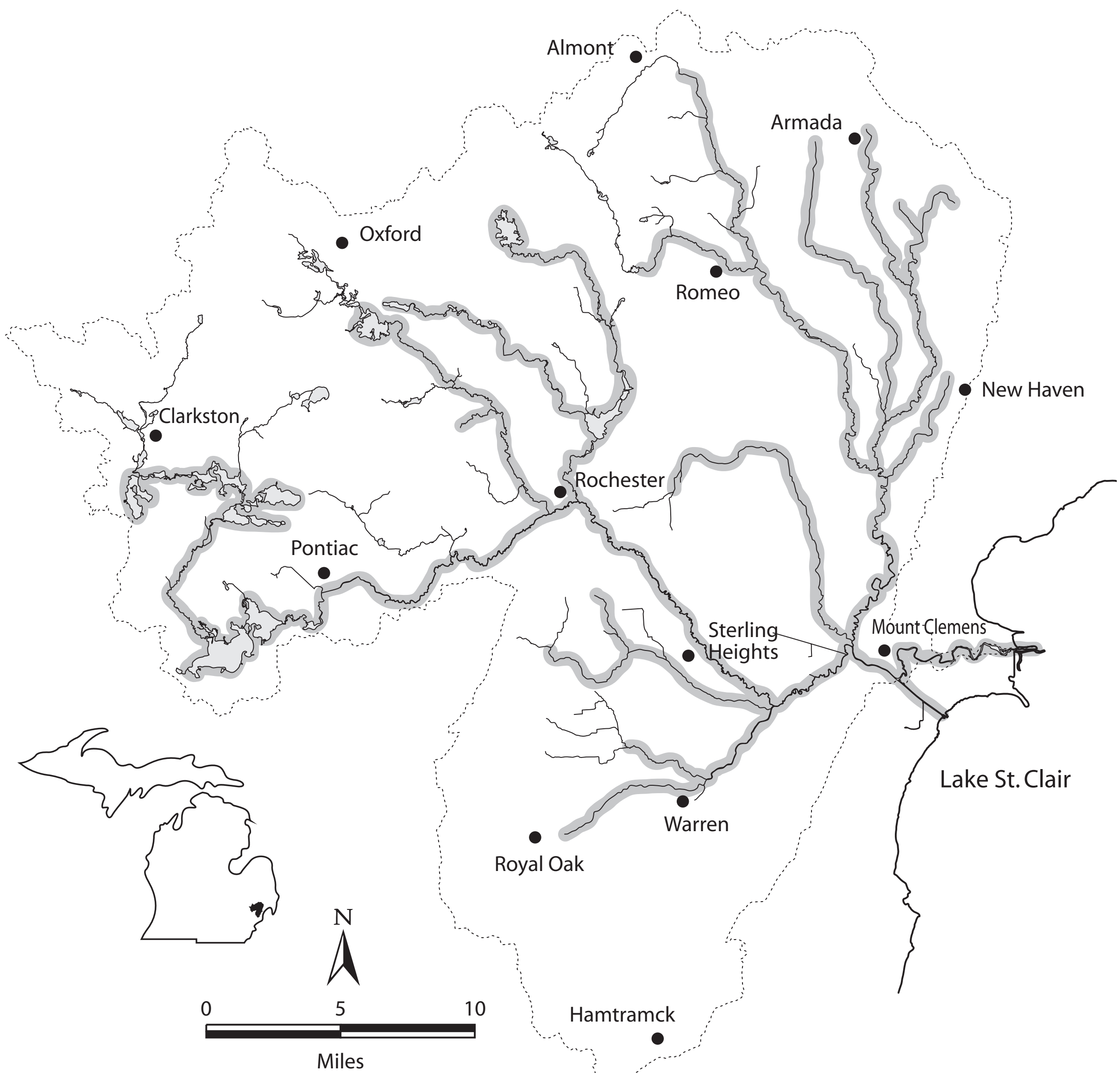


Bluntnose minnow *Pimephales notatus*

Habitat:

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

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

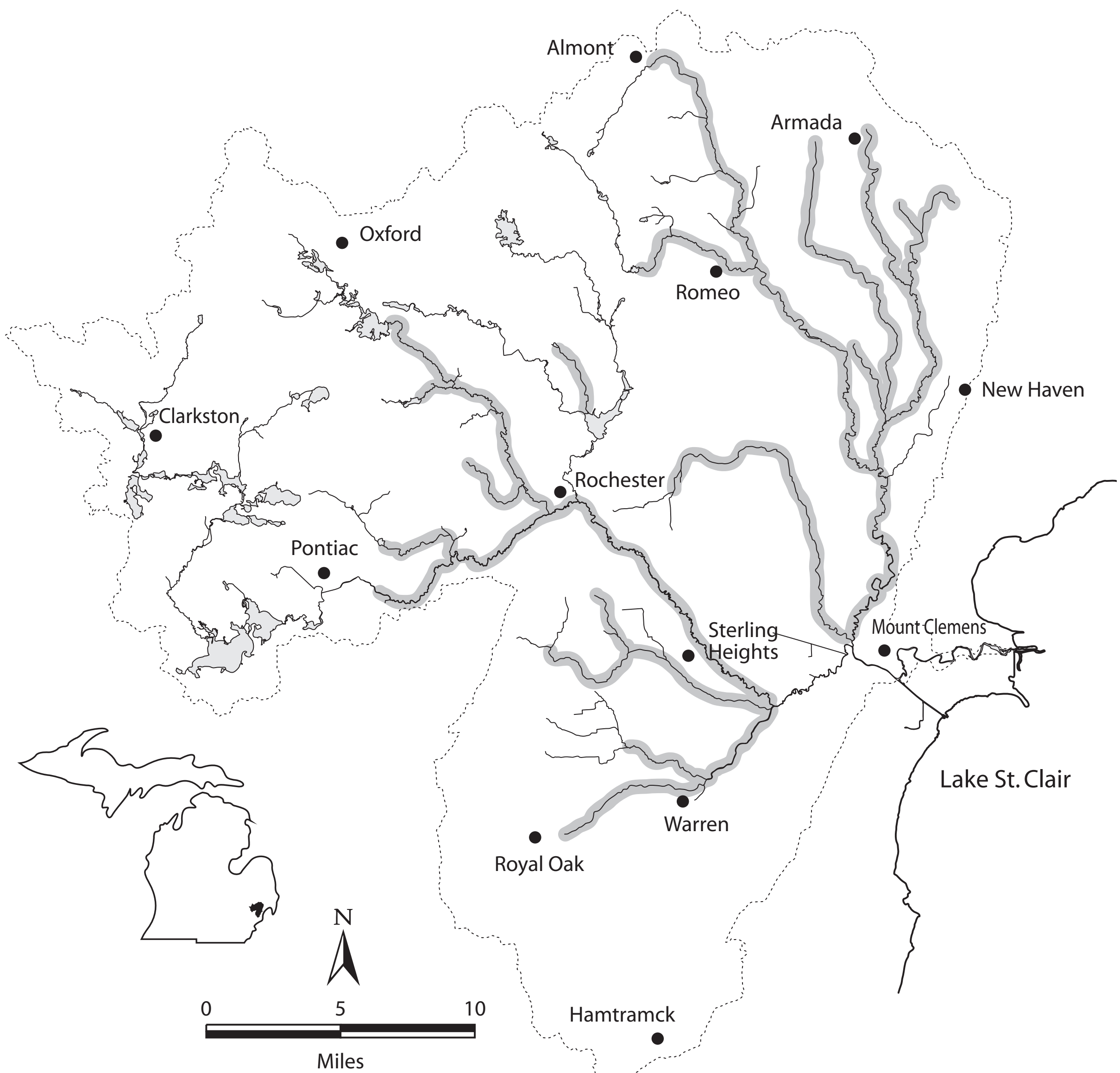


Fathead minnow *Pimephales promelas*

Habitat:

feeding - pools of small streams, lakes, and impoundments
- tolerant of turbidity, high temperatures, and low oxygen

spawning - on underside of objects in water 2 to 3 feet deep
- prefer sand, marl, or gravel substrate



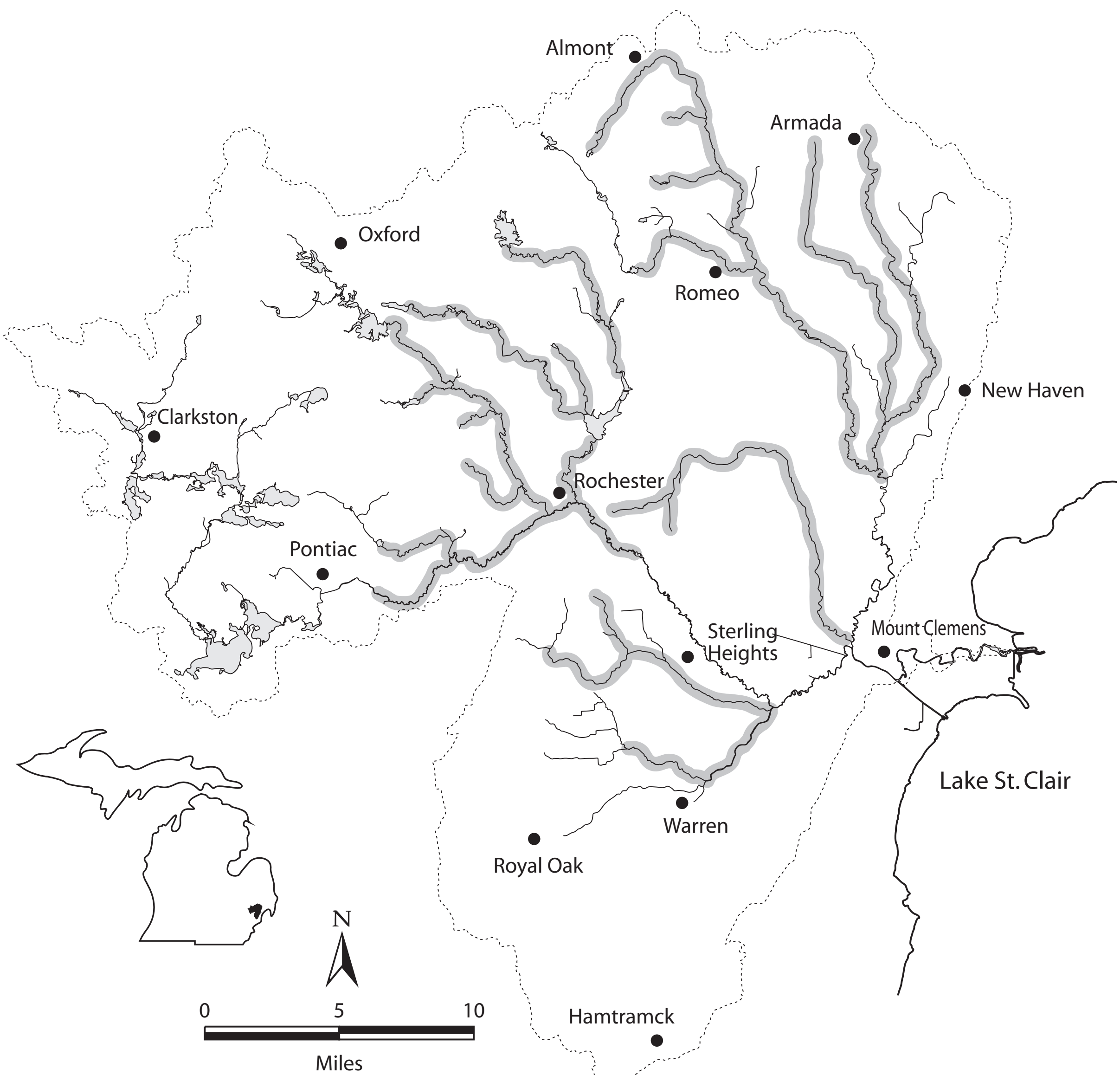
Western blacknose dace *Rhinichthys obtusus*

Habitat:

feeding - moderate to high gradient streams
- sand and gravel substrate
- clear cool water in pools with deep holes and undercut banks
- does not tolerate turbidity and silt well

spawning - riffles with gravel substrate and fast current

winter refuge - larger waters



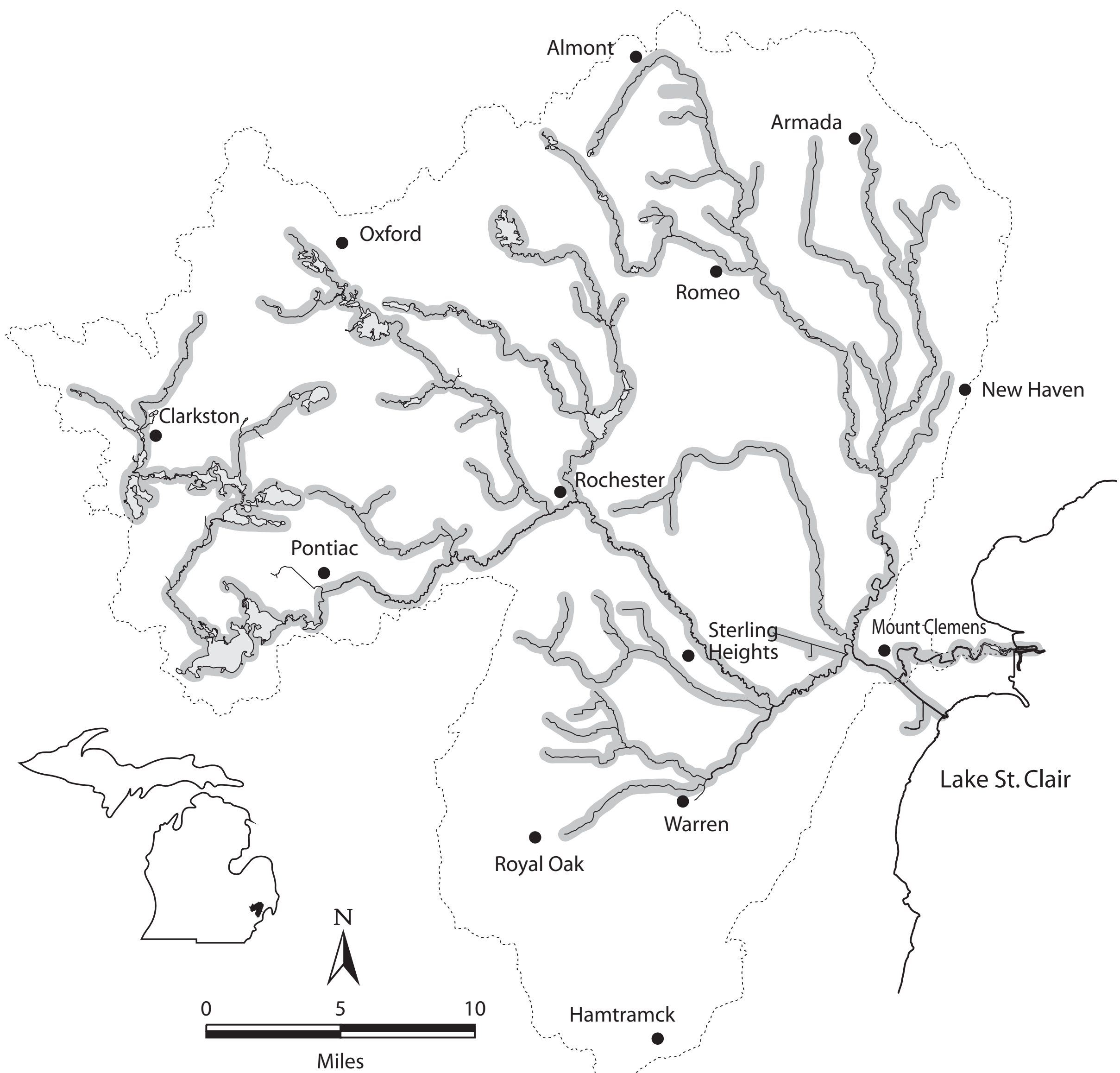
Creek chub *Semotilus atromaculatus*

Habitat:

feeding - streams, rivers, or shore waters of lakes and impoundments
- can tolerate intermittent flows
- tolerates moderate turbidity

spawning - gravel nests
- low current

winter refuge - deeper pools and runs

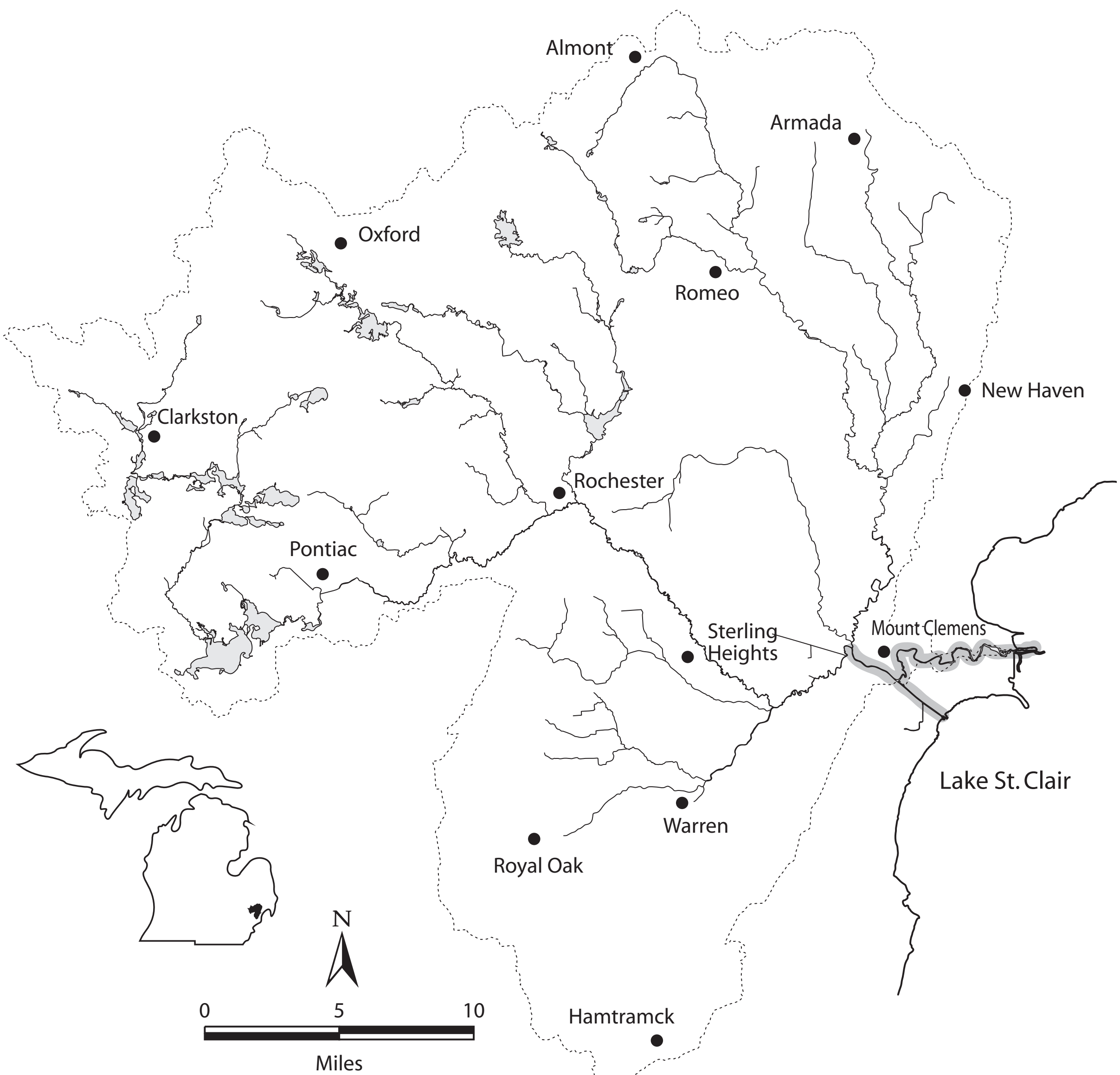


Quillback *Carpoides cyprinus*

Habitat:

feeding
- clear to turbid water
- Lake St. Clair
- 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

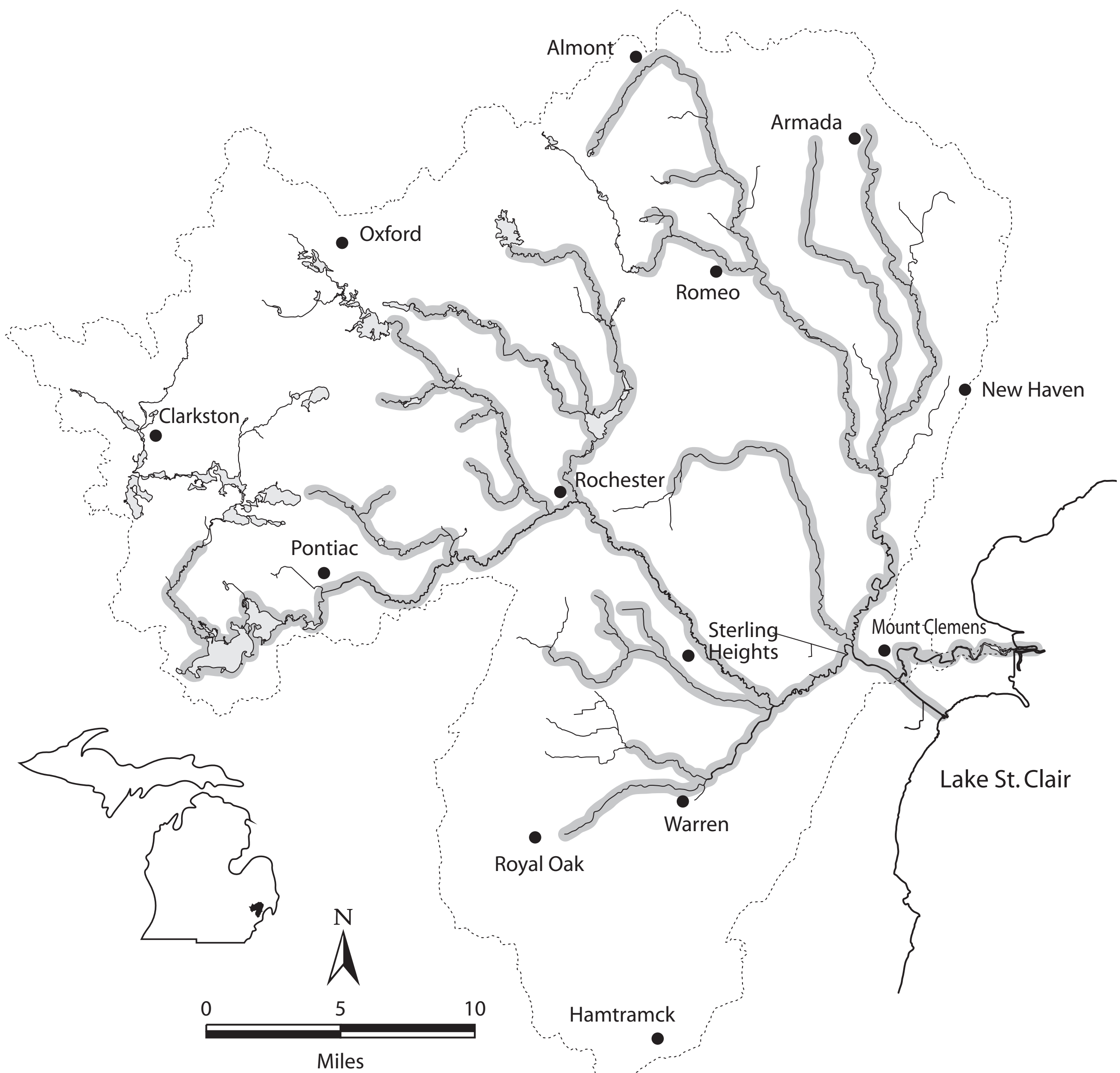


White sucker *Catostomus commersonii*

Habitat:

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

spawning - quiet gravelly shallow areas of streams

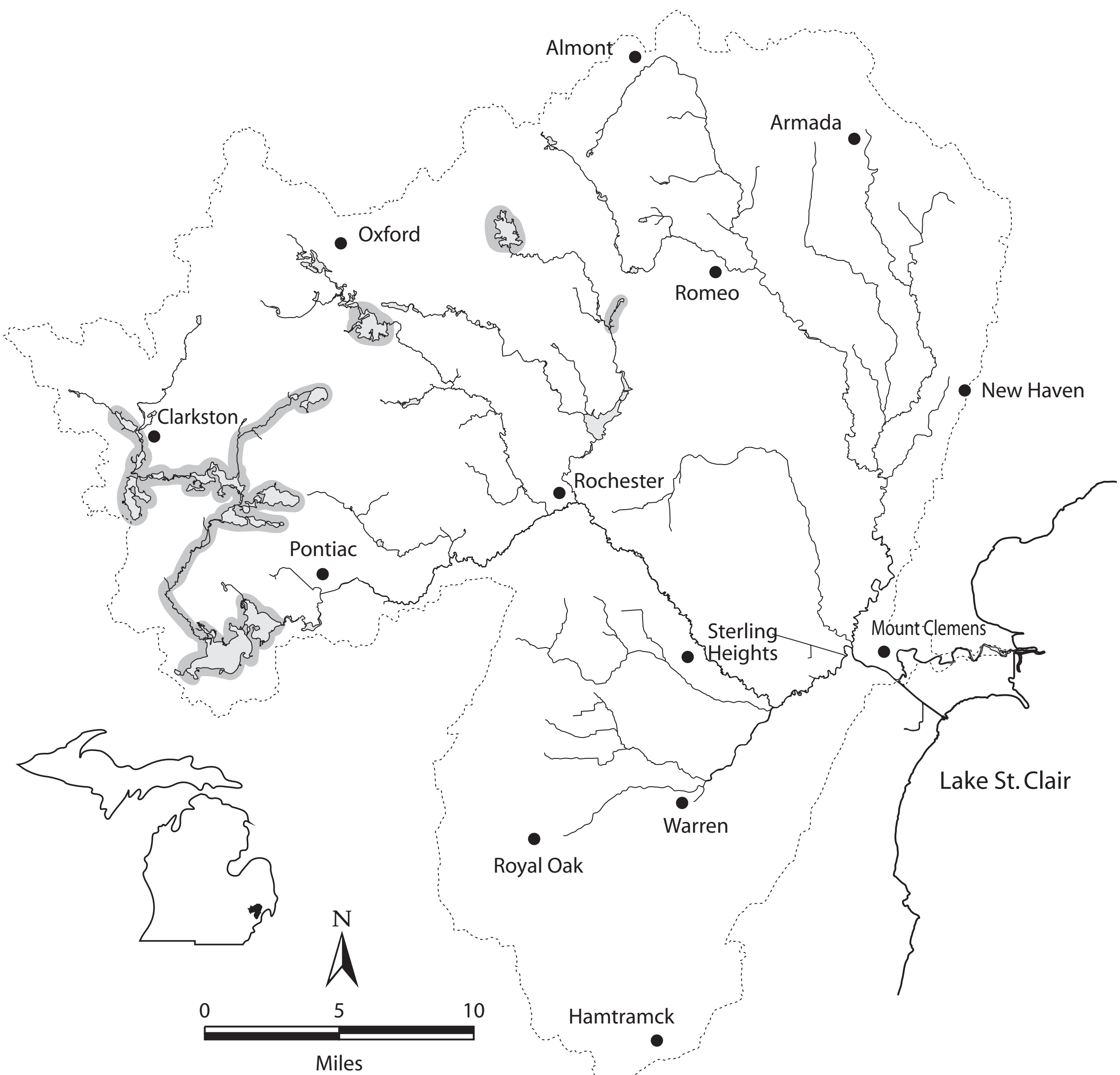


Lake chubsucker *Erimyzon sucetta*

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



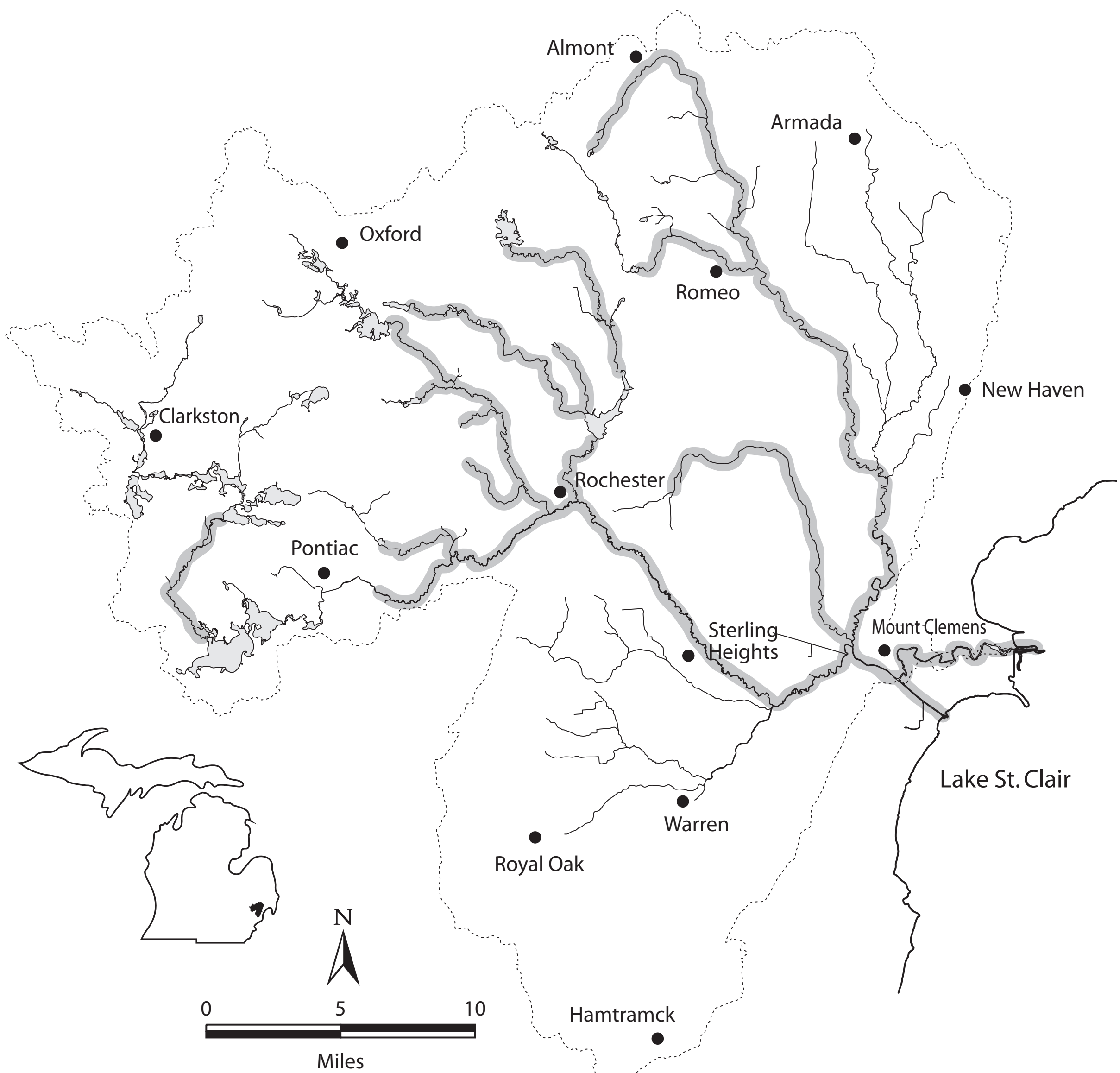
Northern hog sucker *Hypentelium nigricans*

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

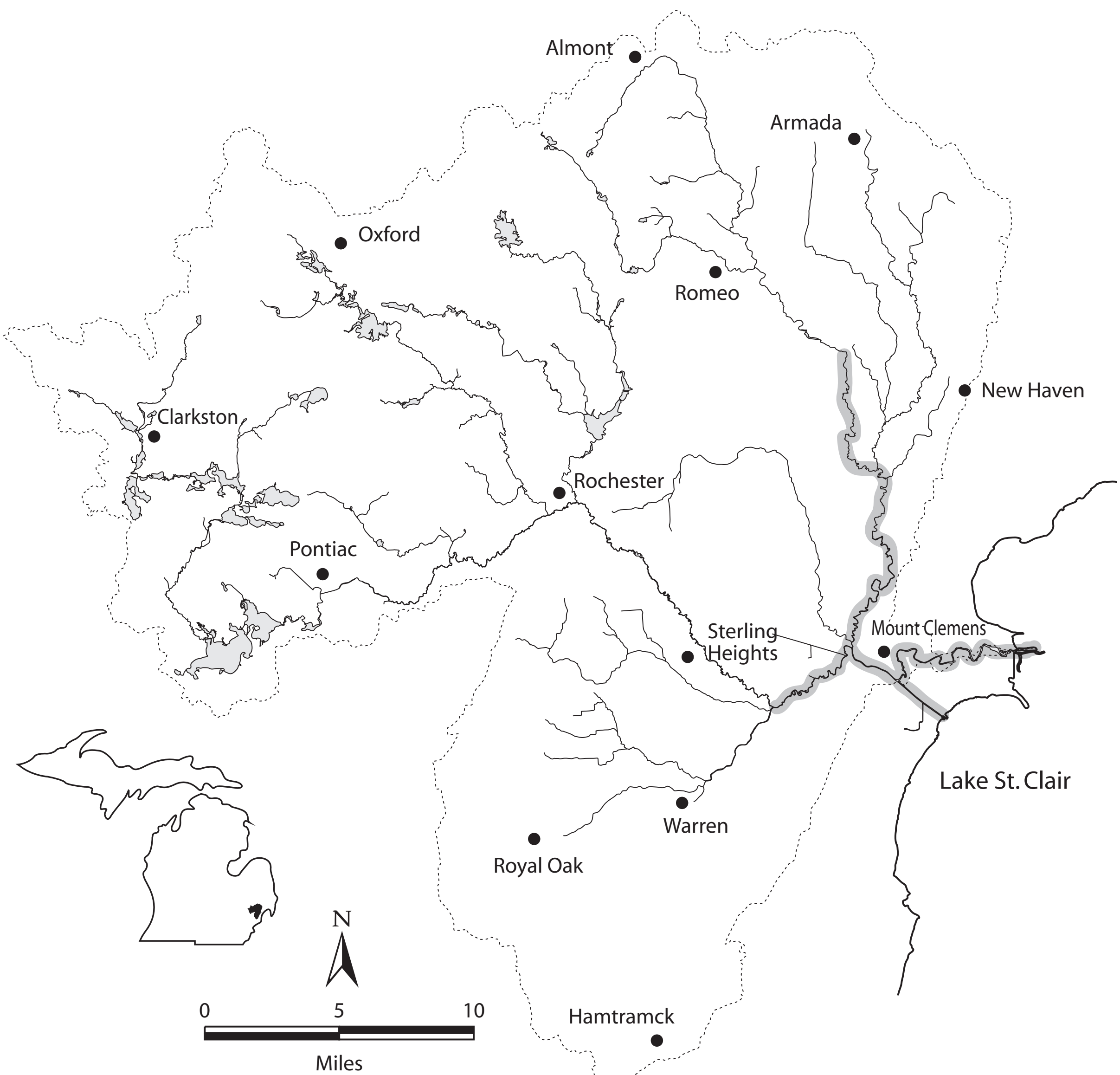


Spotted sucker *Minytrema melanops*

Habitat:

