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St. Joseph River Assessment

Jay K. Wesley
and
Joan E. Duffy

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friend and steward of aquatic resources

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EXECUTIVE SUMMARY

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

River assessments are prepared to provide a comprehensive reference for citizens and agency personnel who desire information about a particular aquatic resource. These assessments will provide an approach to identifying opportunities and solving problems. Hopefully, this river assessment will increase public awareness of the St. Joseph 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 response. The river assessment is the nucleus of the report. The characteristics of the St. Joseph River and its watershed are described in twelve sections: geography, history, geology and hydrology, channel morphology, dams and barriers, soils and land use patterns, water quality, special jurisdictions, biological communities, fishery management, recreational use, and citizen involvement.

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

The St. Joseph River and its tributaries form a network draining approximately 4,685 square miles of southwest Michigan and northern Indiana. The mainstem is 210 miles long and there are 1,641 miles of tributaries. Major tributaries include Prairie, Coldwater, Fawn, Pigeon, Elkhart, Dowagiac, and Paw Paw rivers.

For purpose of discussion, the St. Joseph 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 section is from Baw Beese Lake to Union City. The upper segment is cool and moderately stable and extends down to Mendon. The river goes from medium to large in the middle segment (from Mendon to Elkhart) as it drains a major portion of the watershed. The lower segment is in a confined valley as it cuts though the Kalamazoo moraine and extends 65 miles downstream of Elkhart. The last 8 miles of river flows across a lake plain and makes up the mouth segment.

The hydrology of the St. Joseph River watershed is strongly influenced by glacial deposits. A majority of the surficial geology is composed of outwash sand and gravel. These glacial deposits contribute to the stable flows of the St. Joseph River. The headwater and upper segments have fairly stable flows; however, some tributaries in the middle segment have decreased flow stability. Tributaries in the lower and mouth segments have the most stable flows including Juday Creek, Dowagiac and Paw Paw rivers. Less permeable soils coupled with agricultural land use lead to stream flow instability. Urbanization, stream channelizations, filling of wetland retention areas, and installation of drainage systems for agriculture and urban development also contribute to stream flow instability. Seasonal flooding occurs throughout the watershed, but most damage tends to be to developments within the floodplain.

The average gradient of the St. Joseph River mainstem is 2.5 feet per mile with a range of 0-45 feet per mile. The best gradients on the mainstem (5-45 feet per mile) are in the headwaters below Baw Beese Lake and in small reaches near Union City, Sturgis Dam, and Niles. The lowest gradient (0 feet per mile) is at Sturgeon Lake near the town of Colon. The mainstem of the St. Joseph River is mostly low-gradient channel - 157.5 miles (74.9%) having gradient less than three feet per mile. Fish and other aquatic animals are typically most diverse and productive in river sections with gradient between 10 and 70 feet per mile. This highly desirable gradient class is now found in only 1.9 miles (0.9%) of the mainstem. Dams in Litchfield, Union City (Riley Dam), Centreville (Sturgis Dam), Mottville, Elkhart, Niles, and Buchanan have inundated many of the high-gradient areas. These dams and their impoundments have eliminated and fragmented some of the best fish habitat on the river.

The channel cross section of the St. Joseph River is normal, based on stream widths compared to average discharge. The headwaters are characterized as having a narrow channel that is straight to meandering. The channel widens going downstream through the upper and middle segments. The river channel narrows in the lower segment as it meanders confined in a narrow glacial valley and widens again near the mouth. Tributaries in the middle and lower segments including Pigeon, Forker, and Juday creeks and the Dowagiac River have significantly narrow channels due to channelization. Substrates in the headwaters consist of mostly silt and sand. The upper and middle segments have more diverse substrates that are made up of more sand and gravel with some cobble. The best substrate is in the lower segment where there is more gravel and cobble. The mouth segment has more sand and silt substrate as the river begins to lose power. Woody cover is common in the mainstem but varies in tributaries. Agricultural activities such as stream dredging and riparian vegetation clearing has removed or reduced the availability of woody debris. Woody cover creates excellent fish habitat and provides good substrate for production of aquatic insects and other fish food organisms.

There are 190 dams in the St. Joseph River watershed registered with Michigan Department of Environmental Quality and Indiana Department of Natural Resources. Seventeen are on the mainstem. Dams fragment river systems and turn high gradient river habitat into lentic habitat. Dams were generally constructed in areas of highest stream gradient. These high-gradient riverine areas are essential spawning habitat for several species of fish. Dams impede fish movements to refuge habitats, segment populations, and block spawning migrations. Mortality or injury often results while passing through or over dams, especially those with hydroelectric turbines. Potamodromous fish can migrate from Lake Michigan to the Twin Branch Dam through the use of fish ladders at Berrien Springs, Buchanan, Niles, South Bend, and Mishawaka dams. Salmonines composed 99.6% of all fish passed at the ladders. Existing ladder designs are not sufficient to pass warm water species. Impoundments created by dams warm temperatures and can lead to elimination of certain aquatic species below dams. Dams also act as sediment and woody debris traps. Sediment-free water released below dams has high erosive power and can cause bank erosion. Seasonal flow is disrupted with dams and lake-level control structures by reducing incidence and severity of flooding.

The headwater segment has nine dams that are used for recreation and lake-level control structures. None of the mainstem dams in this area have official portage facilities. There are 24 dams in the upper segment. The Riley Dam at Union City is the largest and only hydroelectric dam in this segment that is not licensed by the Federal Energy Regulatory Commission (FERC). The middle segment has the most dams (104); Sturgis, Three Rivers, Mottville, Constantine, and Elkhart are all hydroelectric dams on the mainstem. Thirty-two dams exist in the lower segment, and four of the eight dams on the mainstem are hydroelectric. Berrien Springs is the only dam in this section exempt from FERC licensing due to an Act of the U.S. Congress. Entrainment at the Niles (French Paper) and Buchanan dams was 12.3% and 21% for chinook salmon and 2.3% and 19.8% for steelhead, respectively. Temporary turbine shut downs in May reduce entrainment mortality for chinook salmon and to a lesser degree for steelhead. There are 24 registered dams in the mouth segment that are all within the Paw Paw River sub-watershed. These dams are all low head or on small tributaries, so potamodromous trout and salmon can migrate into its headwaters at Campbell Creek.

Land use in the St. Joseph River watershed is dominated by agriculture (58%) followed by forested land (19.8%) and urban development (7.7%) based on Michigan counties in the watershed. Intensive agriculture with poor management practices has lead to bank erosion and sedimentation problems. Channelization, drainage of wetlands, and installation of artificial drainage systems have altered stream temperature regimes and decreased flow stability. Most large cities in the watershed are located along the mainstem, and many have significant affects on water quality. The lower and mouth segments are also threatened by increased development pressure. High-speed rail with service from Niles to Chicago is expected to increase residential development of commuters. The potential increase of impervious surfaces (roofs, parking lots, and roads) could change the hydrology of several groundwater fed streams.

Point source water pollution from industrial and municipal sources in the St. Joseph River watershed has decreased significantly over the past 30 years. Pollution from point sources will continue to be reduced as municipal wastewater treatment plants upgrade their facilities and technology and industrial discharge permits are tightened. However, combined sewer overflows from Elkhart and South Bend, Indiana continue to be a problem and are the cause for non-attainment of designated water uses in the lower segment.

Nonpoint source pollution is the greatest factor that degrades water quality in this watershed. 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.streams in southwest Michigan.

Based on Michigan Fish Commission surveys as early as the 1880s and fish collections from the University of Michigan, Museum of Zoology, the St. Joseph River watershed originally had 97 fish species. The watershed now contains 114 species of fish due to intentional and accidental introductions. The creek chubsucker, river redhorse, and lake sturgeon are present and considered threatened in the state of Michigan. Although present fish species diversity in the St. Joseph River watershed remains high, certain species of fish have declined. Dams on the mainstem and headwaters create barriers to upstream migration of potamodromous fish. Dams have inundated high-gradient areas that have gravel, cobble, and rock substrates. These high-gradient areas are of critical importance to certain species as spawning habitat and for the production of aquatic insects and other macroinvertebrates that are important fish food organisms. Silt-tolerant fish species have increased in the watershed, whereas fishes requiring clean gravel substrate or clean water with aquatic vegetation at some point of their life cycles have declined. Agricultural and urban development activities have reduced flow stability and increased sediment load in streams throughout the watershed. Introduced pest species including sea lamprey, zebra mussels, rusty crayfish, purple loosestrife, and Eurasian milfoil have had negative effects on native fishes and macroinvertebrates. Draining and filling of wetlands has negatively affected populations of fish, amphibians, reptiles, birds, and mammals.

Fishery management of the St. Joseph River mainstem and tributaries ranges from low in the headwater and upper segments to high in the lower and mouth segments. Stocking fish is the main management tool used in the headwater and lower segments. Development and enhancement of warmwater fishing opportunities are needed in this area. The Interstate Anadromous Fish Passage Project between the states of Indiana and Michigan has created unique fishing opportunities in the lower and mouth segments by installing fish ladders at five dams, building new boat launches, and construction of the Twin Branch Fish Hatchery in Indiana. In conjunction with this project, fish passage is estimated at three dams using time-lapse video recording, catch rates are estimated through creel surveys, and salmon and trout are stocked. There are also several tributaries in the lower segment managed for brown trout through stocking and habitat improvement projects.

Recreational use of the river is high in the middle, lower, and mouth segments. Many people use the river and corridor for fishing, canoeing, motor boating, swimming, picnicking, and hunting. Lack of assured public access is the largest deterrent to the recreational potential of the mainstem and tributaries. There are only 17 boat and canoe launches on the mainstem. This is an average of one launch site every 12 miles of river. Canoe portages at dams are also lacking. Hydroelectric dams are required to install portages through FERC licensing, but owners of other dams are not required by law to build them.

The St. Joseph River watershed has an improving public image with growing public support. Several organizations work on various aspects of the river including fishing, hunting, and other recreational use. Most groups work at the local level, but Trout Unlimited and Friends of the St. Joseph River work at a watershed level. With decreases in government funding and personnel, public involvement through local and watershed organizations is important to ensure that habitat protection and enhancement of water quality and recreational opportunities continues to move forward in the St. Joseph River watershed.

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. However, this assessment is admittedly biased towards aquatic systems.

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 the system. Using this knowledge we will identify opportunities that provide and protect sustainable fishery benefits while maintaining, and at times rehabilitating, system structures or processes.

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

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

River assessments provide an organized approach to identifying opportunities and solving problems. They provide a mechanism for public involvement in management decisions, allowing citizens to learn, participate, and help determine decisions. As well these projects 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 the 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.
>
> **Channel Morphology -** the shape of the 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.

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.

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 species, 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 of the goals of fishery management. 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 early fall, 1998. Three public meetings were held November 2, 1998 in Niles, November 3, 1998 in Three Rivers, and November 5, 1998 in Coldwater. Written comments were received through February 28, 1999. Comments were either incorporated into this assessment or responded to in this section.

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

Michigan Department of Natural Resources
Fisheries Division
621 N. 10th Street
Plainwell, MI 49080

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

RIVER ASSESSMENT

Geography

The St. Joseph River basin, located in southwest Michigan and northeast Indiana, is the third largest river basin in Michigan (Figure 1). The river begins in Michigan's Hillsdale County at Baw Beese Lake, and flows in a northerly arc before turning south and entering Indiana. The river flows west across Indiana before making an abrupt turn to the north at South Bend. It re-enters Michigan in southeastern Berrien County and flows northwest until it reaches Lake Michigan between the cities of St. Joseph and Benton Harbor. The St. Joseph River mainstem is 210 miles long, and its tributary streams total an additional 1,641 miles (Brown 1944). The river drains a watershed of 4,685 square miles: 3,000 square miles in Michigan and 1,685 square miles in Indiana. Its major tributaries are the Coldwater, Prairie, Fawn, Pigeon, Elkhart, Dowagiac, and Paw Paw rivers (Figure 2).

The immense size of the St. Joseph River watershed makes it difficult to describe in detail; therefore, the river was split into five sections or valley segments (Figure 3). 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 homogeneous 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 St. Joseph 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. For example, segment 4 of the lower river is described as warm and stable supporting walleye and flathead catfish. However, the Dowagiac River, which enters the St. Joseph River within segment 4, is cold and stable supporting brown trout and mottled sculpins. Although the same type of descriptions will be provided for all major tributaries, only the five mainstem river valley segments are described below.

Segment 1 (Headwaters)
The headwaters consist of Beebe, Sand, Soap, Tekonsha, and Burnett creeks. This segment is 59 miles long and flows through the towns of Jonesville, Litchfield, Tekonsha, and Burlington (Figure 3). The river is small with low gradient and is characterized by cool summer temperatures and moderately stable flows (see **Geology and Hydrology** and **Channel Morphology**)

Segment 2 (Upper)
The upper segment begins near Union City and continues 26 miles to Mendon, Michigan. The river here is medium-sized as it picks up the drainage of the Coldwater River; and Little Portage, Nottawa, and Swan creeks. The mainstem meanders unconfined and is cool in summer and has moderately stable flows.

Segment 3 (Middle)
This segment begins at Mendon and proceeds 52 miles downstream to just beyond Elkhart, Indiana. The river becomes larger and warmer as it drains a major portion of the watershed. Gradient also changes from low to moderate as the river enters a broad glacial river valley. The Portage, Rocky, Pigeon, Fawn, Prairie, Elkhart, and Little Elkhart rivers and Christiana Creek join the mainstem within this section.

Segment 4 (Lower)
This segment begins downstream of Elkhart, Indiana and extends in a northwesterly direction for about 65 miles as it flows through Mishawaka, South Bend, Niles, Buchanan, and Berrien Springs. The river is forced around the southwest lobe of the Kalamazoo moraine until it finally cuts through at Buchanan. The Dowagiac River and several small tributaries including Pipestone, Lemon, Brandywine, and McCoy creeks in Michigan; and Juday, Bowman, Baugo, and Cobus creeks in Indiana; join the river in this section.

Segment 5 (Mouth)
Although this last segment is only about 8 miles long, it is very different from the other segments. The river has very low gradient as it meanders unconfined across a glacial lake plain. It enters Lake Michigan between the cities of St. Joseph and Benton Harbor. The Paw Paw River and Hickory and Yellow creeks connect to the mainstem in this segment.

History

The St. Joseph River basin has been shaped by glacial events. During the Wisconsinan stage of glaciation in the Pleistocene Epoch (10,000 to 75,000 years ago), most of Michigan and Indiana were covered by several ice lobes (Farrand and Eschman 1974). The St. Joseph River basin was an interlobate region; its landscape being shaped by three glacial lobes. The Saginaw lobe came from the northeast, the Erie lobe from the east, and Lake Michigan lobe from the northwest (T. Fleming, Indiana Geological Survey, personal communication). The St. Joseph River flowed south into the Kankakee River and then the Mississippi River and the Gulf of Mexico. During glacial retreat, water was no longer forced by the wall of ice to flow down to the Kankakee River. Therefore, a new channel with less water resistance was formed, and the flow changed to a northward direction at South Bend, downhill to the now lower elevation Lake Michigan. The glacial retreat also left varied moraine and outwash deposits that strongly influence the local hydrology, channel morphology, and gradient of the mainstem and tributaries.

There is evidence that humans roamed the basin during the Paleo-Indian Period over 10,000 years ago (B. Mead, Department of State, Office of the State Archaeologist, personal communication). Small bands of hunters searched for big game such as mastodon or caribou. Between 4,000 and 2,000 BC, settlements of small game hunters sprang up along the river. A larger group of migrants, the mound builders, moved into the area in search of food around 2,000 BC. Their mounds are still evident throughout the St. Joseph River valley. The Hopewellean people, a second group of mound builders, occupied the land in 500 BC.

Native Americans heavily used the St. Joseph River. The Miami Tribe of the Algonquin Nation settled in the area between 800 and 1000 AD. The Miami Tribe frequently traveled along the St. Joseph River on a trail that later was known as the Sauk Trail (present day US-12). The Miami called the river Sauk-Wauk-Sil-Buck which means “mystery” river (B. Owens, independent historian, personal communication). Due to competition in the fur trade, the Iroquois drove most of the Algonquin people out of Southern Michigan by 1625. The Algonquin and to a lesser extent Iroquois used fish weirs and traps along the river to catch fish (B. Owens, independent historian, personal communication). Suckers, walleye, smallmouth bass, northern pike, channel catfish, freshwater drum, and lake sturgeon were part of their catches based on bones found at archaeological sites near the watershed (Holman et al. 1996).

In 1654, Medard Chauart Des Groseilliers of France and a French companion were the first Europeans to travel the St. Joseph River. Within a decade, several other French explorers and missionaries also had traveled the river. The French built Fort Saint Joseph in 1691 on the east river bank near present day Niles, Michigan. The fort was used as a fur trading post and for protection of the Miami tribes from the Iroquois.

> "In the St. Joseph area, the local Miami and Mascouten peoples who lived there in the seventeenth and eighteenth centuries were replaced by the Potawatomi. By the 1840s, most of the Potawatomi were displaced by American settlers who rapidly cleared the land and built farms, towns, and mills. All these historical developments have left traces in the ground. Most archaeological sites are within the uppermost foot of soil, but along major rivers such as the St. Joseph deep trenching has uncovered prehistoric camps as much as eight to ten feet below the present surface.
>
> "The State Archaeological Site file lists 667 archaeological sites within the Michigan portion of the basin. The number of sites for each township is listed in Table 1. Many of these sites were reported by local residents. Professional archaeologists have systematically inspected only 30.8 square miles, about 1% of the total area of the river basin. They were able to locate 313 sites, giving a site density of 10.2 sites per square mile. It has been estimated that there are about 25,000 archaeological sites within the Michigan portion of the basin.
>
> "Archaeological sites are not randomly distributed across the landscape. Prehistoric sites are most frequent along the banks of waterways, particularly the lower reaches of major rivers. Further upstream, and further upland, the sites are smaller and more widely dispersed.
>
> "Two archeological sites in the river basin, Moccasin Bluff and Fort St. Joseph, have been listed on the National Register of Historic Places. Several more are eligible for listing. Carey Mission, Fort Miami, and Burnett Trading Post have been listed as State Registered Historic Sites.
>
> "Archaeological sites are rapidly disappearing because of urbanization, deep plowing, expansion of utility corridors and the widespread use of grading on even minor construction projects. In the St. Joseph river basin, the most serious threats are erosion, deep plowing, and construction in the St. Joseph and Niles areas." (B. Mead, Department of State, Office of the State Archaeologist, personal communication).

Before European settlement, the vegetation of the river basin consisted of tall forests of mostly deciduous trees: oak, elm, walnut, and beech species predominating. Among the forests were numerous streams and lakes as well as bogs, marshes, and vast prairies. Some prairies near South Bend were several miles across. Native American villages were located near these prairies where the soil was easily cultivated for crops, and where deer, elk, and bison grazed (Miller 1996).

The St. Joseph River basin historically had a rich mix of vertebrate species within its boundaries. Reports from the late 1800s noted that deer, moose, elk, buffalo, beaver, swans, geese, and ducks were abundant in the area (Cunningham 1961; Davis 1990). Ballard (1948) reported that in spring, many fish would migrate up the St. Joseph River from Lake Michigan to spawn, including bass, redhorse, mullet (suckers), pickerel (walleye), trout, suckers, and lake sturgeon (refer to **Biological Communities,** *Original Fish Communities*).

After southwestern Michigan was surveyed in 1829, settlement of the area by European Americans began to increase. Prairies and oak openings were settled first. Clearing of land for agriculture and lumber became more profitable after the invention of steam engines. Several dams were constructed along tributaries of the St. Joseph River to supply power for saw and grain mills. The river was used as a super highway to transport logs and grain up and down the river valley by way of steamships and keelboats. In 1863, the city of Niles built its first dam; this was destroyed by high flows and rebuilt in 1871 with an improved design. The river and landscape began to change as forests were cut down, agriculture became the prominent land use, and dams fragmented waterways (Miller 1996). This was a difficult time for Native Americans as they watched the natural resources of the area being destroyed. Simon Pokagon of the Potawatomi wrote:

> "All, all has changed except the sun, moon, and stars and they have not because their God and our God in great wisdom and mercy, hung them beyond the white man's reach" (Cunningham 1961).

By 1925, the river from South Bend downstream was contaminated with sewage. In the 1930s, Michigan approached the State of Indiana to improve water quality by reducing sewage releases. Michigan took the first step towards reducing sewage releases to the St. Joseph River by installing a sewage treatment plant at Buchanan followed by plants at Berrien Springs, Niles, Benton Harbor, and St. Joseph. However, raw sewage continued to flow down the lower river until the upstream towns of South Bend, Mishawaka, and Elkhart built their sewage treatment plants. After the sewage problem was addressed, biological communities began being examined for effects from toxic contamination in the 1960s. Water quality in the St. Joseph River improved through the 1980s and 1990s with strict federal and state water quality protection laws (refer to **Water Quality**).

Geology and Hydrology

Geology and Physiography

The retreat of glaciers 10,000 years ago shaped the contemporary landscape and left deposits that make up the surficial geology in the St. Joseph River basin. The basin consists of a mosaic of outwash sands, ice contact material (unsorted sands and gravel), coarse end moraine (sands and gravel), fine end moraine (loamy), and lake plain (Lineback et al. 1983). About 52% of the surficial geology is made up of outwash, which ranks 3rd among Lower Peninsula watersheds behind the Manistee and Boardman rivers (Gooding 1995). Moraines elevate as high as 570 ft above Lake Michigan (Albert et al. 1986).

Glacial moraines with moderate elevation and pervious material have high water infiltration capacities and head pressure, which combine to produce high groundwater yields to low lying water bodies. Groundwater contribution to a stream determines the stability of both temperature and water flow. Basins, like the St. Joseph, with surficial geologic material dominated by outwash, ice contact, and coarse end moraine materials have higher groundwater yields compared to basins with less pervious and more fine textured materials (Bent 1971; Richards 1990; Wiley and Seelbach 1997). In well-drained soils a large amount of precipitation percolates to the groundwater, which is ultimately delivered to streams, lakes, and wetlands. Poorly drained soils, characteristic of fine till deposits, have low infiltration capacities, so most precipitation reaches the stream channel as surface runoff. Glacial outwash and coarse-textured glacial till are the dominant geologic materials in the basin contributing to moderately high groundwater deliveries to the river system.

These glacial deposits have strong influences on the behavior of streams and rivers, as well as on land use patterns. Outwash and fine-textured end moraine areas are associated with sandy loam and loam type soils typically used for agriculture. The high, steep-sloped moraines, that are associated with coarse texture and ice contact material, are usually forested because of rough terrain, low moisture content, and low soil fertility.

The headwaters and upper St. Joseph River segments mainly drain medium to coarse till and coarse end moraine across outwash sands, so these segments have moderately high groundwater inflows. Sand and Beebe creeks drain mostly coarse end moraine and may have moderate to high groundwater; however, the Coldwater River drains more coarse till and has moderate to low groundwater.

The middle valley segment flows across outwash sands between a mixture of ice contact and coarse to medium till. Several tributary rivers and creeks drain mainly ice contact and have potential for good groundwater such as Trout, Mill, and Christiana creeks, and Black Run. The Portage, Pigeon, Little Elkhart, and Elkhart rivers flow through and around medium and coarse till, so they have moderate to low groundwater. Portions of Portage and Little Elkhart rivers receive locally high groundwater yields from ice-contact hills.

Medium and coarse end moraine deposits with large areas of ice contact material characterize the lower valley segment. The river is forced around the southwest lobe of the Kalamazoo moraine near South Bend and cuts through this moraine at Buchanan. Several creeks flow through this moraine and have high groundwater flow. These streams include Love, Lemon, Brandywine, Cobus and Juday creeks, as well as the Dowagiac River. The mouth segment also drains medium end moraine along with sandy lake plain. More coarse end moraine materials are found within the Paw Paw River basin, so it receives moderate amounts of groundwater.

Climate

Climate in the St. Joseph River basin is primarily controlled by its latitude and by Lake Michigan. Latitude accounts for the seasonal changes that are the most important feature of this state’s climate (Eichenlaub 1990). The basin is one of the warmest in Michigan with a mean annual air temperature of 9.4 °C (49 °F). Precipitation is also high at 34 inches, third behind the neighboring Black and Galien River watersheds (Gooding 1995). It has a long growing season (151 days) with a high growing heat sum (2,630 °C-days). During the growing season, most precipitation is associated with passing cold fronts and showers caused by air-mass instability. The annual average extreme minimum temperature for the entire watershed is -23 °C (-9.4 °F) making for mild winters (Albert et al. 1986).

The lower and mouth segments of the St. Joseph River have a unique climate that is moderated by Lake Michigan. The long (157 days) and warm (heat sum 2,560 °C-days) growing season with an early last freezing date between April and June create a maritime climate that is ideal for flowering fruits. Winters in the lower and mouth segments are milder than the rest of the watershed with an extreme minimum temperature of -22 °C (-7.6 °F). However, considerable lake-effect precipitation falls during fall and winter months (Albert et al. 1986).

Net precipitation, because it is the source of surface runoff, through flow, and groundwater recharge, is the ultimate factor controlling stream flow. Therefore, differences in precipitation are important considerations when comparing stream flows within the watershed. Annual mean precipitation in the headwaters is 37.65 inches. Precipitation decreases in the upper (34.27 inches) and middle segments (35.03). The lower (37.23 inches) and mouth (37.33 inches) segments have increased annual precipitation. The heaviest precipitation occurs during June and July for most of the basin.

Annual Water Flow

The United States Geological Survey (USGS) maintains continuous stream flow gauges at 23 locations throughout the St. Joseph River basin, 12 in Michigan and 11 in Indiana (Figure 4). Data from these gauges have been collected for up to 68 years in Michigan and up to 61 years Indiana. Daily measurements of stream discharges (cubic feet per second or cfs) are published annually by USGS. Twenty additional continuous gauges were operated in the basin in the past, and many miscellaneous discharge measurements have been recorded throughout the basin. All USGS gauge data discussed are through water year 1995.

Annual stream flow in the St. Joseph River watershed is fairly stable. Precipitation and how that precipitation reaches the stream influence these flows. Watersheds dominated by pervious soils and well-vegetated landscapes typically have stable annual flows. Streams with stable flows are characterized by having lower peak flows and higher base flows because precipitation is delivered slowly to the stream through the ground. Streams with unstable flows have higher and sharper peak flows and low base flows because precipitation is transported overland as run-off that is a faster process.

High flows are typical in March and April with low (base) flows in August through October, as shown by the mean monthly flow in the mainstem at Niles (Figure 5). Similar patterns exist for the gauges at Burlington, Three Rivers, and Elkhart. High discharge in early spring is a function of snowmelt and storm water flowing over frozen soils. The peak month for precipitation is June; however, infiltration and evapotranspiration absorb and slow transport of storm water to the stream during summer and fall.

Change in annual flow is a factor that affects fish habitat. High flow in spring flood riparian wetlands and provides good nursery areas for fish. These flooded wetlands are nutrient rich from the decomposition of detritus material and support a large community of macroinvertebrates and plankton. Fish use these areas for feeding and to escape high water velocities in the main river channel. Riparian wetlands also have warmer water temperatures that reduce egg incubation time and increase the growth rate of fish. Change in annual flows is a problem for fish when flow becomes inconsistent with the season (e.g. loses its high flow character in spring). Dams, stream channelization, and dikes can alter spring flooding and affect important fish nursery areas (Junk et al. 1989).

Average discharges for the St. Joseph River and tributaries are listed in Table 2. At the mouth, the St. Joseph River has a discharge of 4,598 cfs making it the third largest river in Michigan behind the Saginaw and Grand rivers. Discharge per square mile increases in a downstream direction. This is directly correlated with the lower and mouth segments receiving more precipitation and having less evapotranspiration due to a higher infiltration rate compared to the upper and middle segments. The lowest discharge per square mile (0.54) was found in Pine Creek at Elkhart which is a small sub-watershed that receives an average of 35.03 inches of precipitation a year. The highest discharge per square mile was 1.18 in the Dowagiac and Paw Paw rivers. Both rivers receive over 37 inches of precipitation and have significant amounts of groundwater yield that increases the annual average discharge.

Seasonal Water Flow

The St. Joseph River mainstem has stable flows and its tributaries range from very unstable to stable in flow. The stable flows on the St. Joseph River have been documented for many years. Turner

(1867) noted the fast current in the river, and the relatively constant flow is "not subjected to rapid and excessive rises nor to inconveniently low stages of water".

Stability of flow provides or represents a tool to examine the combined effects of many characteristics of streams, including source of flow, channel characteristics, temperature, and land cover in the watershed. Since most areas of the watershed have similar seasonal climatic patterns, differences in flow stability can be attributed to surficial geology, land cover, or human influences such as storm sewers, stream channelization, or land use.

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

When comparing exceedence values for streams of varying sizes, it is necessary to standardize values so that direct comparisons can be made. One method of standardization requires dividing exceedence values by median exceedence. This number represents the magnitude of discharge variance from the median flow at each exceedence range. For exceedence flow over 50%, the smaller the standardized value, the more stable the stream. For example, (5% exceedence)/(50% exceedence)=standardized discharge at the 5% exceedence level - if this value is equal to 2, then flood flow is two times greater than median flow.

Exceedence flows are illustrated in Figures 6-15 in downstream descending order (headwaters to mouth) based on gauge location within the basin. The most stable USGS station on the mainstem is at Burlington, which has a standardized discharge at 5% exceedence of 2.3 i.e., flood flow is 2.3 times greater than median flow (Figure 6). This indicates a stable system, regardless of watershed size at this location. For comparison, the most stable streams in Michigan (e.g. the Au Sable, Manistee, and Jordan rivers) have standardized 5% exceedence (high) flows that are slightly less than twice their median flows, whereas the flashy Lower Rouge River in southeast Michigan shows a standardized 5% exceedence of 13.7 (Beam and Braunscheidel 1998).

Flow stability can also be analyzed using low-flow or base-flow patterns. In general, the higher the base flow relative to overland flow, the more stable the stream. The higher the ratio between each exceedence rate and the median discharge, the less variation in stream flow. For USGS stations in the St. Joseph River watershed, the standardized 95% exceedence ranges from 0.1 to 0.6. Hence, streams in the St. Joseph River basin vary from very unstable to stable in flow. The Rouge River has a standardized 95% exceedence of 0.2, whereas the groundwater-fed South Branch Au Sable River near Luzerne has a value of 0.6.

Exceedence flows are described more thoroughly for the St. Joseph River and tributaries by valley segments:

Headwaters and Upper

The mainstem river at Burlington and Nottawa Creek have fairly stable flows with standardized 5% exceedence flows less than 2.9 (Figure 6). Hog Creek has a more flashy flow with a value over 4.1.

Nottawa Creek receives the most groundwater as illustrated by the highest standardized 95% exceedence of 0.4 followed by the St. Joseph River at Burlington and Hog Creek (Figure 7).

Middle

The St. Joseph River at Elkhart has the most stable flow of the three monitoring stations on the mainstem within this segment (Figure 8). There are four impoundments above Elkhart that may have a stabilizing effect on seasonal flows. The highest standardized 5% exceedence flow on the entire mainstem was 2.9 at Three Rivers. The St. Joseph River at Three Rivers may have a slightly higher exceedence flow value because the Rocky and Portage Rivers enter at this location. The mainstem at Three Rivers also has a lower low flow exceedence curve compared to the Mottville and Elkhart locations (Figure 9).

Pine Creek and the Little Elkhart, Pigeon, and Prairie rivers have fairly stable flows with standardized 5% exceedence values between 2.5 and 3.0 (Figure 10). Pigeon Creek, however, had high flow values over 4.7. Pigeon Creek flows though predominately heavy clay loam soils; therefore, it received more runoff than if it had more sandy soils (see **Soils and Land Use**). This is also evident in the standardized 95% exceedence flow (Figure 11). The Little Elkhart River had a low flow value over 5.0, indicating a fair amount of groundwater.

The Elkhart River is a good example of the variability in flow between the mainstem of a river and its tributaries (Figure 12 and 13). Solomon Creek and Elkhart River mainstem are stable whereas the Rimmell Branch near Albion is unstable with standardized 5% exceedence flows of 9.8. Rimmell Branch also has a low standardized 95% exceedence of 0.07. Rimmell Branch and Forker Creek are in heavy-agricultural land use areas and have both been channelized. Solomon Creek's stability may be a function of good groundwater yields and wetlands that buffer against severe increases in flow.

Lower and Mouth

The streams in these segments are the most stabile of the entire watershed. Probably due to its size and groundwater flow, the St. Joseph River through Niles is also stable with low standardized 5% exceedence and high standardized 95% exceedence flows (Figure 14 and 15). Two of the best systems for stability are Juday Creek (1.9 standardized 5% exceedence flows) and Dowagiac River (2.0 standardized 5% exceedence flows). Both of these streams receive high inflows of groundwater. The Paw Paw River is also stable and has standardized 95% exceedence flows similar to the Dowagiac River.

Another index of flow stability is defined by the ratio of mean high flow to mean low flow (Table 3). Using short-term and miscellaneous flow data, the highest mean monthly flow and lowest mean monthly flow for a year are averaged for several years at a specific site to calculate the overall mean high and low flows. High ratios of these two numbers indicate unstable flows dominated by rainfall runoff, low numbers indicate stable flows dominated by groundwater (Table 3) (P. Seelbach, Michigan Department of Natural Resources (MDNR), Fisheries Division, personal communication). Severe stability problems are indicated in the upper segment in Hog Creek and Coldwater River as well as the headwaters of the Elkhart River in Forker Creek, Rimmell Branch, and Turkey Creek. The remaining St. Joseph River and tributaries are rated fair to good for stability.

The dominance of stable streams in the basin is mainly due to abundant permeable surficial geology and soils, both important ingredients for groundwater flow. Broad floodplains and large amounts of wetlands also contribute to stable stream flows by providing good water storage. Large streams also tend to be more average in flow than small streams because they have heterogeneous catchments. The few unstable streams in the basin are small creeks with agricultural and urban land uses. Channelization also contributes to unstable flows.

Several of the more stable tributaries to the St. Joseph River, such as Juday Creek, Dowagiac River, and the headwaters of Paw Paw River, are cold water systems that support trout populations. A significant contribution of groundwater to stream flow ensures steady flows and cool water throughout the year. The flow of the Dowagiac River is especially stable, and is comparable to the flow stability of the Au Sable River and other well-known northern Michigan trout streams (P. Seelbach, MDNR, Fisheries Division, personal communication). Streams with less stable flow often have less permeable soils in the watershed, fewer wetlands, and human-induced disturbances such as channel dredging and construction in the floodplain. Forker Creek, in Indiana, has the highest flow index value at 36.3. This stream has a small drainage basin, a narrow channel, and clay based soil on glacial till, all of which combine to produce poorly sustained stream flows. According to Indiana Department of Natural Resources (IDNR), the operation of lake-level control structures on this stream also reduces flow during summer months (IDNR 1987).

Daily Water Flow

In natural streams, daily flow changes are generally gradual. However some hydroelectric operations and operations of lake-level control structures cause substantial daily flow fluctuations. These daily fluctuations can destabilize banks, create abnormally large moving sediment bedloads, disrupt habitat, strand organisms, block movements of aquatic organisms, and interfere with recreational uses of the river. Aquatic production and diversity are profoundly reduced by such extreme daily fluctuations (Cushman 1985; Gislason 1985; Nelson 1986; Bain et al. 1988).

Hydrographs (graphs of daily discharge over time) are used to analyze stream flow stability. They can be used to examine characteristics of a river channel as well as the source of flow. Since climate is relatively similar across the watershed, change in the shape of a hydrograph over time (several years) or between sites can be attributed to variations in geology, land use, water from storm drains, or human alteration by way of hydroelectric operations and other flow control structures.

Flow peaks for the mainstem are asymmetrical during summer and fall (Figure 16). These peaks indicate a source of throughflow or shallow groundwater to a stream. After a heavy rain event, peak flow declines gradually due to the slow release of water from the surrounding soils. During March and April, flow in the St. Joseph River watershed is more unstable. Peaks are more symmetric in late winter and early spring when the ground is frozen or saturated and less permeable. As a result, snowmelt can release more water into a river and at a faster rate than rainfall. The Rimmell Branch (Figure 17), which drains predominately clayey farmland, has symmetric flow peaks. Water in this stream is delivered over the surface, so rapid increases in flow are followed by equally rapid decreases. The groundwater driven Dowagiac River (Figure 18), shows some evidence of symmetric peaking that may be a result of channelization or saturation from irrigation.

Berry (1992) found an increase in Dowagiac River peak flow between 1960 and 1990. Increase in irrigation that saturates soils may be the cause of increased peak flow, since no major demographic or land use transitions have taken place over the period of record. Irrigation practices saturate soils causing run off to increase during significant storm events. Normally, soils are dry during August and most precipitation is absorbed by the soil and delivered to the river as groundwater.

The percentage of the Dowagiac River watershed that is irrigated increased tenfold between 1960 and 1987. The amount of water applied to each irrigated acre increased from 5.5 to 10.0 inches per year. Peak discharge has increased significantly during the month of August, when irrigation use is high.

Another indication of a groundwater source to a system is the amount of summer base flow on hydrographs. The discharge of the Dowagiac River never descends below 150 cfs in August when precipitation is low and evaporation and evapotranspiration are high. Streams without base flow typically run dry in the summer, for example Rimmell Branch (Figure 17).

Daily flow is also influenced by hydroelectric dams that operate in peaking mode, causing severe habitat degradation (Cushman 1985; Gislason 1985; Nelson 1986; Bain et al. 1988). These dams release high flood flows during peak electrical demand (generally 8 am to 8 pm) and shut down flow creating drought flows during non-peak periods (generally at night). Historically, several projects on the St. Joseph River mainstem operated as peaking projects. Now all projects operate in run-of-river mode (outflow of water about equals inflow of water) as required by the Federal Energy Regulation Commission with exception of Berrien Springs dam. The Berrien Springs dam does not operate in run-of-river flow and continues to cause severe fluctuations in flow down stream. When new computerized turbines (installed in 1996) sense a level increase in the impoundment, a turbine will turn on sending 400 cfs downstream. During low flow situations, the activation of one or two turbines can instantly double the discharge downstream causing unsafe conditions for wading anglers and boaters. Fish spawning success is also adversely affected by these periods of fluctuating flow. Due to concern about the fluctuations, a new operating scheme where a spillway gate is partly opened to pass flow during the time between turbine startups is being implemented to alleviate fluctuations downstream. Berrien Springs dam is not licensed under FERC because of a permit that was issued by an Act of Congress in 1906, Public Act No. 85 (H.R. 16671) (FERC 1981). FERC has no regulatory authority over the Berrien Springs Project. This will not change unless congress amends the act. However, operations at the project may fall under the jurisdiction of the Michigan Natural Resources and Environmental Protection Act (see **Special Jurisdictions**).

The Three Rivers Dam also causes severe flow fluctuations. Instantaneous flow data indicated 30-40% increases and decreases in flow below the dam that correlate with peak electrical demands (Figure 19). Grande Point Power Corporation fills the impoundment during early morning hours causing decreases in flow below the dam. Turbines are turned on at about 9:30 a.m. and run until late evening causing increases in flow. In 1987, FERC determined that the dam was under their jurisdiction and ordered an application for a hydroelectric facility license. The project is now going through the application process, so run-of-river flow should be advocated as part of the new license agreement with FERC.

Flooding and Floodplains

Floods are part of the natural cycle of river systems (Junk et al. 1989). Flood flows are important for sediment transport in river systems, distributing moving sediments downstream and onto a floodplain. Floodplains act as a major storage area for sediments and nutrients. Water flowing into a floodplain expands the area available for fish feeding and breeding, and can wash additional food items into a stream or river. Large woody debris washes into and is moved within streams during high flow periods, this wood is an important component of river ecosystems. Wood is often used by fish as cover habitat and as substrate for aquatic invertebrates. Floods contribute to the diversity of insects and fish found in a stream and contribute to downstream colonization of some species.

Dams on the mainstem and tributaries alter natural flow regimes of systems and sometimes contribute to flood problems. Dams interrupt sediment transport by floods and their operation can modify the effects of floods to the detriment of the natural stream flow cycle.

Floods are common along the River. The St. Joseph River Basin has experienced 50 year floods (flood intensities that have the probability of occurring every 50 years) in 1908, 1937, 1943, 1947, 1950, 1982, and 1985 (Federal Power Commission 1974; USGS 1990). Development in a floodplain is periodically damaged by floods, especially during 100-year or larger rain events. Flooding occurred in several urban areas during the 1950 flood including Coldwater, Union City, Three Rivers, Constantine, Goshen, Elkhart, Mishawaka, South Bend, Niles, Dowagiac, Paw Paw, and Benton Harbor. The City of Three Rivers is unique. This city is situated at the confluence of the Rocky, Portage, and St. Joseph rivers. It experiences floods on a regular basis, and sometimes large areas of the community are inundated. Flooding problems in the city were recorded as early as 1866 (Sillman 1931). The City has sought assistance in dealing with these periodic floods. A 1971 study by the Corps of Engineer in the St. Joseph River basin concluded that no Federal flood control projects be undertaken, because they would not be cost effective (Federal Power Commission 1974).

Seasonal flooding occurs predictably in some reaches in the basin, but tends to be confined to the floodplain (USDA 1985; Federal Insurance Administration 1991). In areas where the floodplain is intensively farmed, flooding may contribute to pollution problems in the basin. Erosion from cropland that has been heavily fertilized, or where animal waste is disposed or stored, releases nutrients to the rivers, and increases sedimentation (refer to **Water Quality**).

The Natural Resources Conservation Service has completed Flood Plain Management studies on several rivers in the basin (USDA 1985). Studies have been completed on the Coldwater and Paw Paw rivers and Portage and McCoy creeks. These studies describe hydraulic characteristics of selected portions of the watershed, identify areas of flooding, and provide information on alternative methods of flood control.

Fifty-three communities within the basin participate in the National Flood Insurance Program (Table 4). Most of these communities have flood plain maps that delineate 100- and 500-year flood boundaries for the rivers within their municipal limits. These are used by State and local agencies and individuals for planning purposes, general floodplain management, and to determine the need for flood insurance.

Channel and land use processes both influence the severity of flooding. Channelization causes increased water velocity reducing the height of flooding in smaller stream reaches, but it increases the magnitude of downstream floods in larger rivers. Roads and construction along rivers act as levees and prevent high flows from expanding across floodplains. Filling wetlands and floodplains decreases the water storage capacity of a watershed, which reduces retention time and increases runoff. Development also increases runoff by creating impervious surfaces such as roads, parking lots, and rooftops. Precipitation that is delivered to streams as runoff enters streams more quickly and can contribute to severe flooding.

Seawalls and levees are often used to protect against floods and eroding banks. Levees prevent floodwaters from entering the floodplain and constrict water flow causing flood peaks in areas downstream. They do not allow sediments to be deposited in the floodplain and prevent fish access to seasonally flooded areas, which are important for spawning and feeding. Seawalls eliminate shallow water areas and the natural diverse edge habitat that can be important to macroinvertebrates. They also block animal access to and from the stream. Through permitting processes, zoning procedures, and education riparian property owners should be encouraged or required to use less intrusive and more natural looking methods to stabilize banks. Rock riprap, log and whole tree revetments, and vegetative plantings are good alternatives to seawalls (Alexander et al. 1995).

New policies are needed to facilitate reclamation of low elevation floodplains. These floodplain areas could be recovered if policies were developed to regulate land use activities after large floods (Doppelt et al. 1993). Reconstruction or reoccupation of floodplain roads, homes, businesses, and other structures should be restricted after flood inundation to prevent future disasters and promote open space floodplains.

Channel Morphology

Gradient

Stream gradient (drop in elevation with distance, usually in feet per mile) is an important factor determining river channel form and streambed composition. Gradient has been related to streambed particle size, discharge, channel pattern (meandering), and sediment transport (Hynes 1970; Knighton 1984). Gradient is one of the most important factors in determining the distribution and abundance of various fish species, such as smallmouth bass (Trautman 1942; Edwards et al. 1983), flathead catfish (Lee and Terrell 1987), bluegill and green sunfish (Stuber et al. 1982a; Stuber et al. 1982b), black crappie (Edwards et al. 1982), northern pike (Inskip 1982), warmouth (McMahon et al. 1984), white sucker (Twomey et al. 1984), blacknose dace (Trial et al. 1983), and creek chub (McMahon 1982).

The average gradient of the mainstem of the St. Joseph River is 2.5 ft/mi with a range from 0-45 ft/mi. Some river portions are much steeper than average, others are more gradual. These areas of different gradient create diverse types of channels, and hence different kinds of habitat for fish and other aquatic life. Typical channel patterns with gradient are listed below (G. Whelan, MDNR, Fisheries Division, unpublished data). In these descriptions, hydraulic diversity refers to the variety of water velocities and depths found at a particular site in the river. The most productive river habitat offers a good variety to support different life histories of various species. Fish and other life are typically most diverse and productive in those parts of a river with gradient between 10 and 69.9 ft/mi (G. Whelan, MDNR, Fisheries Division, personal communication; Trautman 1942). Unfortunately, such gradients are rare in Michigan because of low-relief landscape, and these areas are also the most likely to have been dammed.

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 sequences with good hydraulic diversity
10.0-69.9 ft/mi	excellent	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

The St. Joseph River is predominately low gradient, 157.5 river miles (74.9%) are described by the lowest gradient class (<3.0 ft/mi) (Figure 20). Gradient gradually decreases from the headwaters downstream towards the mouth (Figure 21a and 21b). Gradients between 3.0 and 4.9 ft/mi constitute 37.9 mi (18%) of the mainstem, and 13.1 mi (6.2%) are in the good hydraulic diversity class (5.0-9.9 ft/mi). The most desirable gradient between 10.0 and 69.9 ft/mi is found in only 1.9 mi (0.9%) of the river. However, 74.9 mi (35.6%) of the river are impounded by lake-level control structures or hydroelectric facilities. This includes 14.6 mi (28.6% of the gradient class between 3 and 9.9 ft/mi) and 0.8 mi (44.2% of the gradient class between 10 and 69.9 ft/mi) of river with the best type of hydraulic diversity. The river (free-flowing) portions of the St. Joseph include 96.8 mi of the low gradient run habitat, 36.4 mi of run-riffle habitat with gradient between 3.0 and 9.9 ft/mi, and 1.1 mi of riffle-pool habitat with gradient between 10.0 and 69.9 ft/mi. The run-riffle and riffle-pool habitats are found in the headwaters below Baw Beese Lake and in small reaches near Union City, Sturgis Dam, and Niles.

The stream gradient of the St. Joseph River channel varies from less than 1 ft/mi to over 40 ft/mi. The variation in gradient is a result of diversified landforms with low gradient across flat areas and higher gradients at the edges of moraines. Valley segments are characterized as follows:

Headwaters
These 59.8 mi have the most diverse gradient with a smaller portion (43.8%) of low gradient habitat than other valley segments (Figure 22a). Fair to good gradients make up 53.7% of the segment and excellent gradients constitute only 2.6% of the segment.

Upper
This 25.5 mi segment has the largest proportion (89.3%) of low gradient (Figure 22b). A natural flooding that creates Sturgeon Lake has no gradient for 1.3 mi. Fair to good gradient habitat exists in 9.3% of this segment (2.4 mi), and 1.3% (0.3 mi) consists of excellent hydraulic diversity (10.0 - 69.9 ft/mi). All fair to excellent habitat is flooded by Union City Impoundment.

Middle
Low gradient constitutes most (81.5%) of this 49 mi segment (Figure 23a). The remaining 9.1 mi consists of fair to good with no excellent gradient. Sturgis, Constantine, and Elkhart impoundments inundate 7.6 miles (83.6%) of the fair to good gradient habitat.

Lower
This 63.8 mi segment is dominated by low gradient (Figure 23b). Fair to good gradient (riffle-run habitat) exists in 11.8% (7.5 mi) of the segment. Mishawaka and Niles (French Paper) impoundments flood 65.7% (4.9 mi) of the fair to good gradient.

Mouth
The last 7.4 mi of the river flows across a glacial lake plain and is all low gradient (0.0 - 2.9 ft/mi). No dams exist on the mainstem within this segment.

Channel Cross Section

Channel cross section is another measurement of the quality of fish habitat. Natural channels (Figure 24a) typically provide better habitat than degraded or manipulated channels (Figure 24b). 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. Sand channels are typified by higher velocities and more laminar flows, and have parabolic cross sections (Alexander and Hansen 1988). 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.

Channel width comparisons were done for each valley segment and many tributaries (Table 5). Data were from discharge studies of Blumer et al. (1996). Expected width was estimated from a relation with mean daily discharge (G. Whelan, MDNR, Fisheries Division, unpublished data). Valley segments and tributaries have cross sections as characterized below; cover and substrate measurements are from Shepherd (1975) and Towns (1988):

Headwaters

This segment has a narrow channel characterized as both straight and meandering. From Baw Beese Lake to Jonesville, vegetative cover is moderate to heavy, substrate is mostly silt to sand, and fish habitat is rated as poor. Downstream of Jonesville to Litchfield, substrate is mostly sand and gravel with some silt, cover is moderate to heavy, and fish habitat is better. Substrate becomes more varied in lower reaches of this segment with mostly sand and silt, but some areas of swift current have boulders and rubble. Velocity is higher in this lower reach creating more pool and riffle habitat.

Upper

The channel ranges from moderately straight to meandering unconfined. The channel is average in width and uniform in depth. Substrate is mostly sand and silt with some gravel, rocks, and boulders. Fish habitat (holes, instream logs, and pools) is better in this segment than in the headwaters. Major tributaries show the same channel characteristics. Although not significant, Hog and Nottawa creeks have below average stream widths, probably from channelization (Table 5).

Middle

The river meanders unconfined in a broad glacial fluvial valley. Width doubles between Three Rivers (180 ft) and Elkhart (364 ft) due to the addition of major tributaries. Substrates are mostly sand and gravel with some silt. Substrates and channel widths vary greatly due to the five impoundments in this segment. Variation in channel width can also occur from lateral cutting into soft stream banks. Most of the tributaries have average channel widths given their discharge. Pigeon and Forker creeks have significantly narrow channels, which indicates channelization (Table 5). Stream bank cover is abundant in the upper half of this section. The lower section of this segment is urbanized and has very little stream bank cover.

Lower

The river channel is narrow through this segment as it meanders confined in a narrow glacial valley. Width at Niles is more than one hundred feet narrower than at Elkhart and the river discharges 400 cfs more at Niles than at Elkhart. Substrate is mostly sand and gravel; however, the reach between Mishawaka and Bertrand has gravel and cobble. The stream banks are mostly wooded through residential areas. Juday Creek and Dowagiac River have significantly narrow channels (Table 5). Both these streams have histories of channelization, but they also receive notable amounts of groundwater that increase their average discharge. Groundwater streams also have lower peak flows, so flood events are less prevalent to cut new and wider channels.

Mouth

The channel is generally wide in this segment as it meanders unconfined across the lakeplain. Substrates are mostly gravel and cobble but become finer (sand and silt) closer to the mouth as the river loses power. The Paw Paw River enters this segment and has a significantly narrow channel (Table 5). Usually, streams with significantly narrow channels have been channelized; however, the Paw Paw River has not been channelized. The Paw Paw River receives high amounts of groundwater giving it a higher than average annual discharge, so its expected width may be over estimated.

Dams and Barriers

There are 190 dams in the St. Joseph River basin registered with MDEQ and IDNR, with 17 on the St. Joseph River mainstem (Table 6; Figure 25). Some of these dams are classified by MDEQ Dam Safety Section and IDNR Dam and Levee Safety Section according to their purpose: 18 for hydroelectric power generation, 11 retired hydroelectric dams, 5 for irrigation, 105 for recreation (including lake-level control structures), 9 flood-control dams, 4 for water supply, and 19 for other reasons (private ponds, county park ponds, hatchery ponds etc.). It is not known how many small unregistered dams exist in the basin.

The first dam in the watershed on record was built in 1826 on Dowagiac Creek. Early dams were built across small creeks at high gradient locations to power grain mills. Construction of mill dams continued until 1900. From 1890 to 1940, several large dams were constructed to generate electricity. The last phase of dam building was between 1945 and 1980; these dams were built to control lake levels for recreation and waterfront development.

Dams are regulated under Michigan's Dam Safety, Part 315 of the Natural Resources and Environmental Protection Act, 1994 P.A. 451 as amended; Indiana's Chapter 84, Acts of 1961, Indiana General Assembly; and the Federal Energy Regulatory Commission Regulation 18 of Part 12 of the Code of Federal Regulations. Most existing hydroelectric dams are under FERC authority. The Berrien Springs Dam on the St. Joseph River is not regulated under FERC; it has a permit issued by an Act of Congress in 1906. Dams not regulated under FERC operate without licenses and have limited regulation toward operation of the dam; therefore, no control is offered for the protection of aquatic resources above and below such dams.

All dams in the Michigan portion of the basin are considered safe by the Dam Safety section of MDEQ, LWMD. Thirteen dams are of hazard type 1 (dam failure would cause the loss of life), 12 are of hazard type 2 (dam failure would cause severe property damage), and the remaining 97 dams are of hazard type 3 (have low heads in remote areas). Most of the high hazard dams have a head of over 12 ft and are hydroelectric or retired hydroelectric facilities on the mainstem.

Dams have many detrimental effects on aquatic communities in rivers. They impede fish movements to refuge habitats causing segmented fish populations and block spawning migrations (Goldman and Horne 1983; Schlosser 1991). Dams fragment river systems, and turn high quality river habitat into lentic habitat. Some fish and aquatic insects migrate up or downstream to reach different feeding and temperature habitats throughout the year. Mortality or injury can result while passing through dams, especially with hydroelectric turbines. Entrainment often causes mortality or injury as a result of fish being struck by turbine blades, pressure changes, sheer forces in turbulent flows, and water velocity accelerations (Cadwallader 1986; Cada 1990). Potamodromous fish can migrate up river from Lake Michigan to Twin Branch Dam through the use of fish ladders at the Berrien Springs, Buchanan, Niles, South Bend, and Mishawaka Dams. Salmonines comprised 99.6% of all fish passed at the ladders (Dexter and Ledet 1995). The remaining use of ladders is by warm and coolwater species. Both up and down river movements of walleye, smallmouth bass, channel and flathead catfish, and white and redhorse suckers frequently occur between June and August.

Impoundments that draw water from the surface typically increase downstream water temperatures by spilling warm surface waters. This is especially critical in the warm summer months. Increased water temperatures can lead to elimination of certain aquatic species including fish (Ward 1984). Evaporation rates increase with higher temperatures and much greater impoundment surface area. Dissolved oxygen levels in impoundments are usually lower than those in moving streams, and this change can alter fish populations in impounded portions of the river system. Impoundments also act as sediment and debris traps. Sediment-free water released below the dam has high erosive power causing increased scour and bank erosion. Woody debris, which is important for fish habitat, is caught in impoundments and eventually sinks depriving downstream segments.

The seasonal distribution of flow is also disrupted by reducing incidence and severity of flooding. This reduces the inundation of floodplains causing a decrease in backwater habitat for fish spawning and juvenile rearing. The decrease in flooding also reduces the amount of food deposited into the river. Intense short-term flow fluctuations immediately below dams can strand aquatic organisms during severe low flows and destroy habitat during extremely high flows.

Many dams were built on the areas of highest gradient on the St. Joseph River, and its tributaries, in order to create the largest hydraulic head possible for the lowest cost. Some segments of the St. Joseph River had rapids and fast riffle areas before being impounded. These areas were high quality spawning areas, used by potamodromous and other aquatic species in the river, and are now lost.

Natural stream systems strive to reach equilibrium, where the amount of water and sediment that enter a stream equals what leaves it. Many southern Michigan rivers are still trying to reach equilibrium, and channel forms are still changing. Dams interrupt the natural evolution of stream channels. Aggradation takes place above dams, as sediments are deposited in the reservoirs, and the stream tries to re-establish a new equilibrium downstream. Sediment deposition in these river segments makes the stream channel wider and shallower, with few deep holes, and habitat heterogeneity is lost. This loss of heterogeneity adversely affects fish populations as different life stages of river fish species need many habitat types to survive.

Dams also interfere with free navigation and recreation on rivers. A canoe trip from the headwaters to the mouth would require 17 portages around dams. Some canoe portages are provided, but some are not clearly marked or are poorly maintained. Of the 17 dams on the mainstem, 12 offer official canoe portage or boat launch facilities. Boat launches are more prevalent in the lower and middle sections, where impoundments and the river are deep enough to support use by larger boats (refer to **Recreation Use**).

Some dams are constructed to maintain un-natural levels of lakes, or to deepen natural lakes, with no regard to river levels below the lakes. These lakes have legally-established water levels, and the dams are operated to assure the level is maintained through the year. A few lakes have lower winter levels established to allow dock and seawall maintenance, and to protect these structures and riparian shorelines from ice damage. These legal levels are determined without regard to affects on fish and wildlife above and below the structures. Critical spring spawning areas for fish such as northern pike are eliminated on some lakes when water levels are kept artificially low to protect riparian property. Naturally, water levels rise in lakes during spring and gradually decline in level through summer and fall. Stretches of streams below some of these lake-level control structures have little or no flow in the summer months due to seasonal regulation of outflows - more water is held back in summer for recreation.

Dams on the St. Joseph River are further described within valley segment below.

Headwaters

All nine dams in the headwaters are used for recreation to create lakes or impoundments. Baw Beese Lake control structure is the largest dam in this segment with a head of 12 ft. This segment has the highest gradient, but most of it is flooded under impoundments. These impoundments increase water temperatures and prevent downstream movements of woody debris. None of the mainstem dams have official portage facilities. More investigations of the effects of dams are needed for the headwaters.

Upper

There are 24 dams within this segment with two on the St. Joseph River mainstem. Riley Dam at Union City is the largest dam and the only unlicensed hydroelectric facility in the upper river. State of Michigan legislation exempts the facility from any licensing procedures. Fisheries Division should pursue options to change the existing law that exempts the Riley Dam facility. The impoundment and river below are actively managed fisheries. Therefore, Riley Dam should not be excused from licensing procedures and should be held responsible for any natural resource damages as a result of dam operations.

The Randall Dam on the Coldwater River at Union City is in the process of being removed. City officials have agreed to remove the dam and are pursuing funding. By removing the dam, the city will decrease long term costs associated with dam maintenance and liability insurance. The river will once again become a free flowing system with no barriers. This will allow fish and other organism to freely move up and down stream. It will also allow for the natural downstream movement of sediments and woody debris. Riffles in this high gradient area will become exposed and create excellent gravel and cobble habitat for fish and macroinvertebrates.

Most of the dams are lake-level control structures and are owned by county governments. These dams have the potential to reduce summer flows in small creeks and to increase water temperatures. The Palmer and Long lake control dam was declared unsafe, and the impoundment was drained in 1996 for dam repairs and rebuilt in 1997.

Middle

This segment has 105 recorded dams with five on the mainstem. The Sturgis, Three Rivers, Mottville, Constantine, and Elkhart dams on the mainstem; Centreville dam on Prairie River; and Fawn River Mill, Star Mill, and Greenfield Mill dams on Fawn River all operate as hydroelectric facilities. FERC licenses expire in the year 2000 for Elkhart and Sturgis and 2003 for Mottville. The remaining dams are for recreation and consist of old mill dams and lake-level controls. The Sunset Lake dam on Portage Creek, G.T. Anderson Dam on Pigeon Creek, and Cliff Pettit Dam on Little Elkhart Creek are used for water supply. These dams severely fragment the middle segment of the St. Joseph River basin and prevent the free movement of fish between mainstem and tributaries.

Fish entrainment studies were conducted at the Constantine Hydroelectric Facility (Anonymous 1991). Entrainment was highest in June, and 84% of fish entrained were mimic shiners. Mimic shiners are part of the forage base of larger predators in the system. Largemouth bass made up 2% of the fish entrained. Although bluegill, channel catfish, and walleye were present near the facility, there was no significant mortality from turbines.

An environmental assessment was conducted at the Star Mill dam on Fawn River for FERC re-licensing requirements (FERC 1997). Star Mill dam was required to operate as run of river rather than a peaking mode. It was recommended that a minimum flow of 25 cfs be maintained at all times in the bypass channel to protect the fishery and aquatic resources. There is no fish passage facility, so upstream movement is completely blocked and downstream passage is limited to the spillway or the powerhouse. A trash bar was installed that prevents larger fish from entering the intake water. However, fish less than two inches may be entrained. In order to protect the fishery, increased protection and an entrainment study are recommended.

Lower

Thirty dams exist in this segment. Four of the eight dams on the mainstem are hydroelectric facilities. Twin Branch and Buchanan dams were relicensed under FERC in 1996. The Dowagiac River system has an unusual number of dams including six on Dowagiac Creek and one each for the Dowagiac River proper and McKinzie creeks. Portions of Dowagiac Creek support brown trout, but the dams block trout movements. These impoundment areas also cause stream temperatures to increase to levels that will not support brown trout throughout portions of this system.

A small dam on Kimmerlee Creek (tributary to Pokagon Creek) of the Dowagiac River subwatershed was removed in 1998. Kimmerlee Creek is a wild trout stream, and the dam was blocking trout movement upstream. The landowner wanted to remove the dam for liability and aesthetic purposes. An Inland Fisheries Grant was awarded to the landowner to help with removal costs and to be sure that downstream habitat was not degraded during removal. In less than three months after removal, the stream had recovered to normal conditions. Now trout have full range of the creek.

The Pucker Street Dam on the Dowagiac River was drawn down to sill level in 1999. This lowered the former impoundment by five feet and restored one mile of stream above the dam. The remaining 15 ft of concrete sill is scheduled to be removed once funding is secured by the city of Niles. A major cost of dam removal is management of sediments in the former impoundment. Once the dam is removed, an additional one mile of high gradient (diverse) habitat will be restored in the river. Potamodromous fish will also have access to the entire Dowagiac River.

Turbines at the Niles (French Paper) and Buchanan dams were studied to determine effects of fish entrainment (FERC 1991; FERC 1996). Chinook and steelhead smolts were released at Mishawaka. Of smolts released, 12.3% of chinook and 2.3% of steelhead passed through the project powerhouse at Niles. Turbine mortality was 4.2% for steelhead and 1.2% for chinook. At the Buchanan facility, 19.8% of out-migrating steelhead and 21% of chinook smolts were entrained. Induced turbine mortality was 17.9% for steelhead and 21% for chinook (RES 1992). Smallmouth bass and walleye comprised less than 1% of all fish entrained at Buchanan. It was recommended that fish screens be placed to prevent turbine passage and mortality. Niles dam stops turbines for 72 hours in May to protect out-migrating smolts after release from Twin Branch Fish Hatchery in Mishawaka. However, the temporary shut down does not protect natural chinook and steelhead smolts that may migrate at a different time. Steelhead smolts may take up to 32 days to out-migrate after stocking, whereas chinook salmon will migrate in 48 hours. The shut down does not to protect other riverine fish species that could be entrained throughout the year.

There are also concerns regarding entrainment at the Berrien Springs Dam. Turbines at Berrien Springs draw water from the center of the river, where flow is concentrated. Smolts tend to stay in the main flow (center of the river) when out-migrating. The potential to entrain fish is greatest with turbines that draw water from the center of the river. Due to a FERC license exemption by an Act of Congress, there are no regulations requiring procedures to prevention and evaluate fish entrainment at Berrien Springs.

<u>*Mouth*</u>

All 22 registered dams in this segment are within the Paw Paw River sub-watershed. These dams are located on tributaries to the mainstem; therefore, potamodromous fish can migrate from Lake Michigan to Campbell Creek in the headwaters. These dams generally have low head and are found in remote areas, so they have low hazard ratings. There are no active hydroelectric dams, most of the dams are being used for recreation as lake-level control structures.

Soils and Land Use Patterns

Soils

Soil type is an important component of the hydrology and can also direct land use patterns in the watershed. Sandy soils typically lead to more groundwater flow to streams compared to less permeable clay soils. However, sandy soils are less fertile than loamy soils. General soil maps are available for each county in Michigan and Indiana. Soils have also been described for the Elkhart River basin (USDA 1975). The soils in the St. Joseph River watershed consist of 81% loamy type (sandy, silty, or clay loams), which is similar to the Huron and Shiawassee rivers (Gooding 1995). Land use characteristics of the headwaters of the St. Joseph River have also been studied (Cummings 1978).

The St. Joseph River watershed is predominately outwash plains with many small end and ground moraine ridges. Land is gently to moderately sloping with sand and sandy loam soils. Drainage conditions are mostly well drained with variable areas from poorly to excessively well drained. Moderately well to well-drained portions of the outwash are used for agriculture, but poorly drained outwash deposits remain as swamp or marsh (Albert et al. 1986). The distribution of soils in the watershed has been mapped (Figure 26); however, this is a general description. For specific soil associations and distributions, review county soil survey maps that are available from soil and water conservation districts. In this assessment, soils have been lumped into three groups based on the composition of sand, loam, or clay as described below:

Group	Soil type
A	sandy, loamy sand, or sandy loam
B	silt loam or loam
C	clay loam, silty clay loam, sandy clay, silty clay, or clay

<u>Headwaters</u>
The headwaters consist of coarse-textured end moraine ridges interspersed with deposits of outwash sand. Consequently a majority of the headwaters is made up of patches of Groups A and B soils. These soils are moderately well drained and are fertile for agriculture. There are some small pockets with Group C soils that have very slow infiltration rates and are found in old lake beds.

<u>Upper</u>
The soils in the upper segment are similar to those in the headwaters and are made up of predominately Group A and B soils. There are more Group A soils because of gently to moderately sloping, coarse textured (sandy and sandy loam) drumlins, surrounded by narrow outwash channels. Swamps and marshes make up most of the poorly drained areas.

<u>Middle</u>
Soils in the middle segment are mainly characterized by Group B soils but with a mixture of Group C. There are pockets of Group A soils within the Portage Creek and Rocky River sub-watersheds. Most of the Indiana drainage also consists of loamy soils. In low lying areas near Three Rivers and in several small areas in the Elkhart River basin, there are pockets of organic soils used for muck farming and peat mining.

<u>*Lower*</u>
The lower segment consists of Group B soils with large areas of both Groups A and C soils. There are several small ground moraine ridges with outwash plains. There is also a long band of ice-contact (sand and gravel) and end-moraine ridges about 5 to 20 miles wide running through the middle of this segment from north to south. Agriculture occurs in the sandy loam areas with moderate to low slopes. Most of the ridges are too steep and dry for agricultural use. These areas are either forested or used for pasture. The shallow kettles support marshes and tamarack swamps. There is also a narrow band of Group C soils along the Dowagiac River that also consists of marshes and swamps.

<u>*Mouth*</u>
Sandy lake plains cover most of the mouth segment with some steep, coastal sand dunes and end moraines. Most of the soils are Group A, but there are a fair number of Group C soils in low lying areas. Because of the moderated climate from Lake Michigan, orchards and vineyards are common in this area. The Paw Paw River basin is also made up of Group A soils with large areas of sand in the upper and middle sections but with more Group C soils and wetlands in the lowers section.

Land Use

Various forms of agriculture dominate land use in the St. Joseph River basin, with forested lands comprising the second most frequent land use (Table 7). Wetlands and urban areas make up smaller portions of the basin. Agricultural land use includes croplands (row and close-grown crops, hayfields, cultivated crops, horticulture), pasture, and fallow grasslands. Dominance of agriculture as a land use has significant affects on the St. Joseph River and its tributaries, including water withdrawals for irrigation, nutrient influx, and increased sediment loads (see **Water Quality**).

The St. Joseph River basin contains approximately 513,800 acres of Commercial Forest Land (CFL). Only about 5% of CFL is managed, and lack of current management or past mismanagement has decreased the value of the existing resource (USDA 1985). The elm-ash-soft maple type forest typically found along smaller streams and in wet areas composes 31% of the CFL acreage. Improper forest management can also lead to stream degradation through soil erosion and sedimentation, especially if buffer strips are not maintained.

There is one 85 acre State Forest in the basin, located in section 22 of Arlington Township in Van Buren County. It is used by state foresters for demonstrations of forestry management techniques and by local hunters. Michigan State University operates Russ Forest, a 500 acre forest in the Dowagiac River sub-watershed. It is managed in conjunction with the Kellogg Forest system for research, management demonstrations, and as a Cass County park. About 7,800 acres of forested state game area lands are managed by MDNR, Wildlife Division for multiple recreational uses. Management techniques employed to diversify forest habitat include clear-cutting, shelter woods, selection, and thinning.

Wetlands are critical to any river for floodwater control, groundwater recharge and discharge, water quality improvement, sediment entrapment, shoreline stabilization, fish and wildlife habitat, aquatic invertebrate production (fish food), and recreation. Wetlands make up 4.6% of the land area in the Michigan portion of the basin, and about 11.8% of the Indiana portion. Development in wetlands in Michigan is governed by Part 303, Wetland Protection, of the Natural Resource and Environmental Protection Acts of 1994 and Section 404 of the Clean Water Act, which regulate filling or draining of wetlands. Both Indiana and Michigan wetlands are threatened by draining, filling, irrigation from ponds dug in the wetlands, and high capacity wells located in wetland areas (IDNR 1987). Less than 3% of Indiana’s and an unknown amount of Michigan’s wetlands are protected under wetland conservation and nature preserves. The growth of the marina industry is also threatening critical wetlands in the lower St. Joseph River and Paw Paw River. MNDR, Fisheries Division encourages off-river basins for new marinas, with single outlets to the river, to protect wetlands.

Urban areas compose about 7.7% of the land area in the St. Joseph River basin. Most large cities in the basin are located along the mainstem, and many have significant affects on the water quality. There are several point and non-point sources of pollution in urban areas such as municipal and industrial wastes. Urbanized areas also increase the amount of impervious material in the watershed that can lead to flashy stream flows (see **Water Quality**).

There is a major concern for increased development pressure in the lower valley segment. Amtrak is working on a high-speed rail that would offer service from the city of Niles to Chicago. The estimated commute time is less than one hour. With lower market value of homes and land in southwest Michigan compared to Chicago, development of residential homes is expected to explode. Along with increased development comes an increase in impervious surfaces (roofs, parking lots, and roads) that could change the hydrology of streams. Groundwater fed streams could receive more runoff that would in turn increase water temperature and flashiness of flows. The lower segment has the highest density of coldwater streams in the watershed and this development pressure could jeopardize these. Programs should be supported to educate local land use planners to direct development to areas that reduce affects on critical groundwater recharge and discharge areas.

Bridges and Other Stream Crossings

There are 2,541 bridges and other stream crossings of the St. Joseph River and tributaries, according to manual counts from county maps. General road crossings (bridges and culverts) make up 97% of these, whereas railway crossings only make up 3%. Bridges are defined by most road commissions as structures with width 20 feet or greater. Therefore, culverts are structures between 5 and 20 feet in width (Table 8). Smaller structures may be present in some sections of the basin, but data are not available on them.

Gravel road crossings are potential problem sites because of the amount of sediment that can wash off the road into streams. Crossings can also add sediment if approaches are not maintained or properly stabilized. Some bridges and railways crossings can also lead to stream bank erosion. Improperly designed bridges or culverts redirect channel flow and increase water velocities. Some may even cause flooding if too small for expected flood flows. Culverts and bridge pillars tend to become blocked with debris and can lead to flooding and erosion problems by restricting natural stream flow. This is especially true at multiple culvert crossings. Eaglin and Hubert (1993) reported that trout abundance had a negative relation with density of culverts. Culverts can be physical barriers to fish passage because of excessive water velocity at the crossings or because improper placement and erosion downstream of the culvert results in a “perched” culvert. Culverts can also become behavioral barriers to fish because culverts are generally long dark tubes that fish are reluctant to enter. Hundreds of these crossings exist in the basin.

Through the MDEQ construction permits process, problems with crossings are being addressed when replacement of crossing becomes necessary. Fisheries Division routinely requests that bridges be used in lieu of culverts, and believes that wooden bridges are the best choice. The St. Joseph County Road Commission has been a leader in using wooden bridges in the basin, and several other counties are beginning to follow suit.

Inventories of stream bank erosion at bridge sites are not routinely maintained by any agency. The watershed studies conducted by soil conservation districts identify some erosion sites within watersheds. For example, the Christiana Creek study (Stamm and Bowman 1990) identified 10 significant sources of roadside erosion in this watershed, and 10 were identified within the Dowagiac River watershed (Brennan and Stamm 1991).

Abandonment of road and especially railway bridges are a major concern. As these structures deteriorate, banks will begin to cave and eventually bridge structures will fail completely. Streams will be forced to cut new channels through large amounts of sediment. With railway bridges, dams could be created because of the large amounts of coarse material used to build railroad grades and crossings.

Submerged crossings (pipelines) are usually less evident unless erosion of the stream bottom has exposed them. The number and location of submerged crossings in the St. Joseph River watershed are unknown. Depending on diameter and amount of pipe exposed in a stream channel, some crossings can act as low head dams or catch debris. Sometimes pipes can be exposed enough to prevent navigation. Installation of submerged crossings can be a major source of sedimentation to a stream. Through Part 301 of the Natural Resources and Environmental Protection Act (1994 PA 451), proposed crossings are reviewed to ensure that proper techniques are used to minimize stream degradation. Erosion control and bank stabilization measures as well as boring techniques have limited sedimentation at new crossings.

Water Quality

Overview

Water quality in the St. Joseph River basin is influenced by many human uses of land and water including agriculture, industry, and suburban development. Water quality is evaluated in terms of use of water for: public drinking supplies, irrigation and industry, recreational body contact, and its ability to sustain aquatic life. Waters of the state designated as trout streams by the Director of MDNR (Table 9) have more stringent dissolved oxygen and temperature standards to protected coldwater fish. State and Federal laws have been developed to protect water quality for a variety of given uses (MDNR 1986). Regulatory agencies monitor river water quality and water uses in a basin to ensure standards are met, to determine compliance with the law, and to document water quality conditions in the basin. MDEQ, SWQD is the lead regulatory agency for water quality in Michigan, and in Indiana the Department of Environmental Management (IDEM) is the lead agency.

The St. Joseph River in Michigan and Indiana up to the Twin Branch dam (East of Mishawaka) is designated as a migratory route for anadromous salmonids and is protected for that purpose. Permitted discharges may not increase water temperature or decrease dissolved oxygen content to the degree that migrations would be adversely affected (Table 10). There are six areas on the mainstem and numerous tributaries that are not attaining this designated use (Table 11).

The St. Joseph River basin has historically suffered from poor water quality due to unregulated discharges by industries and municipalities. Water quality in the basin is now considered good, and virtually all point source discharges are regulated. Major effects on water quality are combined sewer overflows (CSOs), nonpoint source flows, and adjacent sites of contamination.

Combined Sewer Overflows

CSOs are the most serious on-going point source impairment to water quality in the basin. Combined sewers are designed to transport both sanitary sewage and storm water runoff. During wet weather events, when flows exceed the storm water capacity of the sewer; sewage, industrial wastes, and storm water overflow into surface waters. Some overflows also occur during dry weather if treatment plants exceed capacity or lines are blocked. These discharges can increase bacterial counts and nutrient loading. Increase in bacteria can temporarily deplete concentrations of oxygen in the water through biological oxygen demand. Short term pH changes also can result. Increased turbidity and sedimentation from CSOs can negatively affect invertebrate populations.

These overflows are considered a public health threat; therefore, several communities have begun to address this problem. Retention basins can be constructed to collect initial releases and can remove some sediments and contaminants. Sewer separation will eliminate discharges of untreated sewage by providing separate storm sewers for rain events. These projects, along with increased capacity at treatment plants and improvements to lift stations and collection systems, should reduce the volume of diluted sewage that reaches the river. This will significantly improve water quality but will not eliminate all CSO discharges to the river (T. Rarick personal communication, IDEM,). Indiana has a "CSO Working Group" that is finalizing a CSO strategy for their state, which will make it possible to determine specific actions needed to eliminate continuing downstream bacterial violations.

Point Source Pollution

There are 221 industrial discharges to surface waters in the St. Joseph River basin (Table 12). These discharges are permitted through the National Pollution Discharge Elimination System (NPDES), which regulates discharges to surface waters. Many investigations have been conducted to evaluate affects that industrial discharges have on water quality and to assist in developing new standards for industrial and municipal water use permits. These effects are commonly referred to as point source pollution, because the source of the pollutants is distinct.

Discharges to the St. Joseph River include effluent from municipalities: wastewater treatment plants, water treatment facilities, storm sewers, and CSOs; industrial discharges: contact and non-contact cooling waters, process wastewater, sanitary wastewater, groundwater remediation sites; and miscellaneous discharges from trailer parks, campgrounds, and highway rest areas. Permits issued to these dischargers contain limits for parameters of concern (metals, organics, dissolved oxygen (DO), carbonaceous biochemical oxygen demand, solids, nutrients, oil and grease, temperature, and chlorine) and are specific to each discharge. Limits for these parameters are based on the assimilative capacity of the receiving water and may incorporate mixing zones in rivers. Permits are issued for five years, and are reviewed by SWQD staff before being reissued. Permits in the St. Joseph River basin were reviewed in 1997 except those in the Paw Paw River sub-watershed that were reviewed in 1996. In general, permitted dischargers are in compliance with specified limits in both Michigan and Indiana.

Nonpoint Source Pollution

A nonpoint source is a pollutant that does not originate from a specific point and enters surface water through atmospheric deposition or water transport. Nonpoint source pollution is contamination made up of sediments, nutrients, bacteria, organic chemicals, or other inorganic chemicals including metals. Sources of these pollutants include: agricultural fields, livestock feedlots, surface runoff from construction sites, parking lots, urban streets, uncontrolled septic seepage, groundwater contamination, open dumps, industrial sites, and inadvertent chemical spills.

Many pollutants from these nonpoint sources use oxygen during their breakdown process. This can limit or even eliminate oxygen needed by fish and other aquatic organisms. Nutrients can lead to excessive aquatic vegetation growth that can further deplete oxygen concentrations through decay and bacterial respiration. Metals, pesticides, and other toxics can accumulate in the aquatic food chain and may have harmful effects on fish or lead to consumption advisories for anglers. Increased sedimentation can limit fish and macroinvertebrate habitat by covering gravel riffles and filling pools.

Agriculture is the largest source of nonpoint source pollution contributing nutrients and sediments. Studies have been conducted on several subwatersheds to determine types of nonpoint pollutants, develop background data for future studies, and identify possible solutions to these problems (Fishbeck et al. 1989; MAS Technology Corporation 1991; Stamm and Bowman 1990; Brennan and Stamm 1991). The Sauk Trails Resource Conservation and Development Area council and the Southwestern Michigan Commission (Stamm and Bowen 1990; Brennan and Stamm 1991) developed nonpoint source pollution control plans for the upper Dowagiac River and Christiana Creek. Similar plans were written and are being implemented for the Sauk-Coldwater rivers (Porter 1996), the Nottawa Creek Watershed (Williams 1998), and the Donnel Lake Watershed (Ervin et al. 1994; Kehew et al. 1994). These plans address primarily agricultural nonpoint source problems and some stream bank and roadside erosion problems. They recommend Best Management Practices to control problems.

A different type of nonpoint source pollution control project was initiated by the Marble Lake Chain Association in Branch County (Warbach et al. 1990). A watershed study determined that two tributaries entering the lake chain contributed significant amounts of nutrients and sediments to the lakes. As part of a larger lake improvement project, sediment basins were constructed in these two streams to remove sediments, and wetlands will be established in these stream basins to promote filtration and phosphorus uptake.

Construction activities can also be a source of nonpoint pollution along rivers. MDEQ, Land and Water Management and Surface Water Quality divisions and IDEM regulate construction activities adjacent to waterways and in floodplains. The biggest threat to the basin from construction activities is sedimentation from uncontrolled runoff. Erosion control permits are required under Part 91 of the Michigan Natural Resources and Environmental Quality Protection Act (1994 PA 451) and 327 of the Indiana Administrative Code 15-5 (Rule 5), but too often local administrators of the law do not enforce permit conditions, do not monitor construction, or work is simply done without required permits.

Storm Water Control

Storm water sewers collect both point and nonpoint sources of pollution and discharge them to the river. These discharges typically have high chloride concentrations, high nutrient and sediment loads, and can increase biological oxygen demand in the receiving stream. They also contribute oils, grease, and tars from roadways. Because storm water sewers usually drain large paved areas, during storm events they can contribute a significant portion of the flow in some small streams for a short time. This can have short-term affects on aquatic communities in these streams and may develop into long-term effects. Increased discharges from several small streams can also have cumulative effects by increasing flows to larger receiving rivers. NPDES are permitted for storm water discharges where large municipalities and industrial activities exist. There are 173 permitted industrial storm water discharges in Michigan within the St. Joseph River watershed (Table 13).

Sites of Environmental Contamination (Part 201 Sites)

MDEQ, Environmental Response Division, has identified 183 sites of environmental contamination within the Michigan portion of the St. Joseph River watershed as of 1995 (Table 14). 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 cleanup of these sites. Many of these sites have the potential to contaminate groundwater and consist of leaking underground storage tanks, spills of waste products from industries, leaking solid waste management facilities, or improperly constructed wastewater treatment facilities. Effects from these sites are unclear since contaminants are released slowly, erratically, and seasonally. Long-term monitoring is required to assess any effects to the system. Cleanup has begun at several of these sites, but it will take many years to complete. Some of the cleanups will result in a discharge of treated groundwater to surface waters, under a NPDES permit. There is the potential for traces of contaminates to be discharged into the St. Joseph River system.

Groundwater contamination in Indiana is regulated under Indiana Ground Water Protection Act of 1989 (IC 13-7-26-7) (IDEM 1996). Under this act, Indiana has designated improvement and protection of groundwater resources as a priority. Major contaminant sources affecting groundwater have been listed for all hydrogeologic settings in the state. These settings are characterized by their sensitivity to groundwater contamination (Fleming 1995). A major portion of the watershed is within the St. Joseph and Elkhart rivers outwash plain hydrogeologic setting. There are 1,052 sites of contamination within this setting (Table 15). There are more sites in Indiana than listed under Michigan's Part 201 sites, because Indiana includes injection wells as a source to groundwater contamination.

The state of Indiana is ahead of Michigan in their groundwater research and protection. IDNR, Division of Water has thoroughly studied the hydrologic characteristics of major aquifer systems in the St. Joseph River basin (IDNR 1987). These characteristics can be used to identify aquifers at high risk of contamination. Aquifer studies in Michigan are limited to isolated projects by MDEQ, Geological Survey Division, and local universities. Indiana is also a leader in groundwater protection. The Indiana Ground Water Protection Act of 1989 (IC 13-7-26-7) established a groundwater task force to formulate a strategy for groundwater protection and education. In 1995, a wellhead protection program was established to protect public water supplies from contamination. The Geological Survey Division in Michigan needs to develop similar groundwater research to create baseline data and protection.

There are 54 sites (Table 16) within the basin that are listed under the Comprehensive Environmental Response Compensation and Liability Act of 1980 as amended (CERCLA) and Remedial Actions (Superfund Act of 1980). The United States Environmental Protection Agency administers this act. Its purpose is to identify and prioritize contaminated sites as well as establishing plans and funding for contaminant removals.

Irrigation and Water Use

Another effect on groundwater and streams is water use for irrigation. Irrigation is common practice in the St. Joseph River basin. Bedell and Van Til (1979) found that 85.5% of the irrigated water use in Michigan in 1977 was for agriculture. Other uses of irrigated water included recreational (9.2%), commercial (4.4%), and miscellaneous use (0.9%). In Indiana, registered irrigators reported using a total of 20.2 MGD (million gallons per day) in 1985, with 11.8 MGD coming from groundwater and 8.4 MGD from surface waters (IDNR 1987). This is only five percent of the amount that registered irrigators are allowed to use in Indiana, so the potential exists for further increases in the amount of water used for irrigation in the area.

Van Buren, St. Joseph, Berrien, and Branch counties were the top four counties in Michigan for number of irrigators and irrigated acres in 1977 (Bedell and Van Til 1979). Irrigation is used more in southwest Michigan because of the well drained character of the sandy loam soils and the availability of groundwater. In Branch and St. Joseph counties, irrigation is used to increase yields of row crops by increasing soil moisture when needed. The specialty crop and fruit growers in Berrien and Van Buren counties also use irrigation to increase yields and for protection against frost.

There has been a significant increase in the number of irrigated acres in Michigan during the last few decades, and this trend is expected to increase in most Michigan counties and several of the largely agricultural Indiana counties. Water use for irrigation is especially significant considering the high consumptive losses. At least 90% of the water used for irrigation is lost through evapotranspiration (Bedell and Van Til 1979). Effects of irrigation are especially critical during summer low flow periods, when aquatic habitats are stressed. Direct withdrawals from streams have the most direct effect, reducing amount of habitat available and magnifying effects of sedimentation and pollution. Wells that tap groundwater reserves can also have long-term effects on streams, possibly affecting groundwater discharge to streams. Most irrigators in the St. Joseph River basin use wells, but some surface water withdrawals exist on smaller tributaries. Irrigators have been known to illegally dam small streams to increase water depth for more efficient pumping. Leaching of nitrates and other by-products of fertilizers to groundwater is a problem in several heavily irrigated portions of the basin, resulting in contamination of drinking water wells. Irrigation in summer months saturates soils and increases runoff peaks during summer storm events.

Industrial water users in Michigan are not required to report water withdrawals to the state, so the total amount of water used by industry is unknown. Surface and groundwater withdrawals in Indiana reached over 100 MGD (million gallons per day) in 1985 (IDNR 1987). The amount of water consumed by registered users (those capable of withdrawing 100,000 gallons per day) reached 90.5 mgd in 1985. These users would withdraw over 700 MGD if operating at capacity. Water use by non-registered wells, including domestic wells and livestock operations, totaled 18.7 MGD.

There are no municipal water withdrawals from surface water in the basin; all municipal withdrawals are from groundwater sources and the Great Lakes (Bedell 1982). As a group, municipalities in the St. Joseph River basin are the fourth largest users of water from non-Great Lakes sources in Michigan. It is unknown if groundwater extracted for municipal use has an affect on streams in the basin. There are no withdrawals from surface waters for thermoelectric power generation (Van Til and Scott 1986). Great Lakes water makes up the largest portion of water used for thermoelectric generation with a small portion coming from groundwater.

Dissolved Oxygen, Temperature, Nutrients, and Bacteria

Chemical and physical characteristics of water, such as temperature and oxygen, are important parts of fish habitat. Physiologically, fish operate in certain temperature regimes that can be generally characterized into two categories - warmwater and coldwater. Warmwater species can be found in mean water temperatures greater than 70 °F (21 °C); whereas, coldwater species require mean water temperatures below 70 °F (21 °C) during summer months. Further, most fish require moderate levels of dissolved oxygen in order to survive. Standards for DO and other parameters have been established to protect fish and other aquatic organisms. These standards are used when setting permit limits for discharges. Water quality standards for DO in warmwater streams is 5.0 ppm in Michigan and 4.0 ppm in Indiana (Table 10).

Stream temperature data have been collected by MDNR, MDEQ, IDNR, IDEM, and USGS for several tributaries, in the basin. These data show that the Dowagiac and Paw Paw rivers and several small St. Joseph River tributaries are coldwater streams with little variation in summer temperature (Table 17). This is consistent with the considerable groundwater flow to these streams which provides steady water flows. It is imperative that the temperature regimes of these coldwater streams remain undisturbed by human effects. Coldwater streams are rare in southern Michigan and northern Indiana and are important in maintaining the highly diverse biological community of the St. Joseph River basin and for trout fisheries.

The MDEQ conducted monthly water quality monitoring of the St. Joseph River at the mouth in the 1980s. Water samples were analyzed for temperature, DO, solids, chlorides, ions, and nutrients (MDNR 1983a). Organic contaminants, metals, and toxics were sampled less frequently. Data were stored in the US Environmental Protection Agency's STORET computer system. In Indiana, IDEM conducted monthly monitoring on the St. Joseph River at South Bend, Mishawaka and Bristol, the Elkhart River at Elkhart, and the Pigeon River at Mongo. These data and data from other rivers in the Indiana portion of the basin were also listed in STORET.

The Southwestern Michigan Commission (1990) summarized bacteriological studies in the lower St. Joseph River from the late 1970s to present, to document continuing problems of elevated fecal coliform levels from CSOs and agricultural runoff. The Berrien County Health Department has issued an open-ended public health warning advising against total body recreation in the mainstem from the State line downstream to Buchanan Dam. At the river mouth, the advisory includes Morrison Channel from the south side of the city of St. Joseph to the downstream end of Marina Island (Figure 27). IDEM has found continuing violations for whole body contact in the St. Joseph River downstream of Elkhart and in the Elkhart River.

Sediment Contamination

Recent water, sediment, and fish contaminant data were reviewed by MDEQ, Surface Water Quality Division to determine if the St. Joseph River should be designated by the International Joint Commission (IJC) as a Great Lakes Area of Concern (MDNR 1990a). These results were compared to IJC listing criteria, and restrictions to dredging matched the listing criteria. The sediments in the Benton Harbor turning basin are restricted to upland disposal, due to levels of some metals and organic constituents (MDNR 1987). Sediment PCB levels have been found to be less than detectable in 1982, but PCB levels in the water are higher than levels recommended by Michigan Water Quality Standards (0.02 ng/l). However, PCB levels detected are much lower than those in other rivers in the state with known sources of PCBs and are among the lowest levels found for Michigan rivers tributary to Lake Michigan. The MDNR recommended to the IJC that the river not be designated an Area of Concern, which was accepted by the IJC.

More recently, the IJC again proposed that the St. Joseph River be designated as an Area of Concern. A Lake Michigan tributary study documented that approximately 40% of the atrazine entering Lake Michigan was coming from the St. Joseph River (G. Warren, Environmental Protection Agency, personal communication). Atrazine is a herbicide commonly used in the production of corn. Atrazine typically bonds to clay particles and is delivered to streams through erosion from cornfields. In sandy soils, which are common in the St. Joseph River basin, atrazine can be directly delivered to streams very quickly because it does not bond to sand particles. MDEQ and IDEM are working on studies to identify subwatersheds with high concentrations of atrazine so programs can be implemented to reduce loading in the St. Joseph River. If atrazine loading can be reduced, the IJC may decline designating the river as an Area of Concern.

Summary of River Segments

Headwaters

The St. Joseph River is immediately influenced by human activities as it flows through Hillsdale. There are 10 NPDES and 20 storm water permits for the towns of Hillsdale, Jonesville, Litchfield, and Tekonsha. One Superfund site is located in Hillsdale, but its effects on the river are unknown. Most of the Part 201 sites (8) involve crude oil in underground storage tanks. The section between Hillsdale and Genesee Road has been in non-attainment of its designated use because of biological degradation and sedimentation. The water temperature is cool to warm with an average July temperature of 75 °F (24 °C).

Upper

This segment has fewer NPDES (7) and storm water (13) permits than the headwaters, but the number of Part 201 sites increases to 32. These contaminated sites involve a variety of pollutants from several municipalities and industries. Superfund sites include North Bronson Industrial and Universal Components in Bronson and Hawkins-Schafer Furniture Manufacturing in Union City. No effects to the river have been documented as a result of any of these contaminated sites.

The St. Joseph River remains cool with an average July temperature of 72 °F (22 °C) as it receives moderate amounts of groundwater. Lower Nottawa Creek and Coldwater Rivers are also characterized as cool to warm with average July temperatures of 74 °F (23 °C). Upper portions of Nottawa Creek, although variable, achieve cold enough temperatures to support stocked trout. Little data are available for the river segments immediately above and below impoundments. However, top-spill-over dams are known to increase downstream water temperatures and should be converted to bottom draws where possible. Shepherd (1975) reported warming effects below impoundments such as Union Lake that increased water temperatures as much as 4 °F.

Nottawa and Fisher creeks are not maintaining their designated uses due to biological degradation and sedimentation from nonpoint sources. Agricultural use increases in this segment contributing to a rise in nutrients. The mainstem, Coldwater River, and Nottawa Creek had autumn nitrate levels approaching 2.0 mg/l, which is about average for the basin. The source was assumed to be nonpoint because higher concentrations were observed when there was increased runoff to streams (Fishbeck et al. 1989).

Middle

The St. Joseph River and tributaries flow through several municipalities, which explains the 112 NPDES permits issued within this section. The Elkhart River received 24% of permitted discharges, the St. Joseph River received 17%, and other tributaries received 59%. The Elkhart River was also permitted for 41 CSOs. Further, 41 storm water permits were issued in Michigan; most of these were in the cities of Three Rivers, Coldwater, and White Pigeon.

Young’s Landfill in St. Joseph County is a Part 201 high priority site because of heavy metal and PCB contamination. There are also several underground storage sites that are being evaluated and cleaned up. Indiana has 12 high priority sites under the Resource Conservation and Recovery Act that are contaminated with volatile organic compounds and metals. There are also 211 leaking underground storage tanks within the St. Joseph and Elkhart Rivers outwash plains (Fleming 1995).

There are 38 sites not meeting designated uses and 71% of these involved high levels of bacteria known as *Escherichia coli* or *E. coli*. *E. coli* is a common organism found in the intestinal tract of humans and animals. It can be found in damp ambient temperature environments such as soil, vegetation, and untreated water. Most of the *E. coli* in the St. Joseph River basin comes from untreated sewage water or runoff from animal feed lots and pastures.

The Prairie River is not meeting its designated use as a trout stream because of dredging in Branch County that extended a quarter of a mile into St. Joseph County. This stream was widened, and riparian vegetation was removed resulting in an increase in stream temperature in an area that was supporting trout. In August of 1992, a fisheries survey near the town of Burr Oak indicated that stream temperatures had increased 9 °F (from 68 °F to 77 °F) compared to past surveys and that habitat had been degraded from increased silt deposition.

Temperature for the St. Joseph River averages 77 °F (25 °C) for the month of July at Jacksonburg Road, 4 miles upstream of Mendon. Portions of Curtis and Pigeon creeks have summer temperatures below 70 °F (21 °C) and support stocked trout populations. Rocky River used to support trout, but sedimentation from nonpoint sources and increased stream temperatures have degraded habitat and reduced trout survival.

Pigeon River had elevated nitrate levels (over 2.0 mg/l) during fall sampling. Fishbeck et al. (1989) indicated that a nonpoint source such as agricultural runoff was probably the cause.

<u>*Lower*</u>

There are 77 NPDES permits issued for this segment, and 25% of these directly enter the St. Joseph River. Most permits are for industries and municipal facilities within the cities of Mishawaka, South Bend, and Niles. Further, there are 41 storm water discharge permits issued by the State of Michigan and most of these are in the city of Niles. Indiana permits several CSOs for the cities of Elkhart (41), Mishawaka (17), and South Bend (44) that discharge to the St. Joseph River. In Michigan, the city of Niles has discharge authorization for 7 outfalls. The city has constructed retention basins to limit the frequency of overflow events. Farmers Creek, which is only about four miles long, receives five discharges near the city of Eau Claire.

CSOs and other municipal discharges are the cause for this entire segment of river to be failing to attain its designated use for body contact. The mainstem from Mishawaka to the mouth has restricted use because of pathogens and PCB contamination. Baugo, Farmers, and Eau Claire creeks have also not met their designated uses because of pathogens from untreated sewage.

Most of the Part 201 sites are for leaking underground storage tanks containing some form of petroleum product. Of the 21 Superfund sites, 13 are in the city of South Bend. Most sites are under preliminary assessments or site inspections, and no sites were on the national priority list.

Land use in this segment is primarily agricultural, and some streams are known to have excessive amounts of nutrients. The Dowagiac River and Baugo Creek have over 4.0 mg/l of nitrates in spring and fall samples. Baugo and Bowman creeks also have elevated phosphorous levels (>0.20 mg/l) (Fishbeck et al. 1989). Some of the nutrients in Baugo Creek may be coming from a point source of untreated sewage.

In 1991, the St. Joseph River had a mean July temperature of 73.9 °F (23 °C) making it a high quality warmwater system. The water temperature of the St. Joseph River does not increase significantly in a downstream direction as in most southern Michigan rivers, because of groundwater inflows. Due to significant yields of groundwater to the river, this segment contains the most coldwater trout streams when compared to the rest of the watershed.

There are good thermal data on the Dowagiac River system due to extensive water temperature monitoring by MDNR, Fisheries Division. Portions of Dowagiac River, and Pokagon, Peavine, McKinzie, and Dowagiac creeks maintain cold summer temperatures and support self-sustaining trout populations. McKinzie Creek at Barron Lake Road and Dowagiac Creek at Goodenough and M62 have temperatures that exceed 70 °F (21 °C) because they are downstream of lakes or constructed impoundments.

Mouth

There are 34 NPDES permits issued for this last seven miles of river. The Paw Paw River receives 47% of the discharges, and the St. Joseph River in Benton Harbor and St. Joseph receives 21%. Of the 59 storm water permits, Ox Creek acquires 31% of the discharges. Only 20% of the storm water permits were issued for the St. Joseph River mainstem.

The Part 201 sites consist of mostly heavy metals, PCBs, and volatile organic compounds. This portion of Berrien County had the most sites in the highest priority category. Industries located in the lower basin filled large areas of wetlands and discharged process wastewater directly to the receiving streams. These fill areas contain elevated levels of PCBs, heavy metals, arsenic, mercury, oils, and other potentially toxic substances. These contaminants are detectable in the sediments of the Paw Paw River, Ox and Hickory creeks, and the lower St. Joseph River. Dredge spoils of the St. Joseph River harbor have been classified by EPA guidelines as extremely polluted and must be disposed of in confined upland facilities (Best 1985). Of the 10 Superfund sites, nine were in the Benton Harbor and St. Joseph area. Aircraft Components in Benton Harbor was the only site in the watershed on the National Priority list.

Hickory Creek had high levels of nitrates (3.8 mg/l), and Paw Paw River had high levels of phosphorous (1.8 mg/l) based on samples taken at their mouth (Fishbeck et al. 1989). Sedimentation is probably the largest cause of habitat degradation. Increased sand bedloads have been reported on the East (Dexter 1991a), North, and South branches of the Paw Paw River according to fishery survey reports.

Similar to the lower segment, the mouth and the Paw Paw River receive high groundwater inflows. There are 10 designated trout streams, most in the Paw Paw River system. Most of the tributaries are coldwater streams with summer temperatures averaging below 70 °F (21°C). The Paw Paw River near Hartford had a July mean temperature of 65 °F (18 °C) with a maximum daily fluctuation of 9 °F in 1992. Dexter (1991b) suggested that the Paw Paw River mainstem is a coolwater rather than a warmwater system based on the presence of burbot and mottled sculpins.

Fish Contaminants

Fish are a highly nutritious food that is enjoyed by many anglers. However, some species of fish in certain waters can accumulate and store contaminants in their body tissue. By eating these fish, some of these contaminants can be transferred to humans and can cause health risks. Therefore, fish contaminant advisories are posted for waters in Michigan and Indiana. Fish have been collected and analyzed for contaminants since 1980 through Michigan's Fish Contaminant Monitoring Program

(FCMP). FCMP is coordinated by MDEQ, SWQD, in cooperation with MDNR, Fisheries Division, Michigan Department of Community Health (MDCH), Michigan Department of Agriculture, and U.S. Environmental Protection Agency. The Indiana Fish Advisory has been in existence since 1972 and is developed with cooperation from IDNR, IDEM, and Indiana State Department of Health.

> “The goals of FCMP are to: (1) evaluate whether fish contamination problems exist in specific surface waters; (2) identify spatial differences and temporal trends in the quality of Michigan’s surface waters with respect to persistent, bioaccumulative chemicals; (3) evaluate whether existing pollution prevention, regulatory, and remedial programs are effectively eliminating or reducing chemical contamination in the aquatic environment; and (4) support the establishment or removal of public health sport fish consumption advisories by the MDCH” (MDEQ 1995).

The Michigan fish contaminant monitoring program consists of both fish collections from streams and caged fish studies. MDCH is responsible for establishing, modifying, and removing sport fish consumption advisories for Michigan’s surface waters. Fish samples are analyzed for contaminates and compared to the fish consumption advisory trigger levels (Table 18). If concentrations of contaminates exceeds a trigger level, a consumption advisory is issued for that species and water body.

Caged fish studies in the St. Joseph River showed a slight decrease between 1989 and 1993 for levels of total chlordane, heptachlor, dieldrin and DDT and its metabolites DDE and DDD in fish held in the river mouth for 28 days (MDEQ 1995). All contaminants listed, including mercury levels, were below MDCH trigger levels.

Michigan has issued fish consumption advisories for carp and channel catfish in the Union Impoundment, for carp in Fawn and Dowagiac rivers, for walleye in the St. Joseph County section of the mainstem, and for carp, smallmouth bass, and walleye in the Berrien County portion of the mainstem, due to PCBs (Figure 28). Indiana has advisories listed for carp in Pigeon Creek and the mainstem below the town of Elkhart for PCBs and lead contamination. Indiana also has an advisory in all Indiana waters for carp over 15 inches in length due to PCBs. Most of the advisories limit consumption of contaminated fish to one meal per week for women and children.

Fish contaminant levels in Michigan are determined from edible portions of fish (skin-off fillets); levels in Indiana are determined from the whole fish. The source of PCBs in the St. Joseph River watershed is presently unknown. There are several Part 201 and Superfund sites that may be contributing to the problem. Fish could also be migrating into the river from Lake Michigan where there are known concentrations of this contaminant. In addition, there is an advisory on mercury for all inland lakes and reservoirs in Michigan. No one should eat more than one meal per week of rock bass, yellow perch, or crappie over nine inches or bass, walleye, northern pike, or muskellunge of any size. Mercury is an airborne pollutant that can contaminate lakes and reservoirs regardless of the environmental health of a watershed.

River Classification by Fisheries Division

Fisheries Division classified water quality throughout Michigan in 1964 for the purpose of fishery management (Figure 29). This system has been useful in considering water quality with respect to stream temperature and fisheries use. Designations are: 1) top quality coldwater streams that are capable of supporting self-sustaining populations of trout; 2) second quality coldwater streams that contain significant trout populations maintained by stocking; 3) top quality warmwater streams that contain self-sustaining populations of warmwater (and coolwater) sport fish; 4) second quality warmwater streams that have limited sport fish populations due to pollution, competition, inadequate reproduction, or lack of suitable habitat. The entire mainstem of the St. Joseph River is classified as top quality warmwater according to this system.

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

Special Jurisdictions

There are several federal, state, and local jurisdiction regarding rivers, riparian zones, and floodplains. The Land and Water Management and Surface Water Quality divisions of MDEQ (Table 19) administer some federal laws and several state statutes.

Navigability

Historical records indicate that the St. Joseph River was navigable as far upstream as Union City before construction of dams on the river, and the Paw Paw River was navigable as far upstream as the City of Paw Paw (Cunningham 1961). The City of Niles was served by several steamboats before the inter-urban railroad lessened river traffic in the mid-1890s. Turner (1867) discusses large steamboats that could travel the river as far as South Bend and that navigation was possible as far upstream as Three Rivers. Keelboats and barges called “arks” were used for commercial navigation on the river as early as 1829 (Anonymous 1976). Navigation upstream was hampered by a large “riffle” located about 2 miles above Niles, known as the “Grandaddy”, and another located between Constantine and Three Rivers. However, experienced boat people successfully navigated these obstacles for years.

Today, the mainstem of the St. Joseph River and portions of several of its tributaries are declared legally navigable by the courts. All waters in the St. Joseph River basin are presumed navigable unless legally declared non-navigable. The Michigan Supreme Court has judged certain streams or portions of streams navigable. In the St. Joseph River basin, these streams include the St. Joseph River downstream of Tekonsha (Department of Natural Resources v Hallden; 51 Mich. App. 176; 1974), and Portage River from Parkville (T5S, R10W, Sec. 24) through Portage Lake and up Bear Creek to Portage Lake Station on the old Grand Rapids & Indiana Railroad (T5S, R10W, Sec. 8). The Paw Paw River is deemed navigable from the village of Lawrence (T3S, R15W, Sec. 10) downstream to the mouth. The Little Portage River, St. Joseph County, is the only stream in the basin that has been adjudicated non-navigable by the Michigan Supreme Court.

The Army Corps of Engineers exercises jurisdiction for navigation on the St. Joseph River up to Berrien Springs, and on the Paw Paw River up to Paw Paw Avenue in Benton Harbor (2 miles above the mouth).

Anglers have the common rights of fishing in a navigable stream, subject to the restraints and regulations of state laws.

Designated County Drains

There are over 1,675 designated drains in the St. Joseph River Watershed (Table 20). In Michigan, these streams fall under the authority of the Michigan Drain Code, Act 40 of the Public Acts of 1956, as amended, and the County Drain Commissioner. Indiana drains are under the jurisdiction of the County Surveyor through Indiana Code 36-9-27 (1-113). County Drain Commissioners in Michigan and Surveyors in Indiana have the authority to designate, extend, and maintain all designated drains. Maintenance activities include dredging, straightening, widening and enclosing. In Michigan, these activities do not require MDEQ approval, if applied to drains designated before 1972.

The artificial drainage and drain maintenance activities promote sedimentation and nutrient loading to rivers and contribute to loss and degradation of wetlands. These county drains are sometimes responsible for draining entire wetlands systems. The Drain Code was written and passed by the legislature well before the need to control erosion and protect ecological functions was recognized. It does, however, provide mechanisms for short-term fixes to problems created by nonpoint source pollution (see **Water Quality**).

Efforts are underway by conservation groups and some legislators to rewrite the Drain Code to include sound environmental practices while continuing to serve the agricultural industry and urban development. The procedures of Drain Commissioners are also beginning to be challenged by riparian landowners and resource protection groups concerned about the shortsightedness of the present Drain Code. A dredging project in the Prairie River (middle valley segment), Branch County, was challenged in court by a local chapter of Trout Unlimited. A portion of this marginal trout stream was previously dredged in 1990-91 in Branch County. The project destroyed the aquatic resources of the stream. The Trout Unlimited lawsuit sought to determine alternatives to dredging that will protect the aquatic habitat and enhance the drainage capacity of the stream. An agreement was reached with the Drain Commissioner to maintain much of the critical stream habitat by limiting the extent and magnitude of the dredging project. However, the Drain Commissioner did not follow the agreement and several miles of marginal trout water were degraded by increased water temperatures and sediments.

Michigan drain commissioners are also responsible for maintenance and operation of many lake-level control structures, particularly those set by the Inland Lake Level Act (PA 146 of 1961). Methods of operation are at the discretion of each Drain Commissioner.

The Indiana Conservancy Act, I.C. 14-33 provides a way that landowners can organize a special taxing district to solve problems related to water resource management. Among these problems are flood prevention and control, improving drainage, providing irrigation, developing wildlife areas, preventing soil erosion, and storage of water for augmentation of stream flow. After a conservancy district is established by the Circuit Court, an initial Board of Directors is appointed by the County Commissioners. Then specific projects can be designed and implemented to solve the water resource problem.

State and Local Parks

Within the basin, the State of Michigan operates four game and wildlife areas (Fulton, Crane Pond, Three Rivers, and Leidy Lake) and three mini game areas (less than one square mile) in Van Buren County and one in St. Joseph County (see **Recreational Use**). The State of Indiana operates the Pigeon River State Fish and Wildlife Area, Tri County Fish and Wildlife Area, Cedar Swamp Conservation Area, and Marsh Lake Wetland Conservation Area.

Public land is limited in the headwaters of the St. Joseph River with only one county and several small city or village parks. In the middle segment, St. Joseph County administers 35 parks located near the St. Joseph River and tributaries. Several county and city parks also exist in the lower and mouth segments of the river. After completion of fish ladders between Berrien Springs and Twin Branch, there has been an emphasis on purchasing and expanding public land for access along the St. Joseph River. The cities of Mishawaka, South Bend, Niles, Buchanan, Berrien Springs, and Benton Harbor now have many public access sites along the mainstem. However, the city with the most accessible waterfront, South Bend, does not allow bank fishing in the city limits to protect banks from erosion and liter. When water levels are too high to wade, this restricts the area to boat fishing.

These public lands are not only important as access points to the river, but are also important green belts that act as buffer zones between the water and adjacent developed areas. Trees in riparian zones stabilize stream banks, moderate water temperatures on small streams by providing shade, and catch nutrients and sediments. Undeveloped floodplains absorb water during high flows and reduce severity of flooding downstream. It should be a high priority to maintain and promote more natural riparian areas in the St. Joseph River system.

Biological Communities

Original Fish Communities

Ninety-seven species of fish were native to the St. Joseph River Basin (Table 21). A description of the fish community before European settlement (mid 1700s) is not available. Historic literature mentions fish as a popular food source, but only a few species were usually noted. Fish bones found with Potawatomi artifacts in the Kankakee River valley from the early 1800s show that several species of fish were present: lake sturgeon, bowfin, northern pike, redhorse, channel catfish, crappie, walleye, and freshwater drum (Holman et al. 1996). Fish collections from the University of Michigan, Museum of Zoology, and results from Michigan Fish Commission surveys were used to describe the original fish community. These surveys dated back to the 1880s and used gill nets, seines, and hook and line sampling techniques. Common names were used in the early Fish Commission survey reports, and only major groups of fish (minnows, shiners, chubs, suckers, etc.) were recorded, not individual species.

Ballard (1948) wrote: “When the spring days came to the St. Joseph Valley and the red and silver maples were bursting into bloom along the river, then the fish felt the urge to spawn and the water would be thick with them as they pushed their way upward to the shallows of the creeks, and of the river, there to reproduce and then, after a time, to return to the blue waters of the lake.” Lake sturgeon, bass (smallmouth and largemouth), redhorse (silver, golden, shorthead, river, and greater), walleyed pike (walleye), lake trout, whitefishes, and pickerel (northern pike and grass pickerel) were quoted as making the pilgrimage. At this time of year, the early settlers used seines and dip nets to catch their annual supply of fish.

The abundance of lake sturgeon made the area around Niles famous in the mid-to late-1800s (Ballard 1948). Lake sturgeon were common in the St. Joseph River and fish up to 12 feet long and three hundred pounds were taken by anglers. A series of large rocks formed a causeway across the river in Niles and at South Bend, and American Indians used these as platforms to spear lake sturgeon during their spawning run. Temporary weirs were constructed at the mouths of small tributaries coming in to the St. Joseph River at Niles, and lake sturgeon destined for market were held in the backwaters. Lake sturgeon eggs were collected and sent to Russia as caviar. When the Niles Dam was constructed in 1868, migrating fish were blocked from moving upstream. Fishing below the dam became an important part of the local economy for about 10 years, but Indiana anglers were forced to come to Niles to get fish they used to capture in South Bend.

Lake sturgeon spawn in areas of swift water or rapids (Scott and Crossman 1973). Before construction of dams on the St. Joseph River, lake sturgeon entering the river to spawn would have access to suitable spawning habitat as far up the river as Hillsdale County. Construction of dams has now limited their spawning grounds to the river immediately below Berrien Springs, which is a difference of 155 river miles.

Old newspaper reports are also useful for describing historical fisheries. One local paper reported a walleye over twenty-three pounds that was taken from the river at Niles in 1849. Freshwater eels were reported to be common enough in some seasons to clog the wheel of a mill in Niles. These fish probably entered Lake Michigan through the Chicago Shipping Canal, which connects Lake Michigan to the Mississippi River. As early as the 1830s the St. Joseph River was known as one of the best smallmouth bass streams in this part of the country, and many anglers came from other states to fish it (Cunningham 1961).

The St. Joseph River watershed was also home to the lake herring. Lake herring or cisco are abundant in several lakes in the watershed. These fish inhabit oligotrophic lakes that develop a thermocline with summer temperatures below 20°C. Lake herring are abundant in southern Michigan and northern Indiana where kettle-hole lakes in moraines were left by the retreating Wisconsin glacier (Latta 1995). Use of this fish was probably limited until gill netting and hook and line techniques were developed because of the water depth inhabited.

Factors Affecting Fish Communities

The St. Joseph River and watershed went through dramatic changes after European settlement. These changes caused alterations in the physical character of the river and affected the fish community. The influence of nonpoint source pollution, point source pollution, dams, agricultural and urban land use, and exotic introductions are covered in greater detail in **Geology and Hydrology**, **Channel Morphology**, **Dams and Barriers**, **Soils and Land Use Patterns**, **Water Quality,** and **Pest Species**. A summary of these effects is appropriate here in order to understand present fish communities and distributions.

> "Fish require several types of habitats throughout their life cycle. Stream species need distinct spawning, feeding and growth, and refuge habitats. Equally as important is the ability to move from one habitat to another (Schlosser 1991). If any one area is lacking or if the ability to migrate from one to another is restricted, the species becomes locally extinct" (Hay-Chmielewski et al. 1995).

Settlement in the watershed brought a need for small dams to power grain and lumber mills. In the 1880s, large dams were built for hydroelectric power. Dams fragment a river system and prevent movement of fish to critical habitats. Access to spawning areas was lost for all potamodromous fish species. Migration to seasonal habitats within the river itself for resident species was also blocked by dams. Dams also affect fish communities by altering flow regimes, flooding, temperature, and sediment transport (Gordon et al. 1992). Only tolerant species, typically large, adult, warmwater species, can tolerate these harsh conditions, eliminating small species and juveniles of large species (Cushman 1985; Gislason 1985; Nelson 1986; Bain et al. 1988).

Drainage of land for agricultural and urban use has altered natural flow regimes. Channelization of streams is typically carried out to improve conveyance and flood-carrying capacity. This practice drains wetland areas for agricultural production and urban development. Channelization and draining of wetlands affect fish by eliminating instream and juvenile nursery habitats. Structural diversity is reduced by elimination of meanders, smoothing of riffles and pools, and removal of snags and riparian vegetation (Gordon et al. 1992). Fish no longer have backwaters, pools, or woody debris for refuge against high flows (Newbury and Gaboury 1988). Increased peak flows cause accelerated erosion and increase sediment load in the river. Sediments increase turbidity and cover critical habitat (gravel and cobble) for certain fish and invertebrate species. Summer water temperatures also have become warmer due to stream widening, removal of riparian vegetation and shading, and reduced base flows.

Clearing and development of land for agriculture, urban, and suburban uses had a significant affect on fisheries. As a result of unvegetated ground and increased impervious surfaces (rooftops, roads, and parking lots) rainwater is delivered to streams more quickly as surface run-off rather than through the ground. This causes higher peak stream flow, decreased flow duration, increased water temperatures, and lower base flow that can alter habitat. Expanding agricultural and urban land use also brought an increase in nonpoint source pollution. Pesticides, herbicides, and fertilizers that were not used by crops and lawns eventually washed into the river. Pesticides and herbicides can be toxic to fish and fertilizers increase aquatic vegetation growth in lakes and streams. With increased cultivation and construction, soils were left bare, causing accelerated erosion and increased stream sediment loads. Fine sediment reduces fish feeding efficiency, covers spawning substrates, and may cause fish mortality by clogging gills (Waters 1995).

Earlier this century, the St. Joseph River had poor water quality from unregulated discharges of industries and municipalities. Fish kills and poor species diversity were reported downstream of municipalities (Snow 1974; Taube and Schultz 1966). Since the 1970s, discharges have been regulated through the Federal Clean Water Act, and water quality is now considered to be good. The fishery has also rebounded as a result of improved water quality (Ledet 1979; Stefanavage 1988). However, combined sewer overflows (CSOs) continue to cause increased fecal bacteria concentrations in the lower and mouth segments. Industrial fill areas are continued sources of toxic substances that contaminate fish and cause decreased reproductive potential as well as mortality.

Several non-indigenous species (Table 22) of fish have been intentionally or inadvertently introduced into the St. Joseph River watershed and have a strong influence on fish communities through predation or competition. Inadvertent introductions result from ship ballast water, shipping canals, bait buckets, and illegal stockings. Some indigenous and non-indigenous species are intentionally stocked (Table 23) through fishery management to enhance fisheries, maintain populations, or to fill an unused ecological niche.

Present Fish Communities

The St. Joseph River basin now contains 114 species of fish (Table 24), based on biological surveys by MDNR (Taube and Shultz 1966; Shepherd 1975; Towns 1988), IDNR (Ledet 1979; Stafanavage 1988; Stafanavage 1989), Michigan Department of Environmental Quality (MDEQ, formerly part of MDNR), Surface Water Quality Division (SWQD) (MDNR 1983b; MDEQ 1996b), University of Michigan Museum of Zoology records, and observations by Fisheries Division personnel. Several species can be found throughout the entire watershed, but some can only be found in isolated areas as shown in distribution maps of each species (Appendix 1). Many native species are still abundant, but some are rare, of special concern, threatened, or endangered as depicted by Table 24 and the Michigan Natural Features Inventory (MNFI) list (Table 25). Three fish species are considered threatened (creek chubsucker, river redhorse, and lake sturgeon). Fish communities have been characterized more extensively within the following valley segments.

Headwaters

This segment has both moderate groundwater inflows that keep the St. Joseph River cool with reasonably stable flows. Cool and warmwater fish species are present. From Baw Beese Lake to Litchfield, habitat is limited by excessive sand and silt substrate. Carp, suckers, and redhorse accounted for 87% by weight of the medium and large sized fish (Towns 1988). Rock bass and yellow bullhead were the primary predators. The fish community was rated as fair (moderately impaired) (MDNR 1991a). Two rare species (pugnose shiner and least darter) have been found in Baw Beese Lake (Latta 1996), and the threatened creek chubsucker had been observed.

The lower section of this segment from Litchfield to Union City has more deep holes and vegetative cover. Substrates are also made up of a high percent of rock and gravel. Species diversity improved in this section from 21 species in 1975 (Shepherd 1975) to 33 species in 1987 (Towns 1988). This variance in species numbers between 1975 and 1987 may also have reflected a difference in sampling gear (nets and electrofishing in 1975 and rotenone in 1987). Fish communities were rated excellent (non-impaired) (MDEQ 1996b). More top predators were also observed including smallmouth bass, largemouth bass, and northern pike. Two rare species, black redhorse and greater redhorse were also observed.

Upper

Instream habitat, pools and logs, was more prevalent in this segment. The fish community consists of cool to warmwater species. Sport fish accounted for 11% of fish biomass and include rock bass, smallmouth bass, largemouth bass, black crappie, bluegill, pumpkinseed, warmouth, yellow perch, northern pike, channel catfish, and bullheads (Towns 1988). Since Shepherd's (1975) survey, channel catfish and walleye have colonized the upper part of this section through successful stocking. Channel catfish made up the highest reported game fish by weight. However, carp, suckers, and redhorse dominated the overall fish biomass. The number of logperch, johnny darters, and creek chubs also increased. One rare (starhead topminnow) and one threatened (creek chubsucker) fish species exist here.

The Coldwater River enters the mainstem in this segment and supports warmwater fishes. There are no fish data available for the Coldwater River mainstem. Several lakes including Coldwater, Marble, and Randall discharge into the river and may influence the present fish community. Hog Creek has predominately creek chubs, common shiners, and green sunfish with smallmouth bass (MDNR 1974a).

Swan Creek is a coolwater stream that mainly supports rock bass, creek chub, common shiner, and central stoneroller. Largemouth bass are common, and probably are from the Matteson Lake outlet that flows to Swan Creek. There is also a large population of grass pickerel that may be indicative of the considerable amount of riparian wetlands. However, habitat loss from heavy siltation may be impairing the existing fish community (MDNR 1990a).

Nottawa Creek is a coolwater stream with cool and warmwater fishes. Darters, suckers, and minnows predominate with a few rock bass and bluegill. The fish community has been rated good (slightly impaired) in the upper half and poor (severely impaired) in the lower half (MDEQ 1996c). Brown trout have been extensively stocked with limited success. Anglers have reported brown trout catches near the town of Athens, but no brown trout were collected during electrofishing surveys in 1996 (MDEQ 1996c). Instream habitat is poor from channelization and water temperatures may get too warm to support brown trout during summer months. Towns (1988) reported higher fish diversity in the lower Nottawa Creek reflecting deeper pool habitats and a connection to the large St. Joseph River fauna.

Middle

This segment of the mainstem is warm in summer and stable in flow. The fish community is strongly influenced by Sturgis, Constantine, Mottville, and Elkhart impoundments. Bluegills, black crappie, and smallmouth bass were reported as the primary sport fish. Redhorse, spotted sucker, longnose gar, and golden shiners were also abundant (Shepherd 1975). However, no present survey data exist for the section of river between Mendon and the Michigan and Indiana state line. Ledet (1979) reports excellent habitat with gravel substrate below impoundments in Indiana. These areas were supporting large numbers of smallmouth bass, redhorse, and northern hog sucker and the impoundments had bluegill and white and black crappie. Walleye also inhabit this segment after several years of stocking by MDNR and IDNR. Although not connected to the river proper, several kettle lakes in the watershed support lake herring (threatened species) indicating high dissolved oxygen in the thermocline and low nutrient loading.

The Portage and Rocky rivers are the first to enter the St. Joseph. Portage River is a coolwater stream that mainly supports rock bass, blackside darters, and creek chubs. The Rocky River is a coldwater stream with mottled sculpin and brown trout inhabiting the headwaters. There is extensive agriculture in the Rocky River sub-watershed that has negatively affected habitat through silt deposition. Several creeks that once supported stocked brook trout in 1956 now have only white suckers and creek chubs (MDNR 1990b).

The Prairie River is another coolwater stream within a primarily agricultural land use watershed. The fish community mainly consists of creek chubs, bluntnose minnow, green sunfish, bluegill, and rock bass. The upper portions of the river formerly supported a marginal brown trout fishery; however, water temperatures have increased because of extensive dredging and clearing of riparian vegetation. Brown trout stocking was discontinued in 1993.

The Fawn River has a diverse community of fish between the headwaters and its confluence with the St. Joseph River. The headwaters are cool and have mottled sculpin with white suckers. Rainbow trout are stocked as a put and take fishery by IDNR in the headwaters. Golden and spotfin shiners, pumpkinseed sunfish, and rock bass are the primary fish species in the middle portion. Habitat is slightly impaired due to silt deposition (MDNR 1991b); however, the biological community has not changed since 1972. The lower portion of Fawn River is still considered cool water and supports rock bass, smallmouth bass, creek chub, hornyhead chub, golden redhorse, and shorthead redhorse. Fish community data are lacking for the lower eight miles of river.

The Pigeon River is characterized as a cool to warmwater system with smallmouth bass and rock bass as top predator fish with common shiner, hog sucker, and various redhorse species dominating the fish community (Stefanavage 1986a). However, fish community data are also lacking for the lower (Michigan) portion of the segment. Rainbow and brown trout have been stocked as a put and take fishery by IDNR in Indiana portions of the river. Spotted gar (rare species) are also found here. Channelization has occurred in the headwaters causing the most severe affects to habitat. Dams also fragment the lower portion of Pigeon River.

The Little Elkhart River acquires moderate amounts of groundwater and is a cold to coolwater stream. Dominant species consist of white sucker, creek chub, blacknose dace, and mottled sculpin (Marenchin and Sever 1981). Rainbow and brown trout have been stocked. Ledet (1991a) reported loss of fish habitat from silt deposition.

The Elkhart River is a warmwater system in a predominately agricultural watershed. The headwaters are cool to warm with some areas supporting stocked brown trout. However, white sucker, creek chub, and blacknose dace are the dominant species. Much of the headwaters have been channelized, but good habitat is reported in the lower five miles of Solomon Creek - a tributary (Ledet 1991b). The middle and lower portions of the river have golden redhorse, northern hog sucker, smallmouth bass, rock bass, and longear sunfish (Ledet 1985a). A lake sturgeon was caught in 1991 out of Lake Wawasee, which outlets to Turkey Creek (Swinford 1997). The population status of lake sturgeon in Lake Wawasee is unknown; the previous lake sturgeon caught was reported in 1913.

Christiana Creek receives a moderate amount of groundwater, and some of its tributaries are coldwater streams. Several lakes discharge into this creek shifting its downstream character to a warmwater stream. Ledet (1984) reported good habitat with creek chub, white sucker, smallmouth bass, and rock bass dominating the fish community. The fish community rated from poor (severely impaired) to excellent (non-impaired) with no changes in status between 1990 and 1996 (MDNR 1991c; MDEQ 1997a). Impaired sections are affected by soil erosion and surface water runoff from animal waste storage areas, feedlots, and overgrazed pastures. Through targeted watershed efforts, Cass County Soil and Water Conservation District has been encouraging best management practices to reduce agricultural runoff.

Lower

This segment of the St. Joseph River is characterized as a warmwater river that is large in size. Redhorse, spotfin shiners, smallmouth bass, and bluegill make up the primary fish community. Impoundments support good populations of white and black crappie, pumpkinseed, and bluegill. Since Shepherd’s (1975) report, walleye and flathead catfish have increased. Potamodromous species from Lake Michigan have access up to the Twin Branch dam since the completion of fish ladders at five mainstem dams in 1992. Steelhead, chinook salmon, coho salmon, brown trout, and lake trout comprised 94.4% of ladder use (Dexter and Ledet 1995). Below Berrien Springs dam, the fish community begins to show an influence from Lake Michigan adding quillback carpsucker, longnose sucker, alewife, and gizzard shad. Lake sturgeon also use this segment and were seen going up the ladders at South Bend and Niles during April and May of 1994 (MDNR, Fisheries Division, unpublished data).

The Dowagiac River is the largest tributary within this segment. This river receives high inflows of groundwater and is designated as a coldwater stream. Some mottled sculpin and stocked brown trout are present, but the river has more of a coolwater community due to habitat degradation from channelization (Moffett 1940; MDEQ 1996d). Blackside darter, white sucker, common shiner, and hornyhead chub are the dominant species. Potamodromous salmonines have access to and spawn in the Dowagiac River below the Pucker Street Dam at Niles. Many tributaries to the Dowagiac River typically have excellent coldwater habitat and support naturally reproducing brown trout (MDNR 1985; MDEQ 1996d; MDEQ 1997b).

Several small creeks (less than 10 miles in length) are tributary to the St. Joseph River. Most of these are coldwater streams containing (or supporting) mottled sculpin and naturally reproducing brown trout. Potamodromous salmonines also have access to these streams (MDNR 1977; MDNR 1980).

Mouth

The fish community in this segment reflects its large size and proximity to Lake Michigan. Flathead catfish, walleye, quillback carpsucker, freshwater drum, gizzard shad, alewife, and migratory salmon make up a major portion of the community. Since 1975, walleye and flathead catfish have recolonized these waters (Shepherd 1975).

The Paw Paw River is the largest tributary within this segment. The Paw Paw River mainstem is a coolwater stream containing hornyhead chub, common shiner, johnny darter, walleye, and burbot (Dexter 1991b). Several riparian wetlands provide excellent habitat for northern pike. The fish community near the mouth is influenced by its proximity to Lake Michigan, and potamodromous salmonines have access to most of the river system. The north branch receives drainage from Wolf Lake Hatchery, and angler reports indicate that tiger muskellunge have escaped this hatchery into these waters. The east, west, and south branches of the river are characterized as coldwater streams and have communities consisting of mottled sculpin, brown trout, and mudminnows. Several small tributaries drain lakes and have warmwater fish communities. There are several wetland complexes on the mainstem about eight miles downstream of Watervliet making access and surveying difficult; therefore, data are limited.

Aquatic Invertebrates (except mussels and snails)

Invertebrates are less mobile than other aquatic species and often are better indicators of water and habitat quality (Statzner and Higler 1986). Most mayfly, caddisfly, and stonefly species are only found in streams with good water quality. Several surveys of aquatic invertebrates have been conducted on major tributaries within the St. Joseph River basin. MDNR Fisheries Division personnel note presence and abundance of major fish food species during fisheries surveys. Staff of the MDEQ, SWQD inventory invertebrates as part of their water quality studies. Since 1991, SWQD, Great Lakes Environmental and Assessment Section (GLEAS) has used Procedure No. 51 (MDNR 1991d), a standardized method to conduct biological investigations on wadeable streams. These data were compiled by valley segment (Table 26). The St. Joseph basin is home to several rare and endangered insects including longhorned caddisfly; Douglas Stenelmis riffle beetle, American burying beetle, and culvers root borer (beetles); swamp metalmark, Mitchells satyr, ottoe skipper, spartina moth, silphium borer moth, karner blue, green adders moth, and pipe vine swallowtail (moths and butterflies) (Table 25). The diversity of invertebrates is high in southwest Michigan because it is in the junction of three major ecoregions. Aquatic invertebrate data on the St. Joseph River mainstem are non-existent except for the headwaters; a more complete inventory of the mainstem is needed and recommended. Invertebrate communities are discussed below by valley segment.

Headwaters

In 1990, the macroinvertebrate community in the St. Joseph River was rated as fair (moderately impaired) near the city of Hillsdale. The river improved to good in 1995 with more caddisflies and mayflies indicating better habitat or water quality (MDNR 1991a; MDEQ 1996b). Macroinvertebrate communities could be improved by reducing sediment bedload. Water quality would improve with nutrient reductions of effluent at the Hillsdale Waste Water Treatment Plant. High nutrients below the plant were indicated by the presence of small amount of green algae and bacterial slimes.

Upper
The mainstem invertebrate community was rated as fair with a few taxa of mayflies, caddisflies, and stoneflies. The Coldwater River was rated fair to good with improvements reported in 1996 (MDNR 1983b; MDNR 1991e; MDEQ 1996b). Nottawa Creek was also rated fair to good with no improvements between 1991 and 1996 (MDNR 1991f; MDEQ 1996c).

Middle
Portage Creek and Fawn River had fair invertebrate communities that have been improving (MDNR 1972a; MDNR 1972b; MDNR 1982). Rocky River has a poor community due to severe siltation. The Pigeon River was rated as fair due to low macroinvertebrate abundance compared to historical samples possibly caused by siltation (Stefanavage 1986b). The Little Elkhart and Elkhart rivers were rated poor to fair with the worst community ranking where heavy agricultural land use exists. Christiana Creek has shown improvements from poor to good invertebrate communities. From 1991 to 1994, Cass County Soil and Water Conservation District implemented a nonpoint source program to reduce sediment and nutrient loading to Christiana Creek. Data are lacking for the mainstem and Prairie River.

Lower
No data exist for the mainstem. Baugo Creek was one of the worst reported sites in the watershed; its watershed is mainly urban as it runs between the cities of Mishawaka and Elkhart. Dowagiac River had fair to good invertebrate communities in the headwaters, and below the dam in Niles was rated as excellent (very diverse community) in a 1996 survey (MDEQ 1997b).

Mouth
Again there were no data for the mainstem river. The Paw Paw River had a good to excellent invertebrate community. West Branch of Paw Paw River was rated very poor in 1958 with predominately midge larvae that are pollution tolerant (MDNR 1959; MDNR 1969). A 1982 survey indicated an increase in diversity with larger numbers of mayfly and caddisfly larvae indicating better water quality (MDNR 1983c). Improvements in water quality are due to cleaner effluents from the Watervliet Paper Company.

Mussels and Snails

The distributions of snails and mussels have been documented by several MDEQ, SWQD, GLEAS reports, Van der Schalie (1930), Horvath et al. (1994), Sherman (1997), and Fisher (1998) (Table 27). Since Van der Schalie (1930), only Sherman (1997) has conducted comprehensive surveys of mussel distributions on the St. Joseph River. Twenty-three species of native clams have been recorded along with two introduced species, the zebra mussel and Asian clam. Presence of mussels indicates good water quality because they are sessile and sensitive to pollution and siltation. Mussels are also long lived, so older individuals can document the water quality history of a river section. Mussel distributions can be affected by fluctuating water levels caused by dams. Dams also restrict access to suitable fish hosts required to complete their lifecycle. The invasion of zebra mussels (see *Pest Species*) is also expected to have negative affects by attaching to and hindering movements and feeding of native species.

In the early part of this century, clamming (commercial fishing for mussels) was a big industry on the St. Joseph River. Clamshells were used to make buttons, and unsold shells were ground for chicken feed. Some shells were used locally and others were shipped out of state for processing. Van der Schalie (1930) investigated the clamming industry on the St. Joseph River and found the three most common clam species used were mucket, pocket book, and sand shell. Clammers used flat bottom boats to collect clams between Union City and Mendon (the upper valley segment), in the Three Rivers area, and below Berrien Springs. Large piles of clams were stored on river banks for processing. Van der Schalie (1930) noted that due to over harvest, large individuals were scarce in many river sections. Pollution and the effects of dams on water levels were a major concern to clammers.

It is now unlawful to harvest or attempt to harvest living or dead mussels (except zebra mussels) in Michigan without a scientific collectors permit. Pressures from the pearl industry have brought poachers to the state, particularly in the neighboring Grand River watershed. Thick shelled species are harvested and sold to the Japanese for slugs for pearl oysters. Since the St. Joseph River historically had commercial harvests of mussels for the button industry (Van der Schalie 1930), poachers may also target this watershed (Sherman 1997).

Michigan Natural Features Inventory (MDNR 1997) and Indiana Nature Preserves (IDNR 1996) lists two snails of special concern, brown walker and proud globe, and two mussels, the endangered snuffbox and purple wartyback of special concern (Table 25). Van der Schalie (1930) observed one site in the middle segment near Mottville with purple wartyback and no sites with snuffbox. Sherman (1997) recorded dead specimens of purple wartyback at Mottville and Berrien Springs.

The introduction of zebra mussels may cause a decline in the number of mussels in the St. Joseph River watershed (Horvath et al. 1994). Densities of zebra mussels on other native mussels suggest that local populations are being negatively effected. Added weight from attached zebra mussels causes increased stress. Zebra mussels also cover valves of native mussels and decrease efficiency of feeding which results in starvation or decreased growth. The apparent absence of large populations of unionids in tributaries and the St. Joseph River proper leaves them vulnerable to local extinction if the invasion of zebra mussels proceeds throughout the river system. The St. Joseph River basin will serve as an important model for predicting ecological effects in other Indiana and Michigan rivers (Horvath et al. 1994).

Amphibians and Reptiles

Thirty-two species of amphibians and reptiles that require the river or wetlands during portions or all of their life history stages have been found in the watershed (Table 28). Little information is available on the distribution and abundance of amphibians and reptiles in the basin. Michigan Natural Features Inventory and Indiana Natural Heritage list six species of concern: spotted turtle, eastern box turtle, Massasauga rattlesnake, blue-spotted salamander, Blanchards cricket frog, and northern leopard frog and three as threatened or endangered: Kirtlands snake is threatened, and copperbelly water snake and Blandings turtle are endangered (Table 25).

*Bird*s

Many birds use the rivers and river corridors in the St. Joseph River basin as nesting, feeding, and resting areas (Table 29). Some species are year-long residents, but many others migrate through during different times of the year. As part of the Mississippi Flyway, Canada geese, many species of dabbling and diving ducks, and mute swans, use the St. Joseph River watershed. Hardwood stands in river lowland areas are crucial to many songbirds such as yellow-throated warblers. Loons, herons, mergansers, cormorants, ospreys, and kingfishers feed primarily on fish. The extent of their effect on fish populations is not known, but several of these species are known to consume considerable quantities of fish in their lifetime (Peterson 1965; Alexander 1976). MDNR, Wildlife Division is now introducing turkeys into several areas of the basin. These birds will use river corridors and groundwater seeps in the basin, and hopefully will spread to new locations. Bald eagle, osprey, common loon, and yellow-throated warbler are considered threatened. King rail, black tern, marsh wren, upland sandpiper, barn owl, and short-eared owl are listed as endangered species, and heron rookeries exist in five counties within the basin (Table 25).

Mammals

River corridors are critical habitats for mammals providing refuge and a source of water. Beaver, otter, muskrat, mink, and raccoon are present (Table 30). Beavers influence streams by altering channels and building dams. They are found in low numbers in this basin but populations are increasing. Muskrats are common. They burrow in stream banks and this can lead to erosion problems and alter channel characteristics. Otter are rare but were reported on Flowerfield Creek tributary of the Rocky River. Indiana conducted a feasibility study for reintroduction of otters, and Fawn, Pigeon, and Elkhart rivers were named as suitable (Johnson and Madej 1994). Kotanchik (1997) studied distribution of river otters in Michigan and concluded that PCBs in fish tissue would be too high for reintroduction of otter in the St. Joseph River and many tributaries. Mink and raccoons are common. Predation on fish by vertebrate predators can be significant in some areas (Alexander 1976) but is probably not significant in the St. Joseph River basin (Bailey, MDNR, Wildlife Division, personal communication). The Indiana bat and bobcat (Indiana) are listed as endangered; least shrew and prairie vole are threatened in Michigan (Table 25).

Other Natural Features of Concern

The Michigan Natural Features Inventory (MDNR 1997) and Indiana Natural Heritage (IDNR 1996) maintain a list of endangered, threatened, or otherwise significant plant and animal species, plant communities, and other natural features (Table 25). Vascular plants are the most commonly listed group of threatened and endangered species in the basin. Many of these are wetland plants or are found in floodplains and river corridors. Plant communities include southern swamps, prairie fens, coastal plain marshes, tall grass prairies, bogs, Great Lakes marshes, inundated shrub swamps, submergent and emergent marshes, wet meadows and prairies, hard-wood conifer swamps, relic conifer swamps (forested bog), and intermittent wetlands.

Other unique features not listed include coldwater tributaries to the mainstem that are spawning areas for coho and chinook salmon, steelhead, and brown trout that ascend the river from Lake Michigan. Natural reproduction of these species has been documented (Figure 30), and it is probable that there is natural reproduction in other tributaries. Some of these streams have wild populations of resident brown and brook trout.

Love Creek is a unique tributary to the mainstem below Berrien Springs. The headwaters are intermittent, but as the creek enters the deep St. Joseph River valley, it receives significant amounts of groundwater seepage. The steep gradient, gravel substrate, and cold summer temperatures make lower Love Creek ideal habitat for salmonids (MDNR 1974b; Dexter 1992a). An area of floodplain known as the Indian Bowl surrounds this stream. The Indian Bowl is a depression in the Valparaiso Moraine, which has been caused by repeated slumping of portions of the moraine slope due to undercutting of the moraine by springs. Various universities and state organizations have intensively studied the groundwater fed wet prairie that was created. It contains many rare and threatened species of plants and animals, and the Love Creek Nature Center and the Nature Conservancy preserve most of the area.

Large areas of grasslands or prairies existed in the St. Joseph River basin. Prairies extended into southern Michigan from the Great Plains, where climatic conditions or periodic fires kept out invading woody plants. Some areas included oak barrens, in which a few large trees dotted the landscape. Prairies typically have rich topsoil and have been extensively cultivated. However, remnants of prairies can be found near the towns of White Pigeon, Sturgis, and Three Rivers in St. Joseph County of the middle segment and scattered within Branch, Kalamazoo, Cass, and Berrien counties. Prairies are important features because they contain a great diversity of grasses and forbs.

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 any threat unless present in high densities.

Sea lampreys are probably the deadliest aquatic pest (parasitic) species encountered by fish in the St. Joseph River basin. The sea lamprey attaches to other fish with its sucking disk and horny teeth. Its sharp tongue rasps through scales and skin as it feeds on body fluids, often killing the prey fish. Adult sea lamprey prey on large fish in Lake Michigan until these adult lamprey migrate up streams to spawn. Lampreys spawn on gravel riffles in the lower St. Joseph River and tributaries (Figure 31). Eggs hatch into larvae (ammocete) that burrow in sand and silt areas. The larvae live there for 3 to 17 years. The United States Fish and Wildlife Service routinely surveys tributaries accessible to sea lampreys. Streams with viable juvenile populations are treated with the lampricide TFM (3-trifluoromethyl-4-nitrophenol) to eliminate or reduce lamprey populations. Treatments are scheduled every three to four years, or as often as necessary to ensure no lampreys older than age 3+ will be in a stream. Pipestone, Sand, and Blue creeks and the Paw Paw and lower St. Joseph rivers have populations of lampreys and receive regular treatments. Sea lamprey ammocetes were found for the first time ever in the mainstem below Berrien Springs Dam in 1991. Sea lampreys are limited to the area below the Berrien Springs Dam on the mainstem because the fish ladder has a lamprey barrier.

The lampricide TFM can negatively affect local aquatic communities. Studies have found a temporary reduction of mayflies after treatments. Tadpoles and salamanders are susceptible, but most amphibians have left the water for terrestrial habitats during treatment time. Limited fish kills do happen on occasion. TFM may affect fish that are already stressed from pollutants, low dissolved oxygen levels, increased water temperatures, or spawning. Besides lampreys, channel catfish have the highest sensitivity to TFM followed by rainbow trout. However, most fish have low sensitivity to the lampricide except lake sturgeon juveniles (GLFC 1985; Hay-Chmielewski and Whelan 1997).

Zebra mussels are established in Lake Michigan and have been found in the St. Joseph River at the mouth and near the town of Elkhart, IN. Several lakes within the basin have also been invaded including Baw Beese Lake in the headwaters, Marble Lake in the Coldwater River, Corey Lake in the Rocky River, Klinger Lake in the Fawn River, Lake Wawasee in Turkey Creek, Eagle Lake in Christiana Creek, and Paw Paw Lake in the Paw Paw River subwatershed (Horvath et al. 1994) The potential for veligers to spread throughout most of the watershed is great based on their existing distribution (Table 31). Through human activities such as boating, zebra mussels have the potential to spread throughout the basin. However, veligers can only settle in slow current areas, so high densities of zebra mussels will be limited to lakes and impoundments. Zebra mussels attach to any hard surface and can clog water intake pipes. They can become a nuisance on docks and piers, and may compete with resident aquatic species that filter algae and zooplankton for food. Zebra mussels also kill native mussel species through suffocation and starvation. They do, however, improve water clarity and may contribute to increases in rooted aquatic vegetation.

Rusty crayfish also pose a threat to the ecology of streams. These exotic crayfish often exclude native crayfish through competition for food and habitat, and can decimate aquatic plant communities by over grazing. The presence of rusty crayfish was reported in Pipestone Creek during a routine fish evaluation survey in 1997 (S. Markham, MDNR, Fisheries Division, personal communication). Rusty crayfish prefer areas that offer rocks, logs, or other debris as cover and inhabit both pools and fast water areas of streams. Juveniles feed heavily on benthic invertebrates and may directly compete with fish for food. Some fish will eat crayfish, but crayfish food quality is not as high as other invertebrates because of their thick exoskeleton. Fish growth in streams can be affected by less invertebrate food and lower food quality. Once established in an area, birds, anglers, and bait dealers can spread rusty crayfish. Environmentally sound ways to eradicate or control introduced populations of rusty crayfish have not been developed (Gunderson 1995).

Purple loosestrife is the most serious plant pest. It can be found in virtually all wetlands, and in some areas it dominates wetland vegetation. Purple loosestrife spreads quickly. Due to its attractive purple flower, it has been spread by humans through transplantation to gardens and lakeshores. Seeds are dispersed by wind, flowing water, and animals. Purple loosestrife will out compete more beneficial native plants for space. It provides little cover for wildlife, and is not used as a food source (Eggers and Reed 1987). It has the potential to destroy the wildlife value of wetlands. The United States Fish and Wildlife Service is attempting to control spread of loosestrife by spraying existing stands with a selective herbicide. Other means of control are also being researched, including biological control with an exotic beetle species that feeds exclusively on loosestrife. MDEQ, Land & Water Management Division is proposing to add purple loosestrife to the State noxious plant list (D. Kenaga, MDEQ, LWMD, personal communication).

Eurasian milfoil and curly leaf pondweed are two widespread nuisance plants in lakes. Lakes with public access sites have a greater tendency to have problem densities of these aquatic plants, because species are transferred by boats and trailers (D. Kenaga, MDEQ, LWMD, personal communication). Cabomba, a introduced European aquatic plant commonly used in the aquarium industry, was first discovered in Kimble Lake of the Portage River subwatershed in 1935 and has the potential to reach nuisance levels (Voss 1985). There was also an unconfirmed identification of Cabomba in the St. Joseph River near Elkhart. Nuisance plants form vast mats of vegetation in nutrient-rich lakes and in river mouths. In shallow areas, these plants can interfere with water recreation such as boating, fishing, and swimming. They can also crowd out important native aquatic vegetation. MDEQ issues aquatic vegetation control permits for lakes and impoundments but not for flowing waters. A treatment permit is needed on all lakes, except those less than 10 acres, with no outlet, and owned by one person. The number of permits by county has remained constant from 1988 to 1996 (Table 32).

Fishery Management

MDNR, Fisheries Division and IDNR, Fisheries Section actively manage fish communities in the St. Joseph River watershed. In this section, growth rates of various St. Joseph River fish species are compared to Michigan state average growth rates (Merna et al. 1981). Fish communities in most of the watershed are healthy; however, some fish populations are limited and require management through special regulations, habitat improvement, and stocking to maintain a fishery (Table 23). Most fishery management is in the middle and lower segments for trout and salmon. Interest in warmwater species continues to rise, and managers are spending more time with walleye and smallmouth bass projects. With increased projects addressing nonpoint source pollution in the upper and headwater segments, fishery management will become more active in those areas. A discussion of fishery management follows by valley segment.

Headwaters

Fishery management has been limited. There are neither active fish stocking nor habitat improvements projects in the St. Joseph River proper. Baw Beese Lake is stocked with redear sunfish and has been stocked with walleye in the past, but there have been no walleye reported in the mainstem of the river. Towns (1988) evaluated fish communities in the St. Joseph River using rotenone and concluded that poor substrate and insufficient fish cover were major factors limiting fish abundance. Construction of sediment traps and habitat structures would probably increase carrying capacity of fish.

Sand Creek has been stocked annually with various strains of brown trout but only supports a marginal fishery. In 1987, Sand Creek was treated with rotenone to eliminate competing species and encourage stocked trout. This treatment was not successful and brown trout stocking has been discontinued.

Upper

The mainstem is stocked with channel catfish and walleye. Anglers report good catches of both species in the St. Joseph River and channel catfish in Union Lake. There is a substantial walleye fishery below Union Lake Dam during late winter spawning runs. Channel catfish prefer deep water, and Union Lake provides the best channel catfish fishing in this segment. Union Lake has also been stocked with redear sunfish and northern pike. With draining of wetlands, spawning habitat for northern pike may be limiting. Therefore, stocking of northern pike may augment existing population and provide a fishery (Towns 1988).

The Marble to Coldwater Lake chain within the Coldwater River subwatershed provides some of the best bluegill fishing in Michigan. Panfish have better than state average growth (MDNR, Fisheries Division, unpublished data). These lakes have also been stocked with tiger muskellunge, which provided a good fishery. Tiger muskellunge have not been stocked since 1990, due to problems with availability from hatcheries. Coldwater Lake is also stocked with walleye, and a self-sustaining redear sunfish population has been established. Redear sunfish have not officially been stocked but may have come in from nearby lakes. Both walleye and redear sunfish provide modest fisheries. The Coldwater River is small (15-20 feet wide) between the chain of lakes and supports a limited sport fishery. However, the river is important as nursery areas for northern pike and is a major producer of forage fish (shiners, chubs, and suckers).

Swan Creek was stocked with brown trout in 1985 after a chemical treatment on Matteson Lake, which has an outlet to the creek. Due to poor habitat and warm stream temperatures, brown trout stocking was discontinued after warmwater fish species rapidly re-colonized. Most fishery management in the Swan Creek subwatershed is for Matteson, Palmer, and Long lakes. Matteson Lake is stocked with walleye and channel catfish and has received largemouth bass, northern pike, redear sunfish, and rainbow trout. Palmer and Long lakes are stocked with channel catfish and walleye. The Colon Area Anglers Association participates in a cooperative agreement with MDNR, Fisheries Division and raises walleye fry to fingerlings for stocking in Long, Palmer, and Sturgeon lakes and the St. Joseph River above the town of Mendon. Historically, tiger muskellunge were stocked in Long Lake but stocking was discontinued in 1985. Long Lake increased in size after a dam was built in the early 1900s. This flooded a woodland, so there is ample fish habitat such as tree stumps. Long Lake was drawn down for dam repair in 1997 and was refilled in 1998. Long Lake may require a survey to investigate effects on the fish community.

Nottawa Creek is another marginal stream stocked with brown trout. Poor habitat from channelization and warm-summer stream temperatures decrease survival of trout (Towns 1988). Nottawa Lake is stocked with channel catfish from private plants and hybrid sunfish. In 1988, the lake association with assistance from MDNR removed suckers with fyke nets after complaints of overpopulation from residents. A 1983 survey also indicated an over abundance of this species in Nottawa Lake. Although 500 suckers were removed, the effect on the fish community was minimal. Nottawa Creek runs through Nottawa Lake, so there is continuous source of suckers to replenish the lake. A weir between Nottawa Lake and Nottawa Creek was suggested by the association to prevent suckers from entering the lake. However, weirs would prevent all fish from migrating through the lake, so the project was not pursued.

Middle

The St. Joseph River is managed for channel catfish, smallmouth bass, and walleye. Walleye and channel catfish are stocked by MDNR, and IDNR stocks tiger muskellunge and walleye. Sturgis, Three Rivers, Constantine, and Mottville impoundments were surveyed in 1992, and walleye growth was excellent (above state average) in each impoundment. IDNR has evaluated the smallmouth bass fishery in the St. Joseph River extensively (Ledet 1979; Ledet 1985b; Stefanavage 1989; Stefanavage 1990). Smallmouth bass growth is excellent, and this self-sustaining population provides an excellent fishery. IDNR has experimented with stocking predator fish to use the abundant forage fish in impoundments.

The Rocky River is a marginal trout stream with the best habitat in the headwaters near the town of Marcellus. It has been managed for trout since 1938 by stocking brook, rainbow, and brown trout. Stocking of the St. Joseph County portion of the river was discontinued in 1990 due to poor survival. The Cass County portion of the river received annual stocking of brown trout until 1996. After an assessment of angler use, it was recommended to discontinue stocking entirely (Dexter 1992b). There is evidence of some natural reproduction in the headwaters, so a limited trout fishery still exists.

The Prairie River has been managed as a marginal trout stream since 1970, when portions of the river were chemically treated to remove rough fish and then stocked with trout. Stocking of brown trout was suspended in 1993 because of a dredging project in the upstream section (Branch and St. Joseph counties) that widened the channel and cleared shade trees. This caused stream temperatures to increase above the limit for trout survival. Provided re-growth of shade trees decreases stream temperature, trout could be restocked. Habitat improvement in the form of woody debris should also be implemented.

Fawn River is managed as a put and take rainbow trout fishery in the upper reaches (Stueben County, Indiana). Ten inch trout are stocked there annually. Sherman Mill Creek near Sturgis is also stocked with brown trout. The rest of the river is managed as a smallmouth bass fishery. Sections of the river were evaluated in a 1996 general survey. The survey report recommended a sediment trap to remove a high sand bedload. A dam blew out in 1987 near the town of Fawn River contributing to the sediment problem.

Portions of the Pigeon River are managed for rainbow trout by IDNR; however, the majority of the river is managed for smallmouth bass. Smallmouth bass habitat and population characteristics were surveyed by Stefanavage (1987) to evaluate declining populations due to stream habitat degradation. To control flooding, the Palmiter Method of channel clearing and bank stabilization was used to remove logjams. IDNR has stocked smallmouth bass in an attempt to increase densities in areas of low or non-existent numbers. No general surveys have been conducted by MDNR, Fisheries Division to evaluate fish populations.

The Little Elkhart River is managed for trout. IDNR stocks rainbow trout and Elkhart Conservation Club stocks brown trout. A 1990 survey indicated good survival of brown trout with four year classes (Ledet 1991b). Siltation is the primary habitat degradation in this stream.

The Elkhart River is managed primarily for smallmouth bass. Several studies have assessed smallmouth bass abundance, growth, and habitat requirements within Elkhart River (Ledet 1985a; Stefanavage 1988; Stefanavage 1989). Solomon Creek, part of the headwaters of Elkhart River, is stocked with brown trout by the Elkhart Conservation Club and rainbow trout by IDNR (Ledet 1991b).

Lower

The most aggressive fish management of the entire river system is within this segment. As discussed earlier, Michigan and Indiana completed the first cooperative interstate anadromous fish passage project. Beginning in 1977, plans were developed to construct a coldwater fish hatchery in Indiana and fish passage facilities at four dams. Twin Branch Fish Hatchery was completed in 1983. Cooperative steelhead and chinook salmon stockings began in 1984. By 1992, all construction and modification of the ladders were completed. Fish viewing windows were installed in the Berrien Springs, Niles, and South Bend fish ladders. Estimates of fish passage are made using time-lapse video recording (Dexter and Ledet 1995). These video data are also used to determine when fish run, time of year and day, river temperature, and stream discharges. Year-round creel surveys are also conducted throughout the lower St. Joseph River to estimate angler harvest and effort (see **Recreational Use**).

Nearly 6 million chinook salmon, 2.5 million steelhead (winter and summer run), and 1 million coho have been stocked in the lower St. Joseph River since 1986. In addition, Michigan stocks brown trout and walleye, and Indiana stocks channel catfish. Seelbach (1989) estimated that annual catch of returning steelhead to the St. Joseph River was 4,400 between 1980 and 1985, and most of these fish were from hatchery origin. Between 1988 and 1994, annual catch increased to about 15,000 steelhead (Seelbach et al. 1994). This was a 15% return rate for stocked smolts, which is typical for Lake Michigan tributaries that average 10-20% return rates. Huron River, which is a Lake Erie tributary, had a much lower return rate (less than 1%).

The largest managed tributary within this segment is the Dowagiac River. Dowagiac River as well as Peavine, Pokagon, McKinzie, and Dowagiac creeks are managed for trout. Dowagiac River and Creek are stocked annually with brown trout, whereas Peavine, Pokagon, and McKinzie creeks have supported natural reproducing populations of brown trout since 1992. Partnership for MEANDRS (Meeting Ecological and Agricultural Needs within the Dowagiac River System), a nonprofit watershed group, is planning major rehabilitation of old meanders to improve fish habitat in channelized portions of the Dowagiac River (B. Westrate, president of MEANDRS, personal communication; see **Citizen Involvement**). Restoring meanders will improve channel morphology by allowing the river to behave more naturally and create pool and riffle sequences that provide more diverse habitat.

Dowagiac Creek was chemically treated in 1971 and 1980 to remove suckers (Dodge 1979). A rough fish (sucker) barrier was constructed in 1977 to prevent upstream movements of fish from Lake LaGrange. In 1989, the St. Joseph River Valley Fly Fishers conducted a habitat-improvement project by adding logs, current deflectors, and lunker structures. A fisheries survey in 1992 found natural reproducing brown trout in the creek; therefore, stocking was reduced but not eliminated due to high fishing pressure. Stocking of the upper site below Bunker Lake was discontinued after a temperature study revealed that it was too warm to sustain trout (Dexter 1996).

There are several small tributaries to the St. Joseph River that are also managed for trout: Brandywine, Pipestone, and McCoy creeks have all been stocked with brown trout since 1986. Love Creek supports a natural population of brown trout and was stocked with brook trout until 1997. Stocking of brook trout in Love Creek was discontinued due to competition with wild brown trout. Pipestone Creek was chemically reclaimed in 1977. Portions of Brandywine Creek have undergone bank stabilization and habitat improvement projects. Upper sections of Brandywine Creek continue to be stocked, but stocking in the lower sections has been dropped because of natural reproduction (Dexter 1991c). A blocking weir was constructed in 1992 to prevent steelhead and chinook salmon from entering Brandywine Creek and competing with natural brown trout. Research has shown that rainbow trout may compete with brown trout (Ziegler 1988; Kocik 1992). The weir has been a success and has prevented most potamodromous salmonids from ascending up the creek. A few steelhead manage to jump over the weir but not enough to degrade the brown trout population.

Mouth

A portion of the chinook salmon stocked into the St. Joseph River is temporarily held in net pens at the mouth of the river. This promotes imprinting, so the salmon will home back to the St. Joseph River for spawning after maturing in Lake Michigan. The lower and mouth segments also have special trout and salmon fishing regulations. The minimum size limit is 10 inches during the regular season and 16 inches during the extended trout and salmon season. This allows anglers to harvest steelhead and chinook salmon, while protecting spawning brown trout and rearing or smolting steelhead.

The Paw Paw River is the largest tributary entering the mainstem within this segment. The mouth is annually stocked with steelhead. In 1989, the mainstem was surveyed using rotenone (Dexter 1991b). The survey indicated that the Paw Paw River was more of a coolwater rather than a warmwater stream by the presence of burbot and mottled sculpin. Although they are not actively managed in this river, walleye and northern pike provide a moderate fishery. Walleye are not stocked directly but may be immigrating from the St. Joseph River, escaping from MDNR rearing ponds in Almena, moving downstream from annual stockings in Maple Lake, or reproducing naturally. The most limiting factor to the Paw Paw River fishery is public access. Several miles of river are inaccessible because no roads cross between Riverside and Benton Harbor.