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

spawning - riffles

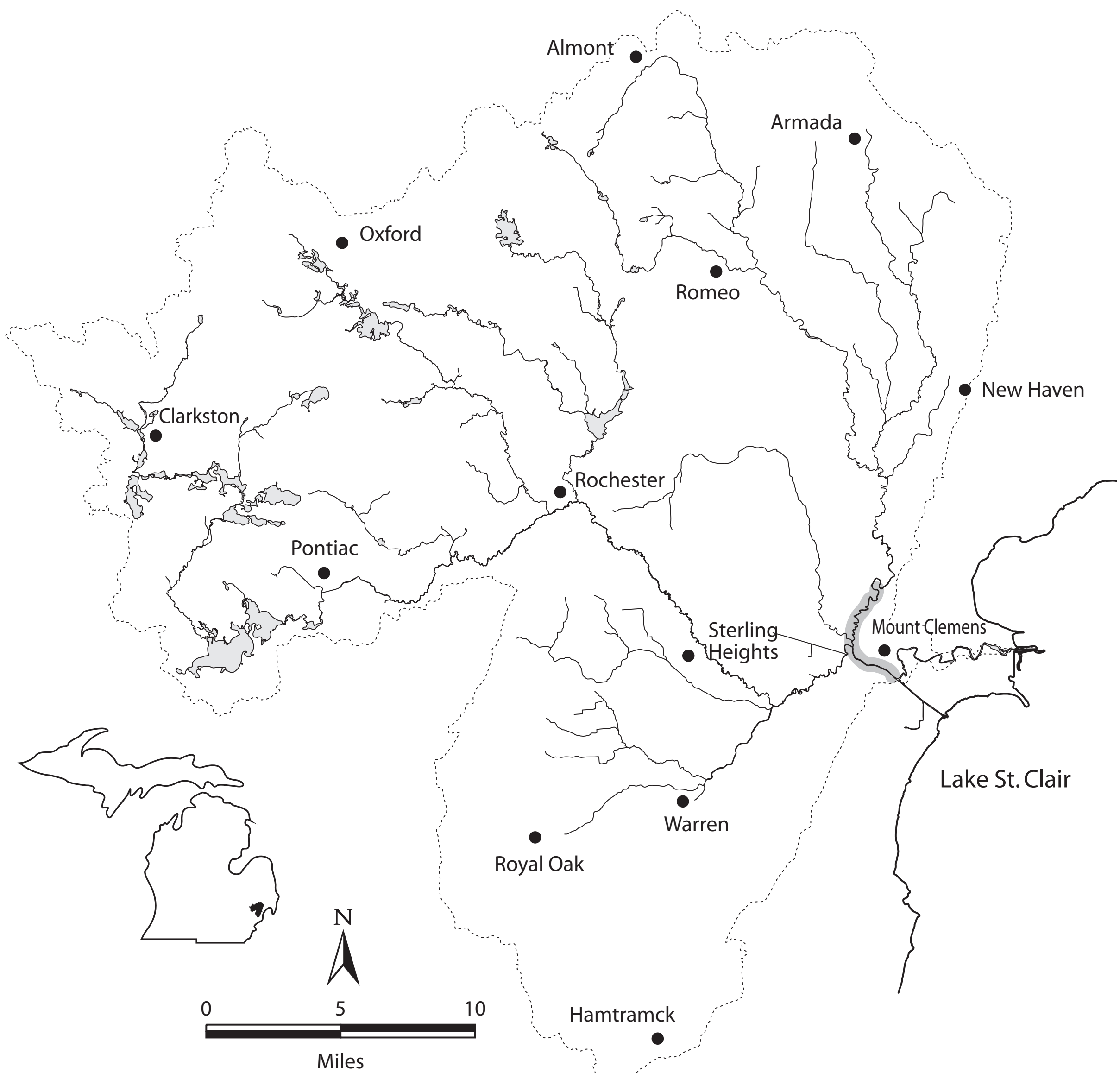


Silver redhorse *Moxostoma anisurum*

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



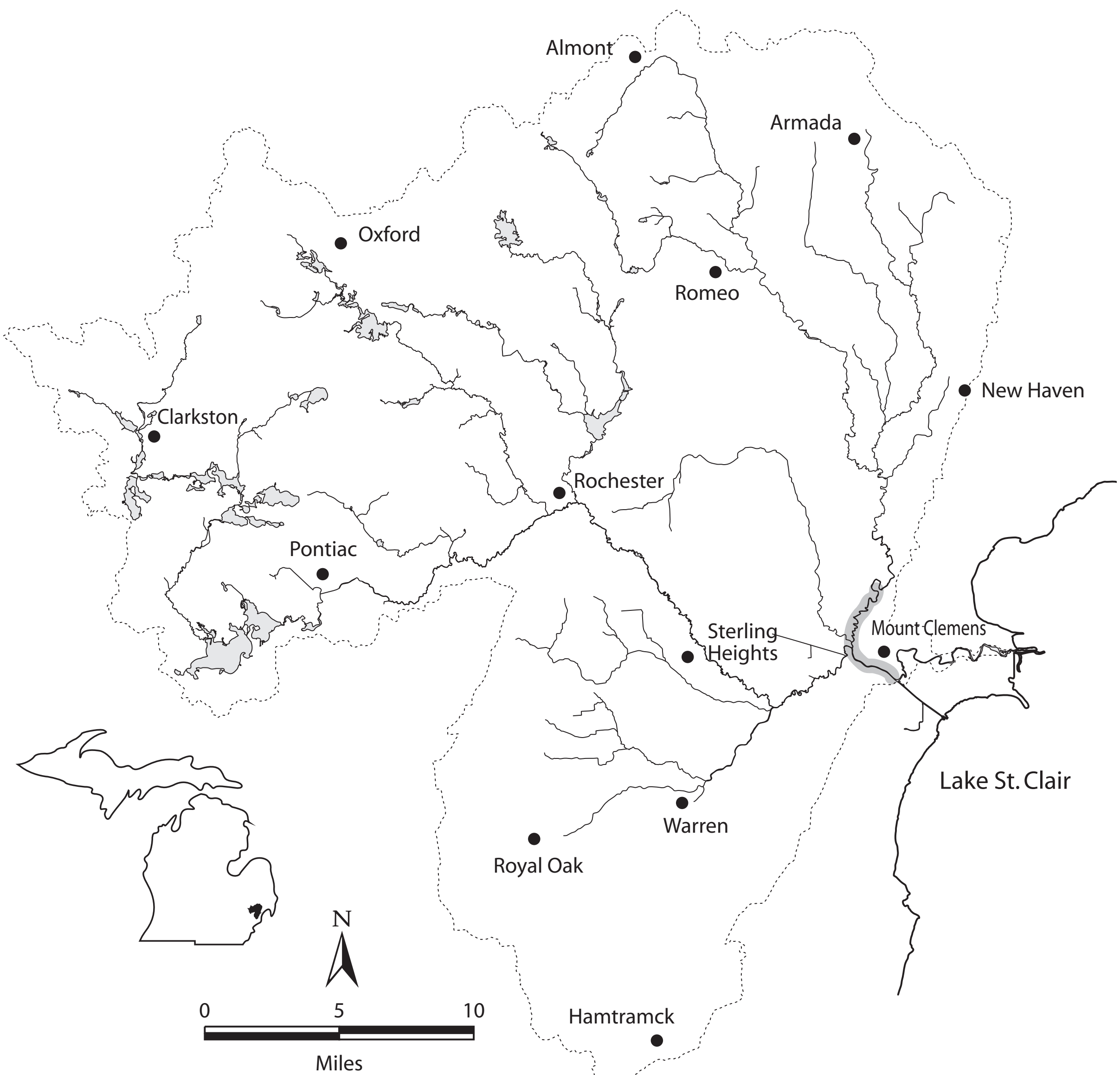
Black redhorse *Moxostoma duquesnei*

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

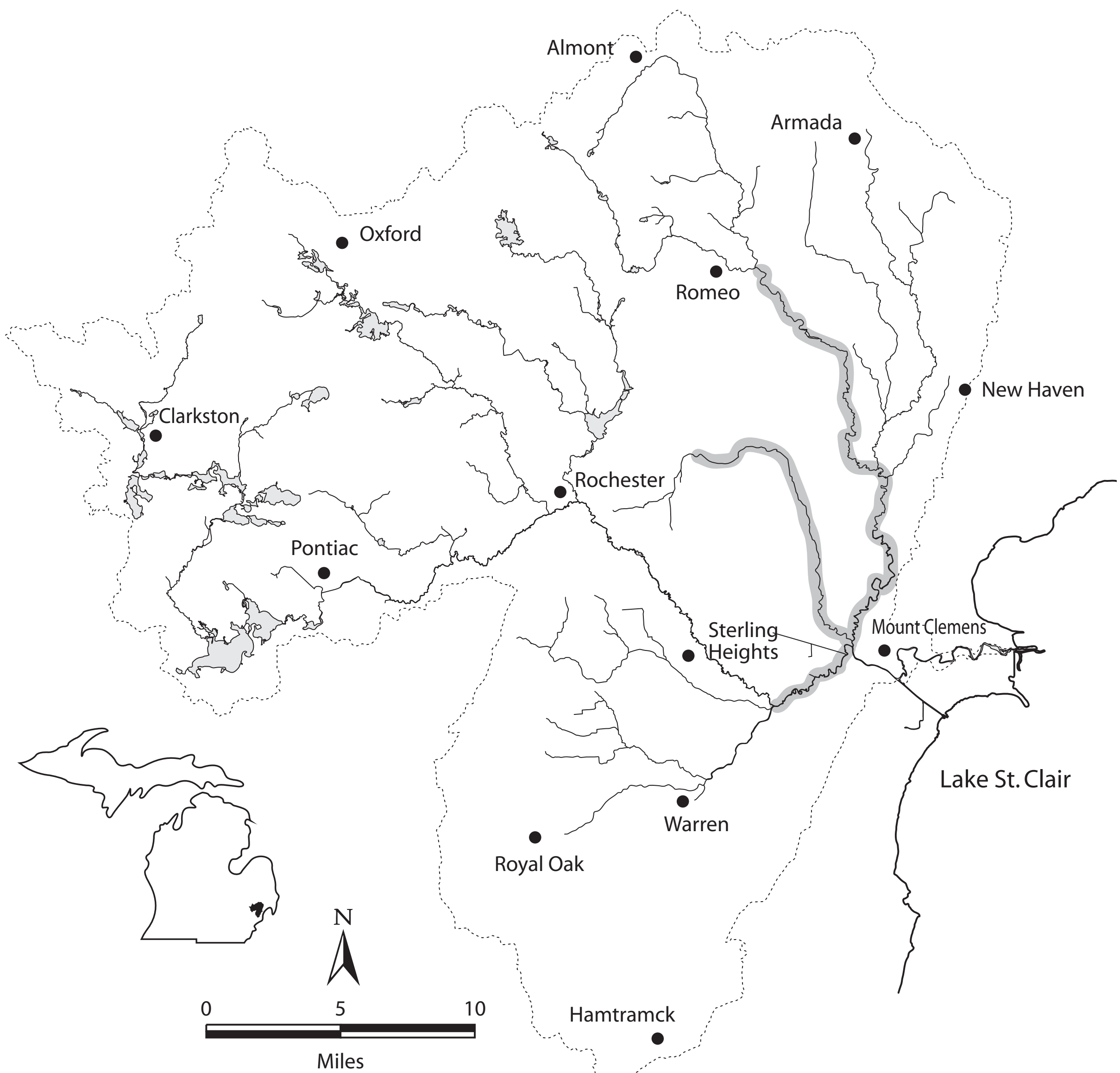
winter refuge
- deeper holes



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

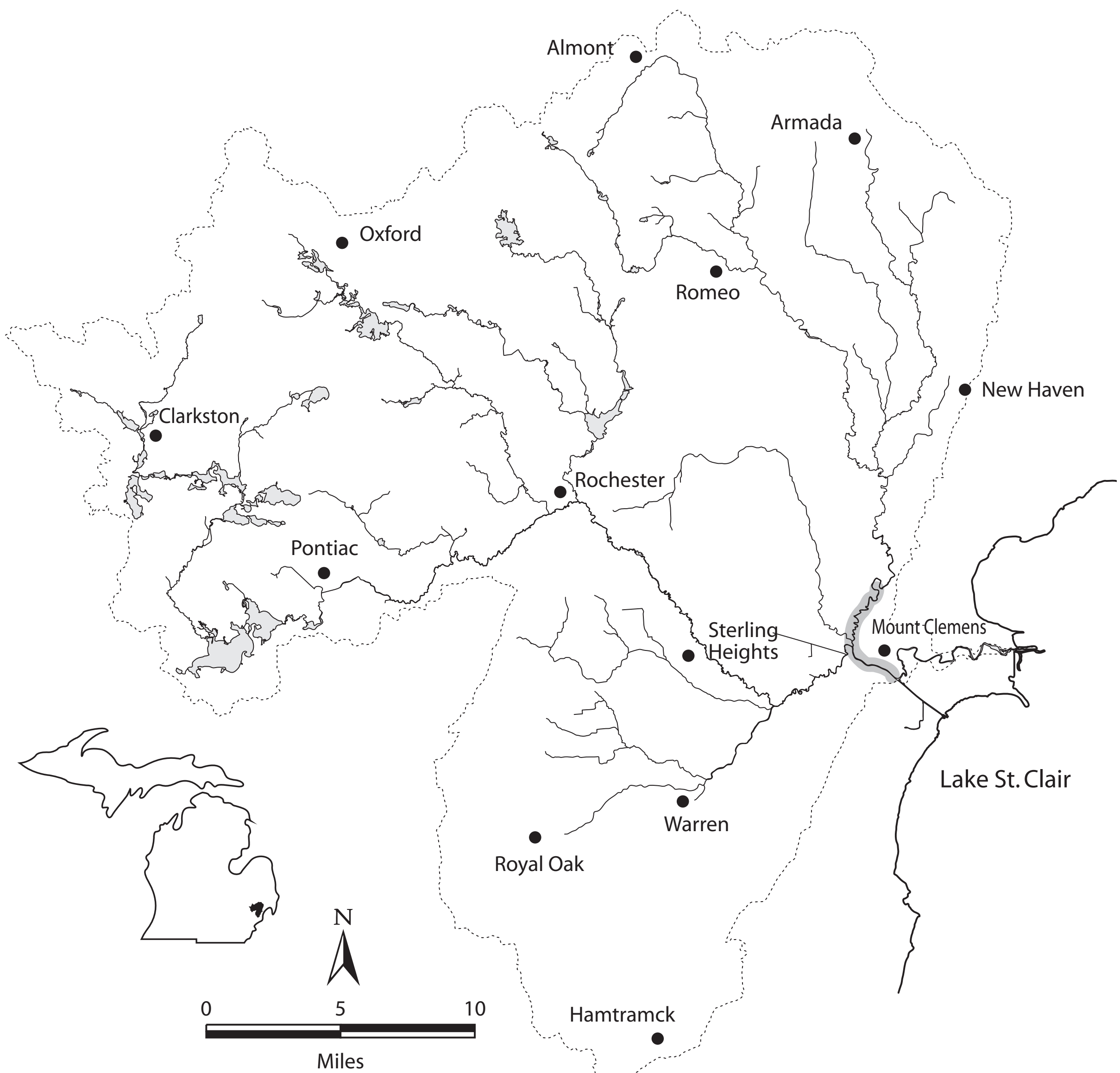


Shorthead redhorse *Moxostoma macrolepidotum*

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

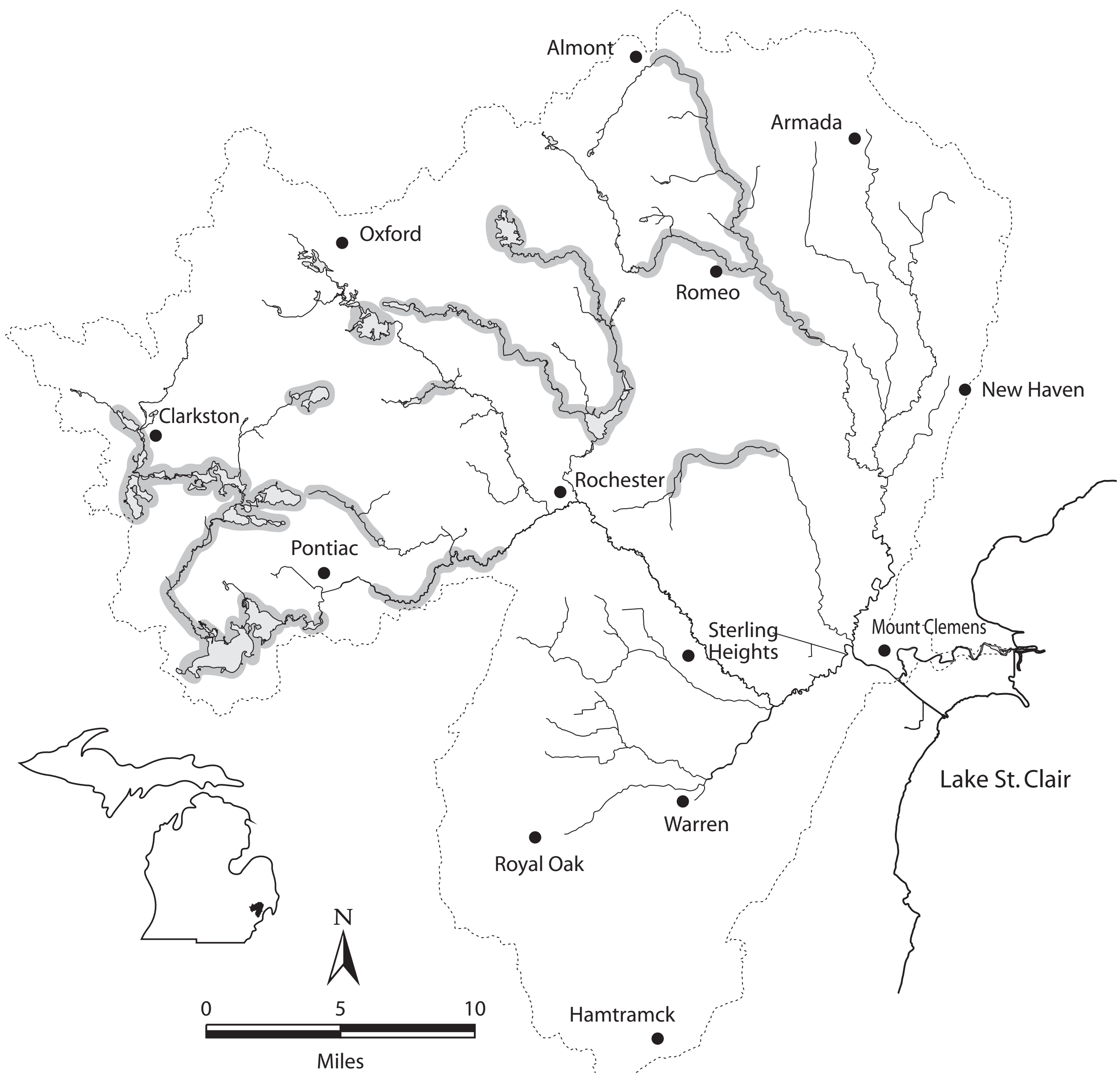


Black bullhead *Ameiurus melas*

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

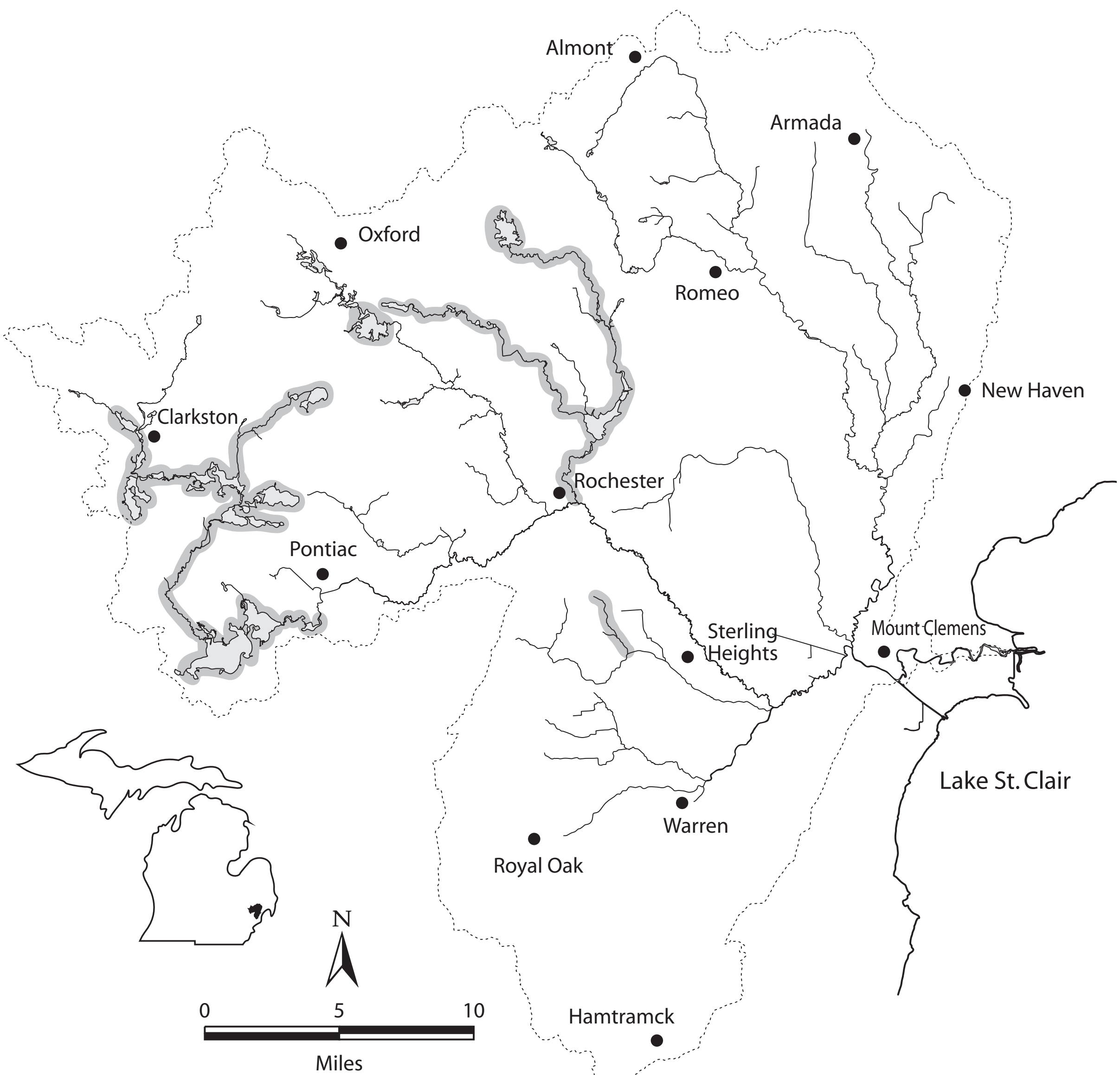


Yellow bullhead *Ameiurus natalis*

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



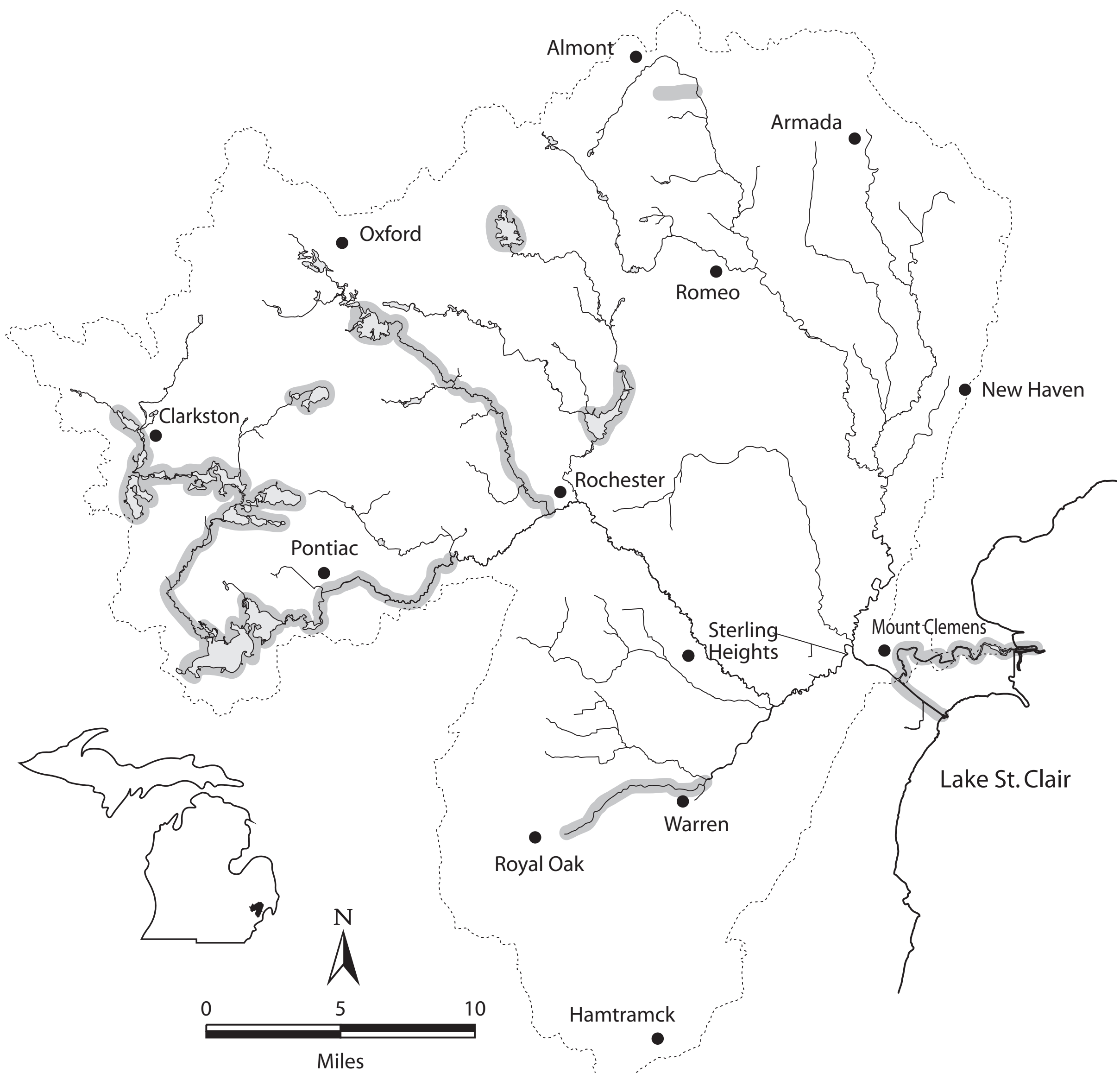
Brown bullhead *Ameiurus nebulosus*

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

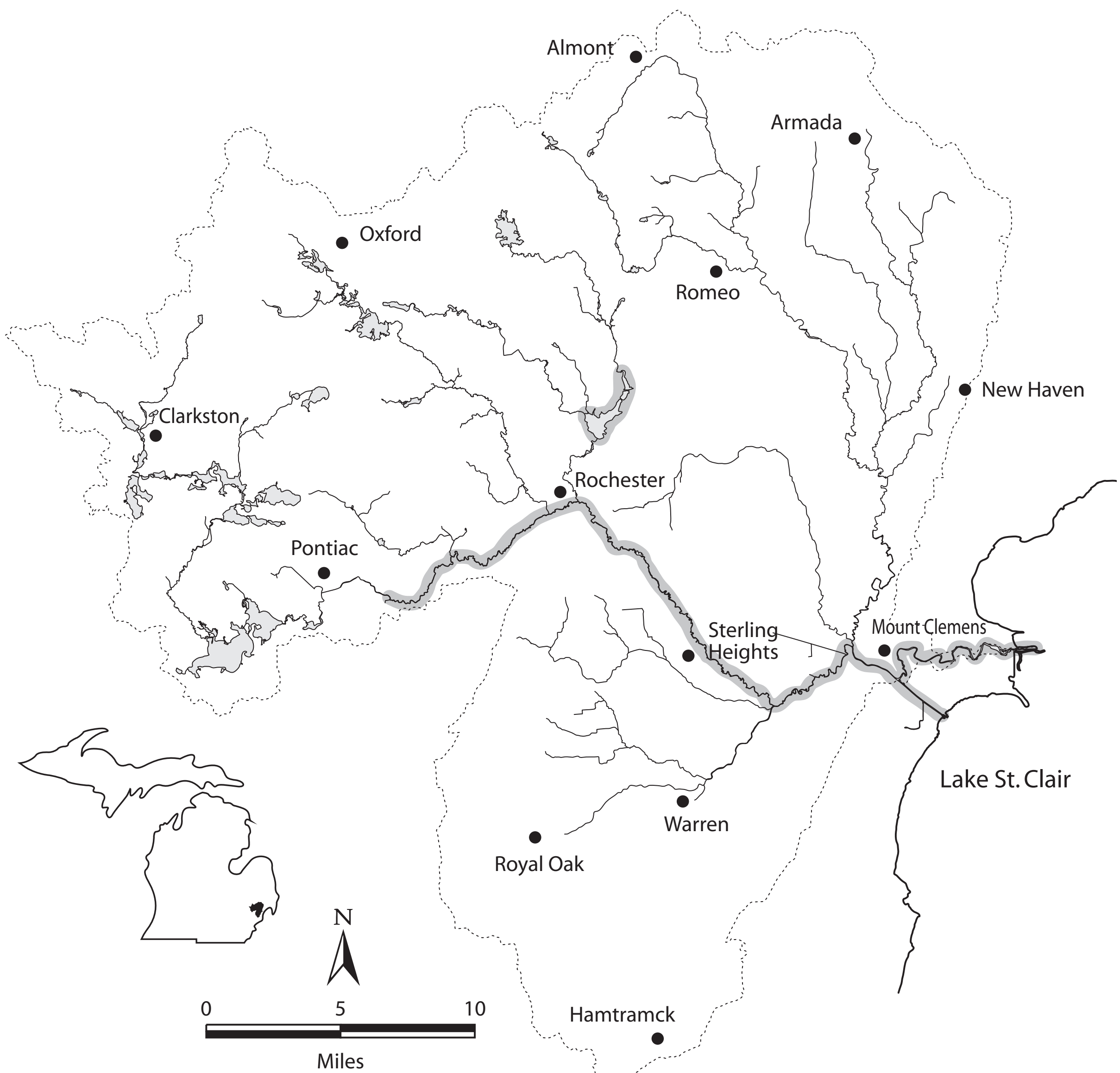


Channel catfish *Ictalurus punctatus*

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

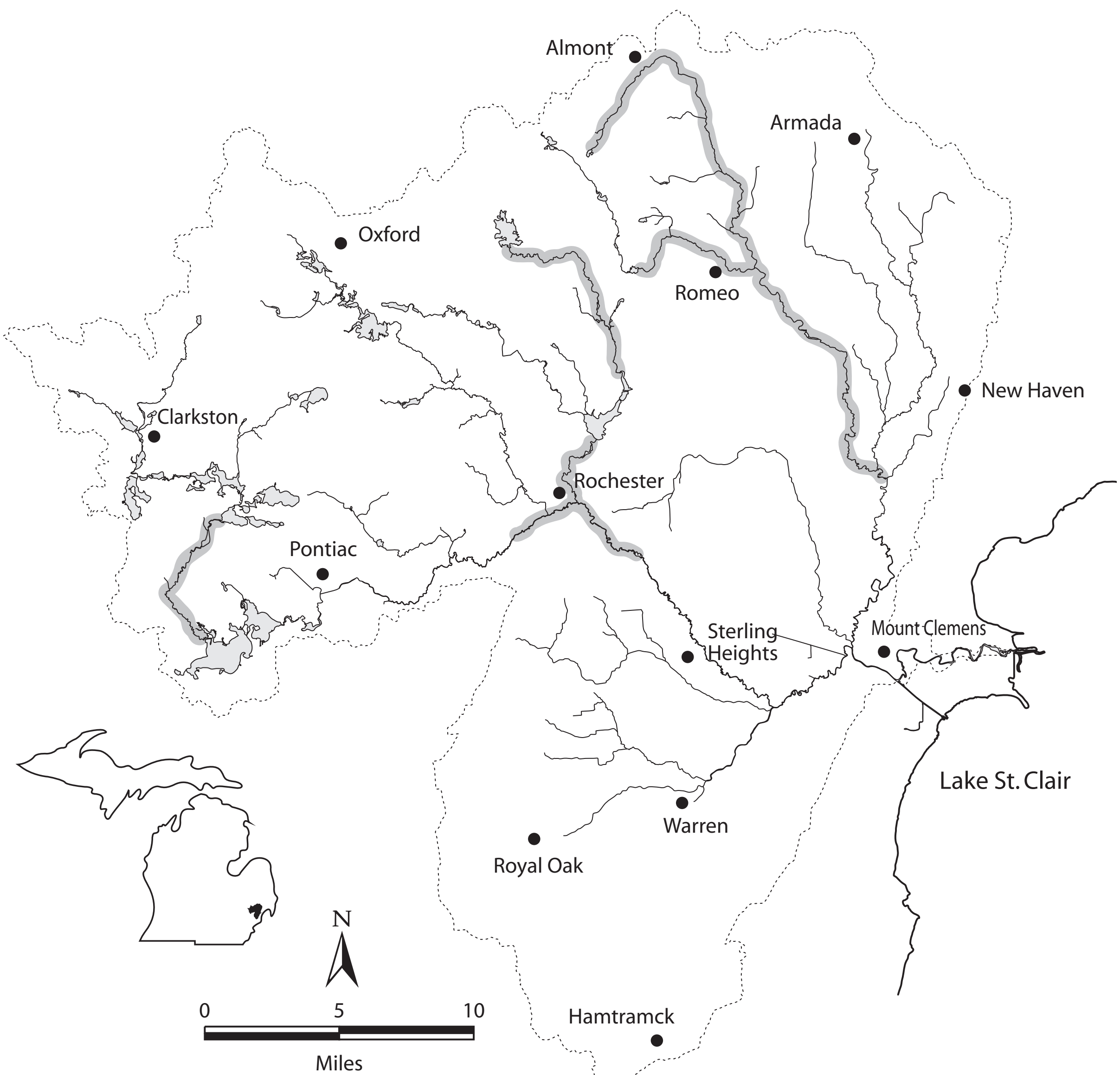


Stonecat *Noturus flavus*

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

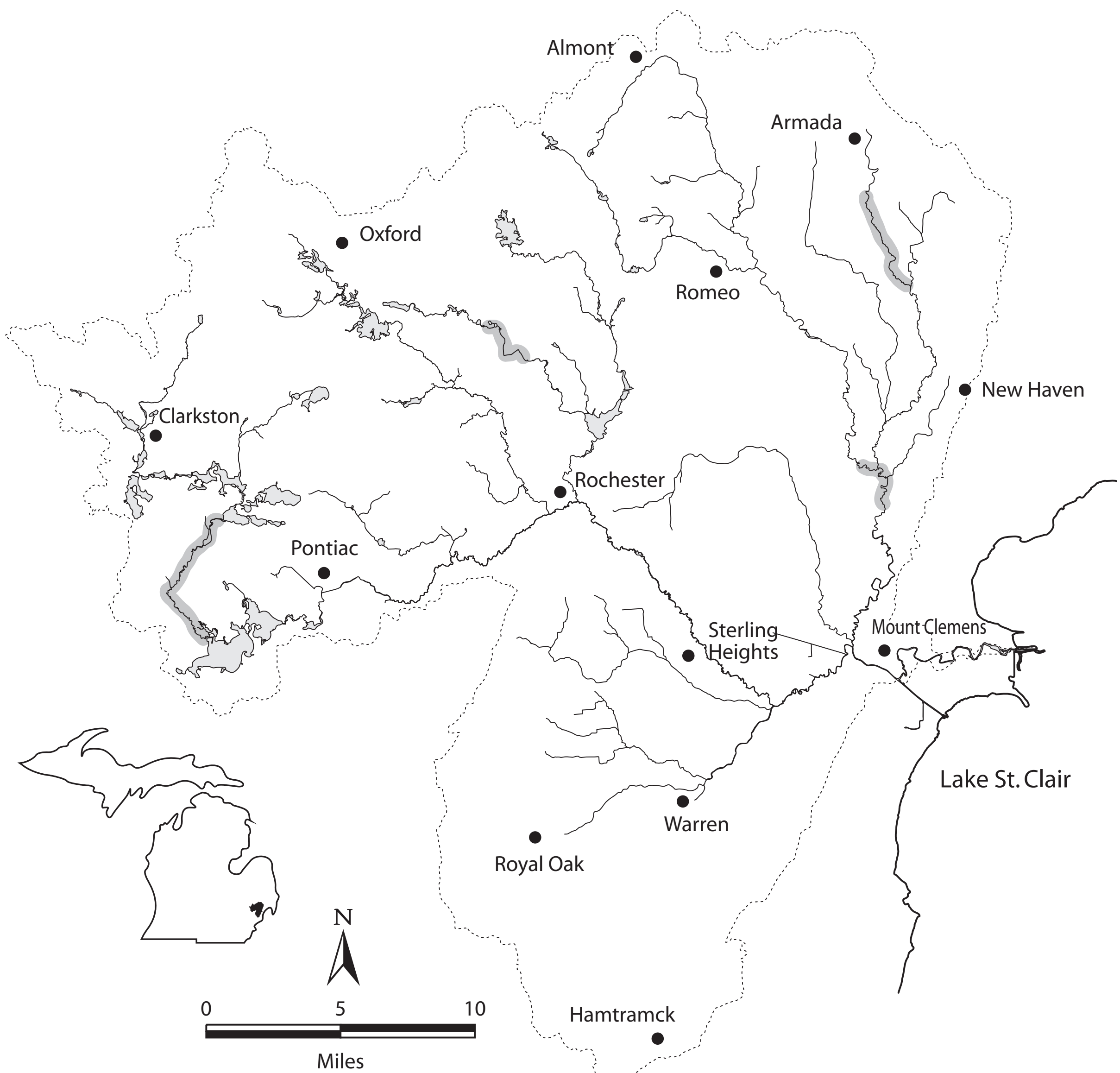


Tadpole madtom *Noturus gyrinus*

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)