The lower Paw Paw River is also treated by the U.S. Fish and Wildlife Service every three years with TFM to kill sea lamprey ammocetes. With increasing water quality in Michigan rivers, sea lamprey populations have increased (see **Biological Communities**, *Pest Species*). A blocking weir has been proposed for the river near Watervliet to prevent seasonal movements of adult sea lampreys into upper portions of the river.

Several tributaries within the Paw Paw River system are stocked with brown trout including Hayden, Brush, Blue, and Mill creeks and the East, North, and West branches of the Paw Paw River. Stocking of brown trout was discontinued in Campbell Creek in 1996 to reduce competition with wild brown and brook trout. Campbell Creek habitat has been improved by installing half logs; further, Van Buren County Road Commission has paved a road crossing and popular access point to prevent sediment from entering the creek. A sediment trap has been proposed to remove a high sand bedload from the managed section. Similarly, a sediment trap has been installed on a tributary to Brush Creek in Van Buren County to remove sand that has washed into the stream from improper agricultural practices.

Recreational Use

The St. Joseph River has high recreational potential because this large river flows through the towns of Three Rivers, Elkhart, South Bend, Niles, and Benton Harbor. Many people use the river and its corridor for fishing, canoeing, motor-boating, swimming, picnicking, hunting, trapping, mushrooming, hiking, nature study, and bird watching. There are only 17 public boat and canoe launches on the mainstem that can be used by canoeist and boaters (Figure 32). This is an average of one launch site for every 12 miles of river. There are several other launch sites on tributaries and lakes within the basin.

Several medium to large sized streams in the basin support canoeing and boating. Informal canoe launch sites are common throughout the basin and mainly consist of bridge crossings; however, formal sites (publicly owned and maintained) are scarce and more are needed. Canoe portages around dams are not required by law, but are required at hydroelectric dams licensed by FERC. However, they are not always marked and sometimes are not well developed for use. Canoe and boat travel on several streams is impeded by dams, low bridges, and log jams.

Some conflicts between user groups are seen on the St. Joseph River and its tributaries, especially between pleasure boaters and anglers. This problem is more evident on lakes, impoundments, and the lower river below Berrien Springs. Some large lakes are virtually unfishable on weekends during the summer because of the heavy pleasure boat traffic. On smaller tributaries, excessive removal of woody fish habitat to enhance canoeing opportunities is a problem.

There are many marinas in the lower St. Joseph and Paw Paw rivers, and there is potential for more marina development. There are 13 marina operating permits issued for 829 boat slips, three boat ramps and five fuel pumps (T. Bennett, MDEQ, LWMD, personal communication). At least another 108 boat slips are proposed. Three additional marina operating permits have expired but the facilities are still operating, with 527 boat slips and one fuel pump. Only one registered marina operates in the upper part of the basin, on the chain of lakes on the Coldwater River, with two gas pumps but no boat slips. A low railroad bridge currently prevents marina development on the Paw Paw River above Benton Harbor, but proposals to alter this bridge to allow boat passage upstream have been considered. Many acres of wetlands would be threatened by development proposals, boat traffic, and wake disturbance, if this marina is developed.

Many areas along the St. Joseph River and its tributaries provide good shore fishing access. In addition to the developed access sites maintained by MDNR Parks and Recreation Division and local governments, many road crossing are used by anglers to reach streams. Anglers can fish on private property outside the road right-of-way with the property owners permission and can fish all streams on state land. Although access is good on the St. Joseph River proper, access to both cold and warm water tributaries is limited. Better access would promote better recreational use of these waters.

Estimates of fishing pressure or angler harvest are limited to the lower St. Joseph River below Mishawaka, Indiana. Traditional access or roving creel surveys have not been conducted elsewhere in the basin because they are costly and time consuming. Estimates of harvest and fishing pressure can also be made using tagged fish or angler-returned post cards, and these techniques will be attempted in the future on some managed streams in the basin. Any analysis of fishing pressure and success for headwaters, upper, and middle segments are limited to perceptions derived from discussions with anglers, charter boat captains, conservation officers, and bait and tackle dealers.

Waterfowl hunters use much of the mainstem and major tributaries, especially impoundments. Many of the stream floodplains are wooded wetlands, providing excellent habitat for deer and are hunted extensively. Deer hunters with permission from riparian land owners canoe the St. Joseph River tributaries during gun season. Trapping is also a popular business in the St. Joseph River basin. Many of the smaller tributaries and associated marshes are trapped for muskrat and mink.

There are several nature centers that have hiking trails along streams or adjacent wetlands. There are eight State game areas and mini-game areas in the basin, providing hunting opportunities and hiking trails (Figure 33). However, none of them are on the St. Joseph River proper, and only three game areas provide fishing access to lakes or small creeks. Local communities and counties also support parks along the river and tributaries for public use. A state park and several private campgrounds provide opportunities for non-residents to stay in the area.

Recreational use of the river system is described more thoroughly by valley segment below. Fishing information was compiled from angler reports, fishery surveys, and miscellaneous creel reports (Appendix 2).

Headwaters
Canoeing and fishing are the primary uses of the river, and there is some float hunting for ducks and deer. Boating and fishing are popular on Baw Beese Lake. The river proper receives light fishing pressure for northern pike, largemouth and smallmouth bass, white and redhorse suckers, and carp (Towns 1988). Most of the river fishing is near Tekonsha. Soap Creek gets some fishing pressure at road crossings. For the most part, recreational use is light on this segment of river. Access is limited to two roadside parks and bridge crossings.

Upper
Fishing and canoeing take place in most portions. Motorized boating is limited to Union and Sturgeon lakes on the St. Joseph River; Coldwater, Loon, Marble, Lake of the Woods, Randall, and Morrison lakes on the Coldwater River; and Long and Palmer lakes on Swan Creek. Fishing pressure is high on Union, Coldwater, Marble, and Randall lakes and moderate for the rest of the lakes with bluegill, black crappie, and channel catfish being the most sought after fish. There is heavy fishing below Union Lake for channel catfish, smallmouth bass, northern pike, and walleye. The St. Joseph River is also great fishing for white and redhorse suckers in the spring (Towns 1988). Hog Creek, Coldwater River, and Swan Creek are also fished regularly at road crossings.

All of the mainstem is canoeable. Nottawa Creek is canoeable downstream of Athens, and Hog Creek and Coldwater River are canoeable between impoundments. Waterfowl hunters use the mainstem downstream of Sturgeon Lake near Colon. There is also some waterfowl hunting on Nottawa Creek. Leidy Lake State Game Area is used for hunting and bird watching. Historically, trapping was heavy, but recent low fur prices have reduced this activity.

Middle
Canoeing and fishing are the main recreational uses with some boating and swimming. Access is excellent between Mendon and Sturgis Dam with a boat launch in Mendon and Covered Bridge Park on the Sturgis Impoundment. Power boaters use the impoundment, but size of boats is limited to a height less than 4 feet due to the covered bridge. The canoe portage around Sturgis Dam is long with no designated take-out area. Canoeing below the dam becomes difficult during low flows when most of the water is diverted through a bypass. Fishing pressure for walleye, largemouth bass, and bluegill is light through most of this stretch but increases near the park and below the dam. There is also some waterfowl hunting in the area.

Between Sturgis and Mottville dam, fishing pressure is moderate with some waterfowl hunting. Walleye and smallmouth bass are the most sought after fish. Three Rivers, Constantine, and

Mottville impoundments provide a bluegill and largemouth bass fishery along with some power boating. Constantine Dam has an excellent canoe portage and tailwater fishing platform. There is good access to the river at all dam sites, and county roads are used for access between dams.

From the state line to Elkhart, the St. Joseph River provides an excellent smallmouth bass fishery with moderate fishing pressure (Stefanavage 1989; Ledet 1979). Power boaters and water skiers frequently use Elkhart impoundment. There is a boat launch on the river at Bristol and at the upper end of the Elkhart impoundment. Shoreline access is fair in most places, but is good in Bristol at the county park. Impoundments are fished frequently for black and white crappie, bluegill, pumpkinseed, walleye, and channel catfish.

Portage River is canoeable and receives light fishing pressure at road crossings. Portage Lake has a public access and campground and provides fishing, boating, and swimming activities. Rocky River provides a light fishery for brown trout near Marcellus (Dexter 1992b). The lower half is readily canoeable, and deer and waterfowl hunters frequently canoe some of the upper parts. Access is limited to road crossings or by permission from private landowners.

The upper Prairie River has a marginal trout population that receives light fishing pressure. Access is available in the village of Bur Oak. Prairie Lake has access through boat launches or parks and provides boating, fishing, and swimming activities. Lake Templene has been privately developed, and there is no public access. Lower portions of the river are also canoeable. The upper half of the Fawn River is a popular canoeing section because it has mostly natural land cover and is adjacent to forested wetlands. Most canoeing is between Nevada Mill and Star Mill. Fawn River receives moderate fishing pressure for smallmouth bass, largemouth bass, northern pike, channel catfish, and redhorse suckers (Stefanavage 1988). Most fishing takes place on small mill ponds.

Pigeon River State Fish and Wildlife Area is 11,500 acres and offers bluegill, largemouth bass, northern pike, and trout fishing; deer, upland game, squirrel, and waterfowl hunting; primitive camping and picnicking; hiking; and bird watching. The Pigeon River is canoeable from 327 Road downstream through the game area to its confluence with the St. Joseph River.

The Little Elkhart River offers a put-and-take trout fishery. Access is limited to Bonneyville Mill County Park and by permission from private landowners. The headwaters of Elkhart River also provide trout fishing, but the middle and lower portions provide a smallmouth bass, northern pike, and rock bass fishery (Ledet 1985a). The South Branch of the river is slow moving but still is used by canoeists. Bird watching is also popular because the South Branch Elkhart River flows through vast wetland areas. There are several recreational facilities including Chain O'Lakes State Park, Tri-County State Fish and Wildlife Areas, Rogers Park in Goshen, and Oxbow Park in Elkhart. Lloyd W. Bender Nature Preserve, Porter Memorial Woods, and Edna Spurgeon Nature Preserve are held by private organizations but are open to the public.

Lower

Access improves through this segment because of the amount of city property along the river. Canoeing is difficult between Elkhart and South Bend because of the number of dams that need to be portaged. Most canoeists start at Central Park in South Bend. South Bend also has a constructed waterway for white-water kayaking, rafting, and innertubing in the old millrace. This waterway attracts many white-water enthusiasts including the United States Olympic kayaking team. Below South Bend boating and canoeing becomes easier due to river width and depth. There are dams at Niles, Buchanan, and Berrien Springs that need to be portaged, but access sites and boat launches are common making it easy to get boats in and out of the river. Lake Chapin, created by Berrien Springs Dam, provides boating, swimming, and fishing activities.

Most of the recreational use of the lower river is for fishing. Since the completion in 1992 of a 17 year project to construct fish passage facilities at the first 5 dams (see **Fishery Management**), access and angler use of the lower river system has increased dramatically. There is good access below each dam along with city and state parks between dams. South Bend has 16 access sites for wade fishing with boat ramps at Miami Island, Lincoln, Memorial, and Woodlawn parks, IDNR Public Access, and St. Patricks Park. Niles has five access points, and Marmont Street, St. Joseph River Park, and Bond Street accesses have boat ramps. There are also five access points at Buchanan Dam with two public boat ramps. Berrien Springs Dam has good shore access with a boat ramp at Shamrock Park. The last public access point in the lower segment is the Jasper Dairy Road Public Boat launch.

Angler use and harvest has been measured using creel surveys. These surveys have been conducted since 1985 to estimate angler use and catch before and after the completion of the fish ladders. IDNR conducted creel surveys from below Twin Branch to the state line. In 1985, a total of 19,923 fish were harvested between the Twin Branch Dam and the state line. Fishing pressure totaled 69,459 hours. Most fish harvested were bluegill (28%), smallmouth bass (24%), and redhorse suckers (18%). Smallmouth bass fishing is considered good with a catch rate of 0.12 fish per hour (Robertson et al. 1985). In 1986, 16,348 fish were harvested in this same section. However, total fishing pressure increased to 75,818 hours, with shore fishing accounting for 84% of the fishing pressure and harvest (Ledet and Koza 1986).

MDNR has also conducted creel surveys in the lower and mouth segments annually since 1985. Below Berrien Springs, a total of 42,240 fish were harvested, and fishing pressure totaled 172,099 angler hours in 1985. Fishing pressure was twice as high below Berrien Springs compared to the Indiana section below Twin Branch Dam before the ladders were completed. Channel catfish had the highest catch rate at 0.035 fish per hour followed by chinook salmon at 0.024 fish per hour. In 1993, one year after the ladders were completed, Indiana had an increase in fishing pressure to 100,419 angler hours, which was a 45% increase from 1985. Catch rates (fish per hour) for smallmouth bass (0.024) and rainbow trout (0.022) were highest. Angler hours decreased below Berrien Springs to 106,164 with rainbow trout (0.031) and walleye (0.018) producing highest catch rates. The immediate reward from ladders was a shift from angler use below Berrien Springs to more use in Indiana waters. Also, more rainbow trout were being caught between Berrien Springs and Twin Branch dams.

Since 1992, continuous creel harvest data have been collected from below Twin Branch Dam to the mouth of the St. Joseph River (Figure 34). Angler hours increased 59% between 1992 and 1996, and number of angler days increased 73%. Total catch of all species has also increased from 32,889 in 1992 to 117,904 in 1996. Obviously, the ladder projects as well as enhanced access has increased use of this river segment.

Although salmon, bass, and walleye are the most sought after fish species and make up 47% of the State’s master angler award entries, there is a unique opportunity below Berrien Springs to catch trophy flathead catfish. This large catfish prefers deep holes with log cover, which is typical habitat for the St. Joseph River in this area. In each of the past five years, a flathead catfish from the St. Joseph River has won the catfish category in the Kalamazoo Gazette Big Fish Contest with entries exceeding 38 pounds!

Christiana Creek crosses the border from Michigan to Indiana and is the first major tributary to enter the St. Joseph River in the lower valley segment. The upper sections of Christiana Creek get good spring sucker runs and the lower half has good smallmouth and rock bass fishing. It is canoeable from the state line to the St. Joseph River. Juday Creek also enters the St. Joseph River north of South Bend. It has a small population of brown trout and supports a small fishery.

The Dowagiac River is the most heavily used tributary for recreation within the lower segment. There are two canoe liveries on this subwatershed mainstem. There is a MDNR access site off Sink Road for small boats and canoes. Dodd Park and the City of Niles, Pucker Street Park provide two other access points in addition to road crossings. Public land with riparian frontage is limited to Russ Forest along Dowagiac Creek and Dowagiac Woods along the Dowagiac River. Keeler mini-game area, located just north of the Dowagiac watershed, offers public hunting and nature viewing. Fishing pressure in most of the Dowagiac River is low; high water velocity and limited habitat make fishing difficult. Proposed meander rehabilitation of this channelized stream may increase recreational use of the mainstem (see **Citizen Involvement**). Fishing pressure is high below the dam in Niles. Salmon and steelhead have access to the lower three miles of the Dowagiac River and are stopped by the Pucker Street Dam at Niles. Between 1992 and 1996, angler use has increase from 896 to 4,691 angler days. Chinook salmon and steelhead harvest has increased seven fold during the same period. Most tributaries within the Dowagiac River system receive light to medium fishing pressure for brown trout, but access is limited to road crossings and private land with permission from riparians.

The remaining tributaries within the lower segment offer some recreation including hunting, trapping, and fishing. Most are small coldwater streams that flow less than three miles to the St. Joseph River. Natural populations of brown trout along with some steelhead and chinook smolts live in these streams and provide a small fishery.

<u>*Mouth*</u>

The last seven miles of the river have good access. There are six parks in Benton Harbor and five have boat launches. The south pier head can be accessed by Silver Beach County Park and the north pier head by Tiscornia Park. Most river use is for recreational boating. The St. Joseph River Harbor has 13 marinas capable of docking large-sized pleasure boats. Personal watercraft use is popular between and outside of the pier heads. Most fishing pressure is off the south pier during spring and fall, when coho salmon, chinook salmon, steelhead, brown trout, whitefish, rainbow smelt, or yellow perch are feeding close to shore or migrating upstream.

The Paw Paw River has limited recreational use because of lack of public access. Only one public boat launch exists near the town of Lawrence. Upstream of Hartford shore anglers fish for chinook salmon and steelhead in the fall. Paw Paw River Campground upstream of Watervliet gives anglers an opportunity to shore fish for northern pike, walleye, smallmouth bass, steelhead, and salmon. Due to large amounts of wooded bottomlands and wetlands, the Paw Paw River valley is excellent habitat for deer, furbearers, and waterfowl. The river near Benton Harbor is difficult to fish because of limited access from shore; however, there are good boat fishing opportunities (Dexter 1991b). Campbell Creek is wadeable and popular with anglers for trout and salmon. The East and West branches of the mainstem, Blue Creek, and Brush Creek also offer trout fishing opportunities.

Citizen Involvement

Most citizen involvement with management of the St. Joseph River is through government agencies, including Michigan Department of Natural Resources, Michigan Department of Environmental Quality, Indiana Department of Natural Resources, Indiana Department of Environmental Management, soil conservation districts, county drain commissioners, and community governments. These agencies are primarily involved with water quality, animal populations, water flows, landscape use, and recreational opportunities.

The St. Joseph River Fish Management Team was formed in 1978 to plan the development of fish passage structures on the Buchanan, Niles, South Bend and Mishawaka dams, and to manage the potamodromous fishery developed in the lower St. Joseph River. Members include representatives from the MDNR, IDNR, and US Fish and Wildlife Service. With the completion of the Niles fish ladder in late 1991, the team now manages the potamodromous fishery from the mouth of the river upstream to Twin Branch Dam in Mishawaka.

Several organizations work on aspects of the St. Joseph River (Table 33). These organizations are largely associated with fishing, hunting, and recreation. Southwest Michigan Planning Commission and St. Joseph River Basin Commission are organizations that work with basin wide issues. They participate in studies concerning water quality and planning within the watershed. More importantly, they have the ability to provide information to, and communicate with, several agencies and organizations within the watershed.

The Friends of the St. Joseph River Association is a non-profit organization that was formed in 1994. There are 29 chapters within the basin from Hillsdale to Lake Michigan. Each chapter is made up of dedicated local citizens that join together each spring and fall to clean and monitor their assigned stretch of river. The goal of the organization is to have enough chapters so that the entire stretch of the St. Joseph River can be cleaned of trash every spring. Their long-term goals include the installation of parks and launch sites in communities along the river and production of a water testing program for schools to monitor water quality in every tributary in the watershed.

Partnership for MEANDRS (Meeting the Ecological and Agricultural Needs within the Dowagiac River System) is a non-profit citizen based organization that is interested in restoring portions of the Dowagiac River that were channelized in the 1920s. MEANDRS goals are to rehabilitate the functional ecology of the Dowagiac River, re-create some of the characteristics of the original channel, and improve the diversity of fisheries and wildlife habitats. The river would then support a coldwater fish community, dominated by self-sustaining trout populations. Headwater and riparian wetlands would also be restored, improving water quality, flow, and temperature stability. The partnership is multi-faceted, drawing on expertise from a variety of interest groups in southwest Michigan. The governing board consists of riparian landowners, local units of government, and the scientific advisory team is made up of federal and state agencies, university faculty, and sporting and land preservation groups. MEANDRS has the potential to orchestrate rehabilitation of a rare and valuable ecosystem that will provide an exceptional recreational opportunity to the St. Joseph River watershed.

Local watershed projects, often receiving assistance from state or federal grants are also a tool for local citizen involvement. Local watershed projects receiving federal grants from the Clean Water Act in the St. Joseph River basin include: Sauk-Coldwater rivers, Nottawa Creek, Christiana Creek, Donnel Lake, and Dowagiac River watershed projects and the Paw Paw River Groundwater Project.

MANAGEMENT OPTIONS

The St. Joseph River is fairly healthy and is predominately warm with some cold and cool water habitats. However, there are problems contributing to degradation of fish populations and habitat that need attention. The management options presented in this assessment are to address the most important problems that are now understood and to establish priorities for further investigation.

The options follow recommendations of Dewberry (1992), who outlined measures necessary to protect the health of river ecosystems. Dewberry stressed protection and rehabilitation of headwater streams, riparian areas, and floodplains. Streams and floodplains need to be reconnected where possible. We must view a river system as a whole, for many important elements of fish habitat are driven by whole system processes.

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 understandings of fish, fishing, and fishery management.

We convey four types of options for correcting problems in the watershed. First, we present options to protect and preserve existing resources. Second are options requiring additional surveys. Third are opportunities for rehabilitation of degraded resources. Opportunities to improve an area or resources, above and beyond the original condition, are listed last.

Geology and Hydrology

The St. Joseph River has moderately stable flows due to a thick surficial layer of coarse-textured glacial deposits and pervious soils. Some reaches and tributaries have less-stable flows than expected based on their surrounding geology. Poor land use, channelization and extensive drainage, irrigation practices, and dams cause most of these flow problems.

Option: Protect all existing coldwater, stable streams from effects of land use changes (increase in impervious surfaces from development practices), channelization, irrigation, and construction of dams and other activities that may disrupt the hydrologic cycle by educating and working with planners, zoning boards, developers, drain commissioners, and land owners.

Option: Protect critical groundwater recharge areas by identifying these and developing a strategy to protect them. Identify major removals of groundwater and analyze potential effects of existing groundwater removals (e.g. irrigation in St. Joseph County Michigan).

Option: Protect and rehabilitate the function of wetlands and floodplains as water retention structures for high flow conditions. Develop an inventory of existing and potential areas for creation or protection of wetlands, with emphasis on riparian areas.

Option: Protect remaining natural lake outlets by opposing construction of new lake-level control structures. This would allow for the natural fluctuation of water levels needed for maintenance of lake-associated wetlands.

Option: Protect and rehabilitate 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. It could also be used to identify critical tributary watersheds.

Option: Protect near shore habitats and floodplain connectivity by encouraging and requiring natural methods of bank stabilization (e.g. rock riprap, log or whole tree revetments, and vegetative plantings) through permitting processes, zoning procedures, and education.

Option: Survey surface and groundwater withdrawals and establish minimum flow requirements in high use areas. Support programs that target high user groups.

Option: Survey flows below mainstem and tributary dams and lake-level control structures to determine if minimum flow or run-of-river flow requirements are necessary.

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

Option: Rehabilitate summer base flows on mainstem and tributaries by establishing minimum flow requirements downstream of all dams and lake-level control structures. These minimum flows could be established through administrative or legal processes.

Option: Rehabilitate headwater and tributary flow stabilities by working with county drain commissioners to incorporate flow patterns into criteria for drain design and storm water management.

Option: Rehabilitate flow stability by removing or plugging drain tile fields that are no longer critical for land drainage.

Option: Rehabilitate developed floodplains by supporting policies that regulate land use activities and reconstruction of roads, homes, and other structures after large floods.

Option: Develop preliminary flow criteria based on landscape-scale modeling of flow regimes required to produce target temperatures and fish assemblages, based on state-wide Michigan Rivers Inventory models. Refine these criteria as more detailed data and models become available.

Channel Morphology

The channel of the St. Joseph River ranges from normal to degraded for habitat diversity and natural form. Most high-gradient areas have been impounded, so the river lacks good hydraulic diversity.

Dredging, straightening, and high sediment loads causing channels to be simple, over wide, shallow, lacking diversity, and lacking woody structure have adversely affected several tributaries.

Option: Protect tributaries from further channelization by developing alternatives to current dredging drainage practices.

Option: Rehabilitate rare high-gradient habitats by removing dams no longer used for their original purpose (example retired hydroelectric facilities)(e.g. Randall, Portage Plant, Pollack, Fox and Bears, Upper Constantine, and Niles (Pucker Street) dams) and dams that are a safety hazard (e.g. Three Rivers, Sturgis, Mottville, Constantine Hydro, Adamsville Mill, Niles French Paper, LaGrange Lake, Lower Mill (Dowagiac Creek), Buchanan, and Berrien Springs dams). Failed dams should be thoroughly evaluated on the basis of environmental and social factors to determine whether reconstruction is appropriate.

Option: Rehabilitate recruitment of woody debris by developing and managing wooded greenbelts on riparian lands and managing amounts of wood in the channel (e.g. river clean-ups should be carefully carried out to ensure that some structure remains).

Option: Restore natural channel morphology in streams with high resource potential to enhance existing habitat diversity (e.g. Dowagiac River - meander rehabilitation).

Dams and Barriers

There are 190 dams in the St. Joseph River watershed, and many have negative effects on aquatic resources. Dams fragment habitat for resident fish, impede potamodromous fish migrations, impound high gradient areas, trap sediments and woody debris, cause flow fluctuations, cause fish mortalities (entrainment with hydroelectric dams), and block navigation. Lake-level control structures alter natural water regimes and can severely impair downstream aquatic habitat. Some of the dams, however, provide impoundments with existing and future potential for fisheries and other recreational uses not provided by flowing water.

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

Option: Protect fishery resources by screening turbine intakes at operating hydroelectric dams (e.g. Riley, Sturgis, Constantine, Mottville, Elkhart, Niles, Buchanan, and Berrien Springs dams on the mainstem; and Star Mill Dam on Fawn River).

Option: Protect remaining connectivity of system by opposing construction of dams and in-line storm water detention basins.

Option: Survey and develop procedures to change legislation that exempts the Riley Dam at Union City and Berrien Springs Dam from FERC licensing and review.

Option: Survey and develop an inventory of barriers to fish passage, such as culverts, and explore options to correct the problem.

Option: Survey and develop a watershed list of the most environmentally damaging dams and barriers to fish passage in the river, with recommendations to mitigate damage.

Option: Determine the number of small unregistered dams in the basin.

Option: Rehabilitate high quality coldwater habitat by retrofitting existing top-draw dams into bottom-draw dams (e.g. Dowagiac Creek Mill Pond in Dowagiac).

Option: Rehabilitate free-flowing river conditions by encouraging dam owners to make appropriate financial provisions for future dam removal.

Option: Rehabilitate free-flowing river conditions by removing dams, requiring dam owners to operate at run-of-the-river (e.g. Three Rivers Dam), modifying all possible dams to fixed-crest structures, or modifying the largest dams to incorporate a bottom draw system to mitigate warming effects on impoundments.

Option: Rehabilitate river navigability by constructing canoe portages and upstream and downstream access sites at dam locations on the mainstem and major tributaries.

Option: Rehabilitate natural water levels by requiring all lake-level control structures to be operated to maintain existing seasonal fisheries and minimum flows downstream. Lake-level control structures could be removed or converted to fixed crest to accomplish this.

Soils and Land Use Patterns

Agricultural and urban land use has altered portions of the St. Joseph River system. Undeveloped land within the watershed has buffered some changes. Projected urban sprawl and intensive, high acreage farming threaten the integrity of the buffer and alter water budget, routing more water along a surface path. There are 2,541 known road and railway crossings in the watershed; adverse effects attributable to these sources are significant. In addition, pipelines and other submerged crossings affect streams during placement and can cause erosion and barrier problems when exposed in the streambed.

Option: Protect undeveloped landscape through property tax incentives, transportation policies, integrated land use planning, and policies to encourage redevelopment of urban areas.

Option: Preserve agricultural landscape by supporting best management practices and agricultural zoning plans.

Option: Protect developed and undeveloped lands through land use planning and zoning guidelines that emphasize protection of critical areas, minimizing impervious surfaces, and improve storm water management for quality and quantity.

Option: Protect and rehabilitate functions of wetlands and floodplains.

Option: Protect and rehabilitate forested corridor along the river and its tributaries. Encourage additional tree planting and reforestation throughout the watershed.

Option: Protect and rehabilitate critical areas through maintenance of current storm water management systems and retrofitting of areas that are in need of storm water management systems.

Option: Protect existing streams from sedimentation and flow constrictions by routing new roads to avoid streams rather than crossing, where feasible. Review crossing reconstruction proposals to ensure adequate stream protection.

Option: Protect streams from degradation by promoting bore and jacking or flume methods of pipeline stream crossings as an alternative to open ditching.

Option: Survey watershed to locate crossings that are degrading streams through sedimentation, disruption of stream flow, or creation of barriers to fish passage.

Option: Survey watershed and create map of all known submerged pipelines. Identify pipelines that are exposed and causing bank erosion or barriers to fish movement and notify the appropriate pipeline company for repairs.

Option: Survey, identify, prioritize, and draft options for abandoned railway crossings with degraded structures that could collapse causing stream flow redirection and damming.

Option: Rehabilitate any crossings identified above through erosion control measures, reconstruction of poorly placed crossings, and replacing perched and narrow culverts.

Water Quality

Water quality is good in most parts of the watershed. However, CSOs, storm-sewers, NPDES discharges, and nonpoint sources have significant effects on bacteria and dissolved oxygen levels. The many Part 201 sites in the watershed raise concern about future and current loading of toxic materials to the river and groundwater. The effects are reflected in high fecal coliform levels, PCB contaminated fish, and contaminated sediments in the lower and mouth segments.

Option: Protect and rehabilitate water quality by implementing improved storm water and nonpoint source best management practices.

Option: Protect and rehabilitate water quality by more effective use of regulatory tools (enforcement) available within SWQ, LWM, Waste Mangement, and Environmental Response divisions of the Department of Environmental Quality.

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

Option: Protect river quality by supporting educational programs for farmers, land developers, and other resource users that teach land and water management practices that prevent further degradation of aquatic resources.

Option: Protect groundwater and stream flows by supporting laws that would require major water withdrawals from surface or groundwater to register, report volumes used, and document that protected uses of the source of water will not be impaired to the appropriate Department of Environmental Quality division. Establish a program similar to the state of Indiana.

Option: Protect major aquifers in the watershed by promoting hydrogeologic studies to characterize groundwater and programs to protect groundwater from contamination in the St. Joseph River (i.e. follow the lead already established by the state of Indiana).

Option: Survey potential river sources of PCBs in the lower and mouth segments of the St. Joseph River by performing outfall and sediment surveys. Eliminate identified sources to reduce PCB contamination in fish.

Option: Survey the watershed with wide-scale sampling to determine areas with contaminated fish. Wide-scale sampling will provide baseline information on areas of the watershed with no or limited data.

Option: Survey loading of nutrients and sediments to the river and develop strategies to reduce nonpoint source pollution problems by working with MDEQ, SWQD and local Natural Resource Conservation Service offices.

Option: Survey groundwater use to determine resource availability and potential for overuse.

Option: Rehabilitate and protect water quality by supporting Part 201 site and Superfund cleanups.

Option: Rehabilitate water quality by continuing to implement requirements in municipal NPDES discharge permits to eliminate untreated discharges of sewage from combined sewer overflows.

Option: Rehabilitate water quality in the lower and mouth segments by eliminating CSO problems (ex. disconnect any sewer or other waste lines to storm water drains. Route all sewer and waste lines to treatment facilities).

Special Jurisdictions

The Federal Energy Regulatory Commission licenses 12 active hydropower facilities within this watershed. The states of Michigan and Indiana manage 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 that can also have an affect on the quality of the river system.

Option: Protect and rehabilitate the river system by supporting cooperative planning and decision making. Develop a Geographic Information System that could be used in these processes.

Option: Protect coldwater tributaries by designating appropriate reaches as trout streams to ensure proper management and environmental protection.

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

Option: Survey and review management of land and dams owned by the State of Michigan.

Option: Rehabilitate natural stream flows below the dam at Berrien Springs by identifying and implementing regulatory procedures within State of Michigan statutes; explore any contingency to amend the Act of Congress to give FERC the authority to regulate the Berrien Springs Project.

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

Option: Rehabilitate designated drains to natural stream status where such designation is no longer appropriate or where past drainage modifications have been excessive (e.g. Dowagiac and Prairie rivers).

Biological Communities

Although 114 species of fish were identified in 1997 in the St. Joseph River watershed, certain problems demand consideration. There has been a decline in species that require clean gravel substrates. This habitat has been lost to sediment deposition, impoundments of high gradient areas from dams, and channelization. There has also been a loss of potamodromous species that historically used the river for spawning. These species have been cut off from spawning habitats by dams on the mainstem and tributaries. Furthermore, channelization and stream clearing has degraded channel morphology and removed woody debris used for habitat and raised stream temperature. Mussel and aquatic invertebrate species have declined from poor water quality, sedimentation, and loss of flowing river and gravel habitats from impoundments. Amphibians and reptiles have been on the decline presumably from loss of wetlands.

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 agricultural set aside programs, conservation easements, or direct purchases from conservation organizations or government agencies.

Option: Preserve remaining high gradient and naturally-graveled habitats, especially between Riley and Sturgis dams, Sturgis and Constantine dams, Twin Branch and Niles dams on the mainstem, and the Dowagiac River below the dam in Niles. Other short stretches exist on the mainstem and tributaries.

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

Option: Survey distribution and status of aquatic invertebrate (mussels and insects) and fish fauna (e.g. mainstem between impoundments, Coldwater, Prairie, Fawn, Pigeon, and lower Paw Paw rivers).

Option: Survey distribution and status of amphibians and reptiles within the watershed and protect critical habitats.

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

Option: Survey distribution and status of lake sturgeon in the middle, lower, and mouth valley segments. Areas to target include Lake Wawasee, Elkhart River, and the St. Joseph River at South Bend, Niles, and Berrien Springs.

Option: Survey and map the Rocky River for nonpoint sources causing high sediment load.

Option: Rehabilitate rare, high-gradient areas and fragmented habitats by removal of unnecessary dams (e.g. Randall, Portage Plant, Pollack, Fox and Bears, Upper Constantine, and Niles (Pucker Street) dams).

Option: Rehabilitate populations of potamodromous fish by removal of unnecessary dams and installing upstream and downstream passage at other dams and barriers in the watershed. Passage facilities should allow the migration of salmonids as well as warm water species (smallmouth bass, walleye, flathead catfish, lake sturgeon, and redhorse suckers).

Fishery Management

Angling is good in the St. Joseph River basin, especially in the lower and mouth segments for potamodromous salmonids. Fish populations and fishing pressure are low, however, in the headwater segment. Lack of woody debris and poor substrate prevent this segment from reaching its fishery potential. The opportunity exists to expand angling opportunities in the basin through more concerted management and careful review of existing management practices.

Option: Survey fish populations and inventory habitat in waters lacking data (e.g. Prairie, Fawn, Pigeon, and lower Paw Paw rivers).

Option: Survey water temperatures and trout survival in managed waters to determine if trout stocking is prudent (e.g. summer temperatures too marginal, natural reproduction can sustain fishery, or adjust strains).

Option: Survey waters in the upper valley segment, especially the Coldwater River between Marble and Coldwater lakes, to determine status of northern pike populations and request stocking if necessary.

Option: Rehabilitate habitat continuity by removing unnecessary dams (e.g. Jonesville Dam on St. Joseph River, Upper Constantine on Fawn River, and Niles Dam on Dowagiac River). Require upstream and downstream fish passage as well as bottom draw release on those dams that remain (e.g. Sturgis, Three Rivers, Constantine, and Mottville dams).

Option: Rehabilitate the coolwater fishery in the headwater segment through habitat improvement (e.g. sediment traps, addition of woody debris, bank stabilization, and wetland protection). Stock fish (smallmouth bass or northern pike) to re-establish self-sustaining populations in areas that can support the stocked fish species.

Option: Rehabilitate the brown trout fishery in Prairie River near the town of Burr Oak by promoting trees, bank stabilization, and woody debris and by opposing further dredging upstream in Branch County.

Option: Rehabilitate trout habitat on the Dowagiac River by restoring meanders to increase pools and riffles.

Option: Rehabilitate trout habitat on Campbell Creek by installing a sediment basin upstream of 28th Street to reduce sand bedload through the managed section.

Option: Improve angling opportunities by stocking northern muskellunge in waters that once supported good tiger muskellunge fisheries (Coldwater, Fish, Marble, Round, Austin, Long, and Garver lakes).

Option: Improve angling opportunities by continued improvement and acquisition of public access property.

Option: Improve the fishery in upper and middle segments through habitat improvement to encourage natural reproduction of walleye and smallmouth bass.

Option: Rehabilitate historical potamodromous runs through stocking if needed. The original species that are best suited are walleye and lake sturgeon.

Option: Develop a Fisheries Division or Lake Michigan Basin Team policy regarding the use of blocking weirs to prevent potamodromous fish (e.g. suckers, sea lampreys, chinook salmon, coho salmon, or steelhead) from migrating up tributary streams.

Option: Continue stocking fish that provide fisheries. Stocked waters should continue to be surveyed to evaluate fish populations and angler use to justify future stocking.

Recreational Use

The watershed provides fair recreational opportunities in public owned areas. The river and tributaries are used frequently for fishing, hunting, canoeing, and nature watching. These recreational opportunities would be enhanced by increased public access to the river, especially in the headwater and upper segments. Navigation is impeded by poorly designed and maintained portages around some mainstem and tributary dams.

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

Option: Protect recreational (fishing, canoeing, hunting, etc.) use of small tributaries by supporting the establishment of a "recreational" definition of legal navigability as opposed to the "commercial" definition.

Option: Improve small-scale public access where lacking (e.g. headwaters of mainstem, Dowagiac, and Paw Paw rivers) through MDNR, county, township, and other municipal recreation departments, as well as private organizations.

Option: Survey and quantify recreational user groups within the river system, and identify programs to enhance compatible use of resources (ex. educate liveries of the importance of woody debris in streams; educate pleasure boaters and personal watercraft users of proper operational etiquette near wild shorelines, wildlife, swimmers, and anglers).

Option: Develop a basin public access plan similar to the one developed by Parks and Recreation Division for the Grand River basin, with the goal of a public access site every six miles along the St. Joseph River.

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

Option: Improve canoe portages and boat launches at all dams along the mainstem. These sites can be maintained by hydropower facilities under FERC relicensing agreements where applicable.

Citizen Involvement

There is an increasingly active citizen component to the St. Joseph River watershed that should be continued and expanded.

Option: Protect and rehabilitate watershed integrity by supporting Friends of the St. Joseph River, the St. Joseph River Basin Commission, and other watershed groups as they build public support.

Option: Support Michigan legislation to appropriate funds to create an organization in Michigan that is similar to the St. Joseph River Basin Commission in Indiana.

Option: Support programs that encourage local citizen use and contact with “their” river.

Option: Support the Southwest Michigan Land Conservancy and other land conservancies (e.g. Michigan Nature Association and the Nature Conservancy) in identifying lands for conservation easements.

Option: Improve and implement strategies to educate the community to the benefits of river ecosystems, wetlands, and floodplains by supporting local conservation organizations.

Option: Encourage and support habitat improvement projects conducted by sports groups.

Option: Encourage and support further studies by elementary and secondary school students to monitor local water conditions within their portion of the watershed (e.g. Friends of the St. Joseph River and St. Joseph River Basin Commission “River Watch”).

Option: Evaluate the St. Joseph River basin in terms of the issues-needs-concerns of the major subwatersheds (e.g. Portage, Fawn, Prairie, and Elkhart river watersheds). Prioritize the watersheds according to natural resource criteria and level of local public involvement. Encourage and develop watershed plans specific to each watershed.

PUBLIC COMMENT AND RESPONSE

The draft assessment was distributed during early fall, 1998. The draft was sent to all district offices of the MDNR, IDNR, MDEQ, and IDEM in the watershed and selected statewide offices. Copies were distributed to federal, state, and regional agencies as well as all units of local government (townships, villages, and cities) in the watershed. County offices of the Board of Commissioners, Drain Commission, Road Commission, NRCS, Soil and Water Conservation, and MSU Cooperative Extension Service also received copies. Other organizations receiving copies included the Friends of the St. Joseph River Association, Southwest Michigan Land Conservancy, American Electric Power Company, Indiana and Michigan Power, Grande Pointe Power, French Paper Company, and several citizen organizations. A letter explaining the purpose of the assessment and requesting review comments was enclosed with all copies.

Copies were also sent to public libraries in Benton Harbor, Cassopolis, Coldwater, Hillsdale, Mendon, Mottville, Niles, Paw Paw, Sturgis, Three Rivers, Union City, Vicksburg, and Watervliet. It was requested that these copies would be kept in the reference section to assure they would be available. Copies for distribution were available at the Plainwell and Ann Arbor Fisheries Division offices. Bound copies of the full assessment were sent to any person or group requesting one.

Public meetings to receive comments concerning the draft assessment were held on November 2, 1998, at the Senior Citizens Center in Niles; November 3, 1998 at the Community Center in Three Rivers; and November 5, 1998 at the City Building in Coldwater. A MDNR news release was issued on October 21, 1998, regarding the purpose of the St. Joseph River Assessment and the date, time, and location of the public meetings. Several daily and weekly newspapers, radio stations, and community calendars in the watershed were sent notification of the public meetings. A total of approximately forty people attended the three meetings.

Although the official comment period ended February 28th, 1999, comments received up to several weeks after that date were included. All comments received were considered. The suggested change was either incorporated into the final assessment or listed with the reason it was not included.

Introduction

Comment: Various comments were made supporting the watershed assessment process and complimenting the 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 all people who requested one.

Comment: Public meetings were not advertised well, and it was difficult to obtain a copy of the draft report. Several people at the public meeting did not have the opportunity to read the report.

Response: The distribution of the draft assessment was discussed in detail at the beginning of this **Public Comment and Response** section. Although the distribution was extensive, not everyone who desired a copy received one. Suggestions on methods to improve distribution of future draft assessments to the general public would be appreciated.

Comment: Several errors in spelling, punctuation, and grammar were mentioned.

Response: These errors have been corrected.

Comment: It would be a great asset to the reader to have a list of acronyms with their full word equivalent.

Response: Acronyms with their full word equivalent were added to the **Glossary**.

Geography

Comment: Most of the Indiana portion of the St. Joseph River Watershed is actually in northeast Indiana not northwest.

Response: The correction has been made.

Comment: Bowerman Creek in Indiana is actually named Bowman Creek.

Response: The correction has been made.

Comment: Keelo Creek is listed as a separated tributary to the St. Joseph River. It is a direct tributary to Hickory Creek not the St. Joseph River.

Response: The correction has been made.

History

Comment: "The Iroquois Natives did not occupy the St. Joe Valley in any type of permanent basis. Therefore, their use of the fish traps would have been small as compared to the overall use by the Algonquians."

Response: The statement in the assessment concerning fish traps has been modified to suggest less use by the Iroquois.

Comment: A couple of comments suggested that the site of Fort Saint Joseph be changed to the east bank rather than the west bank.

Response: According to Cunningham (1961), the fort was once built on the west side of the river. However, a recent study by Western Michigan University has established the exact location of the fort on the east side of the river. Given this new evidence and comments received from local historians, the fort location has been changed to the east side in this document.

Comment: Table 1 would be more useful if it gave more specific information of what each archeological site contained and if the particulars of the location of each site be more direct.

Response: The purpose of Table 1 is to illustrate the density and distribution of archeological sites within the watershed. It is not intended to be used to locate specific sites. Contact the Department of State, Archaeology Section for more specific information.

Geology and Hydrology

Comment: "Page 16, 1st and 2nd paragraphs: The annual average extreme minimum temperature of paragraph 1 is colder than the extreme minimum temperature of paragraph 2. Both are referenced to Albert, et al. 1986."

Response: Paragraph one refers to the average extreme minimum temperature for the entire watershed. Paragraph two refers only to the extreme minimum temperature of the mouth and lower segments of the watershed. The extreme minimum temperature of the mouth and lower segments is warmer than the average for the entire watershed due to warming effects from Lake Michigan. Wording was changed in the paragraphs to make this point more clear.

Comment: "Page 17, 5th paragraph: suggest changing the word trend to direction, so that the sentence reads "Discharge per square mile increases in a downstream direction" (not downstream trend)."

Response: The suggested change has been made.

Comment: "Page 18, 2nd to last paragraph: the Au Sable River at Mio stream gaging station is directly affected by the Mio dam and Mio Pond located 500 feet upstream. You may have already considered this, but a longterm unaffected by hydroelectric operations "site" might be the South Branch Au Sable River near Luzerne."

Response: The Au Sable River example was changed from the Mio site to the South Branch site near Luzerne.

Comment: "p. 18, paragraph 5, first line. Should read "Exceedence flows are illustrated in Figures 6-15…"."

Response: The correction has been made.

Comment: "Figures 6-15, pp. 199-208; I believe these figures need some additional explanation. Most people will not understand the meaning of "Standardized". It needs to be defined in lay terms, on the figures where the term is used. The Glossary defines exceedence curves as "the probability of a discharge exceeding a given value". I don't see this as being clearly indicated on the figures. Can interpretation be made clearer on the figures?"

Response: The definitions of standardized discharge and exceedence curves have been added to figures 6-15. Exceedence curves are difficult to understand for readers with limited hydrological backgrounds. Exceedence curves are described more thoroughly in the text.

Comment: "Page 19, 5th paragraph: What is the definition of "mean high flow" and "mean low flow"? The ratio(s) are shown, but no information about how or what numbers were used to arrive at the ratio. Without a definition, few people could arrive at the same mean high or mean low flow."

Response: Short-time frame and miscellaneous flow data were used. High and low mean monthly values for each year by site were identified, and a mean of the high and low flows for several years was calculated by site. The mean of the high flows was divided by the mean of the low flows to calculate the index of flow stability. Although exceedence curves are probably a better method of looking at flow stability, this flow index allows us to use miscellaneous flow data and increase the number of sites within the watershed. The index was better defined in the final report.

Comment: "Page 20, last paragraph: your point is well taken, but remember the only year you show is 1995. Each year is different. You might want to review several low flow years, maybe in the mid 1960s or late 1980s".

Response: The comment has been considered; however, our point was to show the difference in summer base flow between a groundwater fed system (Dowagiac River) and a runoff system (Rimmell Branch). This point can easily be seen with the 1995 data, so no changes were made. Data from the 1960s and 1980s show the same type of pattern.

Comment: "Page 21, 1st paragraph: you have already been talking about "daily flow related to hydroelectric dams". Did you mean to say "instantaneous" here? If you wish to place emphasis on flow instability, consider showing instantaneous discharge."

Response: The comment was considered, and instantaneous flow data were used to illustrate a peaking hydroelectric operation.

Comment: "On page 21 under the section entitled *Daily Flow*, the assessment states that "Berrien Springs dam…continues to cause severe fluctuations in flow." And "During low flow situations, the activation of one or two turbines can instantly double the discharge downstream causing unsafe conditions for wading anglers and boaters." Because of our concern for public safety, we now employ an operating scheme whereby a spillway gate is partly opened to pass flow during the time between unit startups. This scheme tends to even out the flow and alleviate the fluctuations downstream caused by the operation of the Berrien Springs Project. Flows can still vary considerably, but these variations are caused by natural changes in the river flow and not the operation of the hydro facility."

Response: We recognize efforts to alleviate flow fluctuations below the dam at Berrien Springs. A sentence has been added to describe the new operation scheme.

Comment: "In the same paragraph (page 21), the assessment states that "Berrien Springs dam is not licensed under FERC because of a permit that was issued by the War Powers Act in 1906 (FERC 1981)." This statement is not entirely accurate. Although it is true that the Berrien Springs Project is not licensed under FERC, the building of Berrien Springs Dam was actually authorized by Public Act No.85 of April 5, 1906 (H.R. 16671). Therefore, the Berrien Springs Dam was constructed under an act of the U.S. Congress and not a War Powers Act."

Response: The correction has been made.

Comment: “Page 21, top paragraph: In addition to the Berrien Springs hydro, I believe that one of the hydros on the upper section of the St. Joseph River still operates in a peaking mode.”

Response: Instantaneous flow data were reviewed for Burlington, Three Rivers, Mottville, and Niles. The instantaneous flow at the Three Rivers gauge showed dramatic fluctuations indicative of a peaking operation. After further investigation, it was determined that the fluctuations were due to a pulsed operation of the City of Sturgis' generators.

Comment: “Page 21, 4th paragraph: Since you reference a 1974 document (almost 25 years old), we are supplying a more recent flood frequency analysis for Niles for your use. The x-year flood discharges are shown on the analysis as well as the annual flood peak discharges for each year of station operation.”

Response: The data that were supplied were very useful. Updates to the assessment were made.

Comment: “We did not find any discussion about the use of real-time streamflow data. The use of real-time streamflow data can aid management decisions, contaminant spill and movement evaluations, the scheduling of water sampling, and has been widely used by recreationists for canoeing and fishing purposes. About half of the USGS stream gaging stations in the State are now on the Internet. Three St. Joseph River sites are currently available on the Internet.”

Response: This is an excellent suggestion and information concerning the availability of real-time stream flow data has been added to the text.

Comment: “Page 92, Table 2: the average discharge show (1005 cfs) for the Elkhart River at Goshen, IN is incorrect. The highest annual mean (1950) is 1005 cfs. The annual mean, as reported in the 1995 Annual Report, is 537 cfs. Also, the station St. Joseph River at Elkhart is not shown in the table, as well as several discontinued stations.”

Response: The correction has been made to Table 2, and the St. Joseph River station at Elkhart has been added as well as several discontinued stations.

Comment: “Page 93, Table 3a heading: “calculated from miscellaneous and short time frame” is confusing. Did you mean to add “data” or “streamflow data”? Also, you may want to add a footer that includes the definition of “flow index”, so that the table can stand alone without the text on page 19.”

Response: The suggested changes have been made.

Comment: “Pages 199-208, Figures 6-15: you may want to include the definition of standardized discharge on each figure so that the figures can stand alone without the text on page 18.”

Response: The definition of standardized discharge has been added to Figures 6 through 15.

Channel Morphology

Comment: The gradient in the headwaters segment (45ft/mi) seems excessive. Is this right?

Response: Although a gradient of 45 ft/mi seems excessive, it is correct. Gradient measurements were made at varied points along the stream course. Sometimes one to two foot drops in gradient are recorded in a short distance of river (less than a tenth of a mile). When those areas are extrapolated out to a mile (we record gradient in ft/mi), the gradient can be very impressive. In this short section of the St. Joseph River near Hillsdale, there are several one to two foot drops in gradient in short distances that create excellent habitat.

Comment: "Figure 19, p. 212, I do not understand some of the meaning of "gradient class". Perhaps there are other people who do not understand some of the terms used on other Tables and Figures. A brief definition on the Figure could be helpful, even though it may be defined in the beginning text."

Response: Gradient class is simply an index of hydraulic diversity. Habitat typically increases with increased hydraulic diversity until gradients reach 70.0 ft/mi or above. The x-axis of the figures indicate whether a stream gradient class is low, fair, good, or excellent. Gradient class has also been added to the glossary.

Dams and Barriers

Comment: "Pages 36 and 69, Dams and Barriers: on page 36 you state there are 191 dams; on page 69 you state there are 194."

Response: There are 190 dams that are registered within the St. Joseph River watershed; one was removed during the time this manuscript was written. The correction was made.

Comment: Baw Beese Lake level control structure is not the largest dam in the headwaters segment. This must be a mistake.

Response: Hillsdale College is the largest dam in the headwaters segment not Baw Beese Lake level control structure. The correction has been made.

Comment: "Page 38, last paragraph: Star Mill hydro and Greenfield Mills hydro both are operating on the Fawn River."

Response: They have been added to the paragraph under Fawn River.

Comment: "Page 39, second full paragraph: During the FERC process, Star Mill was also required to stop its peaking operations and begin operating run of river."

Response: A note on the peaking operations was added to the paragraph.

Comment: "Table 18, p. 146, add Paw Paw Lake outlet dam installed in 1979 on the west side of M-140. This was an inexpensive dam meant to limit the flow out of Paw Paw Lake when the level dropped below a legal limit set at 621.8 feet. It did not limit incoming floodwaters. In 1986, the U.S. Army Corps installed a fully operable flood control dam on the east side of M-140. It is normally supposed to be open unless there is an impending flood."

Response: The above mentioned dam is listed in Table 18 under the Mouth segment as Paw Paw Lake Control.

Soils and Land Use Patterns

Comment: What influence does the Department of Natural Resources have on zoning?

Response: The Department of Natural Resources has no legal influence on zoning, but they can encourage township officials to update their master plans. The Michigan Department of Natural Resources can also provide information on critical habitats, areas of concern, and waterbody buffers, so these areas can be incorporated into master plans and protected with special zoning ordinances.

Comment: "Page 40, 2nd paragraph: The reference "Cummings 1978" (page 40) does not show up in the list of references (page 80)."

Response: The reference to Cummings 1978 has been added to the **REFERENCES** section.

Comment: "Table 19, p. 147, Shouldn't Van Buren County be listed under "Lower", and Berrien County listed under "Mouth"?"

Response: Most of Van Buren County is drained be the Paw Paw River, which enters the St. Joseph River in the mouth segment. Although the mouth of the St. Joseph River is in Berrien County, most of Berrien County drains into the lower segment of the river. This is a good example of the problems associated with using political and watershed boundaries.

Water Quality

Comment: "The Lake Michigan tributary study (EPA et al.) documented the St. Joseph River as the largest contributor of atrazine to Lake Michigan"

Response: The document has been reviewed, and a section on atrazine has been added to the *Nonpoint Pollution Sources* section under **Water Quality**.

Comment: "Page 50, 3rd paragraph: Is MDEQ still collecting monthly samples at the mouth of the St. Joseph River? I thought this effort was terminated a couple of years ago. Although we have discontinued sampling, the USGS collected a fairly broad group of constituents at Niles during the period 1967, 1972-75, and 1979-95. Also as part of the Lake Michigan Tributary monitoring project we measured the discharge and sampled the river at the mouth for common constituents, nutrients, selected herbicides, metals, and organics between April 1994 and October 1995. These data, because they were collected at the mouth, document the concentrations and loads being delivered to Lake Michigan by the St. Joseph River. Photocopies of some of the above mentioned data are enclosed."

Response: MDEQ has discontinued the monthly sampling at the mouth of the St. Joseph River. However, MDEQ conducts water quality and biological surveys on a five year cycle at the mouth of the river. The correction was made. The data that were supplied were very useful and were used to expand the **Water Quality** section in the final copy of the assessment.

Comment: "Page 51, 1st paragraph, last sentence: I was at a meeting about a month ago where it was stated that an AOC designation for the St. Joseph River was very likely to occur. I assume the reference (1990) is the reason for the discrepancy."

Response: In 1999, the International Joint Commission again proposed that the St. Joseph River be designated as a Great Lakes Area of Concern. The Michigan Department of Environmental Quality will have the opportunity to comment on this proposal. The assessment has been updated with this new information.

Comment: "p. 52, paragraph 4. Reference to the Prairie River temperature increase of "9 °C". There is nothing to suggest that exceeding an "allowable" temperature is correctable. Indeed, is nine degrees Celsius an "allowable" increase? It certainly seems extreme.

Response: The increase of 9 °C was a mistake. It has been changed to an increase of 9 °F. Under the existing water quality standards listed in Table 24a, this would be a violation of the allowable temperature increase of 2 °F established for coldwater streams. However, the temperature increase was not the result of a point discharge, rather by the actions of a county drain commissioner. Under the current drain code, it is very difficult to stop a stream dredging and clearing project. It is even more difficult to require rehabilitation after such a project.

Comment: "Tables 24a and 24b, p. 167, The lead line for both tables refer to "temperatures allowed" and "allowable degrees of increase". Could this be a poor choice of words? Nature is rather independent when dealing with "allowable" ranges. If there is some control that can be exercised by human intervention to maintain appropriate levels shouldn't it be addressed?"

Response: The language in tables 24a and 24b is directly from standards that have been established by Michigan Department of Environmental Quality, Indiana Department of Environmental Management, and the Environmental Protection Agency. The temperature and oxygen limits that have been established are biologically based to protect either coldwater or warmwater communities. For the best protection of aquatic communities in an ideal world, there would be no increases in temperature or decreases in oxygen allowed. However, an ideal world for aquatic communities would not include factories and power plants that are so important to our economy and industrial society.

Special Jurisdiction

Comment: "Table 22, p. 158 Watervliet and the drains listed therein should be listed in Berrien County (not Branch County)".

Response: The correction has been made.

Comment: "Table 23, p. 167, second line from the top of the page. Change "…designated from upstream from the town…" to "…designated upstream of the town…"".

Response: We liked your suggestion and made the change.

Comment: "The proposed dredging project in the Prairie River (middle valley segment) was challenged in court by Trout Unlimited. It was resolved and the project completed – no illegal dredging took place as stated. Also, this drain was not extended into St. Joseph County as stated. Please correct another Prairie River misstatement Table 25 p. 168 "illegal dredging" is in error again."

"The drain that is in the court system is Swan Creek. I must point out that this was won twice in Branch County Circuit Court, but it is under appeal to the State Supreme Court by Department of Environmental Quality, so to state that any illegal act has taken place is totally out of line."

"I also sincerely feel that your statements concerning the present Drain Code are editorial and have no place in a factual report."

Response: After a thorough investigation of the Prairie River dredging project, we still believe that illegal dredging took place but no legal action was instituted. The original plan was to return the bottom of the river to its condition after the last extensive dredging project in 1954. At the Board of Determination meeting virtually everyone present spoke against the project. The Board of Determination unanimously approved the project anyway. Therefore, the Kalamazoo-Battle Creek Chapter of Trout Unlimited filed suit in Branch County Court to halt the project. Some local farmers joined suit on the side of the Drain Commissioner. The judge wanted the parties involved to work out an agreement so that a modified project could begin. With assistance from the Office of Litigation and Program Services and Land and Water Management Division of the Department of Environmental Quality, a modified project was developed that got the agreement from all parties. This agreement specified removal of snags and logjams only in much of the downstream and extreme upstream portions of the project area. Snag removal was to be done with hand tools. Some sediment removal was allowed if work was done on one side (the east or north side) to minimize removal of trees which provide shade for cooler stream temperatures.

Fisheries Division was not notified before the construction phase of the project as was specified in the agreement. When the project was inspected, the contractor was not using hand tools and methods for snag removal as was specified in the agreement. An excavator was operated down the middle of the stream to remove logs and other obstructions. Several trees were also removed along the banks. The dredging project was conducted in a manner that was much more damaging to the stream than the agreement specified. A substantial amount of evidence, including video footage, was submitted to the Attorney General's Office. Legal action and mitigation was requested but no legal action was pursued. Because work was conducted that was prohibited in the legal agreement between the two parties, we feel that an illegal act did take place but no action was taken in court.

We have made corrections regarding the statement about dredging extending into St. Joseph County. The dredging stopped right at the county line; however, water quality damage extended several miles into St. Joseph County. Water temperatures increased significantly (9 °F) changing a marginal trout stream into a warmwater stream absent of trout.

We also do not feel that our comments regarding the Drain Code are "editorial". The Drain Code is very powerful and effective for designating and maintaining drains. Many of these drains are headwater streams and are very important habitats for aquatic organisms. Under the existing drain code there are no protections for these critical habitats. One of the purposes of this assessment is to identify problems in the watershed that are degrading habitat and aquatic populations. Activities associated with drain projects (bank clearing, straightening, widening, and deepening streams, and snag removal) severely degrade aquatic habitats. Drain Code reform is needed to allow for a balanced use of the aquatic resource. Best management practices should be used to remove major drainage obstructions with out completely dredging or straightening a stream. We understand the importance of agriculture and the need for some drainage in this watershed, but the existing Drain Code offers no ecological protection to streams.

Comment: “Table 21; Would it be possible to expand this list with a short description of the types of conditions that are regulated or controlled by these statutes?”

Response: A brief description has been added to the table for the Natural Resource and Environmental Protection Act parts.

Comment: “Page 45, third paragraph: In addition to the Pigeon River F&W Area, you might want to add Tri County F&W Area and Cedar Swamp and Marsh Lake Wetland Conservation Areas.”

Response: The additions have been made.

Biological Communities

Comment: “Page 28, top paragraph, last sentence: Three fish species are considered threatened (but four are listed). I am not sure that ironcolor shiner exists in the watershed. I believe that ironcolor shiner was listed in Indiana’s 1979 St Joe River survey, but I don’t have a voucher specimen and the ID for that shiner is debatable, This would also apply to table 9 on pave 108.”

Response: There are only three species considered threatened. The correction has been made. Ironcolor shiner has been removed from the list of species found in the St. Joseph River Watershed. No voucher specimens have even been found for that species within the watershed.

Comment: “Page 29, last paragraph: At one time, IDNR stocked brown trout into the Fawn River. However, we presently only stock rainbows. Are you referring to brown trout stocked by Michigan?”

Response: The correction has been made.

Comment: “Pages 100-101, Table 7 & 8: Tiger muskellunge non-indigenous?

Response: Tiger muskellunge are a hybrid between male northern pike and female northern muskellunge. Both species have natural distributions in the Great Lakes and also within the St. Joseph River watershed. Individually, they are both indigenous to the St. Joseph River; therefore, tiger muskellunge will be treated as indigenous within this assessment even though the hybrid probably does not occur naturally within the watershed. The hybrid between striped bass and white bass is treated as a non-indigenous fish species because the striped bass is not native to the Great Lakes or St. Joseph River.

Comment: "Appendix I, pp. 227-335: Is there a reason for the order in which these are presented? Have you considered any of the following: By habitat, by species, alphabetically, etc.,."

Response: Appendix I is in taxonomic order by family. This type of order is commonly used in fish identification books and with other groups in the animal kingdom like birds and mammals. The order is by family then by species according to the official list of common and scientific names of the American Fisheries Society. An index, in alphabetical order by common name, has been added.

Comment: "Page 32, last paragraph: See two mussel reports enclosed. There is also a third mussel report by G.T. Watters for the Pigeon River."

Response: The section on mussels has been updated with these new references.

Comment: "Page 36, second paragraph: Cabomba has been reported to occur on the St. Joseph River near Elkhart by a commercial applicator."

Response: Although we could not verify the presence of Cabomba in the St. Joseph River near Elkhart, we did add the species to the list as an exotic and potential nuisance. Cabomba was first found in 1935 within Kimble Lake, which is part of the Portage River subwatershed. It is possible that the species has spread to the St. Joseph River and downstream to Elkhart.

Comment: There were several suggestions for additions to species lists.

Response: These additions have been made.

Comment: "Enclosed you will find a fish species list of our findings and a list of birds found by the South Bend Audubon Society in St. Joseph (Indiana) County. I highlighted 3 species from the bird list that I have personally observed on the river this year that were not on your list. You might take a closer look at this bird list and add more of it to your list. The fish species that I highlighted are ones that are being confirmed right now."

Response: The list of birds was very useful. Over 60 species have been added to the list. The presence of fish species information was also useful and will be used to update the fish distribution maps in the appendix.

Comment: "p.138, Unless one has applied for an aquatic vegetation control permit, I doubt they would know what it is. Is this the type of permit that is required for chemical control of excessive plant growth? Just a brief explanation would be helpful."

Response: A brief explanation was added to the table heading.

Fishery Management

Comment: "p. 64, paragraph 1, last sentence. Actually there are several roads that cross the Paw Paw River between Watervliet and Coloma. The first one is Paw Paw Lake Road at the northeast boundary between Coloma City limits and Coloma Charter Township. The second is DeField Road at the north boundary between the city and township. Further down stream is Bundy Road, then Coloma Road just east of Riverside. The river passes under I-96, but is not accessible at that point. From there to Benton Harbor, most of the property belongs to the Sarrett Nature Center. The river is accessible at Sarrett."

Response: There are no boat or canoe launches between Coloma and Benton Harbor on the Paw Paw River. The road crossings that you mentioned are fairly close to Watervliet and Coloma. From Riverside downstream to Benton Harbor, there are no road crossings. Not only is it difficult for anglers to use this part of the river, but it is also difficult for Fisheries Division to access the river with survey boats. The sentence that was referred to above has been changed from reading "Watervliet downstream" to "Riverside downstream".

Comment: "Page 62, fifth paragraph, last sentence: IDNR stocks rainbow trout. Brown trout are stocked by the Elkhart Conservation Club."

Response: The correction has been made.

Comment: "Page 62, third full paragraph: The Fawn River trout fishery is put & take. Ten inch fish are stocked and rarely, if ever, survive the summer."

Response: The correction has been made.

Comment: "I'm sure you realize that we have some organizations that are installing rearing ponds along the river. Some of which are being used to raise walleye fingerlings and pike fingerlings. We sincerely hope to see this practice on the increase. We believe the parties involved in this aspect of the overall program should be encouraged in their endeavor, and should be supported financially by the state. We also believe that this practice will be much less expensive than the use of the hatcheries, and we have the blessing of the public and volunteers to help."

Response: The cooperative groups that you are referring to work very closely with Fisheries Division. These groups receive walleye and northern pike fry from our hatcheries and raise them in their ponds to a fingerling size. These fish are then stocked at specific rates into certain waters as designated by Fisheries Division. The program has been extremely successful and is supported financially by the Department of Natural Resources through the Inland Fisheries Grant Program. Although this supplemental stocking has helped with the existing walleye and northern pike fishery in the St. Joseph River watershed, it is not Fisheries Divisions goal to increase stocking of fish in the St. Joseph River. Stocking is required now because these fish are not supplying or sustaining the existing fishery through natural reproduction. Our goal is to protect and improve water quality and habitat so these fish can be more successful at naturally reproducing. Stocking is an expensive management tool and typically is a short-term fix to a problem. By encouraging more natural reproduction, we will ensure that these fish are available for many years to come.

Recreational Use

Comment: "Page 57, fifth paragraph, last sentence: There is a ramp at Bristol on the river and one off CR17 on the upper end of the Elkhart Impoundment. However, the river at Bristol is not impounded."

Response: The correction has been made.

Citizen Involvement

Comment: "Table 33, p. 191: Communication among these organizations may well be desirable. Would you be willing to add the address of each of these organizations?"

Response: Although it may be useful to have the addresses of each organization within the watershed, we chose not to include them in this document. This river assessment is intended as a long-term (30 year) document. Addresses and organizations change frequently and would soon become out of date.

Management Options

Comment: "….. I would like to see the options presented in a different format. Some of the biggest proponents of change along the river are the grass roots organizations and local forums of concerned citizens. I would like to see the options in the management section catered a bit more to this audience. Perhaps the inclusion of a section entitled "Management Options" and then one titled "Community Options," would help."

Response: Grass roots organizations and local forums of concerned citizens are major proponents to change along the river. However, to list out specific options for organizations and agencies would be a very difficult task. The management options are a list of actions that will serve to protect, rehabilitate, and enhance the river system. Management options listed are intended to provide a foundation for public discussion, setting of priorities, and embarking on a process of planning the future of the river system. The management options are not a list for just the Department of Natural Resources to work off. Several options that are listed are beyond the scope of any one agency or organization. The options are for the entire watershed and may be pursued by any interested organization and will more than likely require several groups cooperation to complete.

Comment: "Another water quality management option would be to promote a groundwater well abandonment program to add in the protection of groundwater resources."

Response: The option was added.

GLOSSARY

acre-feet - volume of water required to cover 1 acre of land to a depth of 1 foot; equivalent to 325,851 gallons

aggradation - the accumulation of bed materials

ammocete - juvenile lampreys that burrow in the substrate of streams for 3 to 6 years before smolting to Lake Michigan

anadromous - migrating from salt water to a fresh water river to spawn

base flow - the groundwater discharge to the system

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

biological oxygen demand - the measure of the consumption (usually by aerobic bacteria) of oxygen in an ecosystem within a fixed period of time

catchment - see watershed

CFL – Commercial Forest Land

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

CSOs – Combined Sewer Overflows

deciduous - vegetation that sheds its foliage annually

detritus - debris broken away by the action of water (e.g. small pieces of wood or leaves)

DO - Dissolved Oxygen

drumlins - long , narrow, or oval smoothly rounded hill of unstratified glacial drift.

entrainment - to trap an object during a given mechanical process (e.g. fish in hydropower turbine)

evapotranspiration - the loss of water from plant material to the atmosphere

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

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

FCMP - Fish Contaminant Monitoring Program

FERC - Federal Energy Regulatory Commission

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

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

GLEAS - Great Lakes Environmental and Assessment Section

GLFC - Great Lakes Fishery Commission

gradient class - an index of hydraulic diversity in streams.

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

heterogeneity - having composition of dissimilar parts

hydrology - the science of water

hydrograph - a graph of the water level or rate of flow of a stream as a function of time, showing seasonal change

hydrogeologic - pertaining to groundwater and the type geological material (clay, gravel, and bedrock) that influences groundwater flows

ice contact - pervious glacial material (gravel) found in moraines that is associated with groundwater recharge

IDEM - Indiana Department of Environmental Management

IDNR - Indiana Department of Natural Resources

IJC - Internal Joint Commission

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

keelboat - roughly built, shallow freight boat with a keel to promote sailing in the wind

laminar flow - the smooth pattern in which water flows in a uniform rate

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

lentic - pertaining to or living in still water

LWMD - Land and Water Management Division

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

mainstem - the primary branch of a river or stream

MDCH - Michigan Department of Community Health

MDEQ - Michigan Department of Environmental Quality

MDNR - Michigan Department of Natural Resources

MEANDRS - Meeting Ecological and Agricultural Needs within the Dowagiac River System

MGD - Million Gallons per Day

MNFI - Michigan Natural Features Inventory

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

niche - the position or function of an organism in a community of plants and animals

NPDES - National Pollution Discharge Elimination System

oligotrophic - a lake characterized by a low accumulation of dissolved nutrients and having a high oxygen content

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

PCB - Polychlorinated biphenyl

peaking mode - operational mode for a hydroelectric project that maximizes economic return by operating at maximum possible capacity during peak demand periods (generally 8 am to 8 pm) and reducing operations and discharge during non-peak periods

physiography - the science of physical geography (landform and texture)

plankton - floating or drifting organisms in a body of water

potamodromous - fish that migrate from fresh water lakes up fresh water rivers to spawn; in the context of this report it refers to fish that migrate into the St. Joseph River from Lake Michigan

riparian - owner of property that fronts on a river or lake

riverine - of or pertaining to a river

run habitat - fast non-turbulent water

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

salmonids - collective group of all trout and salmon in the family Salmonidae

salmonines - collective group of all trout, salmon, and whitefishes in the family Salmonidae

sessile - to be attached or associated with the substrate of a lake or stream

surficial - referring to something on or at the surface

SWQD - Surface Water Quality Division

synoptic - a condensed view of a subject (e.g. mussel distributions)

TFM - 3-trifluoromethyl-4-nitrophenol

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

till - a mix of glacial clay, sand, boulders, and gravel

throughflow - the act of water moving within soil (but not as part of an aquifer or groundwater)

turbidity - the measure of suspended sediments in the water column

USDA - United States Department of Agriculture

USGS - United States Geological Survey

valley segment - reaches of a river with similar ecological characteristics

veliger - the free-swimming larval stage of zebra mussels

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

REFERENCES

Albert, D.A., S.R. Denton, and B.V. Barnes. 1986. Regional landscape ecosystem of Michigan. University of Michigan, School of Natural Resources, Ann Arbor, Michigan.

Alexander, G.R. 1976. Diet of vertebrate predators on trout waters in northern central lower Michigan. Michigan Department of Natural Resources, Fisheries Division, Fisheries Research Report 1839, Ann Arbor, Michigan.

Alexander, G.R., J.L. Fenske, and D.W. Smith. 1995. A fishery management guide to stream protection and restoration. Michigan Department of Natural Resources, Fisheries Division, Special Report 15, Ann Arbor, Michigan.

Alexander, G.R., and E.A. Hansen. 1988. Decline and recovery of a brook trout stream following an experimental addition of sand sediment. Michigan Department of Natural Resources, Fisheries Division, Fisheries Research Report 1943, Ann Arbor, Michigan.

Anonymous. 1976. History of St. Joseph County, Michigan. L.H. Everts & Co., Philadelphia, Pennsylvania.

Anonymous. 1991. Studies of fish entrainment and St. Joseph River fish populations near the Constantine Hydroelectric Project. FERC Project 10661. EA Report 60160, Columbus, Ohio.

Bain, M.B, J.T. Finn, and H.E. Booke. 1988. Streamflow regulation and fish community structure. Ecology 69(2):382-392.

Ballard, R. 1948. Tales of early Niles. Niles Printing Co, Niles, Michigan.

Beam, J.D. and J.J. Braunscheidel. 1998. Rouge river assessment. Michigan Department of Natural Resources, Fisheries Division, Special Report 22, Ann Arbor, Michigan.

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

Bedell, D.J. 1982. Municipal water withdrawals in Michigan. Michigan Department of Natural Resources, Water Management, Lansing, Michigan.

Bedell, D.J. and R.L. Van Til. 1979. Irrigation in Michigan-1977. Michigan Department of Natural Resources, Water Management, Lansing, Michigan.

Bent, P.C. 1971. Influence of surface glacial deposits on streamflow characteristics of Michigan streams. United States Geological Survey, Lansing, Michigan.

Berry, T. 1992. Land use and stream discharge in Michigan's coldwater streams. Master's thesis. University of Michigan, Ann Arbor, Michigan.

Best, D.A. 1985. Evaluation of dredge disposal options at St. Joseph Harbor, Michigan. United States Department of the Interior, Fish and Wildlife Service, East Lansing, Michigan.

Blumer, S.P., T.E. Behrendt, J.M. Ellis, R.J. Minnerick, R.L. LeuVoy, and C.R. Whited. 1996. Water Resources Data Michigan Water Year 1995. United States Geological Survey Water-Data Report MI-95-1, Lansing, Michigan.

Brennan, P.O. and C. Stamm. 1991. Dowagiac river watershed nonpoint pollution inventory and implementation plan. United States Department of Agriculture, Saulk Trails RC&D Area Council, Mattawan, Michigan.

Brown, C.J.D. 1944. Michigan streams - their lengths, distribution and drainage areas. Michigan Department of Natural Resources, Fisheries Division, Miscellaneous Publication 1, Ann Arbor, Michigan.

Cada, G.F. 1990. A review of studies relating to the effects of propeller-type turbine passage on fish early life stages. North American Journal of Fisheries Management 10:418-426.

Cadwallader, P.L. 1986. Flow regulation in the Murray River system and its effect on the native fish fauna. Pages 115-34 i*n* I.C. Campbell, editor. Stream protection: the management of rivers for instream uses. Water Studies Centre, Chisholm Institute of Technology, East Caulfield, Australia. (as cited in Gordon et al. 1992).

Cummings, T.R. 1978. Agricultural land use and water quality in the upper St. Joseph River basin, Michigan. United States Department of the Interior, Geological Survey, Report 78-950, Lansing, Michigan.

Cunningham, W.M. 1961. Land of four flags - an early history of the St. Joseph River valley. Hardscrabble Books, Berrien Springs, Michigan.

Cushman, R.M. 1985. Review of ecological effects of rapidly varying flows downstream from hydroelectric facilities. North American Journal of Fisheries Management 5:330-339.

Davis, R.M. 1990. Paw Paw River times and people, Volume 1. Johnson Graphics, Decatur, Michigan.

Dewberry, T.C. 1992. Protecting the biodiversity of riverine and riparian ecosystems: the national river public land policy development project. Transactions of the 57th North American Wildlife and Natural Resources Conference. pp. 424-432.

Dexter, J.L. 1991a. East Branch Paw Paw River. Michigan Department of Natural Resources, Fisheries Division, Status of the Fishery Resources Report 91-16, Ann Arbor, Michigan.

Dexter, J.L. 1991b. A fisheries survey of the Paw Paw River, July 1989. Michigan Department of Natural Resources, Fisheries Division, Fisheries Technical Report 91-2, Ann Arbor, Michigan.

Dexter, J.L. 1991c. Brandywine Creek. Michigan Department of Natural Resources, Fisheries Division, Status of the Fishery Resources Report 91-11, Ann Arbor, Michigan.

Dexter, J.L. 1992a. Love Creek. Michigan Department of Natural Resources, Fisheries Division, Status of the Fishery Resources Report 92-2, Ann Arbor, Michigan.

Dexter, J.L. 1992b. Rocky River. Michigan Department of Natural Resources, Fisheries Division, Status of the Fishery Resources Report 92-4, Ann Arbor, Michigan.

Dexter, J.L. 1996. Dowagiac Creek. Michigan Department of Natural Resources, Fisheries Division, Status of the Fishery Resources Report 96-5, Ann Arbor, Michigan.

Dexter, J.L. and N.D. Ledet. 1995. Estimates of fish passage at St. Joseph River in 1993 using time-lapse video recording. Michigan Department of Natural Resources, Fisheries Technical Report 95-4, Ann Arbor, Michigan.

Doppelt, B., M. Scurlock, C. Frissell, and J. Karr. 1993. Entering the watershed. Island Press, Washington, DC.

Dodge, K. 1979. Chemical reclamation project statement, Dowagiac Creek, Cass County. Michigan Department of Natural Resources, Fisheries Division, Plainwell, Michigan.

Eaglin, G. S. and W.A. Hubert. 1993. Effects of logging and roads on substrate and trout in streams of the Medicine Bow National Forest, Wyoming. North American Journal of Fisheries Management 13: 844-846.

Edwards, E.A., D.A. Krieger, M. Bacteller, and O.E. Maughan. 1982. Habitat suitability index models: Black crappie. United States Department of the Interior, Fish and Wildlife Service. FWS/OBS-82/10.6, Washington, DC.

Edwards, E.A., G. Gebhart, and O.E. Maughan. 1983. Habitat suitability index models: Smallmouth Bass. United States Department of the Interior, Fish and Wildlife Service Biological Report 82 (10.36), Washington, DC.

Eggers, S.T, and D.M. Reed. 1987. Wetland plants and plant communities of Minnesota and Wisconsin. United States Army Corps of Engineers, St. Paul, Minnesota.

Eichenlaub, V.L. 1990. The climate atlas of Michigan. University of Notre Dame Press, Notre Dame, Indiana.

Ervin, J.L., D.P. Lusch, T.E. Zahniser, L.G. Wolfson, D.J. Mumby, K.D. Klomp. 1994. A study of ground water and groundwater/surface water interfaces in a priority agricultural watershed, Cass County, Michigan – Part A. Michigan State University, Institute of Water Research, East Lansing, Michigan.

Farrand, W.R. and D.F. Eschman. 1974. Glaciation of the southern peninsula of Michigan. Michigan Academician 7:31-56.

Federal Power Commission. 1974. Evaluation report, water resources appraisal for hydroelectric licensing: Mottville Development. Bureau of Power No. 401, Washington, DC.

FERC (Federal Energy Regulatory Commission). 1981. Planning status report, water resources appraisals for hydroelectric licensing: St. Joseph-Kalamazoo River Basin, Indiana-Michigan. Office of Electric Power Regulation, Chicago Regional Office, Chicago, Illinois.

FERC (Federal Energy Regulatory Commission). 1991. Buchanan hydroelectric project. FERC Project No. 25551-004, Fort Wayne, Michigan.

FERC (Federal Energy Regulatory Commission). 1996. Buchanan hydroelectric project. FERC Project No. 2551-004, Fort Wayne, Michigan.

FERC (Federal Energy Regulatory Commission). 1997. Environmental assessment for hydropower license: Star Milling and Electric Minor waterpower project. FERC Project No. 11291-001, Fort Wayne, Michigan.

Federal Insurance Administration, Federal Emergency Management Agency. 1991. National flood insurance program-community status book. United States Department of Housing and Urban Development, Washington, DC.

Fishbeck, Thompson, Carr & Huber, Inc. 1989. Water quality investigation for the St. Joseph River System. Ada, Michigan.

Fisher, B.E. 1998. Freshwater mussel survey of the Fawn River watershed in the vicinity of the Fawn River State Fish Hatchery. Indiana Department of Natural Resources, Division of Fish and Wildlife, Indianapolis, Indiana.

Fleming, T. 1995. Atlas of hydrogeologic terrains and settings of Indiana. Indiana Geological Survey, Bloomington, Indiana.

Gislason, J.C. 1985. Aquatic insect abundance in a regulated stream under fluctuating and stable diel flow patterns. North American Journal of Fisheries Management 5:39-46.

Goldman, C.R. and A.J. Horne. 1983. Limnology. McGraw-Hill, New York.

Gooding, M.P. 1995. A watershed classification scheme for lower Michigan. Master's thesis, University of Michigan, Ann Arbor, Michigan.

Gordon, N.D., T.A. McMahon, B.L. Finlayson. 1992. Stream hydrology: an introduction for ecologists. John Wiley and Sons, West Sussey, England.

GLFC (Great Lakes Fishery Commission). 1985. TFM vs. the sea lamprey: a generation later. Great Lakes Fishery Commission Special Publication 85-6. Ann Arbor, Michigan.

Gunderson, J. 1995. Rusty crayfish: a nasty invader. Minnesota Sea Grant, Duluth, Minnesota.

Hay-Chmielewski, E.M., P.W. Seelbach, G.E. Whelan, and D.B. Jester Jr. 1995. Huron River Assessment. Michigan Department of Natural Resources, Fisheries Division, Special Report 16, Ann Arbor, Michigan.

Hay-Chmielewski, E.M. and G.E. Whelan. 1997. Lake sturgeon rehabilitation strategy. Michigan Department of Natural Resources, Fisheries Division, Special Report Number 18, Ann Arbor, Michigan.

Holman, M.B., J.G. Brashler, and K.E. Parker. 1996. Investigating the archaeological record of the Great Lakes state. Western Michigan University, Kalamazoo, Michigan.

Horvath, T.G., W.L Perry, G.A. Lamberti, and D.M. Lodge. 1994. Zebra mussel dispersal in the St. Joseph River basin (Indiana-Michigan): lakes as sources for downstream dispersal. University of Notre Dame, Notre Dame, Indiana.

Hubbs, C.L. and K.F. Lagler. 1947. Fishes of the great lakes region. The University of Michigan Press, Ann Arbor, Michigan.

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

IDEM (Indiana Department of Environmental Management). 1996. Indiana 305 (b) Report, 1994-95. Indiana Department of Environmental Management, Indianapolis, Indiana.

IDNR (Indiana Department of Natural Resources). 1987. Water resource availability in the St. Joseph River Basin, Indiana. Indiana Department of Natural Resources, Division of Water, Water Resources Assessment 87-1, Indianapolis, Indiana.

IDNR (Indiana Department of Natural Resources). 1996. Indiana's rare plants and animals. Indiana Department of Natural Resources, Division of Nature Preserves, Indianapolis, Indiana.

Inskip, P.D. 1982. Habitat suitability index models: Northern pike. United States Fish and Wildlife Service Biological Report 82 (10.17), Washington, DC.

Johnson, S.A. and R.E. Madej. 1994. Reintroduction of the river otter in Indiana - feasibility study. Indiana Department of Natural Resources, Division of Fish and Wildlife. Bloomington, Indiana.

Junk, W.L., P.B. Bayley, and R.E. Sparks. 1989. The flood pulse concept in river-floodplain systems. *In* D.P. Dodge, editor. Proceedings of the international large river symposium. Canadian Special Publication of Fisheries and Aquatic Sciences 106.

Kehew, A.E., R.N. Passero, W.A. Sauck, W.T. Straw, C.K. Lovett, M.A. Stuk, M.A. Betts. 1994. A study of ground water and ground water/surface water interfaces in a priority agricultural watershed, Cass County, Michigan – Part B: Hydrology of the Donnell Lake watershed. Western Michigan University, Institute for Water Sciences, Kalamazoo, Michigan.

Kocik, J.F. 1992. Evaluation of juvenile brown trout and steelhead competition in Great Lakes tributaries. Michigan Department of Natural Resources, Fisheries Division, Fisheries Research Report 1989, Ann Arbor, Michigan.

Kotanchik, J.C. 1997. Large-scale distribution of river otters in Michigan's lower peninsula. Master's thesis. University of Michigan, Ann Arbor, Michigan.

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

Latta, W.C. 1995. Distribution and abundance of lake herring (*Coregonus artedi*) in Michigan. Michigan Department of Natural Resources, Fisheries Division, Fisheries Research Report 2007, Ann Arbor, Michigan.

Latta, W.C. 1996. Status of some of the endangered, threatened, special-concern, and rare fishes of Michigan in 1996. Michigan Department of Natural Resources, Wildlife Division, Natural Heritage Program, Lansing, Michigan.

Ledet, N.D. 1979. A fisheries survey of the St. Joseph River in St. Joseph and Elkhart counties, Indiana. Indiana Department of Natural Resources, Fisheries Section, Indianapolis, Indiana.

Ledet, N.D. 1984. St. Joseph River, St. Joseph and Elkhart Counties. Indiana Department of Natural Resources, Division of Fish and Wildlife, Indianapolis, Indiana.

Ledet, N.D. 1985a. Elkhart River Fishery Survey. Indiana Department of Natural Resources, Division of Fish and Wildlife, Indianapolis, Indiana.

Ledet, N.D. 1985b. St. Joseph River, St. Joseph and Elkhart Counties. Indiana Department of Natural Resources, Division of Fish and Wildlife, Indianapolis, Indiana.

Ledet, N.D. 1991a. Little Elkhart River, LaGrange and Elkhart counties. Indiana Department of Natural Resources, Division of Fish and Wildlife, Indianapolis, Indiana.

Ledet, N.D. 1991b. Solomon Creek, Elkhart County. Indiana Department of Natural Resources, Division of Fish and Wildlife, Indianapolis, Indiana.

Ledet, N.D. and L. Koza. 1986. Fish harvest, fishing pressure and species of fish sought by St. Joseph River fishermen. Indiana Department of Natural Resources, Division of Fish and Wildlife, Indianapolis, Indiana.

Lee, L.A. and J.W. Terrell. 1987. Habitat suitability index models: Flathead catfish. United States Department of the Interior, Fish and Wildlife Service, Biological Report 82 (10.152), Washington, DC.

Lineback, J.A., N.K. Blever, D.M. Mickelson, W.R. Farrand, and R.P. Goldthwait. 1983. Quaternary geologic map of the Chicago quadrangle, United States Department of the Interior, Geological Survey, Washington, DC.

Marenchin, G.L. and D.M. Sever. 1981. A survey of the fish of the St. Joseph River drainage in St. Joseph and Elkhart counties, Indiana. Indiana Academic Science 80: 454-460.

MAS Technology Corporation. 1991. St. Joseph River basin commission non-point source pollution study, June 1990. Environmental Health Laboratories, South Bend, Indiana.

McMahon, T.E. 1982. Habitat suitability index models: Creek chub. United States Department of the Interior, Fish and Wildlife Service, Biological Report 82 (10.4), Washington, DC.

McMahon, T.E., G., Gebhart, O.E. Maughan, and P.C. Nelson. 1984. Habitat suitability index models and instream flow suitability curves: Warmouth. United States Department of the Interior, Fish and Wildlife Service. FWS/OBS-82/10.67, Washington, DC.

Merna, J.W., J.C. Schneider, G.R. Alexander, W.D. Alward, and R.L. Eshenroder. 1981. Manual of fisheries survey methods. Michigan Department of Natural Resources, Fisheries Division, Fisheries Management Report 9, Ann Arbor, Michigan.

MDEQ (Michigan Department of Environmental Quality). 1995. Michigan fish contamination monitoring program: 1995 Report. Michigan Department of Environmental Quality, Surface Water Quality Division, MI/DEQ/SWQ-95/087, Lansing, Michigan.

MDEQ (Michigan Department of Environmental Quality). 1996a. Water quality and pollution control in Michigan: 1996 Report. Michigan Department of Environmental Quality, Surface Water Quality Division, Michigan 305(b) Report 14, Lansing, Michigan.

MDEQ (Michigan Department of Environmental Quality). 1996b. A biological survey of the St. Joseph River watershed Hillsdale, Calhoun, and Branch counties July-August, 1995. Michigan Department of Environmental Quality, Surface Water Quality Division, Report # MI/DEQ/SWQ-96/015, Lansing, Michigan.

MDEQ (Michigan Department of Environmental Quality). 1996c. A biological survey of Nottawa Creek, Calhoun County, August 1995. Michigan Department of Environmental Quality, Surface Water Quality Division, Report # MI/DEQ/SWQ-96/014, Lansing, Michigan.

MDEQ (Michigan Department of Environmental Quality). 1996d. A biological survey of the Dowagiac Creek and Dowagiac River watersheds Berrien, Cass, and Van Buren counties, Michigan 1991. Michigan Department of Environmental Quality, Surface Water Quality Division, Report # MI/DEQ/SWQ-96/006, Lansing, Michigan.

MDEQ (Michigan Department of Environmental Quality). 1997a. A biological survey of Christiana Creek, Cass County, July 1996. Michigan Department of Environmental Quality, Surface Water Quality Division, Report # MI/DEQ/SWQ-97/01, Lansing, Michigan.

MDEQ (Michigan Department of Environmental Quality). 1997b. A biological survey of the Dowagiac Creek and Dowagiac River watersheds Berrien, Cass, and Van Buren counties, Michigan 1996. Michigan Department of Environmental Quality, Surface Water Quality Division, Report # MI/DEQ/SWQ-97/074, Lansing, Michigan.

MDNR (Michigan Department of Natural Resources). 1959. Biological survey of the East and South Branches Paw Paw River, vicinity of Paw Paw, Van Buren County, Michigan; summer and fall, 1958. Michigan Department of Natural Resources, Surface Water Quality Division, Technical Report 00600, Lansing, Michigan.

MDNR (Michigan Department of Natural Resources).1969. Biological evaluation of Ox Creek, Benton Harbor, Michigan; June 3, 1969. Michigan Department of Natural Resources, Surface Water Quality Division, Technical Report 06400, Lansing, Michigan.

MDNR (Michigan Department of Natural Resources).1972a. A biological investigation of the Fawn River, vicinity of Sturgis, St. Joseph Co., Michigan, September 13-14, 1972. Michigan Department of Natural Resources, Surface Water Quality Division, Technical Report 02160, Lansing, Michigan.

MDNR (Michigan Department of Natural Resources).1972b. Biological investigation of Fawn River and Nye Drain, vicinity of Sturgis, Michigan; June 19, July 25, 1972. Michigan Department of Natural Resources, Surface Water Quality Division, Technical Report 63560, Lansing, Michigan.

MDNR (Michigan Department of Natural Resources).1974a. Background data on Hog Creek, Branch Co., Michigan, 1969-1973. Michigan Department of Natural Resources, Surface Water Quality Division, Technical Report 01490, Lansing, Michigan.

MDNR (Michigan Department of Natural Resources).1974b. Biological investigation of Love Creek, in the vicinity of Berrien Springs, Berrien Co., Berrien Township, T. 6 S., R. 17 W., Section 17; January 17, 1974. Michigan Department of Natural Resources, Surface Water Quality Division, Technical Report 02790, Lansing, Michigan.

MDNR (Michigan Department of Natural Resources).1977. A Biological Survey of Pipestone Creek, Berrien Co., Michigan; September 21 and October 31, 1977. Michigan Department of Natural Resources, Surface Water Quality Division, Technical Report 02790, Lansing, Michigan.

MDNR (Michigan Department of Natural Resources).1980. Stream assessment of Walton Creek, Berrien Co., Michigan, January 16 and April 22, 1980. Michigan Department of Natural Resources, Surface Water Quality Division, Technical Report 03580, Lansing, Michigan.

MDNR (Michigan Department of Natural Resources). 1982. Macroinvertebrate and fish survey of Little Portage Creek, vicinity of Mendon, September 8, 1982. Michigan Department of Natural Resources, Surface Water Quality Division, Technical Report 04170, Lansing, Michigan.

MDNR (Michigan Department of Natural Resources). 1983a. Water quality station inventory: a guide to Michigan water quality data in STORET. Michigan Department of Natural Resources, Surface Water Quality Division, Technical Report 3730-0032, Lansing, Michigan.

MDNR (Michigan Department of Natural Resources). 1983b. A biological and chemical survey of Craig Lake, Coldwater River, St. Joseph River and Union Lake, Branch Co., Michigan; August 5, 1982 through June 9, 1983. Michigan Department of Natural Resources, Surface Water Quality Division, Technical Report 04640, Lansing, Michigan.

MDNR (Michigan Department of Natural Resources). 1983c. Macroinvertebrate survey of the Paw Paw River, vicinity of Watervliet Paper Company, Watervliet, June 29, and November 30, 1982. Michigan Department of Natural Resources, Surface Water Quality Division, Technical Report 04210, Lansing, Michigan.

MDNR (Michigan Department of Natural Resources). 1985. Biological investigation of Pokagon Creek, Cass Co., April 9, 1985. Michigan Department of Natural Resources, Surface Water Quality Division, Technical Report 04860, Lansing, Michigan.

MDNR (Michigan Department of Natural Resources). 1986. Water Resources Commission. Act 245 of 1929; General Rules, Part 4. Water Quality Standards, Lansing, Michigan.

MDNR (Michigan Department of Natural Resources). 1987. Concentrations of PCB in fish, water, and sediment from the St. Joseph River, Michigan, 1972-1986. Michigan Department of Natural Resources, Surface Water Quality Division, Technical Report 87/045, Lansing, Michigan.

MDNR (Michigan Department of Natural Resources). 1990a. Assessment of the St. Joseph River for designation as a Great Lakes area of concern. Michigan Department of Natural Resources, Surface Water Quality Division, Technical Report 90/047, Lansing, Michigan.

MDNR (Michigan Department of Natural Resources). 1990b. Reference site scores for wadeable streams. Michigan Department of Natural Resources, Surface Water Quality Division, Technical Report 90/119, Lansing, Michigan.

MDNR (Michigan Department of Natural Resources). 1991a. A biological survey of the St. Joseph River in the vicinity of Hillsdale, Hillsdale Co., August 30, 1990. Michigan Department of Natural Resources, Surface Water Quality Division, Technical Report 91/076, Lansing, Michigan.

MDNR (Michigan Department of Natural Resources). 1991b. A biological survey of Fawn River St. Joseph County, Michigan, July 18, 1990. Michigan Department of Natural Resources, Surface Water Quality Division, MI/DNR/SWQ-91/089, Lansing, Michigan.

MDNR (Michigan Department of Natural Resources). 1991c. A biological survey of the Christiana Creek watershed, Cass County, Michigan; September 4-5, 1990. Michigan Department of Natural Resources, Surface Water Quality Division, Technical Report 91/096, Lansing, Michigan.

MDNR (Michigan Department of Natural Resources). 1991d. GLEAS Procedure #51: Qualitative biological and habitat survey protocols for wadeable streams and rivers. Michigan Department of Natural Resources, Surface Water Quality Division, Great Lakes Environmental Assessment Section, Lansing, Michigan.

MDNR (Michigan Department of Natural Resources). 1991e. A biological survey of the Coldwater River, Branch County; September 6-7, 1990. Michigan Department of Natural Resources, Surface Water Quality Division, Technical Report 91/083, Lansing, Michigan.

MDNR (Michigan Department of Natural Resources). 1991f. A biological survey of Nottawa Creek, St. Joseph and Calhoun Counties, Michigan; May 17, 1989. Michigan Department of Natural Resources, Surface Water Quality Division, Technical Report 91/081, Lansing, Michigan.

MDNR (Michigan Department of Natural Resources). 1997. Natural features of the St. Joseph River watershed. Michigan Department of Natural Resources, Wildlife Division, Michigan Natural Features Inventory, Lansing, Michigan.

Miller, S.W. 1996. At the waters edge: a selective history of the Saint Joseph River. Fernwood, Inc. South Bend, Indiana.

Moffett, J.W. 1940. The Dowagiac River system-its trout possibilities. Michigan Department of Natural Resources, Fisheries Division, Fisheries Research Report 577, Ann Arbor, Michigan.

Nelson, F.A. 1986. Effect of flow fluctuations on brown trout in the Beaverhead River, Montana. North American Journal of Fisheries Management 6:551-559.

Newbury, R.W., and M. Gaboury. 1988. The use of natural stream characteristics for stream rehabilitation works below the Manitoba escarpment. Canadian Water Resource Journal 13:35-51 (as cited in Gordon et al. 1992).

Peterson, J. 1965. Foods eaten by aquatic fish-eating birds. Michigan Department of Natural Resources, Fisheries Division, Fisheries Research Report 1708, Ann Arbor, Michigan.

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

Porter, G. 1996. Sauk/Coldwater rivers watershed management plan. Branch County Soil Conservation District, Coldwater, Michigan.

RES (RMC Environmental Services, Inc.). 1992. Study of steelhead and chinook salmon smolt outmigration in the St. Joseph River Buchanan Hydroelectric Project, Buchanan Michigan. Utility Consulting Division, Drumore, Pennsylvania.

Richards, R.P. 1990. Measures of flow variability and a new flow-based classification of Great Lakes tributaries. Journal of Great Lakes Research 16(1): 53-70.

Robins, C.R., R.M. Bailey, C.E. Bond, J.R. Brooker, E.A. Lachner, R.N. Lea, and W.B. Scott. 1991. Common and scientific names of fishes from the United States and Canada, 5th edition. American Fisheries Society Special Publication 20, Bethesda, Maryland.

Robertson, W., J. Dexter, and T. Behnke. 1985. Fish harvest, fishing pressure and species of fish sought by St. Joseph River fishermen. Indiana Department of Natural Resources, Fisheries Section, Division of Fish and Wildlife, Indianapolis, Indiana.

Schlosser, I.J. 1991. Stream fish ecology: a landscape perspective. BioScience 41(10):704-712.

Scott, W.B., and E.J. Crossman. 1973. Freshwater fishes of Canada. Bulletin 184. Fisheries Research Board of Canada, Ottawa, Canada.

Seelbach, P.W. 1989. Characteristics of adult steelhead populations, including returns of hatchery yearlings, in the St. Joseph and Grand rivers, Michigan, 1979-85. Michigan Department of Natural Resources, Fisheries Division, Fisheries Technical Report 89-3, Ann Arbor, Michigan.

Seelbach, P.W., J.L. Dexter, and N.D. Ledet. 1994. Performance of steelhead smolts stocked in southern Michigan warmwater rivers. Michigan Department of Natural Resources, Fisheries Division, Fisheries Research Report 2003, Ann Arbor, Michigan.

Seelbach, P.W., M.J. Wiley, J.C. Kotanchik, and M.E. Baker. 1997. A landscape-based ecological classification system for river valley segments in lower Michigan. Michigan Department of Natural Resources, Fisheries Division, Fisheries Research Report 2036, Ann Arbor, Michigan.

Shepherd, R. 1975. Inventory of fish and evaluation of water quality during minimum flow period in the St. Joseph River. Michigan Department of Natural Resources, Fisheries Division, Fisheries Technical Report 75-9, Ann Arbor, Michigan.

Sherman, R.A. 1997. The freshwater mussels (Bivalvia: Unionidae) of the St. Joseph and Kalamazoo rivers, Michigan. University of Michigan, Museum of Zoology/Mollusk Division, Ann Arbor, Michigan.

Sillman, S.I. 1931. St. Joseph in Homespun. Three Rivers Publishing Co., Three Rivers, Michigan.

Southwestern Michigan Commission. 1990. Bacteriological Water Quality in the lower St. Joseph River, Berrien County, Michigan. St. Joseph, Michigan.

Snow, G.E. 1974. A report of a fish die-off in the St. Joseph River, Benton Harbor, Michigan, during late July and early August, 1974. Andrews University, Berrien Springs, Michigan.

Stamm, C. and S.A. Bowman, 1990. Christiana Creek nonpoint pollution control plan. United States Department of Agriculture, Saulk Trails RC&D Area Council, Mattawan, Michigan.

Statzner, B. and B. Higler. 1986. Stream hydraulics as a major determinant of benthic invertebrate zonation patterns. Freshwater Biology 16: 127-139.

Stefanavage, T.C. 1986a. Evaluation of smallmouth bass stocking in Pigeon River 1985: Progress report. Indiana Department of Natural Resources, Division of Fish and Wildlife, Fisheries Section, Indianapolis, Indiana.

Stefanavage, T.C. 1986b. Benthic invertebrate collections from the Eel and Pigeon rivers. Indiana Department of Natural Resources, Division of Fish and Wildlife, Fisheries Section, Indianapolis, Indiana

Stefanavage, T.C. 1987. Evaluation of smallmouth bass stocking, native populations, and habitat at Pigeon River: 1986. Completion Report. Indiana Department of Natural Resources, Division of Fish and Wildlife, Fisheries Section, Indianapolis, Indiana.

Stefanavage, T.C. 1988. Assessment of smallmouth bass populations at five northern Indiana rivers. Indiana Department of Natural Resources, Division of Fish and Wildlife, Fisheries Section, Indianapolis, Indiana.

Stefanavage, T.C. 1989. Assessment of smallmouth bass populations and habitat at three northern Indiana rivers. Indiana Department of Natural Resources, Division of Fish and Wildlife, Fisheries Section, Indianapolis, Indiana.

Stefanavage, T.C. 1990. Evaluation of smallmouth bass year class strength and population size at three northern Indiana rivers. Indiana Department of Natural Resources, Division of Fish and Wildlife, Fisheries Section, Indianapolis, Indiana.

Stuber, R.J., G. Gebhart, and O.E. Maughan. 1982a. Habitat suitability index models: Bluegill. United States Department of the Interior, Fish and Wildlife Service Biological Report 82 (10.8), Washington, DC.

Stuber, R.J., G. Gebhart, and O.E. Maughan. 1982b. Habitat suitability index models: Green sunfish. United States Department of the Interior, Fish and Wildlife Service Biological Report 82 (10.15), Washington, DC.

Swinford, T.O. 1997. Indiana's other endangered species. Outdoor Indiana 62:6.

Taube, C.M. and E.E. Schultz. 1966. Fish populations in five polluted streams in southern Michigan. Michigan Department of Natural Resources, Fisheries Division, Fisheries Research Report 1720, Ann Arbor, Michigan.

Towns, G.L. 1988. A fishery survey of the upper St. Joseph River Basin, July and August, 1987. Michigan Department of Natural Resources, Fisheries Division, Fisheries Technical Report 88-12, Ann Arbor, Michigan.

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

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

Trial, J.G., J.G. Stanley, M. Batcheller, G. Gebhart, O.E. Maughan, P.C. Nelson, R.F. Raleigh, and J.W. Terrell. 1983. Habitat suitability index models: Blacknose dace. United States Department of the Interior, Fish and Wildlife Service Biological Report 82 (10.41), Washington, DC.

Turner, T.G. 1867. Gazetteer of the St. Joseph Valley, Michigan and Indiana, with a review of its hydraulic and business capacities. Hazlett and Reed Printers, Chicago, Illinois.

Twomey, K.A., K.L. Williamson, P.C. Nelson, and C. Armour. 1984. Habitat suitability index models and instream flow suitability curves: White sucker. United States Department of the Interior, Fish and Wildlife Service Biological Report 82 (10.64), Washington, DC.

USDA (United States Department of Agriculture). 1975. Elkhart River basin comprehensive basin study: general soils map. 5,R-29, 837.

USDA (United States Department of Agriculture). 1985. Michigan tributaries of the St. Joseph River basin report. United States Department of Agriculture, Economic, Forest, and Soil Conservation Services, Paw Paw, Michigan.

USGS (United States Geological Survey). 1990. Annual peak flow frequency analysis for the St. Joseph River at Niles. Water Resources Division, Lansing, Michigan.

Van Til, R., and G. Scott. 1986. Water use for thermoelectric power generation in Michigan. Michigan Department of Natural Resources and United States Department of Interior, Geological Survey, Lansing, Michigan.

Van der Schalie, H. 1930. The clamming industry of the St. Joseph River. Michigan Department of Natural Resources, Fisheries Division, Fisheries Research Report 38, Ann Arbor, Michigan.

Voss, E.G. 1985. Michigan flora. University of Michigan, Ann Arbor.

Ward, J.V. 1984. Ecological perspectives in the management of aquatic insect habitat. Pages 558-577 *in* V.H. Resh and D.M. Rosenberg, editors. The ecology of aquatic insects. Praeger, New York. (as cited in Gordon et al. 1992).

Warbach, J.D., M. A. Wyckoff, and K. Williams. 1990. Protecting inland lakes: a watershed management guidebook. Case Studies: Part IV. Planning & Zoning Center, Inc. Lansing, Michigan.

Waters, T.F. 1995. Sediment in streams: sources, biological effects, and control. American Fisheries Society Monograph 7, Bethesda, Maryland.

Wiley, M.J. and P.W. Seelbach. 1997. An introduction to rivers – the conceptual basis for the Michigan Rivers Inventory (MRI) Project. Michigan Department of Natural Resources, Fisheries Division, Fisheries Special Report 20, Ann Arbor, Michigan.

Williams, S. 1998. Nottawa Creek watershed plan. Calhoun Conservation District, Marshal, Michigan.

Ziegler, R. L. 1988. Stream resource utilization of sympatric and allopatric juvenile brown (*Salmo trutta*) and steelhead trout (*Salmo gairdneri*). Michigan Department of Natural Resources, Fisheries Division, Fisheries Research Report 1957, Ann Arbor, Michigan.

Table 1.–Number of archeological sites within St. Joseph River basin, listed by valley segment and congressional township. Data from B. Mead, Office of the State Archaeologist, personal communication.

Segment and county	Township	Number of sites
Headwaters		
Hillsdale	T5S, R4W	4
Hillsdale	T6S, R2W	1
Hillsdale	T6S, R4W	1
Upper		
Branch	T5S, R5W	4
Branch	T5S, R6W	6
Branch	T5S, R7W	2
Branch	T5S, R8W	3
Branch	T6S, R5W	4
Branch	T7S, R5W	1
Branch	T6S, R6W	10
Branch	T6S, R7W	3
Branch	T6S, R8W	5
Branch	T7S, R6W	6
Cass	T4S, R7W	2
St. Joseph	T6S, R9W	44
St. Joseph	T5S, R9W	66
Middle		
Kalamazoo	T2S, R9W	1
Kalamazoo	T3S, R9W	16
St. Joseph	T5S, R10W	19
Kalamazoo	T3S, R10W	70
Kalamazoo	T4S, R9W	2
Kalamazoo	T4S, R10W	9
Kalamazoo	T4S, R11W	21
St. Joseph	T5S, R11W	7
Kalamazoo	T4S, R12W	17
St. Joseph	T5S, R12W	1
Cass	T5S, R13W	6
Cass	T6S, R13W	2
Branch	T7S, R8W	5
Branch	T8S, R13W	3
Branch	T8S, R7W	4
St. Joseph	T6S, R12W	1
St. Joseph	T7S, R9W	1
St. Joseph	T6S, R10W	4
St. Joseph	T6S, R11W	3
St. Joseph	T7S, R10W	1
St. Joseph	T7S, R11W	1
St. Joseph	T7S, R12W	1
St. Joseph	T8S, 12W	3

Table 1.–Continued.

Segment and county	Township	Number of sites
Cass	T7S, R13W	4
Cass	T8S, R13W	7
Cass	T6S, R14W	10
Cass	T7S, R14W	4
Lower		
Berrien	T8S, R17W	15
Van Buren	T4S, R13W	1
Van Buren	T4S, R14W	2
Cass	T5S, R14W	12
Cass	T5S, R15W	3
Cass	T5S, R16W	5
Cass	T6S, R16W	10
Cass	T6S, R15W	10
Cass	T7S, R15W	9
Cass	T7S, R16W	8
Cass	T8S, R15W	3
Berrien	T7S, R17W	24
Berrien	T7S, R17W	29
Berrien	T8S, R18W	9
Berrien	T6S, R17W	19
Berrien	T6S, R18W	18
Berrien	T5S, R17W	40
Berrien	T5S, R18W	25
Mouth		
Berrien	T6S, R19W	4
Berrien	T5S, R19W	14
Berrien	T4S, R17W	2
Berrien	T4S, R18W	4
Berrien	T4S, R19W	11

Table 2.–St. Joseph River and tributary average discharge summary. Watershed area corresponds to area upstream of each gauge location. Data from United States Geological Survey.

Segment and river	Location	Average discharge (cfs)	Watershed area (mi^2)	Discharge per mi^2
Headwaters				
Beebe Creek	Hillsdale	35.8	42.4	0.84
Soap Creek	Litchfield	11.9	10.9	1.09
St. Joseph	Burlington	177.0	206.0	0.86
Upper				
Hog Creek	Allen	43.4	48.7	0.89
Coldwater River	Hodunk	252.6	293.0	0.86
Nottawa Creek	Athens	153.0	162.0	0.94
Middle				
Gourdneck Canal	Schoolcraft	4.7	7.3	0.64
Portage River	Vicksburg	59.2	68.2	0.87
St. Joseph	Three Rivers	1177.0	1350.0	0.87
Prairie	Nottawa	97.3	106.0	0.92
Fawn River	White Pigeon	159.1	192.0	0.82
St. Joseph	Mottville	1643.0	1866.0	0.88
Pigeon Creek	Angola	81.9	106	0.77
Pigeon	Scott	367.0	361.0	1.02
Little Elkhart	Middlebury	102.0	97.6	1.05
Pine Creek	Elkhart	19.7	31.0	0.54
Rimmell Branch	Albion	10.8	10.7	1.01
N.B. Elkhart	Cosperville	141.0	142.0	0.99
Solomon Creek	Syracuse	36.3	36.1	1.01
Forker Creek	Burr Oak	17.9	19.2	0.93
Elkhart	Goshen	537.0	594.0	0.90
Lower				
Juday Creek	South Bend	22.9	38.0	0.60
St. Joseph	Niles	3403.0	3666.0	0.93
Dowagiac	Sumnerville	300.0	255.0	1.18
St. Joseph River	Berrien Springs	3928.0	4081.0	0.96
Mouth				
Paw Paw	Riverside	462.0	390.0	1.18
St. Joseph	Benton Harbor	4598.0	4670.0	0.98

Table 3a.–Flow stability indices in the St. Joseph River watershed, calculated from miscellaneous and short-time frame stream flow data. Numbers bolded indicate poor flow stability. Data from United States Geological Survey.

Location	Flow index*	Classification
Headwaters		
St. Joseph River @ Burlington	5.9	fair
Upper		
Hog Creek @ Allen	**12.2**	poor
Coldwater River @ Hodunk	**10.5**	poor
Nottawa Creek @ Athens	4.4	good
Middle		
Gourdneck Canal	3.6	good
St. Joseph @ Three Rivers	4.2	good
Prairie River @ Nottawa	4.4	good
St. Joseph River @ Mottville	3.9	good
Pigeon River near Scott	4.9	good
Pigeon Creek	7.6	fair
Little Elkhart River	4.3	good
Pine Creek	4.0	good
Forker Creek	**36.3**	poor
Rimmell Branch	**35.8**	poor
Solomon Creek	3.2	good
Turkey Creek	**23.5**	poor
North Branch Elkhart	7.5	fair
Elkhart River @ Goshen	6.4	fair
St. Joseph River @ Elkhart	3.8	good
Lower		
St. Joseph River @ Niles	3.5	good
Dowagiac River	2.6	good
Mouth		
Paw Paw River @ Riverside	3.0	good

* Flow index is calculated using the ratio between mean high flow to mean low flow. The highest mean monthly flow and lowest mean monthly flow for a year are averaged for several years at a specific site to calculate the overall mean high and low flows

Table 3b.–Definition of flow stability indices using ratio of mean high flow to mean low flow. Data from P. Seelbach, Michigan Department of Natural Resources, Fisheries Division.

Flow index	Classification	Description
1.0 - 2.0	very good	typical of self sustaining trout streams
2.1-5.0	good	better warmwater rivers
5.1-10	fair	somewhat flashy warmwater rivers
>10	poor	very flashy warmwater river

Table 4.–Communities participating in the National Flood Insurance Program. Data from Federal Insurance Administration, Federal Emergency Management Agency (1991).

Segment and community name	County	Date of current map
Headwaters		
City of Hillsdale	Hillsdale	1988
City of Litchfield	Hillsdale	1987
Burlington Township	Calhoun	1987
Upper		
Coldwater Township	Branch	
City of Coldwater	Branch	
Colon Township	St. Joseph	1988
Village of Colon	St. Joseph	1988
City of Athens	Calhoun	
Eckford Township	Calhoun	1986
Fredonia Township	Calhoun	1987
Newton Township	Calhoun	1986
Leroy Township	Calhoun	1967
Mendon Township	St. Joseph	1987
Middle		
Oshtemo Charter Township	Kalamazoo	
Village of Vicksburg	Kalamazoo	1987
Nottawa Township	St. Joseph	1989
City of Three Rivers	St. Joseph	1990
Village of Centreville	St. Joseph	1988
Lockport Township	St. Joseph	1989
Fabius Township	St. Joseph	1988
Village of Constantine	St. Joseph	1986
Village of Vandalia	Cass	1979
Village of Edwardsburg	Cass	1979
Village of Cassopolis	Cass	1979
Lower		
City of Niles	Berrien	1987
Niles Township	Berrien	1986
Silver Creek Township	Cass	1988
City of Dowagiac	Cass	
LaGrange Township	Cass	1986
City of Buchanan	Berrien	1975
Buchanan Township	Berrien	1976
Village of Berrien Springs	Berrien	1986
Berrien Township	Berrien	1988
Oronoko Township	Berrien	1986
Royalton Township	Berrien	1977
Sodus Township	Berrien	1978

Table 4.–Continued.

Segment and community name	County	Date of current map
Mouth		
Lake Township	Berrien	1979
Lincoln Township	Berrien	1978
Almena Township	Van Buren	
Arlington Township	Van Buren	1985
Village of Paw Paw	Van Buren	1979
City of Watervliet	Berrien	1983
Watervliet Township	Berrien	1983
City of Coloma	Berrien	1980
Coloma Township	Berrien	1984
Hagar Township	Berrien	1977
City of Benton Harbor	Berrien	1978
Benton Township	Berrien	1978
City of St. Joseph	Berrien	1978
St. Joseph Township	Berrien	1980

Table 5.–Actual and expected channel widths, in feet, for gauge sites within the St. Joseph River. Numbers in bold indicate stream width is significantly smaller than expected width based on average discharge. Data from United States Geological Survey, 1995. Width and discharge (Q) measurements were used to calculate expected width as follows:

Lower 95% width = 10^(0.662895 + (0.471522*log(Q)));
Expected mean width = 10^(0.741436 + (0.498473*log(Q)));
Upper 95% width = 10^(0.819976 + (0.525423*log(Q))).

Segment and river	Width (ft)	Average discharge (cfs)	Lower 95% width (ft)	Expected mean width (ft)	Upper 95% width (ft)
Headwaters					
St. Joseph	66	177.0	52.9	72.8	100.3
Upper					
Nottawa Creek	63	153.0	49.3	67.7	92.9
Hog Creek	28	43.4	27.2	36.1	47.9
Middle					
St. Joseph	180	1177.0	129.1	187.1	271.3
Prairie	56	97.3	39.8	54.0	73.2
St. Joseph	275	1643.0	151.1	221.0	323.3
Pigeon	82	251.0	61.6	85.7	119.2
Pigeon Creek	**28**	52.4	29.8	**39.7**	52.9
Little Elkhart	42	93.1	37.8	51.1	69.2
Pine Creek	20	14.8	15.6	20.1	25.9
Forker Creek	**15**	23.4	16.2	**21.2**	27.7
Rimmell Branch	9	2.5	6.5	7.9	9.8
Solomon Creek	26	37.2	24.2	31.9	42.2
Elkhart	52	121.0	42.5	58.0	79.1
Elkhart	147	664.0	90.2	128.8	184.1
St. Joseph	364	3006.0	192.2	285.8	425.0
Lower					
Juday Creek	**18**	21.2	19.0	**24.7**	32.2
St. Joseph	220	3403.0	212.9	317.7	473.9
Dowagiac	**48**	300.0	67.8	**94.7**	132.3
Mouth					
Paw Paw	**75**	462.0	83.1	**117.4**	166.0

Table 6.–Information on St. Joseph River dams and impoundments. Dam purpose: flood control (C), hydroelectric (H), retired hydroelectric (RH), irrigation (I), recreation (R), water supply (S), or other (O). Hazard type: 1=high, 2=significant, and 3=low. High hazard--loss of life would occur; significant hazard--large amounts of property damage would occur. Blanks indicate no data available. Data from Michigan Department of Environmental Quality, Land and Water Management Division and Indiana Department of Natural Resources, Division of Water.

Segment and dam name	Stream	Date built	Current purpose	Owner	Head (ft)	Surface acres	Storage (acre-ft)	Average depth (ft)	Hazard type
Headwaters									
Baw Beese Lake Control	St. Joseph River	1837	R	City	12	11	20	1.8	2
Hillsdale College Dam	St. Joseph River		O	College	3	2	0	0.0	3
Lewis Emery County Park #2	St. Joseph River tributary	1934	O	County	8	47	150	3.2	3
Lake Bel Air Control	Beebe Creek	1966	R	Private	8	103	412	4.0	3
Jonesville Millpond Dam	St. Joseph River	1872	R	City	7	35	90	2.6	3
Litchfield Dam	St. Joseph River	1846	O	City	5	13	26	2.0	3
Loveles Dam	No Name Creek	1972	R	Private	6	1	14	14.0	3
Randall Milling Dam	St. Joseph River	1836	O	Private	5	20	40	2.0	3
Mc Gee Dam	St. Joseph River	1957		Private	5	1	0	0.0	3
Upper									
Coldwater Lake Control	Coldwater River	1962	R	County	1	1610	0	0.0	3
Rose Lake Control	Betts Drain	1959	R	County	1	355	0	0.0	3
Little Rose Lake Dam	Little Rose Lake outlet	1960	R	County	2	14	12	0.9	3
Marble Lake Dam	Coldwater River	1962	O	County	4	780	1968	2.5	3
Randalls Dam	Coldwater River	1838	R	City	5	14	50	3.6	2
Blackhawk Dam	Coldwater River	1830	R	County	13	200	1020	5.1	3
Hog Creek Dam	Hog Creek		R	County	2	386	112	0.3	3
Union Lake (Riley Dam)	St. Joseph River	1900	H	City	16	518	3240	6.3	2
Trine Dam	Otto Drain	1960	R	Private	6	2	5	2.5	3
Briskey Pond Dam	Bowen Creek	1970	R,O	Private	1	5	20	4.0	2
Hanchett Lake Control	Hanchett Lake outlet	1967	R	County	1	25	10	0.4	3
Stancer Dam	Coldwater River	1835	R	Private	3	4		0.0	3

Table 6.–Continued.

Segment and dam name	Stream	Date built	Current purpose	Owner	Head (ft)	Surface acres	Storage (acre-ft)	Average depth (ft)	Hazard type
Maxsons Dam	Hog Creek	1875		Private	1	2	0	0.0	3
Sharpe Dam	Hog Creek	1900	O	Private	2	3	2	0.7	
Matteson Lake Control	Swan Creek	1966	R	County	2	256	245	1.0	3
Swan Creek Dam	Swan Creek			County	1	5	0	0.0	3
Palmer and Long Lake Control	Swan River	1839	RH	City	8	670	2400	3.6	3
Rearing Pond Dam	St Joseph River tributary			City	1	3	0	0.0	3
Cotton Lake Dam	Cotton Lake outlet			Private					
Athens Dam	Nottawa Creek	1956	R	City	13	1	2	2.0	3
Nottawa Lake Control	Nottawa Creek	1964	R	Private	2	138	110	0.8	3
Leonidus Roller Mill Dam	Nottawa Creek	1880	R	Private	9	1	80	80.0	3
Kings Mill Dam	Nottawa Creek	1836	R	County	8	23	110	4.8	3
Beaver Lake Control	Beaver Drain		R,O	County	2	166	43	0.3	3
Middle									
Three Rivers Dam	St. Joseph River	1917	H	Private	12	240	3650	15.2	1
Sturgis Dam	St. Joseph River	1912	H	City	26	480	6550	13.6	1
Taylor Dam	Portage River		R	Private	4	42	67	1.6	3
Scotts Dam	Scotts Creek	1859	R	County	15	8	170	21.3	2
Cooks Mill Dam	Portage River	1870	R	Private	16	100	100	1.0	2
Sunset Lake	Portage Creek	1850	S	Private	11	97	320	3.3	
Sugarloaf Lake	Sugarloaf Lake outlet	1937	O	Private	5	1	1	1.0	3
Portage Plant Dam	Portage River	1922	RH	Private	12	81	900	11.1	1
Parkville Dam	Portage River		O	Private	1	1	0	0.0	3
Pollack Dam	Pollocks Pond outlet	1920	RH	Private	6	1	0	0.0	3
No Name	Rocky River		O	Private	1	5	0	0.0	3
Streater Mill Dam	Rocky River	1840	R	Private	10	4	20	5.0	2
Pyle Dam	Shelden Creek	1960	O	Private	4	1	1	1.0	3
Fox and Bears Dam	Flowerfield Creek	1840	RH	Private	8	5	20	4.0	3

Table 6.–Continued.

Segment and dam name	Stream	Date built	Current purpose	Owner	Head (ft)	Surface acres	Storage (acre-ft)	Average depth (ft)	Hazard type
Flowerfield Dam	Flowerfield Creek	1850	R	City	5	6	35	5.8	3
Corey Lake Control	Corey Lake outlet	1974	R	Private	1	567	215	0.4	3
Pleasant Lake Control	Pleasant Lake outlet	1968	R	Private	2	262	210	0.8	3
Mayes Dam	Four County Drain			Private	1	2	0	0.0	3
Kaiser Lake Control	Kaiser Lake outlet			Private	1	89	0	0.0	
Springs Mill Dam	Kerr Creek		O	Private	6	4	12	3.0	
Leverence Dam	Kerr Creek	1920	O	Private	8	5	0	0.0	
Harwood Lake Control	Harwood Lake outlet	1932	R	County	3	129	155	1.2	
Fish Lake	Unnamed		C						
Perry Dam	Omena Lake outlet	1967	R	Private	2	2	0	0.0	
Teeny Tiny Lake Dam	Spring Creek		R	Private	3	1	1	1.0	
Lake Templene Dam	Prairie River	1972	R	Private	14	950	5225	5.5	2
Centreville Dam	Prairie River	1890	H	Private	7	37	100	2.7	
Brown Lake Dam	Brown Lake outlet	NA	R	Private	12				
Jimmerson Lake Dam	Crooked Creek	1945	C,R	IDNR	13	305		0.0	
Crooked Lake	Crooked Lake outlet		C,R	Private					
Lake Gage	Lake Gage outlet		C,R	Private					
Lake George	Crooked Creek	1927	C,R	Private	15	538		0.0	
Fawn R. Fishery D.@ Orland	Fawn River		O	IDNR	10	2		0.0	
Mud Lake	Fawn River		R	Private	14				
Wall Lake	Fawn River		R	Private					
Greenfield Mills Dam	Fawn River	1835	H	Private	27	13		0.0	
Fawn River Mill Dam	Fawn River	1830	H	Private	5	15	55	3.7	3
Star Mill Dam	Fawn River		H	Private	6				
Klinger Lake Control	Fawn River	1969	R	Private	2	830	665	0.8	
Upper Constantine Dam	Fawn River	1948	RH	Private	9	90	404	4.5	1
Fawn River Power Company	Fawn River	1830	R	City	13	100	160	1.6	

Table 6.–Continued.

Segment and dam name	Stream	Date built	Current purpose	Owner	Head (ft)	Surface acres	Storage (acre-ft)	Average depth (ft)	Hazard type
Mottville Dam	St. Joseph River	1923	H	Private	11	487	3570	7.3	1
Constantine Hydro Dam	St. Joseph River	1873	H	Private	12	555	2800	5.0	1
Hartenstene Dam	Mill Creek	1912	RH	Private	21	69	600	8.7	
Gordon T. Anderson Earthen	Pigeon Creek		S,R	Private	18	25		0.0	
Fox Lake	Pigeon Creek		C,R	Private					
Silver Lake Control Structure	Silver Lake outlet		C	IDNR					
Otter Lake (West)	Pigeon Creek		R	Private					
Lake Of The Woods	Turkey Creek		C,R	Private					
Mongo Reservoir Dam	Pigeon River	1920	R	IDNR	17	73		0.0	
Lake of The Woods	Lake of the Woods outlet								
Big Long Lake	Big Long Lake outlet		R	Private					
Pretty Lake	Pretty Lake outlet		R	IDNR					
Big Turkey Lake	Turkey Creek		R	IDNR					
Nasby Lake Dam	Pigeon River	1925	R	IDNR	17	40		0.0	
Ontario Millpond Dam	Pigeon River	1920	R	IDNR	15	100		0.0	
North Twin Lake	North Twin Lake outlet		R	Private					
Pigeon River Dam	Pigeon River		R	IDNR					
Shipshewana Lake	Page Ditch		R	IDNR					
Stone Lake	Stone Lake outlet		R	Private					
Fish Lake Nr. Scott	Fish Lake outlet		R	Private					
Adams Lake	Little Elkhart Creek	1952	R	IDNR					
Cliff Pettit Dam	Little Elkhart Creek		S	Private	8				
Little Elkhart River Dam	Little Elkhart River		H	Private					
Birch Lake Control	Birch Lake outlet	1885	R	Private	1	300	120	0.4	3
Shavehead Lake Control	Mud Creek	1960	R	County	3	93	260	2.8	3
Lower Stamp Dam	Mud Creek	1988		Private	5	2	4	2.0	3
Upper Stamp Dam	Mud Creek	1988		Private	11	1	2	2.0	

Table 6.–Continued.

Segment and dam name	Stream	Date built	Current purpose	Owner	Head (ft)	Surface acres	Storage (acre-ft)	Average depth (ft)	Hazard type
Williamsville Mill Dam	Mud Creek	1885	R	Private	1	7	0	0.0	
Depa Dam	Sweets Creek	1960		Private	7	14	0	0.0	
No Name	Trout Creek		O	Private	5	16	10	0.6	3
Centenial Mill Dam	Mud Creek	1895	RH	Private	7	13	70	5.4	
Blackman Lake	Adams Lake		R	Private					
High Lake	Carrol Creek		R	Private					
Messick Lake	Elkhart River		R	IDNR					
Rivir Lake Control	Forker Creek		R	IDNR					
Oliver Lake	Oliver Lake outlet		R	IDNR					
Bear Lake	Unnamed		R	IDNR					
Bixler Lake	Bixler Lake Ditch		R	City					
Skinner Lake	Croft Ditch		R	IDNR					
Lake Barbara Dam	Elkhart River	1979	R	Private	11				
Lower Long Lake	Elkhart River		R	County					
Richard Grieger Lake	Elkhart River		R	Private					
Latta Lake	Latta Lake outlet		R	Private					
Marvin Morgan Dam	Offstr-Croft Ditch	1973	S,R	Private	18				
Lake Maxler Dam	Round Lake	1964	R	Private	20	26		0.0	
Sylvan Lake Dam	Sylvan Lake outlet	1837	R	Private	30				
Little Long Lake	Waterhouse Ditch	1969	R	Private					
Waldron Lake (West Lakes)	Elkhart River		R	IDNR					
Flatbelly Lake Dam	Flatbelly Lake outlet	1962	O	Private	17	3		0.0	
Papakeechie Lake	Papakeechie Lake	1913	R	Private	10	178		0.0	
Shock Lake Dam	Shock Lake outlet		R	IDNR	6	35		0.0	
Dewart Lake	Hammond Ditch	1965	R	Private					
Syracuse Lake	Turkey Creek		R	City					
Benton Dam	Elkhart River		R	County	4				

Table 6.–Continued.

Segment and dam name	Stream	Date built	Current purpose	Owner	Head (ft)	Surface acres	Storage (acre-ft)	Average depth (ft)	Hazard type
Bainter Town Dam	Elkhart River		R	County	4				
Bainter Town Hydro Plant	Elkhart River		H	County	18				
Goshen Pond Dam	Elkhart River	1868	R	County	16	122		0.0	
Elkhart River Dam	Elkhart River		R	City	10				
Bonneyville Mill Dam	Elkhart River		R	County					
Heaton Lake Control	Puterbaugh Creek		R	Private					
Elkhart Dam	St. Joseph River	1913	H	Private	28				
Diamond Lake Dam	Christiana Creek	1968	O	Private	3	680	816	1.2	3
Adamsville Mill Dam	Christiana Creek	1865	H,R	City	8	398	1590	4.0	1
Eagle Lake Level Control	Eagle Lake outlet	1989	R	Private	2	288	230	0.8	3
Lower									
Twin Branch Plant Dam	St. Joseph River	1904	H	Private	33				
South Bend Dam	St. Joseph River	1930	C	City	12				
Warton Lake (Goodman)	Unnamed		R	Private					
Garver Lake Control	Garver Lake outlet	1959	R	Private	2	44	35	0.8	3
Niles French Paper Dam	St. Joseph River	1887	H	Private	13	80	510	6.4	1
Lake of the Woods Control	Lake of the Woods Drain	1952	R	County	1	265	105	0.4	3
Priest Lake Control	Priest Lake outlet	1974	R	Private	7	15	70	4.7	3
Magician Lake Control	Silver Creek	1964	R	Private	2	498	55	0.1	3
Meyer Dam	Dowagiac Creek	1957	I	Private		1		0.0	3
Finch Lake Control	Dowagiac Creek	1941	R	County	1	114	0	0.0	3
Gravel Lake Control	Gravel Lake outlet	1950	R	Private	2	296	235	0.8	3
Benedict Mill Dam	Dowagiac Creek	1895	R	Private	11	7	30	4.3	3
LaGrange Lake Dam	Dowagiac Creek	1835	R	Private	8	600	1920	3.2	2
Upper Mill Dam	Dowagiac Creek	1970	R	Private	11	125	700	5.6	1
Lower Mill Dam	Dowagiac Creek	1826	R	City	8	6	30	5.0	1
Arthur Dodd Roadside Dam	Dowagiac River	1980		County	4				3

Table 6.–Continued.

Segment and dam name	Stream	Date built	Current purpose	Owner	Head (ft)	Surface acres	Storage (acre-ft)	Average depth (ft)	Hazard type
Graber Dam	Mud Lake Ext Drain	1990	R	Private	4	2			3
Glover Dam	Kimmerlee Creek	1965	Removed	Private	4	5	0	0.0	3
Pucker Street Dam	Dowagiac River	1928	RH	City	22	49	580	11.8	1
Neib Dam	McKinzie Creek			Private	1	18	0	0.0	3
Buchanan Dam	St. Joseph River	1902	H	Private	13	300	2000	6.7	1
Christie Dam	Madron Lake outlet	1966	R	Private	1	3	18	6.0	3
McCoy Creek Dam	McCoy Creek	1919	O	Private	4	2	3	1.5	3
Trickett Dam	Painter Creek	1969	R	Private	8	28	91	3.3	3
Berrien Springs Dam	St. Joseph River	1908	H	Private	24	600	5500	9.2	1
Fisher Dam	Farmsers Creek	1972		Private	1	1	0	0.0	3
Oronoko Lakes Dam	Lemon Creek			Private	1	20	0	0.0	3
Storick Dam	Lemon Creek	1967	I	Private	6	4	30	7.5	3
Andres Dam	Love Creek	1959	I	Private	1	1	1	1.0	3
Rowe Lake Control	Pipestone Creek	1970	R	County	3	31	37	1.2	3
Andres Dam	Pipestone Creek	1959	I	Private	8	1	1	1.0	3
Mouth									3
Wolf Lake Fish Hatchery	Campbell Creek	1930	O	MDNR	6	51	56	1.1	3
Old Masonry Dam	Hayden Creek		O	MDNR	7	0	0		2
Blocker’s Pond Dam	Blocker’s Pond outlet	1951	R	Town.	12	3	14	4.7	3
Brandywine Lake Control	Brandywine Creek	1971	R	Town.	1	70	30	0.4	3
Adams Dam	Paw Paw River	1946	R	Private	4	2	0	0.0	3
Maple Lake Dam	Paw Paw River	1907	RH	City	17	168	1846	11.0	3
Briggs Mill Dam	Paw Paw River	1898	H,R	City	9	24	7	0.3	2
Paw Paw Lumber Dam	Paw Paw River	1892	R	Private	12	3	15	5.0	3
Wasman Dam	Paw Paw River tributary	1860	R,O	Private	4	19	30	1.6	3
Pugsley Lake Control	Pugsley Lake outlet	1970	R	Private	3	150	180	1.2	3
Reynolds Lake Control	Red Creek	1975	R	Private	1	123	35	0.3	3

Table 6.–Continued.

Segment and dam name	Stream	Date built	Current purpose	Owner	Head (ft)	Surface acres	Storage (acre-ft)	Average depth (ft)	Hazard type
Schafer Lake Control	Schafer Lake outlet	1978	R	Private	1	81	30	0.4	3
Heuser Dam	Paw Paw River	1963	R,O	Private	1	4	28	7.0	3
Van Auken Lake Control	Paw Paw River	1959	R	County	1	244	100	0.4	3
Paw Paw Lake Control	Paw Paw Lake outlet	1979	R	County	1	900	0	0.0	3
Watervliet Dam	Paw Paw River	1849	RH	Private	8	106	340	3.2	3
Hibbard Lake Dam	Hibbard Lake outlet			Private	1	20	0	0.0	3
McCormick Dam	Paw Paw tributary			Private	1	4	0	0.0	
O'leary Dam 1	Paw Paw tributary			Private	1	3	0	0.0	3
O'leary Dam 2	Paw Paw tributary			Private	1	20	0	0.0	3
Schmuhl Dam	Paw Paw River	1958	I	Private	1	10	32	3.2	3
Yellow Creek Dam	Yellow Creek			Private	1	10	0	0.0	3

Table 7.–Land use in the St. Joseph River watershed, percent by Michigan county. Data from Michigan Department of Natural Resources, Michigan Resource Inventory System (MIRIS).

Segment & county	Agriculture	Forest	Urban	Open	Wetlands	Water	Barren
Headwaters							
Hillsdale	68.5	15.4	5.2	5.2	4.1	1.6	0.0
Upper							
Branch	71.3	16.9	3.6	4.6	1.3	2.2	0.0
Calhoun	45.2	23.2	14.4	8.2	7.6	1.3	0.0
Middle							
Kalamazoo	52.3	21.0	8.8	9.6	5.8	2.5	0.0
St. Joseph	64.6	17.5	4.8	4.8	5.4	2.9	0.0
Lower							
Cass	58.3	21.0	5.5	6.0	6.6	2.8	0.0
Berrien	51.9	17.7	14.2	11.4	2.7	1.8	0.2
Mouth							
Van Buren	53.7	26.0	5.0	9.3	3.4	1.7	0.1
AVERAGE	58.2	19.8	7.7	7.4	4.6	2.1	0.0

Table 8.–Bridge and culvert data, by valley segment and county, for the St. Joseph River basin. Data from County Road Commissioners, Michigan Department of Transportation, and county maps. Blanks indicate no data.

Segment & county	Bridges (paved)	Bridges (gravel)	Bridges (total)	Culverts (paved)	Culverts (gravel)	Culverts (total)
Headwaters						
Hillsdale	31	16	47	71	86	157
Upper						
Branch	12		98			172
Calhoun	24	14	38	34	32	66
Middle						
Kalamazoo	19	7	26	67	13	80
St. Joseph	107	17	124			
Steuben			27			208
LaGrange			56			110
Noble			17			317
Kosciusko			32			14
Elkhart			112			230
Lower						
St. Joseph, IN			20			77
Cass			30			122
Berrien	93	2	95			
Mouth						
Van Buren	49	11	60	76	43	119
TOTAL			782			1553

Table 9.–Designated trout streams in the Michigan portion of the St. Joseph River watershed. Streams are designated upstream of the town, range, and section number unless specified otherwise.

Segment County Stream	Location
Upper	
St. Joseph	
Little Swan Creek	T6S, R9W, Sec. 22
Middle	
Kalamazoo	
Mill Creek	Upstream from impoundment (T7S, R12W, Sec. 29) to Preston Rd. (T7S, R12W, Sec. 7)
Cass	
Rocky River	Mainstem up from T5S, R13W, Sec. 24
Sheldon Creek	T5S, R13W, Sec. 24
Creamery Creek	T5S, R13W, Sec. 23
Flowerfield Creek	T4S, R12W, Sec. 36 (mainstem only)
Wilson Creek	T5S, R15W, Sec. 9
Thorpe Creek	T7S, R15W, Sec. 36
Trout Creek	Above confluence with Sweets Creek T8S, R13W, Sec. 11
St. Joseph	
Flowerfield Creek	T5S, R12W, Sec. 13 upstream to Kalamazoo County line
Rocky River	Mainstem from Bent Rd. (T5S, R12W, Sec. 21) to Cass County Line
Sherman Mills Creek	Above Thompson Lake (T7S, R10W, Sec. 28)
Spring Creek	T6S, R10W, Sec. 19 mainstem to M-66
Unnamed trib. to Spring Creek	T6S, R10W, Sec. 16
Unnamed tributary	T6S, R10W, Sec. 26
Prairie River	Mainstem from Branch County line downstream to Mckale Rd. (T7S, R9W, Sec. 8)
Curtis Creek	T7S, R12W, Sec. 7
Lower	
Van Buren	
Dowagiac River	Upstream from Cass County line to M-51 (T4S, R15W, Sec. 26)
Dowagiac Drain	T4S, R15W, Sec. 34
Cass	
Dowagiac River	Berrien Co line to Van Buren Co line
McKinzie Creek	T7S, R16W, Sec. 7
Pokagon Creek	T6S, R16W, Sec. 30
Peavine Creek	T6S, R16W, Sec. 17
Dowagiac Creek	Between Lake LaGrange and Bunker Lake
Cook Lake Drain	T5S, R16W, Sec. 24
Unnamed tributary	T5S, R15W, Sec. 18
Osborn Drain	T5S, R15W, Sec. 9
Glenwood Creek	T5S, R15W, Sec. 4

Table 9.–Continued.

Segment County Stream	Location
Lower (continued)	
Berrien	
Dowagiac River	T7S, R17W, Sec. 22; Except from the dam in T7S,R17W, Sec. 13 upstream to first bridge
Pipestone Creek	T5S, R18W, Sec. 4
Lemon Creek	T6S, R18W, Sec. 11
Puterbaugh Creek	T6S, R17W, Sec. 8
Love Creek	T6S, R17W, Sec. 7
Townsend Creek	T6S, R17W, Sec. 19
Old Bitty Creek	T7S, R18W, Sec. 23
McCoy Creek	T7S, R18W, Sec. 25
Walton Creek	T7S, R17W, Sec. 16
Glen Creek	T7S, R17W, Sec. 15
Unnamed Tributary	T8S, R17W, Sec. 10
Farmers Creek	T6S, R17W, Sec. 6
Mouth	
Van Buren	
Mill Creek	T3S & 4S, R16W, Sec. 7, 30, 31) upsteam from Berrien County line
Brush Creek	T3S, R15W, Sec. 10; Except: Reynolds Lake Drain
E. Branch Paw Paw	Upstream from M-40 (T3S, R14W, Sec. 14)
W. Branch Paw Paw	Upstream from Mill Pond (T3S, R14W, Sec. 14)
N. Branch Paw Paw	Upstream from M-40
Berrien	
Sand Creek	T4S, R18W, Sec.7
Blue Creek	T4S, R18W, Sec. 4
Mill Creek	T3S, R17W, Sec. 23; Except: Ryno Drain
Hickory Creek	T4S, R19W, Sec. 35
Yellow Creek	T5S, R18W, Sec. 8

Table 10a.–Monthly maximum river temperatures allowed in selected streams. Data from Michigan Department of Environmental Quality, Surface Water Quality Division.

Stream	Month											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Cold water streams	38	38	43	54	65	68	68	68	63	56	48	40
Warm water streams except St. Joseph River	41	40	50	63	76	84	85	85	79	68	55	43
St. Joseph River	50	50	55	65	75	85	85	85	85	70	60	50

Table 10b.–Dissolved oxygen and temperature standards for designated uses of the St. Joseph River and tributaries. Temperatures represent allowable degrees of increase from the monthly river maximum. Data from Michigan Department of Environmental Quality, Surface Water Quality Division.

Designated use and state	Minimum dissolved oxygen (mg/l)	Temperature (°F)
Warmwater fish		
Michigan	5.0	5
Indiana	4.0	5
Coldwater fish		
Michigan		
Designated trout	7.0	2
Designated migratory route	5.0	5
Indiana		
Put-and-take trout	6.0	5 (must remain below 65)
Salmon fishing, spawning, rearing, or imprinting	6.0 (7.0 during spawning)	0
Migratory routes	5.0	2 (must remain below 85; below 70 during spawning)

Table 11.–Areas not attaining designated uses in the St. Joseph River watershed, by valley segment. Acronyms: BD=biological degradation, S=sedimentation, NPS=Nonpoint source pollution, PS=Point source pollution, PCB=polychlorinated biphenyl, AA=animal access, DO=dissolved oxygen, *E. coli*=bacteria associated with human and animal fecal waste. Data from IDEM (1996) and MDEQ (1996a).

Segment and stream	County	Location	Problems
Headwaters			
St. Joseph River	Hillsdale	City of Hillsdale to Genesee Rd. downstream of Jonesville	BD, S
Upper			
Fisher Creek	Branch		BD, S
Coldwater Lake	Branch	Ovid Township	Mercury
Nottawa Creek	Calhoun		BD, NPS, S
Middle			
Barton Lake	Kalamzoo	Schoolcraft	Mercury
Prairie River	Branch	Kinderhook Township	BD
Prairie River	Branch	Down to T7S, R8W, Sec. 19	Dredging
Fawn River	St. Joseph		BD, S, NPS
Pigeon Creek	Steuben	Angola	*E. coli*
Mud Creek	Steuben	Angola	PS, Ammonia
Ewing Ditch	Steuben	Angola	*E. coli*
Johnson Ditch	Steuben	Hudson	PS, BD, DO, Ammonia
Pigeon River	La Grange	Scott to state line	*E. coli*
Little Elkhart Ck.	La Grange	South Milford	*E. coli*
Little Elkhart Ck.	La Grange	Wolcottville	PS, *E. coli*
Little Elkhart R.	Elkhart	From Topeka to Middlebury 30mi	PS, NPS, *E. coli*
St. Joseph River	Elkhart	Bristol	*E. coli*
St. Joseph River	Elkhart	Elkhart	*E. coli*
Pine Creek	Elkhart	Bristol	*E. coli*
N. Br. Elkhart R.	Noble	Cosperville	*E. coli*
N. Br. Elkhart R.	Noble	Eddy	*E. coli*
S. Br. Elkhart R.	Noble	Albion	*E. coli*
Henderson Lk. Dr.	Noble	near Kendallville	DO
Waterhouse Ditch	Noble	Albion	BD, DO, Iron
Oviatt Ditch	Noble	Rome City	*E. coli*
Boyd Ditch	Noble	Cosperville	*E. coli*
Huston Ditch	Noble	Wawaka	*E. coli*
Forker Creek	Noble	Burr Oak	*E. coli*
Rimmell Branch	Noble	Bakertown	*E. coli*
Croft Ditch	Noble	Albion	BD, ammonia
Long Ditch	Noble	Albion	*E. coli*
Solomon Creek	Noble	Cromwell	PS, NPS
Rocky River	Cass/St. Joe	M-40 to Fabius Township	BD
Rocky River	Cass	Down stream of Pioneer Rd.	BD, S
Turkey Creek	Kosciusko	near Syracuse	*E. coli*
Turkey Creek	Kosciusko	near Milford	*E. coli*

Table 11.–Continued.

Segment and stream	County	Location	Problems
Middle (continued)			
Coopers Ditch	Kosciusko	Between Leeburg and Milford	PS, Sewage
Elkhart River	Noble	Ligonier	*E. coli*
Elkhart River	Elkhart	Goshen	*E. coli*
Wisler Ditch	Elkhart	near Wakarusa	*E. coli*
Peterbaugh Creek	Elkhart	Elkhart	*E. coli*
Crawford Ditch	Elkhart	Elkhart	*E. coli*, Metals, Oil
Auten Ditch	Elkhart	Elkhart	*E. coli*, Ammonia
Mather's Ditch	Elkhart	Middlebury	*E. coli*, DO
Christiana Creek	Cass		BD, S
Lower			
Baugo Creek	Elkhart	near Wakarusa	*E. coli*
Silver Creek	Cass	M-152 to Mouth	BD
McKinzie Creek	Cass	Barron Lake Rd to mouth	Temp., S
St. Joseph River	St. Joseph	Mishawaka	PCB
St. Joseph River	St. Joseph	South Bend	PCB
St. Joseph River	Berrien	State line down to mouth	PCB, *E. coli*
Eau Claire Drain	Berrien		BD, PS
Farmers Creek	Berrien		Untreated sewage, PS
Mouth			
Hickory Creek	Berrien	Stevensville	BD
St. Joseph River	Berrien	Below Business Loop 94	Mercury, PCB
Eagle Lake Drain	Van Buren	to confluence S. Br. Paw Paw R.	BD, S, NPS, AA
Lawton Drain	Van Buren	Trib. to S.Br Paw Paw River	BD, S, NPS, AA
Mill Creek	Van Buren		BD, S, NPS
Pine Creek	Van Buren	south to I94	BD, S, NPS
Paw Paw R. S. Br	Van Buren	to 64th Ave	BD, S, NPS
Mill Creek	Berrien		BD, S, NPS
Paw Paw River	Berrien	Riverside to St. Joe River	BD, S, copper, Zinc, Anthracene, and PCB
Ox Creek	Berrien	to Paw Paw River	BD, S, PS

Table 12.–National Pollution Discharge Elimination System permits issued in the St. Joseph River watershed by Michigan Department of Environmental Quality, Surface Water Quality Division and Indiana Department of Environmental Management.

Segment and Facility	Watercourse	City
Headwaters		
Hillsdale Power Plant	Baw Beese Lake	Hillsdale
Hillsdale WWTP	St. Joseph River	Hillsdale
RC Plastics Inc	St. Joseph River	Hillsdale
Hillsdale Terminal Products	St. Joseph River	Hillsdale
Camp Michindoh Ministries	Weatherwood Lake	Hillsdale
Addison Products Co	St. Joseph River	Jonesville
Litchfield WWTP	St. Joseph River	Litchfield
Mich. South Cen Power Agency	St. Joseph River	Litchfield
Tekonsha WWSL	St. Joseph River	Tekonsha
Randall Food Products	St. Joseph River	Tekonsha
Upper		
Coldwater WWTP	Coldwater River	Coldwater
Lear Plastics Corp.	Little Portage Creek	Mendon
Union City WWSL	St. Joseph River	Union City
Douglas Autotech	Swan Creek	Bronson
Solvay Automotive Inc	Swan Creek	Bronson
Bronson Plating Co	Swan Creek	Bronson
Bronson WWTP	Swan Creek	Coldwater
Middle		
MDEQ-ERD-Edwardsburg	Pleasant Lake	Edwardsburg
Marcellus WWSL	Rocky River	Marcellus
Armstrong Machine Works	Rocky River	Three Rivers
Ber Enterprises Inc	St. Joseph River	Leonidas
Mottville Downs Race Track	St. Joseph River	Three Rivers
Roys Motor Sales	St. Joseph River	Three Rivers
Engineered Stadium Systems	St. Joseph River	Three Rivers
Republic Roller Corp	St. Joseph River	Three Rivers
Three Rivers WWTP	St. Joseph River	Three Rivers
Day International	St. Joseph River	Three Rivers
Fonda Group	St. Joseph River	Three Rivers
T-H Plastics Inc	St. Joseph River	Mendon
North Adams RSD	Portage Creek	North Adams
Arco IN Corp.	Portage Creek	Schoolcraft
Constantine WWTP	St. Joseph River	Constantine
Amoco Pipeline-Constantine	St. Joseph River	Constantine
Anthony Ind-Simplex	St. Joseph River	Constantine
MMPA-Constantine Plant	St. Joseph River	Constantine
Day’s Molding & Machinery Inc	St. Joseph River	Constantine
Centreville WWSL	Prairie River	Centreville

Table 12.–Continued.

Segment and Facility	Watercourse	City
Middle (continued)		
Sturgis Foundry	Prairie River	Sturgis
Abbott Mfg Inc	Fawn River	Sturgis
White Pigeon/Klinger Lake WWTP	Fawn River	White Pigeon
Murphys Fisher Lake Grocery	Fish Lake	Three Rivers
Mendon WWTP 1 & 2	Little Portage Creek	Mendon
Sturgis Well Field	Nye Drain/Fawn River	Sturgis
Cooper-Kirsch Div-Sturgis	Nye Drain/Fawn River	Sturgis
Sturgis WWTP	Nye Drain/Fawn River	Sturgis
Sutton Tool Company Inc	Nye Drain/Fawn River	Sturgis
Rood Industries Inc	Nye Drain/Fawn River	Sturgis
Wakarusa Municipal STP	Baugo Creek	Wakarusa
Arco Ind Corp	Black Lake	Schoolcraft
Marathon Gasoline Station	Christiana Creek	Elkhart
Angola Inn	Crooked Creek	Angola
Angola 76 Truck Plaza	Crooked Creek	Angola
Pokagon State Park	Crooked Creek	Angola
Consolidated Freightways	Crooked Creek	Fremont
Fremont Municipal STP	Crooked Creek	Fremont
Western Rubber Company	Crooked Creek	Fremont
Orland Public Water Supply	Crooked Creek	Orland
Dana Corp. Weatherhead Div.	Crooked Lake	Angola
Eaton Corp.	Eklhart River	Kendallville
Kendallville Municipal STP	Eklhart River	Kendallville
Kendallville Public Water Sup.	Eklhart River	Kendallville
Albion Municipal STP	Elkhart River	Albion
Albion Wire, Inc.	Elkhart River	Albion
Chain O'Lakes Youth Camp	Elkhart River	Albion
Chain O'Lakes State Park	Elkhart River	Albion
Concord Eastside Elem. School	Elkhart River	Elkhart
Nibco-Goshen Division	Elkhart River	Goshen
Bachor Home	Elkhart River	Goshen
Benteler Industries	Elkhart River	Goshen
Dairy Farms Products Company	Elkhart River	Goshen
Fairfield Jr-Sr High School	Elkhart River	Goshen
Goshen Municipal	Elkhart River	Goshen
Johnson Controls	Elkhart River	Goshen
Perfection/Walker Manuf. Co	Elkhart River	Goshen
Sunrise Orchards, Inc.	Elkhart River	Goshen
Indian Lake Moblile Village	Elkhart River	Ligonier
Freudenberg Nok	Elkhart River	Ligonier
Ligonier Municipal STP	Elkhart River	Ligonier
Silgan Plastics Corp.	Elkhart River	Ligonier
New Paris Conservancy	Elkhart River	New Paris
Rome City Municipal STP	Elkhart River	Rome City
Topeka Municipal STP	Elkhart River	Topeka

Table 12.–Continued.

Segment and Facility	Watercourse	City
Middle (continued)		
Topeka Municipal Water Utility	Elkhart River	Topeka
East Shore Bear Lk Sub.	Elkhart River	Wolf Lake
First Baptist Church - WWTP	Elkhart R. via Howard Dr.	Elkhart
LaGrange Municipal STP	Fly Creek of Pigeon River	LaGrange
LaGrange Packing Center	Fly Creek of Pigeon River	LaGrange
Sturgis-Big Hill Road	Groundwater	Sturgis
Elkhart Mun. Airport	Groundwater	Elkhart
Elkhart Products Corp.	Groundwater	Elkhart
IDOT Products Corp.	Groundwater, By Christiana	Elkhart
Bristol Products	Little Elkhart River	Bristol
Deutsch Kase Haus, Inc.	Little Elkhart River	Middlebury
Middlebury EMS Bldg	Little Elkhart River	Middlebury
Middlebury Municipal STP	Little Elkhart River	Middlebury
Syndicate Store Fixtures, Inc.	Little Elkhart River	Middlebury
Westview School Corp.	Little Elkhart River	Topeka
Adams Lake Reg. Sewer Dist.	Little Elkhart River	Wolcottville
Wolcottville Municipal STP	Little Elkhart River	Wolcottville
American Rollform & Man. CO	Pigeon Creek	Angola
Angola Municipal STP	Pigeon Creek	Angola
Silver Lake Mobile Home Park	Pigeon Creek	Angola
Pigeon Creek Rest Area	Pigeon Creek	Angola
Ashley Municipal STP	Pigeon Creek	Ashley
Ashley Water Works	Pigeon Creek	Ashley
Service Area 7	Pigeon River	Howe
LaGrange CO. Sewer Dist.	Pigeon River	LaGrange
Shipshewanna Municipal STP	Pigeon River	Shipshewana
Midway Transportation Center	Pine Creek	Elkhart
Three Oaks Mobile Manor	Pine Creek	Goshen
Cromwell Municipal STP	Solomon Creek	Cromwell
Maple Leaf Farms Hatchery	Solomon Creek	Cromwell
Turkey Creek Regional Sewer	Solomon Creek	Syracuse
Millburn Peat Co	Spring Creek	Three Rivers
Bristol Municipal STP	St. Joseph River	Bristol
Timberbrook Mobile Home Park	St. Joseph River	Bristol
Bayer Corporation	St. Joseph River	Elkhart
Consolidated Rail Corp.	St. Joseph River	Elkhart
Elkhart Municipal STP	St. Joseph River	Elkhart
Millersburg Municipal STP	Stoney Creek	Millersburg
LaGrange CO. Sewer Dist.	Taylor Lake	LaGrange
Midwest Foundry Company	Turkey Creek	Hudson
Maple Leaf Farms	Turkey Creek	Milford
Milford Junction	Turkey Creek	Milford Junction
Nappanee Municipal STP	Turkey Creek	Nappanee
Burger Dairy Company	Turkey Creek	New Paris
Sea Nymph Boats	Turkey Creek	Syracuse

Table 12.–Continued.

Segment and Facility	Watercourse	City
Middle (continued)		
Syracuse Municipal STP	Turkey Creek	Syracuse
Syracuse Rubber Products, Inc.	Turkey Creek	Syracuse
Lower		
Jimtown Schools	Baugo Creek	Elkhart
Virgil Grissom Middle School	Baugo Creek	Mishawaka
Bodine State Fish Hatchery	St. Joseph River	Mishawaka
Mishawaka Municipal STP	St. Joseph River	Mishawaka
Mishiwaka Municipal Utilities	St. Joseph River	Mishawaka
Uniroyal Technology, Ensolite	St. Joseph River	Mishawaka
Westinghouse Electric Corp.	St. Joseph River	Mishawaka
Sunset Trailer Village	Bowman Creek	South Bend
Berliner & Marx. Inc.	Bowman Creek	South Bend
Clear Water Mobile Village	Bowman Creek	South Bend
Coz Terminaling Inc.	Bowman Creek	South Bend
South Bend Municipal	St. Joseph River	South Bend
St. Marys Convent & College	St. Joseph River	South Bend
Juday Creek Estates	Judy Creek	Granger
USEPA-Region V	St. Joseph River	
Jack Corbit-Keiths Garage	Stone Lake	Cassopolis
Service Oil Co	Wetlands	Cassopolis
National Copper Products	Pine Lake Creek	Dowagiac
Service Oil-Union US 12	St. Joseph River	Cassopolis
MDEQ-ERD-Niles	Brandywine Creek	Niles
Service Oil Co-Dowagiac	Dowagiac Creek	Cassopolis
Energy Oil-US 12	Pleasent Lake	Dowagiac
Westgate Oil Co-Pokagon	Pokagon Creek	Niles
Dowagiac WWTP	Dowagiac River	Dowagiac
Decatur WWSL	Dowagiac R. via Mud Lk	Decatur
Amoco Oil Co, Granger Site	Groundwater	Granger
Amoco Oil Co, Granger Terminal	Groundwater	Granger
Eau Claire Packing Co	Farmers Creek	Eau Claire
Eau Claire WWSL	Farmers Creek	Eau Claire
Hermel Die Casting Corp.	Farmers Creek	Eau Claire
Michiana Publications	Farmers Creek	Eau Claire
Suncrest Juice Inc	Farmers Creek	Eau Claire
Buchanan Ind	McCoy Creek	Buchanan
Clark Equipment	McCoy Creek	Buchanan
Jack-Post	McCoy Creek	Buchanan
Camp Rosenthal	Pipestone Creek	Dowagiac
Meadow Streams Estates	Pipestone Creek	Sodus
Mich. Fruit Canners-Sodus	Pipestone Creek	Sodus
Sodus Hard Chrome Co	Pipestone Creek	Sodus
French Paper Co	St. Joseph River	Niles
Nat Standard-City Complex	St. Joseph River	Niles

Table 12.–Continued.