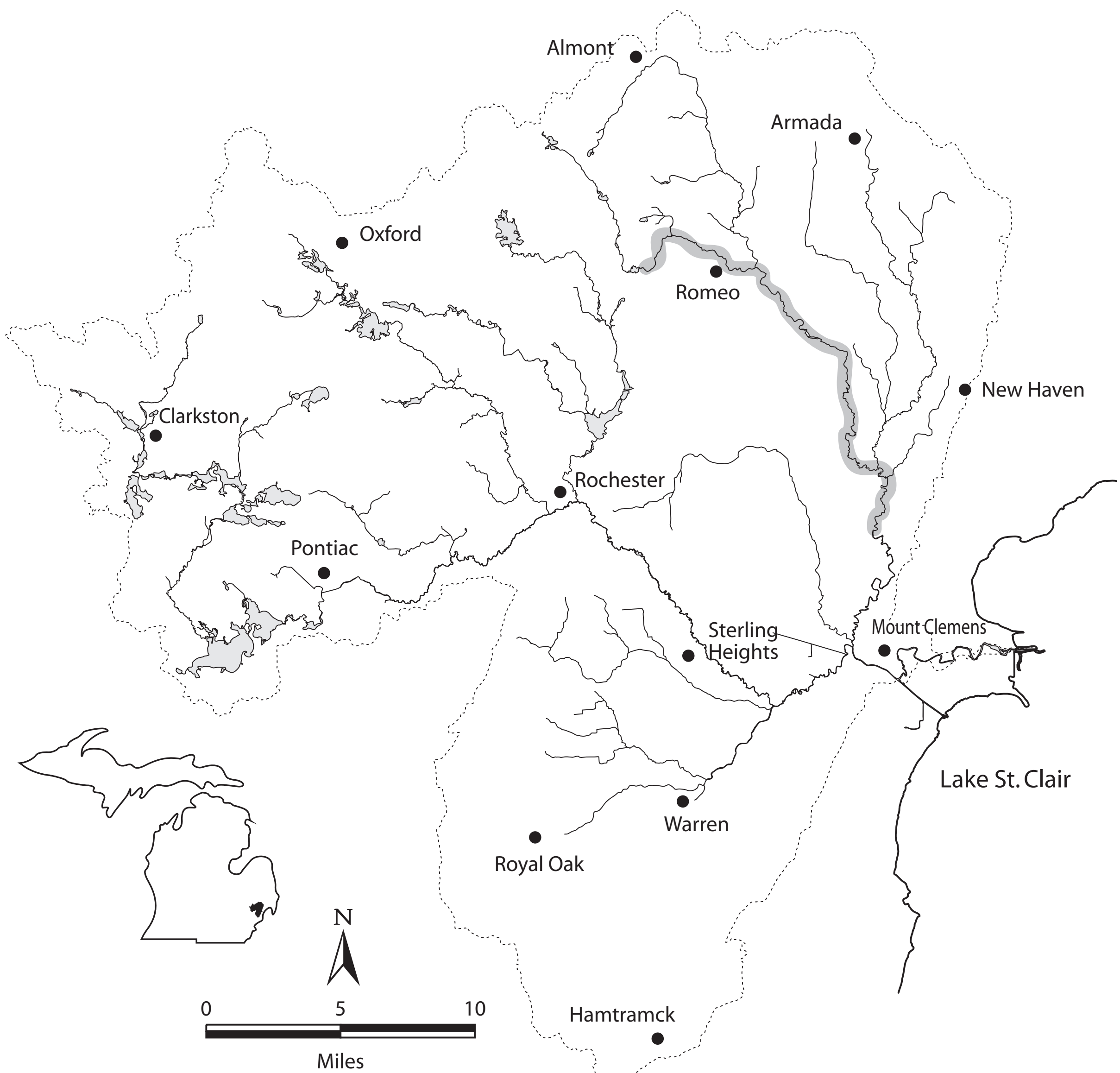


Brindled madtom *Noturus miurus* – **special concern**

Habitat:

feeding
- low gradient streams or pools of higher gradient reaches
- sand or organic debris substrate - no clayey silts
- in riffles of sluggish or moderate flow if sand is present

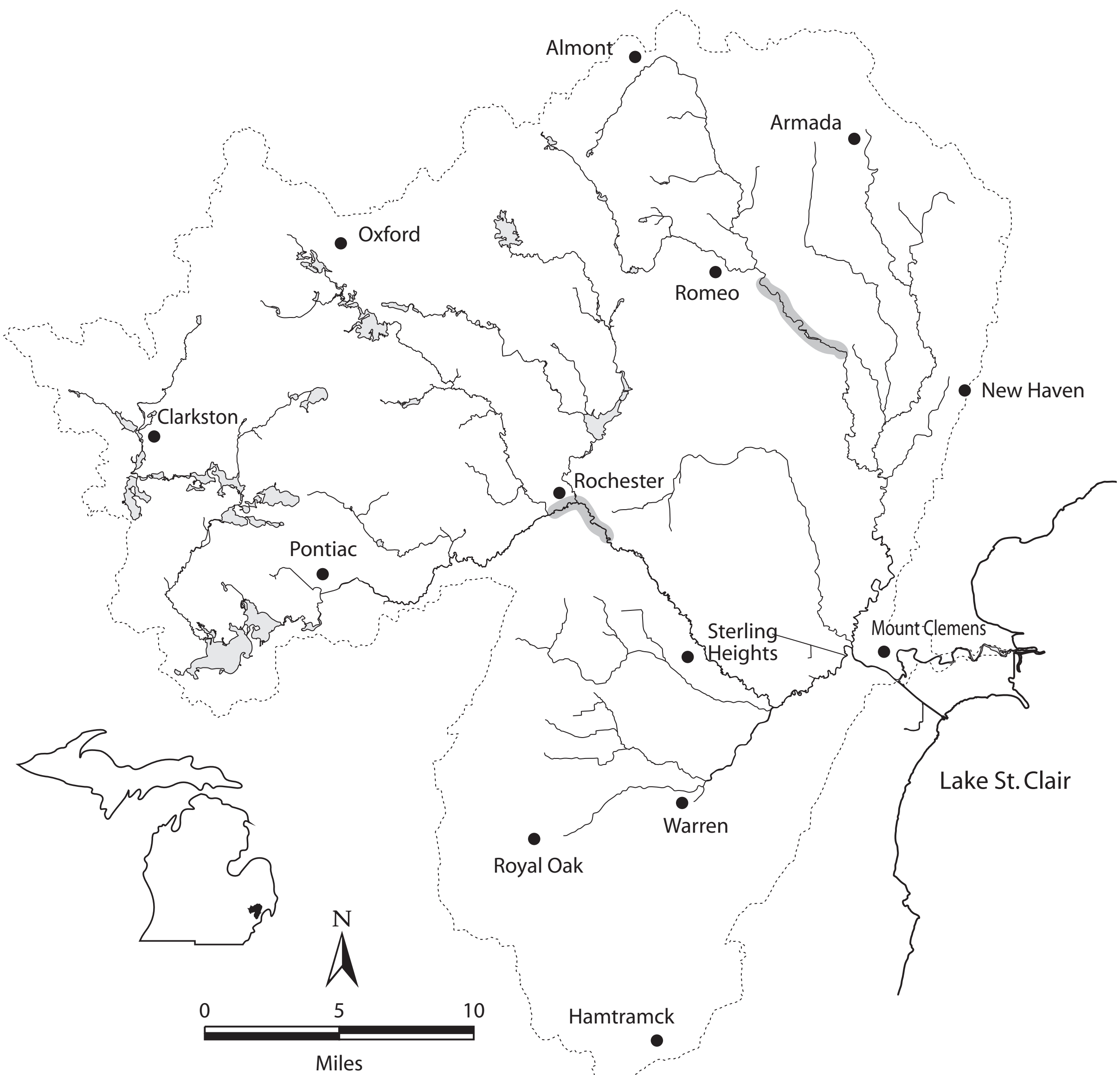
spawning
- silt or mud substrate
- emergent vegetation



Northern madtom *Noturus stigmosus* – **endangered**

Habitat:

feeding - deep, wide, swift riffles of streams and rivers
- gravel and boulder substrates

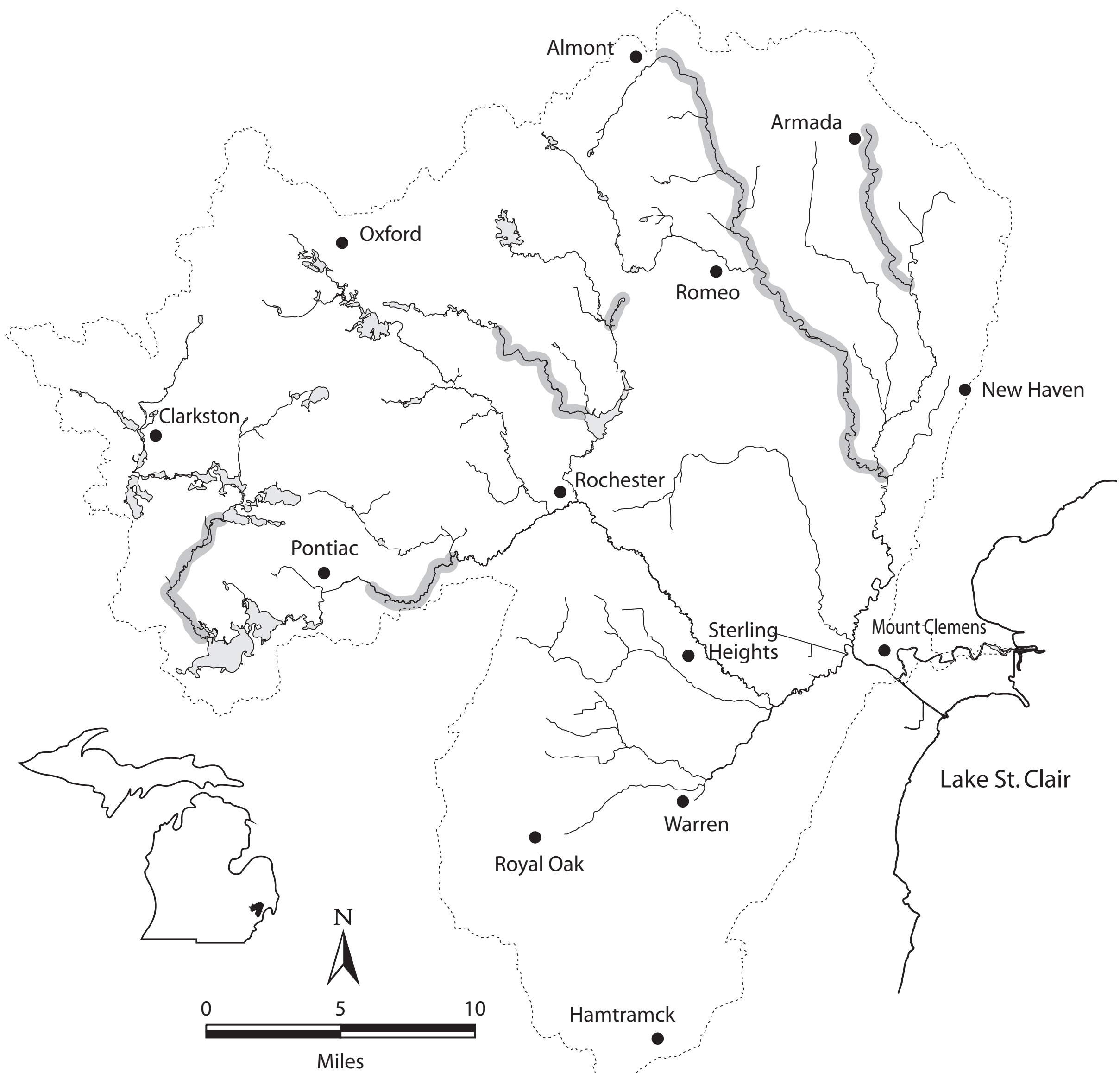


Grass pickerel *Esox americanus vermiculatus*

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

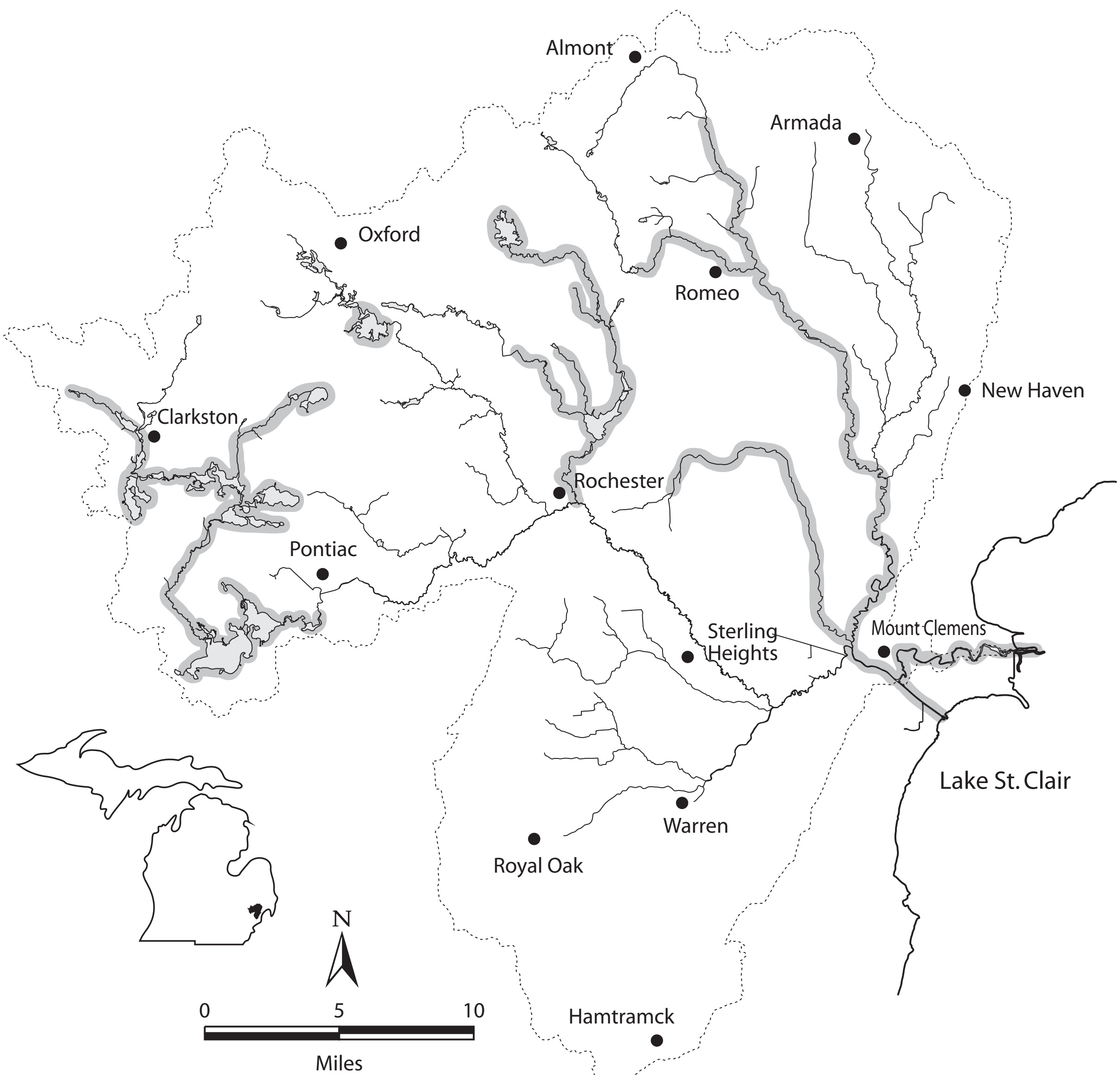


Northern pike *Esox lucius*

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

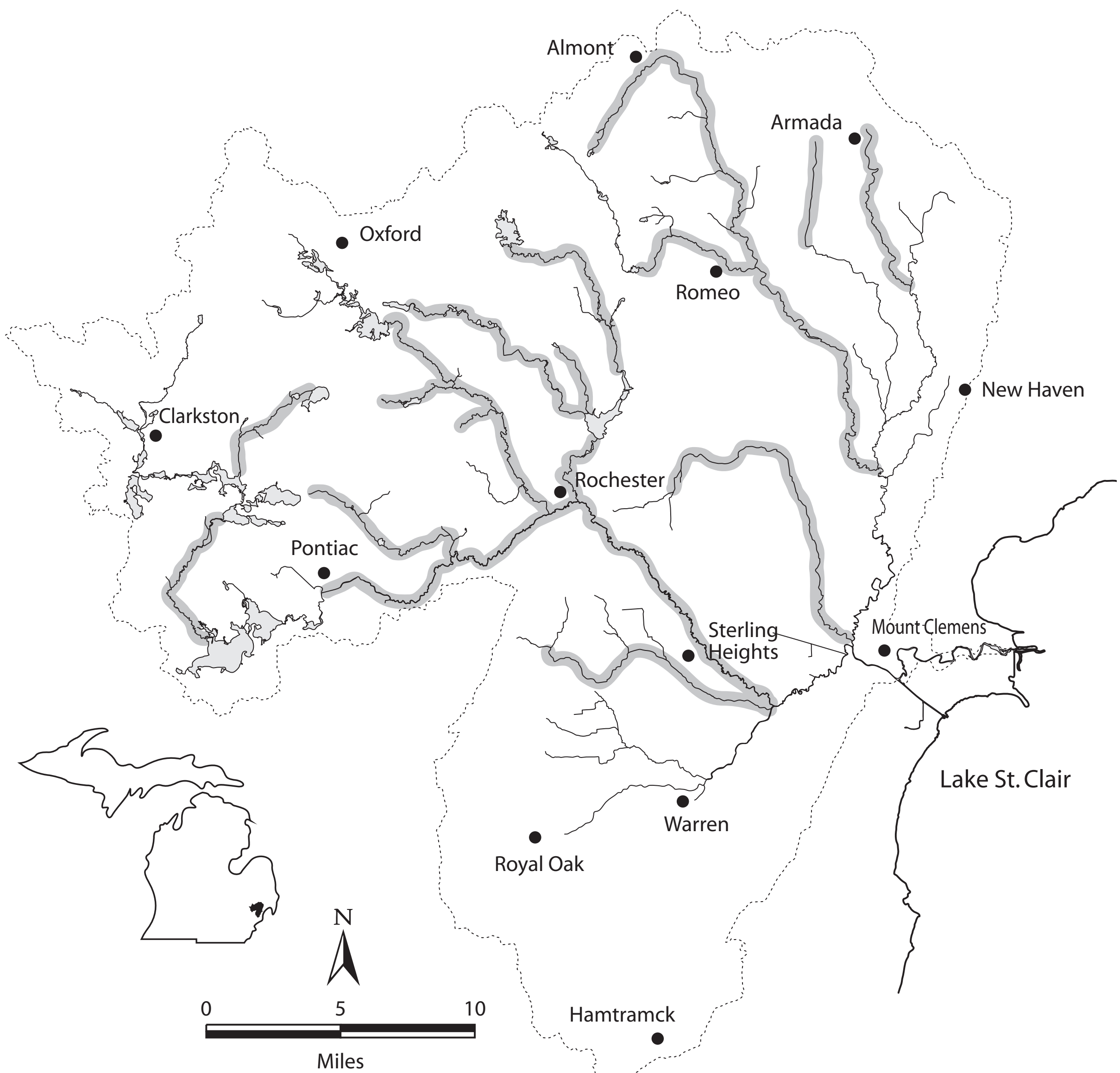


Central mudminnow *Umbra limi*

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



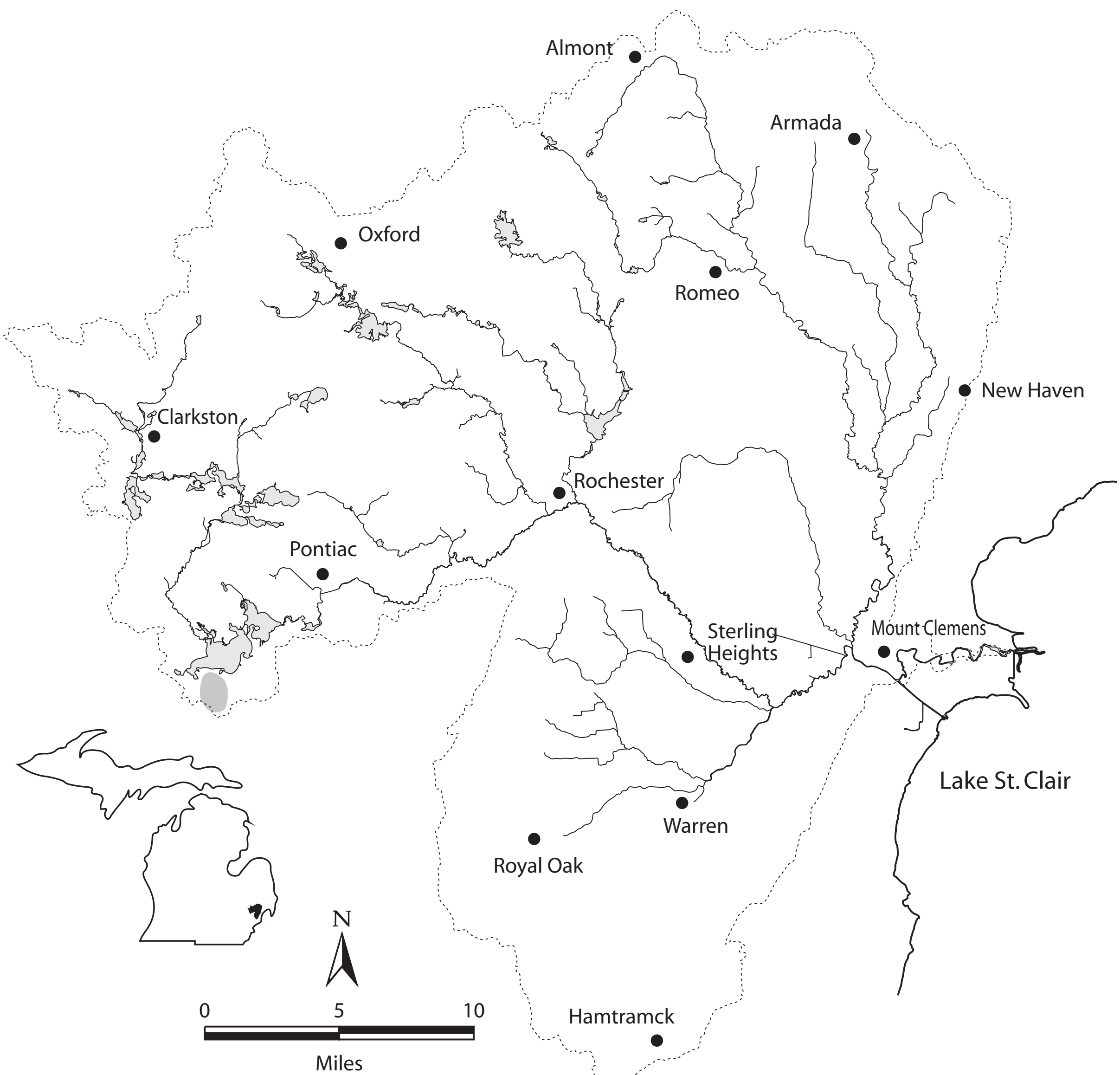
Rainbow smelt *Osmerus mordax*

Habitat:

feeding - young:close inshore lake habitat along sand and gravel beaches
- cold water

spawning - clear high-gradient streams or wave swept shoreline
- riffles with coarse sand or gravel substrate

winter refuge - midwaters of lakes or inshore coastal waters

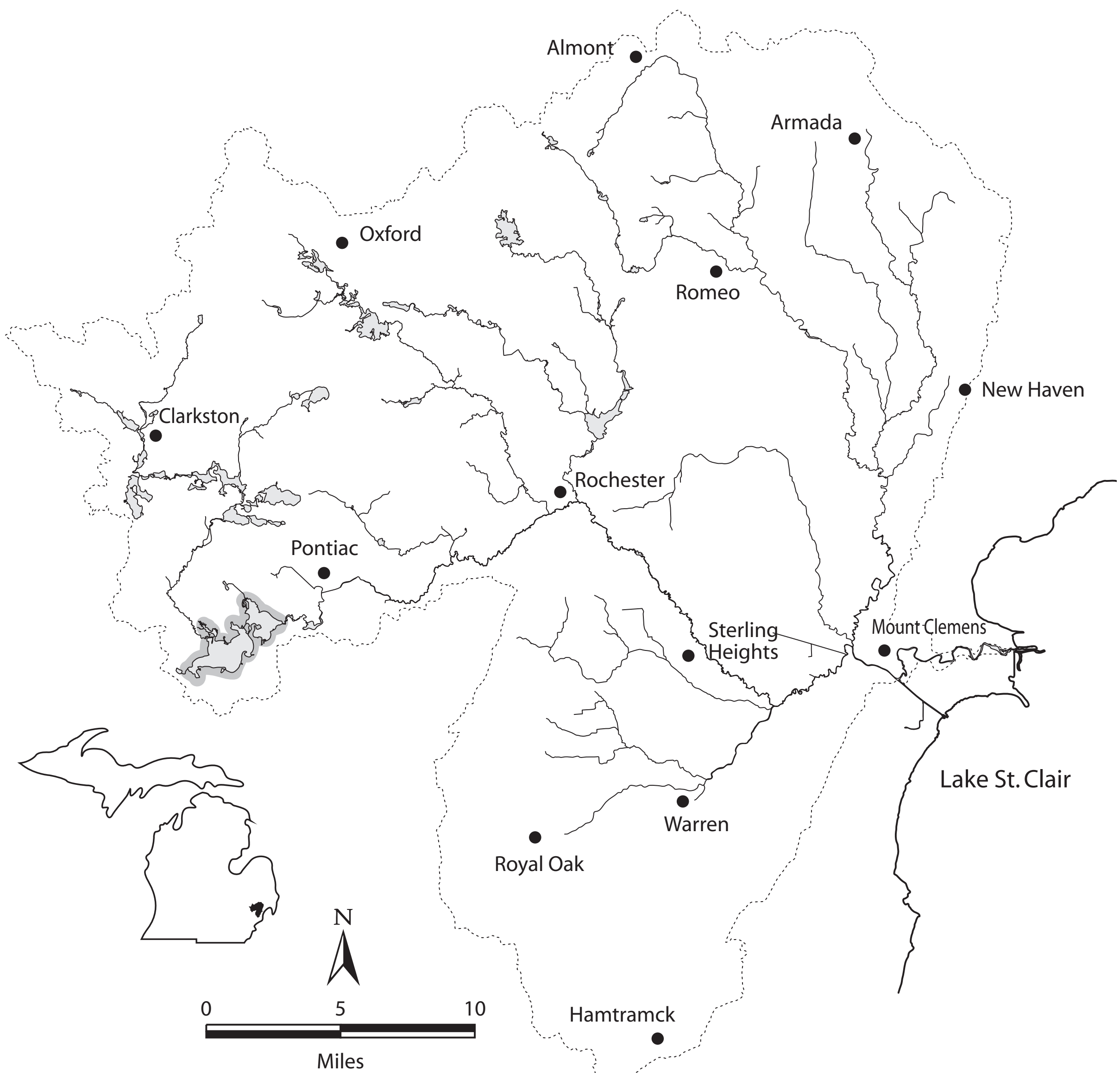


Cisco {lake herring} *Coregonus artedi* – **threatened**

Habitat:

feeding - deep cool lakes, preferably oligotrophic

spawning - usually in lakes
- 3 to 6 feet of water with no vegetation
- often over gravel or stony substrate