Segment and Facility	Watercourse	City
Lower (continued)		
Nat Standard-Lake St.	St. Joseph River	Niles
Niles WWTP	St. Joseph River	Niles
Citgo Corp-Niles	St. Joseph River	Niles
Marathon Petro Co-Niles	St. Joseph River	Niles
Shell Oil Co-Niles	St. Joseph River	Niles
Camp Betz WWSL	St. Joseph River	Buchanan
Riverside Estates WWTP	St. Joseph River	Buchanan
Southeast Berrien Co Landfill	St. Joseph River	Buchanan
Berrien Springs WWTP	St. Joseph River	Berrien Springs
Mouth		
Chardon Rubber Co	Hickory Creek	Stevensville
Baroda WWSL	Hickory Creek	Baroda
Southern Mich. Cold Storage	Pipestone Creek	Benton Harbor
Country Holiday Est WWSL	Woodhouse Drain	Paw Paw
Covert Public Schools	Brandywine Creek	Covert
Coca-Cola Co (Minute Maid)	Jennings Drain	Paw Paw
Welch Foods Inc	Lawton Drain	Lawton
MDNR-Wolf Lake Hatchery	N. Branch Paw Paw River	Almena
Paw Paw Lake Area WWTP	Paw Paw River	Coloma
Ravine View Estates	Paw Paw River	Coloma
Hartford WWTP	Paw Paw River	Hartford
Lawrence WWSL	Paw Paw River	Lawrence
Fletcher Paper Co-Watervliet	Paw Paw River	Watervliet
Crystal Flash	Pine Creek	Hartford
Lawton Oil	S. Branch Paw Paw River	Lawton
Lawton WWTP	S. Branch Paw Paw River	Lawton
Paw Paw WWTP	S. Branch Paw Paw River	Paw Paw
St. Julian Wine Co Inc.	S. Branch Paw Paw River	Paw Paw
Duo-Tang Inc	South Branch Paw Paw	Paw Paw
Great Lakes Concentrates	E. Branch Paw Paw River	Paw Paw
Crystal Flash Petro-Paw Paw	East Branch Paw Paw	Paw Paw
Hoffmann Die Cast Corp.	Ox Creek/ Paw Paw River	Benton Harbor
Mich. Standard Alloys	Ox Creek/Paw Paw River	Benton Harbor
Sumitec Inc	Paw Paw River	Benton Harbor
Whirlpool-Admin. Center	Paw Paw River	Benton Harbor
Whirlpool-Plts 2,5, & 6	Paw Paw River	Benton Harbor
Ameritech-Benton Harbor	St. Joseph River	Benton Harbor
New Products Corp.	St. Joseph River	Benton Harbor
Benton Harbor-St. Joseph WWTP	St. Joseph River	St. Joseph
St. Joseph CSO	St. Joseph River	St. Joseph
Whirlpool-Plt 8	St. Joseph River	St. Joseph
Alliedsignal Brake Systems	Hickory Creek	St. Joseph
Hills Haven WWTP	St. Joseph River	
Gast Mfg. Corp.-Benton Harbor	St. Joseph River	Benton Harbor

Table 13.–Industrial storm water permits issued in 1997 by Michigan Department of Environmental Quality, Surface Water Quality Division, in the St. Joseph River watershed.

Segment and stream	Facility name	Location
Headwaters		
St. Joseph River	Hillsdale Tool-Daisy 2&H&R	Hillsdale
St Joseph River	Hillsdale Tool- South St Plt	Hillsdale
St Joseph River	Eaton Technologies Inc	Hillsdale
St Joseph River	Kerry Ingredients	Hillsdale
St Joseph River	Bundy Corp-Tubing Div	Hillsdale
St Joseph River	Quality Industries Inc	Hillsdale
St Joseph River	Becker & Scrivens Concrete	Hillsdale
St Joseph River	Abrasive Materials Inc	Hillsdale
St Joseph River	Essex Specialty Products	Hillsdale
St Joseph River	Bailey Manufacturing	Hillsdale
St Joseph River	Alsons Corp	Hillsdale
St Joseph River	Hillsdale Tool & Mfg Jonesvill	Jonesville
St Joseph River	United Feeds Inc	Jonesville
St Joseph River	Klein Tools Inc	Jonesville
St. Joseph River	Quincy Holdings Inc	Jonesville
St Joseph River	Litchfield Grain Co	Litchfield
St Joseph River	Walker Mfg-3 Litchfield	Litchfield
Snow Creek	Finishing Touch	Litchfield
St Joseph River	Livonia Tool	Litchfield
St Joseph River	Recon Of Litchfield	Litchfield
Upper		
St Joseph River	Batavia Elevator Inc-Coldwater	Coldwater
Coldwater River	Coldwater Bakery Div	Coldwater
Coldwater River	Darling International Inc	Coldwater
Coldwater River	L & S Products Inc	Coldwater
Coldwater River	Coldwater Veneer Inc	Coldwater
Coldwater River	Dougs Auto Recyclers	Coldwater
Coldwater Lake	Coldwater Lake Marine	Coldwater
Coldwater Lake	Lake Drive Marine	Coldwater
Hog Creek	Arkansaw Auto Parts	Allen
South Hog Creek	Quincy Sandblasting Inc	Quincy
Little Portage Ck	Lear Plastics Corp	Mendon
St. Joseph River	St Joseph Valley Seed Co	Mendon
St. Joseph River	T-H Plastics Inc	Mendon
Middle		
Spring Creek	Biewer Lumber Co-Schoolcraft	Schoolcraft
Gourdneck Creek	Simpson Paper Co-Vicksburg	Vicksburg
Portage River	Consumers Concrete-5-Three Rivers	Three Rivers
St. Joseph River	Day International	Three Rivers
St. Joseph River	Dock Foundry-Three Rivers-4 St.	Three Rivers
Portage River	Johnson Corp-Three Rivers	Three Rivers
Spring Creek	Millburn Peat Co Inc	Three Rivers

Table 13.–Continued.

Segment and stream	Facility name	Location
Middle (continued)		
St. Joseph River	Peterson Spring-Three Rivers	Three Rivers
St. Joseph River	Surfinco Inc - Three Rivers	Three Rivers
St. Joseph River	Three Rivers Iron And Metal	Three Rivers
St. Joseph River	Weyerhaeuser Paper-Three Rivers	Three Rivers
Rocky River	American Axle & Mfg Inc	Three Rivers
Rocky River	Armstrong International	Three Rivers
Prairie River	Crocker Ltd-Centreville	Centreville
Mill Race	Shears Sawmill	Centreville
Prarie River	Viking Rv-Centreville	Centreville
Nye Drain	Abbott Labs-Ross Products Div	Sturgis
Fawn River	Acm Plastic Products	Sturgis
Fawn River	Anthony Industries-Simplex	Constantine
Fawn River	E L Nickell Co Inc	Constantine
Fawn River	Kirsch Municipal-Sturgis	Sturgis
Fawn River	Oak International-Sturgis	Sturgis
Fawn River	Rood Industries	Sturgis
Fawn River	Sturgis Foundry-W West	Sturgis
Nye Drain	Sturgis Iron & Metal Co	Sturgis
Fawn River	Sutton Tool Co Inc	Sturgis
Fawn River	Telemark Pc Forms-Sturgis	Sturgis
St. Joseph River	Mmpa-Constantine Plant	Constantine
Corey Lake	Corey Lake Marina	Three Rivers
Pigeon River	Centurion Veh-White Pigeon-131	White Pigeon
Pigeon River	Centurion-White Pigeon-Miller	White Pigeon
Pigeon River	Gray Bros-White Pigeon	White Pigeon
Pigeon River	Kysor Metal Prod-White Pigeon	White Pigeon
Pigeon River	Process Metals-Elkhart St	White Pigeon
Pigeon River	White Pigeon Paper Co	White Pigeon
Gast Ditch	Georgie Boy Mfg-Plt 1-Edwardsburg	Edwardsburg
Gast Ditch	Georgie Boy Mfg-Plt 2-3-Edwardsburg	Edwardsburg
Pleasant Lake	North American Forest Products	Edwardsburg
Diamond Lake	Diamond Lake Marina	Cassopolis
Stone Lake	Mobile Facility Engineering	Cassopolis
Juno Lake	Wallace’s Salvage Yard	Cassopolis
Lower		
Brandywine Creek	B & R Oil Co Inc	Niles
Brandywine Creek	United Tech Auto Sys-Niles	Niles
Brandywine Creek	Four Flags Bath Factory	Niles
Silverbrook Ck	Jerry Tyler Memorial-Niles	Niles
Unnamed Drain	Modular And Plastic Products Inc	Niles
St. Joseph River	French Paper Co	Niles
St. Joseph River	Nat Standard-City Complex	Niles
St. Joseph River	Niles Precision Co	Niles
St. Joseph River	Niles Riverfront Park Landfill	Niles
St. Joseph River	Ozinga Bros-Niles	Niles

Table 13.–Continued.

Segment and stream	Facility name	Location
Lower (continued)		
St. Joseph River	Printco Inc-Niles	Niles
St. Joseph River	United Fixtures Co-Niles	Niles
St. Joseph River	Holts Auto Parts-Niles	Niles
Dowagiac Drain	Special-Lite-Decatur	Decatur
Dowagiac Creek	Niles Plym Park Landfill	Niles
Dowagiac Creek	Contech Div Spx Corp	Dowagiac
Dowagiac Creek	Inverness Casting Group	Dowagiac
Dowagiac Creek	Jessup Door Company	Dowagiac
Dowagiac Creek	Lyons Ind-Heddon Div	Dowagiac
Dowagiac Creek	Mennel Milling Co Of Michigan	Dowagiac
Dowagiac Creek	Mich Ang-Dowagiac	Dowagiac
Dowagiac River	Ameriwood Furniture Div	Dowagiac
Dowagiac River	Keenes Auto Sales-51027	Dowagiac
Magician Lake	Midway Recreation Inc	Dowagiac
Dowagiac River	Michiana Box & Crate	Niles
Dowagiac River	Earl Williams	Niles
Lemon Creek	Andrews University Airport	Berrien Springs
Mccoy Creek	Buchanan Metal Forming Inc	Buchanan
St. Joseph River	Electro-Voice Inc-Buchanan	Buchanan
St. Joseph River	Southeast Berrien Co Landfill	Buchanan
St. Joseph River	Premier Tool Die Cast	Berrien Springs
St. Joseph River	Ray’s Auto Sales-Berrien Springs	Berrien Springs
St. Joseph River	Symonds Bros Auto Sales	Berrien Springs
Eau Claire Creek	Eau Claire Fruit Exchange	Eau Claire
Crystal Creek	Five Corners Garage Inc	Eau Claire
Farmers Creek	Hermel Die Casting Corp	Eau Claire
Farmers Creek	Hofmann Ind-Mich Tube Div	Eau Claire
Farmers Creek	Seneca Food Corp-Linn	Eau Claire
Farmers Creek	Seneca Food Corp-Pipestone	Eau Claire
Pipestone Creek	Shawnee Specialties Inc	Eau Claire
Sucker Brook	Mich Fruit Canners-Sodus	Sodus
Mouth		
Keelo Creek	Reliable Disposal-Stevensville	Stevensville
Hickory Creek	Anstey Foundry Co	Stevensville
Hickory Creek	Bosch Braking Systems	St. Joseph
Hickory Creek	Cast-Matic Corp-Stevensville	Stevensville
Hickory Creek	Lakeshore Electro-Plate Inc	Stevensville
Hickory Creek	Leco Corp-St Joseph-Lakeview	St. Joseph
Hickory Creek	Moxness Thermoplastics	Stevensville
Hickory Creek	Shepherd Products-St Joseph	St. Joseph
Hickory Creek	Wolverine Metal Stamping	St. Joseph
Sand Creek	Southwest Mich Regional Airport	Benton Harbor
Sand Creek	Square Deal Auto-Benton Harbor	Benton Harbor
Paw Paw River	Coloma Frozen Foods	Coloma
Paw Paw River	Fletcher Paper Co-Watervliet	Watervliet

Table 13.–Continued.

Segment and stream	Facility name	Location
Mouth (continued)		
Paw Paw River	Menasha Corp-Coloma	Coloma
Ryno And Knapp Drains	Orchard Hill Lf-Watervliet	Watervliet
Paw Paw Lake	Paw Paw Sports & Marina	Coloma
Paw Paw River	Postelli Steel Fab	Coloma
Cook Inter County Drain	Chem Rex Inc-Mattawan	Mattawan
Hog Creek	Hanson Cold Storage-Hartford	Hartford
Iron Run Creek	Knouse Foods Coop Inc-Paw Paw	Paw Paw
Paw Paw River	R A Imus Inc	Paw Paw
Maple Lake	Van Denbos Inc-Paw Paw	Paw Paw
S.B. Paw Paw River	West Michigan Railroad Co	Paw Paw
Paw Paw River	Abf Freight Sys-Paw Paw	Benton Harbor
Paw Paw River	Max Casting Co Inc	Benton Harbor
Paw Paw River	Sumitec Inc	Benton Harbor
Paw Paw River	Ztar Finishing Sys-Benton Harbor	Benton Harbor
Ox Creek	Abc Precision Machining-Yore	Benton Harbor
Ox Creek	Ausco Products-St Joseph	Benton Harbor
Ox Creek	Benton Harbor Engineering	Benton Harbor
Ox Creek	Brutsche Concrete-Benton Harbor	Benton Harbor
Ox Creek	Consumers Asphalt Co	Benton Harbor
Ox Creek	Gast Mfg Corp-Remark-Benton Harbor	Benton Harbor
Ox Creek	K-O Products-Benton Harbor	Benton Harbor
Ox Creek	Kaywood Shutter Co	Benton Harbor
Ox Creek	Leco-Michigan Ceramics Div	Benton Harbor
Ox Creek	Mich Standard Alloys	Benton Harbor
Ox Creek	Modern Plastics Corp	Benton Harbor
Ox Creek	Mono Ceramics-Benton Harbor	Benton Harbor
Ox Creek	New Products Corp	Benton Harbor
Ox Creek	Old Europe Cheese Inc	Benton Harbor
Ox Creek	P R & D Casting Corp	Benton Harbor
Ox Creek	Sandvik Steel	Benton Harbor
Ox Creek	Summit Powders Inc	Benton Harbor
Ox Creek	United Die Cast Corp-Benton Harbor	Benton Harbor
Barnes & Hamilton Co. Dr	Alloy Foundry Company	Benton Harbor
St. Joseph River	Brians Marine Service	St. Joseph
St. Joseph River	Certified Metal Finishing	Benton Harbor
St. Joseph River	Comstock Michigan Fruit	Benton Harbor
St. Joseph River	Gm-Brass-Aluminum Foundry-Benton Harbor	Benton Harbor
St. Joseph River	Harbor Metal Treating Co	Benton Harbor
St. Joseph River	Riverview 1000 Inc	Benton Harbor
St. Joseph River	Whirlpool Corp	Benton Harbor
St. Joseph River	Eagle Point Harbor-St Joseph	St. Joseph
St. Joseph River	Harbor Isle Marina	St. Joseph
St. Joseph River	Leco-Pier 33-St Joseph	St. Joseph
St. Joseph River	Manchester Plastics-Hughes Division	St. Joseph
St. Joseph River	Vail Rubber Works Inc	St. Joseph

Table 14.–Contamination sites in the Michigan portion of the St. Joseph River watershed (1995), by valley segment. Data from Michigan Department of Environmental Quality, Environmental Response Division. Acronyms: BTEX=benzene, toluene, ethylbenzene, and xylene; DCA=dichloroethane; 1,1DCA=isomer of previous; DCE=dichloroethylene; 1,2 DCE=isomer of DCE; DDE=dichlorodiphenyldichloroethylene; MTBE=methyl tertiary butyl ether; DDT=dDechlorodiphenyltrichloroethane; PCB=polychlorinated biphenyl; PCE or PERC=perchloroethylene; PNAs=polynuclear aromatic hydrocarbons; TCA=trichloroethane; TCE=trichloroethylene; TPH=total petroleum hydrocarbons; LF=landfill. Blanks indicate that data were not listed.

Site location	Category	Pollutant
Headwaters		
Hillsdale County		
Former Licensed City LF	No actions taken	Domestic Comm
Litchfield Old Dump	"	Arsenic, Lead, Diethylphthalate
Lopresto Auto Body	"	Paint Thinners
Lucas LF/Jonesville Garbage Srvc	"	Chloroform, PAHs, DCA, Benzene, Methylphenol
Markle, Ralph 1-A	"	Condensate-BTEX, Crude oil
Reading Village Dump	"	Domestic Comm
Stillwell Ford Mercury	"	Paint, Paint thinners
Hillsdale Iron and Metal	Evaluation/interim response - fund [a]	Zinc, Copper, Lead, PCB
Jonesville Vlg Old Dump	"	PCB, DDT, TCE, AS
Kesselring, Howard 3	"	Crude Oil, BEXT
Kesselring, Howard 5	"	Crude Oil, BEXT
Kesselring, Howard 7	"	Crude Oil, BEXT
Millman & Sanderson 3	"	Crude Oil, BEXT
Millman & Sanderson 1	"	Crude Oil, BEXT
Roberts, Everett 2	"	Crude Oil, BEXT
Roberts, Everett 3	"	Crude Oil, BEXT
Calhoun County		
Res Well Tekonsha	Evaluation/interim response - fund [a]	1,1,1-TCA, TCE, PCE
Burlington Village GW Contam	Evaluation/interim response - PRP/other [b]	Sodium Chloride
Upper		
Branch County	No actions taken	
B's Shop & Fly	"	Kerosene
Branch Co Rd Comm Coldwater	"	Salt, Gasoline
Coldwater Salt Storage City of	"	Salt
Gilchrest Landfill	"	Dichloroethane, Trichloroethane
Arborgast Rd GW Contamination	Evaluation/interim response - fund [a]	Atrazine, Alachor
Ridge Road	"	DCE, TCE
Union City GW Contam	"	Nitrates
Acorn Building Components	Evaluation/interim response - PRP/other [b]	Cyanide, Xylene, TCE, PCE
Board of Public Util Coldwater	"	Fuel Oil
Coldwater Regional Mental Health	"	PCBs
Douglas Components Corp	"	Waste Oils, Xylene, Trichloroethane

Table 14.–Continued.

Site location	Category	Pollutant
Upper (continued)		
Former Midwest Foundry	Evaluation/interim response - PRP/other [b]	Benzene, Lead, PCE, Ethylbenzene, Xylene
Hawkens Furn Form Schafer Mfg	"	Chromium, Arsenic, Cyanide, Lead
MDOT Coldwater	"	Salt
Otto & Sons Marine	"	Lead, Cadmium, Benzene
Ovid Twp Dump	"	Arsenic, Cobalt
United Technologies Automotive	"	PCBs, Aluminum
W Chicago St GW Contam	"	Hydrocarbons
Calhoun County		
Manicipal Wells Athens	No actions taken	Nitrates
Douglas Corp./Hampton Bros. Prop	Evaluation/interim response - fund [a]	PCE, Xylene
Vincent's Industrial Panting	"	PCE, TCE
Amoco Pipeline Co	Evaluation/interim response - PRP/other [b]	Fuel Oil
Former Bennett Manufacturing	"	TCE, Toluene, Lead
Former Gulf Station	"	PCE, Benzene
Hawley Oil Co Amoco	"	Benzene, Ethylbenzene
House and Stable Antiques	"	Methylene, Chloride, Xylene
Keith Fransted Construction Co	"	Gasoline
St. Joseph County		
Lear Siegel Inc Mendon Twp	Evaluation/interim response - PRP/other [b]	Nickle, Lead, Zinc, DCE, DCA, TCE, PCE
Middle		
Kalamazoo County		
Colonial Village Laundry	No actions taken	PCE, Chloroform
Portage St & Zylam Ave Res Well	"	TCE
Newport Rd & East Milham Rd	Evaluation/interim response - fund [a]	PCE, TCE
Res Well Rimmel St Brady Twp	"	Trichloroethne
Res Well V Ave	"	1,2 DCA
Schoolcraft Area Organics Contam	"	Chromium, PCE, TCE
B&L Auto Center	EvaluationiInterim response - PRP/other [b]	BTEX
Market Place Development	"	Ethylbenzene, Toluene, Xylenes
Plastic Engineering Vanderbilt	"	1,1,1 TCA, PCE, TCE
Stewart Sutherland Inc	"	1,1,1 TCA, PCE, TCE
U Ave & 12 St	"	Lead, Chromium, Cadmium, Nickel
Vicksburg Laundry & Dry Cleaners	"	Tetrachloroethylene
Branch County		
Bronson Salt Storage City of	No actions taken	Salt
Bronson Sanitary LF	"	Chromium, Lead, Manganese, Copper
Bronson Precision Products	Evaluation/interim response - PRP/other [b]	Waste Oils
North Bronson Industrial Area	"	Cadmium, Chromium, Lead, Nickel, Copper
Saint Joseph County		
Youngs LF	Highest priority	Chromium, Lead, Nickel, PCB, 1,1DCA
Eddy Paper Co Abandoned LF	No actions taken	Light Indust. Waste
Res Well Cooper St.	"	Fuel Oil

Table 14.–Continued.

Site location	Category	Pollutant
Middle (continued)		
Res Well Hoffman St.	No actions taken	Benzene, Xylene, Dichloroethane
Former Zephyr Facility	Evaluation/interim response - fund [a]	Fuel Oil
Youngs LF	"	Chromium, Lead, Nickel, PCB, 1,1 DCA
Bainridge Sherman Twp	Evaluation/interim response - PRP/other [b]	Gasoline
Constantine Municipal Well	"	111 Trichloroethane, Toluene
Fibre Converters	"	PCE, TCE
Laundromat West of Centreville	"	Laundry Detergents, Chlorides
Martin Products Co	"	Dichloroethane, Lead, Trichloroethane
Mottville truck Stop	"	Gasoline
Sohigro	"	Anhydrous Ammonia
Sturgis Hospital	"	Heating Oil
Superamerica Payless	"	Benzene, Toluene, Ethylbenzene
Three Rivers Anodizing	"	Copper, Chrome, Zinc, Aluminum
Three Rivers Millard Court Area	"	Toluene, PCE, 1,2 DCE, TCE
Travel Accessories	"	DCA, TCA, BTEX
Victor Screw Products	"	Tetrachloroethylene
Weyerhaeuser	"	Gas Components, Fuel Oil
Amoco Pipeline Leak	Final cleanup - PRP/ other [d]	Petroleum Product
Sturgis City of LF	"	TCE, PCE
Sturgis Municipal Wells	"	TCE, PCE
Three Rivers W Mich Ave	"	Diisopropyl Ether, 1,1,1 TCA, Benzene
Westside LF	"	DCE, PCE, TCA, TCE, Methylene, Chloride
Cass County		
Marcellus Creamer/Dow Plating	No actions taken	Lead, Chromium
Baer Drive Area Marcellus	Evaluation/interim response - fund [a]	1,2 DCA, BTEX
Cass St Area Edwardsburg	"	Benzene, TCE, PCE
Southwest Cass Co LF	Evaluation/interim response - PRP/other [b]	Paint Sludges, BTEX
Lower		
Cass County		
Sunstrand Heat Transfer	Highest priority	TCE, Lead, Chromium
Hilltop Laun and Dry Clnrs Union	No actionstTaken	Perchloroethylene
Jessco	"	Arsenic, Cadimum, TCE, Vinyl, Chloride
Myer Property	"	Solvents
Res Well Conrad and Coulter Rd	"	Benzene
Sacred Heart No 2 Fuel Oil Spill	"	Fuel Oil
Dowagiac LF City of	Evaluation/interim response - fund [a]	TCE, PCE, DCE, DCA, TCA
Edwardsburg Industrial Park	"	TCE, TCA, DCA, PCE, DCB, Xylene
Juniper St Contam	"	1,1,1-TCA 1,1 DCA
Lee Manufacturing	"	Toluene, PCE, 1,1,1-TCA
Dowagiac Public Services	Evaluation/interim response - PRP/other [b]	Diesel Fuel
Henco Enterprises, Inc	"	Cadmium, Zinc, Nickel, Cyanide, Chromium

Table 14.–Continued.

Site location	Category	Pollutant
Lower (continued)		
Redfield Road Fuel Oil Spill	Evaluation/interim response - PRP/other [b]	Fuel Oil
Sunstrand Heat Transfer	"	TCE, Lead, Chromium
Terminal Rd LF	"	VOCs
Pokagon Spill	Final cleanup - PRP/ other [d]	Gasoline
U.S. Aviex	Final cleanup - fund [c]	TCE, TCA
Berrien County		
Berrien Springs Mun Well	Evaluation/interim response - fund [a]	TCE
Niles Municipal Well Decker St	"	TCE
Citgo Terminal Niles	Evaluation/interim response - PRP/other [b]	BTEX
Fifth St Niles	"	Gasoline
SE Berrien Co Sanitary Auth	"	Toluene, 1,1 DCA
Sheller Globe Corp Niles	"	Dichloroethane, Trichloroethane
Res Well Niles 3rd St	Final cleanup - fund [c]	TCE, PCE
Primar Petroleum, Niles Terminal	Final cleanup - PRP/ other [d]	Benzene, Toluene, Ethylbenzene, Xylenes
Mouth		
Berrien County		
Auto Specialist Graves Street	Highest priority	Lead, Arsenic, Chromium, PCB, Benzene
Tri Township LF	"	Lead, Cyanide, Methylene Chloride
Harbor Plating	"	Chromium
Martin Brothers Mill and Foundry	"	Oils
Woodstock Manufacturing	"	PCB, Heavy Metals
Berrien Farm Bureau Oils Co	No actions taken	#2 Fuel Oil
Bridgman Printing	"	Lead, Chromium, Cooper, Zinc
Malleable Site	"	Chromium, Iron, Lead, Cyanide
Michigan Tube Div	"	Cyanide, Chromium, PCE
NW Berrien CO Sanitary Auth	"	4,4 DDT
Plaza Zephyr Station	"	Gasoline
Priebe Bros CO Truck Spill	"	Petroleum Product
Swan Oil Henry Res Allen Rd Spill	"	Fuel Oil
Us Aviex Terminal Rd	"	TCA, Toluene, Benzene, Ethylbenzene
Auto Specialties Graves St	Evaluation/interim response - fund [a]	Lead, Arsenic, Chromium, PCB, Benzene
Auto Specialties Riverside	"	Chromium, Lead, PCB, Mercury, Cadmium, PNAs
N Roosevelt Rd Area Stevensville	"	PCE, Methylene Chloride
Red Oak Furniture	"	Methylene Chloride, Tetrachloroethene
Res Well E Bertrand rd	"	TCE
ALRECO	Evaluation/interim response - PRP/other [b]	PCB, Cyanide
Amerson Bowman Oil Co	"	Benzene, Toluene
Bendix Corp/Allied Automative	"	TCE, Vinyl, Chloride, Trans-1,2-DCE
Benton Harbor Ship Canal	"	PNAs
Birchcrest Estates Mobile Hm Pk	"	Chlorides
Buckhorm Trailer Ct	"	BTEX
Enterprise Oil Tank Farm	"	Benzene, Toluene

Table 14.–Continued.

Site location	Category	Pollutant
Mouth (continued)		
Fairplain Area	Evaluation/interim response - PRP/other [b]	PCE, TCE, 1,1,1 TCA, Methylene, Chloride
Fairplain Plaza	"	BTEX
FMB Community Bank	"	BTEX
Ham's Home Improvement	"	TCE
Harbor Plating	"	Chromium
Hoffmann Die Cast	"	Benzene, Toluene, Ethylbenzene, Xylenes
Koch Industries	"	BTEX
Martin Brothers Mill and Foundry	"	Oils, Grease
Midwest Timer	"	Chrome, Cyanide, Zinc
New Products Production Wells	"	Vinyl, Chloride, Dichloroethane
Sodus Hard Chrome Inc	"	Chromium
Swan Oil Co Station 9	"	Gasoline, Diesel Fuel
Terminal Grounds Abandoned Tank	"	PCB
Tile Mart Site	"	Cadmium, Cyanide, Arsenic, Nickel, Lead
Travel Inn Motel	"	Fuel Oil
Cast Matic Corporation	Final cleanup-PRP/ other [d]	Zinc
Electrovoice	"	Nickel, Chromium, TCE, Toluene
Shell Oil Niles Distrib Facility	"	Benzene, Toluene, Ethylbenzene
Sumtec Inc	"	Trichloroethylene, BTEX, TCA
Van Buren County		
Duo Tang Products	Highest priority	Trichloroethene, cis-1,2-DCE
Auto Specialties Hartford	No actions taken	Trichloroethylene, 1,1,1 TCE, Asbestos
Commercial St Storm Sewer	"	Chlorinated solvents
DeVrou Chevrolet	"	Trichloroethane, Xylene
Hartford Municipal Wells	"	PCE
Kalamazoo Lkshore & Chicago RR	"	PNAs, BTEX
Securit Metal Products	"	Oil, Grease, Nitrates
65108 Red Arrow Hwy. Hartford	Evaluation/interim response - fund [a]	Trichloroethylene
95th Ave Contamination	"	Tetrachloroethylene
Intersect 51st St. & 76th Ave	"	Dichloropropane
Intersect 78th Ave & 46th St	"	1,2 DCP, 1,2,3 TCP
M-51 45182	"	Carbon, Tetrachloride
Res Well Pine Grove Twp	"	Methylene, Chloride
Du Wel Metal Products	Evaluation/interim response - PRP/other [b]	Copper, Nickel, Chrome, Zinc
Duo Tang Products	"	Trichloroethane, cis-1,2-DCE
Intl Research Dev Corp	"	Ethylhexyl Phthalate, Metals
Lakeview Community Hospital	"	BETX, PNA
Paw Paw Plating	"	Cadmium, Chromium
Paw Paw Well No 5	"	Trichloroethylene, Dichloroethylene
Swing-Lo Scaffolding	"	Arsenic, Lead, Silver
Wolf Lake Fish Hatchery	"	Lead, Cyanide, Chromium
Burrows Sanitation	Final cleanup - PRP/ other [d]	Chromium, Nickel, Lead

[a] Cleanup plan not approved by MDEQ and interim response activity has been, or is being provided, by state funds.
[b] Cleanup plan approved by MDEQ and interim response activity is being provided by potentially responsible party (PRP) of other funds.
[c] Cleanup plan approved by MDEQ and remedial actions have been or are being provided by the state.
[d] Cleanup plan approved by MDEQ and remedial actions have been or are being provided by potentially responsible party or other funds.

Table 15.–Summary of groundwater contamination sites in the St. Joseph and Elkhart rivers outwash plains. Data from Indiana Department of Environmental Management (1996). Acronyms: VOC=volatile organic compounds; SOV=semi-volatile organic compounds; RCRA=resource conservation and recovery act.

Source type	Number of areas listed	Contaminants
Leaking underground storage	211	VOC
High priority RCRA sites	12	VOC, SOC, metals
Underground injection wells	761	VOC, nutrients, metals, pesticides, septic, acid
State cleanup	1	VOC
Voluntary cleanup	10	VOC
Material spills	57	VOC, SOC, nutrients, metals, pesticides, hazardous materials

Table 16.–Sites within the St. Joseph River watershed listed under the Comprehensive Environmental Response, Compensation and Liability Act or CERCLA (Superfund). Acronyms: pre-remedial (DS=discovery, PA=preliminary assessment, SI=site inspection, SP=site inspection prioritization, ES=expanded site inspection, NF=final national priority list, ND=deleted from national priority list); removals (RS=removal investigation, RV=removal action); remedial (AR=administrative record, MA=management assistance, RA=remedial action, RD=remedial design); EPA=Environmental Protection Agency; RP=responsible party.

Segment and site name	City	Last action	Date	Event lead
Headwaters				
Card & Hillsdale Site	Hillsdale	SI	9/29/92	State
Middle				
Schafer Manu./Hawkins	Union City	ES	9/29/95	State
Eddy Paper Co.	White Pigeon	SP	8/31/95	EPA
North Bronson Industrial	Bronson	RS	6/9/92	EPA
Universal Components	Bronson	RV	8/21/95	EPA
Sturges FNDRY	Sturgis	SP	9/28/95	EPA
Sturgis Municipal Wells	Sturgis	MA	6/30/95	RP
General Motors Corp.	Three Rivers	PA	12/11/92	EPA
Galen Meyer’s Dump	Osceola	RV	5/6/94	EPA
Holly Park Industries	Shipshewana	PA	11/2/94	State
Universal Forests Prod.	Granger	SP	6/14/95	EPA
Main Street Well Field	Elkhart	RA	6/30/95	EPA
HIMCO Dump	Elkhart	RD	4/13/95	EPA
Sycamore Street	Elkhart	PA	9/12/91	State
Conrail Railyard Elkhart	Elkhart	RD	6/14/95	RP
Solvent Release/Bisher	Elkhart	PA	7/24/96	State
ACCRA Pac Inc	Elkhart	AR	2/19/91	EPA
Lusher St. Groundwater	Elkhart	AR	11/9/90	EPA
Belmont-Huron Streets	Elkhart	RV	1/25/96	EPA
Woodlawn Industrial	Elkhart	RV	12/20/96	EPA
Gemeinhardt Co Inc	Elkhart	PA	11/1/93	EPA
Kendallville Transfer	Kedalville	DS	9/22/94	State
Ligoner Dump	Ligonier	SP	9/30/94	EPA
Spill Site (Fricks Service)	Wawaka	SI	9/29/93	State
Lower				
Douglas Rd Uniroyal Inc.	Mishawaka	RD	9/30/96	EPA
Wheelabrator Corp.	Mishawaka	PA	3/13/90	State
Old Mishawaka Dump	Mishawaka	SP	9/9/94	State
Mishawaka STP Landfill	Mishawaka	SP	9/9/94	EPA
Linden Road Site	South Bend	ES	9/22/95	State
Settling Pond	South Bend	SP	6/9/95	EPA
St. Joseph CO GW	South Bend	AR	9/5/95	EPA
Sands & Howell	South Bend	SI	4/6/93	EPA
South Bend Ave. Site	South Bend	SP	9/26/95	EPA
Steel Warehouse Inc.	South Bend	SP	6/16/95	EPA
JT Jennings Landfill	South Bend	PA	11/6/87	State

Table 16.–Continued.

Segment and site name	City	Last action	Date	Event lead
Lower (continued)				
Rolford	South Bend	SI	4/6/93	EPA
Whiteford Sales & Ser.	South Bend	ND	9/6/96	EPA
Sibley Machine	South Bend	PA	11/2/94	State
Former City Landfill	South Bend	SP	9/26/95	EPA
Allied Corp. Aerospace	South Bend	PA	8/2/90	State
Butternut Road Site	South Bend	SI	1/4/89	EPA
US Aviex	Niles	RS	7/7/93	EPA
Electrovoice	Buchanan	RD	11/8/95	RP
Michigan Tube Co.	Eau Claire	SP	9/28/95	EPA
Mouth				
Burrows Sanitation	Hartford TWP	RA	4/5/93	RP
Aircraft Components	Benton Harbor	NF	6/17/96	State
Auto Specialities	Benton Harbor	RV	7/31/92	EPA
Auto Specialities	Benton Harbor	PA	3/25/94	State
Benton Harbor Radiation	Benton Harbor	RV	9/1/95	EPA
Certified Metal Finishing	Benton Harbor	PA	12/9/91	EPA
Harbor Plating Works	Benton Harbor	SI	8/26/94	EPA
NW Berrien CO San Auth	Benton Harbor	SP	8/3/95	EPA
Bendix Corp/Allied	St. Joseph	RS	7/6/90	EPA
Former Whirlpool Corp.	St. Joseph	PA	1/12/94	EPA

Table 17.–July average stream temperature (°F) for the St. Joseph River and tributaries. Blanks indicate missing information.

Segment and stream	County	Site	Year	Temperature(°F) Minimum	Maximum	Mean
Headwaters						
St. Joseph River	Hillsdale	Moore		67.0	83.0	75.0
Upper						
St. Joseph River	Calhoun	22 Mile Rd		62.0	78.0	70.0
St. Joseph River	Calhoun	14 Mile Rd		63.0	75.0	69.0
Coldwater River	Branch	Gerrand		68.0	79.0	74.0
St. Joseph River	Branch	Athens		73.0	84.0	79.0
Nottawa Creek	St. Joseph	Olney Rd		65.5	86.0	74.5
Middle						
Rocky River	St. Joseph	Bent Rd		65.0	76.0	71.0
Prairie River	St. Joseph	County Line Rd	1993	57.0	73.4	65.3
Prairie River	St. Joseph	Truchenmiller	1993	68.5	83.5	77.4
Prairie River	St. Joseph	Rambadt	1993	69.4	87.3	78.1
St. Joseph River	St. Joseph	Jacksonburg Rd		70.0	84.0	77.0
Curtis Creek	St. Joseph	Corey Lake Rd	1996	50.0	62.4	55.2
St. Joseph River	St. Joseph	Constantine	1991	69.8	78.8	73.0
Pigeon River	LaGrange	South Branch		53.4	68.5	60.6
Pigeon Creek	Steuben					77.2
Lower						
Brandywine Creek	Berrien	Hwy 12	1996	51.3	63.3	57.4
Brandywine Creek	Berrien	3rd Street	1996	53.1	64.4	58.8
St. Joseph River	Berrien	City of Niles		70.7	78.8	75.2
Dowagiac River	Cass	Sink Rd	1992	60.1	72.0	64.9
Dowagiac Creek	Cass	Decatur Rd	1996	55.4	75.2	65.3
Dowagiac Creek	Cass	McKenzie Rd	1996	54.7	76.6	65.7
Dowagiac Creek	Cass	Kelsey Lake Rd	1995	57.7	75.9	66.0
Dowagiac Creek	Cass	Engle at Labars	1996	55.2	75.6	66.4
Dowagiac Creek	Cass	Marcellus Hwy	1996	56.8	79.7	68.2
Dowagiac Creek	Cass	M62 N. of La Grange	1996	62.1	78.8	72.3
Dowagiac Creek	Cass	Goodenough Rd	1995	66.6	83.3	74.3
Dowagiac Creek	Cass	M62 @ Lk La Grange	1996	62.8	82.2	76.6
Dowagiac Creek	Cass	Griffis Rd	1996	53.8	75.4	64.0
Dowagiac Creek	Cass	Dutch Settlement	1996	54.0	75.6	64.9
Pokagon Creek	Cass	Old Mill Rd	1996	51.4	62.8	57.2
Pokagon Creek	Cass	Pokagon Hwy	1996	54.1	70.3	62.1
Pokagon Creek	Cass	Wood Rd	1996	55.0	69.8	63.0
McKenzie Creek	Cass	M51	1994	62.4	73.4	67.8
McKenzie Creek	Cass	Barron Lake Rd	1994	66.2	77.0	71.2
Dowagiac River	Berrien	Old US 31		60.6	79.9	69.3
St. Joseph River	Berrien	Buchanan	1991	68.0	78.8	73.9

Table 17.–Continued.

Segment and stream	County	Site	Year	Temperature(°F) Minimum	Maximum	Mean
Mouth						
Campbell Creek	Van Buren	28th Street	1996	49.3	63.9	54.9
Brush Creek	Van Buren	63rd Street	1996	54.9	67.3	60.6
Brush Creek	Van Buren	75th Street	1996	54.1	69.8	62.2
Paw Paw River	Van Buren	57th Street	1992	60.1	73.8	65.1

Table 18.–Trigger levels for nine chemicals used by the Michigan Department of Community Health in establishment of fish consumption advisories (ppm = parts per million = mg/kg; ppt = parts per trillion).

Chemical	Advisory triggers
Total chlordane	0.3 ppm
Total DDT	5.0 ppm
Dieldrin	0.3 ppm
Toxic dioxin equivalents	10.0 ppt
Heptachlor	0.3 ppm
Mercury	0.5 ppm
Mirex	0.1 ppm
Total PCB	2.0 ppm
Toxaphene	5.0 ppm

Table 19.–Statutes administered by Michigan Department of Environmental Quality, Land and Water Management and Surface Water Quality divisions, that protect the aquatic resource. N.R.P. Act = Natural Resources and Environmental Protection Act (1994 PA 451).

State of Michigan Acts	Description of Acts
Public Health Code (1978 PA 386, as amended)	Aquatic Nuisance Control: regulates the use of substances for the treatment of swimmer's itch, and excessive aquatic plants and algae.
Part 13 N.R.P. Act	Floodplain Regulatory Authority: regulates activities that occupy, fill, and/or grade lands within floodplains of rivers.
Part 31 N.R.P. Act	Water Resource Protection: regulates discharges to surface waters according to set water quality standards.
Part 41 N.R.P. Act	Sewerage Systems: regulates wastewater or sewer system facilities.
Part 91 N.R.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.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.P. Act	Wetland Protection: regulates dredging, filling, and structure placement within wetlands.
Part 307 N.R.P. Act	Inland Lake Level: regulates the establishment of legal lake levels and lake level control structures.
Part 309 N.R.P. Act	Inland Improvement: regulates the establishment of lake boards and revolving funds to protect and improve lakes.
Part 315 N.R.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.
Part 323 N.R.P. Act	Shoreland Protection and Management: regulates construction activities within designated Great Lakes shoreline areas.
Part 325 N.R.P. Act	Great Lakes Submerged Lands: regulates certain activities on Great Lakes bottomlands, such as marina construction, dredging, filling and placement of shore protection structures.
Part 341 N.R.P. Act	Irrigation: regulates the use of Great Lakes water for irrigation.

US Federal Acts
Federal Water Pollution Control Act, Section 314 (PL 92-55)
Coastal Zone Management Act (PL 92-583, 1972)
Clean Water Act, Section 402 and 404 (PL 95-2117)
River and Harbor Act, Section 10 (1899)
Coastal Energy Impact Program (PL 92-538)

Table 20.–Designated drains in the St. Joseph River watershed, by state (bold), county (bold), and township (italics). Information provided by each county drain office.

MICHIGAN

Van Buren County

Almena
Brandywine Lake
Covey Hill
Todd
Overacker
Watkins & Wiskey Run
Olson
Hudson & Slack
Brown & Hipp
Shaefer
O'Roark & Lewis
Stevens
Paw Paw & Allegan Road
Dyer
Markley
Brand
Ritter
Armstrong, Hymes, & Paw Paw
Lockman

Antwerp
Lawton
Coldbrook
Cheeseman
Lockwood
Townline
Moon
Cook Inter-County
Paw Paw Outlet Drain

Arlington
Butterfield
Bierce & Section Line
Blaisdell & Lane
Nickols & Taylor
Cronin

Bangor
Whitmore
Tamarack
Stowe
Raven
Mud Lake
Duck Lake
Wilson
Duffy
Van Auken Lake
Sink Hole

Bangor (continued)
Holdridge
Efting
Williams

Bloomingdale
Clements
North & Extensions
Sage
Thayer Lake
Martin Lake
King McCoy
Hoffman & Mumford
McCulloch & Farnsworth
Grove & Branch
Lyle Lake
Billsborough
East Branch of North
Baughman & Ledrow Branch
Sage & North
Allen

Covert
Branch & Derby
McConnell & Olcott
Cargill Branch
Gering

Decatur
Lindsley & Branch
Eagle Lake Extension & Branch
Gates
Gates Extension
Swanson
Coldbrook
Lee & Canning
Blade & Extension
Beuchner & Millard
Power
Ives
Jackson
Maxwell & Branches
Fifield
Kinney
Dowagiac River Inter-County
Mud Lake
Latham
Spring Creek

Decatur (continued)
Red Run
Carney
Johnson & Nowlan
Haefner
Fountain
O'Rourke & Bennett
Shellenberger
Isham
Eckard
Millard & Townline
Sherburn
Harris & XConrad
Rose & Johnson
Storms-McGuire

Hamilton
Red Lake
Sherwin
Eagle Lake Extension
Shoudy
Cagney
School Lot
Fritz
Lake of the Woods
Ryan
Marsden
Kraak
Cady
Osborn
Geer
Mead
Dowagiac River Inter-County
Twin Lakes Road Inter-County
Millard & Townline
Clafflin
Wilson & Brown
Friendly Neighbors
Pine Lake
Conway

Hartford
Camp & Root
Van Auken Lake
Mud Lake
Sink Hole
Williams
Kabel

Table 20.–Continued.

Van Buren County (continued)

Hartford (continued)
Holdridge
Doyle
Woolsey
Holden
Health & Cemetery
Sherburn
Luke Conklin
Shafer #1
Lane
Hartford
Shafer #2
Oaks
Wilson Inter-County
Stickney
Johnson
Hupp Inter-County
Sherwin
Clinton
Howlett & Conklin
Woolcot Branch
Hall & Pitcher
Gridleys

Keeler
Brague
Fisher
Phillips & Walker
Sherwin
Red Lake
Mud Lake & Osborn
Barnaby
Center
Vanderlyn
Hasbein
Woodland Point
Howlett & Conklin

Lawrence
Jones
Blaisdell & Lane
Upton & Centerline
Nelson Lake
Gage
Lawrence
Reynolds Lake & Tucker
Alden & Crawford
Tuttle & Shaul
Johnson
Eagle Extension
Wison & Brown
Sherwin

Lawerence (continued)
Lanphear-Witter-Jennings
Hall & Pitcher
Branch & Fisk
Parks & Fuller
Baker, Richards, Cross & Law.
Nickols & Hollund Lake
Clark & Moffet
Cornwall
Mc Allister & Calvin
Pitcher & Cronin
Clark

Paw Paw
Buskirk
Wilson & Wildey
Moon & Allan
Carter Creek
Butler
Buckley
Cutter
Cavanaugh
Thomas
Woodman & Hudson
Howe-Webb-Labadie
Van Blaricom
Waite
Three Mile Lake & Jennings
Detmars
Gates
Lawrence-Martin
Galligan
McNeil
Hall
Eagle Lake
Graham
Dunnington Road
Lawton
Coldbrook
Gooding
Scotese
Thompson& Harrington
Mud Marsh
Scott & Tuttle
Willard, Sherman, & Gates
Griffin & Salsbury
Payne & Dunnington Road
Tuttle & Tracy
Coffman & Mumford
Richmond

Pine Grove
Brandywine Lake
Todd

Porter
Gates Extension
Van Cass Inter-County
Conklin
Andrews & Gillette
Four County Inter-County
Gravel Lake & Vincent

Waverly
Jones & Allan
McCulloch & Farnsworth
Bush
Wilson #2
Brandywine
North
Allan
Covey Hill
Indian Run
Valleau
Shears & Chase
Butterfield
Spring Run
Teman
Rich & Dillon
Carr
Rawson & Huckleberry
Conant
Elm Flat
Cleveland
Bean
Jordan
Shaefer
Swick & Smith
Owen
Woodman
Paw Paw & Allegan Road
Taylor
Carter Creek
Mud Marsh
Moon & Allan
Highway
Longwell
Carter Creek Ext.
Colburn
Buckley
Butler
Cole & Cutter
Raymond

Table 20.–Continued.

Van Buren County (continued)
Waverly (continued)
Brandywine Lake
Mather & Nowlin
Randall-Anton-Smith Rd
Armstrong-Brown & Allegan

Kalamazoo County
Climax
No. 7
Cook
No. 19
Lafever Lake
Eldred
Willow Swamp
Bush
Pierce
No. 14
Longman
Sager & Enler Bear Creek
Osborn
Jones
Johnson North
Johnson South
Johnson
Ford
Ford Branch
Brown
Wakeshma
Proctor
Four Towns

Pavilion
Mather
Hamilton
Big Marsh
Adams
Briggs
Knapp
Cook
Moore
Mathews
Hass
Nash

Wakeshma
N. Parker
Hendrixson
Snyder & Snyder
Carter & Bower
Sager & Enler Bear Creek
Fulton
Comp & Holland

Wakeshma (continued)
Little Portage Creek
Snake
Brady
Northam
Indian Lake
Henry
Grovenburg
Reinbold
Murray
Parker
Martin
Burdick
Crouchy
Bear Creek Extension
Prolo
Axtell
Annis
Seminar
Falcon
Honeysett
Mayer
Fisher
Vicksburg
Shick
Strome
Section Line
Mattis

Schoolcraft
Follmer
Roberts

Prairie
Andrews & Gillet
Calvert
Buell & Murray
Lee Clark

Hillsdale County
Adams
Adams 3
Adams Hwy
Broomcorn
Broomcorn Extension
Lake Adams
Big Hog
Reynolds

Allen
Sand Creek
Soap Creek

Allen (continued)
Donnelly
McConnell
Swaney
Allen #3

Fayette
Emery

Hillsdale
Emery Br 1
DuBois
Frankhauser
Phillips
Carleton

Litchfield
Doty Chamberlain
Sand Creek
Fairbanks-Adams
Lindsey
Booream
Jennings
Litchfield
Soap Creek
Perry Thompson
Bowen Creek
Small

Reading
Murray
Null
Gaye
Morning Glory
West Reading Road

Wheatland
Shull
Church
Otto

Cass County
Calvin
Chess
East
Goodwin
Goose and Mud Lake
Northrup
Long Marsh
Section Ten

Table 20.–Continued.

Cass County (continued)

Howard
Bame and Huntley
Brandywine
Dibble
Dodd and Doane
Knowlton and Miller
Mud Lake
Mud Lake Extension
Ely Creek
Mays-Martin

Jefferson
Emmons and Moran
Goose and Mud Lake
Mud Lake Extension
Pleasant Lake
Adams-Simpson

La Grange
Kingsbury
Park Shore #1
Park Shore #2

Marcellus
Van-Cass
Eggleston
Four County & Calvert
Hayes
Mud and Pine Lake
Nottingham and Jones
Red Run and Extension
Swift Lk & Prairie Ronde
Bartlett
Hoover-Kelly

Mason
Mud Lake-Mason Consolidated
Long Marsh
Firestone
Burema Beach

Milton
Brandywine
Brandywine East Branch
Brandywine West Branch
Knowlton & Miller
Peter Truitt
Lacey
Mud Lake
Bame & Huntley

Newberg
Colton and Brown
Hartman
Kirk Lake
Russey
Lilly Lake
Poe
Draper Miller
Jones
Harwood Lake Dam
Long Lake Level Control

Ontwa
Pleasant Lake
Beaver Dam & State Line
Garver Lake
Garver Lake Level Control
Eagle Lake Control
Lawndale
French's Landing

Penn
Big Huckleberry Marsh
Big Huckleberry Extension
Jones and Thompson
Kirk Lake
Youngs Prairie Marsh
Hilderbridle

Pokagon
Dowagiac River
Cleary
Frantz
Groat & Wyant
Johnson Street
Owen and McCoy
Peavine North Branch
Smith Lake
Stock Farm
Swamp & Rapp
Miller & Roberson

Wayne
Dowagiac River
Gard & Pendergrass
Pine Lake
Pine Lake Branch
Pitcher
Lawrence and Maxon
Lee & Hungerford
Garland
Ruple

Wayne (continued)
Osborne (Wilson)
Twin Lakes Water Level
Twin Lakes Road Branch

Porter
Henderson
Draper & Miller
Shavehead Lake Dam
Union & State Line

Silver Creek
Dowagiac River
Hays
Jerue & Flynn
Lyle & Daily
Owen & McCoy
Parks & Jones
Patrick Hamilton
Pine Lake
Salts
Reed
Clark
Mann
California
Magician Lake

Volinia
Gould
Robinson
Swift Lk & L. Prairie Rhonde
Roy
Red Run
Whitaker
Whitaker NE Extension
Whitaker Branch B
Whitaker Branch C
Finch Lake Dam
McLillan Dam

Saint Joseph County

Burr Oak
Findley
Brooks
Eberhard
Needham
Saddawasser
Hog Creek Lake Drain
Sandorn and Hog Creek
Dry Lake
Lawrence & Reed
Johnson Kelly

Table 20.–Continued.

Saint Joseph County (continued)

Burr Oak (continued)
Wood & Watson
Moore Betts
Shaw Acker
Skirvin
Stewart Lake
Reed & Hagan
Plum
Graves
Seilkins
Gordon
Gillette

Colon
Gorton
Benedict Lake
Ames
Bear Creek
Yeatter
Beaver Marsh
Thornton
Bartholomew Spring Creek
Colon #1
Keightly
Davis
Little Swan Creek
Copenhafer Extension
Marvin
Freeman
Brooks

Constantine
Mill Creek Sec. #4 & #5
Kiser
Berkley and Reed
Hassinger
Thomas

Fabius
Semberling
Gill and Try
Goose Lake
Corey Lake
Profile Lake

Fawn River
Graves
Gillette
St. Joseph & Branch Iter-Co
Sweet Lake
Moe
Plum

Fawn River (continued)
Bristol
Himebaugh
Fawn River

Florence
Harrison East
Harrison West
Cook
Hepner
Kiser Bickel
Moore & Burgener
Hull Gaul
Hallwood
Branch No 2
Moore & Wordleman
Mandigo
Kehoe & Meert
Meert
Fillams
Branch No 1

Flowerfield
Dent
Four County
Staphweather
Casten
Hoover Kelly
Hartman Casile
Park & Flowerfield
Gill Fry
Cooper
Miller
Cranberry
Section 36

Leonidas
Carter
Silas Kline
Snake
Wakeshma
Smith Woodworth
Portage Creek
Metty Rice
Yaple
Watkins
Clarks
Outwater
Plug Extension
Town Line
Plug
Tutewiter

Leonidas (continued)
Farnham
Ainsley
Shannon & Guthrie
Bennett Birch
Mc Cauley
Benedict Lake

Lockport
Handshaw
Oldorf
Lockport & Nottawa

Mendon
Cole & Darling
Bear Creek
Section Line
Leon., Mendon, & L. Portage
Metty
Smith & Tyler
Portage Lake
Garman Foster
Fletcher
Section 28
Laird, Thompson & Doan

Nottawa
Nottawa No 1
Wilcox
Colon No 1
Wabepi
Simpson
Hasbrook Mumby
Klady
Warren
Mc Kercher

Park
Section 7
Hill
Park
Felker
Moorepark
Garman Foster

Sherman
Fowler
Reed
Sacawasser
Carl

Table 20.–Continued.

Saint Joseph County (continued)

Sturgis
Nye
Section 16
Winger

White Pigeon
Marl Lake
Stevenson

Calhoun County

Leroy
Shu-Pixen
Allen & Davis
Dog-Town

Athens
Dog-Town
Waterman
Athens-Indian Creek
Histand
Nottowa Creek
Taylor
Snyder
Brokaw
Rowe & Wallace
Section 35

Newton
Root
Laupp
Stylers
Goff
Fanning
Woodward Extension
Branch
Smith & Hyde
Yost & Francisco
Rocho
Mud Creek & Fanning
Phillips
Houghton
Porter
Alder Creek

Fredonia
Smith & Hyde
Thwing & Hutchins
Kidney & Snyder
Nottowa Creek
Pine, Long, & Fish Lakes
Gleason
Goodrich & Nottowa

Fredonia (continued)
E.F. Goodrich
Herron & Nottowa
East-Nottowa Creek

Homer
Brewer
Dryer

Burlington
Barnes
John Wood
Cronkhite
Alder
Kemler
Buell
Miller & Melody
French
Nottowa Creek
Pulman & Knapp
Tonciet
Hudson
Lucas
Rowe Wallace
Clay
Fox Extension
Parks
Summit

Tekonsha
Heath & Bartlett
Bach & Ellis
Black Lake
Boston
Werner
Acker
Acker Extension
Mitchel
Hartson
Len Dean
Brown & Osborn
Failing
Dorris & Schaffer
Hill & Granger
Hill
Tamarack Creek
Tekonsha Creek
J.C. Blake
Still
Union & Tekonsha
Wagner

Clarendon
Goose Pond
Andrews
Keeney
Clarendon & Eckford
Ball
Drain No 3
Hess
Bolton
Hoeness
Dryer
Sloan
Lawrence & Brooks
Drain No 1
Drain No 2
Sweet
Goodrich
Rams Horn
Ford
Shilling
Powers
Tekonsha Creek
Pritchard
Tamarack Creek
Doolittle
Eldred

Branch County

Algansee
Swaney
Ransom
Hermance
Pridgeon & Warner
Townline
Archer
Gray
Stone Creek
Algansee No 81
Hendriks
Hendriks Branch 1
Hendriks Branch 2
Schultz
Wilmarth
Algansee No 89
Purdy
Southworth
Tal
George
Calvin
Stowe
Briggs
County No 51

Table 20.–Continued.

Branch County (continued)

Algansee(continued)
Bradley Joint
Price
Braman
Algansee No 14
Tellahassee Creek
Hall
Algansee No 66
Algansee No 60
Clark

Batavia
Joint No 3
Joint No 19
Union & Batavia No 18 & 20
Union & Batavia No 10
County No 5
Batavia No 15
Batavia No 3
Batavia No 4
Batavia No 1 & 7
Batavia No 6
Batavia No 2
Batavia No 16
County No 20
Batavia No 32
Batavia No 78
Batavia No 8
Batavia No 11
Benton & Batavia No 7
Batavia No 17
County No 47
Bethel No16

Bethel
County No 47
Bethel No 18
Sylver
Bethel No12
Swan Creek
County No 14
Bethel No 34
Bethel No 83
Bethel No 35
Bethel No 36
Bethel No 13
Bethel No 30
Bethel No 84
Bethel No 27
Bethel No 23
County No 6 & 3
Betney & Bronson No 451

Bethel (continued)
Bethel No 22
Bethel No 20
Bethel No 28
Bethel No 91
Bethel No 3
Bethel No 15
Hog Creek No 40
Branch 81 of Co 851
Bethel No 24
Bethel No 29
Bethel & Ovid No 8

Bronson
Swan Creek
Monroe
County No 30
Branch No 3 of Co 30
Bronson No 11
County No 21
Holmes
County No 56
Sackett
Earl No 1
County No 1
Bronson No 6
Bronsom No 7
Bronson No 1
Branch No 3 of Co 1
Adams No 19
Dunn No 20
County No 10
Bronson No 9
Bronson No 13
County No 41
Bronson No 12
Bronson No 5
Bethel & Bronson No 4 & 1
Hog Creek No 5
Hog Creek No 4
County No 25
Bronson No 6
Snippy
Bronson No 14
Sutter & Pinney
Havens No 19
Daley No 35
County No 25

Butler
Drinkwater
County No 50
Powers
Tekonsha Creek
County No 30
Vicory & Bursley No 10
Soap Crek No 15
Warren Creek
Menslick
Holmes
Lucas & Burch
Butler No 22
Knowles Co
Knowles Co Branch No 1
Allen
County No 2
Messenger & Bush
County No 33
Bowen Creek

California
Calif. No 67
Calif. No 67 Branch 1
Pridgeon & Warner
Cass
Tallahassee Creek
Calif. No 2
Hall
Calif. No 66
Townline
Calif. No 88
Calif. No 63
Withington Lake

Coldwater
County No 33
Joint No 3
State School
Benton Pond
Branch No 2 of Co No 15
Coldwater No 1
County No 15
Branch No 1 of Co No 15
South Branch of Co No 15
County No 1
Dickey
County No 22
County No 40
Alden No 26
William No 20
County No 63

Table 20.–Continued.

Branch County (continued)

Coldwater (continued)
County No 65
Coldwater No 76

Gilead
County No 23
Gilead No 2
Weaver Br 1
Weaver Br 2
Ritter
Hog Creek
Gilead No 5
Lanes
Gilead No 6
County No 54
Gilead No 3
Gilead No 9
County No 39
County No 59
Gilead No 7
Gilead No 10

Girard
Tekonsha Creek
Sherman
Girard No 9
County No 57
Girard No 3
Girard No 8
Girard No 15
Girard No 4
Girard No 5
Warren Brook
Girard No 6
Girard No 25
Girard No 20 & 34
Girard & Butler No 90
Girard No 2
County No 4
Girard No 49
County No 6
Girard Extension
Girard No 23
County No 33

Kinderhook
Withington Lake
Kinderhook No 1
County No 53
Hilton
Gilead No 2
County No 39

Kinderhook (continued)
Kinderhook No 4
Kinderhook No 2
Kinderhook No 8
Kinderhook No 3

Matteson
County No 16
County No 5
Strong
County No 17
Branch No 1 of Co No 17
Tilton
McCarty
Ames
Matteson No 70
Yeatter
Little Sand Creek
Case
Rich
Batavia No 16
County No 21

Noble
County No 25
Sutter & Pinney
Blosser
Noble No 3
Noble No 1
Nobel No 4 & 5
Burr Oak
Himebaugh
Honey Lake

Ovid
County No 40
Ovid No 69
Branch No 31
Branch No 32
Rappaleye
Ovid No 80
County No 24
Ovid No 7
Betts
County No 52
County No 62
Tallahassee Creek

Quincy
Quincy No 68
Quincy No 8
County No 8

Quincy (continued)
Noble
Sparks
County No 33
Burton
Quincy No 15
Quincy No 37
County No 64
Quincy No 10
County No 60
Quincy No 1
Quincy No 2
Bowen
Quincy No 18
County No 22
County No 23
Quincy No 9

Sherwood
Summit
Stanton
Kindig
Sherwood No 60
County No 18
Billings
Sargent
Fimple
Cline
Buell
Kilbourn
Hill
Specer
Sherwood No 89
Blackwell

Union
Union & Tekonsha
Union No 11
Speaker
Allen
Union & Girard No 15
County No 18
Lee
Lincoln
Ford
County No 46
Buell No 10
County No 58
Union No 12
Morse No 20
Union No 13
County No 14

Table 20.–Continued.

Branch County (continued)
Union (continued)
Union & Batavia No 10
Union No 8
Joint No 3

Berrien County
Watervliet
Schoorover
Branch & Derby
Sherwood
Wilson
Watervliet
Knapp
Morelock & Allen
Morelock & Schearer
Holle & BuJack
Bucher
Hupp
Red Arrow

Lincoln
Hickory Creek
Halliday
Glenlord Road
Lawrence
Keeler
Davis
Sullivan
Williamson
Parker
Morrow

Baroda
Hickory Creek
Big Feather
Town Corners
Hausei & Hendrix
Starr & Wellington
Miller
Singer Lake Outlet
Phiscator & Wetzel
Fowler
Beebe
Hyatt
Little Hickory Creek

Lake
Keeler Creek
John & Emlong

Buchanan
Weaver Lake Drain
Clear Lake

Bertrand
Pike Lake Drain
Dixon & Dye
McCoy Creek

Niles
Spring Valley
Franz
Norton
Ely Creek
Metzger & Thompson

Oronoko
Moatz
Hall & French
Edison, Williams, & College
Singer Lake
Beaver Dam
Bihlmire & Martin
Bihlmire & Nelson
Stearns
Hollenbeck & Ryan
Grays Run
Lutz
Billy Graham
Lemon Creek
Lemon Creek Ext.
Yellow Creek

Royalton
Yellow Creek
Greenbook Estates
Palisades
Elm Flat
Boswell & Briney
Bartz & Bender
Weed & Fogle
Smith & Metzger
Tobias
Buckhorn
Brunke
Buckhorn Outlet
Sinn & Burkett

Saint Joseph
Hickory Creek
Cleavland
Nelson

Saint Joseph (continued)
Anderson & Smith
Royalton Heights
Dozer

Sodus
Howard & Sink
Strome
Sink & Stewart
Jerue
Akright
Dana & Rector
Bauske & Simper
Bittner & Rector
Benke
Winters
Allen & Taylor

Pipestone
Pipestone Creek
Jenning
Kerstetter
Lewis & Thompkins
Pipestone Lake Drain
Moss Lake
Langlan
Aumack & Kelly
Mud Lake
Zech
Easton
Greenfield & Smallage
Vladic
Clark
Crooked Brook

Bainbridge
BuJack
Sonnenberg
Geisler & Kneibes
Potes
Kammerer
Kitron
Molter
Breit
Yund & Ellis
Brant & Dix
Yore & Stoeffer
Porter Brant
Russell
Hill
Slinker
Pipestone Lake

Table 20.–Continued.

Berrien County (continued)
Bainbridge (continued)
Wooten & Bishop
Reese & Merrill

Benton
Twelve Corners
Barnes & Hamilton
George & Johnston
Wright & Woodley
Stewart & Hess
Flood
Ox Creek
Lempke & Long
Yore & Stoeffer
McCrome & Zimmerman
Kelley & Miller
Sink & Stewart
Knapp, Stewart, & Kent

Hagar
Rogers Creek
Morgan
Riverside
Curtis
Granger
Fiehler
Defields
Thompson
Russel & Havens
Bauske & Brado

Coloma
Becht & Peck
Dedrick-Johnson
Dedrick
Cutler & Schmidt
Beryman
Hudson
Howe, Ryno, & Worden
Defield & Crumb
Little Paw Paw Lake

Berrien
Eau Claire
Dwan & Kerstetter
Eau Claire Ext.
Berrien Centers Ext.
Berrien Centers
Major & Michael
Groat & Wyant
Spring Valley Ext.

INDIANA
Elkhart County
Baugo
Manning Osborne
Cobus Creek
Crawford
Baugo Creek
Rogers

Benton
Ben Blue
Bollinger
Damey
Dry Run
Hinderer
Hire
Horn
Juday
Long
McNutt
Meyer
Millersburg
Stetler
Stiver
Stoney
Worley
Zollinger

Cleveland
Cobus
Manning Osborne
Thorton

Concord
Bechtel
Bock Ditch North
Cline
Christiana Creek
Fulmer
Howard
New Miller - Stutzman
Pine Creek
Riggle
Sailor
Shaffer
Stauffer
Yellow Creek

Clinton
Anan
Berkey
Boyer
Farmwalt

Clinton (continued)
Fryberger & Lutz
Horn
Horn-Berkey
Horn-Rockinbaugh
Horn-Scrannage
Horn-Hess
Horn-Green
Horn-Elliot
Horn-Price
Horn-J.C. Stroup
Horn-Garver
Horn-Cripe-Metz
Horn-Cripe
Horn-Chiddister
Lehman
Lorhi-Cripe-Lehman
Marty
McCallister
Philps
Rink
Rock Run
Rohrer
Stoney Creek
Vance Swilhart

Elkhart
Boyer
Elkhart River
Horn
Horn-Kauffman
Horn-Collins
Horn-Yoder
Hydraulic Canal
John M. Hoover
Leedy
Rock Run
Swoveland
Turkey Creek

Harrison
Adam B. Miller
Anglemeyer-Loucks
Bock Ditch South
Fetters Martin
Fetters Pletcher
Fulmer
Hoke
Huber Powles
Kehr
Landis
Leedy

Table 20.–Continued.

Elkhart County (continued)
Harrison (continued)
Little Yellow Creek
New Miller-Stutzman
Nunemaker
Owl
Shaffer
Swoveland
Werntz
Wise
Yellow Creek

Jackson
Berkey
Darr
Dausman
Elkhart River
Hydraulic Canal
Josiah Neff
Kiefer
Kitson
Preston Miles
Schriver
Swoveland
Turkey Creek
Twaits
Whetten
Worley
Zollinger

Jefferson
Barthol
Comstock
Hildreth
Indian
John Hoover
Karn
Kessler
Menges
Osborne
Pine Creek
Rowell
Sailor
Snively

Locke
Wisler
Holderman
Doering-Davidhizer-Christoph.
Adam B. Miller
Weldy

Middlebury
Boyer
Karch
Little Elkhart River
Mather
Pine Creek-North
Pine Creek-South
Pfeiffer
Rowe-Eden
Stutz

Olive
Barkley
Baugo Creek
Billman
Grimes
Harrington
Nunamaker
Olive
Pletcher
Weldy
Werntz
Wisler

Osolo
Bishop
Christiana Creek
Coe Meyer
Kindig
Kellog
Mather
Osolo
Pine Creek
Pratt
Puterbaugh Cr.-Jocob Meyers
Rhinehart

Union
Berlin Court
Dausman
Doering-Davidhizer-Christophe
Havestick Darkwood
Jerome D. Smith
Kauffman
Louis Mishler
Mishler
Stuckman
Swoveland
Wagner
Wagner-John Drake
Weaver
Wisler

Washington
Corpe
Kellog
Little Elkhart River
Menges
Sheep Creek
Washington Township
York Township

York
Corpe
East Lake
Little Elkhart River
Lovejoy
Mather
York Township
York-Middlebury Twp South
York-Middlebury Twp North

Kosciusko County
Jefferson
Omar-Neff
Davison

Van Buren
Preston
Davison
Coppes
Hammond
Hoopingarner
Perry Mathews

Turkey Creek
Baker Arm
Hoopingarner
Skinner
West Lake
Meyer

Steuben County
Fremont
Gleason
Kinsey-Dygert
Deller
Albright
Weaver-Grove
Griffin
Painter-Dally
Ryan-Reppard

Table 20.–Continued.

Steuben County (continued)
Jackson
Munger
Hammond-Greeno
Mundy
Stout

Jamestown
Ayres
Lucas

Millgrove
Webb
Merill-Sanders-Barber
Roberts-Giles-Swiger
Lucas

Otsego
Dole
Zabst
Johnson

Pleasant
Carpenter
Croxton
DeLancey
Cole
Wood

Salem
Walters
Clay-Deller
Deller-Mortorff
Munger
Hammond-Greeno
Deetz
Slick
Conrad
DeWitt-Weicht-Sparks
Hovarter
Teal
Nelson
Nelson Lateral 6
Schweitzer
Miller
Krehl
Wagner
Kirlin Lateral
Hughs
Lower Turkey Creek
Camp
Middle Turkey Creek
Monroe-Wright 2

Salem (continued)
Chasey
Allen
Town of Hudson
Town of Hudson Storm
Upper Turkey Creek

Scott
Kinsey-Dygert
Dole
Berlien
Sanders
Cole
Eatinger 2
Metz-Balding-Goodale
Ryan-Reppard
Jack

Steuben
Walters
Hoyer
Clay-Deller
Deller-Mortorff
DeLancey
Crampton
Carver
Wood
Malone 2
Malone Lateral 10
Teal

York
Ryan-Reppard

Dekalb County
Fairfield
Bickel
Albert
Hovarter
Barkley
Smith
Carter
Deetz
Nelson
Fifer
Higgea
Reinoehl
Wilsey

Noble County
Allen
Bixler
Kraft
Lash
Lane
Aungst
Aungst-Shaffe
Aungst-Holsinger
Gretzinger
Penn
McKee
Crothers
Varner
Dolan
Roush
Moree
Yeiser
Yarian-Wolf

Clay
Sec. 29
Laurel Rd
Pipeline Rd
Clay
Sec. 18
Sec. 21

German
Sec. 10
Sec. 15-1
Sec. 15-2

Portage
Bowman Creek
Ironwood

Center
Eberly
Center
Sec. 35-1
Sec. 35-2
Sec. 35-3
Sec. 2
Sec. 12
Sec. 18-1
Sec. 18-2
Sec. 18-3

Greene
Eberly

Table 20.–Continued.

Noble County (continued)

Penn
Woodward
Woodward Ext. 1
Woodward Ext. 2
Woodward Ext. 3
Woodward Ext. 4
Woodward Ext. 5
Eller
Eller Ext. 1
Eller Ext. 2
Blackberry Rd
Eller Ext. 3
Harrison Rd

Elkhart
Gonser
Eddy
Shull-Rowe
Marshall
Frick
Pancake-Remmell
Stewart
Remmell
Boyd
Harrison-Boyd
Hunter
Mawhorter
Huston
Kessler-Ramer
Palmer
Jacobs
Smalley
Brill
Schwab
Kinnison
Cook
Rink
Peffer
Yant

Green
Varian
Hanlon
Engle
Thomas
Forker
Hoffman
Sherwood
Easterday
Parker

Jefferson
Gretzinger
Boughey
Stillinger
Huston
Knox
Hardendorff
Croft
Weimer
Rimmell
Halferty
McFarland
Moree
Clapp
Melvin
Black
Stanley
Neal
Lewis
Summers
Hines
Brumbaugh
Steffey
Easterday
Roush
Yarian

Noble
Thumma
Roscoe
Oliver
Forker
Phillips
Braden
Parker
Depew
Stewart
Winebrenner
Galloway
Thomas Ott
Wildcat
Mayfield
Seymour
Crandall
Clark
Prickett
Wolf Lake
Surfus
Marker
Sherwood
Smalley
Prichard

Noble (continued)
Sinkhole
Rockey
Line
Beal
Davis-Nobles

Orange
Strayer
Raber
Holsinger
Gonser
Shultz
Blanchard
Oviatt
Rimmell
Swogger
Gretzinger
Strater
Boughey
Weaver
Frick
Stillinger
Ramer
Singery

Perry
Damey
Slabaugh
Simpson
Miller
Chiddister
Green
Kadleck
Sparta Lake
Smith
Stuff
Leslie
Kimmell

Sparta
Sparta Lake
Kalbeck
Kimmell
Swager
Earnhart
Feldheiser
Gorsuch
Kirkland
Gloyd
Iden
Buckles

Table 20.–Continued.

Noble County (continued)

Sparta (continued)
Cromwell
Norris
Launcer
Clingerman
Galloway

Swan
Yarian

Washington
Buckles
Piper
Galloway
Ritter

Wayne
Hutchins
Uhl
Strayer
JW Uhl
Auman
Kimmell
Devoe
Oviatt
Frey
Hill
Waterhouse
Kendallville
Ivey
Henderson
Bixler
Sherman
Aungst

York
Huston
Palmer
Peffer
Willets
Pollock
Chas. Bender
Crothers
Norris
Black
Starmer
McLallen
Kirkpatrick
Earnhart
Pleasant
Long
Knox

York (continued)
Weeks
Thumma
Roscoe
Sparrow
Hursey

Saint Joseph County

Harris
Judy Creek
R3E/R4E
Sec. 25
Sec. 26
Bittersweet Rd
Buckeye Rd
Willow Creek
Gast Ditch

LaGrange County

Bloomfield
Appleman
Cohler
Debow
Fly Creek
Gilhams
Kilpatrick
Mc Coy
Mc Nutt
Pigeon
Powers
Richards
Rowe
Royer
Sisson
Stoner
Wade

Clay
Bontrager
Chrystler
Gilhams
Hostetler
Kauffman
Long
Mc Mannus
Metzger
Rowe
Van Natta
Vaughn

Clearspring
Blough
Buchanan
Buck Creek
Charles
Colwell
Dunten
Gonser
Hostetler
Kime
Long
Miller
Miller
Ramer
Schermerhorn
Sigler

Eden
Bobeck
Eden
Fox
Hostetler
Elkhart Ditch
Miller
Phillips
Prough
Schrock
Yoder
Zook

Greenfield
Bradford
Graves
Knight

Johnson
Affolder
Appleman
Baugher
Broughton
Buck Creek
Case
Colwell
Fly Creek
Hart
Hogue
Logan
Royer
Stoner

Table 20.–Continued.

La Grange County (continued)

Lima
Fly Creek
Hawkins
Hoerl
Mc Mannus
Ontario
Pigeon
Rowe
Sexauer

Milford
Cochran
Deal
Debow
Fly Creek
Francis
Hassell
Hutchens
Lieberenz
Long
Lovett
Maumee
Newman
Powers
Randol
Reinhart
S. Milford
Spaulding
Strayer
Turkey Creek

Newbury
Bontrager
Brandberry
Dalman
Davis
Eash
Eden
Farver
Haarer
Hostetler
Elkhart Ditch
Mather
Miller
Page
Prough
Stahley

Springfield
Alleshouse
Danner
Debow
Fair
Huss
Kurrle
Pigeon
Powers
Reichard
Sanderson
Spangle
Turkey Creek
Wade

Van Buren
Pigeon
Schrock
Snyder
Truesdale
Vannepps
Wenger
Wolf
Fetch
Huff
Page

Table 21.–List of fishes historically found in the St. Joseph River watershed. Compiled by G.R Smith, University of Michigan, Museum of Zoology, E.M. Hay-Chmielewski and J.K. Wesley, Michigan Department of Natural Resources, Fisheries Division.

Common name	Scientific name
Lampreys	
Chestnut lamprey	*Ichthyomyzon castaneus*
Northern brook lamprey	*Ichthyomyzon fossor*
Silver lamprey	*Ichthyomyzon unicuspis*
American brook lamprey	*Lampetra appendix*
Sturgeons	
Lake sturgeon	*Acipenser fulvescens*
Gars	
Spotted gar	*Lepisosteus oculatus*
Longnose gar	*Lepisosteus osseus*
Bowfins	
Bowfin	*Amia calva*
Freshwater eels	
American eel	*Anguilla rostrata*
Herrings	
Gizzard shad	*Dorosoma cepedianum*
Minnows	
Central stoneroller	*Campostoma anomalum*
Satinfin shiner	*Cyprinella analostana*
Spotfin shiner	*Cyprinella spiloptera*
Steelcolor shiner	*Cyprinella whipplei*
Brassy minnow	*Hybognathus hankinsoni*
Striped shiner	*Luxilus chrysocephalus*
Common shiner	*Luxilus cornutus*
Pearl dace	*Margariscus margarita*
Hornyhead chub	*Nocomis biguttatus*
River chub	*Nocomis micropogon*
Golden shiner	*Notemigonus crysoleucas*
Emerald shiner	*Notropis atherinoides*
Silverjaw minnow	*Notropis buccatus*
Blackchin shiner	*Notropis heterodon*
Blacknose shiner	*Notropis heterolepis*
Spottail shiner	*Notropis hudsonius*
Rosyface shiner	*Notropis rubellus*
Sand shiner	*Notropis stramineus*
Mimic shiner	*Notropis volucellus*
Pugnose shiner	*Notropis anogenus*
Northern redbelly dace	*Phoxinus eos*
Bluntnose minnow	*Pimephales notatus*

Table 21.–Continued.