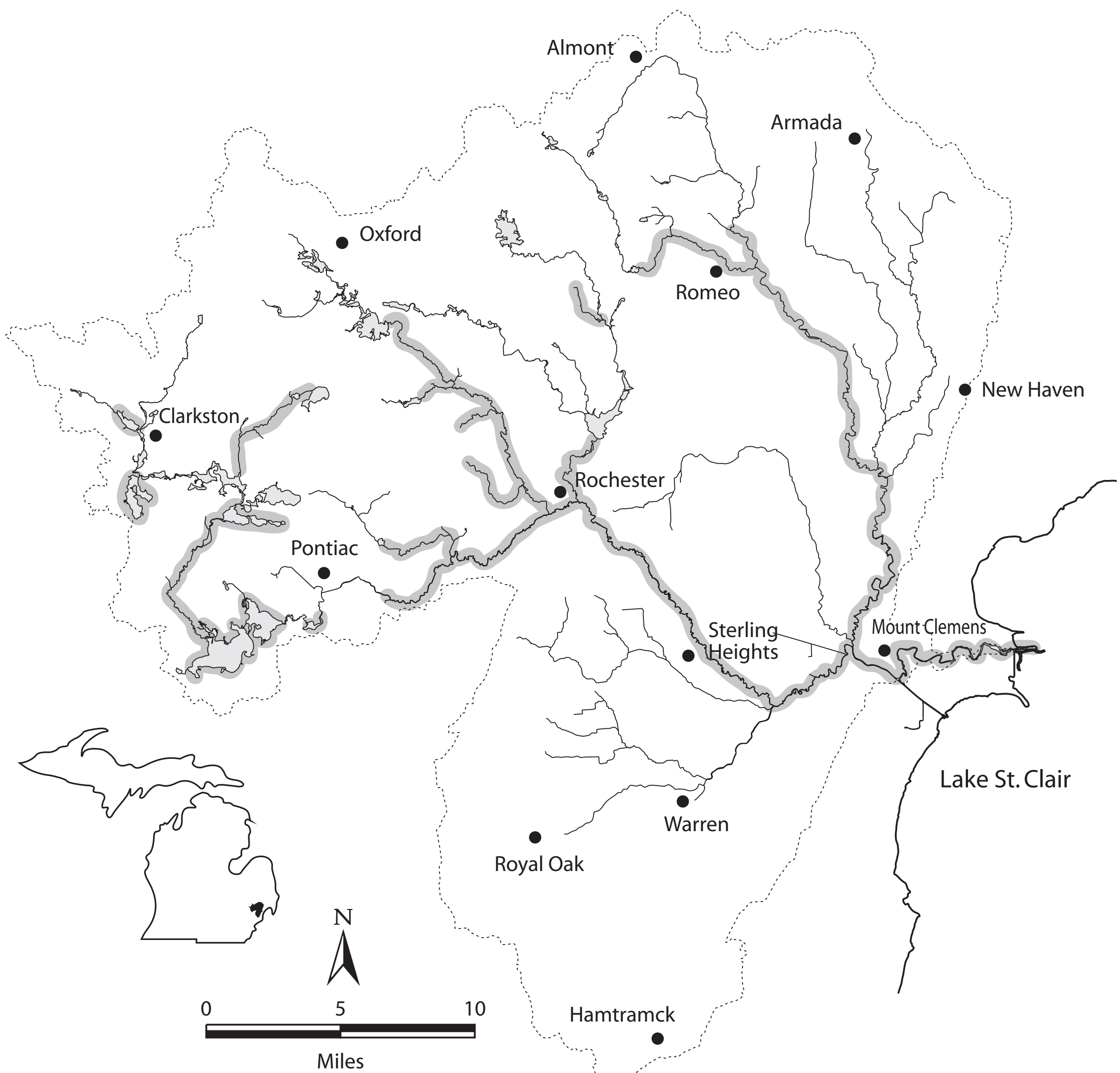


Rainbow trout *Oncorhynchus mykiss*

Habitat:

feeding - cold clear water of rivers and Lake Huron
- moderate current

spawning - gravelly riffles above a pool
- smaller tributaries

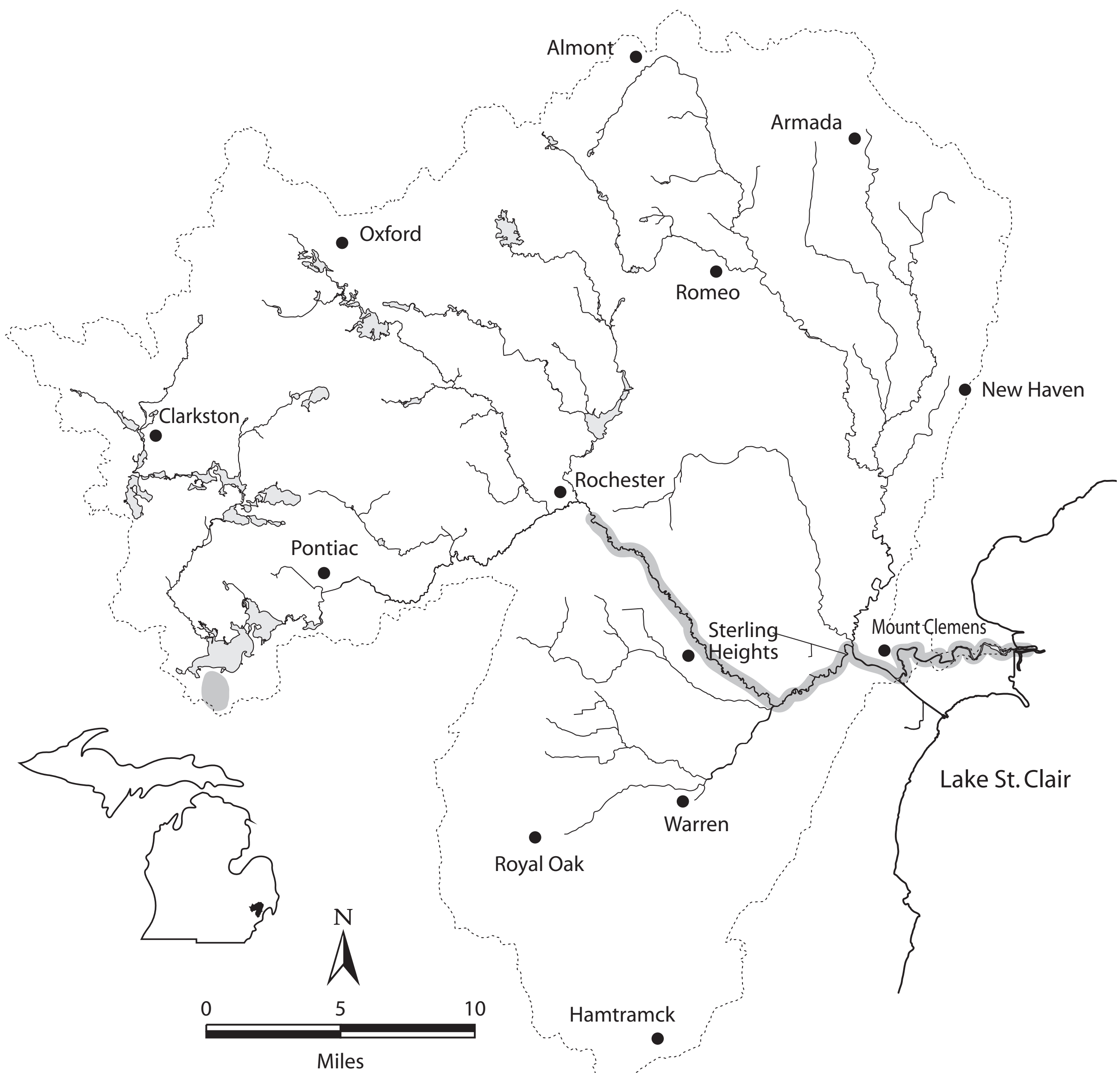


Chinook salmon *Oncorhynchus tshawyscha*

Habitat:

feeding - adults: Lake Huron
- young: shallow gravel substrate in cool streams, later into pools

spawning - gravelly substrate in cool streams

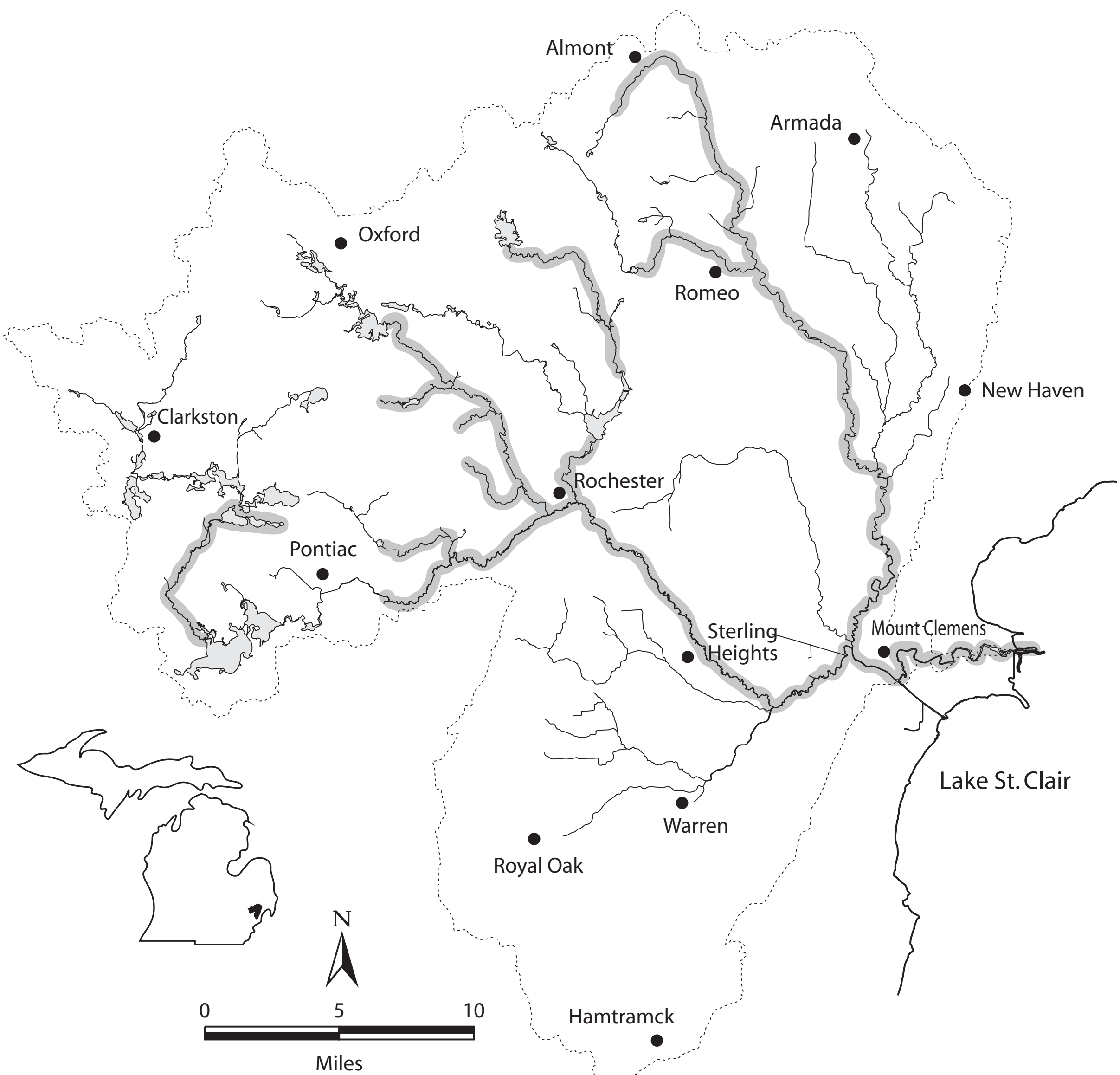


Brown trout *Salmo trutta*

Habitat:

feeding
- cold, clear streams, rivers, and lakes (not >70°F)
- medium to swift current in streams
- does not tolerate silt well
- prefers few individuals and species around
- abundance of aquatic and land insects

spawning
- gravelly riffles; shallow headwater areas

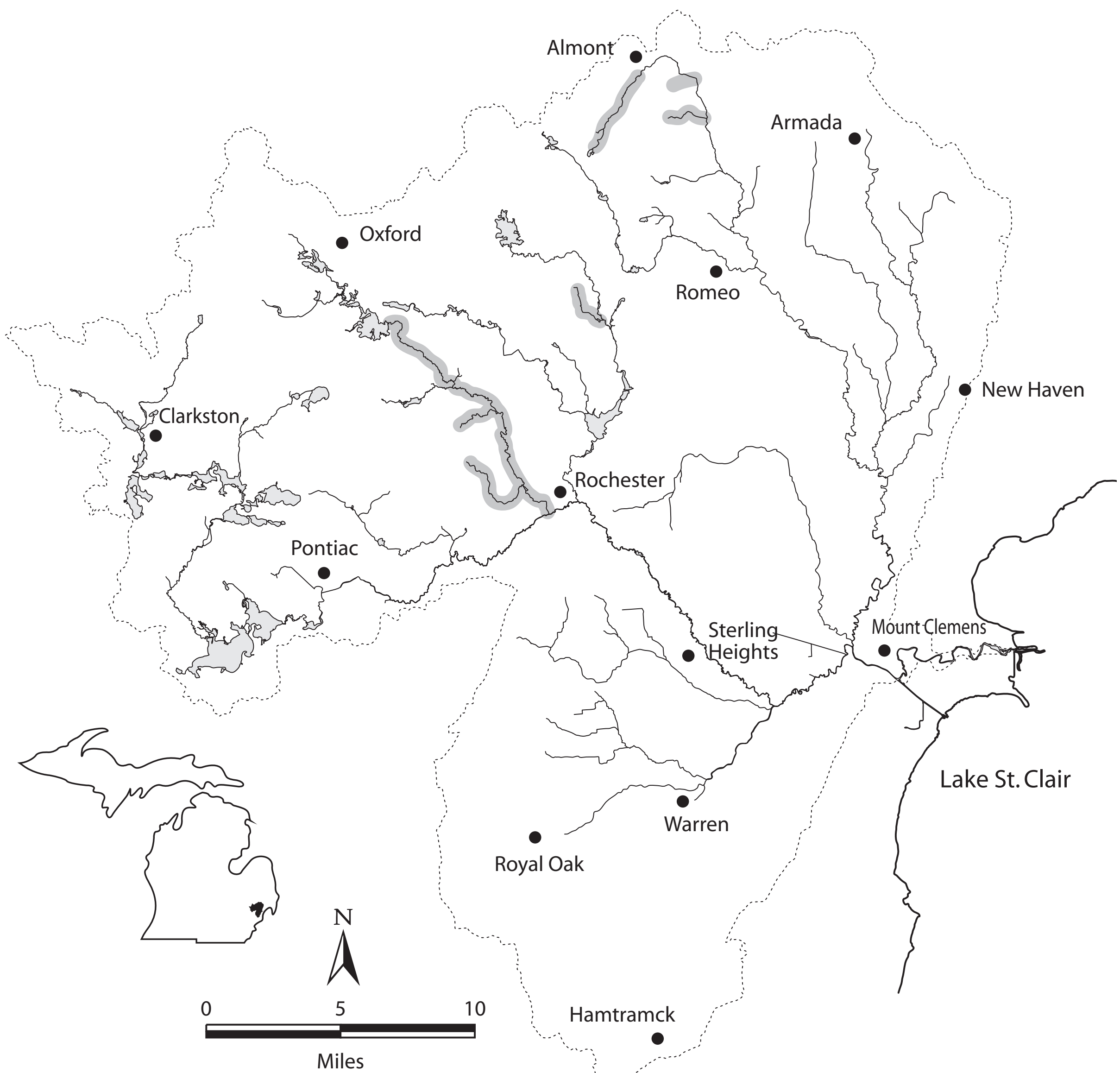


Brook trout *Salvelinus fontinalis*

Habitat:

feeding - cold, clear streams, rivers, and lakes (not >65°F)
- low current
- well oxygenated water

spawning - gravelly riffles; shallow or headwater streams

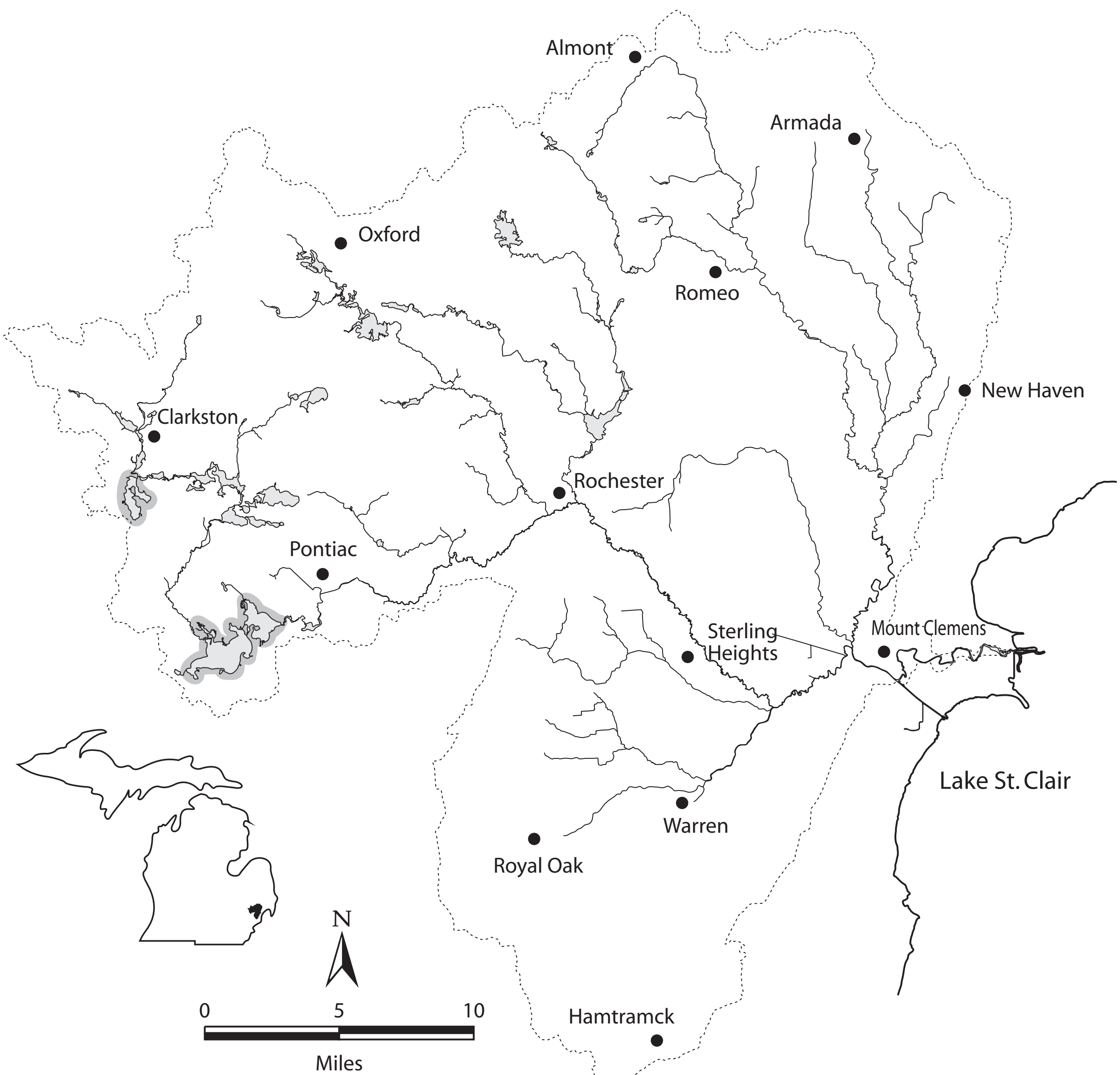


Lake trout *Salvelinus namaycush*

Habitat:

feeding - cold lakes and rivers

spawning - large boulder or rubble substrate
- shallow water of lakes and rivers

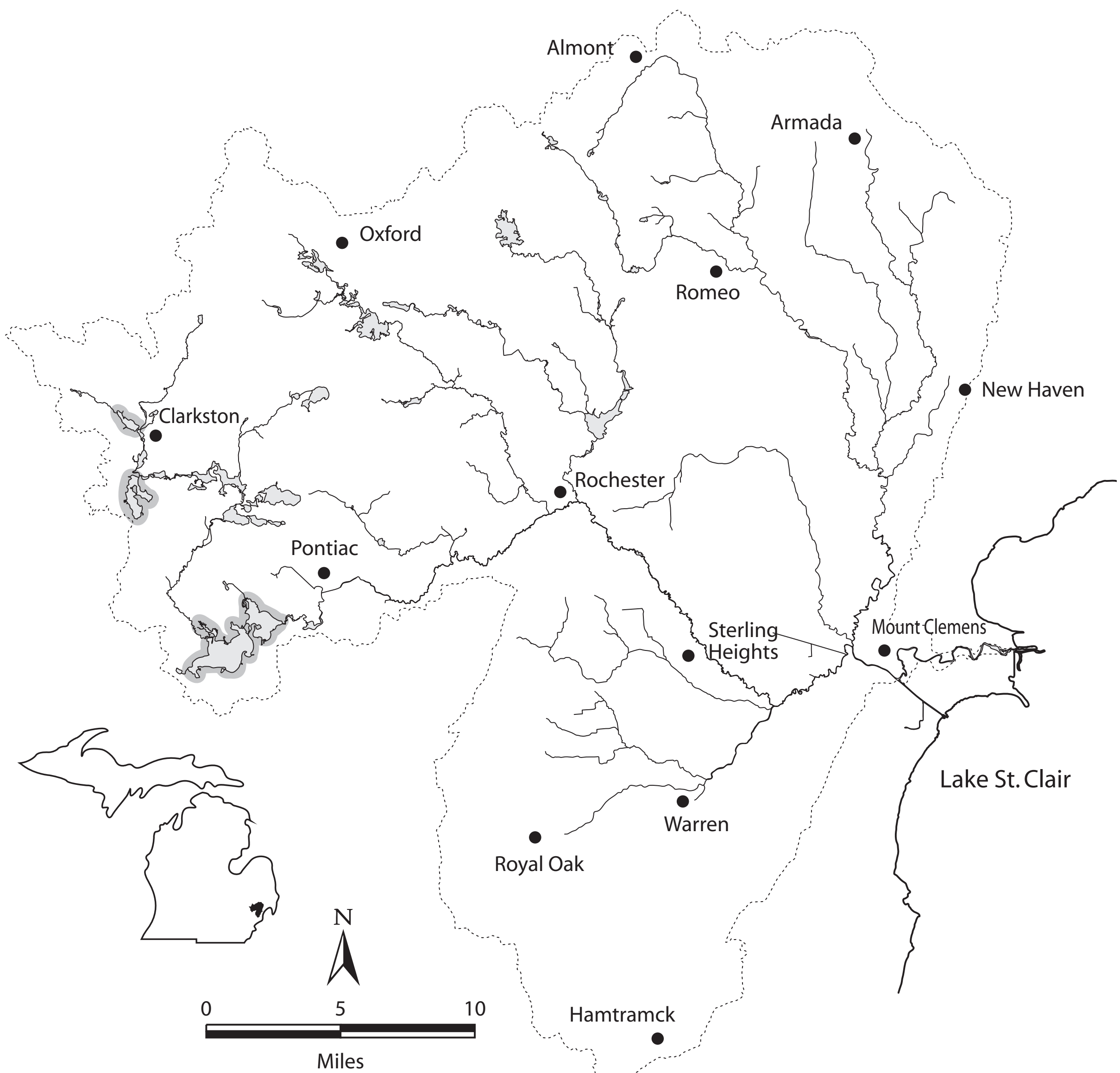


Splake *Salvelinus fontinalis* x *Salvelinus namaycush*

Habitat:

feeding - littoral habitat
- cool water lakes

spawning - hatchery produced cross of brook and lake trout
- offspring usually fertile, but with lower fecundity than either parent species

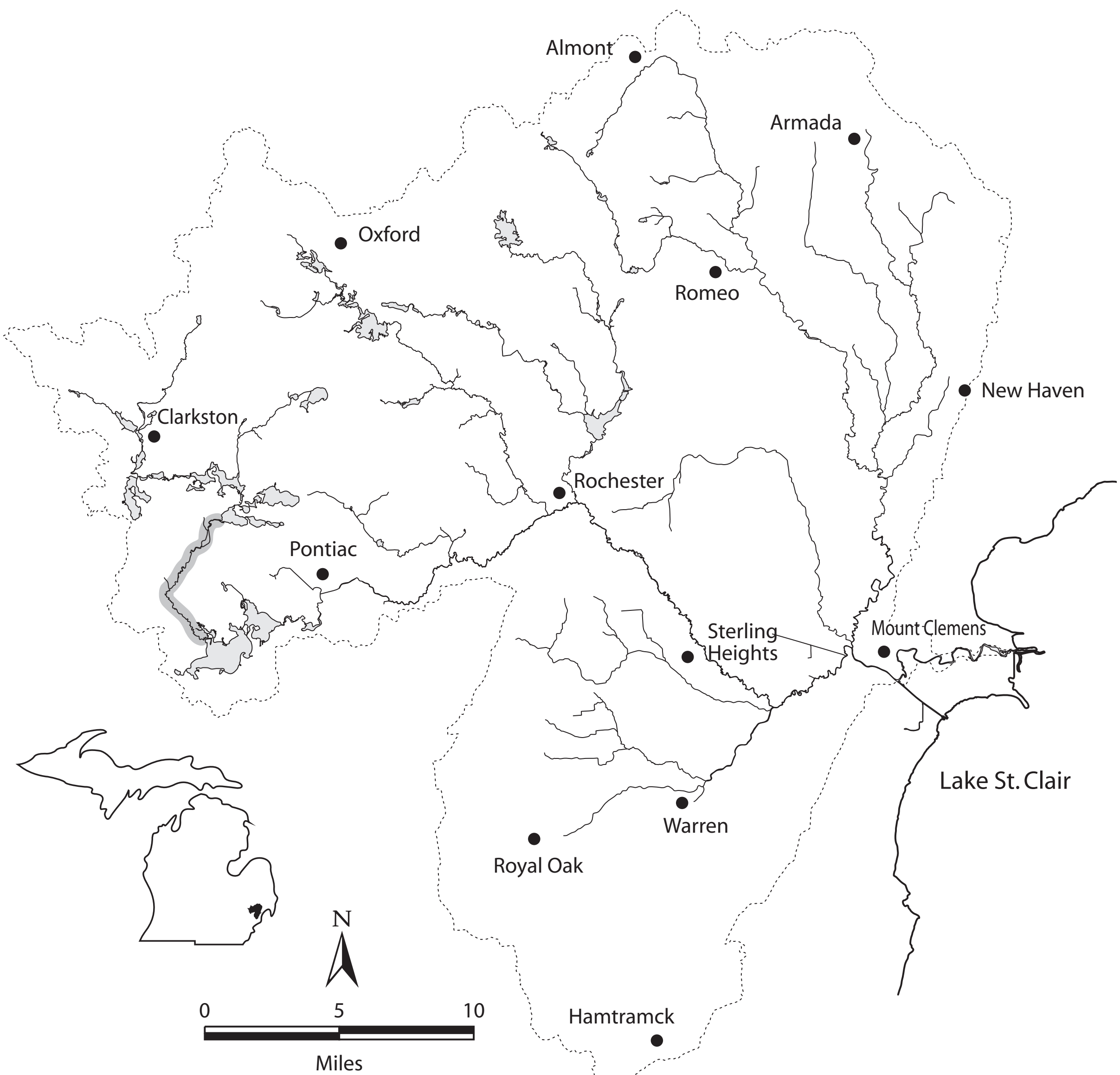


Western banded killifish *Fundulus diaphanus*

Habitat:

feeding - quiet backwaters at the mouths of streams and lakes
- substrate of sand, gravel, and a few boulders
- also found over detritus substrate where patches of submerged aquatic vegetation are present

spawning - quiet areas of weedy pools

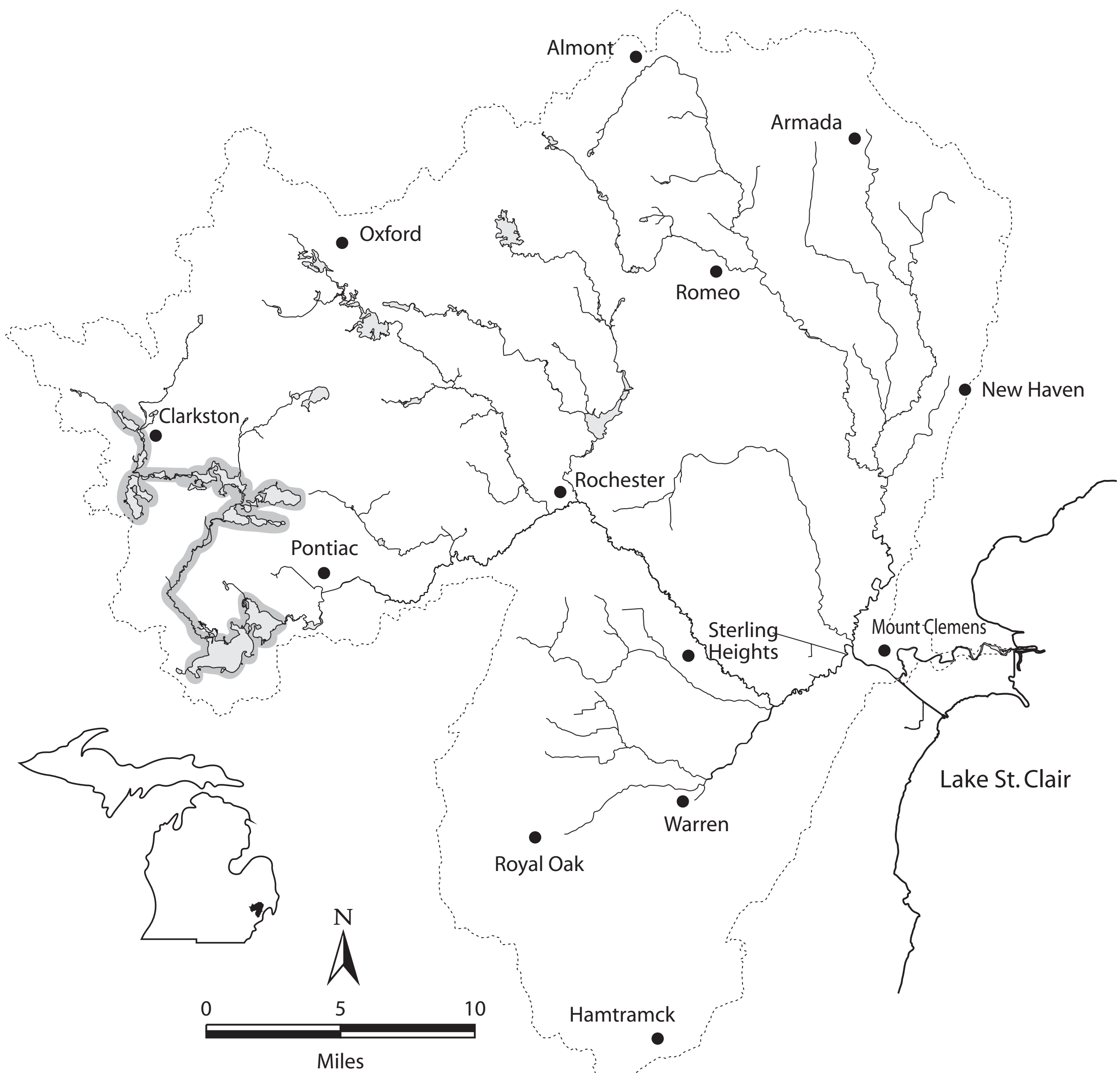


Brook silverside *Labidesthes sicculus*

Habitat:

feeding - clear, warm pools in streams and rivers; also lakes
- does not tolerate turbidity
- most frequently at surface

spawning - in and around aquatic vegetation or over gravel substrate with a moderate current

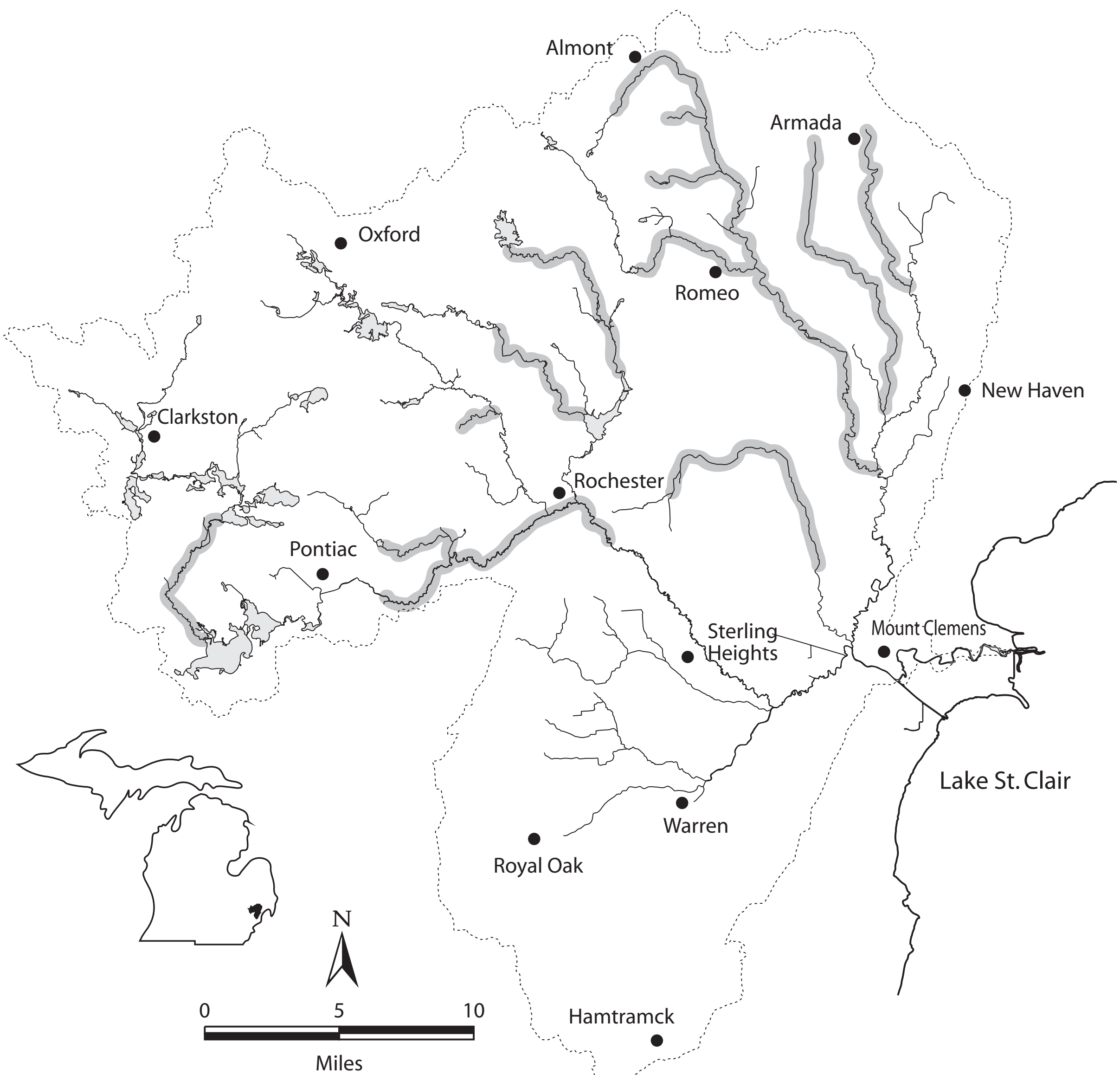


Brook stickleback *Cluaea inconstans*

Habitat:

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

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

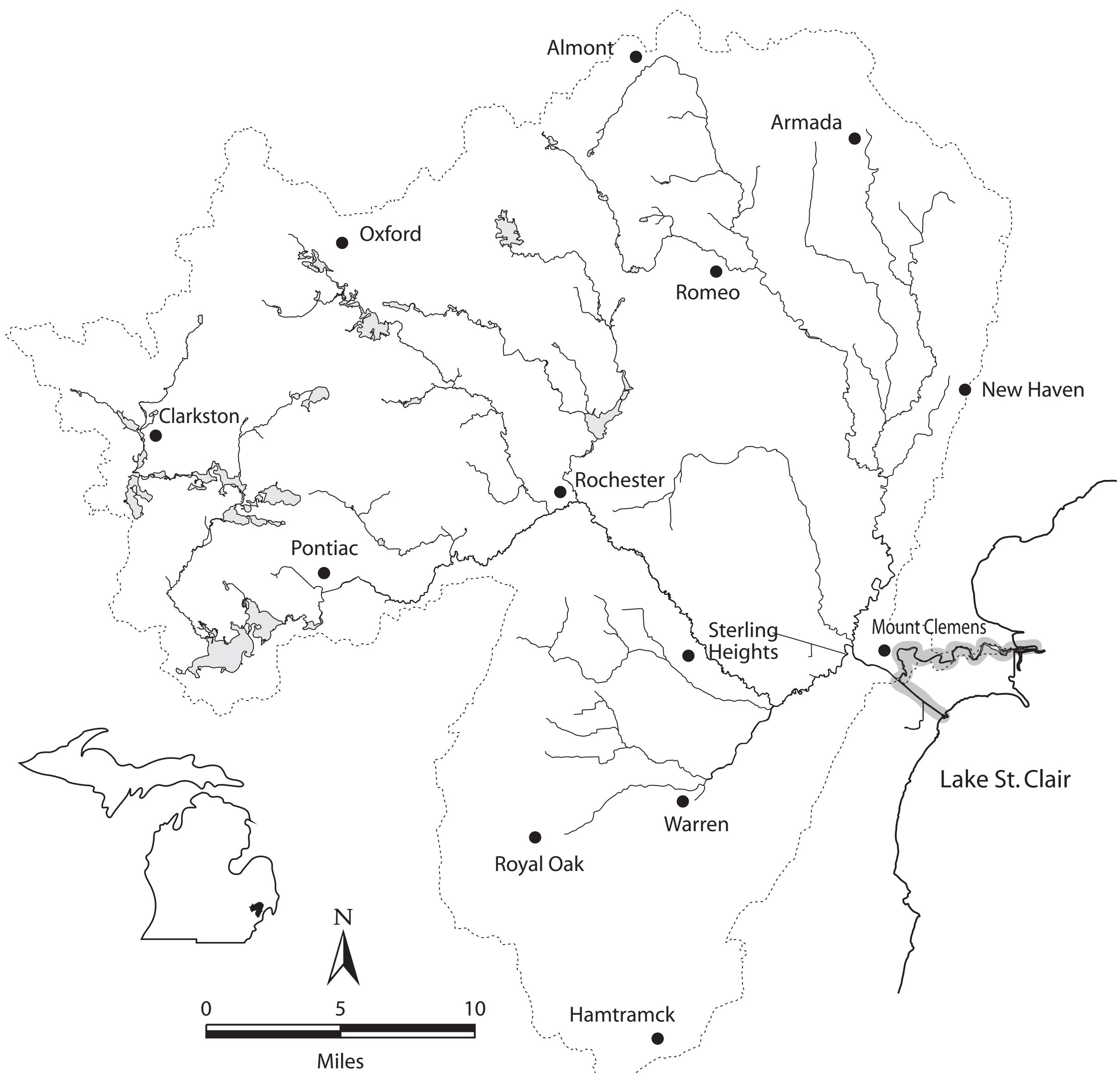


Ninespine stickleback *Pungitius pungitius*

Habitat:

feeding - open water of lakes; also Lake St. Clair
- cool quiet waters

spawning - builds nests among aquatic vegetation in creeks and streams

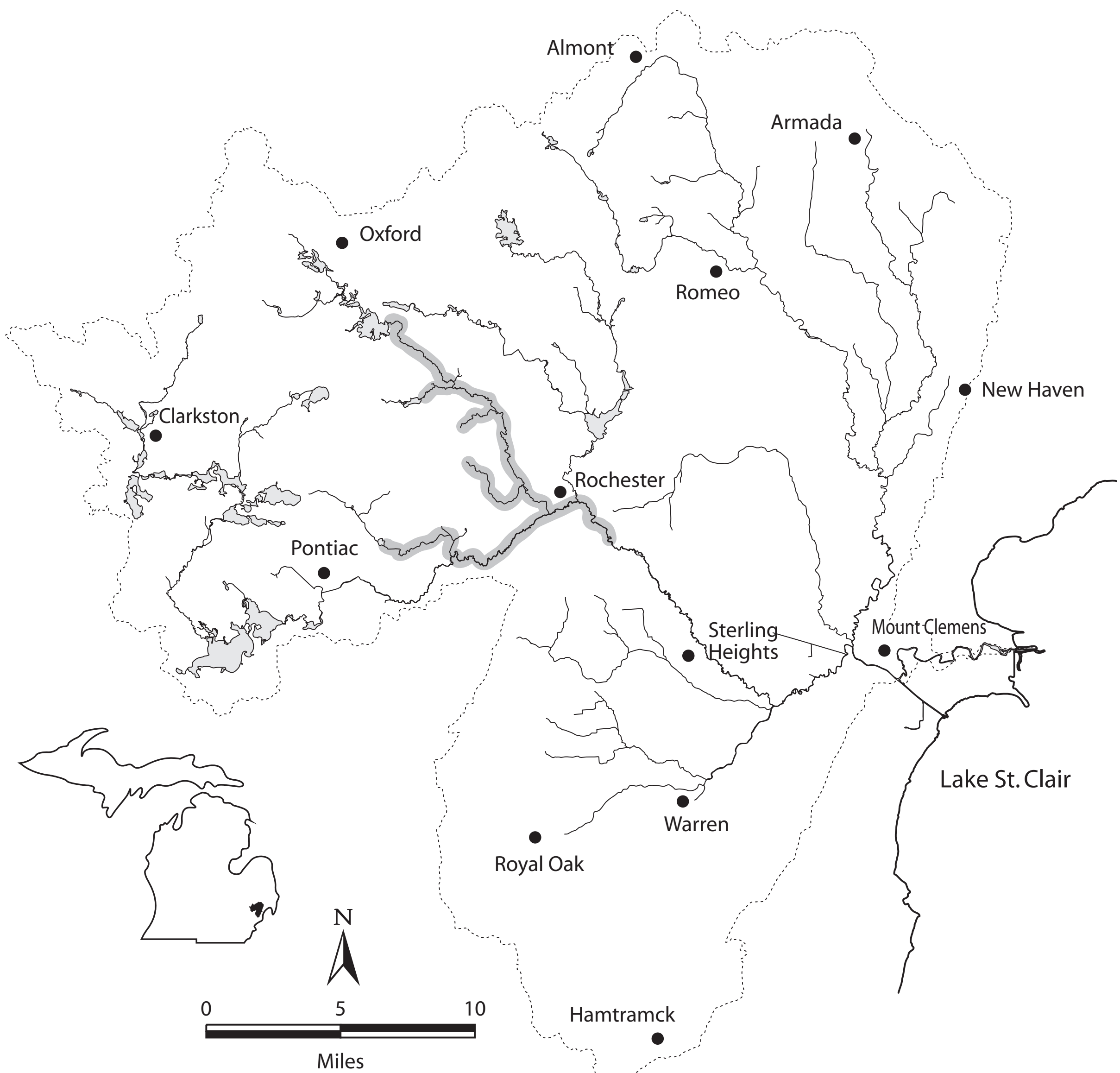


Mottled sculpin *Cottus bairdi*

Habitat:

feeding - cool to cold streams
- riffle and rock substrates preferred
- clear to slightly turbid shallow water

spawning - nests under logs or rock

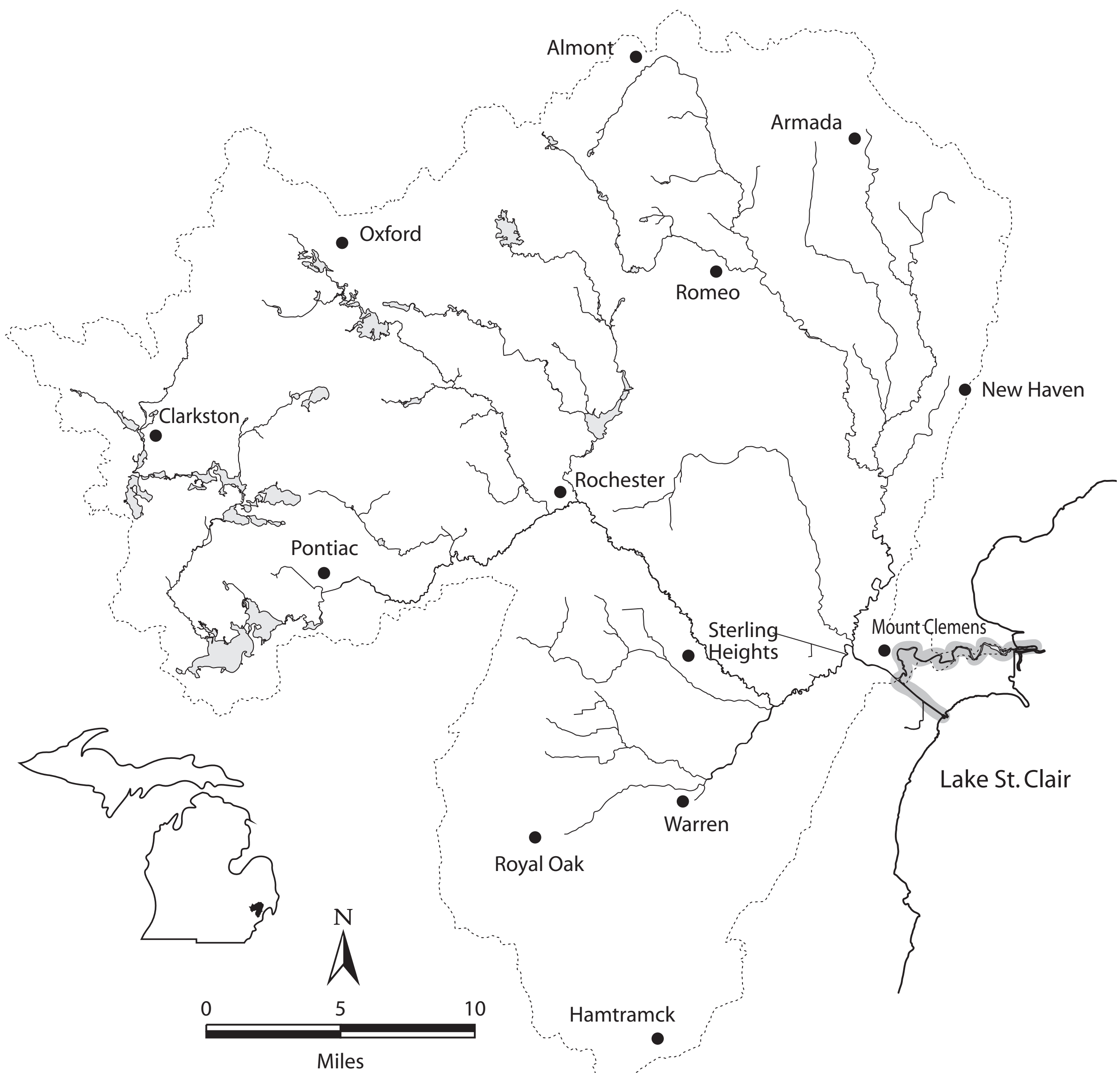


White perch *Morone americana*

Habitat:

feeding - clear, warm water of low-gradient streams, lakes, impoundments, and Lake St. Clair

spawning - shallow water over firm substrate

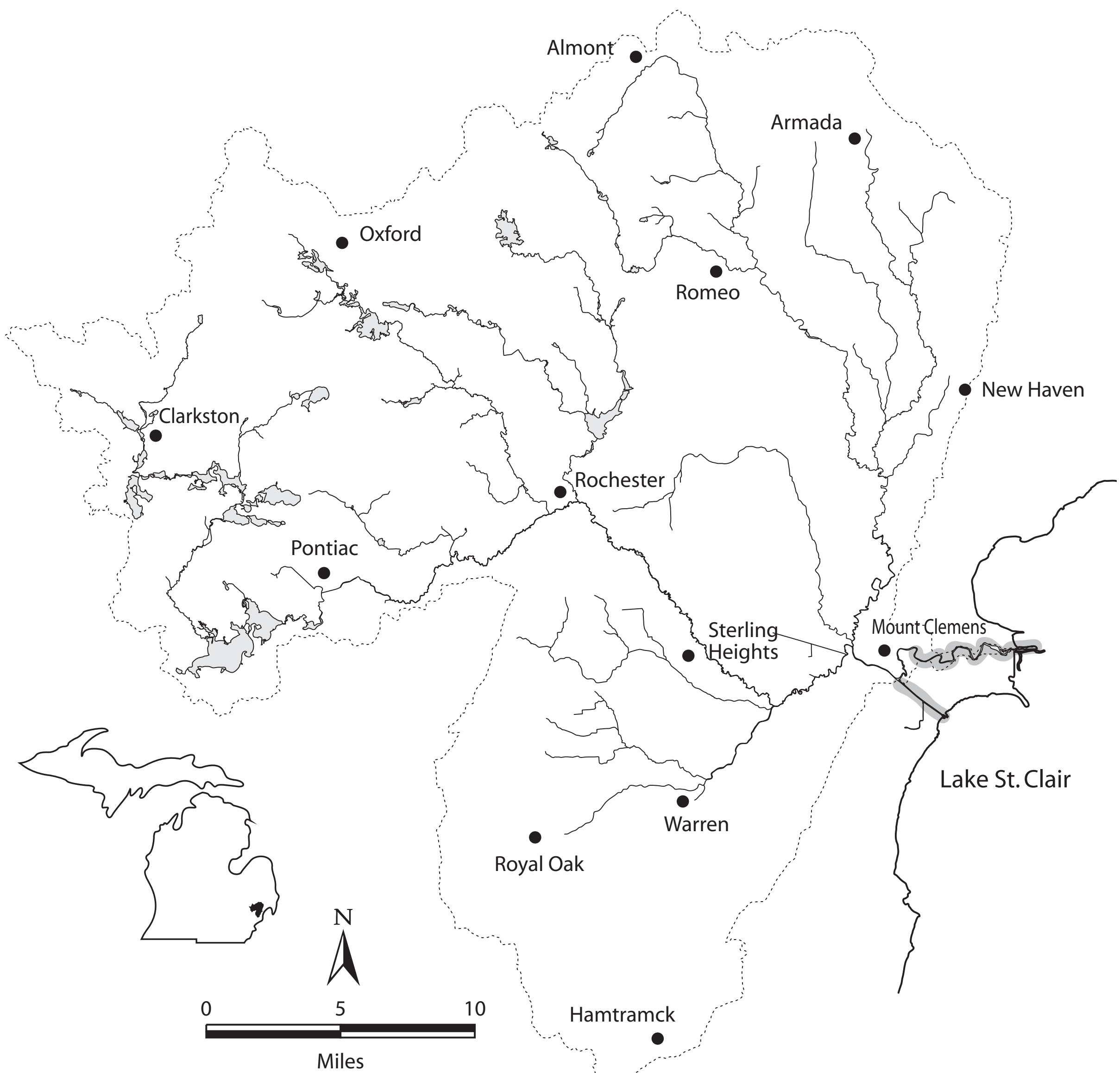


White bass *Morone chrysops*

Habitat:

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

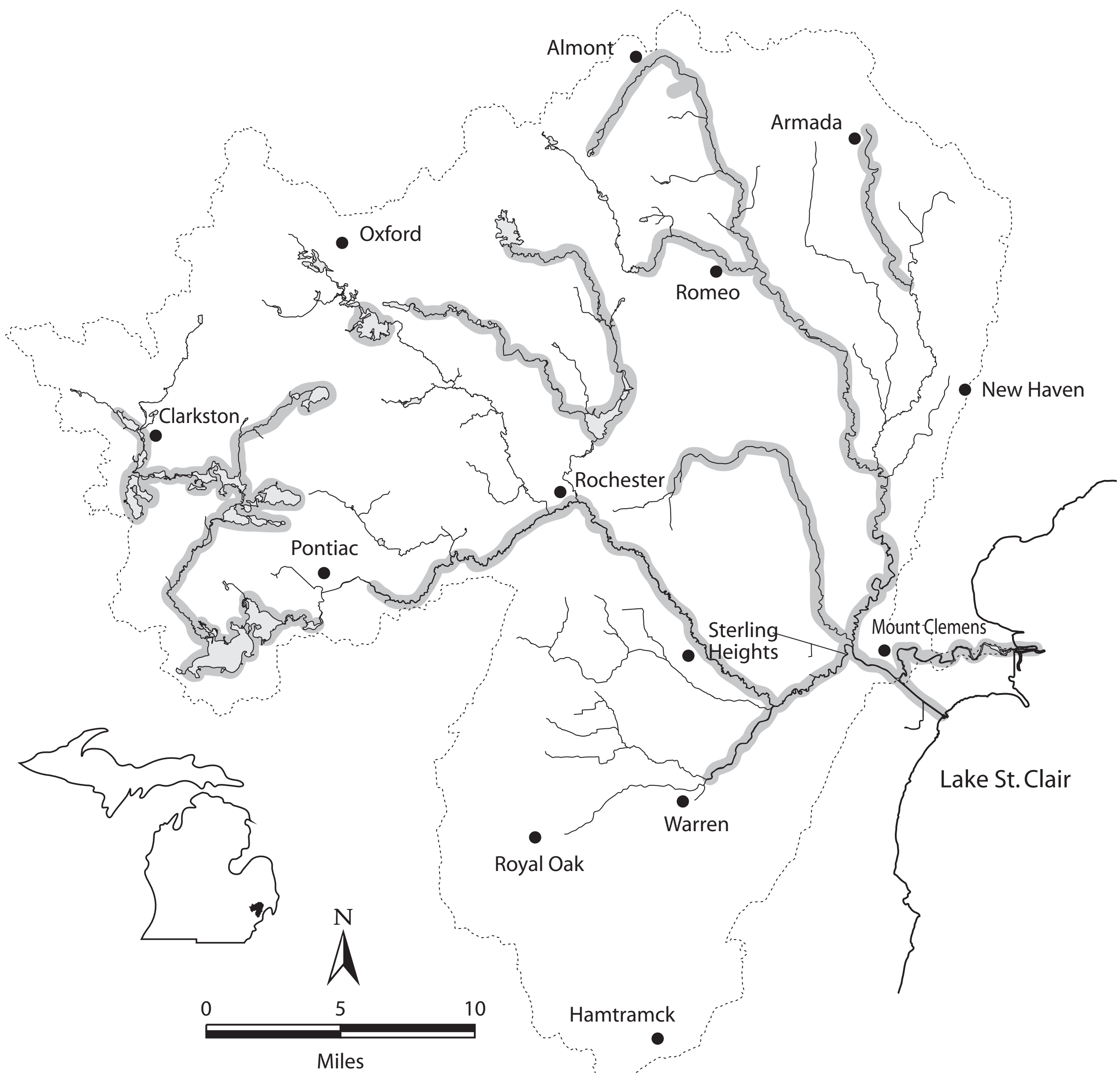
spawning
- tributary streams or shallow water of lakes
- over firm substrate



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

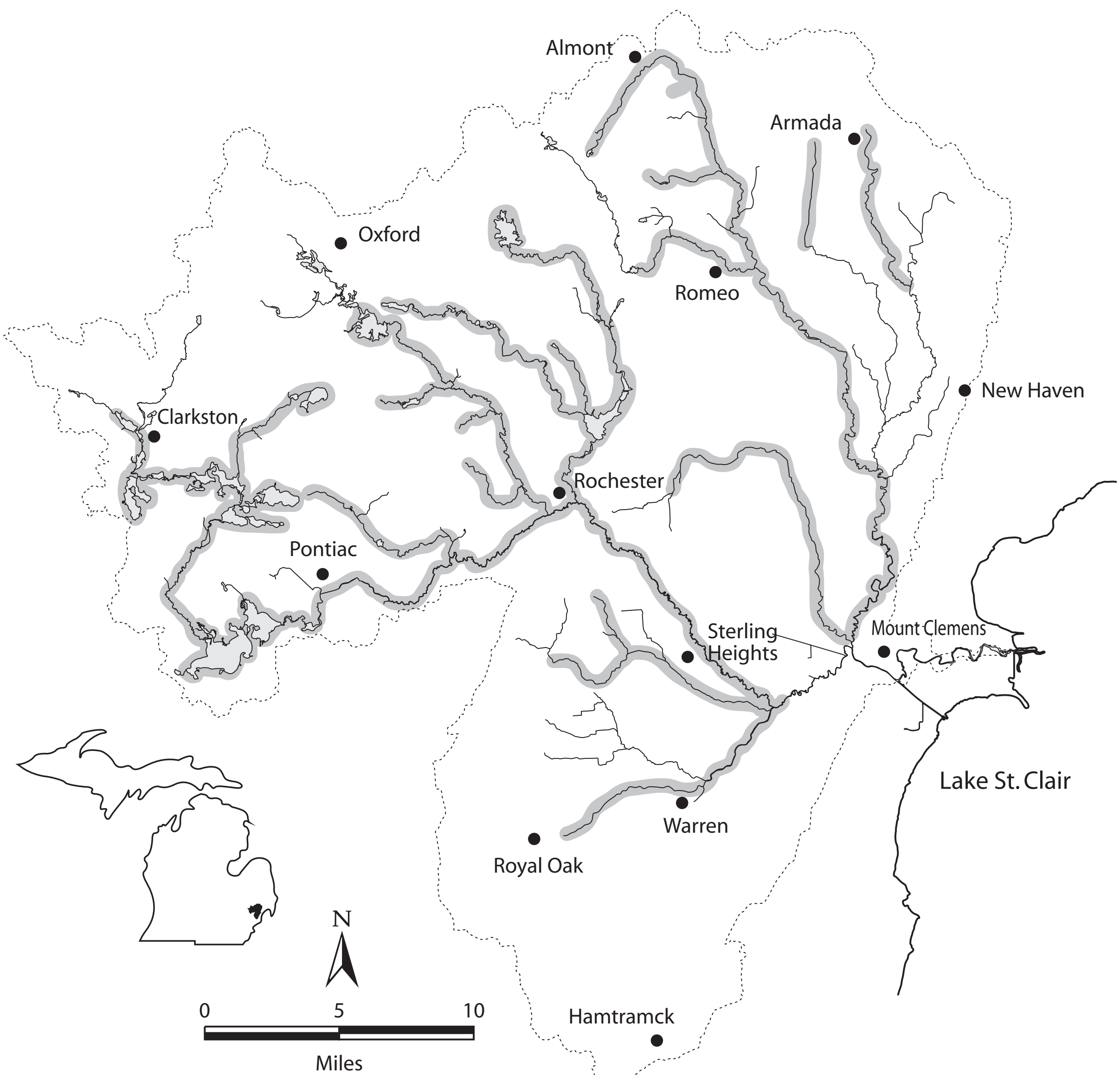


Green sunfish *Lepomis cyanellus*

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

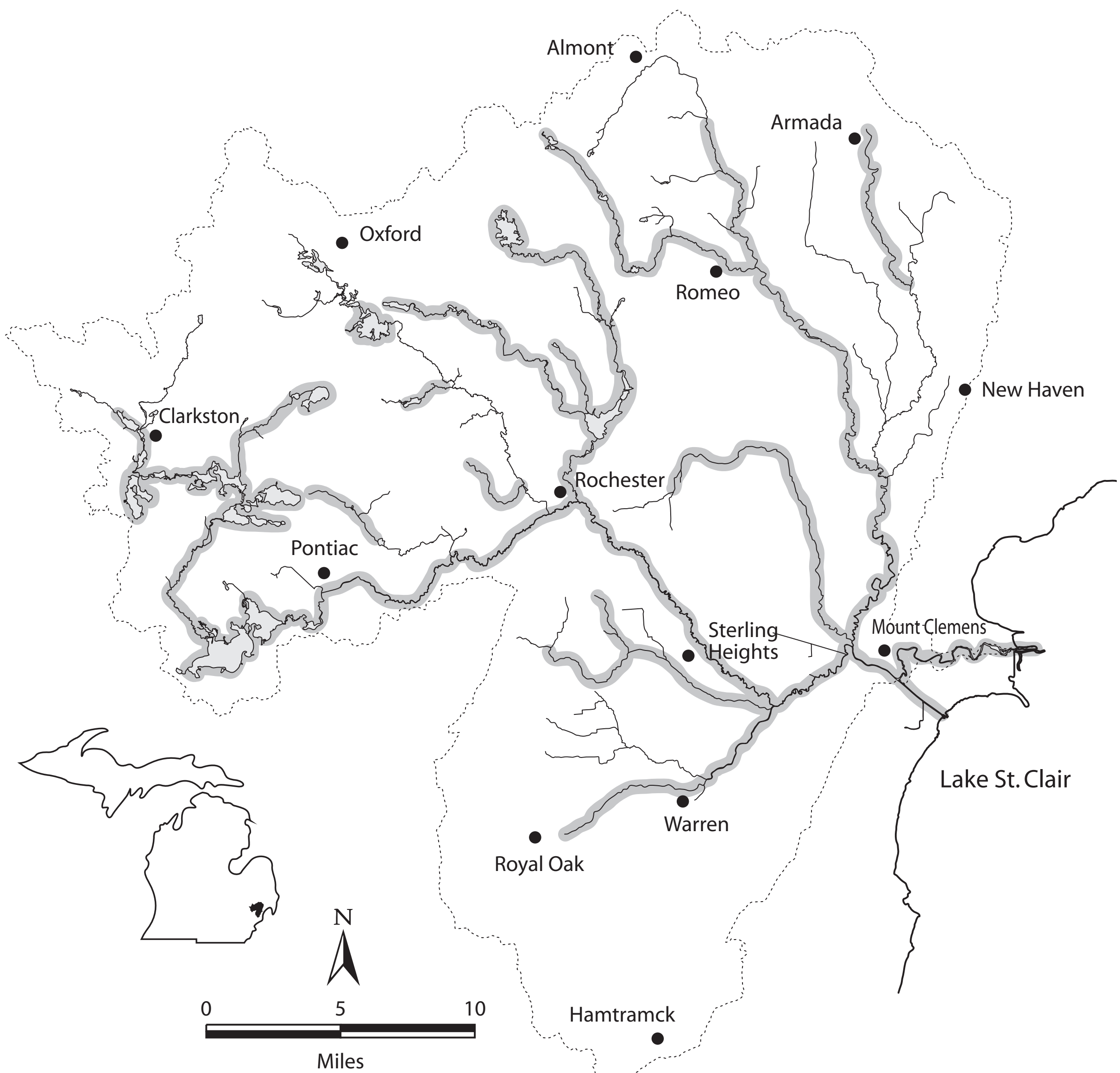


Pumpkinseed *Lepomis gibbosus*

Habitat:

feeding - non-flowing clear water in streams and rivers; also lakes and impoundments
- muck or sand partly covered with organic debris substrate
- dense beds of submerged aquatic vegetation

spawning - nest in sand, gravel, or rock substrate
- in shallow water near submerged vegetation

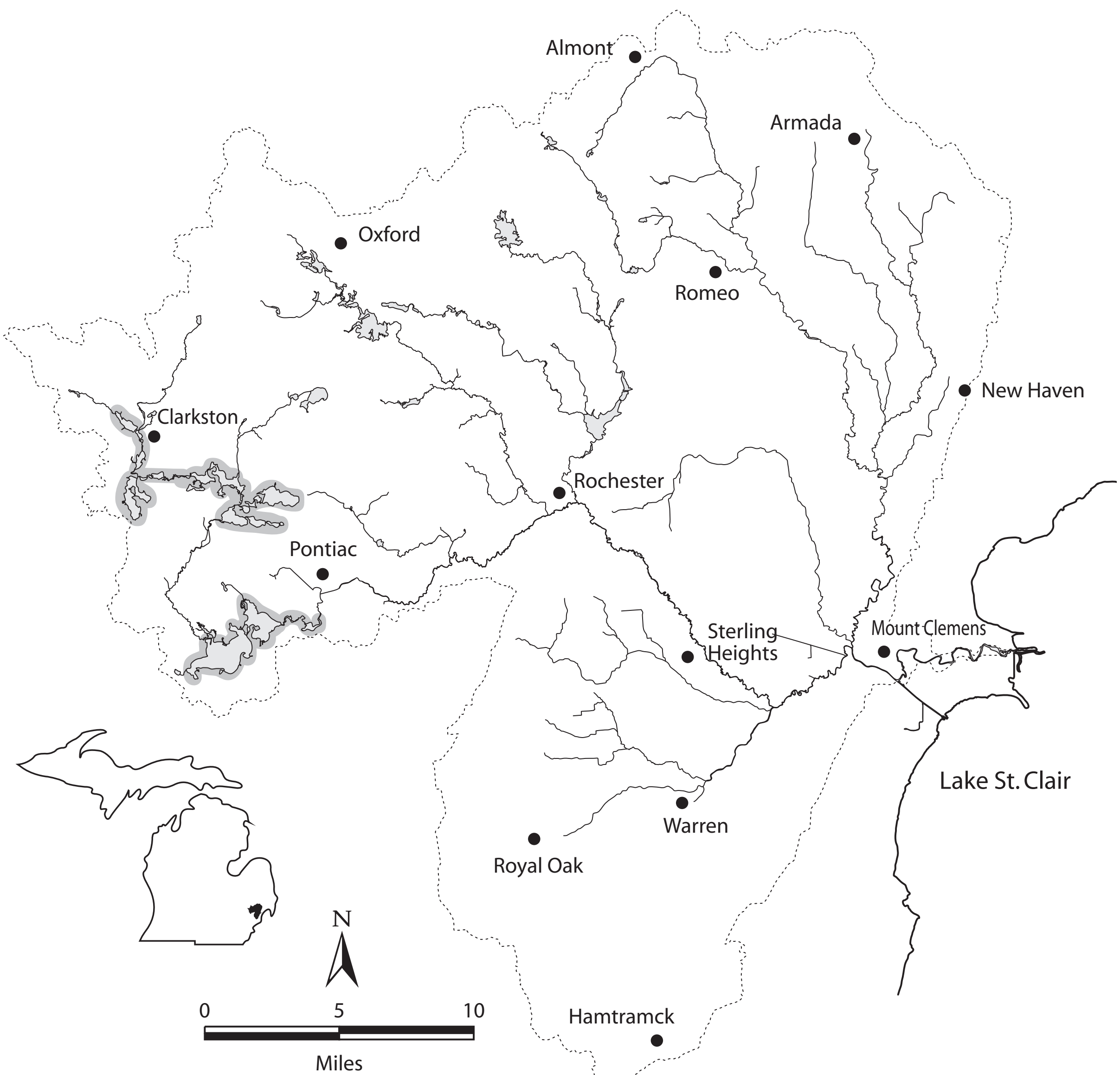


Warmouth *Lepomis gulosus*

Habitat:

feeding
- clear lakes and impoundments and very low-gradient streams
- abundant aquatic vegetation
- silt-free water
- mucky substrate often covered with organic debris

spawning
- nesting sites in loose silt, sand with silt, or rubble over silt near stumps, roots, or vegetation



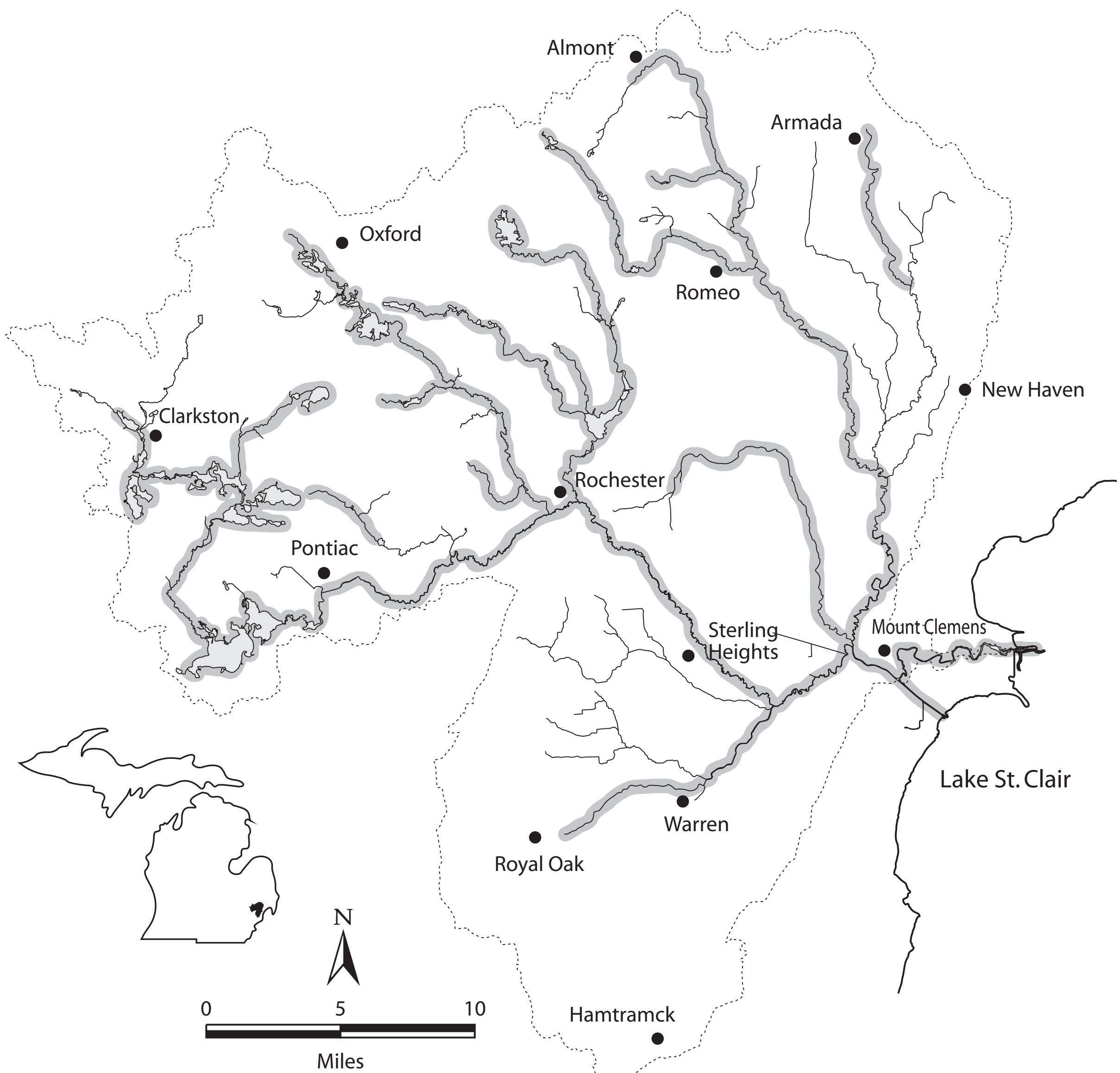
Bluegill *Lepomis macochrius*

Habitat:

feeding - non-flowing clear streams and rivers; also lakes and impoundments
- sand, gravel, or muck containing organic debris substrate
- scattered beds of aquatic vegetation
- cannot tolerate low oxygen or continuous high turbidity and siltation

spawning - nests in firm substrate of gravel, sand, or mud

winter refuge - deep water

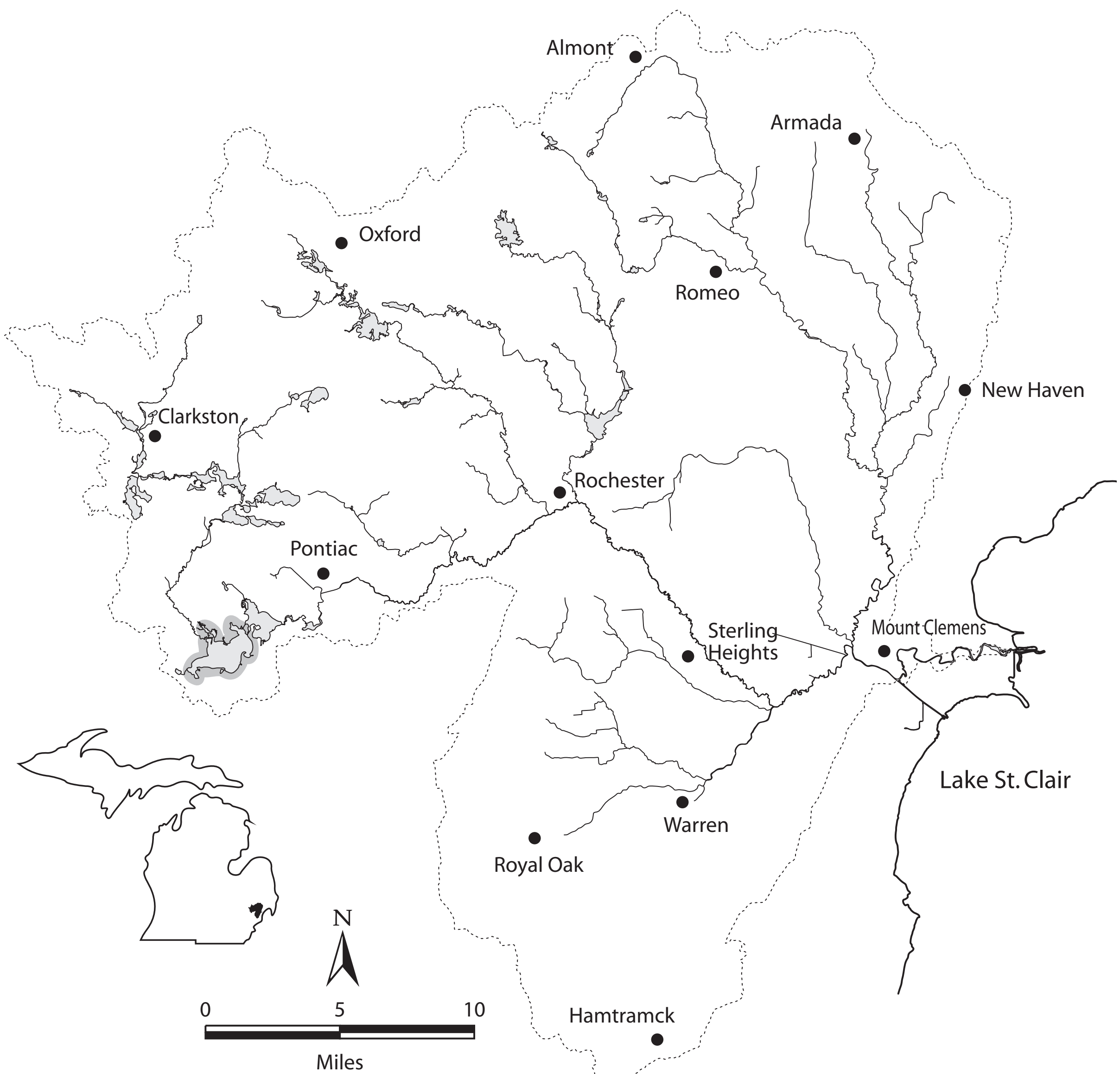


Redear sunfish *Lepomis microlophus*

Habitat:

feeding - non-flowing clear waters of streams and lakes
- some aquatic vegetation

spawning - nest in silt or gravel substrate

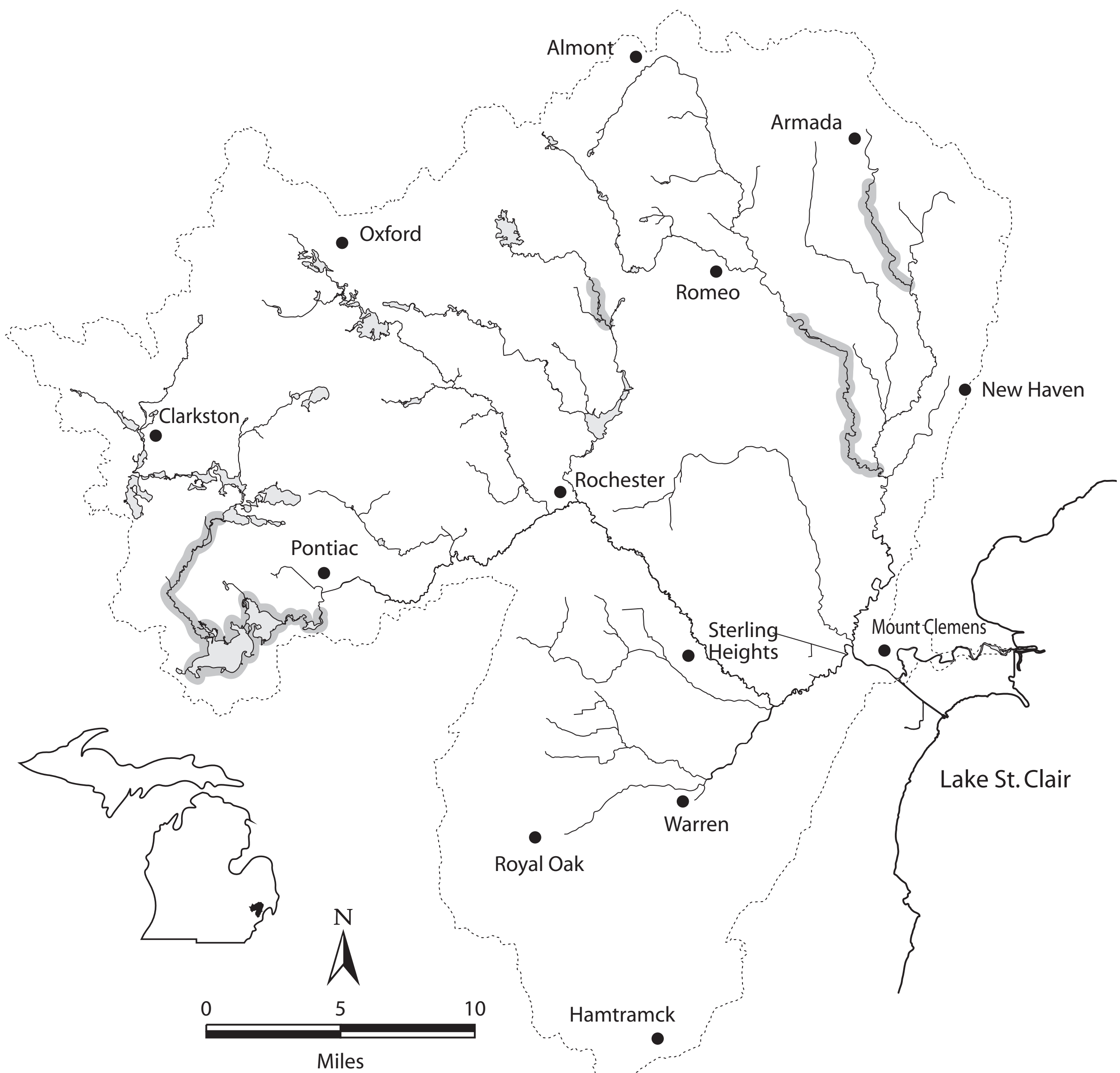


Northern longear sunfish *Lepomis peltastes*

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



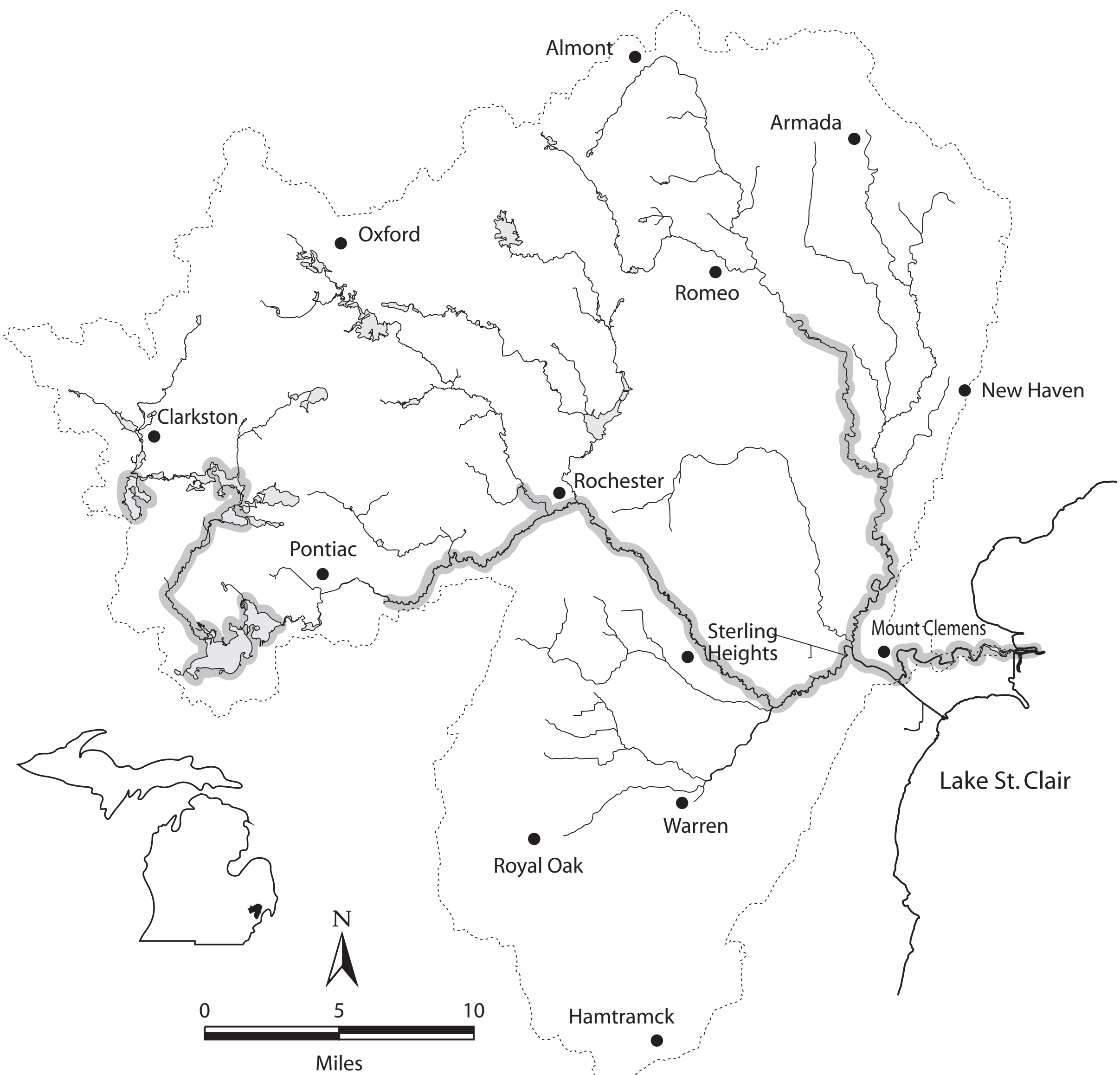
Smallmouth bass *Micropterus dolomieu*

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

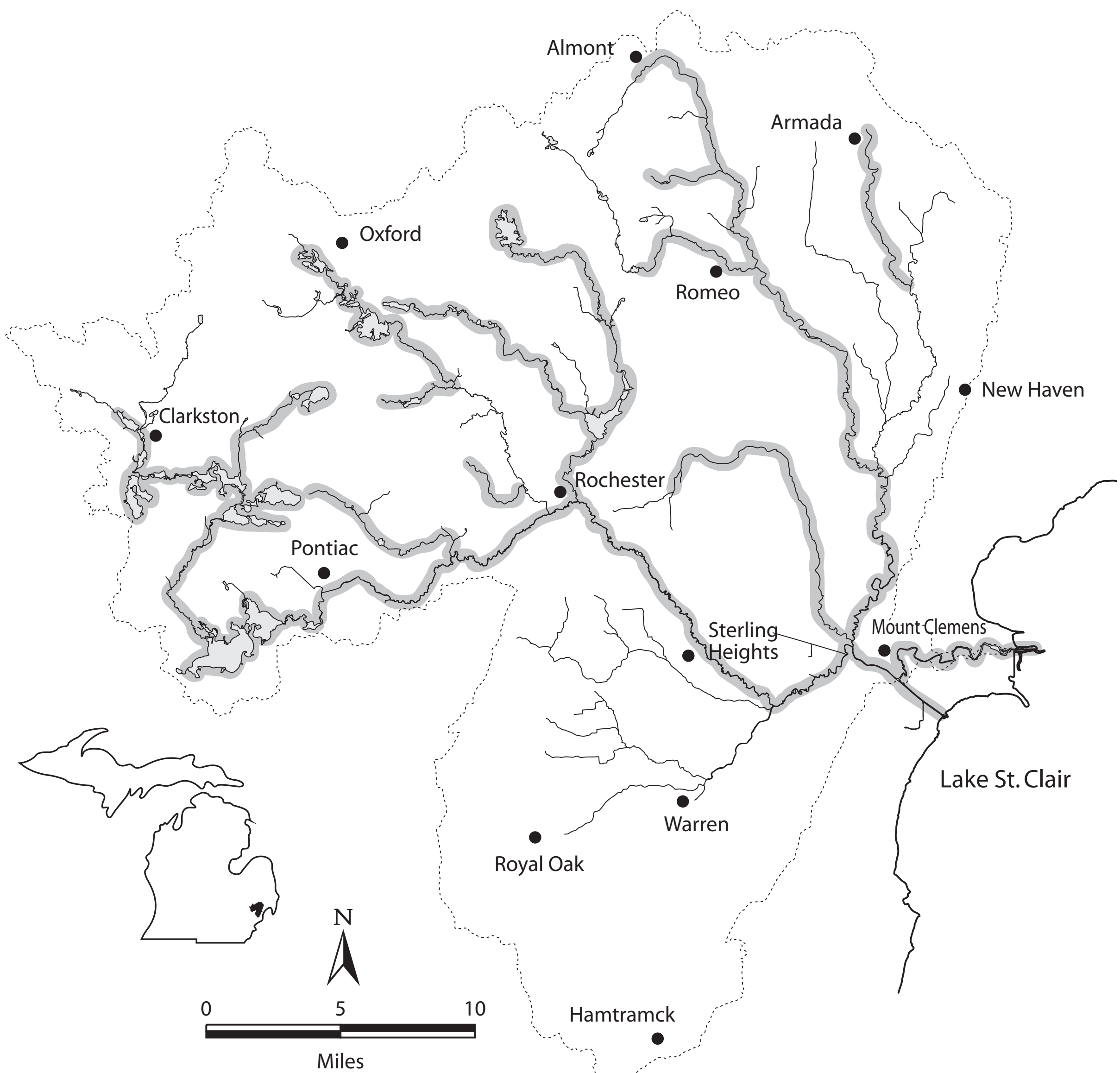


Largemouth bass *Micropterus salmoides*

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

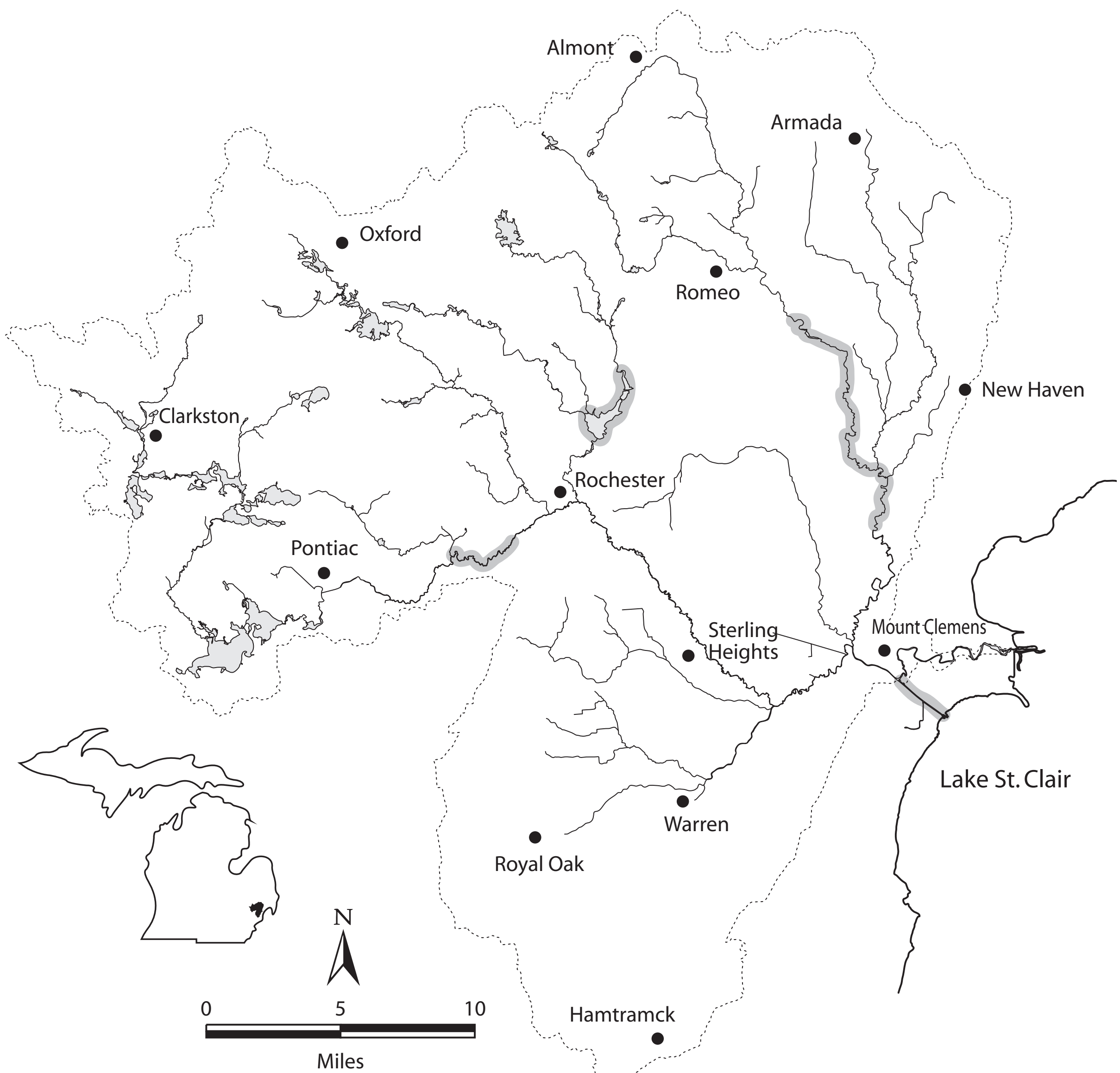


White crappie *Pomoxis annularis*

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

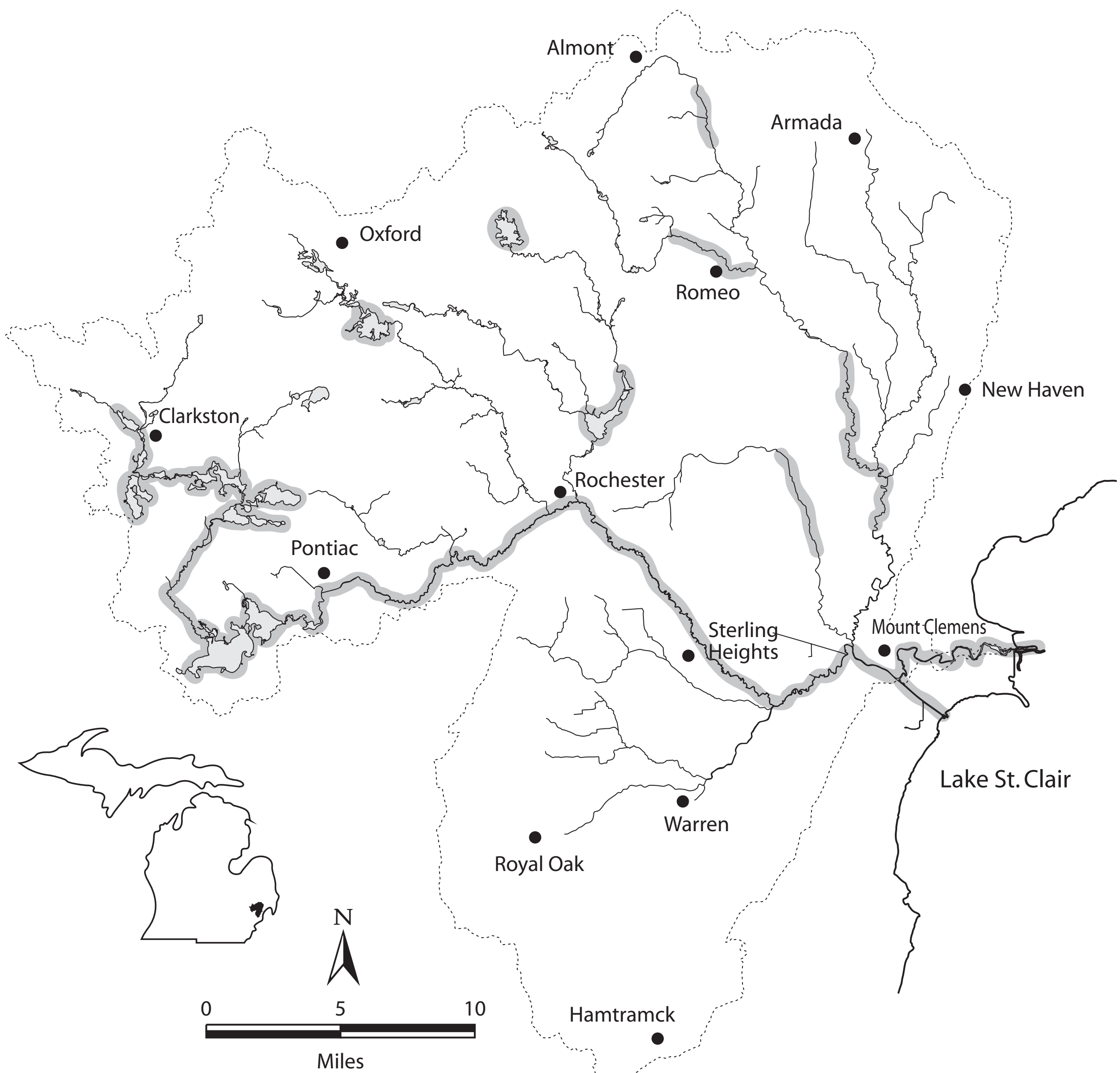


Black crappie *Pomoxis nigromaculatus*

Habitat:

feeding
- larger clear non-silty low-gradient rivers; also in lakes and impoundments
- clean hard sand or muck substrate
- associated with submerged aquatic vegetation
- does not tolerate silt or turbidity well

spawning
- nests in gravel, sand, or mud substrate
- some vegetation must be present
- sometimes nests under banks

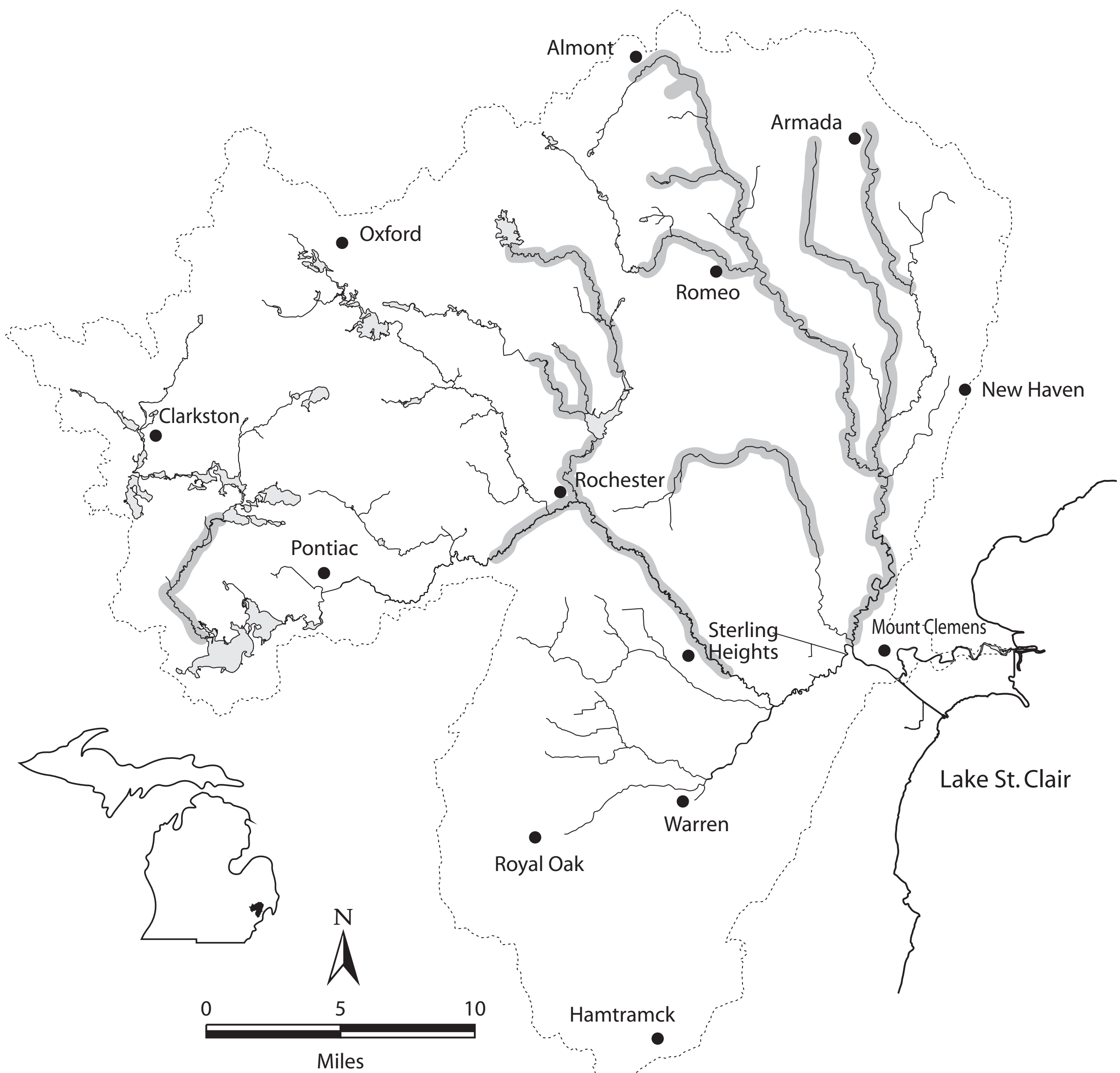


Greenside darter *Etheostoma blennioides*

Habitat:

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

spawning - filamentous algae necessary for egg deposition

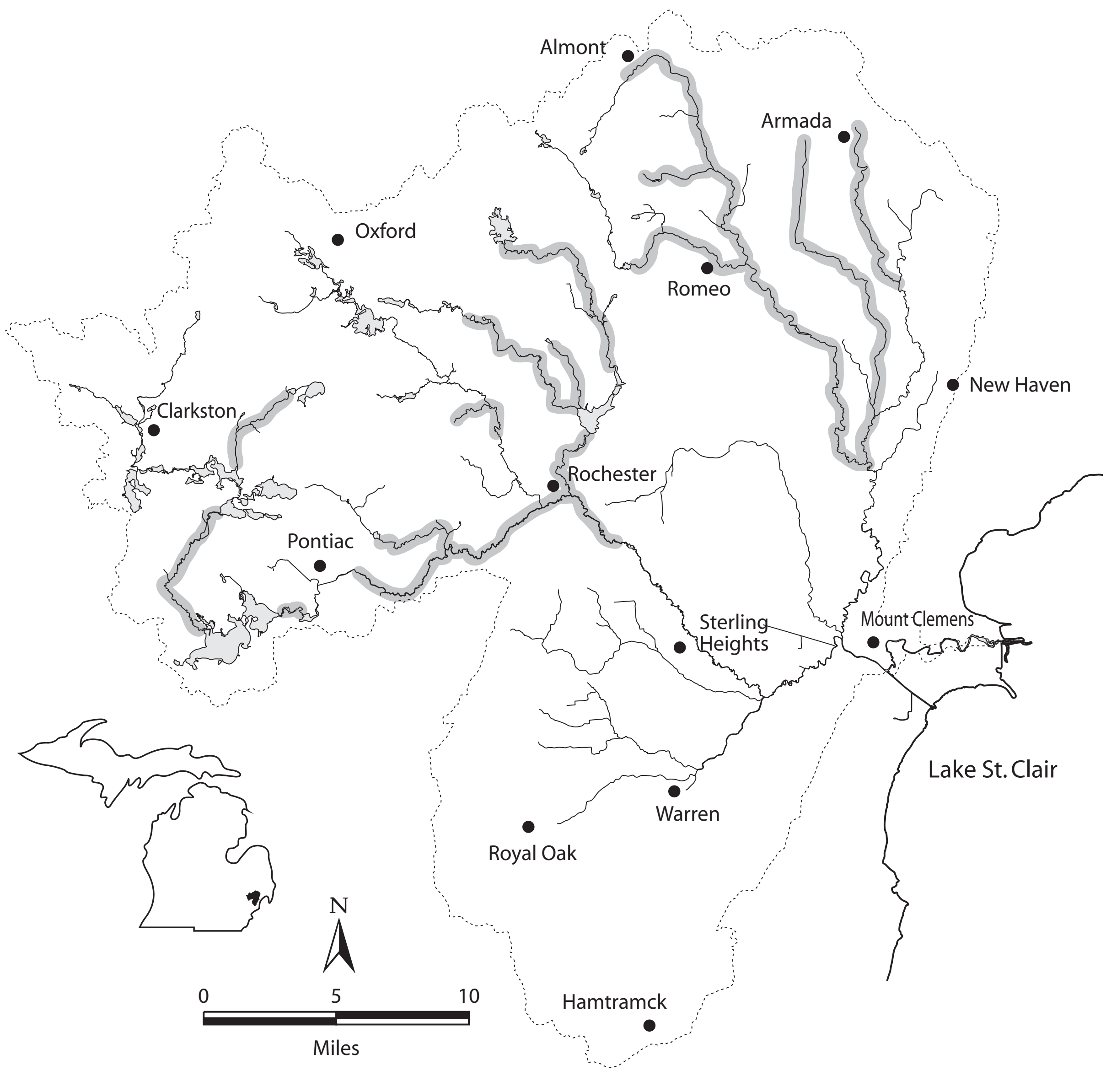


Rainbow darter *Etheostoma caeruleum*

Habitat:

feeding - gravelly high gradient riffles
- clear, moderate to large streams
- in shallows (average 1 foot)

spawning - gravel or rubble riffles

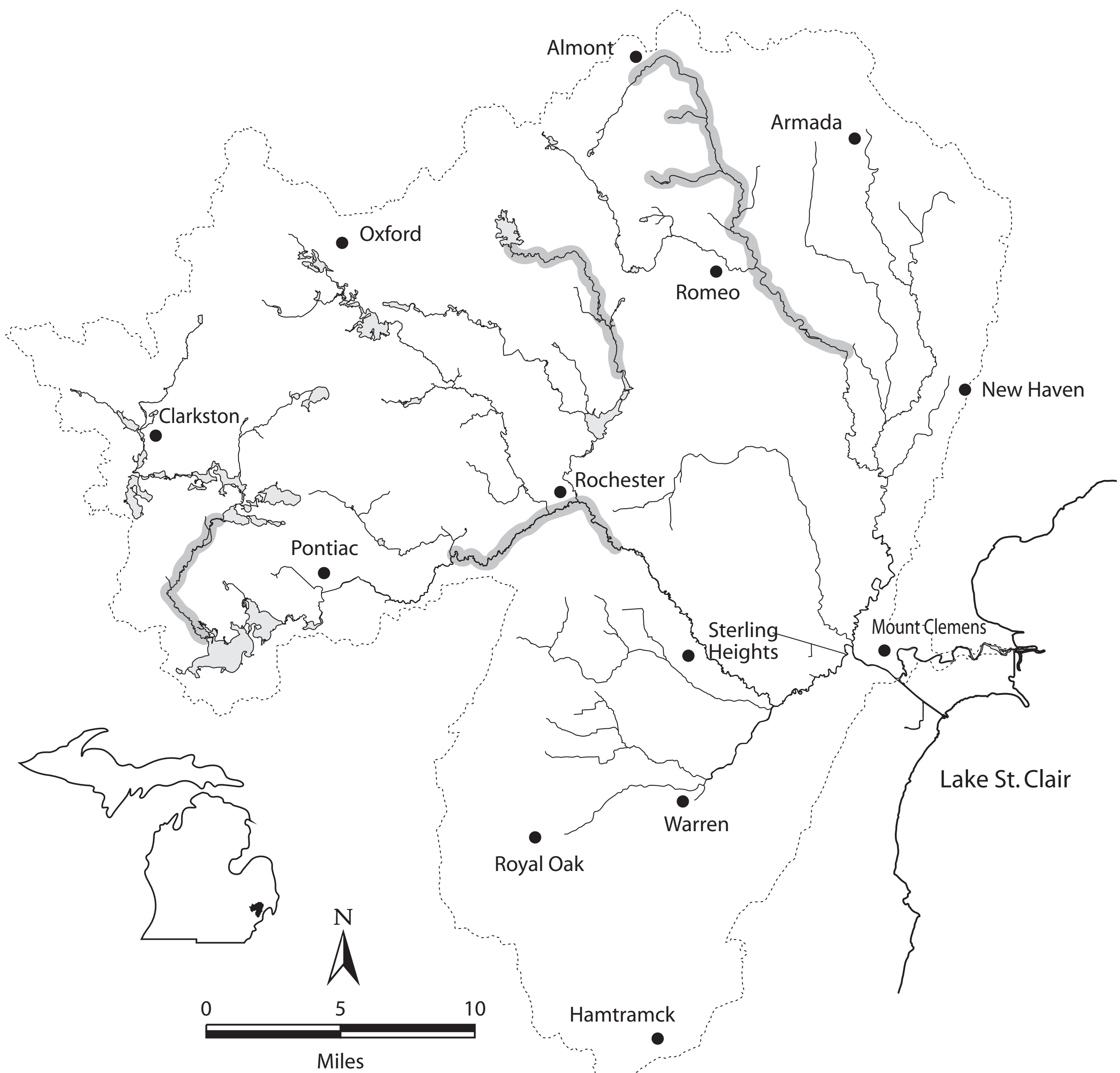


Iowa darter *Etheostoma exile*

Habitat:

feeding
- clear, slow moving streams and lakes
- sandy to muddy substrates
- intolerant of turbid water
- lives in rooted aquatic vegetation

spawning
- in pond-like extensions of streams on organic matter or roots
- in shallows