Common name	Scientific name
Minnows continued	
Fathead minnow	*Pimephales promelas*
Blacknose dace	*Rhinichthys atratulus*
Longnose dace	*Rhinichthys cataractae*
Creek chub	*Semotilus atromaculatus*
Suckers	
Quillback carpsucker	*Carpiodes cyprinus*
Longnose sucker	*Catostomus catostomus*
White sucker	*Catostomus commersoni*
Creek chubsucker	*Erimyzon oblongus*
Lake chubsucker	*Erimyzon sucetta*
Northern hog sucker	*Hypentelium nigricans*
Black buffalo	*Ictiobus niger*
Spotted sucker	*Minytrema melanops*
Silver redhorse	*Moxostoma anisurum*
Golden redhorse	*Moxostoma erythrurum*
Shorthead redhorse	*Moxostoma macrolepidotum*
Greater redhorse	*Moxostoma valenciennesi*
Catfishes	
Black bullhead	*Ameiurus melas*
Yellow bullhead	*Ameiurus natalis*
Brown bullhead	*Ameiurus nebulosus*
Channel catfish	*Ictalurus punctatus*
Stonecat	*Noturus flavus*
Tadpole madtom	*Noturus gyrinus*
Brindled madtom	*Noturus miurus*
Flathead catfish	*Pylodictis olivaris*
Pikes	
Grass pickerel	*Esox americanus vermiculatus*
Northern pike	*Esox lucius*
Muskellunge	*Esox masquinongy*
Mudminnows	
Central mudminnow	*Umbra limi*
Trouts	
Lake herring	*Coregonus artedi*
Lake whitefish	*Coregonus clupeaformis*
Round whitefish	*Prosopium cylindraceum*
Lake trout	*Salvelinus namaycush*
Trout-perches	
Trout-perch	*Percopsis omiscomaycus*
Pirate perches	
Pirate perch	*Aphredoderus sayanus*

Table 21.–Continued.

Common name	Scientific name
Codfishes	
Burbot	*Lota lota*
Killifishes	
Banded killifish	*Fundulus diaphanus*
Starhead topminnow	*Fundulus dispar*
Blackstripe topminnow	*Fundulus notatus*
Silversides	
Brook silverside	*Labidesthes sicculus*
Sticklebacks	
Brook stickleback	*Culaea inconstans*
Ninespine stickleback	*Pungitius pungitius*
Sculpins	
Mottled sculpin	*Cottus bairdi*
Slimy sculpin	*Cottus cognatus*
Sunfishes	
Rock bass	*Ambloplites rupestris*
Green sunfish	*Lepomis cyanellus*
Pumpkinseed	*Lepomis gibbosus*
Warmouth	*Lepomis gulosus*
Bluegill	*Lepomis macrochirus*
Longear sunfish	*Lepomis megalotis*
Smallmouth bass	*Micropterus dolomieu*
Largemouth bass	*Micropterus salmoides*
White crappie	*Pomoxis annularis*
Black crappie	*Pomoxis nigromaculatus*
Perches	
Greenside darter	*Etheostoma blennioides*
Rainbow darter	*Etheostoma caeruleum*
Iowa darter	*Etheostoma exile*
Barred fantail darter	*Etheostoma flabellare flabellare*
Least darter	*Etheostoma microperca*
Johnny darter	*Etheostoma nigrum*
Yellow perch	*Perca flavescens*
Logperch	*Percina caprodes*
Blackside darter	*Percina maculata*
Walleye	*Stizostedion vitreum*
Drums	
Freshwater drum	*Aplodinotus grunniens*

Table 22.–Non-indigenous fish species in the St. Joseph River watershed (Michigan Department of Natural Resources, Fisheries Division, unpublished data).

Common name	Scientific name
Sea lamprey	*Petromyzon marinus*
Alewife	*Alosa pseudoharengus*
Goldfish	*Carassius auratus*
Common carp	*Cyprinus carpio*
Rainbow smelt	*Osmerus mordax*
Rainbow trout	*Oncorhynchus mykiss*
Coho salmon	*Oncorhynchus kisutch*
Chinook salmon	*Oncorhynchus tshawytscha*
Brook trout	*Salvelinus fontinalis*
Brown trout	*Salvelinus trutta*
Striped bass x white bass hybrid	*Morone saxatilis* x *Morone chrysops*
Redear sunfish	*Lepomis microlophus*

Table 23.–Fish stocking in the St. Joseph River watershed, 1986-1996. Data from Michigan Department of Natural Resources, Fisheries Division and Indiana Department of Natural Resources, Division of Fish and Wildlife. Non-indigenous species are in bold, and strains of species are in italics. Age codes: SF = spring fingerling, FF = fall fingerling, YR = yearling, and AD = adult.

Segment and stocking location	Species and strain	Years	Total number
Headwaters			
Baw Beese Lake	**Redear sunfish**	91, 93, 95	171,850
	Walleye SF	86	17,248
	Walleye FF	86	500
Sand Creek	**Brown trout -** *Plymouth Rock*	88, 91	4,785
	Brown trout - *Soda Lake* FF	87	12,500
	Brown trout - *Soda Lake* YR	87, 89, 90	5,238
	Brown trout - *Wild Rose*	86	1,500
Upper			
St. Joseph River	Channel catfish FF	88	10,000
	Channel catfish YR	89, 91, 95	15,300
	Walleye - *Muskegon* SF	91	32,160
	Yellow perch	88	10,000
Hemlock Lake	**Redear sunfish**	90, 91, 92	35,308
	Walleye SF	86	2,000
	Walleye FF	86	1,335
Carpenter Lake	Walleye SF	86	1,000
Long Lake	Walleye SF	86	1,000
Union Lake	Bluegill	90, 93	135,100
	Channel catfish YR	87, 89, 90-92, 95	55,021
	Channel catfish AD	88	10,000
	Largemouth bass	86	3,000
	Northern pike	87-91	77,911
	Redear sunfish	89, 90	13,278
	Walleye SF	86	1,000
	Walleye - *Muskegon* FRY	94	175,000
	Walleye - *Muskegon* SF	87, 88, 94, 95	136,200
	Walleye - *Muskegon* FF	87, 93	19,500
Oliverda Lake	**Redear sunfish**	90	8,000
Coldwater Lake	Tiger muskellunge	86, 89, 91	16,000
	Walleye SF	86	54,438
	Walleye - *Muskegon* SF	92, 93, 94	499,984
	Walleye - *Muskegon* FF	88, 89, 92	89,604
Huyck Lake	Walleye FF	91	1,000
Marble Lake	Walleye - *Muskegon*	87	18,800
Little Rose Lake	Hybrid sunfish	90	1,450
	Walleye SF	90	500
Lake Lavine	**Rainbow trout -** *Arlee*	90, 91	8,747
	Rainbow trout - *Gerrard Kamloop*	96	4,298
	Rainbow trout - *Shasta*	87-89, 92-94	29,897

Table 23.–Continued.

Segment and stocking location	Species and strain	Years	Total number
Lake of the Woods	**Rainbow trout** - *Arlee*	90, 91	8,874
	Rainbow trout - *Shasta*	86-90	79,625
	Redear sunfish	89, 91, 92	114,467
	Walleye SF	88, 90	6,800
	Walleye FF	87	7,100
	Walleye - *Muskegon* SF	96	14,500
Little Swan Creek	**Brown trout** - *Soda Lake*	87	3,400
	Brown trout - *Wild Rose*	86	3,330
Matteson Lake	Bluegill	86	356
	Channel catfish FF	88	4,000
	Channel catfish YR	90, 91, 95	18,535
	Fathead minnow	86	280,500
	Largemouth bass FF	86	7,015
	Largemouth bass AD	86	128
	Northern pike	86, 88-91	19,000
	Rainbow trout - *Shasta*	86	2,908
	Redear sunfish FF	86	9,000
	Redear sunfish AD	86	100
	Walleye SF	86	22,800
	Walleye FF	94, 95	2,025
	Walleye - *Muskegon* SF	95, 96	54,700
Long Lake - Colon Twp	Channel catfish AD	92	1,000
	Walleye - *Muskegon* SF	93-95	31,494
Palmer Lake	Channel catfish AD	92	2,000
	Walleye - *Muskegon* SF	93, 94, 96	48,435
	Walleye - *Muskegon* FF	94	2,400
Sturgeon Lake	Walleye - *Muskegon* SF	87, 89, 93, 96	198,044
Nottawa River	**Brown trout**	86, 89	6,250
	Brown trout - *Plymouth Rock*	88, 91-93	20,906
	Brown trout - *Saint Croix*	94	6,500
	Brown trout - *Soda Lake*	86, 87, 89-91	25,988
	Brown trout - *Wild Rose*	95	12,222
Nottawa Lake	Channel catfish FF	90	1,000
	Channel catfish YR	89	1,000
	Hybrid sunfish	96	2,500
Middle			
St. Joseph River	Channel catfish FF	88, 90	6,000
	Channel catfish YR	89, 91	5,500
	Walleye - SF	86, 88, 91	44,026
	Walleye - *Muskegon* SF	87, 89, 92-94, 96	198,044
St. Joseph River	Walleye - *Muskegon* FF	94	620

Table 23.–Continued.

Segment and stocking location	Species and strain	Years	Total number
Rocky River	**Brown trout** - *Plymouth Rock*	87, 88, 89, 91-93	44,370
	Brown trout - *Soda Lake*	86, 90	19,186
	Brown trout - *Wild Rose*	86, 96	5,790
	Brown trout - *Saint Croix*	94	2,060
	Brown trout - *Seeforellen*	95	1,799
Prairie River	**Brown trout**	86, 87	6,230
	Brown trout - *Plymouth Rock*	87-89, 91, 92	37,219
	Brown trout - *Soda Lake*	86, 87, 89-91	34,805
	Brown trout - *Wild Rose*	86	4,650
Spring Creek	**Brown trout**	87	1,200
	Brown trout - *Plymouth Rock*	88, 89	3,060
	Brown trout - *Soda Lake*	86, 90, 91	4,051
Fawn River	**Rainbow trout -** *Steelhead*	86-96	6,000
Shermen Mills Creek	**Brown trout**	87	680
	Brown trout - *Plymouth Rock*	88, 89, 92	2,440
	Brown trout - *Soda Lake*	86, 90, 91	2,228
Big Pleasant Lake	**Rainbow trout** - *Arlee* YR	90, 91, 95	19,098
	Rainbow trout - *Shasta* FF	86-89	29,100
	Walleye - SF	86, 91	9,642
	Walleye - *Muskegon* SF	87, 89, 93, 95	32,935
Klinger Lake	Walleye - SF	86, 88	25,092
	Walleye - *Muskegon* SF	87, 90, 92, 94, 96	194,617
Birch Lake	**Rainbow trout** - *Arlee*	90, 91	14,045
	Rainbow trout - *Shasta* FF	95	500
	Rainbow trout - *Shasta* YR	86-89, 92-95	67,793
Shavehead Lake	**Rainbow trout** - *Arlee*	91	10,600
	Rainbow trout - *Eagle Lake*	96	5,836
	Rainbow trout - *Shasta*	86-90, 92-96	127,876
Garver Lake	Tiger muskellunge	86-91	2,450
Pigeon River	**Rainbow trout**	86-97	66,600
Rowe-Eden Ditch	**Rainbow trout**	86-96	8,000
Turkey Creek	**Rainbow trout**	86-96	6,851
Curtis Creek	**Rainbow trout**	86-96	1,800
Little Elkhart River	**Rainbow trout**	86-96	10,000
Little Elkhart River	**Rainbow trout**	86-96	25,500
Solomon Creek	**Rainbow trout**	86-97	10,000
St. Joseph River	Tiger muskellunge	86-87	10,000
	Walleye	95-96	117,750
Cobus Creek	**Rainbow trout**	86-96	2,500
Elkhart River	**Rainbow trout**	94	61,428
Diamond Lake	Walleye - SF	86, 88	37,389
	Walleye - *Muskegon* SF	90, 93, 95	157,949
	Walleye - *Muskegon* FF	92	3,321
	Walleye - *Muskegon* YR	94	1,819

Table 23.–Continued.

Segment and stocking location	Species and strain	Years	Total number
Lower			
Baugo Park	Bluegill	87	6,035
	Fathead minnows	87	31,537
	Largemouth bass	89	1,000
Pinhook	**Channel catfish**	89	1,000
St. Joseph River	**Coho salmon**	96	151,960
	Chinook salmon	86-96	1,971,494
	Rainbow trout - *Steelhead*	86-96	2,135,662
Brandywine Creek	**Brown trout**	87, 89	1,740
	Brown trout - *Plymouth Rock*	88, 91-93	7,232
	Brown trout - *Soda Lake*	87, 89, 90	3,540
	Brown trout - *Wild Rose*	86, 95, 96	5,198
	Brown trout - *Saint Croix*	94	1,880
Magician Lake	Walleye - SF	86, 91	30,256
	Walleye - *Muskegon* SF	87, 89, 93, 96	65,712
Fish Lake	Northern pike FF	88	134
	Tiger muskellunge FF	88	16
Lake of the Woods	Walleye - SF	86, 88, 91	16,878
	Walleye - *Muskegon* SF	87, 89, 90	77,469
Dowagiac Creek	**Brown trout**	86, 87	16,770
	Brown trout - *Plymouth Rock*	88, 91-93	47,446
	Brown trout - *Saint Croix*	94	7,540
	Brown trout - *Seeforellen*	95, 96	15,320
	Brown trout - *Soda Lake*	86, 87, 89, 90	26,700
Peavine Creek	**Brown trout**	87, 89	3,420
	Brown trout - *Plymouth Rock*	88, 91, 92	5,439
	Brown trout - *Soda Lake*	90	1,798
	Brown trout - *Wild Rose*	86	1,590
Pokagon Creek	**Brown trout**	87, 89	8,400
	Brown trout - *Plymouth Rock*	88, 91, 92	13,474
	Brown trout - *Soda Lake*	90	4,498
	Brown trout - *Wild Rose*	86	3,770
McKenzie Creek	**Brown trout**	87	1,260
	Brown trout - *Plymouth Rock*	88, 91-93	6,018
	Brown trout - *Soda Lake*	89, 90	3,000
	Brown trout - *Wild Rose*	86	1,200
Dowagiac River	**Brown trout**	86, 87, 89	17,980
	Brown trout - *Plymouth Rock*	88, 91-93	33,644
	Brown trout - *Saint Croix*	94	8,710
	Brown trout - *Seeforellen*	96	8,500
	Brown trout - *Soda Lake*	90	6,994
	Brown trout - *Wild Rose*	86, 95	11,058

Table 23.–Continued.

Segment and stocking location	Species and strain	Years	Total number
McCoy Creek	**Brown trout**	87	3,340
	Brown trout - *Plymouth Rock*	88, 91, 92, 93	16,327
	Brown trout - *Soda Lake*	89, 90	8,596
	Brown trout - *Wild Rose*	86, 95, 96	9,531
	Brown trout - *Saint Croix*	94	3,470
Love Creek	Brook trout - *Assinica/Maine*	88, 90, 93, 94	4,520
	Brook trout - *Assinica*	96	900
	Brook trout - *Assinica/Rome*	86	817
	Brook trout - *Maine*	89	1,110
	Brook trout - *Owhi*	87, 91, 92	2,800
	Brown trout - *Saint Croix*	95	900
Pipestone Creek	**Brown trout**	86, 87,	14,580
	Brown trout - *Plymouth Rock*	88, 91, 92, 93	36,993
	Brown trout - *Wild Rose*	95, 96	17,542
	Brown trout - *Soda Lake*	86, 89, 90	19,196
	Brown trout - *Saint Croix*	94	9,480
Mouth			
Big Meadow Creek	Brook trout - *Assinica/Maine*	88, 90	5,610
	Brook trout - *Assinica/Rome*	86, 87	5,091
	Brook trout - *Maine*	89	2,430
	Brown trout - *Plymouth Rock*	91, 92, 93	3,466
	Brown trout - *Saint Croix*	94	1,590
	Brown trout - *Wild Rose*	95, 96	2,908
Campbell Creek	Brook trout - *Assinica/Maine*	88, 90, 93	4,000
	Brook trout - *Assinica/Rome*	86	1,062
	Brook trout - *Maine*	87, 89	2,410
	Brook trout - *Owhi*	91, 92	2,710
	Brown trout - *Wild Rose* YR	94-96	1,497
Wolf Lake Pond 12	**Brown trout** - *Plymouth Rock*	91	1,000
	Rainbow trout - *Arlee*	91	200
Wolf Lake	Northern pike FF	88	84
	Northern pike YR	92	127
	Tiger muskellunge	88	31
	Largemouth bass	92	256
Hayden Creek	**Brown trout** - *Plymouth Rock*	91-93	2,125
	Brown trout - *Saint Croix*	94	700
	Brown trout - *Seeforellen*	95	570
Paw Paw E. Branch	**Brown trout**	87	2,740
	Brown trout - *Plymouth Rock*	89	3,100
	Brown trout - *Soda Lake*	86, 88, 90, 91	12,264
	Brown trout - *Wild Rose*	96	3,100

Table 23.–Continued.

Segment and stocking location	Species and strain	Years	Total number
Paw Paw N. Branch	**Brown trout**	87	6,640
	Brown trout - *Plymouth Rock*	89, 91-93	13,227
	Brown trout - *Saint Croix*	94	1,540
	Brown trout - *Seeforellen*	95, 96	2,830
	Brown trout - *Soda Lake*	86, 88, 90	23,606
Paw Paw W. Branch	**Brown trout** - *Plymouth Rock*	87-93	19,124
	Brown trout - *Saint Croix*	94	3,460
	Brown trout - *Seeforellen*	95, 96	6,166
	Brown trout - *Soda Lake*	86, 90	5,480
Brush Creek	**Brown trout** - *Plymouth Rock*	88, 89, 92, 93	13,460
	Brown trout - *Saint Croix*	94	3,620
	Brown trout - *Seeforellen*	95	3,210
	Brown trout - *Soda Lake*	86-88, 90, 91	17,974
	Brown trout - *Wild Rose*	96	3,483
Mill Creek	Brook trout - *Assinica/Maine*	88, 90, 93	4,690
	Brook trout - *Assinica/Rome*	86, 87	3,637
	Brook trout - *Maine*	89	1,800
	Brook trout - *Owhi*	91, 92	2,500
	Brown trout	86, 87, 89	8,210
	Brown trout - *Plymouth Rock*	88, 91, 92	9,110
	Brown trout - *Soda Lake*	90	3,300
	Brown trout - *Wild Rose*	93, 94, 95, 96	12,009
Maple Lake	Largemouth bass	91	309
	Walleye - SF	86, 88, 91	16,521
	Walleye AD	87	75
Van Auken Lake	Northern pike FRY	88	175,000
	Northern pike SF	89, 91, 93	8,500
	Northern pike YR	94	745
School Section Lake	Northern pike SF	86, 88, 90, 93-95	4,488
Blue Creek	**Brown trout**	86, 87, 89	6,230
	Brown trout - *Plymouth Rock*	88, 91, 92	7,880
	Brown trout - *Soda Lake*	90	2,600
	Brown trout - *Wild Rose*	93, 95, 96	7,669
	Brown trout - *Saint Croix*	94	2,746
Paw Paw River	**Rainbow trout -** *MI Winter*	86-96	84,392
St. Joseph River	**Brown trout**	87	14,900
	Brown trout - *Plymouth Rock*	88, 91, 92, 93	49,285
	Brown trout - *Wild Rose*	86	15,000
	Brown trout - *Soda Lake*	89, 90	30,000
	Brown trout - *Saint Croix*	94	29,257
	Brown trout - *Seeforellen*	95, 96	32,289
	Chinook salmon	86-96	3,744,261
	Coho salmon	90, 92, 93, 95, 96,	824,585
	Lake trout	86, 88	174,800
	Rainbow trout - *MI Winter*	86-91, 96	276,670

Table 23.–Continued.

Segment and stocking location	Species and strain	Years	Total number
St. Joseph R.continued	**Rainbow trout -** *Skamania*	88, 89, 90	39,763
	Walleye - FRY	87	1,000,000
	Walleye - Bay de N*oc*	86	737,500
	Walleye - *Muskegon*	88, 91	7,528,000
	Walleye - *Ohio*	87	315,000
	Walleye - SF	86, 88, 91	429,436
	Walleye - *Muskegon*	87, 89,	173,527
	Walleye - FF *Muskegon*	91	5,500

Table 24.–Fish species currently found in the St. Joseph River watershed. Bolded designations in parenthesis are species status as determined by Michigan's Endangered Species Act (Part 365, Endangered Species Protection, of the Natural Resource and Environmental Protection Act, Act 451 of the Public Acts of 1994) and Indiana Endangered Species Act of 1973 (Indiana Code 14-2-8.5). Data from Michigan Department of Natural Resources, Fisheries Division and Indiana Department of Natural Resources, Division of Fish and Wildlife.

Common name	Scientific name
Lampreys	
Chestnut lamprey	*Ichthyomyzon castaneus*
Northern brook lamprey	*Ichthyomyzon fossor*
Silver lamprey	*Ichthyomyzon unicuspis*
American brook lamprey	*Lampetra appendix*
Sea lamprey	*Petromyzon marinus*
Sturgeons	
Lake sturgeon (**threatened**)	*Acipenser fulvescens*
Gars	
Spotted gar	*Lepisosteus oculatus*
Longnose gar	*Lepisosteus osseus*
Bowfins	
Bowfin	*Amia calva*
Freshwater eels	
American eel	*Anguilla rostrata*
Herrings	
Alewife	*Alosa pseudoharengus*
Gizzard shad	*Dorosoma cepedianum*
Minnows	
Central stoneroller	*Campostoma anomalum*
Goldfish	*Carassius auratus*
Satinfin shiner	*Cyprinella analostana*
Spotfin shiner	*Cyprinella spiloptera*
Steelcolor shiner	*Cyprinella whipplei*
Common carp	*Cyprinus carpio*
Brassy minnow	*Hybognathus hankinsoni*
Striped shiner	*Luxilus chrysocephalus*
Common shiner	*Luxilus cornutus*
Pearl dace	*Margariscus margarita*
hornyhead chub	*Nocomis biguttatus*
River chub	*Nocomis micropogon*
Golden shiner	*Notemigonus crysoleucas*
Pugnose shiner (**rare**)	*Notropis anogenus*
Emerald shiner	*Notropis atherinoides*
Silverjaw minnow	*Notropis buccatus*
Blackchin shiner	*Notropis heterodon*

Table 24.–Continued.

Common name	Scientific name
Minnows continued	
Blacknose shiner	*Notropis heterolepis*
Spottail shiner	*Notropis hudsonius*
Rosyface shiner	*Notropis rubellus*
Sand shiner	*Notropis stramineus*
Mimic shiner	*Notropis volucellus*
Suckermouth minnow	*Phenacobius mirabilis*
Northern redbelly dace	*Phoxinus eos*
Bluntnose minnow	*Pimephales notatus*
Fathead minnow	*Pimephales promelas*
Blacknose dace	*Rhinichthys atratulus*
Longnose dace	*Rhinichthys cataractae*
Creek chub	*Semotilus atromaculatus*
Suckers	
Quillback	*Carpiodes cyprinus*
Longnose sucker	*Catostomus catostomus*
White sucker	*Catostomus commersoni*
Creek chubsucker (**threatened**)	*Erimyzon oblongus*
Lake chubsucker	*Erimyzon sucetta*
Northern hog sucker	*Hypentelium nigricans*
Black buffalo (rare)	*Ictiobus niger*
Spotted sucker	*Minytrema melanops*
Silver redhorse	*Moxostoma anisurum*
River redhorse (**threatened**)	*Moxostoma carinatum*
Black redhorse	*Moxostoma duquesnei*
Golden redhorse	*Moxostoma erythrurum*
Shorthead redhorse	*Moxostoma macrolepidotum*
Greater redhorse	*Moxostoma valenciennesi*
Catfishes	
Black bullhead	*Ameiurus melas*
Yellow bullhead	*Ameiurus natalis*
Brown bullhead	*Ameiurus nebulosus*
Channel catfish	*Ictalurus punctatus*
Stonecat	*Noturus flavus*
Tadpole madtom	*Noturus gyrinus*
Brindled madtom	*Noturus miurus*
Flathead catfish	*Pylodictis olivaris*
Pikes	
Grass pickerel	*Esox americanus vermiculatus*
Northern pike	*Esox lucius*
Muskellunge	*Esox masquinongy*
Tiger muskellunge	*Esox lucius x masquinongy*
Mudminnows	
Central mudminnow	*Umbra limi*

Table 24.–Continued.

Common name	Scientific name
Smelts	
Rainbow smelt	*Osmerus mordax*
Trouts	
Lake herring (**threatened**)	*Coregonus artedi*
Lake whitefish	*Coregonus clupeaformis*
Pink salmon	*Oncorhynchus gorbuscha*
Coho salmon	*Oncorhynchus kisutch*
Rainbow trout	*Oncorhynchus mykiss*
Chinook salmon	*Oncorhynchus tshawytscha*
Round whitefish	*Prosopium cylindraceum*
Atlantic salmon	*Salmo salar*
Brown trout	*Salmo trutta*
Brook trout	*Salvelinus fontinalis*
Lake trout	*Salvelinus namaycush*
Trout-perches	
Trout-perch	*Percopsis omiscomaycus*
Pirate perches	
Pirate perch	*Aphredoderus sayanus*
Codfishes	
Burbot	*Lota lota*
Killifishes	
Banded killifish	*Fundulus diaphanus*
Starhead topminnow (**rare**)	*Fundulus dispar*
Blackstripe topminnow	*Fundulus notatus*
Silversides	
Brook silverside	*Labidesthes sicculus*
Sticklebacks	
Brook stickleback	*Culaea inconstans*
Ninespine stickleback	*Pungitius pungitius*
Sculpins	
Mottled sculpin	*Cottus bairdi*
Slimy sculpin	*Cottus cognatus*
Sunfishes	
Rock bass	*Ambloplites rupestris*
Green sunfish	*Lepomis cyanellus*
Pumpkinseed	*Lepomis gibbosus*
Warmouth	*Lepomis gulosus*
Bluegill	*Lepomis macrochirus*
Longear sunfish	*Lepomis megalotis*
Redear sunfish	*Lepomis microlophus*
Smallmouth bass	*Micropterus dolomieu*
Largemouth bass	*Micropterus salmoides*

Table 24.–Continued.

Common name	Scientific name
Sunfishes continued	
White crappie	*Pomoxis annularis*
Black crappie	*Pomoxis nigromaculatus*
Perches	
Greenside darter	*Etheostoma blennioides*
Rainbow darter	*Etheostoma caeruleum*
Iowa darter	*Etheostoma exile*
Barred fantail darter	*Etheostoma flabellare flabellare*
Johnny darter	*Etheostoma nigrum*
Orangethroat darter	*Etheostoma spectabile*
Least darter (**rare**)	*Etheostoma microperca*
Yellow perch	*Perca flavescens*
Logperch	*Percina caprodes*
Blackside darter	*Percina maculata*
Walleye	*Stizostedion vitreum*
Drums	
Freshwater drum	*Aplodinotus grunniens*

Table 25.–Natural features of St. Joseph River watershed by valley segment. Data from Michigan Department of Natural Resources, Wildlife Division, Natural Features Inventory, September 26, 1996 and Indiana Department of Natural Resources, Division of Fish and Wildlife, March 11, 1997. State status codes: WL=watch list, SG=significant natural community, E=endangered, T=threatened, SC=special concern (rare, may become E or T in the future), P=proposed, SX=extirpated, SRE=reintroduced. Federal status codes: LE=listed endangered, PT=proposed threatened, LT=listed threatened. Blanks indicate that none of the categories are applicable. Valley segment codes: H=Headwaters, U=Upper, M=Middle, L=Lower, and Mo=Mouth.

		State	Federal	Valley Code				
Common name or feature	Scientific name	status	status	H	U	M	L	Mo
Vertebrate								
Cooper's hawk	*Accipiter cooperii*	WL				X	X	
Sharp-shined hawk	*Accipiter striatus*	SC				X		
Lake sturgeon	*Acipenser fulvescens*	T				X	X	X
Blanchard's cricket frog	*Acris crepitans blanchardi*	SC			X	X	X	X
Blue-spotted salamander	*Ambystoma laterale*	SC				X		
Marbled salamander	*Ambystoma opacum*	T					X	X
Henslow's sparrow	*Ammodramus henslowii*	T				X		
Great egret	*Ardea alba*	E				X		
Great blue heron	*Ardea Herodias*	SC				X		
Long-eared owl	*Asio otus*	WL				X		
Ring-necked duck	*Aythya collaris*					X		
Upland sandpiper	*Bartramia longicauda*	E				X	X	
American bittern	*Botaurus Lentiginosus*	E				X		
Red-shouldered hawk	*Buteo lineatus*	SC				X		
Broad-winged hawk	*Buteo platypterus*	SC				X		
Spotted turtle	*Chemmys guttata*	SC			X			
Black tern	*Chilidonias niger*	E				X		
Northern harrier	*Circus cyaneus*	E				X		
Marsh wren	*Cistothorus palustris*	E				X		
Sedge wren	*Cistothorus platensis*	T				X	X	
Spotted turtle	*Clemmys guttata*	SC				X	X	X
Kirtland's snake	*Clonophis kirtlandii*	E				X	X	X
Star-nosed mole	*Condylura cristata*	SC				X		
Cisco	*Coregonus artedi*	SC				X		
Least shrew	*Cryptotis parva*	T				X		
Cerulean warbler	*Dendroica cerulea*	SC				X		
Black rat snake	*Elaphe obsoleta obsoleta*	SC				X	X	X
Least flycatcher	*Empidonax minimus*	WL				X		
Blanding's turtle	*Emydoidea blandingii*	E				X		
Creek chubsucker	*Erimyzon oblongus*	T		X	X	X	X	
Peregrine falcon	*Falco peregrinus*	E	LE			X		
Starhead topminnow	*Fundulus notti*	SC		X				
Starhead minnow	*Galearis spectabilis*	SC			X			
Sandhill crane	*Grus canadensis*	T				X		

Table 25.–Continued.

Common name or feature	Scientific name	State status	Federal status	Valley Code H	U	M	L	Mo
Vertebrate								
Four-toed salamander	*Hemidactylium scutatum*	T				X		
Black buffalo	*Ictiobus niger*	SC					X	X
Least bittern	*Ixobrychus exilis*	E				X		
Loggerhead shrike	*Lanius ludovicianus*	E				X		
Spotted gar	*Lepisosteus oculatus*	SC			X		X	X
Northern river otter	*Lutra canadensis*	E				X		
Bobcat	*Lynx rufus*	E				X		
Prairie vole	*Microtus ochrogaster*	T				X	X	X
Black-and-white warbler	*Mniotilta varia*	SC					X	
Black redhorse	*Moxostoma duquesnei*	SC					X	X
Greater redhorse	*Moxostoma valenciennesi*	SC				X		
Least weasel	*Mustela nivalis*	SC				X		
Indiana bat	*Myotis sodalis*	E	PT	X	X	X		
Mudpuppy	*Necturus maculosus*	SC				X		
Copperbelly water snake	*Nerodia erythrogaster neglecta*	E		X	X	X	X	
Pugnose shiner	*Notropis anagenus*	SC		X	X			
Ironcolor shiner	*Notropis chalybaeus*	E			X	X	X	
Black shiner	*Notropis heterolepis*	WL				X		
Black crowned night heron	*Nycticorax nycticorax*	E				X		
King rail	*Rallus elegans*	E			X	X	X	X
Virginia rail	*Rallus limicola*	SC				X		
Northern leopard frog	*Rana pipiens*	SC				X		
Eastern massasauga	*Sistrurus catenatus catenatus*	T			X	X	X	X
Western meadowlark	*Sturnella neglecta*	SC				X		
American badger	*Taxidea taxus*	T				X	X	
Eastern box turtle	*Terrapene carolina carolina*	SC			X		X	X
Butler's garter snake	*Thamnophis butleri*	T				X		
Barn owl	*Tyto alba*	E				X		
Golden-winged warbler	*Vermivora chrysoptera*	E				X		
Canada warbler	*Wilsonia canadensis*	SC				X		
Hooded warbler	*Wilsonia citrina*	SC				X		
Invertebrate								
Veined white	*Artogeia napi oleracea*	E				X		
Pine vine swallowtail	*Battus philenor*	T				X		
Silver-bordered fritillary	*Boloria selene myrina*					X		
Swamp metalmark	*Calephelis mutica*	SC				X	X	X
Pointed campeloma	*Campeloma decisum*	SC				X	X	
Quiet underwing	*Catocala dulciola*	SC					X	
Purple wartyback	*Cyclonaias tuberculata*	SC				X	X	X
Snuffbox	*Dysnomia triquetra*	E				X	X	X

Table 25.–Continued.

Common name or feature	Scientific name	State status	Federal status	Valley Code H	U	M	L	Mo
Invertebrate								
Baltimore	*Euphydryas phaeton*					X		
Two-spotted skipper	*Euphyes bimacula*	SC				X		
Scarce swamp skipper	*Euphyes dukesi*	SC				X		
Silvery blue	*Glaucopsyche lygdamus couperi*	E				X		
Liver elimia	*Goniobasis livescens*						X	
Midwestern fen buckmoth	*Hemileuca SP 3*					X		
Ottoe skipper	*Hesperia ottoe*	T				X		
Karner blue butterfly	*Lycaeides melissa samuelis*	E	LE			X		
Dorcas copper	*Lycaena dorcas dorcas*					X		
Purplish copper	*Lycaena helloides*					X		
Swamp lymnaea	*Lymnaea stagnalis*	SC					X	
Green adder's moth	*Malaxis unifolia*	E				X		
Newman's brocade	*Meropleon ambifusca*	SC					X	
Proud globe	*Mesodon elevatus*	SC					X	X
Dwarf skimmer	*Nannothemis bella*					X		
Longhorned caddisfly	*Nectopsyche pavida*	SC				X		
Sphagnum sprite	*Nehalennia gracilis*					X		
Mitchell's satyr	*Neonympha mitchelii mitchelii*	E	PT		X	X	X	X
American burying beetle	*Nicrophorus americanus*	E	LE			X	X	X
Golden borer	*Papaipema cerina*	SC					X	
Maritime sunflower borer	*Papaipema maritima*	SC					X	X
Culvers root borer	*Papaipema sciata*	SC					X	X
Silphium borer moth	*Papaipema silphii*	T				X	X	X
Regal fern borer	*Papaipema speciosissima*	SC					X	
Broad-winged skipper	*Poanes viator viator*					X		
Brown walker	*Pomatiopsis cincinnatiensis*	SC					X	X
Red-legged spittlebug	*Prosapia ignipectus*	SC					X	X
Appalachian eyed brown	*Satyrodes Appalachia Leeuwi*					X		
Leadplant flower moth	*Schinia lucens*	E				X		
Spartina moth	*Spartiniphaga inops*	SC					X	
Regal fritillary	*Speyeria idalia*	E				X	X	
Douglas stenelmis riffle beetle	*Stenelmis douglasensis*	SC				X		
Greyback	*Tachopteryx thoreyi*	T					X	
Plant								
Red baneberry	*Actaea rubra*	SC				X	X	
Gattinger's gerardia	*Agalinis gattingeri*	T				X		
Beaked agrimony	*Agrimonia rostellata*	SC						X
Running serviceberry	*Amelanchier humilis*	E				X		
Leadplant	*Amorpha canescens*	SC			X	X	X	X

Table 25.–Continued.

Common name or feature	Scientific name	State status	Federal status	Valley Code H	U	M	L	Mo
Plant								
Bog rosemary	*Andromeda glaucophylla*	SC				X		
Drummon rockcress	*Arabis Drummandii*	E				X	X	
Tower-mustard	*Arabis glabra*	T					X	
Missouri rockcress	*Arabis missouriensis var deamii*	SC				X	X	X
Michaux's stithwort	*Arenaria stricta*	SC				X	X	
Swamp-pink	*Arethusa bulbosa*	SX				X		
Slim-spike three-awn grass	*Aristida intermedia*	SC				X		
Beach three-awned grass	*Aristida tuberculosa*	SC						X
Virginia snakeroot	*Aristolochia serpentaria*	T			X	X	X	X
Bristly sarsaparilla	*Arlia hispida*	E				X		
Tall green milkweed	*Asclepias hirtella*	T				X		
Rushlike aster	*Aster junciformis*	SC				X		
Western silvery aster	*Aster sericeus*	T				X		
Canadian milk-vetch	*Astragallus canadensis*	T				X	X	X
Cooper's milk-vetch	*Astragalus neglectus*	SC				X		
White or prairie false indigo	*Baptisia lactea*	T		X	X	X	X	X
Cream wild indigo	*Baptisia leucophaea*	E				X	X	
Yellow wild-indigo	*Baptisia tinctoria*	WL				X	X	
Cut-leaved water-parsnip	*Berula erecta*	T				X	X	X
Kitten-tails	*Besseya bullii*	T				X		X
Beck water-marigold	*Bidens beckii*	E				X		
Chamomile grape-fern	*Botrychium matricarifolium*	T				X		
Blunt-lobe grape-fern	*Botrychium oneidense*	WL				X		
Side-oats grama grass	*Bouteloua curtipendula*	T				X		
Prairie indian-plantain	*Cacalia plantaginea*	T				X	X	X
Narrow-leaved reedgrass	*Calamagrostis stricta*	T				X		
Wild calla	*Calla palustris*	E				X		
Wild-hyacinth	*Camassia scilloides*	T					X	X
Broadwing sedge	*Carex alata*	WL				X		
Greenish-white sedge	*Carex albolutescens*	SC				X		
Foxtail sedge	*Carex alopecoidea*	E				X	X	
Golden-fruited sedge	*Carex aurea*	SC				X		
Bebb's sedge	*Carex bebbii*	T				X		
Brownish sedge	*Carex brunnescens*	E				X		
Crawe sedge	*Carex crawei*	T					X	
White-edge sedge	*Carex debilis var rudgei*	T				X		
Softleaf sedge	*Carex disperma*	E				X		
Little prickly sedge	*Carex echinata*	E				X		
Fescue sedge	*Carex festucacea*	SC				X		
Yellow sedge	*Carex flava*	T				X		
Frank's sedge	*Carex frankii*	SC				X		
Sedge	*Carex gravida*	SC					X	X

Table 25.–Continued.

Common name or feature	Scientific name	State status	Federal status	Valley Code H	U	M	L	Mo
Plant								
Jame's sedge	*Carex jamesii*	SC					X	X
Mud sedge	*Carex limosa*	E				X		
False hop sedge	*Carex lupuliformis*	SC					X	
Eastern few-fruited sedge	*Carex oligocarpa*	SC				X	X	X
Longstalk sedge	*Carex pedunculata*	SC				X		
Retrorse sedge	*Carex retrorsa*	E				X	X	
Rough sedge	*Carex scabrata*	E					X	
Weak stellate sedge	*Carex seorsa*	SC				X	X	X
Thinleaf sedge	*Carex sparaniodes var Cephaloidea*	T				X		
Straw sedge	*Carex Straminea*	T				X	X	
Hairy-fruited sedge	*Carex trichocarpa*	SC				X	X	X
Three-seed sedge	*Carex trisperma*	WL				X		
Pretty sedge	*Carex woodii*	WL				X		
Bitternut hickory	*Carya cordiformis*						X	
Shellbark or kingnut hickory	*Carya laciniosa*	SC			X	X		
American chestnut	*Castanea dentata*	E					X	X
Red bud	*Cercis canadensis*						X	X
Pipsissewa	*Chimaphila umbellata cisatlantica*	T				X		
America golden-saxifrage	*Chrysosplenium americanum*	T					X	
Small enchanter's nightshade	*Cirsium alpina*	X				X		
Hill's thistle	*Cirsium hilli*	SC		X		X	X	X
Clinton lily	*Clintonia borealis*	E				X		
Long-bract green orchis	*Coeloglossum viride var virescens*	T				X		
Slender day-flower	*Commelina erecta*	X					X	X
Hemlock parsley	*Conioselinum chinense*	E				X		
Prairie coreopsis	*Coreopsis palmata*	T				X	X	X
Bunchberry	*Cornus canadensis*	E				X		
Roundleaf dogwood	*Cornus rugosa*	R				X		
Yellow fumewort	*Corydalis flavula*	T				X	X	X
Illinois hawthorn	*Crataegus prona*	E				X		
Field dodder	*Cuscuta glomerata*	SC				X	X	X
Knotweed dodder	*Cuscuta polygonorum*	SC				X		
Yellow nut-grass	*Cyperus flavescens*	SC				X	X	X
Pink lady's slipper	*Cypripedium acaule*	WL				X		
Small yellow lady's slipper	*Cypripedium calceolus var parviflorum*	SC				X		
Small white lady's slipper	*Cypripedium candidum*	SC				X		
White lady-slipper	*Cypripedium candidum*	T		X			X	X
Showy lady's slipper	*Cypripedium reginae*	WL				X		

Table 25.–Continued.

Common name or feature	Scientific name	State status	Federal status	Valley Code H	U	M	L	Mo
Plant								
Two-leaf toothwort	*Dentaria diphylla*	WL				X		
Tufted hairgrass	*Deschampsia cespitosa*	SC				X		
Northern bush-honeysuckle	*Diervilla lonicera*	SC				X		
Slender finger-grass	*Digitaria filiformis*	X					X	
Shooting-star	*Dodecatheon meadia*	T					X	X
Spoon-leaved sundew	*Drosera intermedia*	SC				X		
Log fern	*Dryopteris celsa*	T				X	X	X
Clinton woodfern	*Dryopteris clintoniana*	SX				X		
Dwarf burhead	*Echinodorus tenellus*	E				X		X
Flattened spikerush	*Eleocharis compressa*	T				X		
Engelmann's spikerush	*Eleocharis engelmannii*	SC				X		
Black-fruited spikerush	*Eleocharis equisetoides*	SC				X	X	X
Fewflower spikerush	*Eleocharis pauciflora*	E				X		
Robbins spikerush	*Eleocharis robbinsii*	SC				X		
Trailing arbutus	*Epigaea repens*	WL				X		
Narrow-leaved cotton-grass	*Eriocaulon angustifolium*	SC				X		
Pipewort	*Eriocaulon septangulare*	E				X		
Slender cotton-grass	*Eriophorum gracile*	T				X		
Green-keeled cotton-grass	*Eriophorum viridicarinatum*	SC				X		
Rattlesnake-master	*Eryngium yuccifolium*	T				X	X	X
Upland boneset	*Eupatorium sessilifolium*	T					X	
Tinted spurge	*Euphorbia commutata*	T					X	X
Queen-of-the-prairie	*Filipendula rubra*	T					X	X
Chestnut sedge	*Fimbristylis puberula*	X					X	
Red ash	*Fraxinus pennsylvanica*						X	
Dwarf umbrella-sedge	*Fuirena pumila*	T				X		
Umbrella-grass	*Fuirena squarrosa*	T				X	X	X
Showy orchis	*Galearis spectabilis*	SC				X	X	X
Yellow gentian	*Gentiana alba*	SC				X		
White gentian	*Gentiana flavida*	E				X	X	
Soapwort gentian	*Gentiana saponaria*	X					X	X
Stiff gentian	*Gentianella quinquefolia*	T					X	X
Becknell northern crane's-bill	*Geranium bicknellii*	E				X		
Herb-robert	*Geranium robertianum*	T				X	X	
Purple avens	*Geum rivale*	E				X		
Pale avens	*Geum virginianum*	SC					X	
Bowman's root	*Gillenia trifoliata*	T				X		
Manna grass	*Glyceria acutiflora*	X				X		
Small floating manna-grass	*Glyceria borealis*	E				X		
American manna-grass	*Glyceria grandis*	SX				X		
Winged cudweed	*Gnaphalium macounii*	SX				X		
Kentucky coffee-tree	*Gymnocladus dioicus*	SC				X	X	X
Whiskered sunflower	*Helianthus hirsutus*	SC				X	X	X

Table 25.–Continued.

Common name or feature	Scientific name	State status	Federal status	Valley Code H	U	M	L	Mo
Plant								
Downy sunflower	*Helianthus mollis*	T				X	X	
Dwarf-bulrush	*Hemicarpha micrantha*	SC				X	X	X
Swamp rose-mallow	*Hibiscus moscheutos*	SC					X	X
Panicled hawkweed	*Hieracium paniculatum*	SC					X	X
Green violet	*Hybanthus concolor*	SC			X		X	X
Goldenseal	*Hydrastis canadensis*	T	LE	X	X	X	X	X
American water-pennywort	*Hydrocotyle americana*	E				X		
Gentian-leaved st. John's-wort	*Hypericum gentianoides*	SC				X	X	X
Kalm st. John's-wort	*Hypericum kalmianum*	WL				X		
Great st. John's-wort	*Hypericum pyramidatum*	E				X		
Kankakee globe-mallow	*Iliamna remota*	E				X		
Large whorled pogonia	*Isotria verticillata*	WL				X		
Whorled pogonia	*Isotria verticillata*	T				X	X	X
Twinleaf	*Jeffersonia diphylla*	SC					X	X
Butternut	*Juglans cinerea*	WL				X		
Two-flowered rush	*Juncus biflorus*	SC				X	X	X
Scirpus-like rush	*Juncus scirpoides*	T						X
Ground juniper	*Juniperus communis*	SC				X		
False boneset	*Kuhnia eupatoriodes*	SC				X	X	X
Pale vetchling peavine	*Lathyrus ochroleucus*	E				X		
Smooth veiny pea	*Lathyrus venosus*	T				X		
Least pinweed	*Lechea minor*	SC			X	X		X
Minute duckweed	*Lemna perpusilla*	SX				X		
Trailing bush-clover	*Lespedeza procumbens*	SC					X	
Dotted blazing-star	*Liatris punctata*	X				X		
False pimpernel	*Lindernia anagallidea*	SC				X		
Twinflower	*Linnaea borealis*	SX				X		
Ridged yellow flax	*Linum striatum*	T				X		
Grooved yellow flax	*Linum Sulcatum*	SC				X	X	
Virginia flax	*Linum virginianum*	T				X	X	X
Loesel's twayblade	*Liparis loeselii*	WL				X		
Tulip-tree	*Liriodenrodn tulipifera*						X	
American fly-honeysuckle	*Lonicera canadensis*	SX				X		
Seedbox	*Ludwigia alternifolia*	T				X	X	X
Hairy woodrush	*Luzulia acuminata*	E				X		
Northern bog clubmoss	*Lycopodiella inundata*	E				X		
Running pine	*Lycopodium clavatum*	WL				X		
Hickey's clubmoss	*Lycopodium hickeyi*	SC				X		
Shining clubmoss	*Lycopodium lucidulum*	WL				X		
Tree clubmoss	*Lycopodium obscurum*	SC				X	X	
Climbing fern	*Lygodium palmatum*	E				X		
Ostrich fern	*Matteuccia struthiopteris*	SC				X		
American cow-wheat	*Melampyrum lineare*	SC				X		

Table 25.–Continued.

Common name or feature	Scientific name	State status	Federal status	Valley Code H	U	M	L	Mo
Plant								
Tall millet-grass	*Milium effusum*	SC				X		
Oswego tea, beebalm	*Monarda didyma*	X				X		
Red mulberry	*Morus rubra*	SC				X	X	X
Whorled water-milfoil	*Myriophyllum verticillatum*	T				X		
American lotus	*Nelumbo lutea*	T	LE			X		
Mountain holly	*Nemopanthus mucronatus*	WL				X		
Black-gum, tupelo	*Nyssa sylvatica*						X	
Black-fruit mountain-ricegrass	*Oryzopsis racemosa*	T				X	X	
Violet wood-sorrel	*Oxalis violacea*	T					X	X
Ginseng	*Panax quinquefolius*	T		X	X	X	X	X
Dwarf ginseng	*Panax trifolius*	WL				X		
Northern witchgrass	*Panicum boreale*	SC				X		
Leiberg's panic-grass	*Panicum leibergii*	T				x	X	X
Small-fruited panic-grass	*Panicum microcarpon*	SC				X		
A panic-grass	*Panicum subvillosum*	SX				X		
Warty panic-grass	*Panicum verrucosum*	T					X	X
Cleft phlox	*Phlox bifida*	T				X		
Spotted phlox	*Phlox maculata*	T				X	X	X
Eastern white pine	*Pinus strobus*	SC				X		
Prairie fringed orchid	*Plantanthera leucophaea*	E				X	X	X
Orange or yellow fringed orchid	*Platanthera ciliaris*	T				X	X	X
Small green woodland orchis	*Platanthera clavellata*	E				X		
Pale green orchis	*Platanthera flava var herbiola*	WL				X		
Leafy northern green orchis	*Platanthera hyperborea*	T				X		
Prairie white-fringed orchid	*Platanthera leucophaea*	SX				X		
Large roundleaf orchid	*Platanthera orbiculata*	SX				X		
Small purple-fringe orchis	*Platanthera psycodes*	SC				X		
Grove meadow grass	*Poa alsodes*	SC				X		
Bog bluegrass	*Poa paludigena*	T				X	X	
Rose pogonia	*Pogonia ophioglossoides*	WL				X		
Jacob's ladder or greek-valerian	*Polemonium reptans*	T					X	X
Cross-leaved milkwort	*Polygala cruciata*	SC				X	X	X
Carey's smartweed	*Polygonum careyi*	T					X	
Large-flowered leafcup	*Polymnia uvedalia*	T					X	X
Prairie-parsley	*Polytaenia nuttallii*	X				X		
Swamp or black cottonwood	*Populas heterophylla*	E				X		X
Waterthread pondweed	*Potamogeton bicupulatus*	T						X
Nuttall pondweed	*Potamogeton epihydrus*	E				X		
Fries' pondweed	*Potamogeton friesii*	E				X		
Oakes pondweed	*Potamogeton oakesianus*	E				X		

Table 25.–Continued.

Common name or feature	Scientific name	State status	Federal status	Valley Code H	U	M	L	Mo
Plant								
White-stem pondweed	*Potamogeton praelongus*	E				X		
Spotted pondweed	*Potamogeton pulcher*	T					X	X
Slender pondweed	*Potamogeton pusillus*	SC				X		
Redheadgrass	*Potamogeton richardsonii*	T				X		
Flatleaf pondweed	*Potamogeton robbinsii*	T				X		
Straight-leaf pondweed	*Potamogeton strictifolius*	E				X		
Fire cherry	*Prunus pensylvanica*	SC				X		
Bald-rush	*Psilocarya scirpoides*	T					X	X
Long-beaked baldrush	*Psilocarya scirpoides*	T				X		
Hairy mountain-mint	*Pycnanthemum pilosum*	SC					X	X
Whorled mountain-mint	*Pycnanthemum verticillatum*	SC					X	X
Pink wintergreen	*Pyrola asarifolia*	E				X		
Elliptical-leaf wintergreen	*Pyrola elliptica*	WL				X	X	
American wintergreen	*Pyrola rotundifolia var americana*	SC				X		
Greenish-flowered wintergreen	*Pyrola virens*	SX					X	
Bur oak	*Quercus macrocarpa*						X	X
Dwarf chinquapin oak	*Quercus prinoides*	E				X		
Meadow-beauty	*Rhexia virginica*	SC					X	X
Globe beak-rush	*Rhynchospora globularis*	X				X		
Tall beak-rush	*Rhynchospora macrostachya*	SC				X	X	X
Smooth gooseberry	*Ribes hirtellum*	WL				X		
Prairie rose	*Rosa setigera*	SC				X	X	X
Tooth-cup	*Rotala ramosior*	SC				X	X	X
Orange coneflower	*Rudbeckia fulgida var fulgida*	SC				X		
Showy coneflower	*Rudbeckia fulgida var sullivanti*	SC		X		X	X	X
Hairy ruellia	*Ruellia humilis*	T				X	X	
Rose-pink	*Sabatia angularis*	T				X	X	X
Autumn willow	*Salix serissima*	T				X	X	
Northern pitcher-plant	*Sarracenia purpurea*	WL				X		
American scheuchzeria	*Scheuchzeria palustris sp americana*	E				X		
Weakstalk bulrush	*Scirpus purshianus*	E				X		
Water bulrush	*Scirpus subterminalis*	R				X		
Fewflower nutrush	*Scleria pauciflora*	WL				X		X
Tall nut-rush	*Scleria triglomerata*	SC				X		X
Hairy skullcap	*Scutellaria elliptica*	SC				X	X	X
Meadow spike-moss	*Selaginella apoda*	E				X		
Ledge spike-moss	*Selaginella Rupestris*	T				X		
Starry campion	*Silene stellata*	T		X		X	X	X

Table 25.–Continued.

Common name or feature	Scientific name	State status	Federal status	Valley Code				
				H	U	M	L	Mo
Plant								
Rosinweed	*Silphium integrifolium*	T				X	X	X
Compass-plant	*Silphium laciniatum*	T					X	
Cup-plant	*Silphium perfoliatum*	T				X	X	X
Blue-eyed-grass	*Sisyrinchium strictum*	SC		X				
Smooth carrion-flower	*Smilax herbacea*	SC				X		
Hairy goldenrod	*Solidago hispida*	WL				X		
Northern mountain-ash	*Sorbus decora*	SX				X		
Branching bur-reed	*Sparganium androcladum*	T					X	
Shining ladies'-tresses	*Spiranthes lucida*	SC				X		
Great plains ladies'tresses	*Spiranthes magnicamporum*	E				X		
Yellow ladies'-tresses	*Spiranthes ochroleuca*	SC					X	X
Hooded ladies'-tresses	*Spiranthes romanzoffiana*	E				X		
Prairie dropseed	*Sporobolus heterolepis*	T						X
Fleshy stitchwort	*Stellaria crassifolia*	T				X		
Blackseed needlegrass	*Stipa avenacea*	T				X	X	
Sewing needlegrass	*Stipa comata*	SX				X		
Trailing wild bean	*Strophostyles helvula*	SC					X	X
Waxy meadow-rue	*Thalictrum revolutum*	T					X	
Cranefly orchid	*Tipularia discolor*	T					X	X
False asphodel	*Tofieldia glutinosa*	SC				X		
Eared false foxglove	*Tomanthera auriculata*	X				X		
Virginia spiderwort	*Tradescantia virginiana*	SC				X		
Bastard pennyroyal	*Trichostema dichotomum*	T				X		X
Marsh arrow-grass	*Triglochin palustre*	T				X		
Prairie trillium	*Trillium recurvatum*	T					X	X
Toadshade	*Trillium sessile*	T				X	X	X
Painted trillium	*Trillium undulatum*	E					X	X
Three-birds orchid	*Triphora trianthophora*	T					X	X
Sand grass	*Triplasis purpurea*	SC						X
Horned bladderwort	*Utricularia cornuta*	T				X		
Lesser bladderwort	*Utricularia minor*	E				X		
Purple bladderwort	*Utricularia purpurea*	SC				X		
Northern bladderwort	*Utricularia resupinata*	SX				X		
Small cranberry	*Vaccinium oxycoccos*	T				X		
Large cranberry	*Vaccinum macrocarpon*	WL				X		
Edible valerian	*Valeriana ciliata*	T					X	X
Marsh valerian	*Valeriana uliginosa*	E				X		
Goosefoot corn-salad	*Valerianella chenopodiifolia*	T					X	X
Northern wild-raisin	*Viburnum cassinoides*	E				X		
Highbush-cranberry	*Viburnum opulus var americanum*	E				X		
Black haw	*Viburnum pruniflium*	SC		X		X	X	X
Prairie birdfoot violet	*Viola pedatifida*	T				X	X	

Table 25.–Continued.

Common name or feature	Scientific name	State status	Federal status	Valley Code H	U	M	L	Mo
Plant								
Primrose-leaf violet	*Viola primulifolia*	SC					X	
Frost grape	*Vitis vulpina*	SC				X	X	
Wisteria	*Wisteria frutescens*	T					X	
Water-meal	*Wolffia papulifera*	T					X	X
Carolina yellow-eyed grass	*Xyris difformis*	T				X		
Horned pondweed	*Zannichellia palustris*	E				X		
White camas	*Zigadenus ellegans var glaucus*	SC				X		
Wild-rice	*Zizania aquatica var aquatica*	T			X	X	X	
Plant Community								
Acid bog		SG			X	X	X	X
Circumneutral bog		SG				X		
Coastal plain marsh						X	X	X
Dry upland forest		SG				X		
Dry-mesic sand prairie		SG				X		
Dry-mesic sand savanna		SG				X		
Dry-mesic Southern Forest					X		X	
Dry-mesic upland forest		SG				X	X	
Emergent marsh					X		X	
Fen		SG				X		
Forested fen		SG				X		
Forested swamp		SG				X		
Great Lakes marsh								X
Hardwood-conifer swamp							X	
Intermittent wetland							X	
Marsh		SG				X		
Mesic prairie						X		
Mesic sand prairie								X
Mesic upland forest		SG				X		
Muck flat		SG				X	X	
Oak barrens					X		X	
Prairie fen					X	X	X	X
Relict conifer swamp							X	X
Sand flat		SG				X		
Sedge meadow		SG				X		
Shrub swamp		SG				X	X	X
Southern floodplain forest							X	
Southern swamp					X		X	X
Southern wet meadow					X	X	X	
Submergent marsh					X			
Wet-mesic Floodplain Forest		SG				X	X	

Table 25.–Continued.

Common name or feature	Scientific name	State status	Federal status	Valley Code H	U	M	L	Mo
Plant Community								
Wet-mesic Prairie							X	X
Woodland prairie					X	X	X	
Other Feature								
Great blue heron rookery					X	X	X	X
Marl beach		SG				X		
Mississippian earth feature			LE		X			
Drumlin						X		

Table 26.–Distribution of aquatic invertebrates (except mussels) in the St. Joseph River watershed, by valley segments and major tributaries. Data from Michigan Department of Natural Resources, Fisheries Division and Michigan Department of Environmental Quality, Surface Water Quality Division. "x" represents locations where invertebrate groups are found; blanks indicate that a group was not found in that segment in any studies. Invertebrate groups (in bold) are the most sensitive. Station codes: CR=Country road; SR=State road.

Taxa Location	**Ephemeroptera**	**Trichoptera (caddisflies)**	**Plecoptera (stoneflies)**	Diptera (flies, midges)	**Simulidae (black flies)**	Chironomidae (midges)	Culicidae (mosquitoes)	Tipulidae (crane flies)	Anisoptera (dragonflies)	Zygoptera (damselflies)	Hemiptera (true bugs)	Coleoptera (beetles)	Megaloptera (alderflies)	Turbellana (flatworms)	Hirudinea (leeches)	Oligochaeta (worms)	Amphipoda (scuds)	Decapoda (crayfish)	Hydracanna (mites)	Porifera (sponges)
Headwaters																				
St. Joseph River near Hillsdale	x	x		x	x	x		x	x	x	x				x		x	x		
St. Joseph River 22 mile Rd	x	x	x			x				x	x						x	x		
St. Joseph River 9 mile Rd	x	x	x			x			x		x	x		x	x	x	x	x	x	
Upper																				
St. Joseph River near Union City	x	x	x		x			x	x	x	x						x	x		
Coldwater River Central Rd	x	x	x		x	x			x		x	x	x	x			x	x		
Coldwater River Coldwater Rd	x	x	x			x					x						x	x		
Coldwater River Lockwood Rd	x	x			x	x			x	x	x	x					x	x		
Coldwater River Garfield Rd	x	x	x		x	x			x	x		x					x	x		
Coldwater River Steffey Rd	x	x			x	x			x	x	x	x					x	x		
Coldwater River Fox Rd	x	x			x	x		x	x			x					x	x		
Nottawa Creek 19 mile	x	x			x	x		x	x		x	x		x			x	x		
Nottawa Creek 17 mile	x	x			x	x			x		x	x		x			x	x		
Nottawa Creek I69	x	x				x		x	x		x	x	x	x			x	x		
Nottawa Creek 9 mile	x	x			x	x				x	x	x			x	x	x	x		
Nottawa Creek 4 mile	x	x	x		x	x		x	x		x	x					x	x		
Little Portage Creek near Mendon	x	x			x	x			x	x	x	x	x					x		
Middle																				
Rocky River Savage Rd	x	x															x	x		
Rocky River Lovers Lane	x	x	x														x	x		
Rocky River US 131	x	x			x	x			x		x	x			x		x	x		
Prairie River McKale Rd	x	x	x			x	x		x	x		x	x				x			
Fawn River Balk Rd	x	x	x		x	x			x	x	x	x	x		x		x	x	x	
Fawn River Stubey Rd	x	x	x		x				x	x	x	x	x		x		x	x		
Fawn River near Scott, IN	x	x			x	x						x				x			x	
Pigeon Creek SR 327	x	x			x	x						x		x		x	x			
Pigeon River SR 27	x	x				x						x				x				
Pigeon River Ontario Lake Dam	x	x				x						x	x			x		x		
Pigeon River near Scott, IN	x	x			x	x			x			x								
Little Elkhart CR 1000W	x	x			x	x										x	x			
Little Elkhart near Middlebury, IN	x	x		x		x		x				x				x				

Table 26.–Continued.

Location \ Taxa	**Ephemeroptera**	**Trichoptera (caddisflies)**	**Plecoptera (stoneflies)**	Diptera (flies, midges)	**Simulidae (black flies)**	Chironomidae (midges)	Culicidae (mosquitoes)	Tipulidae (crane flies)	Anisoptera (dragonflies)	Zygoptera (damselflies)	Hemiptera (true bugs)	Coleoptera (beetles)	Megaloptera (alderflies)	Turbellana (flatworms)	Hirudinea (leeches)	Oligochaeta (worms)	Amphipoda (scuds)	Decapoda (crayfish)	Hydracanna (mites)	Porifera (sponges)
Middle (continued)																				
Elkhart River CR 450W	x	x		x		x				x		x					x			
Solomon Creek CR 48	x	x		x	x	x						x					x			
Elkhart River SR 13	x	x			x	x						x					x			
Christiana Creek Crooked Cr. Rd	x	x	x		x	x		x		x	x	x	x		x	x	x	x		x
Christiana Creek near Vandalia	x	x	x	x	x	x			x	x	x	x				x	x	x		
Christiana Creek Heaton Lake Rd	x	x			x	x		x				x		x		x	x			
Lower																				
Baugo Creek Roosevelt Rd	x	x		x	x	x				x		x				x				
Dowagiac River Middle Crossing	x	x	x		x	x				x	x	x	x				x	x		
Dowagiac Creek Goodnaugh Rd	x	x		x	x				x	x	x	x	x			x	x	x		
Dowagiac Creek Mckenzie	x	x	x		x	x		x	x	x	x	x				x	x	x		
Dowagiac Creek near Dowagiac	x	x		x	x	x			x	x	x	x	x		x		x	x		
Dowagiac River Pucker St.	x	x	x		x	x	x	x	x	x	x	x		x		x	x	x	x	
Pipestone Creek River Rd	x				x	x						x				x	x	x		
Mouth																				
Paw Paw River near Paw Paw	x	x	x	x	x			x				x		x		x	x		x	
South Branch Paw Paw River	x			x	x			x				x	x		x	x	x			
Paw Paw River near Watervliet	x	x	x		x	x		x		x	x	x		x		x	x	x		

Table 27.–Synoptic table showing the distribution of mussels and snails, by collecting station, in the St. Joseph River watershed. Mussel data from Van der Schalie (1930), Horvath et al. (1994), Sherman (1997), and Fisher (1998). Snail data from various Michigan Department of Environmental Quality, Surface Water Quality Division biological reports. x=locations where species are found; blanks indicate that a species was not at that location or was not reported.

Location / Taxa	Pelecypoda (Mussels)	*Cyclonaias tuberculata*	*Elliptio dilatatus*	*Strophitus rugosus*	*Anodonta grandis*	*Anodontoides ferrussaciana*	*Lasmigona compressa*	*Lasmigona costata*	*Alasmidonta calceolus*	*Alasmidonta marginata*	*Actinonaias carinata*	*Actionaias ellipsiformis*	*Micromya iris*	*Lampsilis siliquoidea*	*Lampsilis ventricosa*	*Fusconaia flava*	*Pleurobema cordatum*	Gastropoda (snails, limpets)	Ancylidae (limpet)	Lymnaeidae	Physidae	Planorbidae
Headwaters																						
St. Joseph River near Hillsdale																			x		x	
Sand Creek																x	x					
St. Joseph River near Litchfield			x	x	x		x	x								x						
St. Joseph River NE of Tekonsha			x	x				x	x	x	x	x	x		x	x						
St. Joseph River at Tekonsha			x	x		x		x	x	x	x	x	x		x	x						
St. Joseph River at Burlington			x							x												
Upper																						
Hog Creek near Union City			x								x	x	x			x						
St. Joseph River near Leonidas			x	x				x		x	x	x	x	x	x	x	x					
Swan Creek Townline Road			x													x						
Nottawa Creek near Leonidas				x							x	x		x	x							
Nottawa Creek 19 mile																					x	
Nottawa Creek 17 mile																		x				
Nottawa Creek I69																		x	x			
Nottawa Creek 9 mile																		x				
St. Joseph River Stowell Road																x						
Middle																						
St. Joseph River by Three Rivers			x	x	x					x		x				x						
Portage River near Three Rivers			x									x	x	x	x	x	x					
Rocky River Bent Road							x	x		x					x	x						
Rocky River US 131																				x	x	
Prairie River at mouth			x	x						x	x	x	x			x	x					
Fawn River Balk Rd																			x	x	x	
Fawn River near Orland			x				x	x		x						x	x					
Pigeon River at White Pigeon			x								x		x		x	x						
St. Joseph River at Mottville		x	x	x		x		x		x	x	x	x		x	x	x					
Spring Run 3 mi W of Mottville			x				x						x									
Christiana Creek at N. Shore Dr.																			x	x		
Christiana Creek at M60																			x	x	x	

Table 27.–Continued.

Location \ Taxa	Pelecypoda (Mussels)	*Cyclonaias tuberculata*	*Elliptio dilatatus*	*Strophitus rugosus*	*Anodonta grandis*	*Anodontoides ferrussaciana*	*Lasmigona compressa*	*Lasmigona costata*	*Alasmidonta calceolus*	*Alasmidonta marginata*	*Actinonaias carinata*	*Actionaias ellipsiformis*	*Micromya iris*	*Lampsilis siliquoidea*	*Lampsilis ventricosa*	*Fusconaia flava*	*Pleurobema cordatum*	Gastropoda (snails, limpets)	Ancylidae (limpet)	Lymnaeidae	Physidae	Planorbidae
Lower																						
Dowagiac River Middle Crossing																			x			
Dowagiac Creek Mckenzie																				x	x	x
Dowagiac Creek near Dowagiac																			x		x	
Dowagiac River Pucker St.																				x	x	x
Dowagiac River at Niles			x			x	x			x		x										
St. Joseph River at Berrien Springs		x	x												x	x	x					
Pipestone Creek at Naomi Rd			x																			
Mouth																						
Paw Paw River near Paw Paw																			x		x	
Paw Paw River near Watervliet			x				x	x		x				x	x	x	x					
South Branch Paw Paw River																					x	
St. Joseph River at St. Joseph					x																	

Table 28.–List of amphibians and reptiles in the St. Joseph River watershed that require an aquatic environment. Data from Best (1985).

Common name	Scientific name
Turtles	
Snapping turtle	*Chelydra serpentina*
Eastern box turtle	*Terrapene carolina coroliona*
Map turtle	*Graptemys geograpnica*
Midland painted turtle	*Chrysemys picta marginata*
Blandings turtle	*Emydiodes blandingi*
Eastern spiny softshell	*Apalone spinifera*
Common musk turtle	*Sternotherus odoratus*
Spotted turtle	*Clemmys guttata*
Snakes	
Eastern garter snake	*Thamnoshis sirtalis sirtalis*
Eastern hognose snake	*Heterodon platyrhinos*
Blue racer	*Coluber constrictor foxi*
Smooth green snake	*Opheodrys vernalis*
Black rat snake	*Elaphne obsoleta obsoleta*
Eastern milk snake	*Lampropeltis triangulum triangulum*
Kirtland's snake	*Clonophis kirtlandii*
Copperbelly water snake	*Nerodia erythrogaster neglecta*
Northern water snake	*Nerodia sipedon sipedon*
Queen snake	*Regina septemvittata*
Brown snake	*Storeria dekayi*
Northern ribben snake	*Thamnophis sauritus septentrionalis*
Massasauga	*Sistrurus catenatus*
Salamanders	
Mudpuppy	*Necturus maculosus maculosus*
Blue-spotted salamander	*Ambystoma laterale*
Spotted salamander	*Ambystoma maculatum*
Eastern tiger salamander	*Ambustoma tigrinum tigrinum*
Marbled salamander	*Ambystoma opacum*
Central newt	*Notophthalmus viridescens louisianensis*
Red-backed salamander	*Plethodon cinereus*
Four-toed salamander	*Hemidactylium scutatum*
Five-lined skink	*Eumeces fasciatus*
Frogs	
American toad	*Bufo americanus*
Fowler's toad	*Bufo woodhousei fowleri*
Blanchard's cricket frog	*Acris crepitans blanchardi*
Spring peeper	*Pseudacris crucifer*
Gray treefrog	*Hyla versicolor*
Western chorus frog	*Pseudacris triseriata triseriata*
Bullfrog	*Rana catesbeiana*
Green frog	*Rana clamitans melanota*

Table 28.–Continued.

Common name	Scientific name
Wood frog	*Rana sylvatica*
Northern leopard frog	*Rana pipiens*
Pickerel frog	*Rana palustris*

Table 29.–Birds in the St. Joseph River watershed that require aquatic or wetland environments. Data from Michigan Department of Natural Resources, Wildlife Division.

Common name	Scientific name
Common loon	*Gavia immer*
Mallard	*Anas platyrhynchos*
Black duck	*Anas rubripes*
Blue-winged teal	*Anas discors*
Canada goose	*Branta canadensis*
Wood duck	*Aix sponsa*
Pied-billed grebe	*Podilymbus podiceps*
Common goldeneye	*Bucephala clangula*
Hooded merganser	*Lophodytes cucullatus*
Common merganser	*Mergus merganser*
Cormorant	*Phalacrocorax auritus*
Trumpeter swan	*Cygnus buccinator*
Mute swan	*Cygnus olor*
Turkey vulture	*Cathartes aura*
Red-tailed hawk	*Buteo jamaicensis*
Northern goshawk	*Accipiter gentilis*
Copper's hawk	*Accipiter cooperii*
Sharp-shinned hawk	*Accipiter striatus*
Northern harrier	*Circus cyaneus*
Broad-winged hawk	*Buteo platypterus*
Red-shouldered hawk	*Buteo lineatus*
Bald eagle	*Haliaeetus leucocephalus*
Golden eagle	*Aquila chrysaetos*
Osprey	*Pandion haliaetus*
Short eared owl	*Asio flammeus*
Eastern screech owl	*Otus asio*
Long-eared owl	*Asio otus*
Barn owl	*Tyto alba*
Great horned owl	*Bubo virginianus*
Barred owl	*Strix varia*
Northern saw-whet owl	*Aegolius acadicus*
Common nighthawk	*Chordeiles minor*
American kestrel	*Falco sparverius*
Ruffed grouse	*Bonasa umbellus*
Wild turkey	*Meleagris galloparo*
Northern bobwhite	*Colinus virginianus*
Ring-necked pheasant	*Phasianus colcnicus*
Great blue heron	*Ardea herodias*
Great egret	*Casmerodius albus*
Green heron	*Butorides virescens*
Sandhill crane	*Grus canadensis*
Least bittern	*Ixobeychus exilis*
Virginia rail	*Rallus limicola*

Table 29.–Continued.

Common name	Scientific name
American bittern	*Botaurus lentiginosus*
King rail	*Rallus elagans*
Sora	*Porzana carolina*
Common moorhen	*Gallinula chloropus*
American coot	*Fulica americana*
Killdeer	*Charadrius vociferus*
Upland sandpiper	*Bartramis longicauda*
Spotted sandpiper	*Actitis macularia*
Herring gull	*Larus argentatus*
Black tern	*Chlidonias niger*
American woodcock	*Scolopax minor*
Rock dove	*Columba livia*
Mourning dove	*Zenaida macroura*
Yellow-billed cuckoo	*Coccyzus americanus*
Black-billed cuckoo	*Coccyzus erythropthalmus*
Chimney swift	*Chaetura pelagica*
Ruby-throated hummingbird	*Archilochus colubris*
Belted kingfisher	*Ceryle alcyon*
Common flicker	*Colaptes auratus*
Red-headed woodpecker	*Melanerpes erythrocephalus*
Hairy woodpecker	*Picoides villosus*
Red-bellied woodpecker	*Melanerpes carolinus*
Downy woodpecker	*Picoides pubescens*
Pileated woodpecker	*Dryocopus pileatus*
Eastern kingbird	*Tyrannus tyrannus*
Eastern phoebe	*Sayornis phoebe*
Acadian flycatcher	*Empidonax virescens*
Willow flycatcher	*Empidonax traillii*
Least flycatcher	*Empidonax minimus*
Eastern wood-pewee	*Contopus sordidulus*
Barn swallow	*Hirundo rustica*
Cliff swallow	*Hirundo pyrrhonota*
Tree swallow	*Iridoprocne bicolor*
Bank swallow	*Riparia riparia*
Northern rough-winged swallow	*Stelgidopteryx serripennis*
Purple martin	*Progne subis*
Blue jay	*Cyanocitta cristata*
Horned lark	*Ermophila alpestris*
Common crow	*Corvus brachyrhynchos*
Black-capped chickadee	*Parus atricapillus*
Tufted titmouse	*Parus bicolor*
White-breasted nuthatch	*Sitta carolinensis*
Red-breasted nuthatch	*Sitta canadensis*
House wren	*Troglodytes aedon*
Sedge wren	*Cistothorus platensis*
Carolina wren	*Thryothorus ludovicianus*

Table 29.–Continued.

Common name	Scientific name
Marsh wren	*Cistothorus palustris*
Catbird	*Dumetella carolinensis*
Brown thrasher	*Toxostoma rufum*
Northern mockingbird	*Mimus polyglottos*
Robin	*Turdus migratorius*
Swainson's thrush	*Catharus ustulatus*
Wood thrush	*Hylocichla mustelina*
Veery	*Catharus fuscescens*
Eastern bluebird	*Sialia sialis*
Golden-crowned kinglet	*Regulus satrapa*
Blue-gray gnatcatcher	*Polioptila caerulea*
Cedar waxwing	*Bombucilla cedrorum*
Starling	*Sturnus vulgaris*
Solitary vireo	*Vireo solitarius*
White-eyed vireo	*Vireo griseus*
Yellow-throated vireo	*Vireo flaviforns*
Red-eyed vireo	*Vireo olivaceus*
Warbling vireo	*Vireo gilvus*
Black-and-white warbler	*Mniotilta varia*
Prothonotary warbler	*Protonotaria citea*
Blue-winged warbler	*Vermivora pinus*
Black-throated green warbler	*Dendroica virens*
Cerulean warbler	*Dendroica cerulea*
Yellow throated warbler	*Dendroica dominica*
Blackburnian warbler	*Dendroica fusca*
Chestnut-sided warbler	*Dendroica pensylvanica*
Yellow warbler	*Dendroica petechia*
Oven bird	*Seiurus aurocapillus*
Louisiana waterthrush	*Seiurus motacilla*
Yellow-breasted chat	*Icteria virens*
Hooded warbler	*Wilsonia citrina*
Canada warbler	*Wilsonia canadensis*
American redstart	*Setophaga ruticilla*
Yellowthroat	*Geothlypis trichas*
House sparrow	*Passer domesticus*
Eastern meadowlark	*Sturnella magna*
Bobolink	*Dolichonyx oryzivorus*
Western meadowlark	*Sturnella neglecta*
Red-winged blackbird	*Aselaius phoeniceus*
Common grackle	*Quiscalus quiscula*
Brown-headed cowbird	*Molothrus ater*
Orchard oriole	*Icterus spurius*
Northern oriole	*Icterus galbula*
Scarlet tanger	*Piranga olivacea*
Cardinal	*Richmondena cardinalis*
Rose-breasted grosbeak	*Pheuticus ludovicianus*

Table 29.–Continued.

Common name	Scientific name
Evening grosbeak	*Coccothraustes vespertinus*
Indigo bunting	*Passerina cyahea*
House finch	*Carpodacus cassinii*
Purple finch	*Carpodacus purpureus*
Pine sisken	*Carduelis pinus*
American goldfinch	*Spinus tristis*
Dickcissel	*Spiza americana*
Rufous-sided towee	*Pipilo erythrophthalmus*
Savannah sparrow	*Passerculus sandwichensis*
Henslow's sparrow	*Ammodramus henslowii*
Vesper sparrow	*Pooecetes gramineus*
Grasshopper sparrow	*Ammodramus savannarum*
Chipping sparrow	*Spizella passerina*
Field sparrow	*Spizella pusilla*
White-crowned sparrow	*Zonotrichia leucopheys*
Swamp sparrow	*Melospiza georgina*
Song sparrow	*Melospiza melodia*

Table 30.–Mammals in the St. Joseph River watershed that use aquatic, wetland, or riparian habitats. Data from Michigan Department of Natural Resources, Wildlife Division.

Common name	Scientific name
Opossum	*Didelphus marsupialis*
Shorttail shrew	*Blarina brevicauda*
Masked shrew	*Sorex cinereus*
Least shrew	*Cryptotis parva*
Eastern mole	*Scalopus aquaticus*
Starnose mole	*Condylura cristata*
Big brown bat	*Epesicus fuscus*
Silver-haired bat	*Lasionycteris noctivagans*
Red bat	*Lasiurus borealis*
Hoary bat	*Lasiurus cinereus*
Little brown myotis	*Myotis luifugus*
Indiana bat	*Myotis sodalis*
Eastern cottontail	*Sylvilagus floridanus*
Eastern chipmunk	*Sylvilagus floridanus*
Woodchuck	*Marmota monax*
Thirteen-lined ground squirrel	*Citellus tridecemineatus*
Eastern fox squirrel	*Sciurus niger*
Red squirrel	*Tamiasciurus hudsonicus*
Southern flying squirrel	*Glaucomys volans*
Beaver	*Castor canadensis*
White-footed mouse	*Peromyscus leucopus*
Deer mouse	*Peromyscus maniculatus*
Prairie vole	*Microtus ochrogaster*
Meadow vole	*Microtus pennsylvanicus*
Pine vole	*Pitymys pinetorum*
Muskrat	*Ondatra zibethicus*
Southern bog lemming	*Synaptomys cooperi*
Norway rat	*Rattus norvegicus*
House mouse	*Mus musculus*
Meadow jumping mouse	*Zapus hudsonius*
Coyote	*Canis latrans*
Red fox	*Vulpes fulva*
Gray fox	*Urocyon cinereoargenteus*
Raccoon	*Procyon lotor*
Longtail weasel	*Mustela frenata*
Mink	*Mustela vison*
Badger	*Taxidea taxus*
Striped skunk	*Mephitis mephitis*
River otter	*Lutra canadensis*
White-tailed deer	*Odocoileus virginianus*

Table 31. Lakes in the St. Joseph River watershed with known populations of zebra mussels as of 1998. Data from Michigan Sea Grant Extension and Horvath (1994).