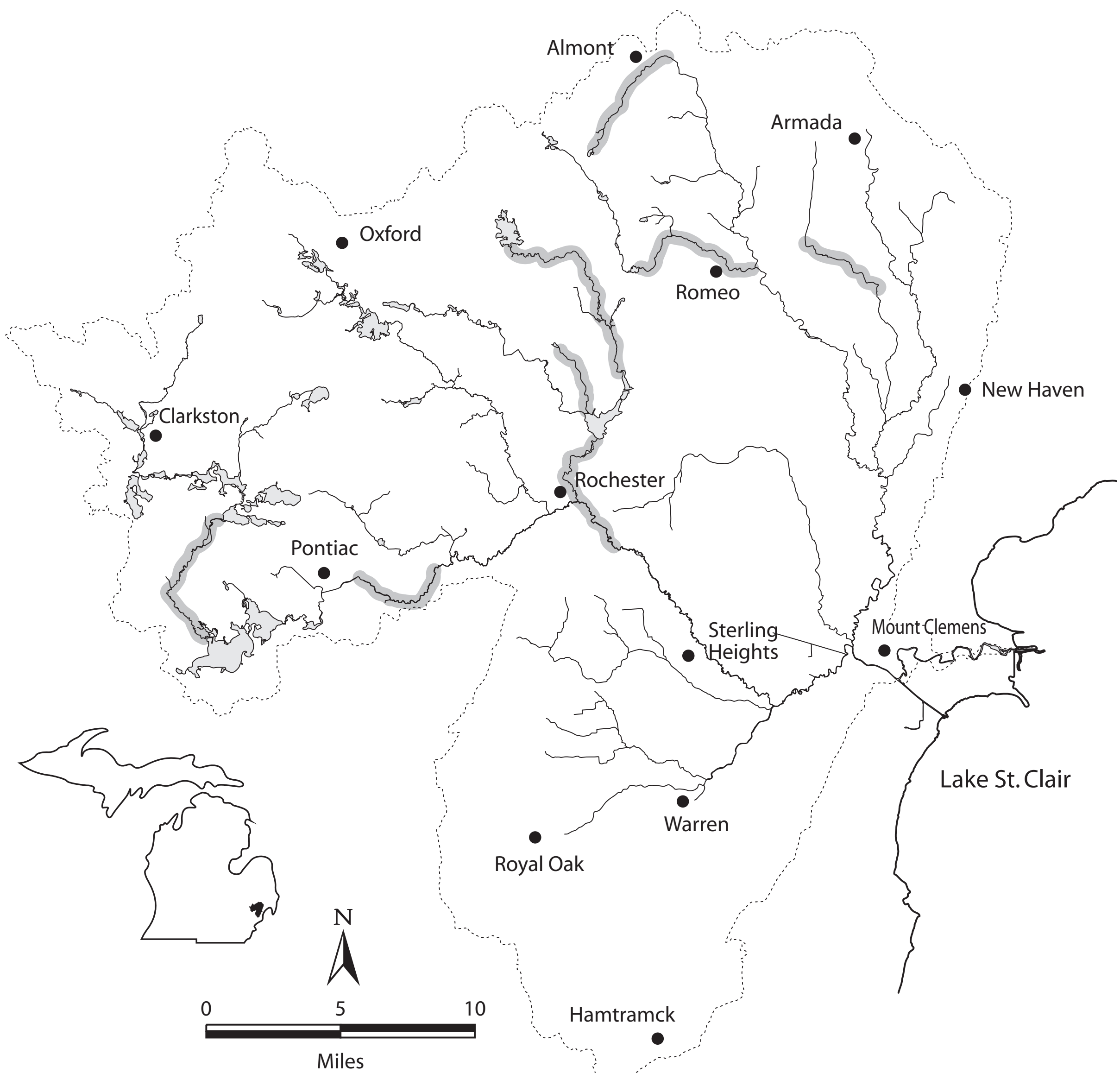
Fantail darter *Etheostoma flabellare*

Habitat:

feeding - small, shallow (<18 inches) streams
- some tolerance of turbidity and siltation
- clear warm waters
- slow to moderate current
- gravel and boulder substrate

spawning - gravel in slower water
- lays eggs on underside of rocks, male guards and fans them

winter refuge - moves downstream to larger and deeper waters

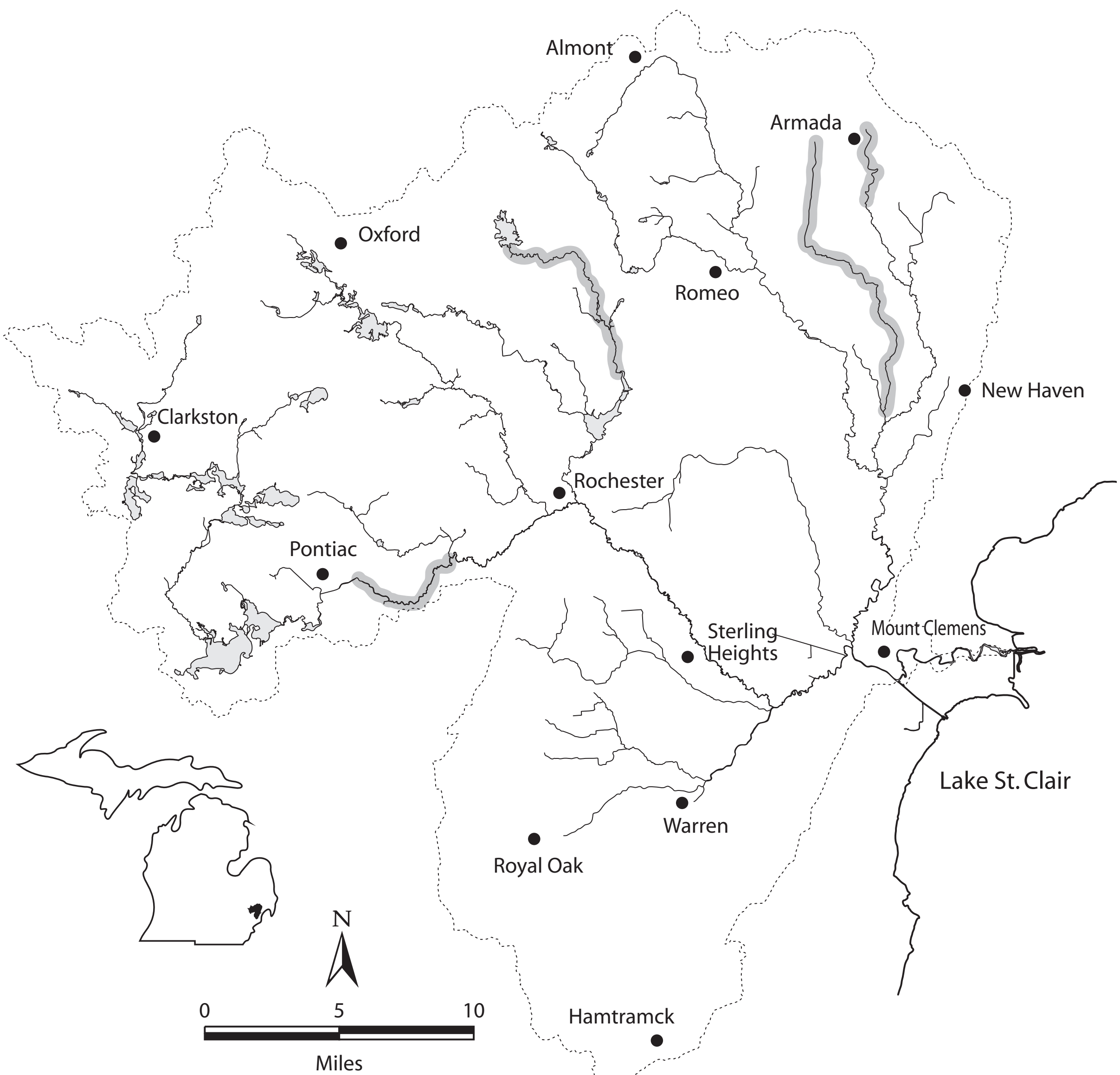


Least darter *Etheostoma microperca*

Habitat:

feeding
- moderate to warm temperature
- clear quiet low-gradient vegetated streams (wetlands, floodplains)
- soft substrate

spawning
- spawning occurs on stems of plants
- male guards a territory in a vegetated area

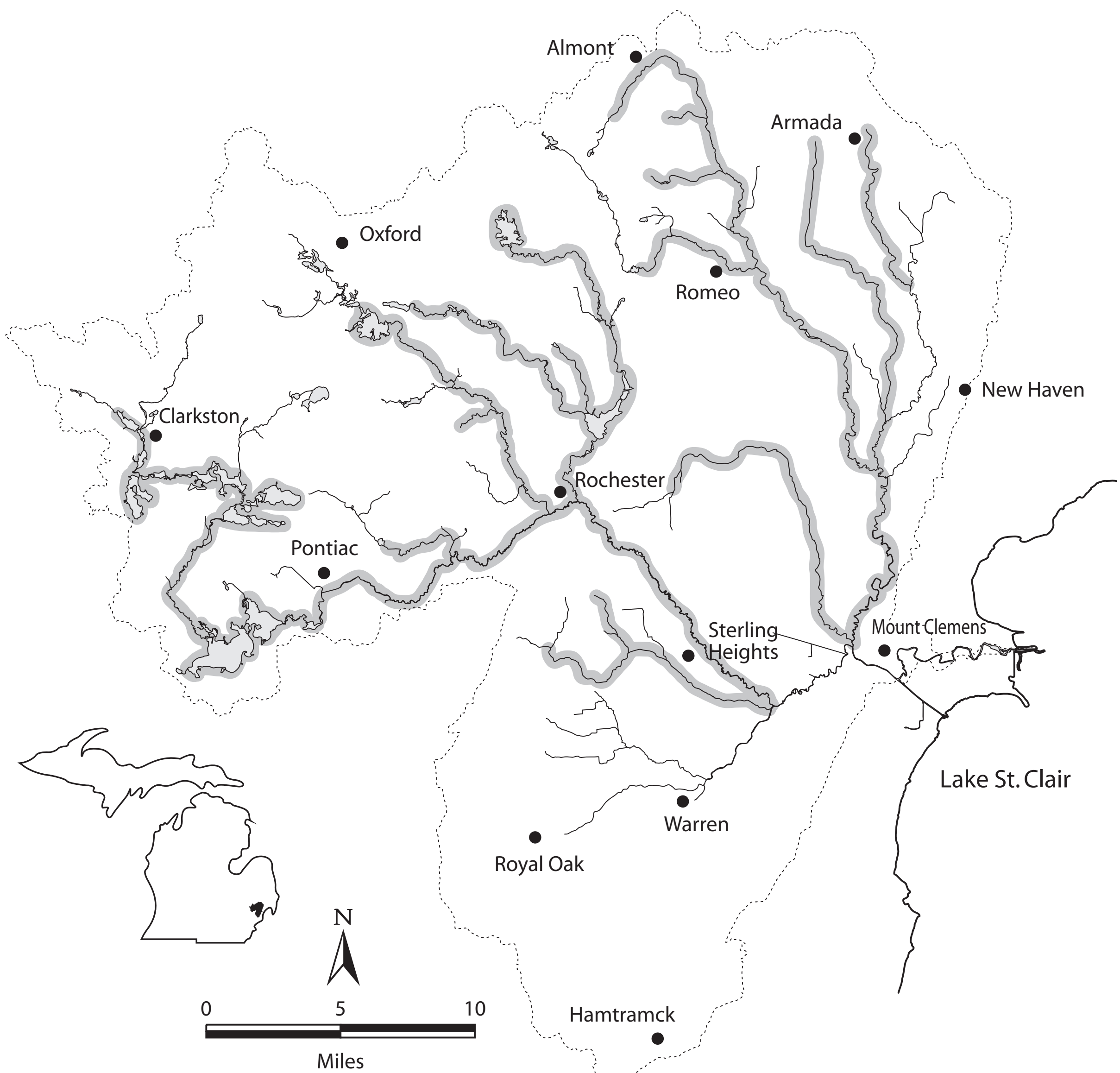


Johnny darter *Etheostoma nigrum*

Habitat:

feeding
- sand and silt substrate
- little to moderate current
- shallow areas of streams, rivers, lakes, and impoundments
- tolerant of many organic and inorganic pollutants and turbidity

spawning
- underneath rocks
- in stream pools or protected shallows of lakes

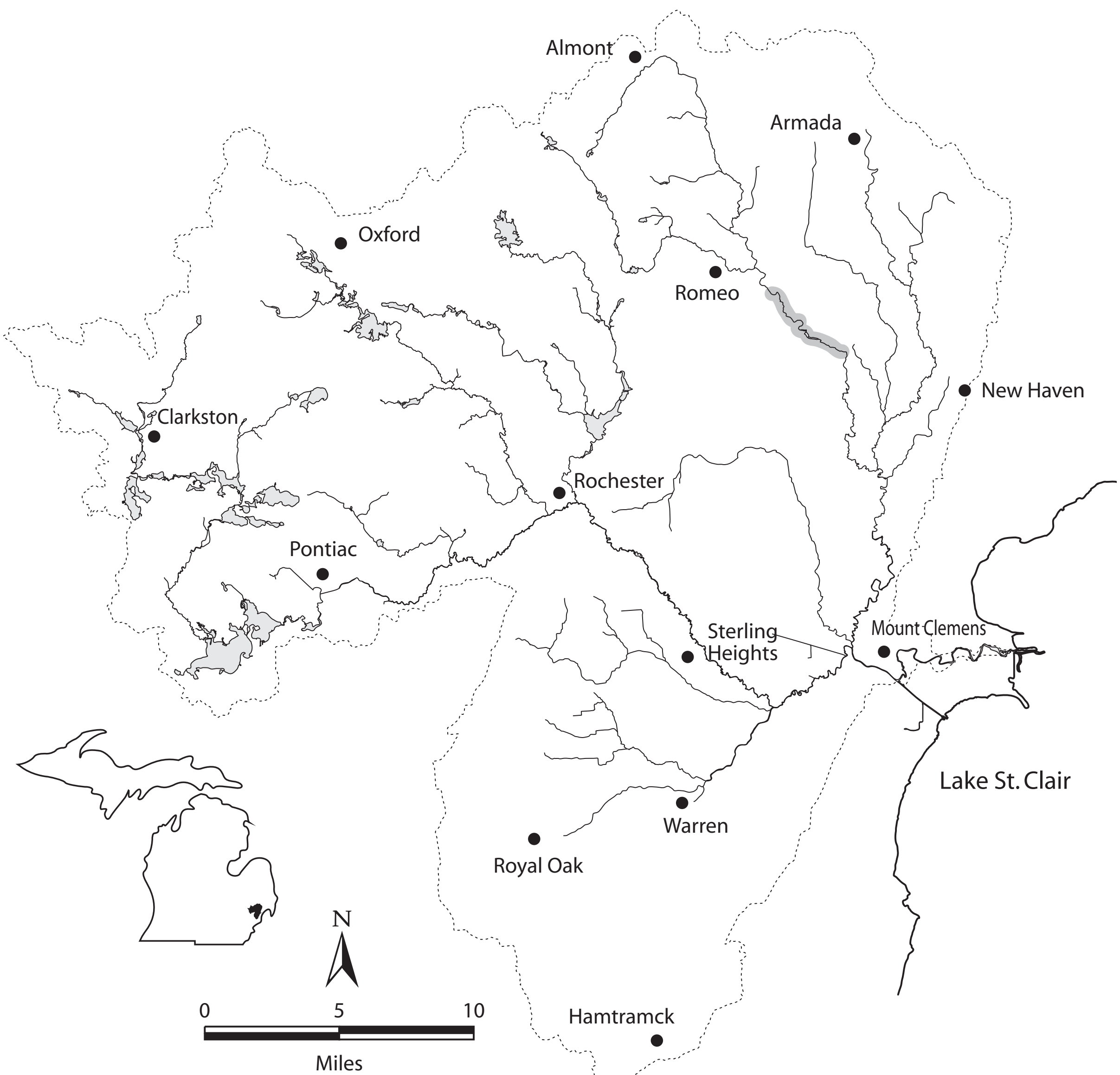


Orangethroat darter *Etheostoma spectabile*

Habitat:

feeding
- small-moderate size creeks and spring branches
- sand, gravel, or rock substrate in sluggish riffles or in pools with sufficient current to prevent siltation
- prefers clear streams but tolerant to turbidity
- low to moderate gradient

spawning
- gravel riffles
- slow current

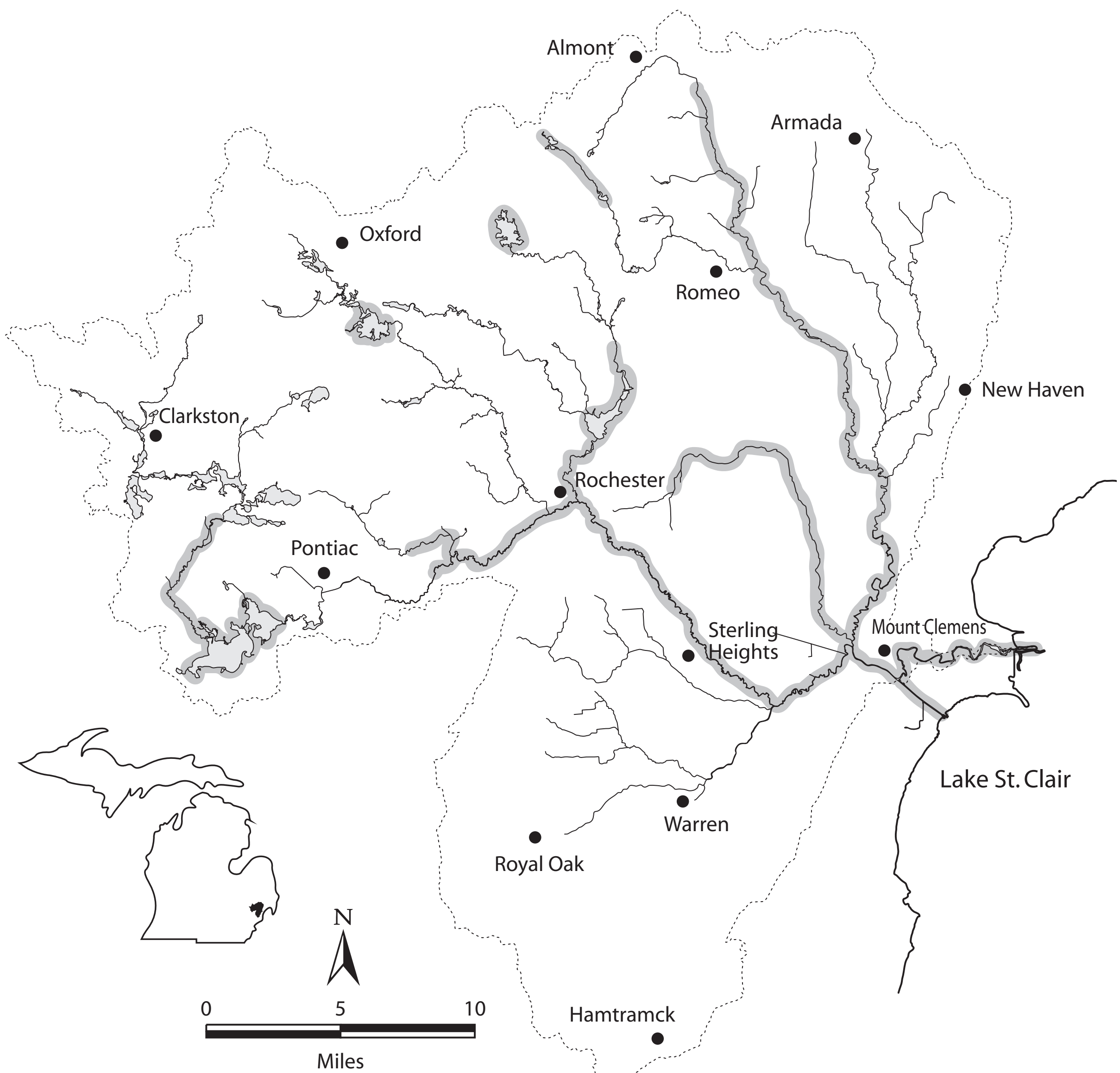


Yellow perch *Perca flavescens*

Habitat:

feeding - clear lakes and impoundments; also Lake St. Clair
- low gradient rivers
- abundance of rooted aquatics
- muck, organic debris, sand, or gravel substrate
- does not tolerate turbidity and siltation

spawning - shallows of lakes, tributaries of streams
- occurs over rooted vegetation, submerged brush, fallen trees
- may occur over sand or gravel

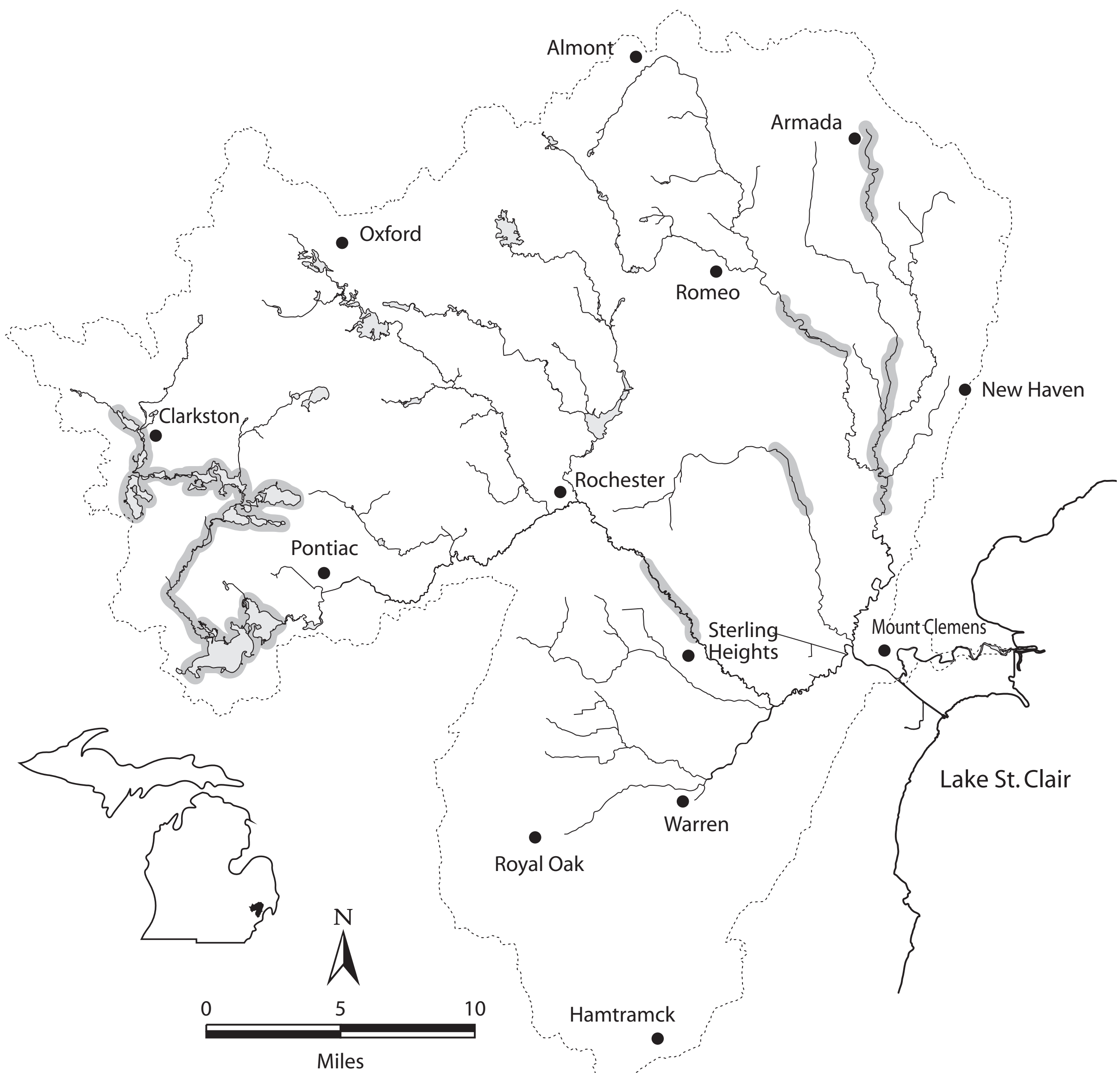


Logperch *Percina caprodes*

Habitat:

feeding - gravel riffles, deeper slower sections of rivers
- medium size streams; also lakes, impoundments, and Lake St. Clair
- sand, gravel, or rock substrate
- avoids turbidity and silt

spawning - riffles or sandy in-shore shallows

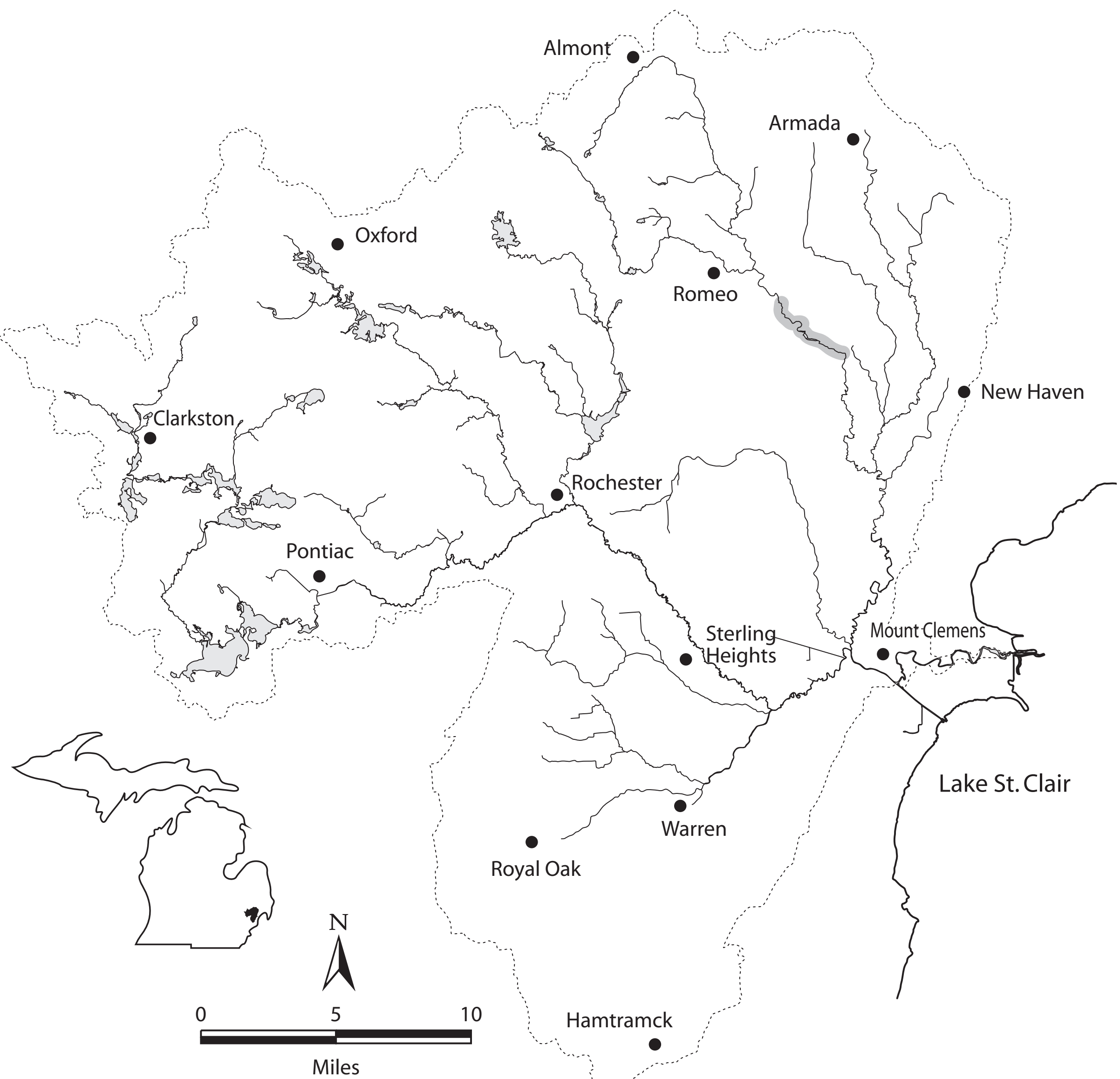


Channel darter *Percina copelandi* – **endangered**

Habitat:

feeding - sand and gravel bars
- slow current
- large rivers

spawning - some current is essential
- a territory is established over gravel

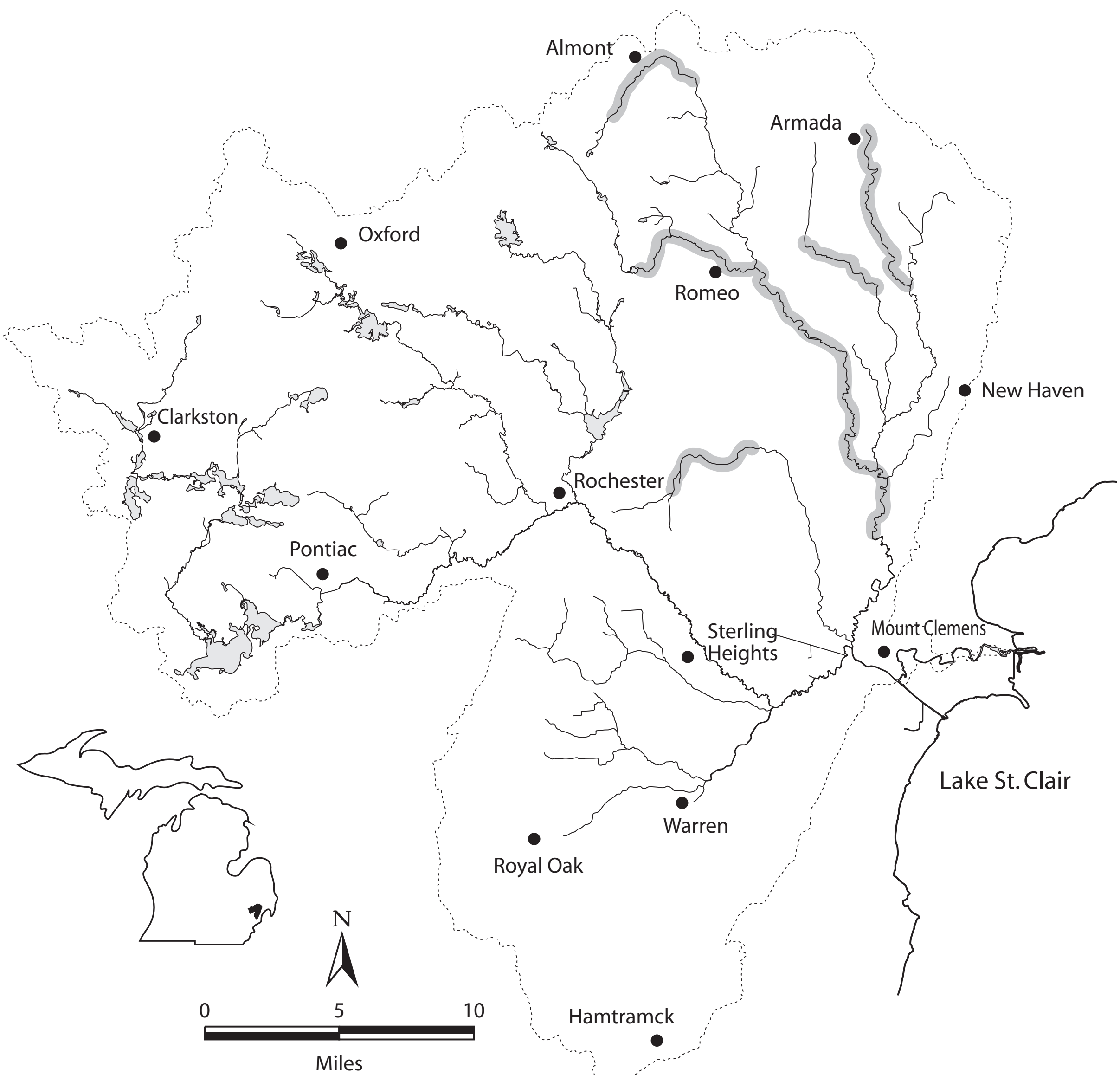


Blackside darter *Percina maculata*

Habitat:

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

spawning - gravel and sand substrate



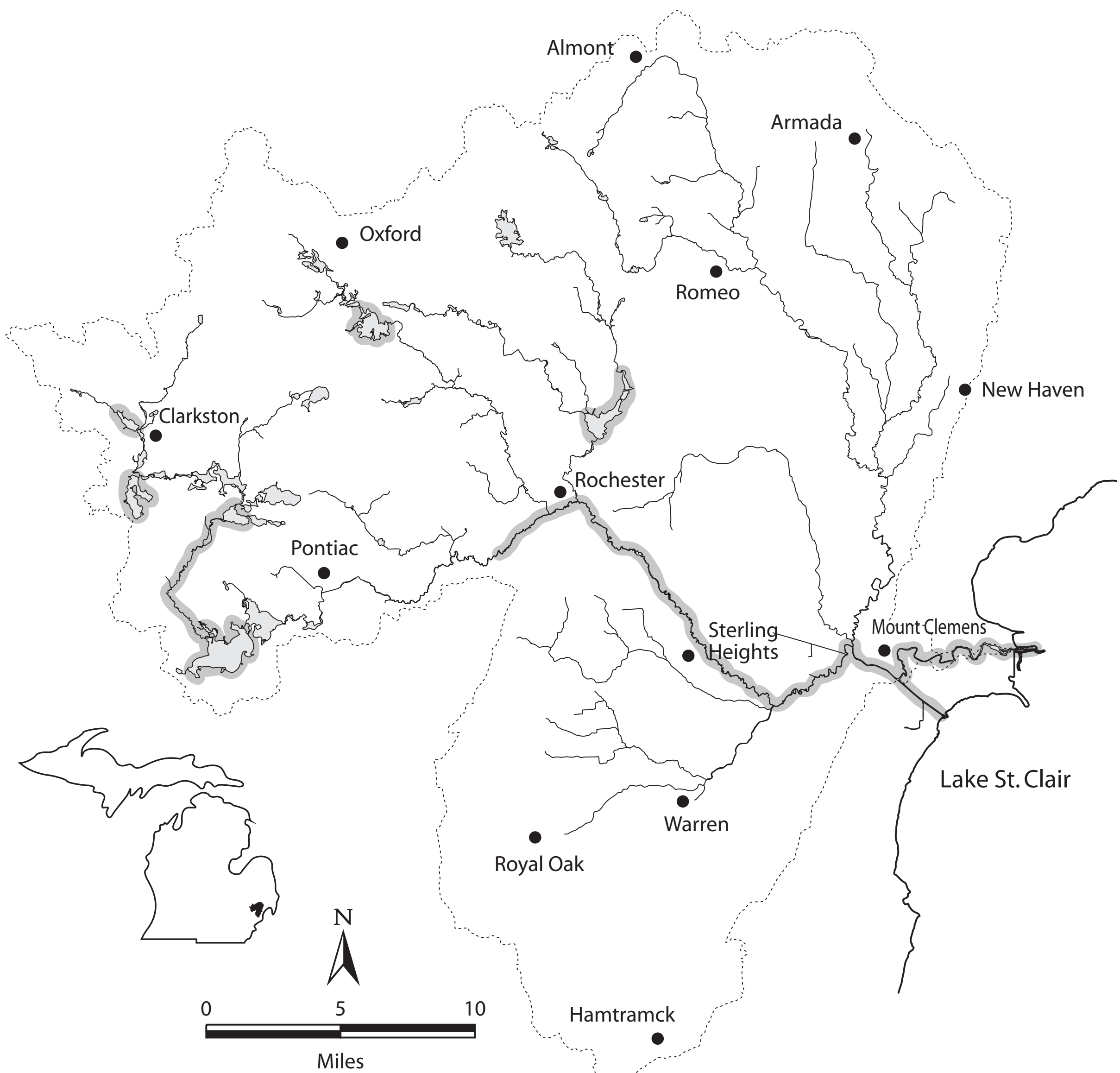
Walleye *Sander vitreus*

Habitat:

feeding - larger, deeper streams and in large, shallow, turbid lakes and impoundments; also Lake St. Clair
- 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

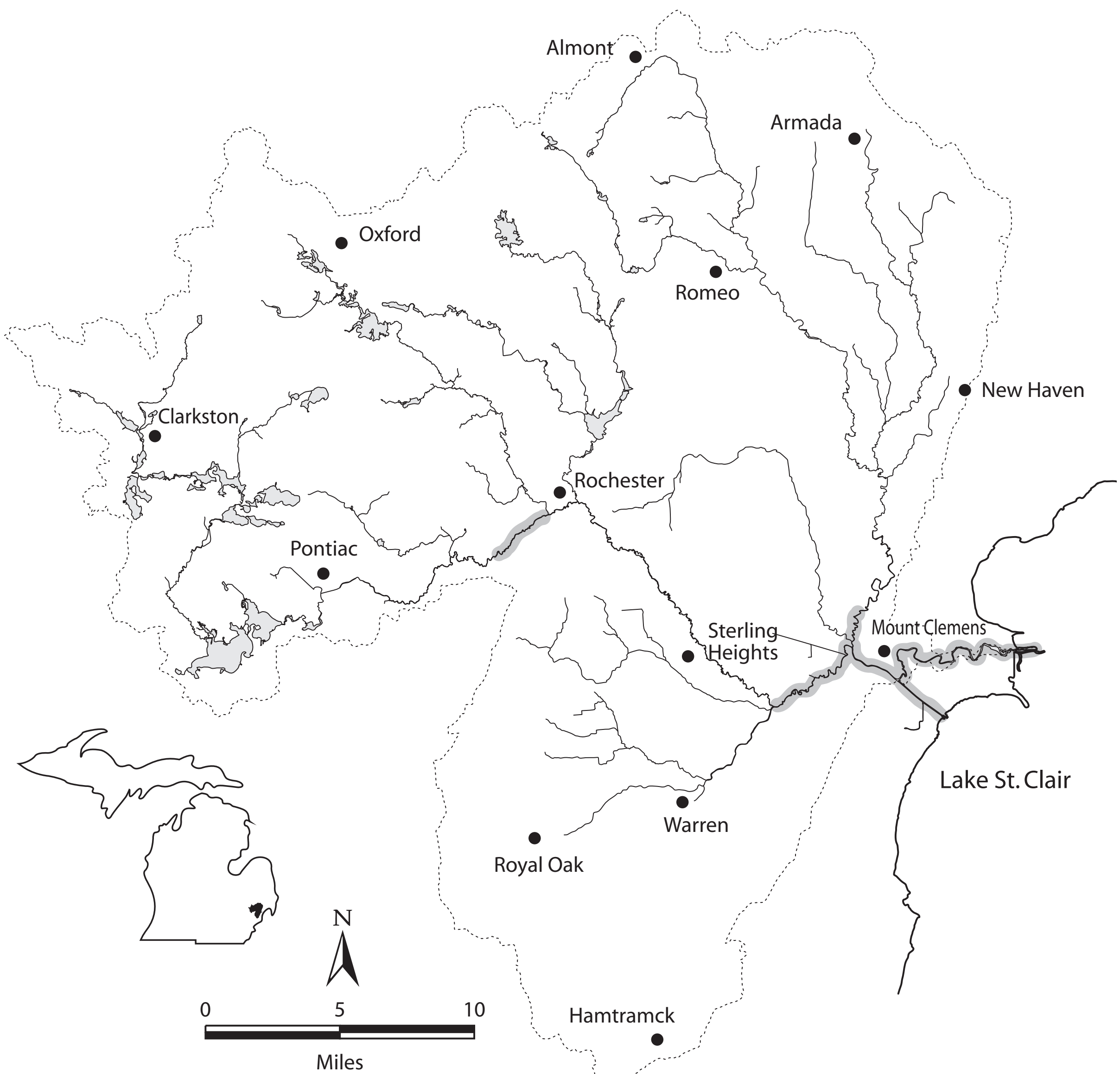


Freshwater drum *Aplodinotus grunniens*

Habitat:

feeding
- deeper pools of rivers and Lake St. Clair
- 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



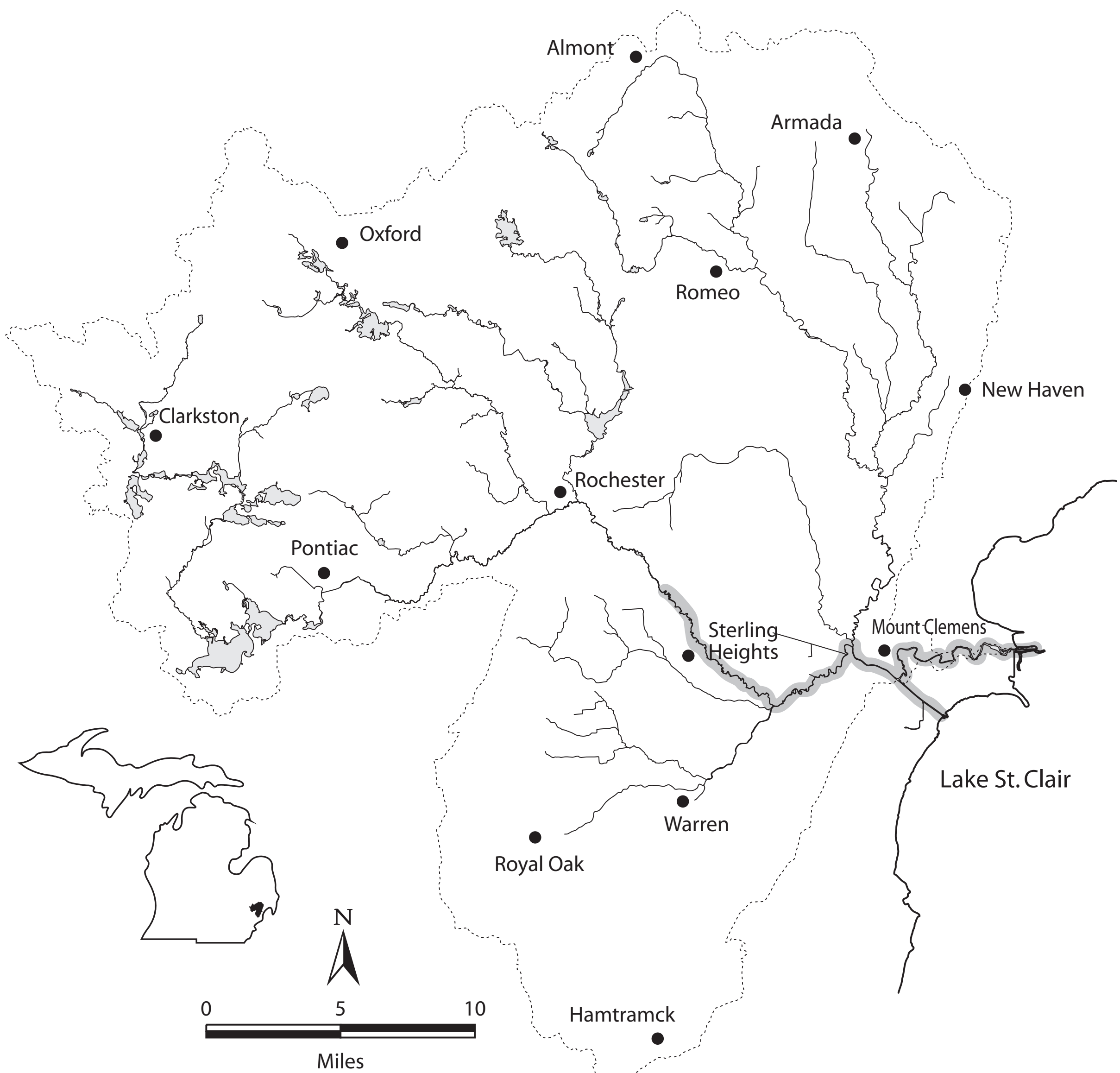
Round goby *Neogobius melanostomus*

Habitat:

feeding - rock,cobble,riprap,and vegetate areas of rivers and lakes
- young found over sand substrate

spawning - rocky substrate with large interstitial spaces

winter refuge - rocky substrate with large interstitial spaces
- deep water



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Appendix 2

Miscellaneous Historical Creel Data

This appendix contains miscellaneous creel data 1928–68 for the Clinton River and tributaries. These data were compiled from records located at Michigan Department of Natural Resources, Institute for Fisheries Research. Species codes: Bkt=brook trout, Bnt=brown trout, Rbt=rainbow trout, Smb=smallmouth bass, Lmb=largemouth bass, Blg=bluegill, Psf=pumpkinseed sunfish, Rkb=rock bass, Bcr=crappie, Yep=yellow perch, Suk=sucker, Bhd=bullhead, Nop=northern pike, Crp=carp, Ccf=channel catfish, Bfn=bowfin, Whb=white bass, Crc=creek chub.

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Appendix 2.–This appendix contains miscellaneous creel data 1928–68 for the Clinton River and tributaries. These data were compiled from records located at Michigan Department of Natural Resources, Institute for Fisheries Research. Species codes: Bkt=brook trout, Bnt=brown trout, Rbt=rainbow trout, Smb=smallmouth bass, Lmb=largemouth bass, Blg=bluegill, Psf=pumpkinseed sunfish, Rkb=rock bass, Bcr=crappie, Yep=yellow perch, Suk=sucker, Bhd=bullhead, Nop=northern pike, Crp=carp, Ccf=channel catfish, Bfn=bowfin, Whb=white bass, Crc=creek chub.

Date	Township	No. anglers	No. hours	Species																	
				Bkt	Bnt	Rbt	Smb	Lmb	Blg	Psf	Rkb	Bcr	Yep	Suc	Bhd	Nop	Crp	Ccf	Bfn	Wbs	Crc
OaklandCounty																					
Clinton River																					
7/4/1928			3.5					2	15	5											
4/24/1934	Waterford		2						8		5		7								
4/4/1939	Waterford	2	3											1							
4/3/1939	Waterford	2	4								1			3							
4/27/1939	Waterford	2	5								2			1							
5/13/1039	Waterford	1	2.5								6				12						
5/13/1939	Waterford	1	2.2												17						
5/15/1939	Waterford	2	0.5												4						
5/17/1939	Waterford	2	8	1		5															
5/19/1939	Waterford	1	1												7						
5/27/1939	Waterford	2	2												21						
6/15/1939	Waterford	1	0.5																		
6/15/1939	Waterford	1	2										1								
5/20/1945	Waterford	4	8			2										1					
4/24/1948	Waterford	3	2.5								1										
4/25/1948	Waterford	1	1.5								2		1								
4/26/1948	Waterford	1	1.5																		
5/2/1948	Waterford	5	11						6												
5/18/1948	Waterford	5	7.5																		
5/23/1948	Waterford	4	6																		
5/31/1948	Waterford	10	8.5																		
4/24/1955	Waterford	4	6			3			1												
4/28/1957		12	40.5			2															
4/24/1960	Avon	12	20								4		3								
4/30/1960	Waterford	12	21			5															
5/15/1960	Pontiac	14	27								5		4								

Appendix 2.–Continued.

				Species																	
Date	Township	No. anglers	No. hours	Bkt	Bnt	Rbt	Smb	Lmb	Blg	Psf	Rkb	Bcr	Yep	Suc	Bhd	Nop	Crp	Ccf	Bfn	Wbs	Crc
6/12/1960	Waterford	10	18								1		6								
4/9/1961	Avon	11	17										5								
4/29/1961	Avon	7	15.5		3																
4/30/1961	Waterford	6	11		1																
5/4/1961	Waterford	10	20													1					
5/4/1961	Avon	10	20							1	3										
5/13/1961	Waterford	14	35								3		4								
5/14/1961	Waterford	10	20								2		3								
5/14/1961	Avon	13	31								6										
5/21/1961	Waterford	9	16			2															
5/21/1961	Waterford	10	20						8												
6/11/1961	Avon	20	37						4		12										
8/18/1961	Waterford	12	26						4												
3/18/1962	W. Bloomfield	19	32								1	9									
4/1/1962	Avon	9	18									5	3								
4/6/1962	Avon	11	22								4		6								
4/8/1962	Avon	10	16								8										
4/9/1962	Avon	9	15								5		6								
5/11/1962	Avon	11	17										9								
5/20/1962	Avon	30	51								4	3	7								
5/26/1962	W. Bloomfield	10	17						4		6										
5/27/1962	Avon	21	33								11		10								
6/30/1962	Waterford	13	21						4		7										
4/1/1963	Avon	10	18																		
4/1/1963	Pontiac	12	23								4		8								
4/28/1963		9	15			3															
5/11/1963		11	18								6										
4/13/1964	Waterford	7	9																		
4/25/1964	Waterford	34	114		3	33															
5/2/1964	Waterford	11	18			5															
5/16/1964	Waterford	11	22			3															

Appendix 2.–Continued.

Date	Township	No. anglers	No. hours	Species																	
				Bkt	Bnt	Rbt	Smb	Lmb	Blg	Psf	Rkb	Bcr	Yep	Suc	Bhd	Nop	Crp	Ccf	Bfn	Wbs	Crc
Paint Creek																					
6/17/1928			3.5					1							1						
6/29/1939	Orion	1	4																		
7/9/1939	Orion	1	4.5																		
7/13/1939	Orion	1	3																		
7/22/1939	Orion	1	3		1																
4/25/1940	Orion	21	66.2																		
4/26/1940	Orion	5	11.5			1															
5/4/1940	Orion	1	3	1	2																
5/4/1940	Orion	1	3																		
5/5/1940	Orion	1	3																		
5/5/1940	Orion	1	3																		
6/9/1940	Orion	2	3		1																
4/29/1944	Orion	77	176																		
4/30/1944	Orion	59	162.5			1															
5/3/1944	Orion	1	2.5																		
5/7/1944	Orion	7	20.5		8																
4/30/1949	Orion	28	64			2															
7/6/1949	Orion	5	8	1																	
4/26/1952	Oakland	9	19			6															
4/27/1952	Oakland	12	15			3															
5/9/1957	Orion	7	11																		
5/28/1957	Orion	4	5			4															
5/29/1957	Orion	5	8			3															
4/30/1960	Oakland	27	58		12	6															
4/30/1960	Oakland	25	62		10	10															
5/1/1960	Avon	8	21			3															
4/28/1962	Orion	7	20		3	4															
4/27/1968	Orion	36	94			36															
5/11/1968	Orion	7	13		2	8															

Appendix 2.–Continued.

Date	Township	No. anglers	No. hours	Species																	
				Bkt	Bnt	Rbt	Smb	Lmb	Blg	Psf	Rkb	Bcr	Yep	Suc	Bhd	Nop	Crp	Ccf	Bfn	Wbs	Crc
Sashabaw Creek																					
4/4/1942	Independence																				
5/1/1948	Independence	3	6											1		1					
Trout Creek																					
8/26/1946	Orion	4	7	3																	
7/6/1949	Orion	3	5.5	3																	
4/27/1952	Orion	11	21	4																	
5/29/1957	Orion	3	3																		
4/30/1960	Orion	18	32	11																	
6/30/1960	Orion	7	17	9																	
4/28/1962	Orion	23	70	40																	
4/27/1963	Orion	14	36	20																	
4/28/1963	Orion	7	27	4																	
5/12/1963	Orion	7	10																		
Lapeer County																					
Townsend Creek																					
4/27/1957																					
Macomb County																					
Townsend Creek																					
5/1/1930	Bruce	1	6	18																	
5/1/1930	Bruce	1	5	6																	
5/1/1930	Bruce	1	0.5	6																	
5/1/1930	Bruce	1	5	5																	
5/1/1930	Bruce	1	6	10																	
5/1/1930	Bruce	1	5	6																	
5/3/1930	Bruce	1	6	8																	
4/26/1947	Bruce	28	89	86																	
4/27/1947	Bruce	4	6	5																	
4/29/1947	Bruce	2	5	4																	
4/30/1948	Bruce	14	33	12																	
5/1/1948	Bruce	14	47	16																	
4/28/1951	Bruce	13	32	36																	

Appendix 2.–Continued.

				Species																	
Date	Township	No. anglers	No. hours	Bkt	Bnt	Rbt	Smb	Lmb	Blg	Psf	Rkb	Bcr	Yep	Suc	Bhd	Nop	Crp	Ccf	Bfn	Wbs	Crc
4/29/1951	Bruce	10	15	3																	
5/19/1951	Bruce	2	5	1																	
5/28/1951	Bruce	2	6	5																	
4/26/1952	Bruce	11	21	25																	
4/27/1952	Bruce	2	6	4																	
4/30/1955	Bruce	15	31	29																	
5/1/1955	Bruce	5	17	9																	
5/3/1955	Bruce	2	4	3																	
4/28/1956	Bruce	9	18	4																	
5/3/1956	Bruce	2	4	5																	
8/4/1956	Bruce	2	4	3																	
4/26/1957	Bruce	4	7	5																	
4/26/1958	Bruce	7	22	26																	
4/27/1958	Bruce	7	14	6																	
5/4/1958	Bruce	4	10	12																	
5/10/1958	Bruce	6	12	3																	
5/16/1958	Bruce	1	2	5																	
4/25/1958	Bruce	20	55	86																	
4/26/1958	Bruce	9	15	9																	
5/2/1958	Bruce	7	16	8																	
5/16/1958	Bruce	5	8	18																	
4/30/1960	Bruce	48	101	112																	
4/29/1961	Bruce	21	45	4																	
4/30/1961	Bruce	5	10	2																	
5/21/1961	Bruce	5	5	4																	
4/28/1962	Bruce	18	24	9																	
4/28/1962	Bruce	10	23	16																	
5/6/1962	Bruce	3	2																		
5/15/1962	Bruce	1	1	2																	
5/20/1962	Bruce	2	2	10																	
4/27/1963	Bruce	10	19	46																	
4/28/1963	Bruce	3	3	3																	
5/4/1963	Bruce	4	10	13																	

Appendix 2.–Continued.

Date	Township	No. anglers	No. hours	Species																	
				Bkt	Bnt	Rbt	Smb	Lmb	Blg	Psf	Rkb	Bcr	Yep	Suc	Bhd	Nop	Crp	Ccf	Bfn	Wbs	Crc
7/20/1963	Bruce	1	4	4																	
4/25/1964	Bruce	26	78	28																	
4/26/1964	Bruce	7	13	13																	
5/1/1964	Bruce	3	7	9																	
Coon Creek																					
4/11/1959	Lenox	6	5								11			4							
4/17/1959	Lenox	8	10											20							
5/8/1959	Lenox	9	7											14							
5/10/1959	Lenox	10	25											10							
6/13/1959	Lenox	2	2																		
6/18/1959	Lenox	2	4												4						
7/31/1959	Lenox	6	6														2				
Clinton River																					
1934		2	12										1		3						
1938		5	22														7				
1939		8	36				1	1			8		1	4		1	4				
1942		55	238								23		585	30		5					
1943		1	4										22								
1944		8	38										5	51							
1945		41	118						7					2	5	1	8				
1946		48	164											1	3		10	4	1		
1948		44	129											19		1	3	1			
1951		20	65										1	10							
1953		40	47																2	13	
1954		252	493									308	486	22	19	1			2	9	
1956		152	315						9	3	24	70	85		20		19				
1958		418	1307									1	2,203		1		15				
1959		246	386								18	10	950	1			2	4			
Clinton River																					
7/17/1934	Harrison	1	6										1								
7/17/1934	Harrison	1	6												3						
4/10/1938	Mt. Clemens	4	11.5														6				

Appendix 2.–Continued.

				Species																	
Date	Township	No. anglers	No. hours	Bkt	Bnt	Rbt	Smb	Lmb	Blg	Psf	Rkb	Bcr	Yep	Suc	Bhd	Nop	Crp	Ccf	Bfn	Wbs	Crc
4/30/1938	Mt. Clemens	1	10.8														1				
5/13/1939	Mt. Clemens	2	2													1					
5/18/1939	Mt. Clemens	2	4								8			4							
6/29/1939	Mt. Clemens	2	8				1														
6/29/1939	Mt. Clemens	1	5					1									4				
6/29/1939	Mt. Clemens	1	3										1								
3/26/1942	Mt. Clemens	25	82								2		397								
3/27/1942	Mt. Clemens	13	77										173	30							
5/19/1942	Mt. Clemens	2	6										1			1					
5/31/1942	Mt. Clemens	2	7								4		3			1					
6/7/1942	Mt. Clemens	2	7								2		9			2					
6/11/1942	Mt. Clemens	2	5								4		1			1					
6/12/1942	Mt. Clemens	2	6								1		1								
6/14/1942	Mt. Clemens	8	26								2										
6/16/1942	Mt. Clemens	2	5																		
3/30/1943	Harrison	1	4										22								
3/10/1944	Harrison	2	4																		
3/15/1944	Harrison	4	28											51							
3/16/1944	Harrison	2	6										5								
8/9/1945	Harrison	2	6																		
8/25/1945	Shelby	6	17																		
8/25/1945	Shelby	8	27						7					1		1	3				
8/29/1945	Harrison	3	11														3				
8/30/1945	Harrison	17	44																		
8/30/1945	Harrison	5	13											1	5		2				
5/19/1946	Harrison	2	6																1		
6/6/1945	Harrison	6	18														2	1			
6/9/1945	Harrison	7	28															2			
6/15/1945	Harrison	4	16												1						
6/17/1945	Harrison	6	18.5																		
6/22/1945	Harrison	3	12														2	1			
6/26/1945	Ray	2	8											1	1						
7/13/1945	Harrison	3	9														2				

Appendix 2.–Continued.

				Species																	
Date	Township	No. anglers	No. hours	Bkt	Bnt	Rbt	Smb	Lmb	Blg	Psf	Rkb	Bcr	Yep	Suc	Bhd	Nop	Crp	Ccf	Bfn	Wbs	Crc
7/15/1945	Harrison	2	7																		
8/3/1945	Harrison	4	10												1		3				
8/6/1946	Harrison	7	27														1				
8/10/1946	Harrison	2	4																		
4/27/1948	Clinton	13	36											3							
5/1/1948	Shelby	12	41											16							
6/5/1948	Macomb	5	17													1		1			
7/7/1948	Harrison	14	35														3				
5/28/1951	Shelby	20	65										1	10							
5/31/1953	Harrison	37	38																2		
8/8/1953		3	9																	13	
1/3/1954	Harrison	66	143									236	92								
1/8/1954	Harrison	14	16										19								
1/9/1954	Harrison	39	108									59	159							7	
1/9/1954	Chesterfield	15	37									4	128							2	
1/10/1954	Harrison	18	40									3	69								
4/3/1954	Harrison	2	2										4								
4/10/1954	Harrison	8	7										4		5						
4/10/1954	Harrison	13	13										7		5						
4/11/1954	Sterling Heights	6	9											2							
4/12/1954	Harrison	10	21										4		2						
4/13/1954	Macomb	2	4																		
4/15/1954	Harrison	4	7											9							
4/15/1954	Shelby	5	10											3							
4/23/1954	Chesterfield	20	33												7						
4/25/1954	Sterling Heights	10	17									6		5							
4/25/1954	Sterling Heights	8	13											3							
4/25/1954	Shelby	1	2																		
5/2/1954	Harrison	11	11													1			2		
1/14/1956	Harrison	11	19									9	27								
4/8/1956	Harrison	11	17								4		1								
4/8/1956	Harrison	10	32									15	28		3						
4/8/1956	Harrison	10	18										1				7				

Appendix 2.–Continued.

Date	Township	No. anglers	No. hours	Species																	
				Bkt	Bnt	Rbt	Smb	Lmb	Blg	Psf	Rkb	Bcr	Yep	Suc	Bhd	Nop	Crp	Ccf	Bfn	Wbs	Crc
4/15/1956		39	96										2		5		10				
4/15/1956		24	35									8	14		6						
5/4/1956		18	42						1	1	20		8		6		1				
5/26/1956		29	56						8	2		38	4				1				
1/4/1958		76	110										63								
1/8/1958		7	11																		
1/10/1958		15	23										26								
1/11/1958	Harrison	18	36								1		24								
1/31/1958	Harrison	9	20										51								
3/15/1958	Harrison	3	6																		
3/23/1958	Harrison	82	217										688								
3/28/1958	Harrison	112	186									1	611								
3/29/1958	Harrison	114	494										637								
3/30/1958	Harrison	68	129										201								
4/11/1958	Harrison	30	68										66		1		13				
4/13/1958		3	6														2				
4/1/1959		113	184										726								
4/12/1959		29	44									8	115								
4/12/1959		12	16									2	50					4			
4/13/1959		31	54								12		34	1							
5/2/1959		38	51								4		11								
5/2/1959		23	37								2	10	950	1			2	4			
Middle Branch																					
4/12/1954	Macomb	18	26											28							
4/25/1954	Macomb	2	4											7			5				
4/6/1956	Macomb	3	3																		
North Branch																					
5/12/1940	Ray	2	6								1		23								
7/2/1940	Ray	2	4.5							2			2								
7/2/1940	Ray	4	2							2			1								
6/17/1946	Ray	2	6.5								4		2								
8/5/1948	Ray	4	10																		

Appendix 2.–Continued.

Date	Township	No. anglers	No. hours	Species																	
				Bkt	Bnt	Rbt	Smb	Lmb	Blg	Psf	Rkb	Bcr	Yep	Suc	Bhd	Nop	Crp	Ccf	Bfn	Wbs	Crc
4/16/1949	Ray	2	4											4			2				
4/23/1949	Ray	5	10											6							
4/24/1949	Ray	7	16											6							
5/6/1949	Ray	2	6								3			3	6						
5/11/1949	Ray	12	17											8			10				
5/14/1949	Ray	3	8											2							
5/22/1949	Ray	6	8											4							
5/23/1949	Ray	6	6																		
4/5/1954	Macomb	2	4											11			5				
4/9/1954	Clinton	9	31										1	42							
4/12/1954	Macomb	7	13											19							
4/20/1954	Macomb	11	15										1	16							
4/25/1954	Clinton	13	23											19							
4/25/1954	Macomb	7	6											4							
5/16/1954	Macomb	12	27											12		1					
5/16/1954	Macomb	10	26											7		3					
3/31/1956	Mt. Clemens	11	17											2							
4/4/1956	Mt. Clemens	2	8											26							
4/6/1956	Mt. Clemens	5	8										1	19							
4/8/1956	Clinton	8	25										7	6							
4/15/1956		14	27											9							
4/15/1956		16	49											8							
3/15/1958	Clinton	3	4.5											15							
3/16/1958	Clinton	4	4											12							
3/17/1958	Clinton	5	13											3							
3/23/1958	Clinton	7	23											16							
3/30/1958	Clinton	6	5														1				
4/13/1958	Clinton	6	8																		
4/4/1959	Ray	3	6																		
4/6/1959	Ray	9	7											7							
4/11/1959	Ray	7	8								11										
4/15/1959	Ray	9	19											2							
4/17/1959	Ray	12	21											32							

Appendix 2.–Continued.

Date	Township	No. anglers	No. hours	Species																	
				Bkt	Bnt	Rbt	Smb	Lmb	Blg	Psf	Rkb	Bcr	Yep	Suc	Bhd	Nop	Crp	Ccf	Bfn	Wbs	Crc
4/18/1959	Ray	12	15						1		2			6							
4/19/1959	Ray	10	15						4		8			5							
4/25/1959	Ray	12	29											23							
5/2/1959	Ray	15	28								9			4							
5/8/1959	Ray	16	23											27							
5/9/1959	Ray	17	47						2		16			8							
5/10/1959	Ray	12	36								13			17							
5/16/1959	Ray	15	33								8			15							
5/18/1959	Ray	2	5								4			3		1					
5/24/1959	Ray	14	26								18			13							
6/6/1959	Ray	9	16								50										
6/9/1959	Ray	2	2																		
6/13/1959	Ray	5	9								12										
6/27/1959	Ray	6	3.5																		
8/4/1959	Ray	1	2																		
9/11/1959	Ray	2	2																		
4/22/1960	Ray	15	14											19							
4/23/1960	Ray	7	9								7			7							
4/24/1960	Ray	11	11								8			9							
5/1/1960	Ray	8	14																		7
5/14/1960	Ray	7	9														1				
5/15/1960	Ray	13	13											4							
5/21/1960	Ray	6	9								24			1							
6/5/1960	Ray	7	4.5								10										
6/19/1960	Ray	3	3								2			4							
6/30/1960	Bruce	2	1																		
7/3/1960	Bruce	2	1																		
8/8/1960	Ray	1	1																		
8/20/1960	Ray	5	6						22		16		22								
8/27/1960	Ray	3	6								2										
3/25/1961	Ray	2	2																		
4/7/1961	Ray	4	3																		
4/8/1961	Armada	3	3																		3

Appendix 2.–Continued.

Date	Township	No. anglers	No. hours	Species																	
				Bkt	Bnt	Rbt	Smb	Lmb	Blg	Psf	Rkb	Bcr	Yep	Suc	Bhd	Nop	Crp	Ccf	Bfn	Wbs	Crc
4/9/1961	Ray	2	1																		6
4/21/1961	Ray	2	2																		
4/22/1961	Ray	1	1																		
4/23/1961	Bruce	13	11											13							
4/28/1961	Washington	4	3										2	5							
5/1/1961	Ray	4	7											12							
5/5/1961	Armada	1	1																		
5/13/1961	Ray	9	15								4	3	6	10							
5/14/1961	Ray	7	28								13			5							
5/20/1961	Ray	6	5											4							
5/21/1961	Ray	4	4																		
5/28/1961	Armada	6	4								2			2							
5/30/1961	Ray	10	13											3							
6/21/1961	Washighton	4	3											2							
7/2/1961	Ray	1	1																		
7/4/1961	Ray	7	7												1						
7/26/1961	Ray	2	1																		
8/12/1961	Bruce	1	1																		
9/13/1961	Ray	3	2								1										
3/25/1962	Ray	2	2																		
4/8/1962	Ray	8	6																		
4/21/1962	Armada	10	8											6							
4/28/1962	Ray	4	8																		
4/29/1962	Washington	10	6								1			1							
5/5/1962	Ray	5	5																		
5/20/1962	Ray	2	1												2						
5/26/1962	Bruce	3	3																		
5/27/1962	Ray	10	7											4							
6/17/1962	Ray	4	3																		
6/24/1962	Ray	5	2																		
7/17/1962	Ray	12	9								3			9							
4/1/1963	Ray	5	2																		
4/7/1963	Ray	3	1																		

Appendix 2.–Continued.

Date	Township	No. anglers	No. hours	Species																	
				Bkt	Bnt	Rbt	Smb	Lmb	Blg	Psf	Rkb	Bcr	Yep	Suc	Bhd	Nop	Crp	Ccf	Bfn	Wbs	Crc
4/13/1963	Ray	14	11											5			2				
4/13/1963	Ray	12	11											4							
4/15/1963	Ray	8	6																		
4/21/1963	Ray	12	13											11							
4/21/1963	Ray	10	8								5			1							
5/12/1963	Ray	4	4														3				
5/13/1963	Ray	2	4								6										
6/30/1963	Ray	8	8								3										
7/20/1963	Ray	2	2																		
4/23/1964	Ray	1	1																		
4/25/1964	Ray	8	11														2				14
4/26/1964	Ray	7	11											13							
5/2/1964	Ray	7	15								13			1							
5/17/1964	Ray	4	3												1		1				
8/7/1964	Ray	3	2																		
9/12/1964	Armada	1	2																		
Coon Creek																					
4/22/1960	Ray	11	11											21							
4/23/1960	Ray										3	1		8							
5/15/1960	Lenox	15	15											5							
7/11/1960	Lenox	6	9												1		2				
4/7/1961	Ray	5	3.5											8							
4/23/1961	Ray	4	4											6							
5/8/1961	Ray	4	4											1							
5/13/1961	Ray	7	9												8						
5/20/1961	Ray	6	6																		
5/25/1961	Ray	1	2												3						
5/30/1961	Ray	11	19											2		1					
7/2/1961	Ray	3	3																		
7/4/1961	Ray	4	4												4						
8/12/1961	Ray	4	5				2		5		8				16						
4/4/1962	Ray	4	2											1							

Appendix 2.–Continued.

Date	Township	No. anglers	No. hours	Species																	
				Bkt	Bnt	Rbt	Smb	Lmb	Blg	Psf	Rkb	Bcr	Yep	Suc	Bhd	Nop	Crp	Ccf	Bfn	Wbs	Crc
4/7/1962	Ray	2	1											1							
4/8/1962	Ray	2	2																		
4/16/1962	Ray	5	6											7							
4/21/1962	Ray	5	10											13							
4/24/1962	Ray	2	1											3							
4/28/1962	Ray	8	11											4	12	1					
5/5/1962	Ray	8	7								3	3									
5/6/1962	Ray	6	5											1							
5/12/1962	Ray	7	7											5							
7/4/1962	Ray	5	3											2							
3/30/1963	Lenox	8	7											3							
4/1/1963	Lenox	5	3																		
4/6/1963	Ray	4	5													2					
4/14/1963	Ray	4	4											2							
4/14/1963	Lenox	3	3																		
4/21/1963	Ray	4	2											2							
5/5/1963	Ray	9	9											1							
5/11/1963	Ray	4	4																		
5/12/1963	Ray	5	5														1				
5/18/1963	Ray	2	2											3							
6/30/1963	Lenox	8	8											3							
Stony Creek																					
5/28/1939	Shelby	4	6																		
4/25/1940	Shelby	6	20	7	1																
4/28/1940	Shelby	2	6	5																	
5/2/1940	Shelby	2	6																		
5/3/1940	Shelby	7	16.5	7																	
5/9/1940	Shelby	1	0.5																		
5/10/1940	Shelby	7	25																		
6/23/1940	Shelby	2	5											10							
3/26/1944	Washington	5	12											20							
3/27/1944	Washington	8	15											26							

Appendix 2.–Continued.

Date	Township	No. anglers	No. hours	Species																	
				Bkt	Bnt	Rbt	Smb	Lmb	Blg	Psf	Rkb	Bcr	Yep	Suc	Bhd	Nop	Crp	Ccf	Bfn	Wbs	Crc
4/10/1944	Washington	6	17											26							
4/26/1944	Washington	7	16											30							
4/5/1959	Shelby	4	5								2			6							
5/23/1959	Shelby	5	10					2	2	4	2										
4/24/1960	Shelby	6	3						7												
5/5/1960	Shelby	2	2																		
5/8/1960	Shelby	2	2																		12
8/3/1960	Shelby	2	1																		
8/13/1960	Shelby	1	1																		
8/20/1960	Shelby	7	6								19										
8/21/1960	Shelby	9	10					2		12											
4/29/1961	Shelby	2	2																		
5/28/1961	Shelby	5	5																		
6/4/1961	Shelby	2	1						2												
6/11/1961	Shelby	1	1																		
7/4/1961	Shelby	10	5																		
5/13/1962	Shelby	2	1																		
4/17/1963	Washington	1	1											4							
4/20/196	Washington	2	4																		3
6/16/1963	Washington	3	3																		
5/17/1964	Washington	4	3				2														
6/16/1964	Washington	9	9					1							4	1					
7/22/1964	Washington	12	12												4	5					
9/2/1964	Washington	2	1				2	1							8	6					