Segment and Lake	County
Headwaters	
Baw Beese Lake	Hillsdale
Upper	
Marble Lake	Branch
Middle	
Union Lake	Branch
Corey Lake	St. Joseph
Klinger Lake	St. Joseph
Baldwin Lake	Cass
Lake Wawasee	Kosciusko (IN)
Donnell Lake	Cass
Diamond Lake	Cass
Christianna Lake	Cass
Eagle Lake	Cass
Juno Lake	Cass
Julian Lake	Cass
Lower	
Bankson Lake	Van Buren
Gravel Lake	Van Buren
Lake of the Woods	Van Buren
Dewey Lake	Cass
Magician Lake	Cass
North Twin Lake	Cass
South Twin Lake	Cass
Indian Lake	Cass
Mouth	
Paw Paw Lake	Berrien

Table 32.–Number of aquatic vegetation control permits issued by Michigan Department of Environmental Quality, Land and Water Management Division, for excessive aquatic vegetation growth in Michigan counties of the St. Joseph River watershed.

Segment and county	Year								
	1988	1989	1990	1991	1992	1993	1994	1995	1996
Headwaters									
Hillsdale	7	2	4	6	3	3	3	3	4
Upper									
Branch	11	12	8	8	10	13	15	15	15
Calhoun	2	1	2	1	1	0	0	0	0
Middle									
St. Joseph	1	10	9	13	9	12	12	12	14
Kalamazoo	7	7	14	8	4	5	2	2	3
Lower									
Cass	24	20	21	26	26	26	20	20	23
Berrien	4	3	2	3	3	5	4	4	4
Mouth									
Van Buren	7	7	13	14	13	13	9	12	11
TOTAL	63	62	73	79	69	77	65	68	74

Table 33.–Organizations with interests in the St. Joseph River watershed.

Organization name
Citizens for Environmental Concern
Colon Angler Association
Ducks Unlimited
Elkhart Environmental Center
Elkhart River Restoration Association
Friends of McCoy Creek
Friends of the St. Joe River Association
Michiana Area Council of Governments
Michiana Watershed Council
Michigan Chapter of American Fisheries Society
Michigan Duck Hunters Association
Michigan Lake and Stream Association
Michigan Nature Association
Michigan Riparian
Michigan Salmon and Steelhead Fishing Association
Michigan Trappers Assoc.
Michigan United Conservation Club District # 3
Michigan United Conservation Club District # 4
Nature Conservancy
Partnership for MEANDRS
Paw Paw Lake Association
Sauk Trails RC&D
South Bend Fly Fishers
Southwest Michigan Land Conservancy
Southwest Michigan Planning Commission
St. Joseph River Basin Commission
St. Joseph River Valley Fly Fishers
St. Joseph Valley Greens (South Bend)
Trout Unlimited
Water Watchers of Indiana
Wawasee Area Conservancy Foundation
Wetlands Conservation Association

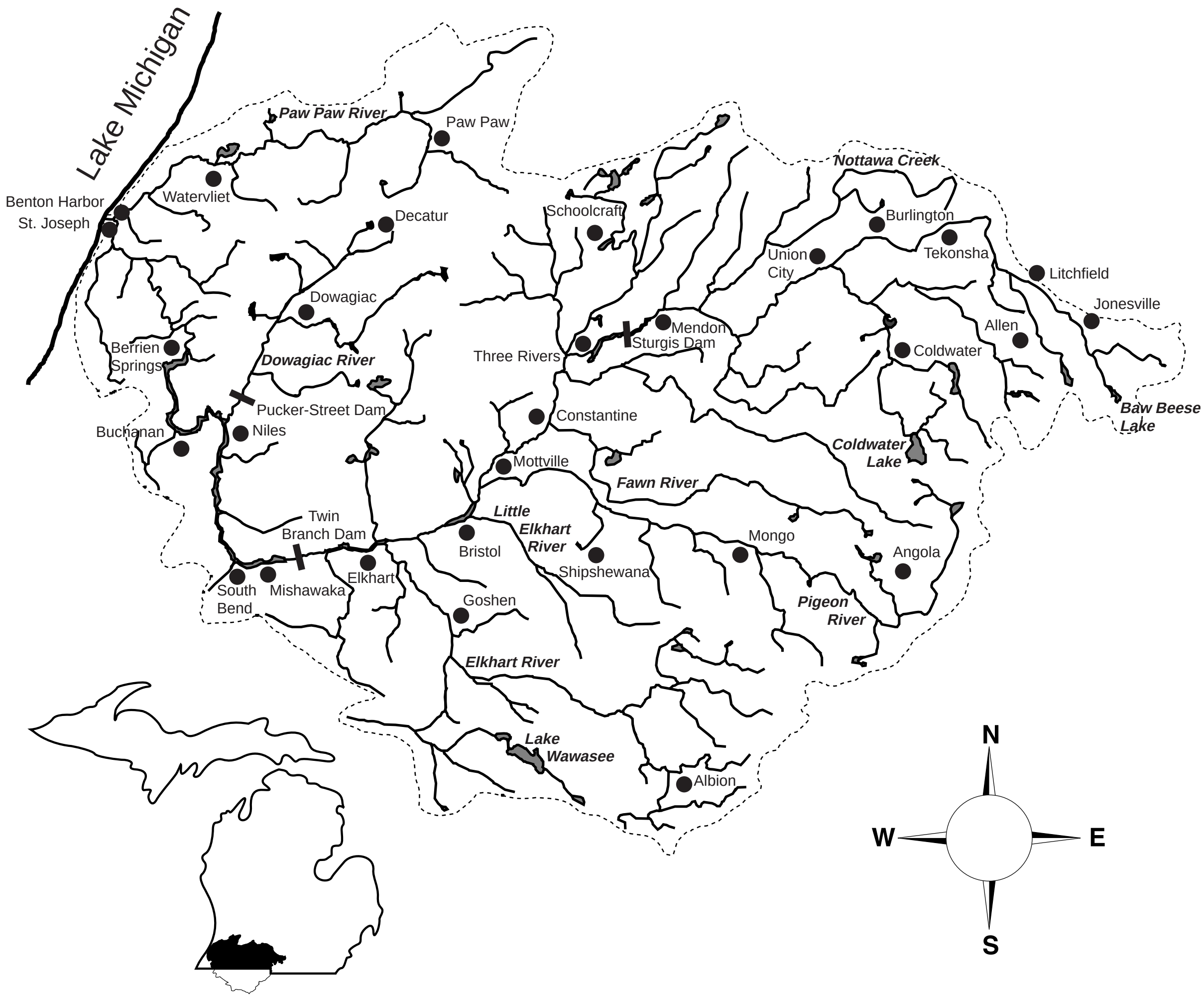

Figure 1.–The St. Joseph River watershed.

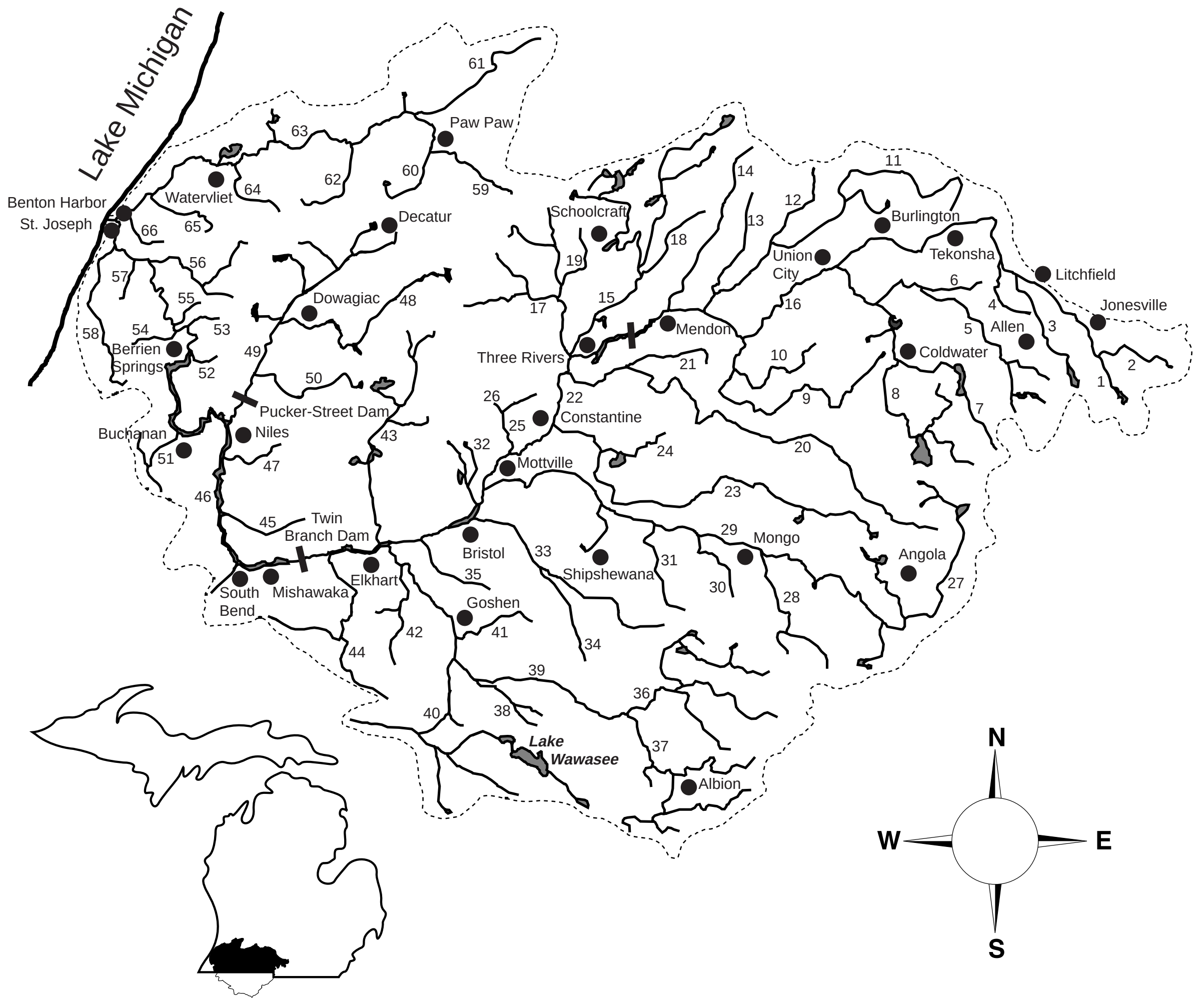

Figure 2.–Major tributaries in St. Joseph River watershed.

1. St. Joseph River (Headwaters)
2. Beebe Creek
3. Sand Creek
4. Soap Creek
5. Hog Creek
6. N. Br. Hog Creek
7. Fisher Creek
8. Coldwater River
9. Swan Creek
10. Little Swan Creek
11. Nottawa Creek
12. Pine Creek
13. Bear Creek
14. Little Portage Creek
15. Portage River
16. St. Joseph River (Upper)
17. Rocky River
18. Little Portage Creek
19. Flowerfield Creek
20. Prairie River
21. Spring Creek
22. St. Joseph River (Middle)
23. Fawn River
24. Sherman Mill Creek
25. Mill Creek
26. Curtis Creek
27. Pigeon Creek
28. Turkey Creek
29. Pigeon River
30. Fly Creek
31. Buck Creek
32. Trout Creek
33. Little Elkhart River
34. Rowe Eden Ditch
35. Pine Creek
36. N. Br. Elkhart River
37. S. Br. Elkhart River (Rimmell Branch)
38. Solomon Creek
39. Elkhart River
40. Turkey Creek
41. Rock Creek
42. Yellow Creek
43. Christiana Creek
44. Baugo Creek
45. Juday Creek
46. St. Joseph River (Lower)
47. Brandywine Creek
48. Dowagiac Creek
49. Dowagiac River
50. Pokagon Creek
51. McCoy Creek
52. Lover Creek
53. Farmers Creek
54. Lemon Creek
55. Love Creek
56. Pipestone Creek
57. Yellow Creek
58. Hickory Creek
59. E. Br. Paw Paw River
60. S. Br. Paw Paw River
61. N. Br. Paw Paw River (Campbell Creek)
62. Brush Creek
63. Paw Paw River
64. Mill Creek
65. Blue Creek
66. Ox Creek

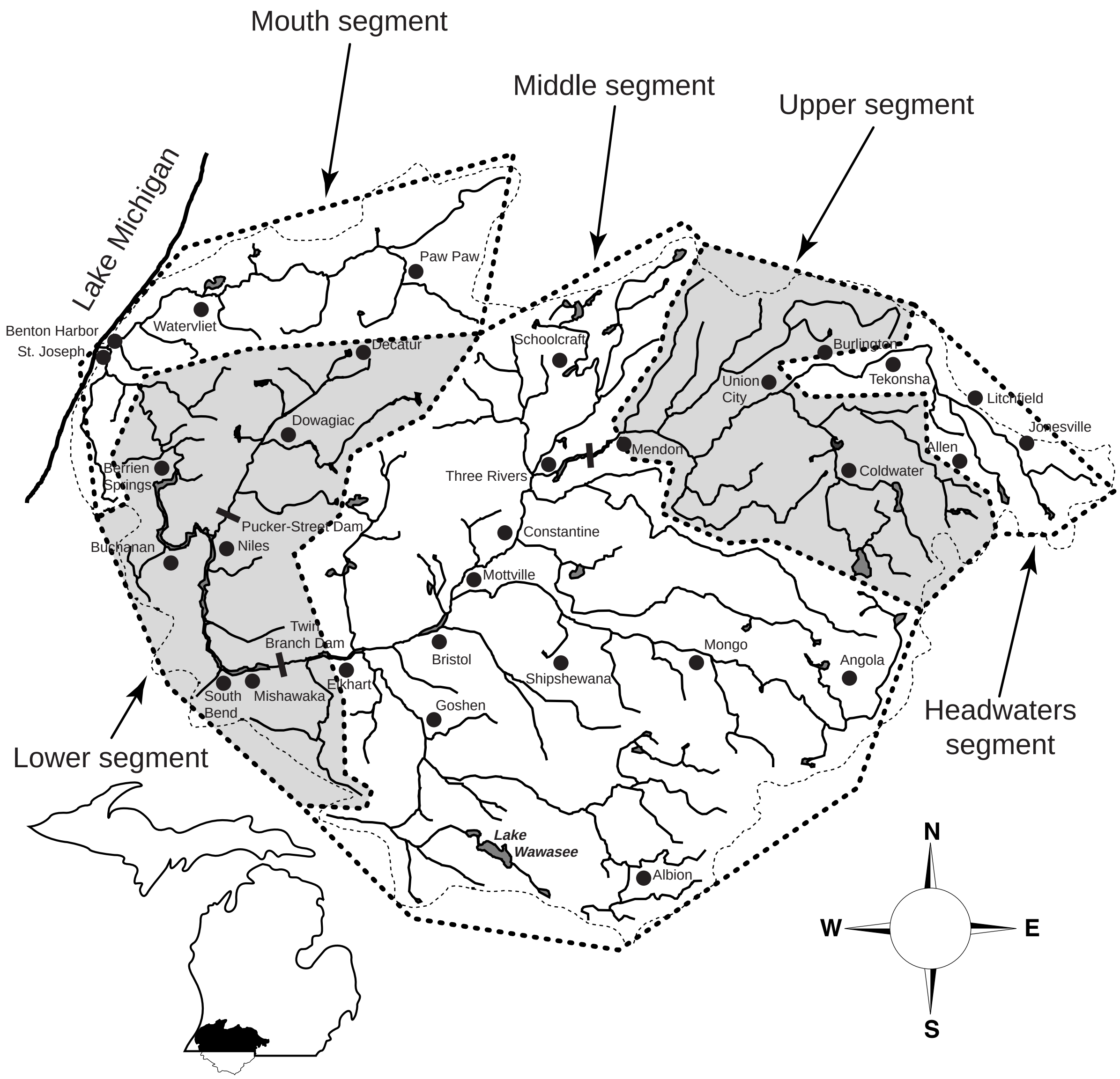

Figure 3.–Valley segements of St. Joseph River mainstem.

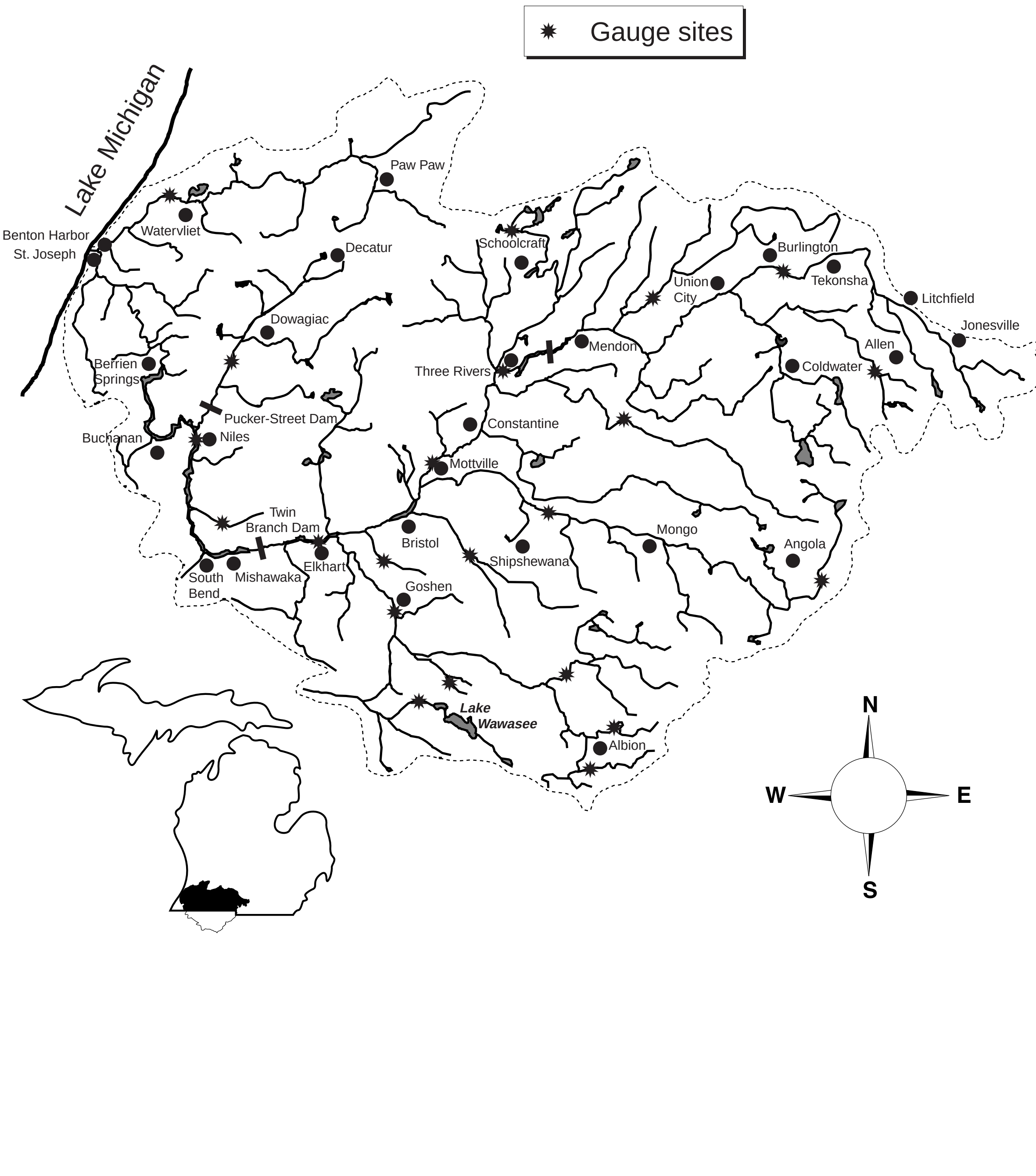

Figure 4.–Location of United States Geological Survey continuous gauges in St. Joseph River watershed.

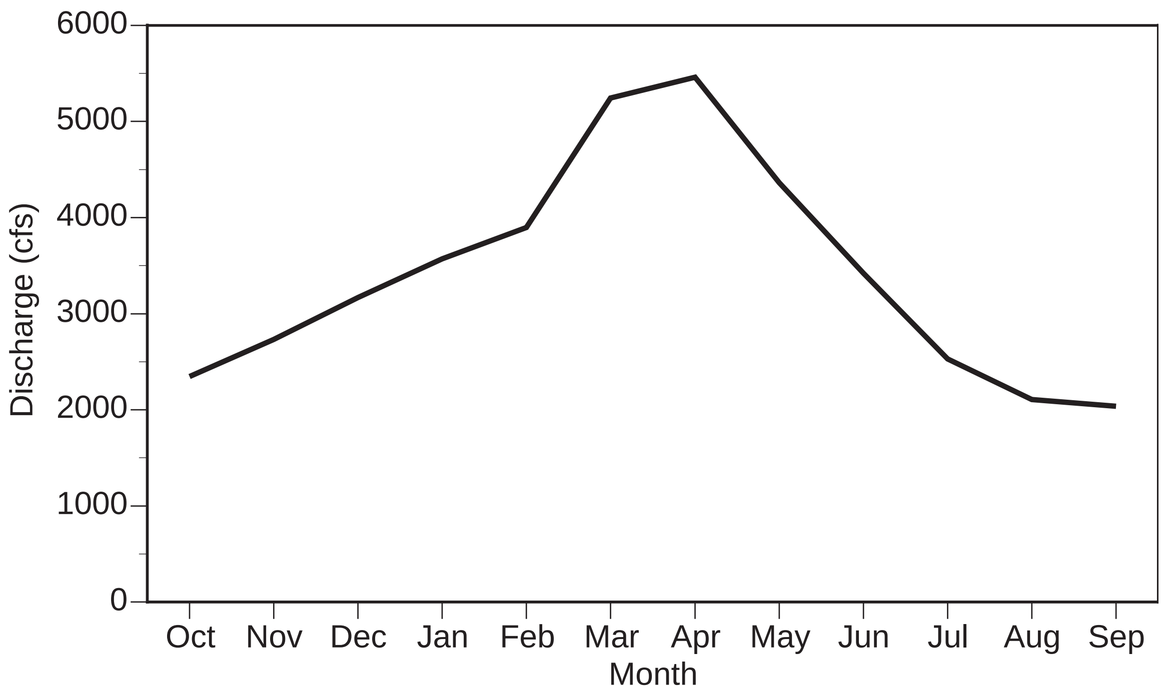

Figure 5.–Mean monthly discharge for St. Joseph River at Niles for period of record (1931-95). Data are shown from October through September, a traditional water year. Data from United States Geological Survey.

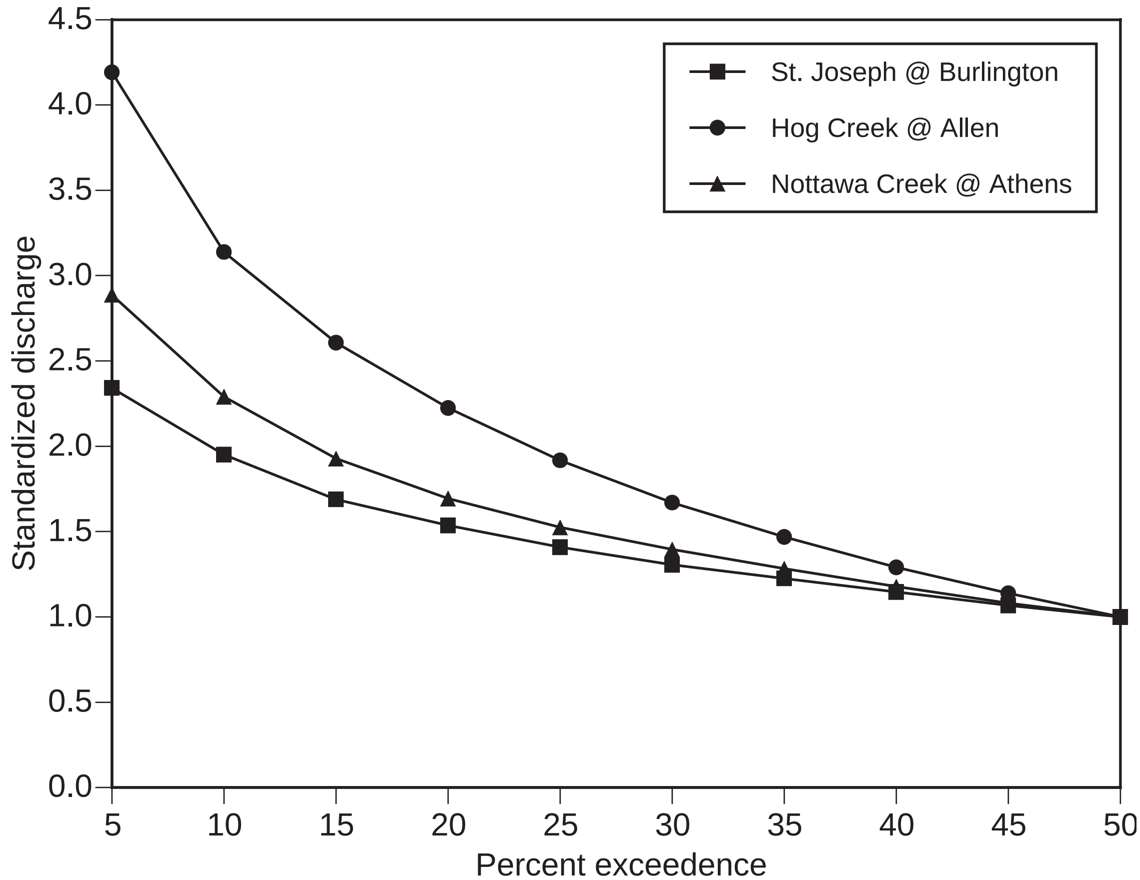

Figure 6.–Standardized high flow exceedence curves for St. Joseph River and tributaries in the headwaters and upper valley segments. Standardized discharge is the discharge (Q)/ median (50% Q) discharge. Exceedence curves represent the probability of a discharge exceeding a given value. Data from United States Geological Survey gauge stations for period of record.

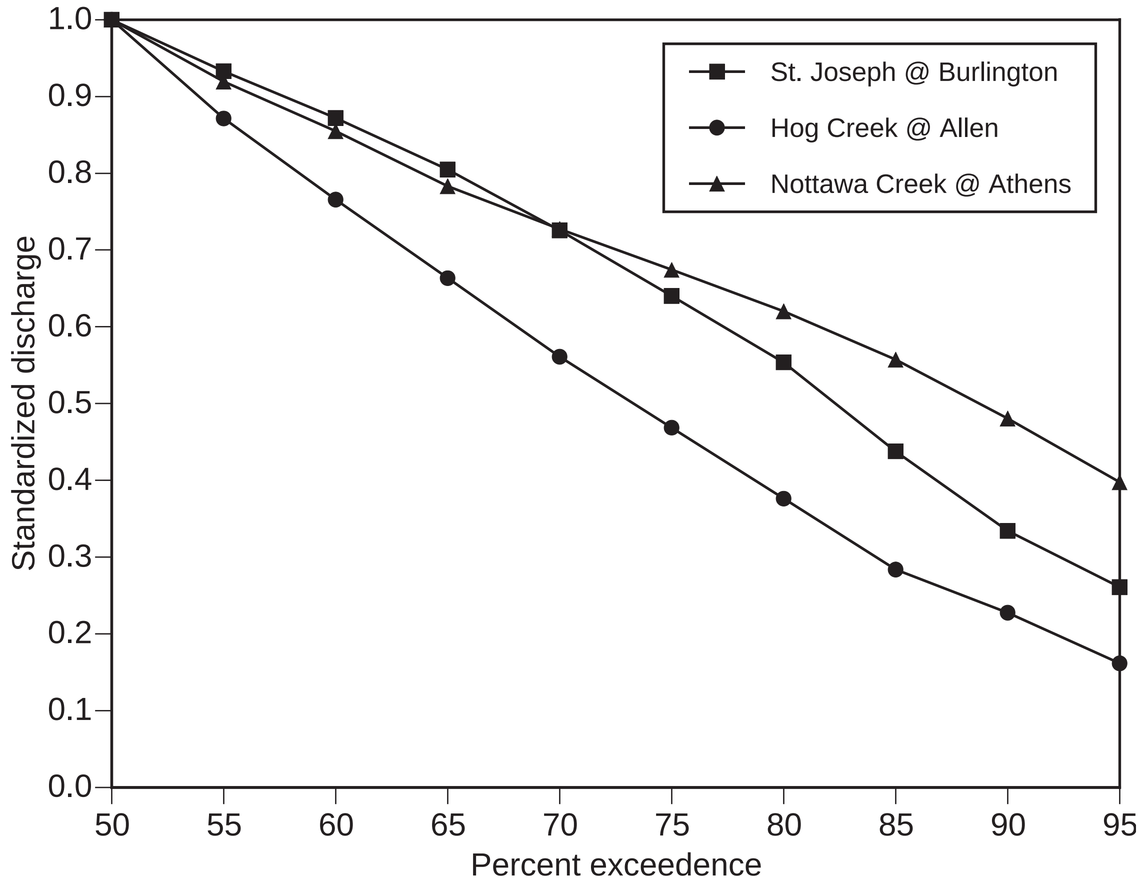

Figure 7.–Standardized low flow exceedence curves for St. Joseph River and tributaries in headwaters and upper valley segments. Standardized discharge is the discharge (Q)/ median (50% Q) discharge. Exceedence curves represent the probability of a discharge exceeding a given value. Data from United States Geological Survey gauge stations for period of record.

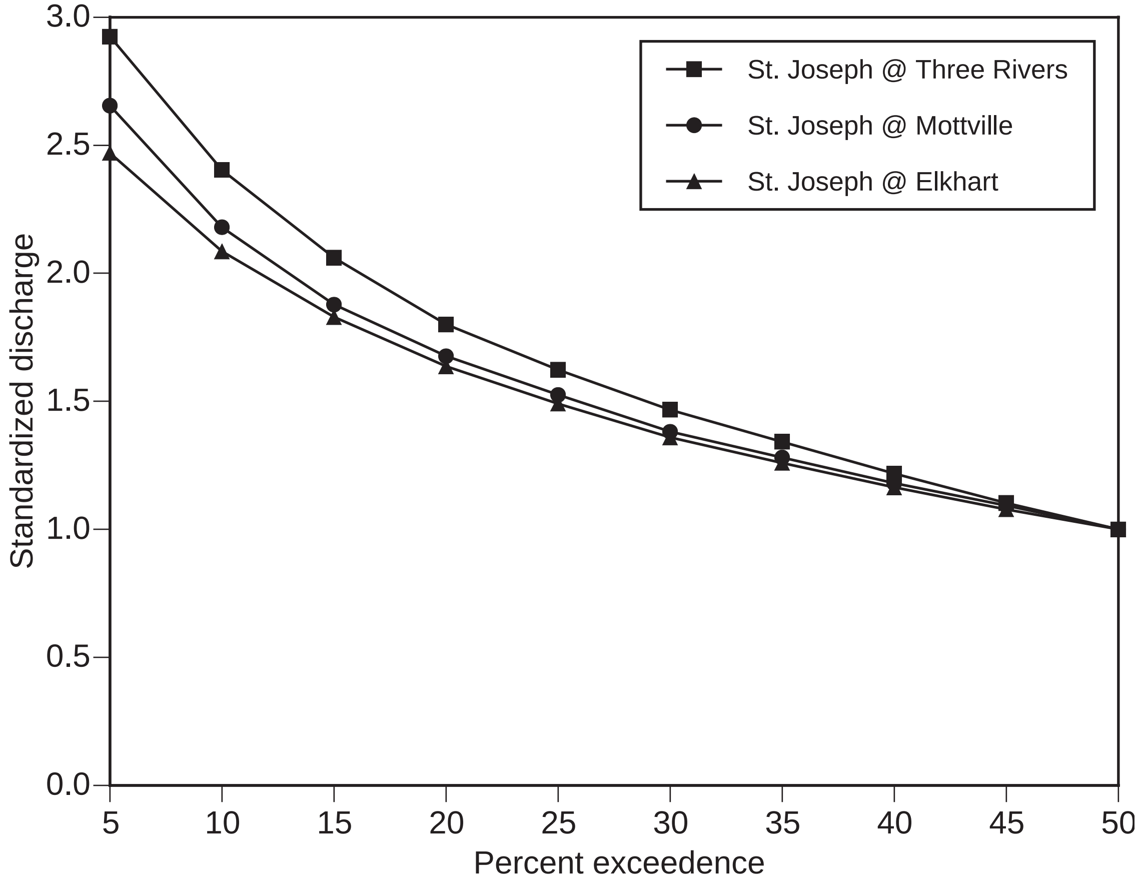

Figure 8.–Standardized high flow exceedence curves for mainstem of St. Joseph River within the middle valley segment. Standardized discharge is the discharge (Q)/ median (50% Q) discharge. Exceedence curves represent the probability of a discharge exceeding a given value. Data from United States Geological Survey gauge stations for period of record.

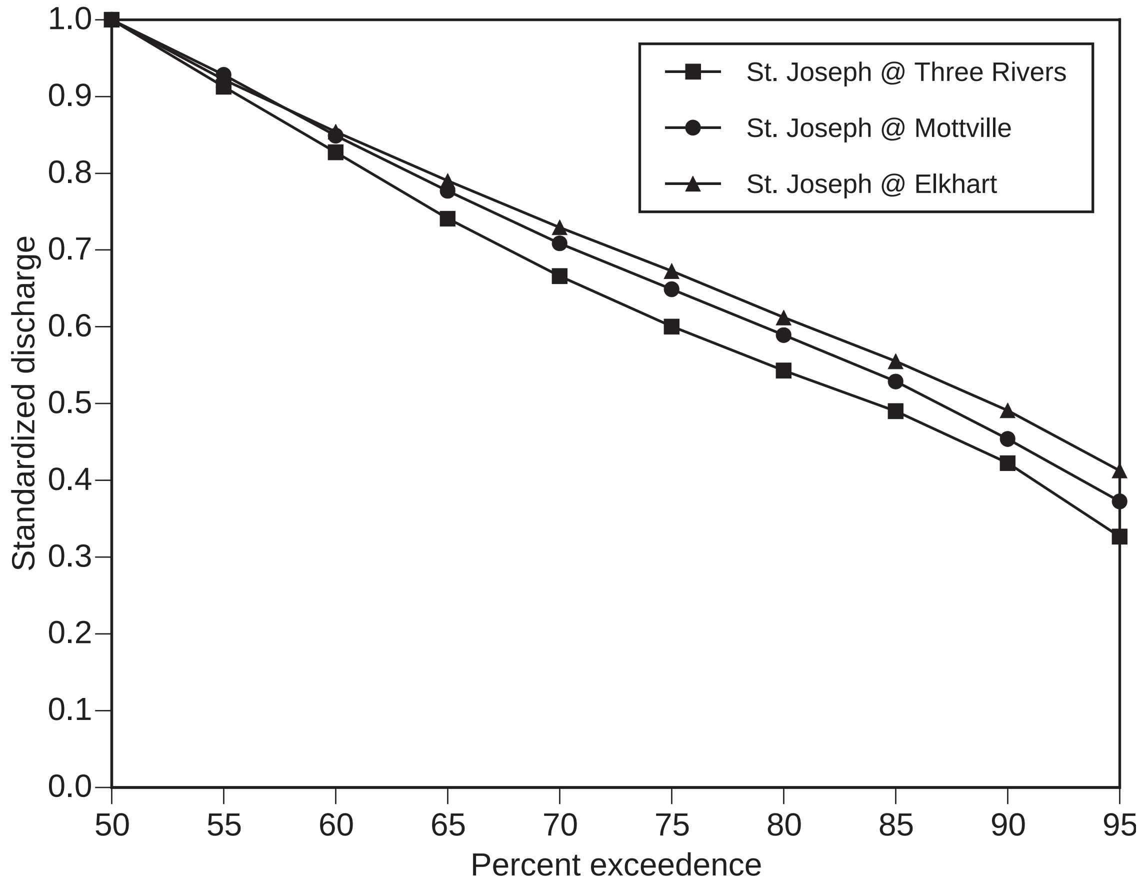

Figure 9.–Standardized low flow exceedence curves for mainstem of St. Joseph River within the middle valley segment. Standardized discharge is the discharge (Q)/ median (50% Q) discharge. Exceedence curves represent the probability of a discharge exceeding a given value. Data from United States Geological Survey gauge stations for period of record.

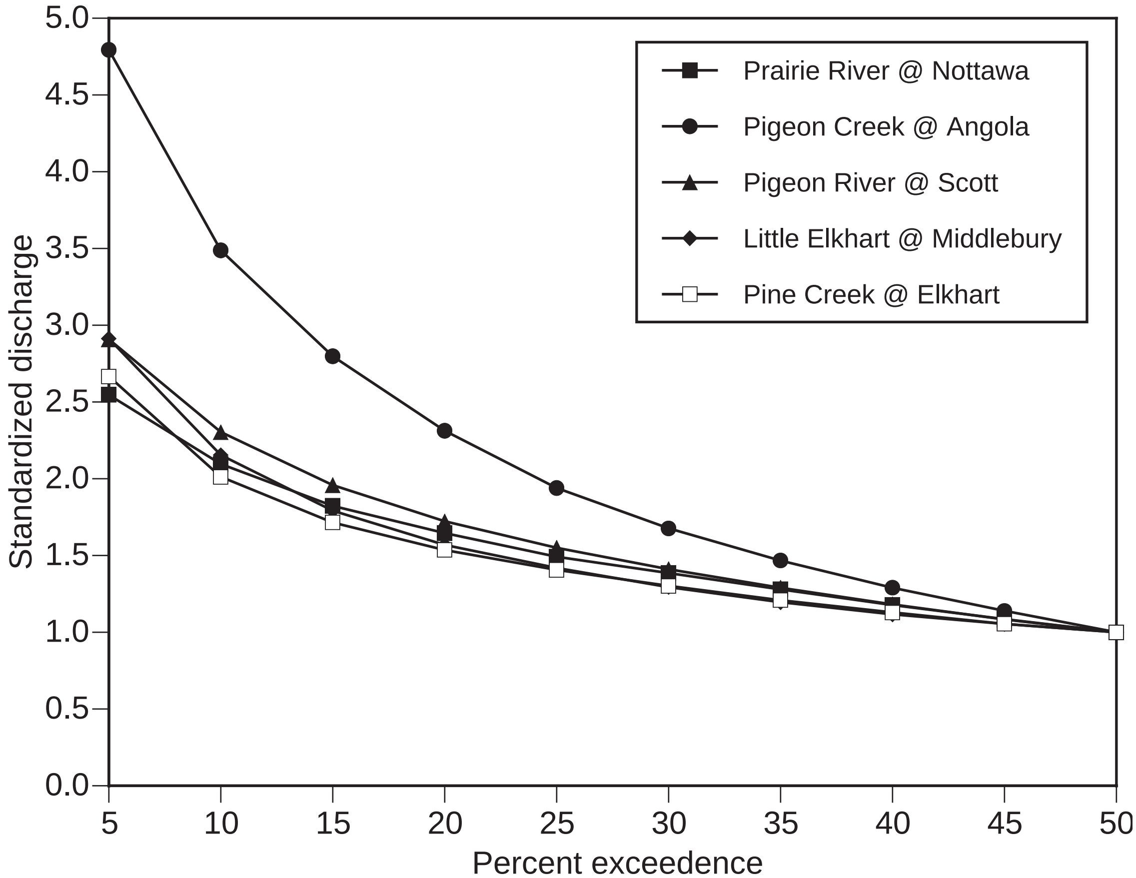

Figure 10.–Standardized high flow exceedence curves for major tributaries within the middle valley segment of St. Joseph River. Standardized discharge is the discharge (Q)/ median (50% Q) discharge. Exceedence curves represent the probability of a discharge exceeding a given value. Data from United States Geological Survey gauge stations for period of record.

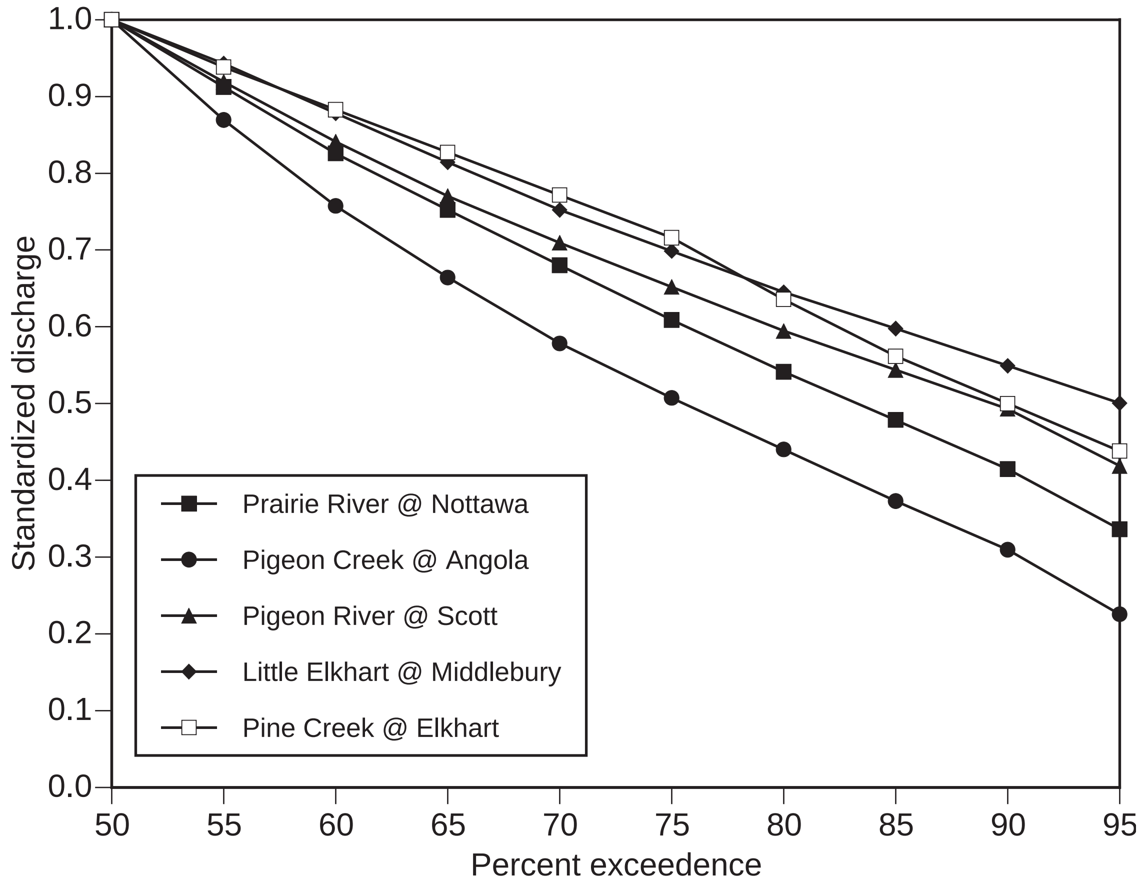

Figure 11.–Standardized low flow exceedence curves for major tributaries within the middle valley segment of St. Joseph River. Standardized discharge is the discharge (Q)/ median (50% Q) discharge. Exceedence curves represent the probability of a discharge exceeding a given value. Data from United States Geological Survey gauge stations for period of record.

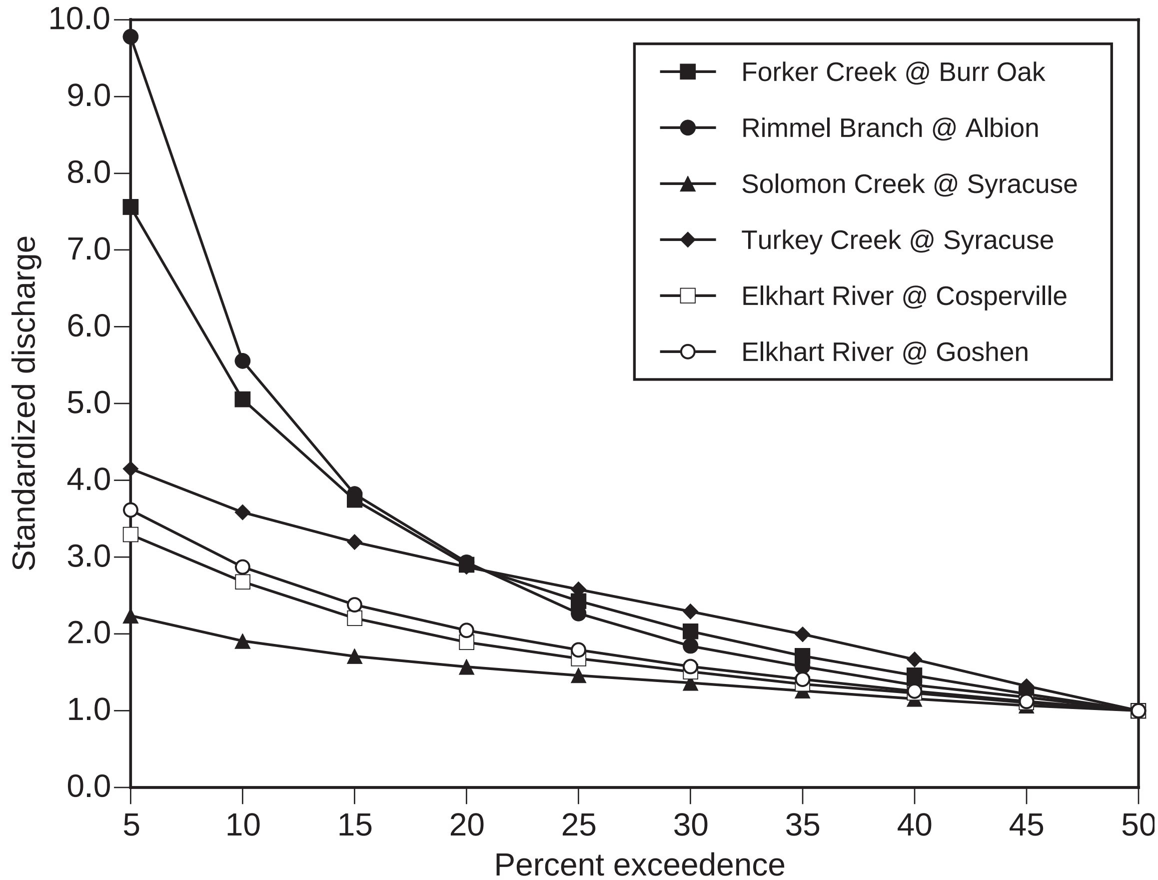

Figure 12.–Standardized high flow exceedence curves for Elkhart River and major tributaries. Standardized discharge is the discharge (Q)/ median (50% Q) discharge. Exceedence curves represent the probability of a discharge exceeding a given value. Data from United States Geological Survey gauge stations for period of record.

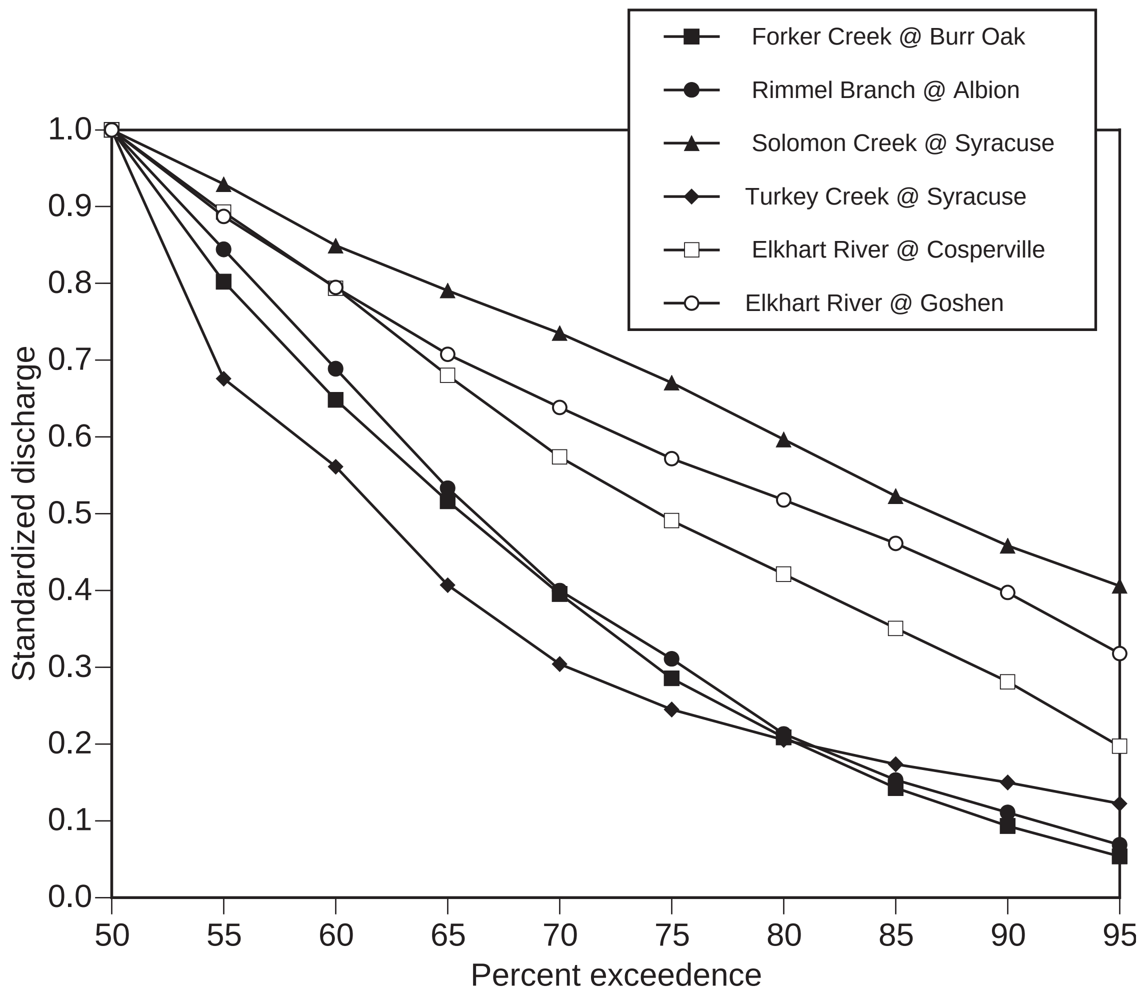

Figure 13.–Standardized low flow exceedence curves for Elkhart River and major tributaries. Standardized discharge is the discharge (Q)/ median (50% Q) discharge. Exceedence curves represent the probability of a discharge exceeding a given value. Data from United States Geological Survey gauge stations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

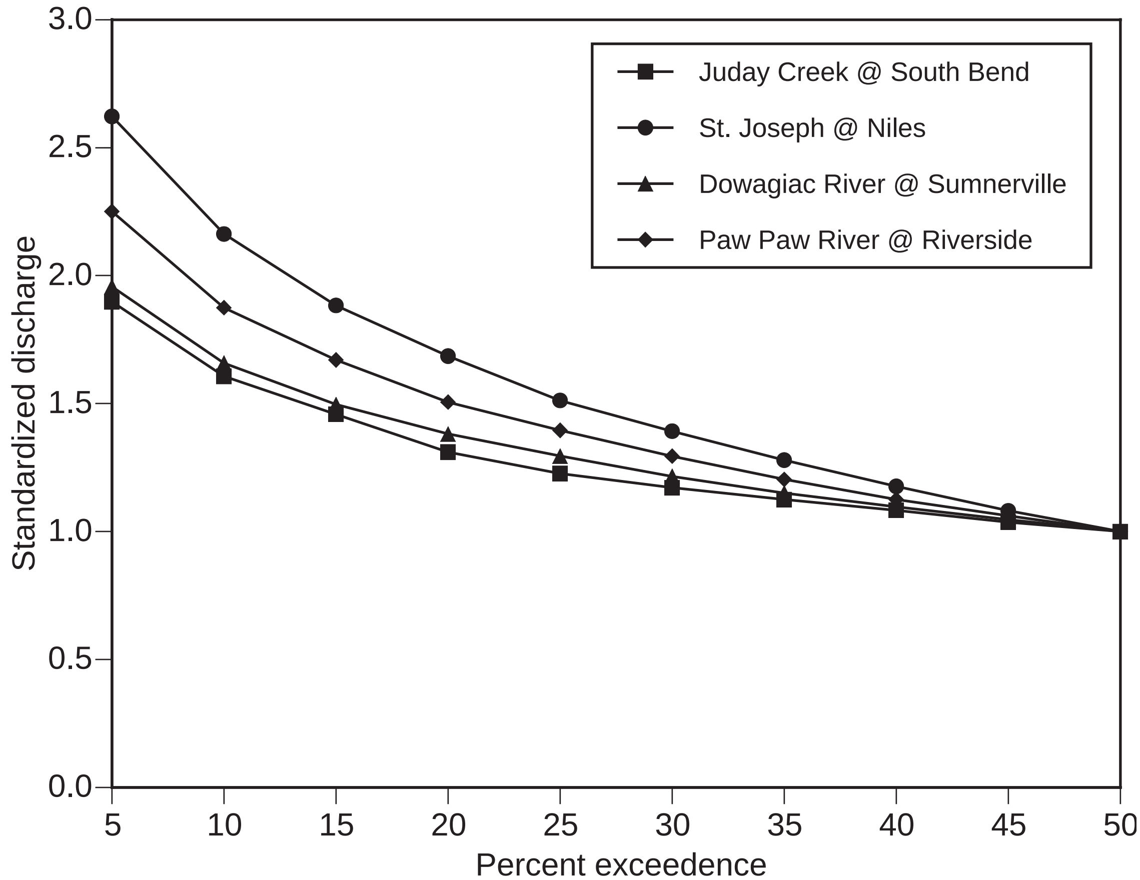

Figure 14.–Standardized high flow exceedence curves for mainstem and major tributaries within lower and mouth valley segments of St. Joseph River. Standardized discharge is the discharge (Q)/ median (50% Q) discharge. Exceedence curves represent the probability of a discharge exceeding a given value. Data from United States Geological Survey gauge stations for period of record.

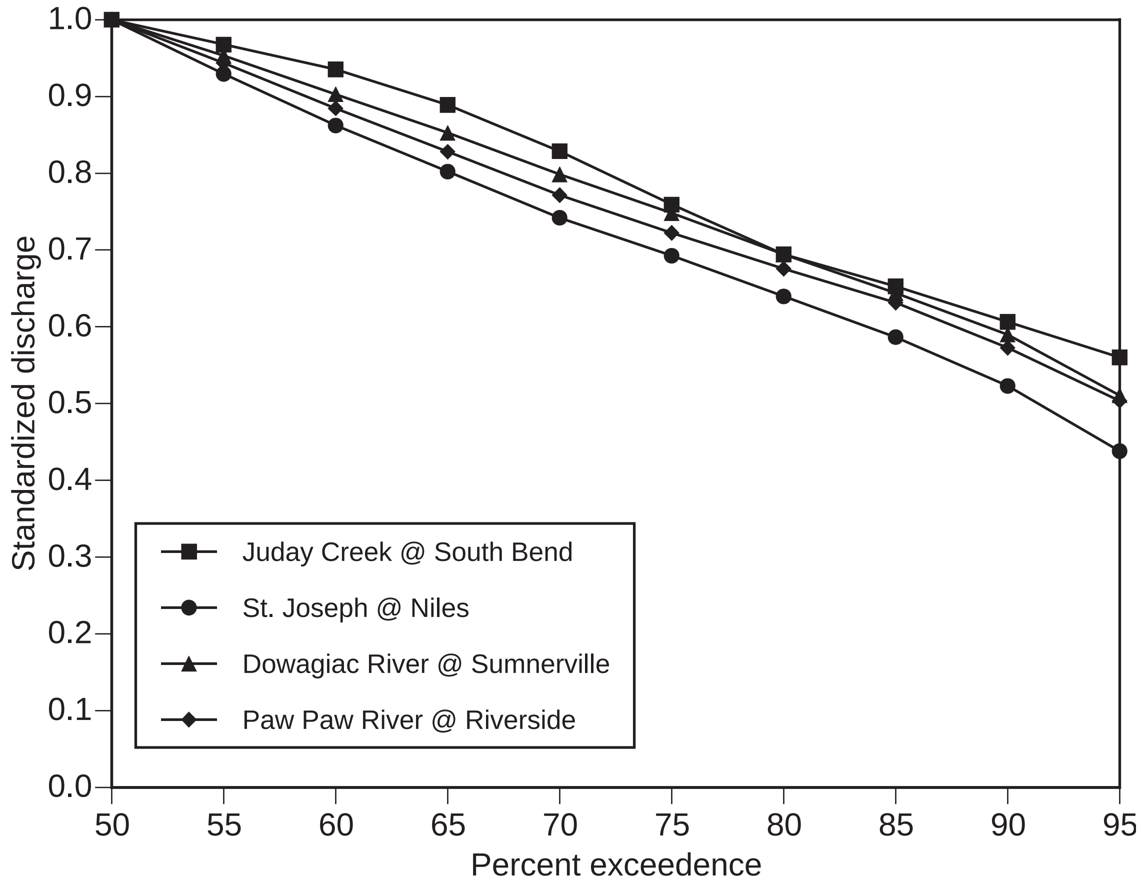

Figure 15.–Standardized low flow exceedence curves for mainstem and major tributaries within lower and mouth valley segments of St. Joseph River. Standardized discharge is the discharge (Q)/ median (50% Q) discharge. Exceedence curves represent the probability of a discharge exceeding a given value. Data from United States Geological Survey gauge stations for period of record.

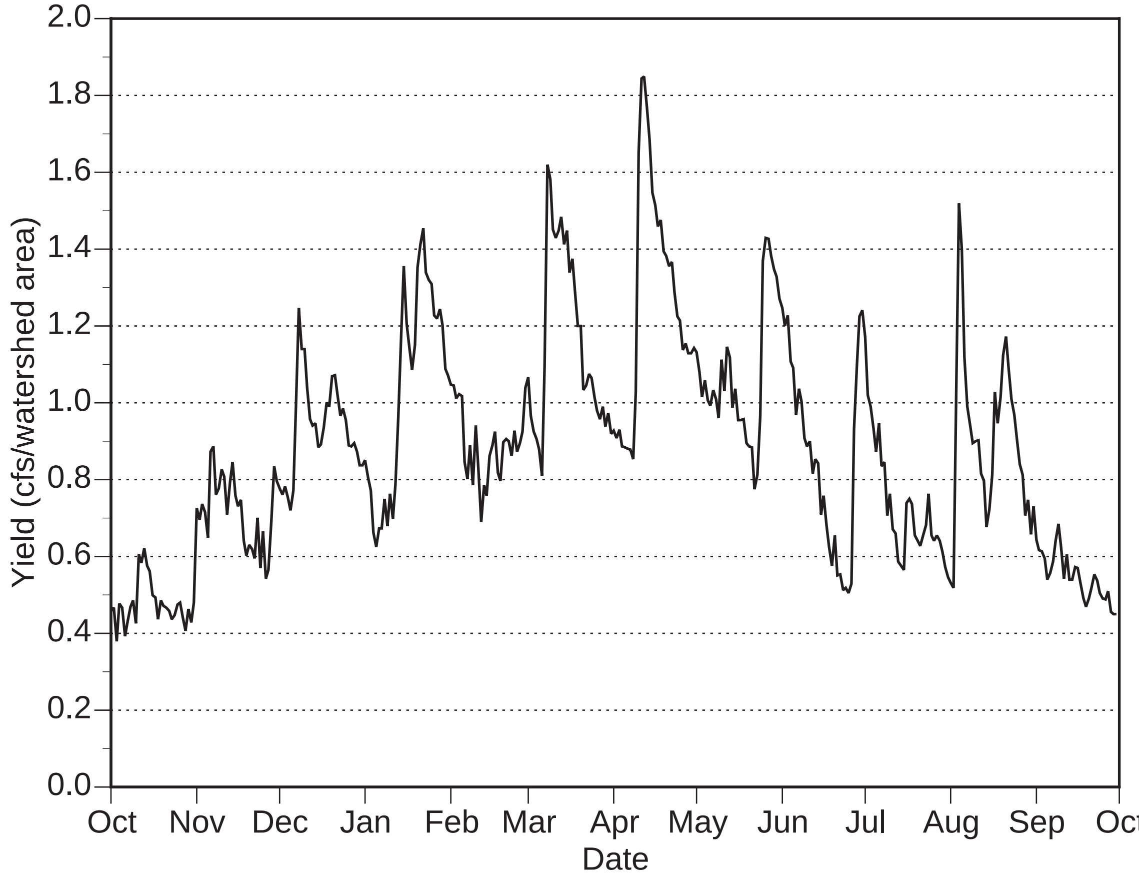

Figure 16.–St. Joseph River yield at Niles for water year 1995. Data from United States Geological Survey.

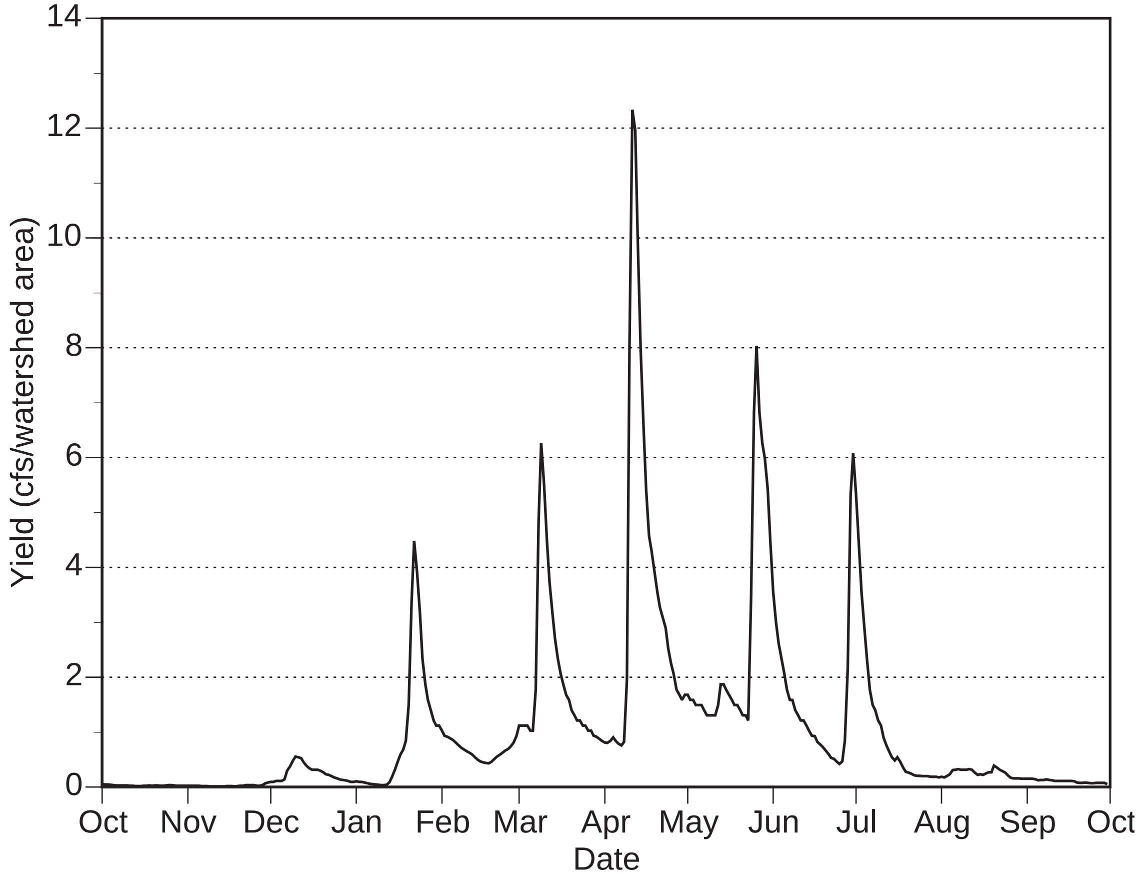

Figure 17.–Rimmell Branch yield for water year 1995. Data from United States Geological Survey.

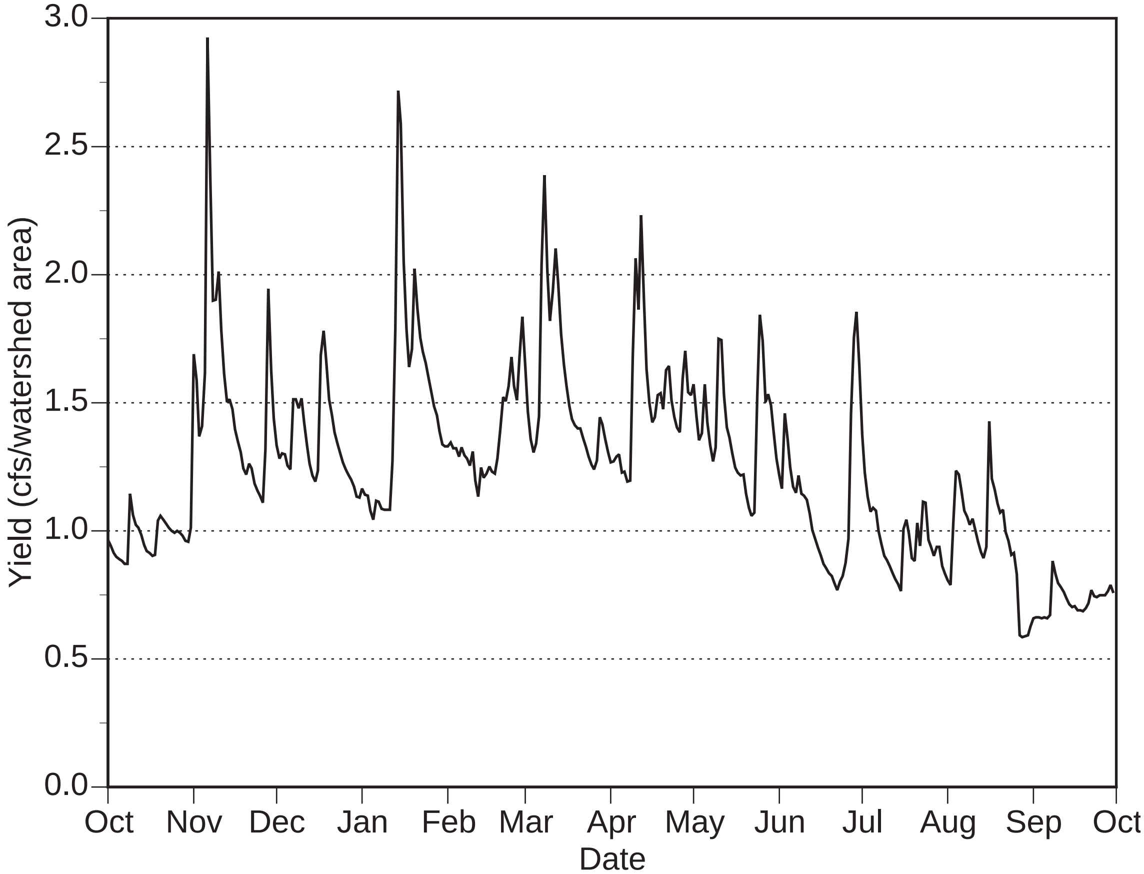

Figure 18.–Dowagiac River yield in Sumnerville for water year 1995. Data from United States Geological Survey.

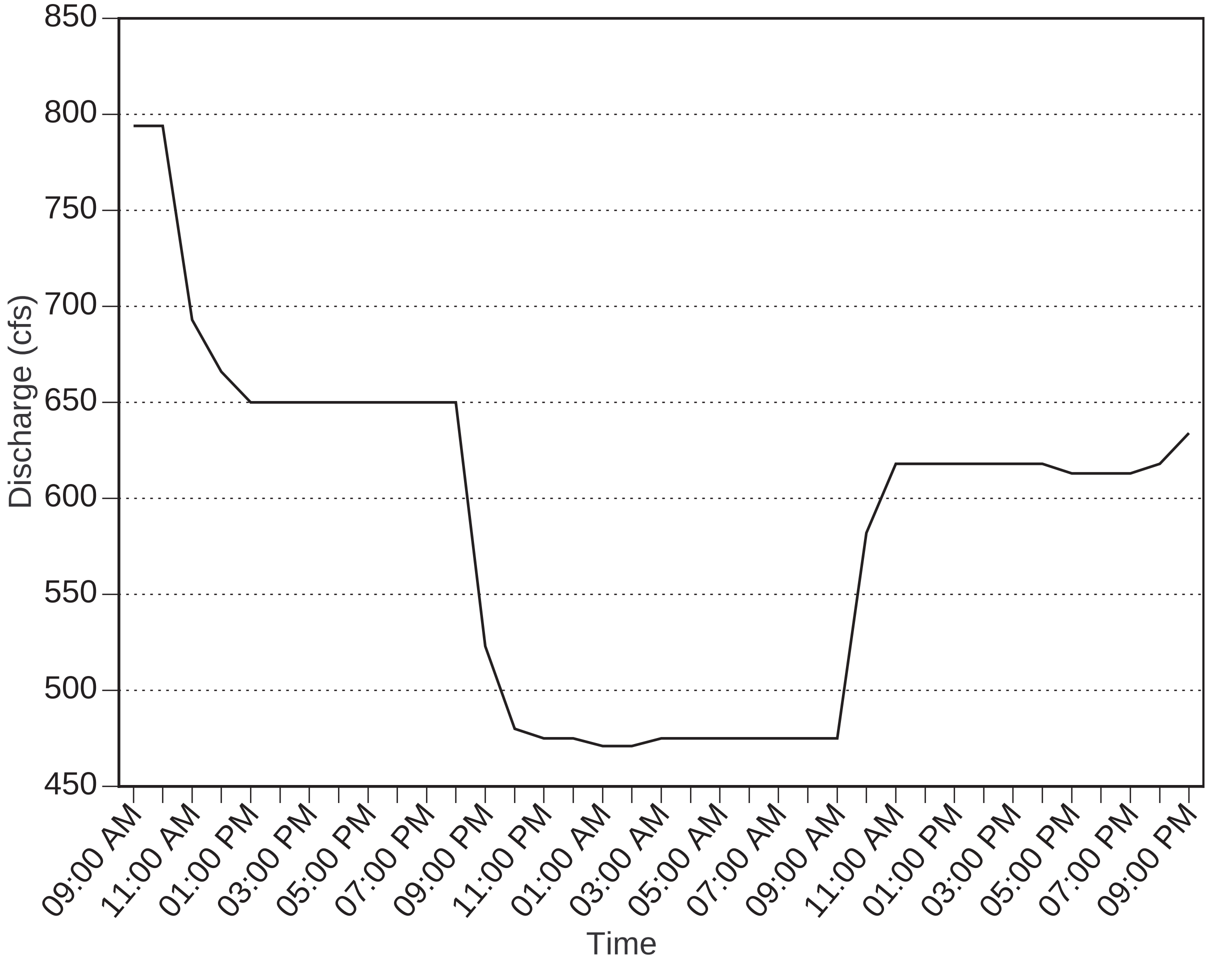

Figure 19.–Instantaneous discharge of St. Joseph River at Three Rivers from June 20 to June 21, 1999. Fish habitat ranking in parenthesis. Data from United States Geological Survey.

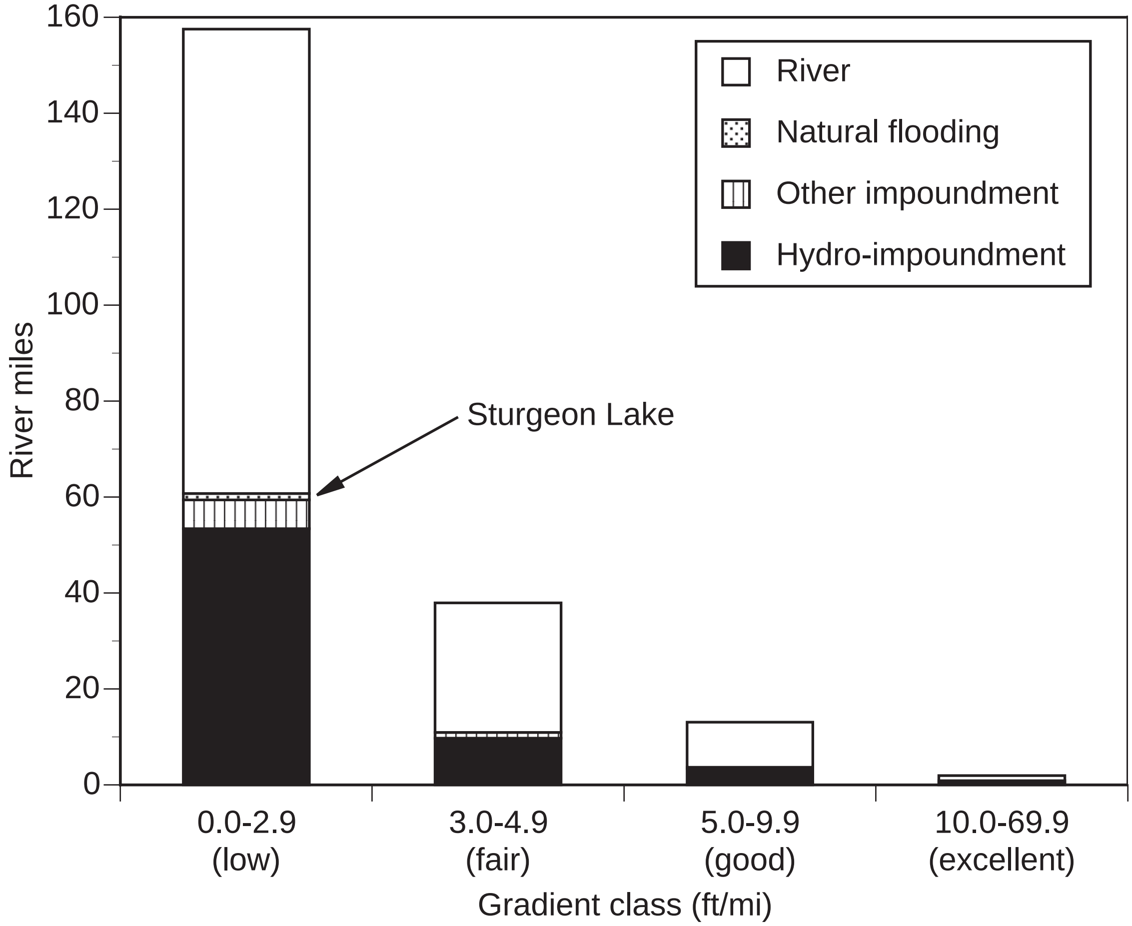

Figure 20.–Gradient class and length of river in each, separated by water type, for St. Joseph River. Fish habitat ranking in parenthesis. Data from Michigan Department of Natural Resources, Fisheries Division.

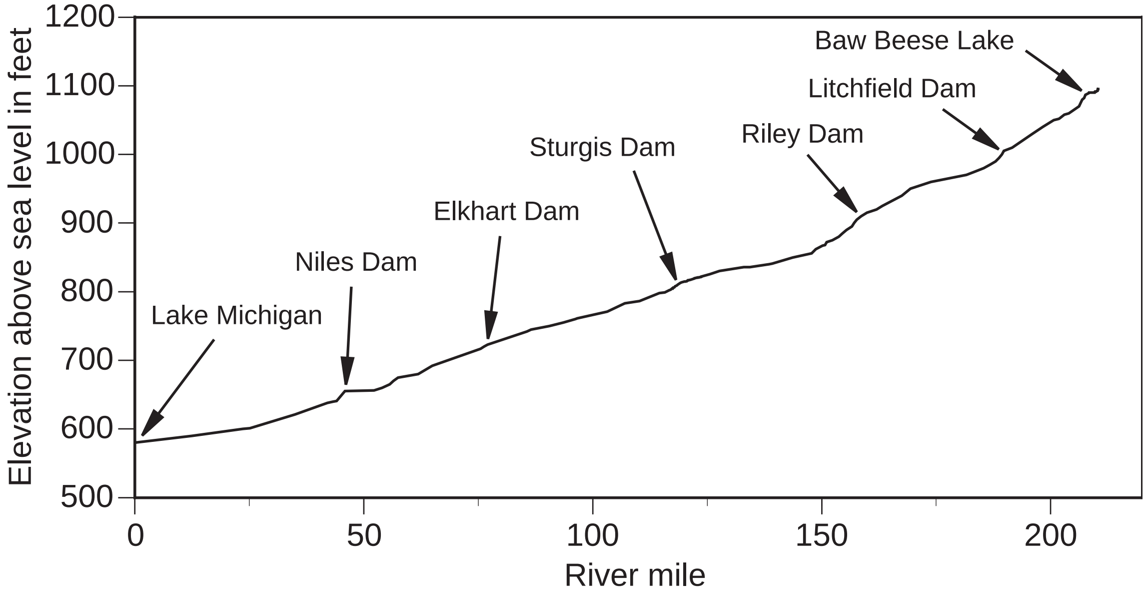

Figure 21a.–Elevation changes, by river mile, from headwaters to mouth of St. Joseph River. Data from Michigan Department of Natural Resources, Fisheries Division.

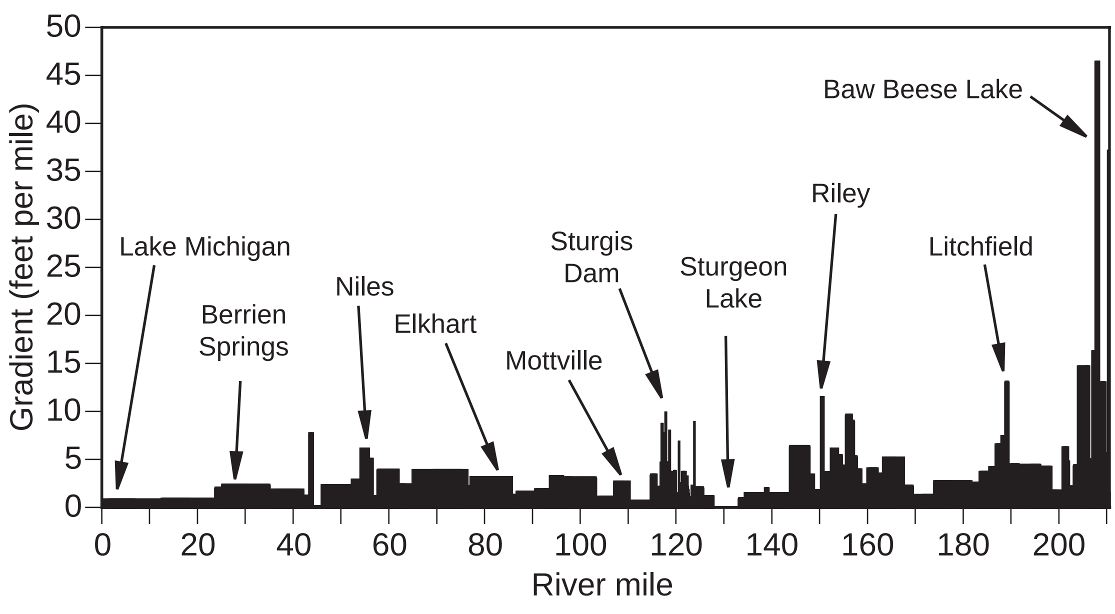

Figure 21b.–Gradient (elevation change in feet per mile) of St. Joseph River. Gradient is shown without existing dams. Data from Michigan Department of Natural Resources, Fisheries Division.

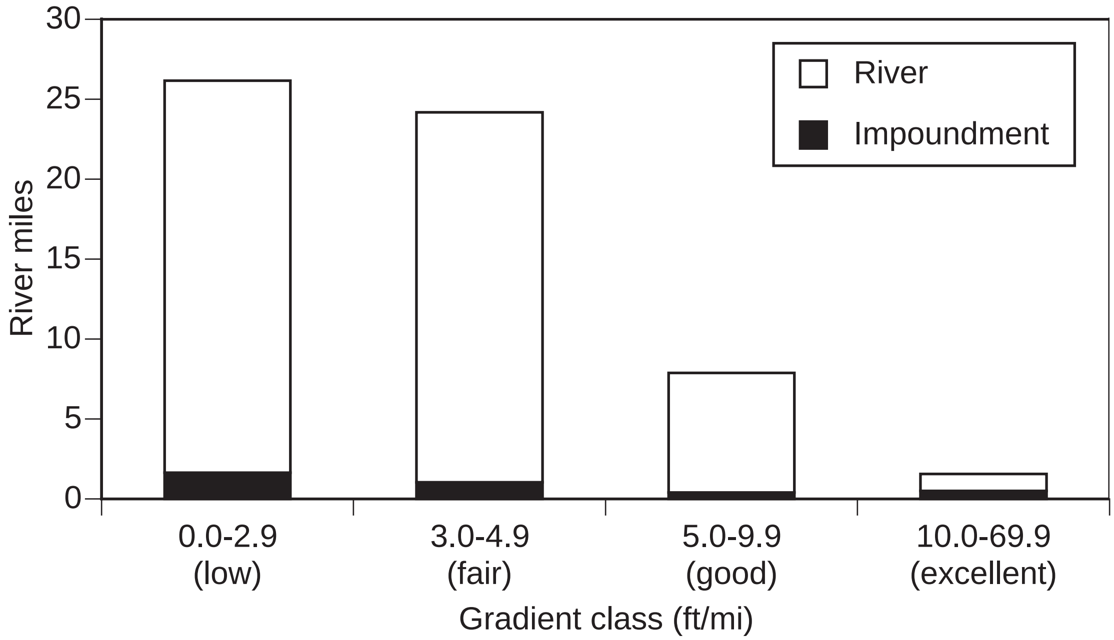

Figure 22a.–Gradient class and length of river in each, separated by water type, for headwater segment of the St. Joseph River. Fish habitat rankings in parenthesis. Data from Michigan Department of Natural Resources, Fisheries Division.

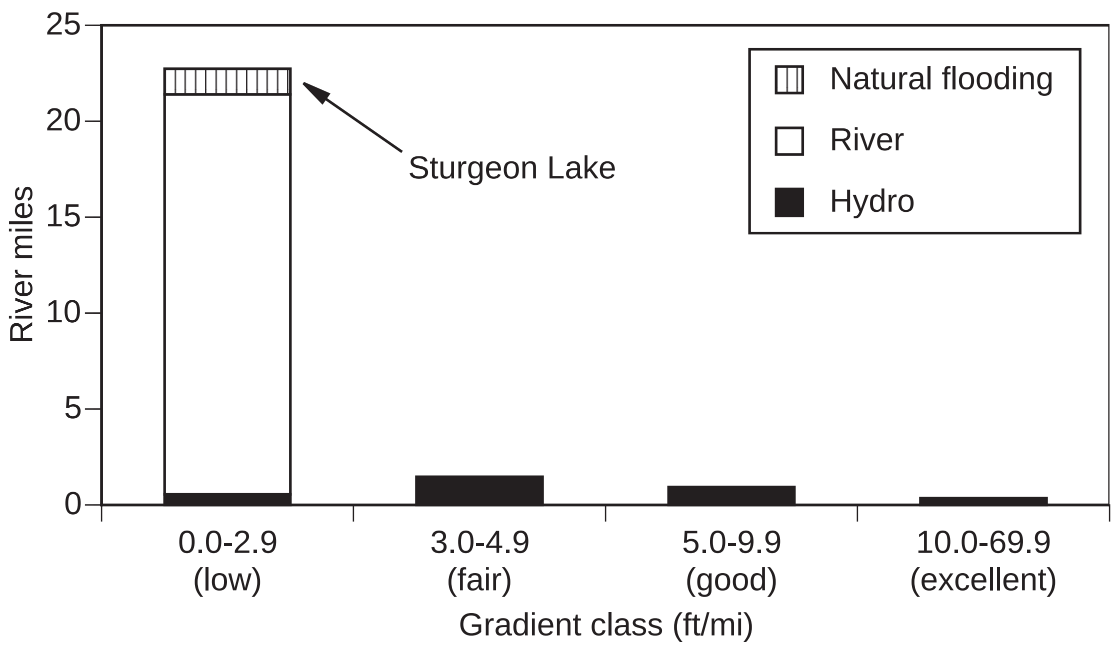

Figure 22b.–Gradient class and length of river in each, separated by water type, for upper segment of the St. Joseph River. Fish habitat rankings in parenthesis. Data from Michigan Department of Natural Resources, Fisheries Division.

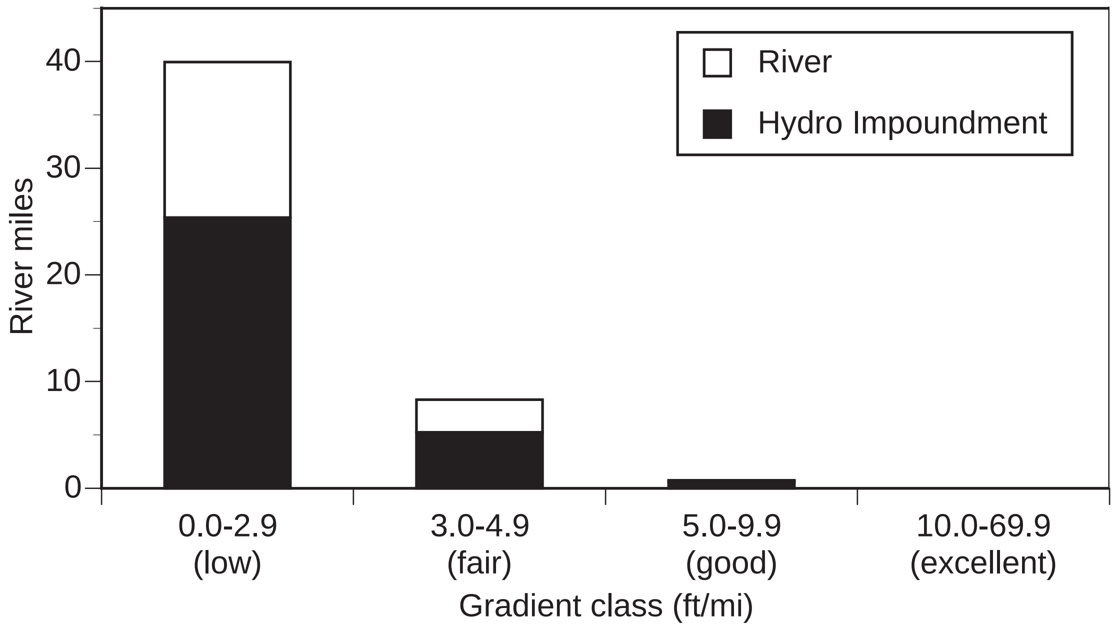

Figure 23a.–Gradient class and length of river in each, separated by water type, for middle segment of the St. Joseph River. Fish habitat rankings in parenthesis. Data from Michigan Department of Natural Resources, Fisheries Division.

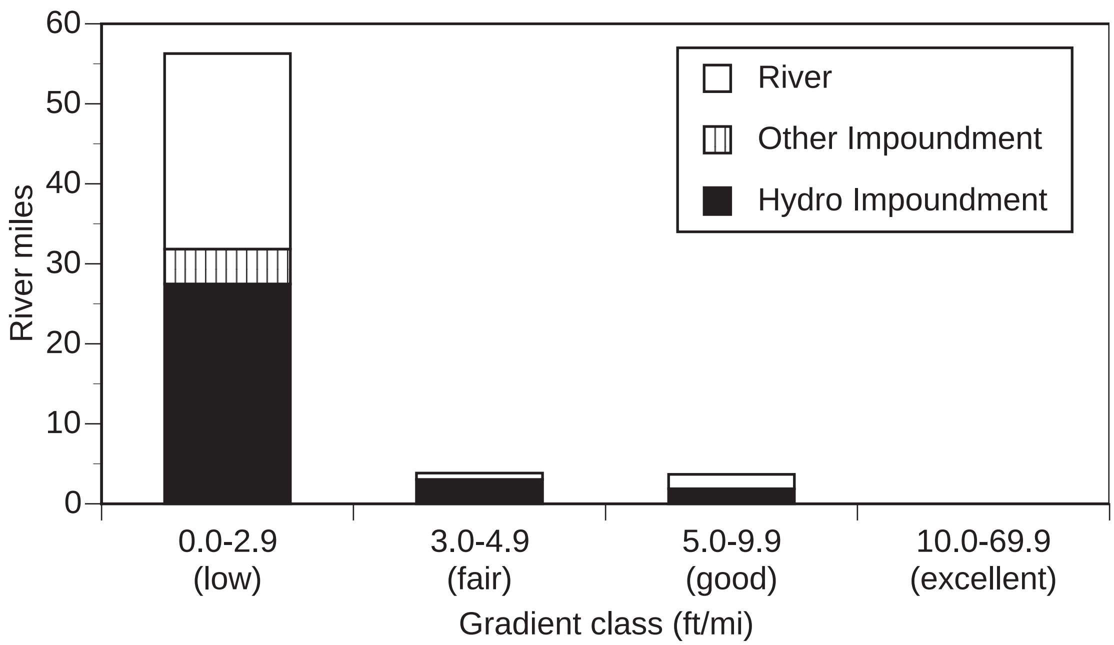

Figure 23b.–Gradient class and length of river in each, separated by water type, for lower segment of the St. Joseph River. Fish habitat rankings in parenthesis. Data from Michigan Department of Natural Resources, Fisheries Division.

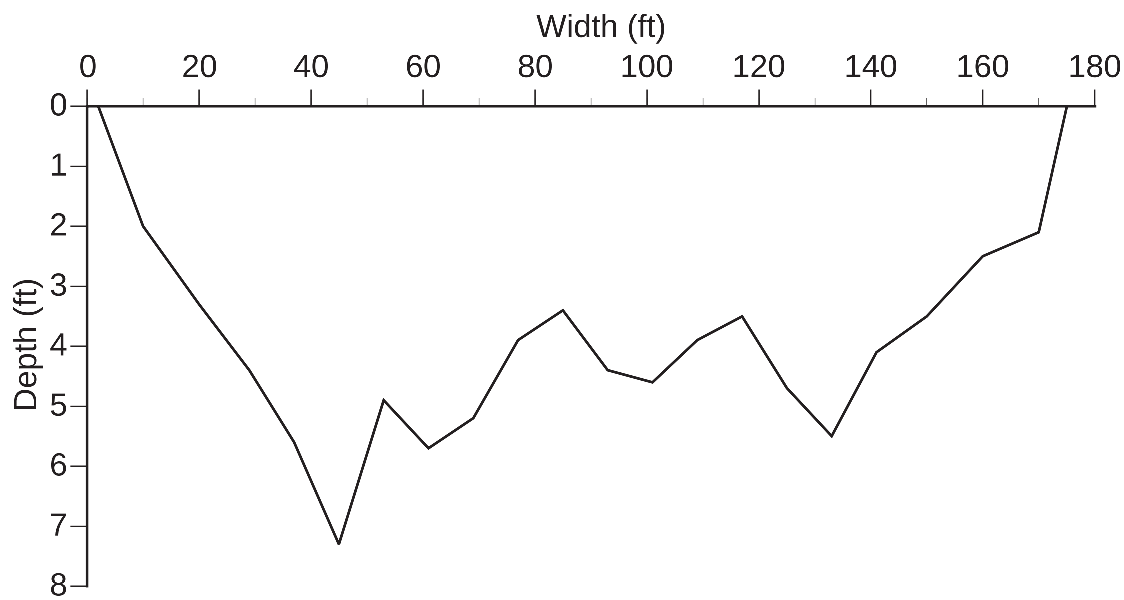

Figure 24a.–Stream channel cross-section of St. Joseph River at Three Rivers. Data from United States Geological Survey.

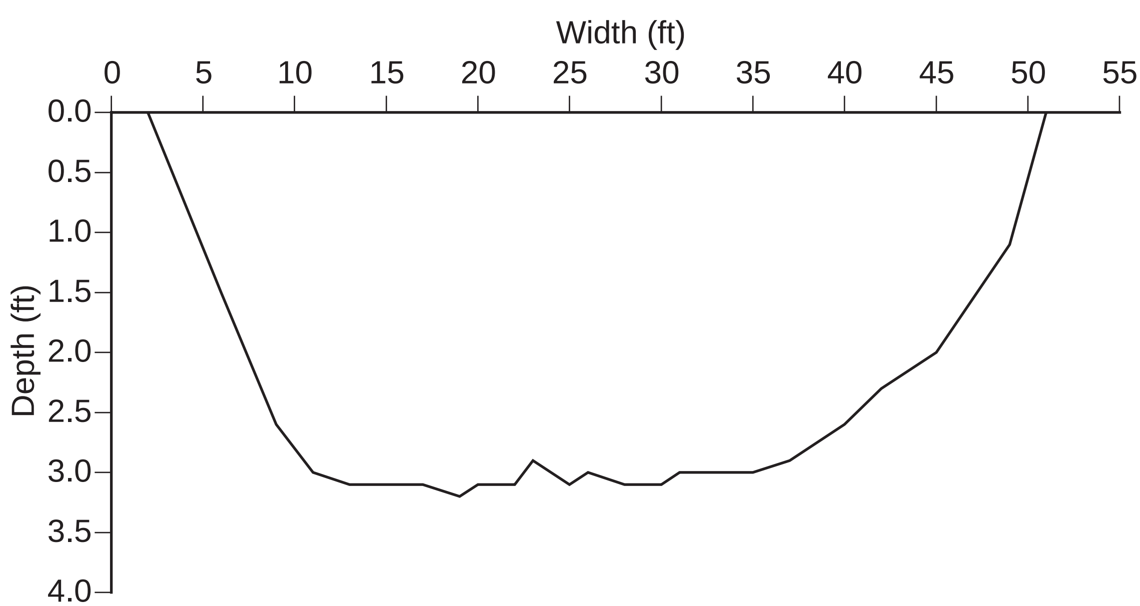

Figure 24b.–Stream channel cross-section of Dowagiac River at Sumnerville. Data from United States Geological Survey.

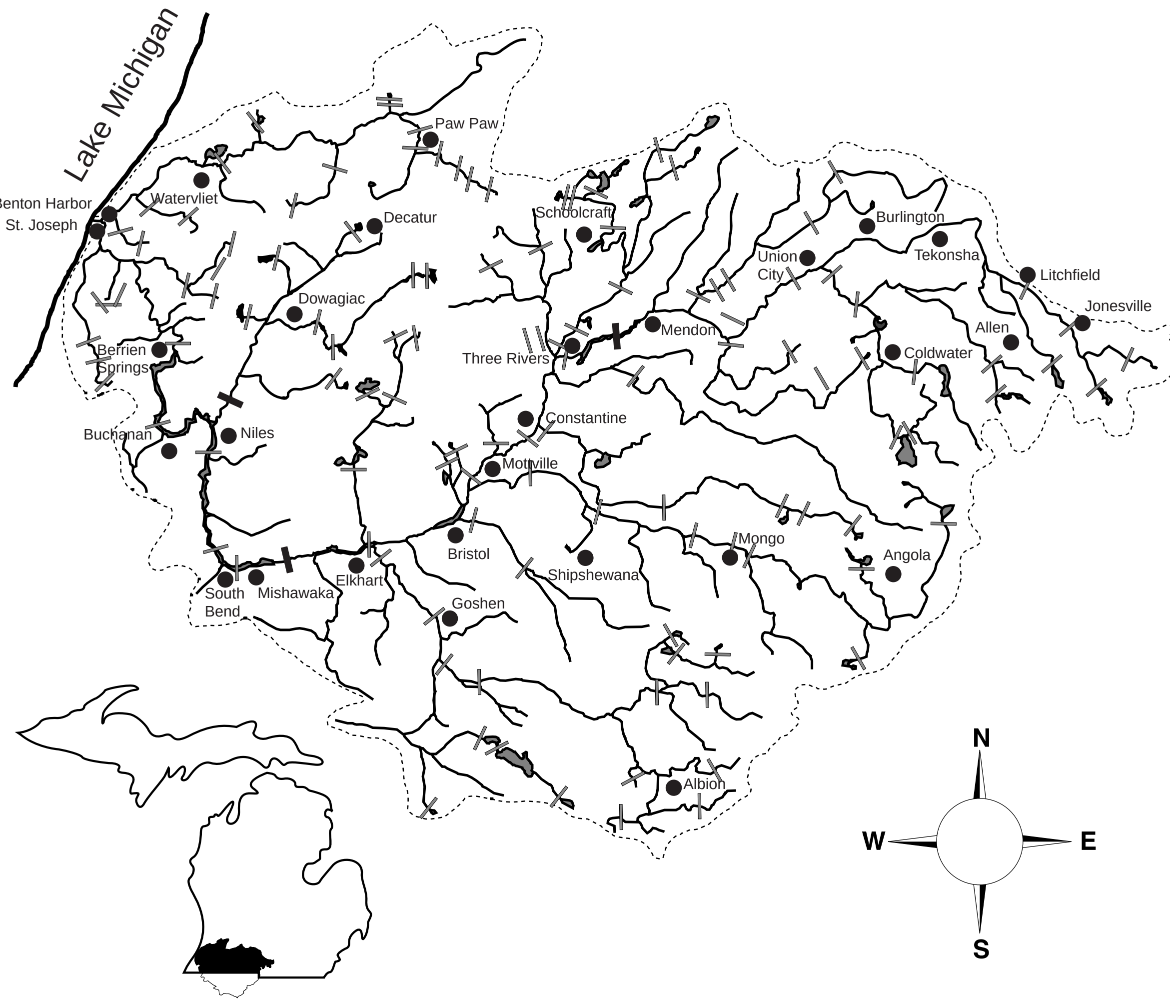

Figure 25.–Approximate locations of major dams (192) in St. Joseph River watershed.

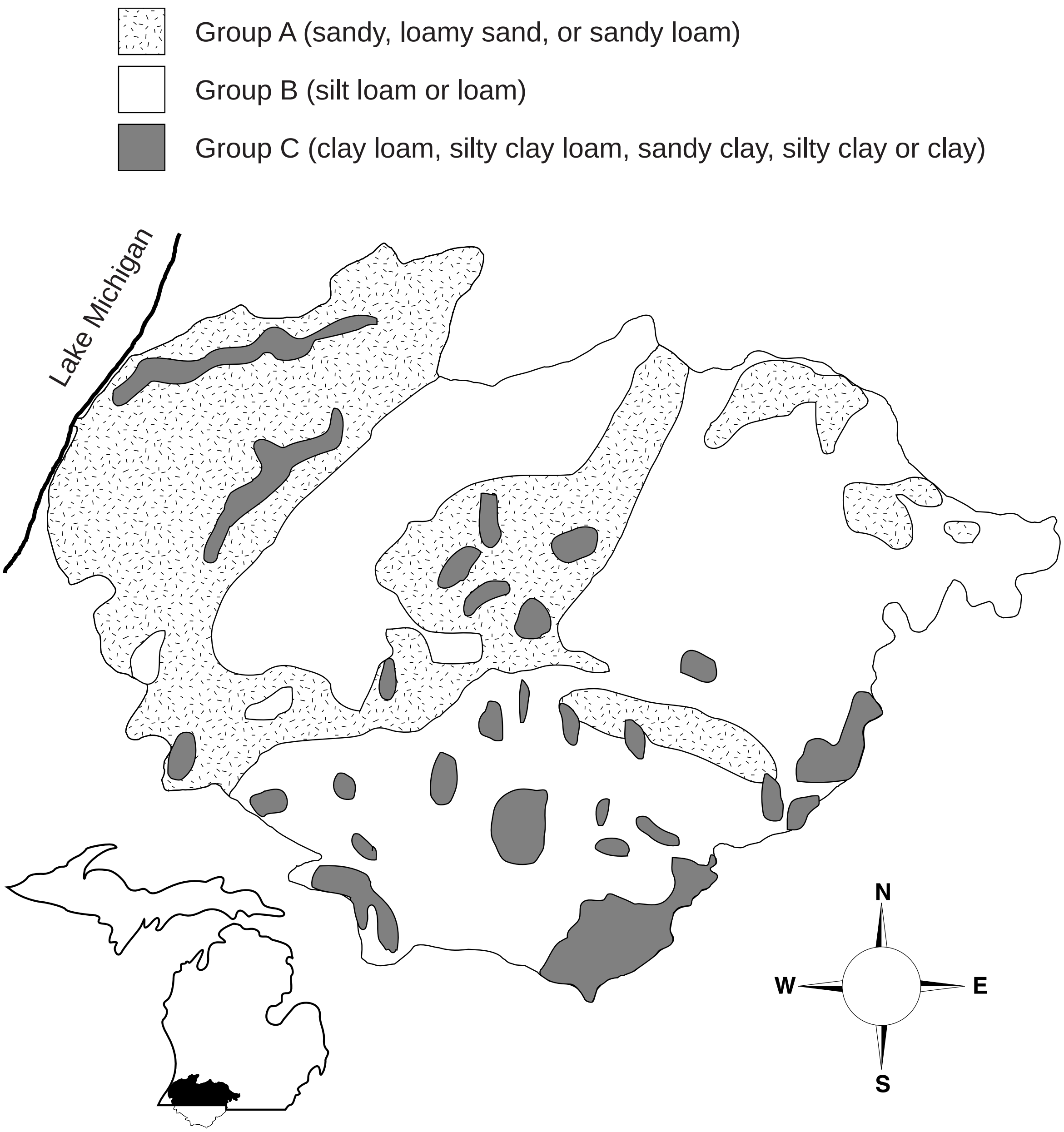

Figure 26.–Soil groups in St. Joseph River basin. Data from State Soil Geographic Database (Michigan); IDNR 1987.

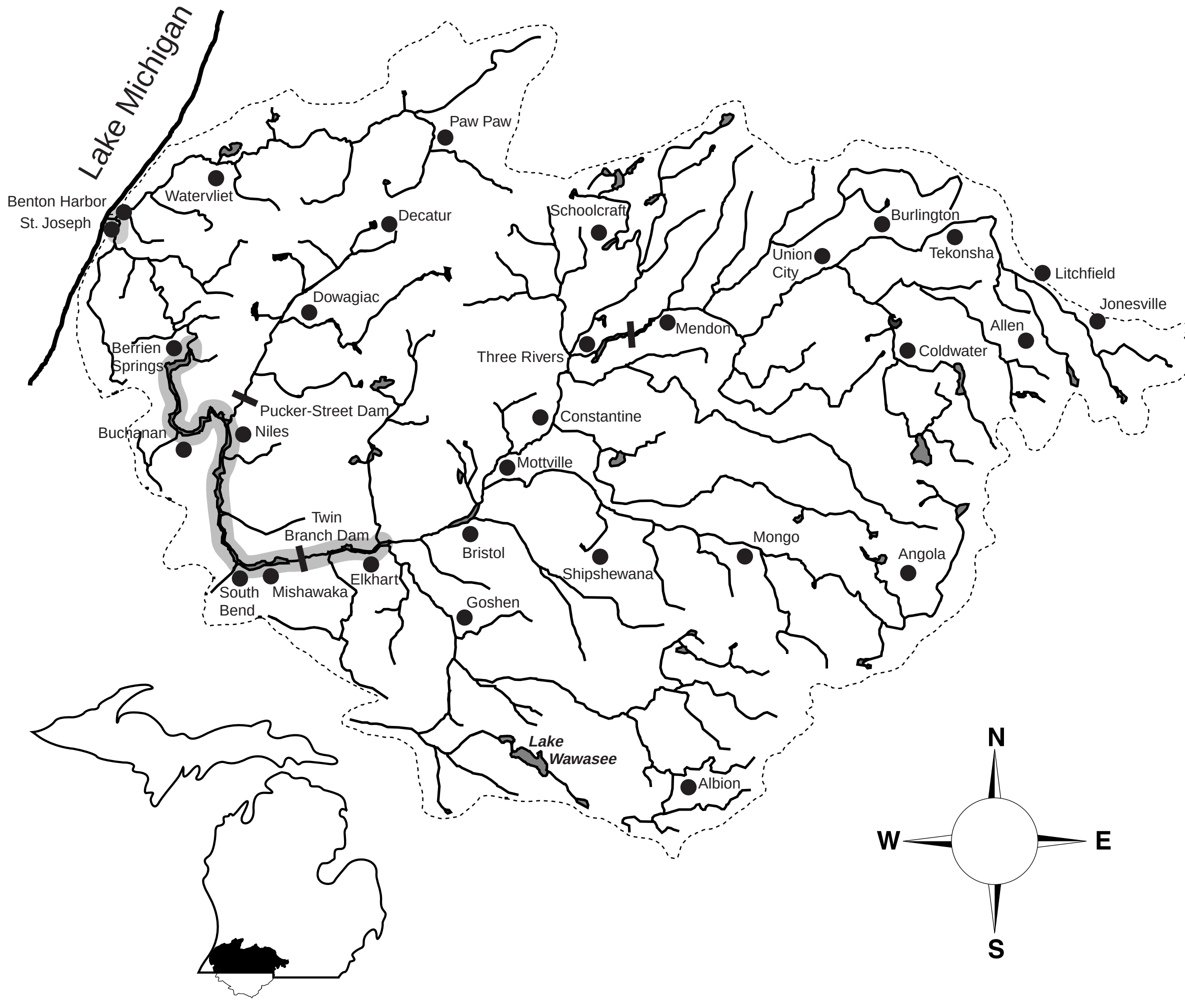

Figure 27.–Sections of St. Joseph River included in advisories against whole body contact. Data from Michigan Department of Community Health.

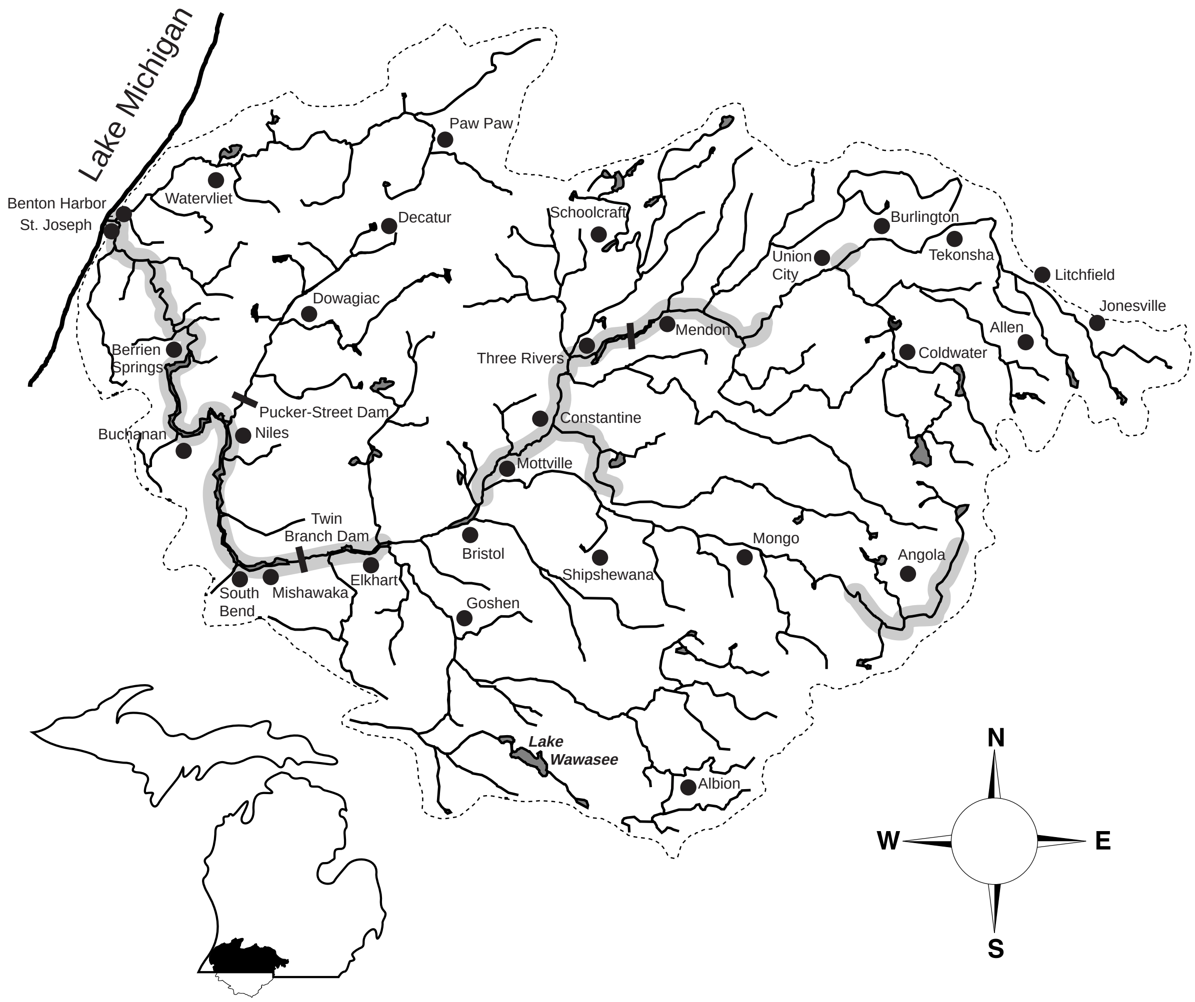

Figure 28.–Reaches in St. Joseph River with fish consumption advisories. Data from Michigan Department of Community Health and Indiana Department of Health.

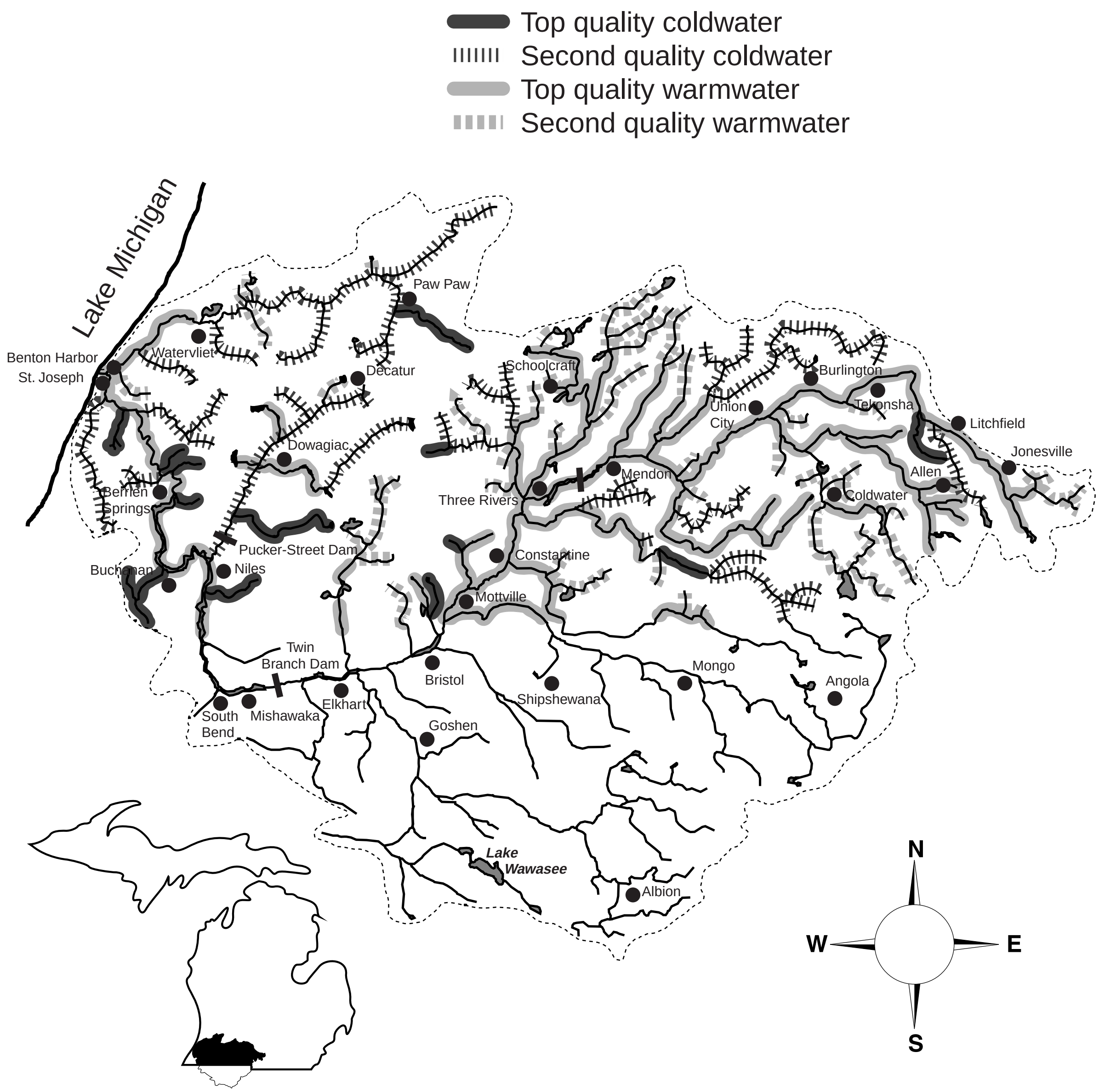

Figure 29.–Michigan Department of Natural Resources, Fisheries Division, stream classifications, 1964. Indiana did not classify streams in this way.

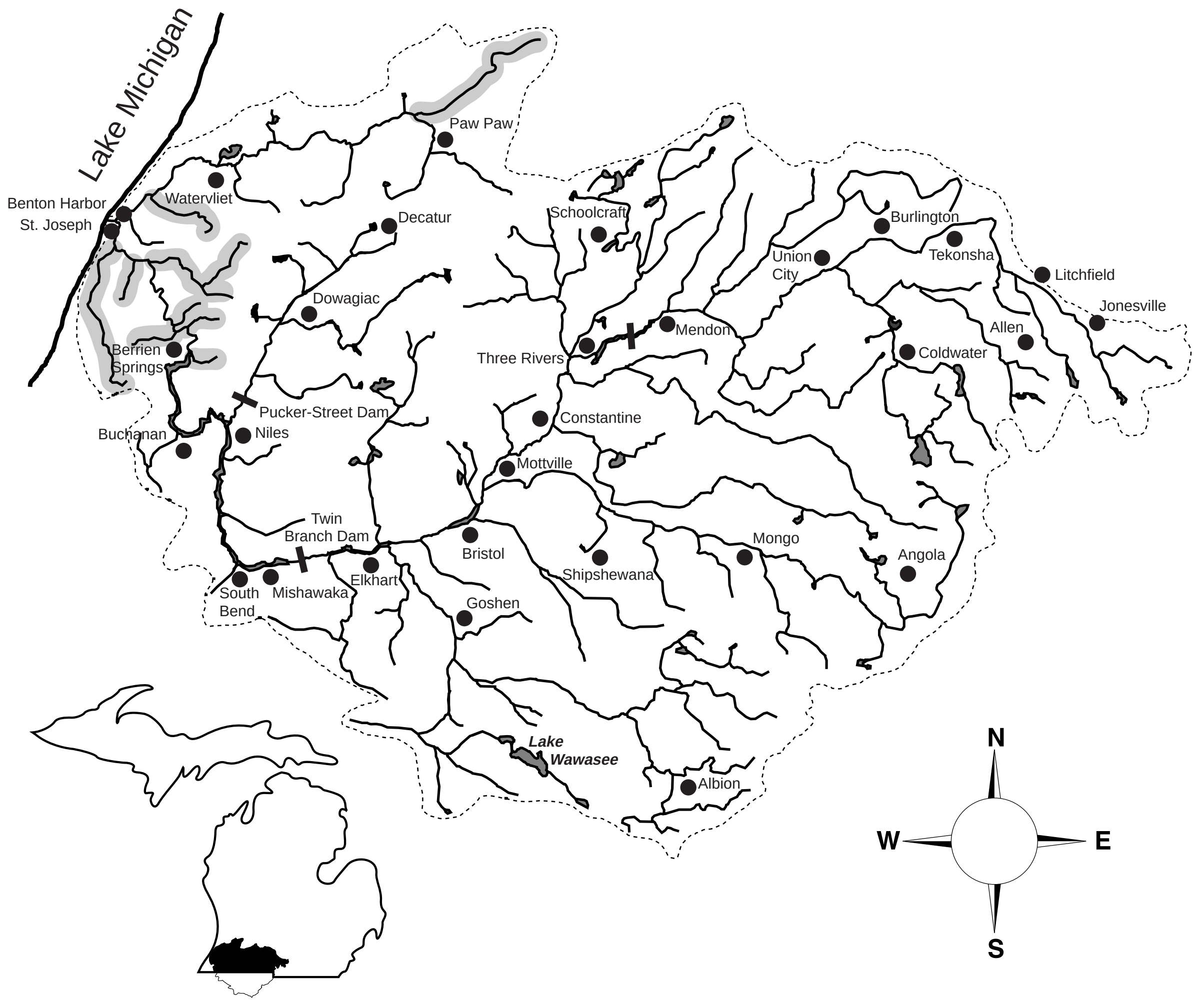

Figure 30.–Streams with natural reproduction of salmon and steelhead in St. Joseph River watershed. Data from Michigan Department of Natural Resources, Fisheries Division.

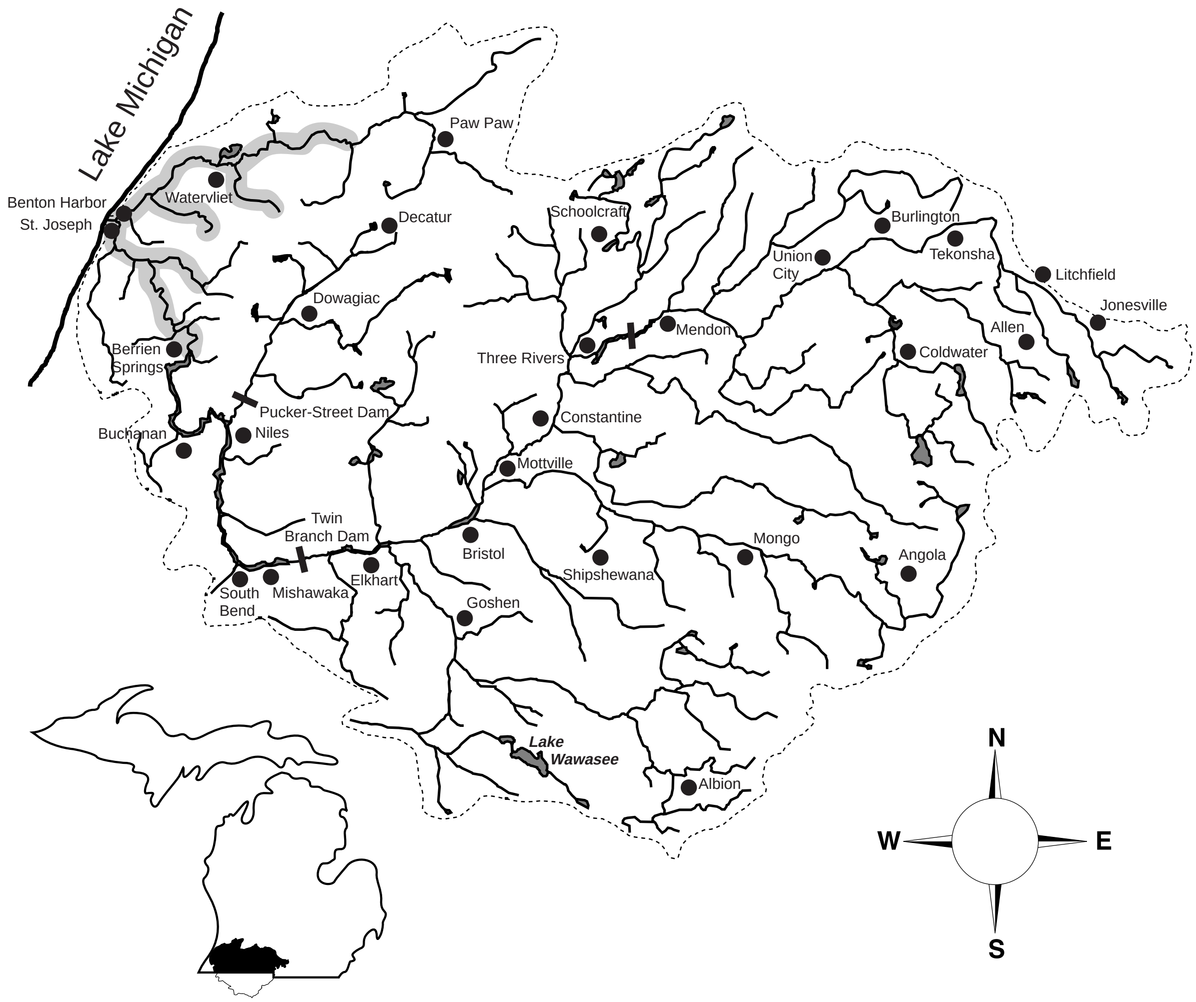

Figure 31.–Streams that sea lampreys have been found in St. Joseph River watershed. Data from United States Fish and Wildlife Service.

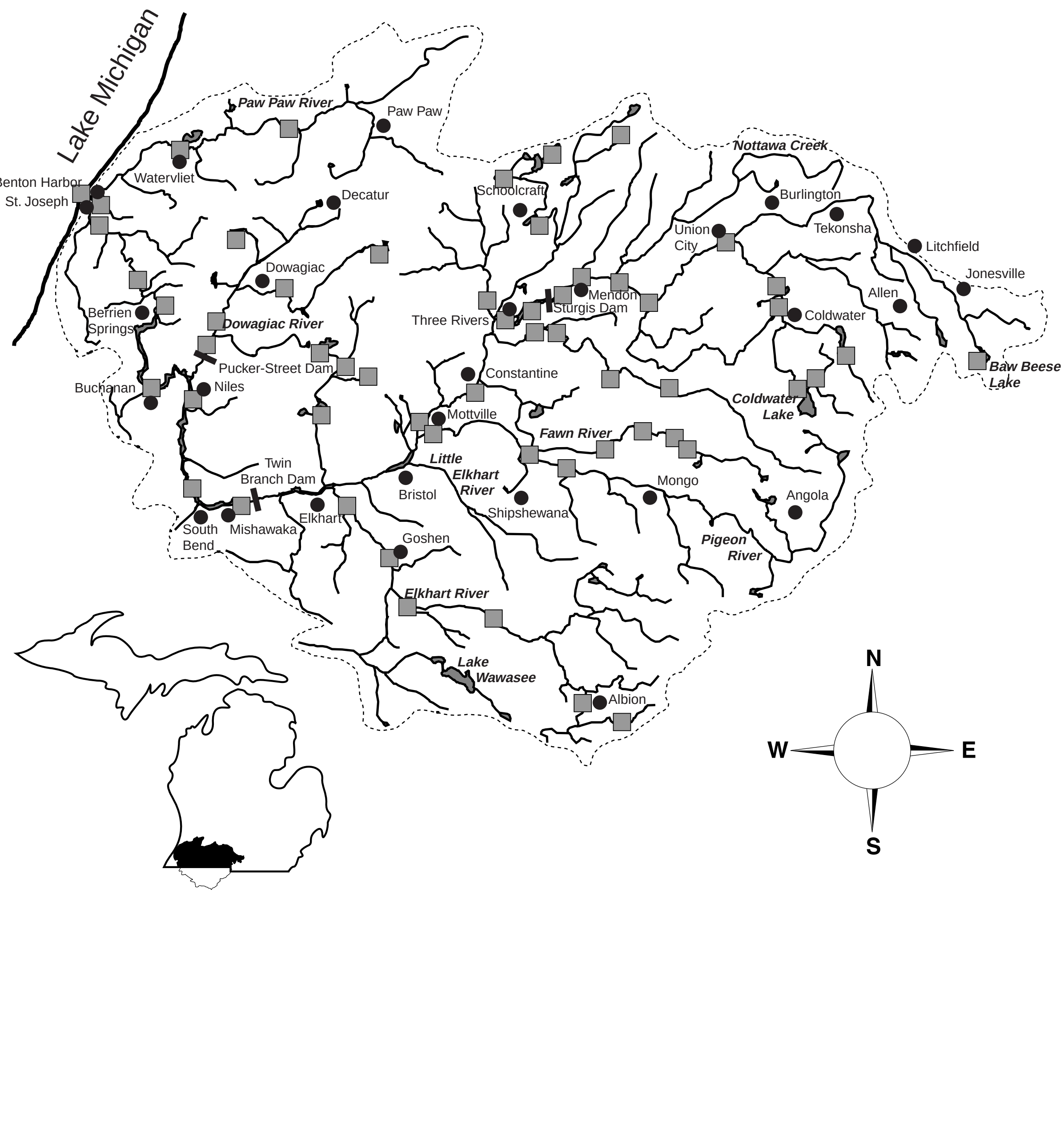

Figure 32.–Canoe and boat launches in St. Joseph River watershed.

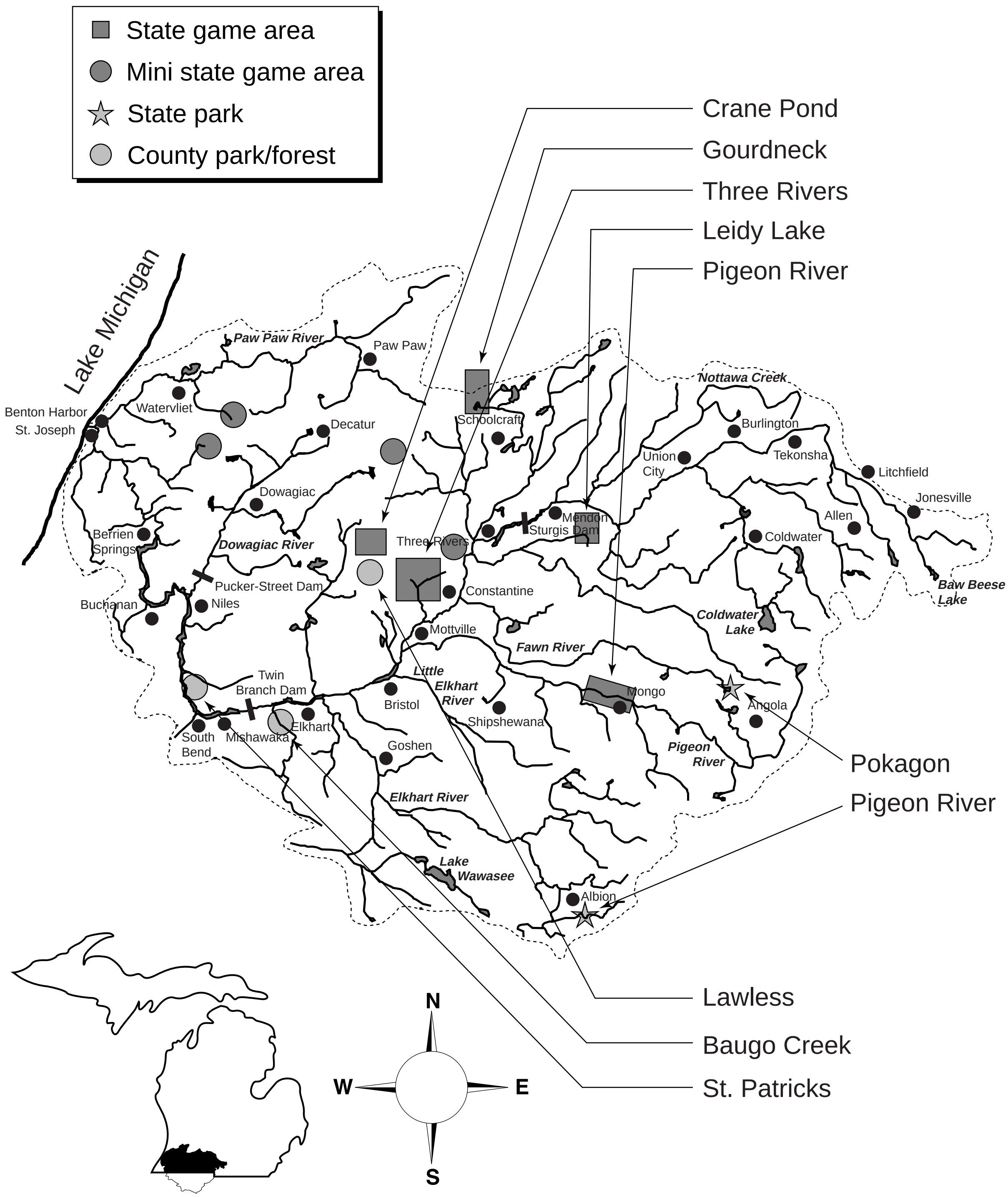

Figure 33.–Large public lands in St. Joseph River watershed.

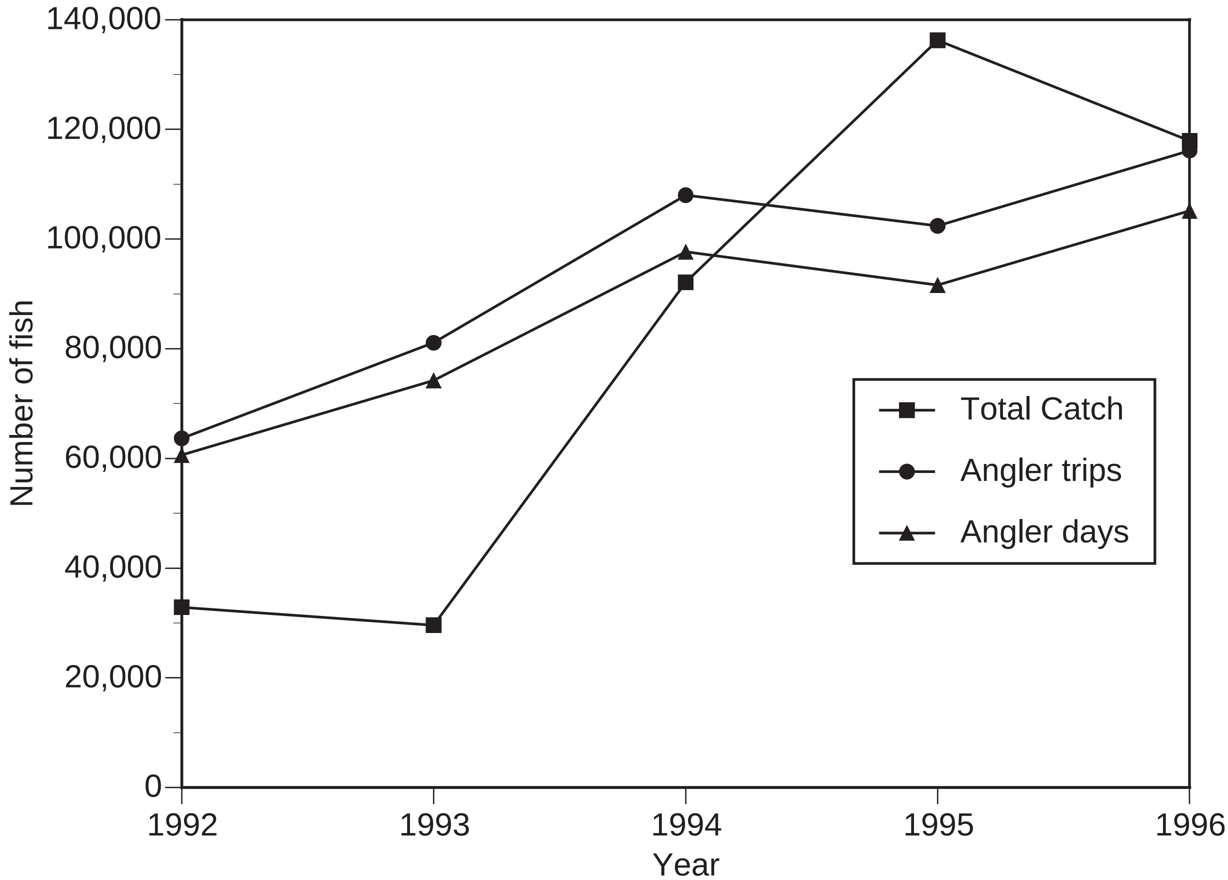

Figure 34.–Estimated total catch and effort (angler hours, trips, and days) for lower St. Joseph River, 1992-96. Data from Michigan Department of Natural Resources, Fisheries Division and Indiana Department of Natural Resources, Fisheries Section.

Michigan DNR

STATE OF MICHIGAN
DEPARTMENT OF NATURAL RESOURCES

Number 24 September 1999

St. Joseph River Assessment
Appendix

Jay K. Wesley
and
Joan E. Duffy

FISHERIES DIVISION
SPECIAL REPORT

MICHIGAN DEPARTMENT OF NATURAL RESOURCES
FISHERIES DIVISION

Fisheries Special Report 24
September 1999

St. Joseph River Assessment
Appendix

Jay K. Wesley
and
Joan E. Duffy

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Appendix 1

Distribution Maps of Fish Species

This appendix contains maps of known past and present fish distributions within the St. Joseph River watershed. The distributions of fish species were compiled from records located at the University of Michigan, Museums Fisheries Library; Michigan Department of Natural Resources, Institute for Fisheries Research and offices in Plainwell and Jackson; and Indiana Department of Natural Resources, Fisheries Section, Twin Lakes and Orland offices. Scientific names and phylogenic order follow Robins et al. (1991). Species that are listed under Michigan's Endangered Species Act (Part 365, Endangered Species Protection, of the Natural Resource and Environmental Protection Act, Act 451 of the Public Acts of 1994), their status follows their scientific name. Categories are declining, rare, threatened, endangered, extinct, and locally extinct.

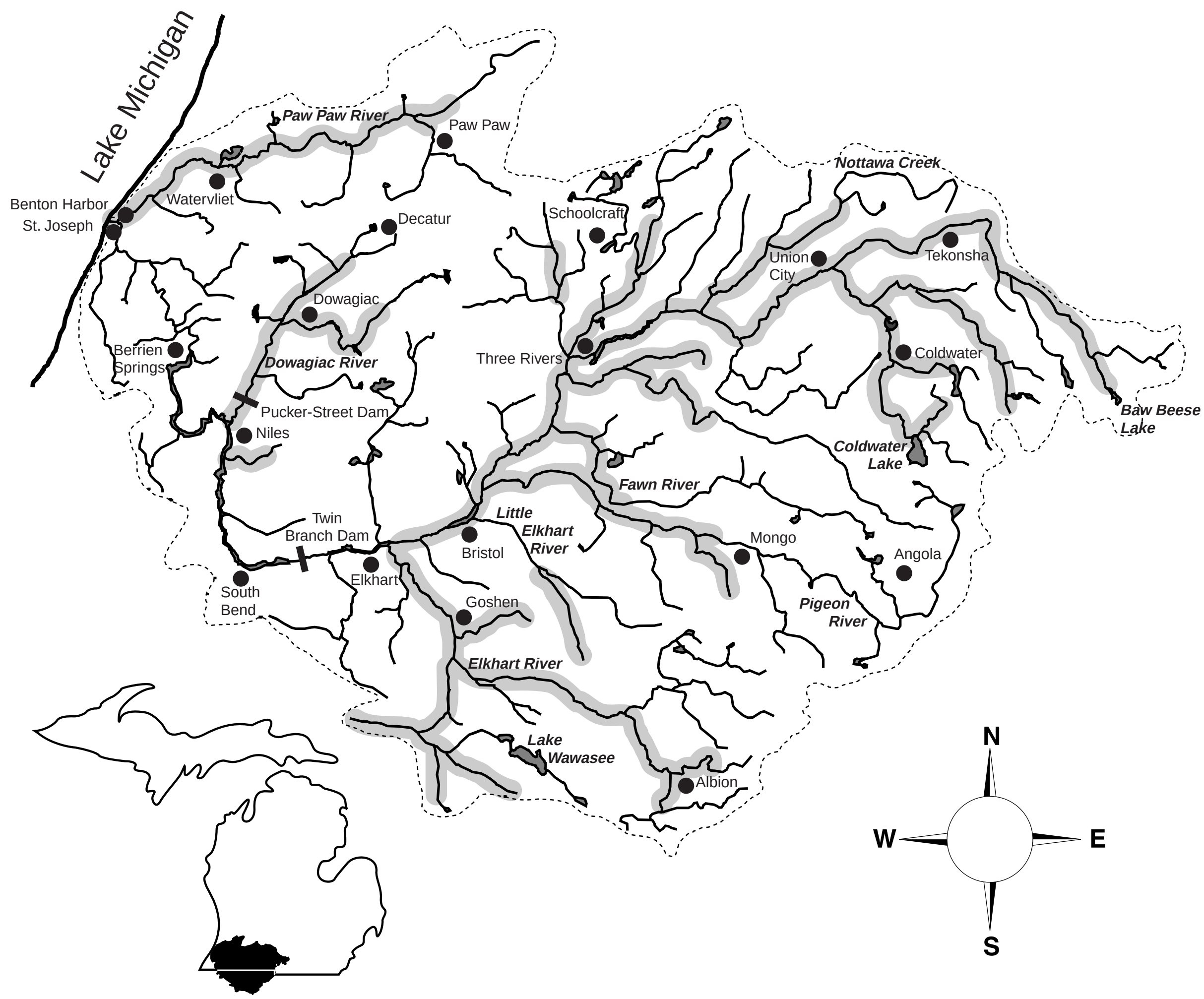
Habitat descriptions were compiled from The Fishes of Ohio (Trautman 1982), Freshwater Fishes of Canada (Scott and Crossman 1973), Fishes of Wisconsin (Becker 1983), Fishes of Missouri (Pflieger 1975), and Fishes of the Great Lakes Region (Hubbs and Lagler 1947).

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

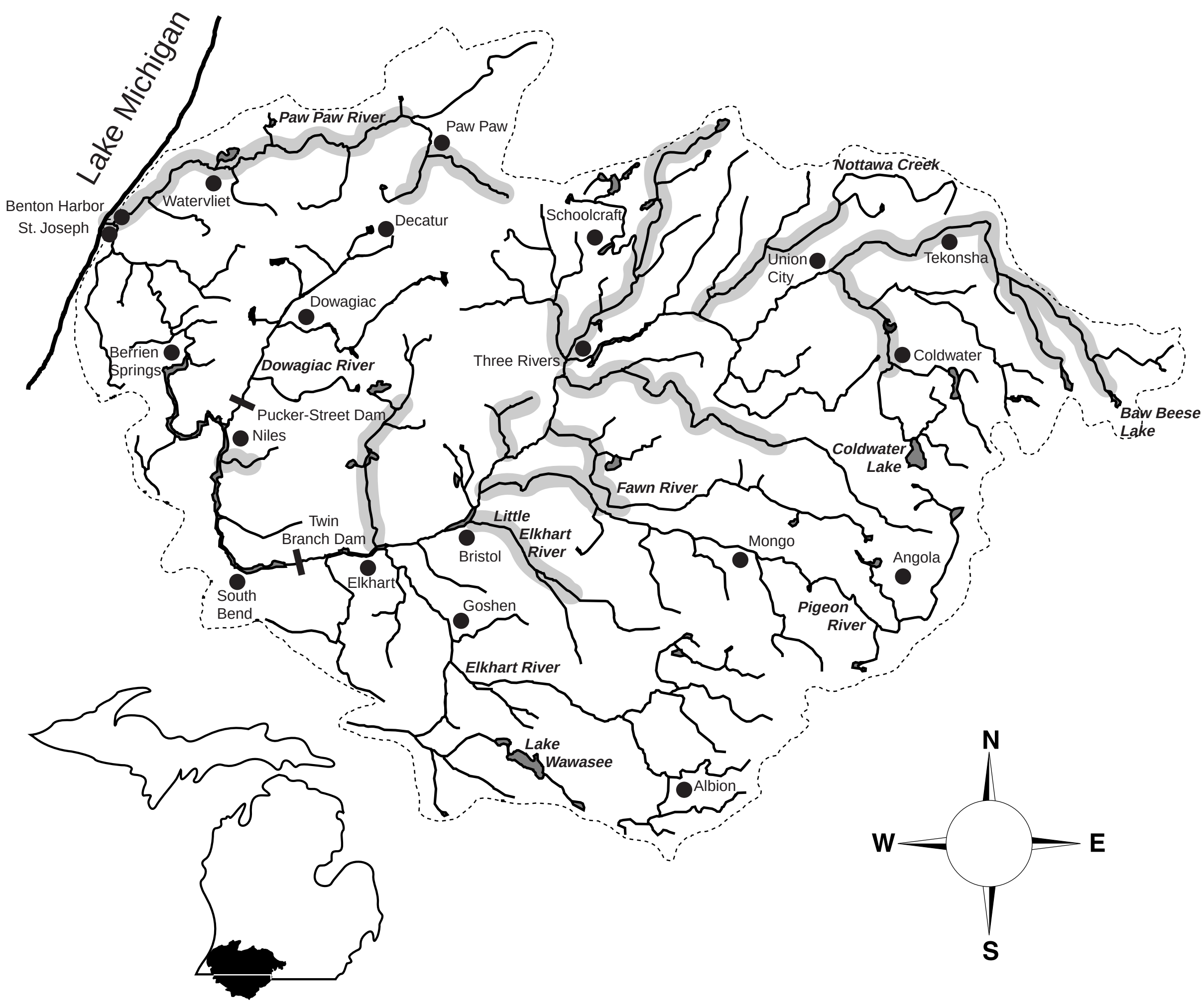


Northern brook lamprey (*Ichthyomyzon fossor*)

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



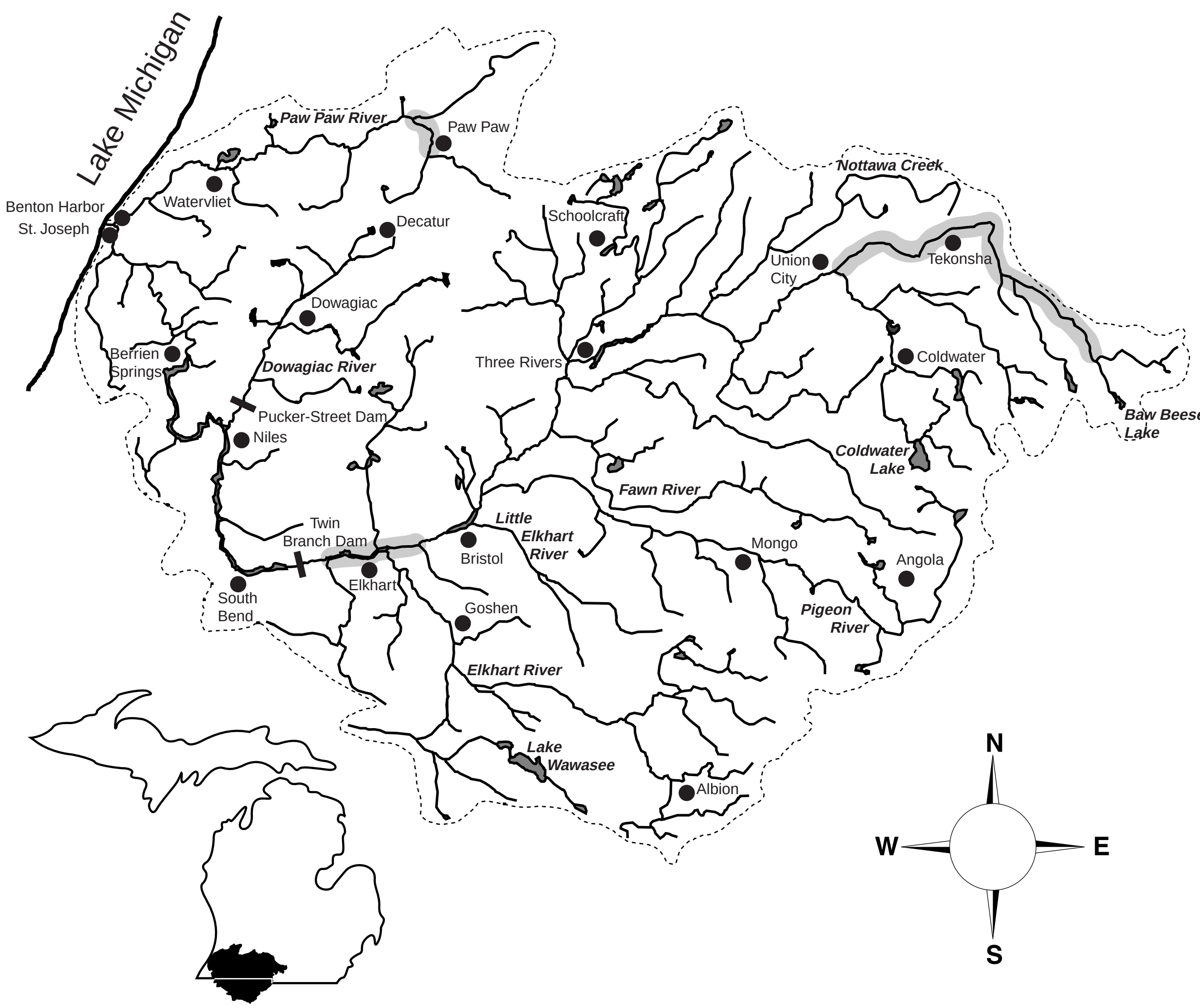
Silver lamprey (*Ichthyomyzon unicuspis*)

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
- amnocetes burrow for 4 to 7 years in mud and silt at river margins



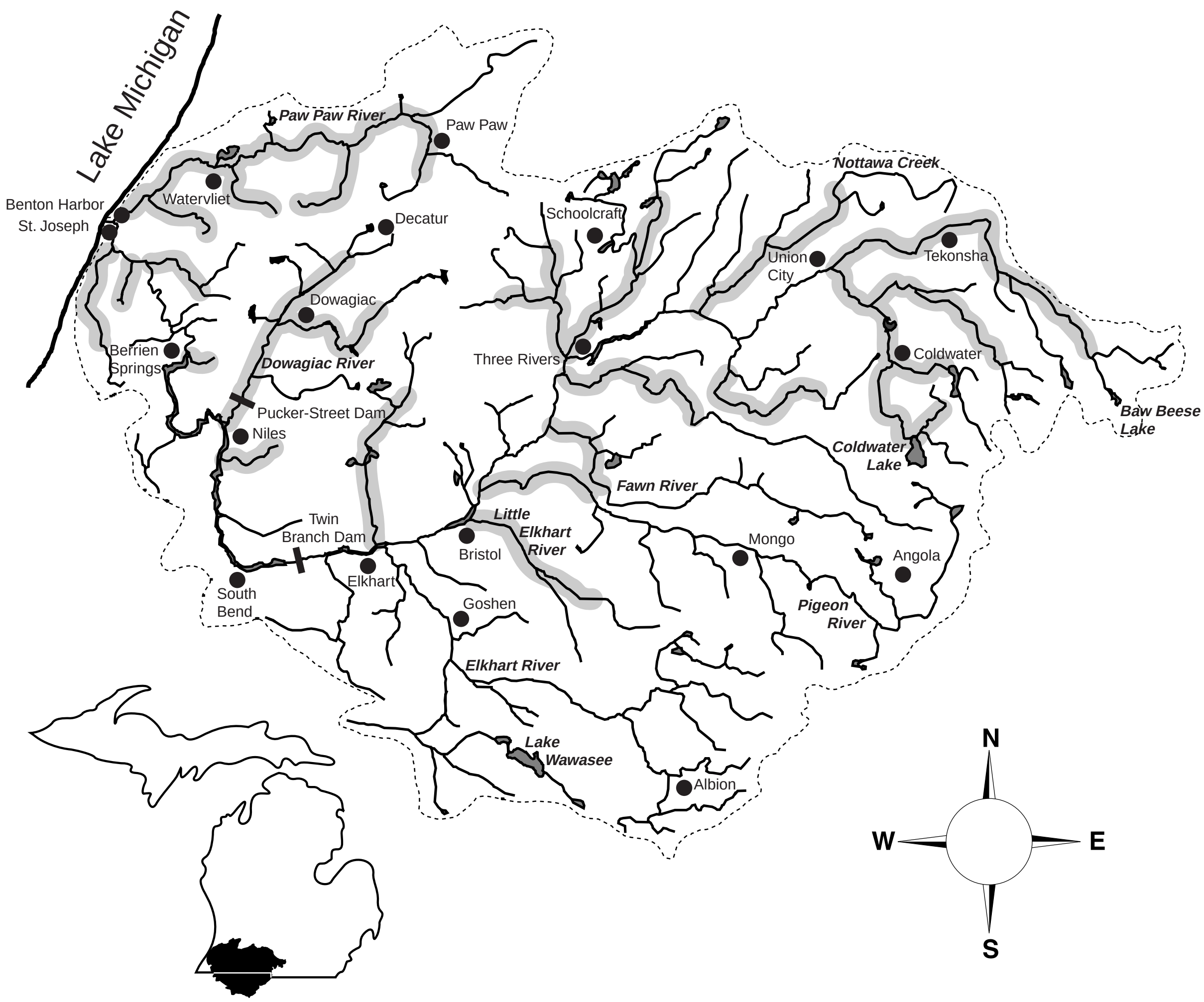
American brook lamprey (*Lampetra appendix*)

Habitat:

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

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

winter refuge - sand or silt substrate for amnocoetes

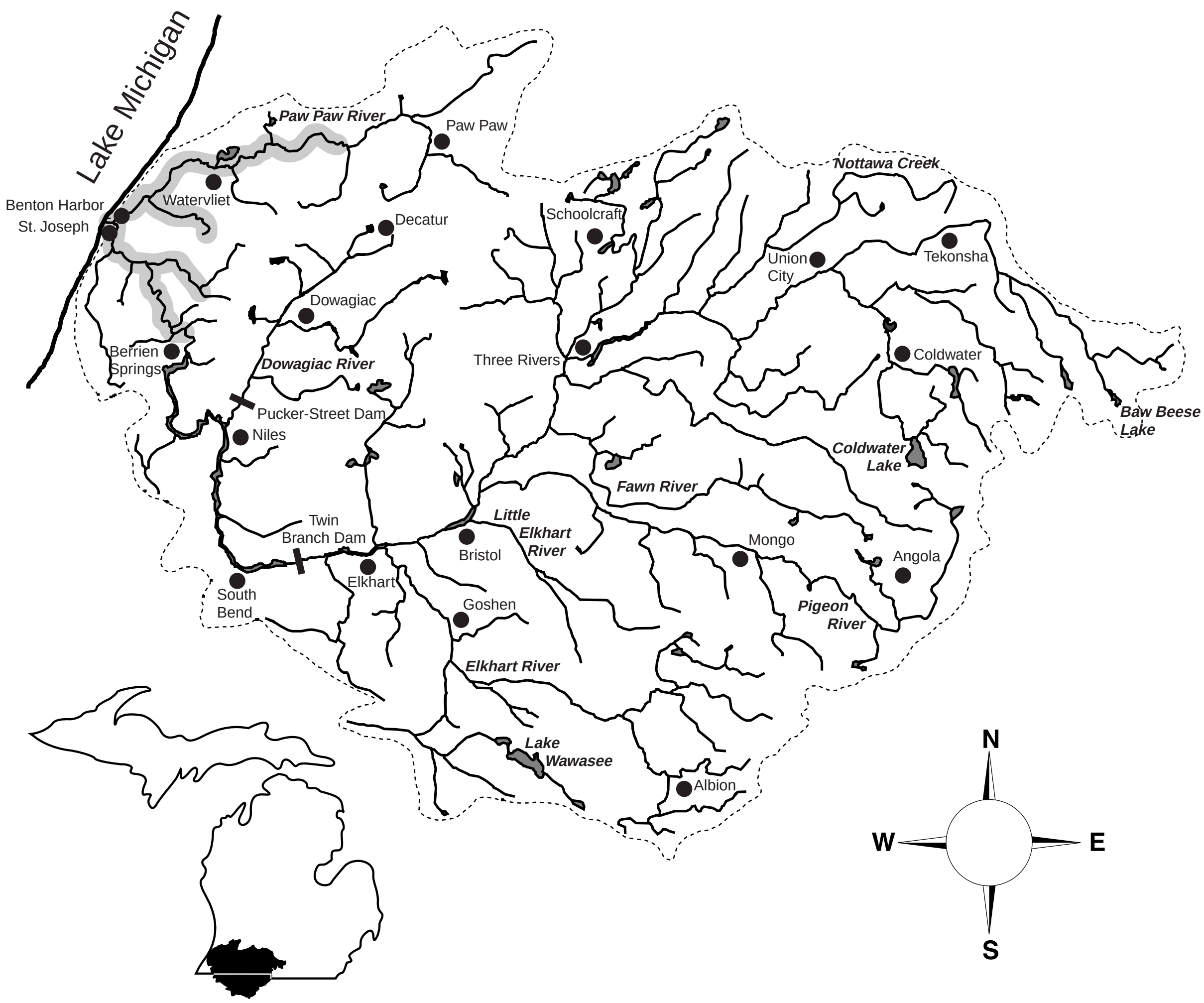


Sea lamprey (*Petromyzon marinus*)

Habitat:

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

spawning
- no dams
- riffles with sand and gravel substrates

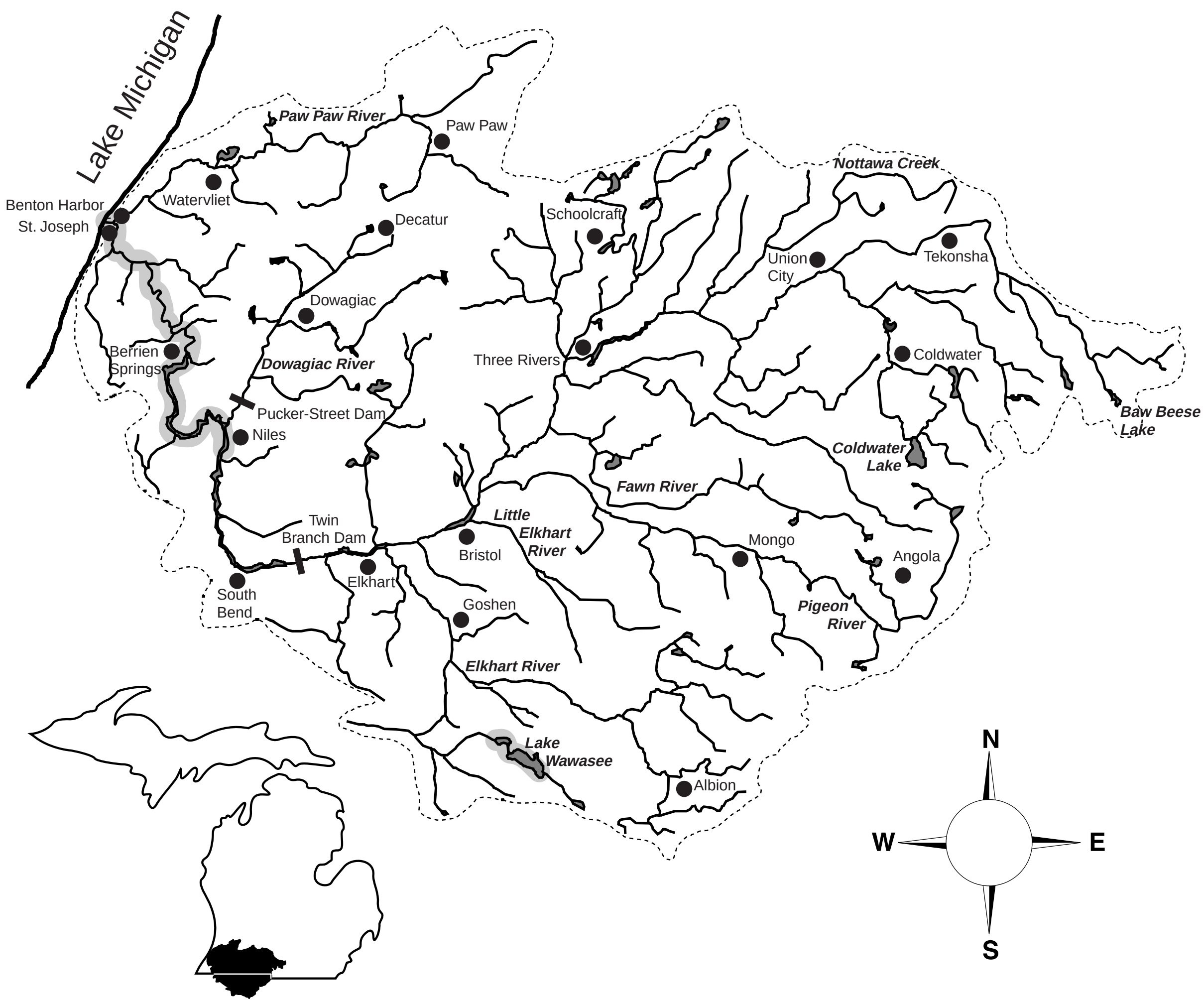


Lake sturgeon (*Acipenser fulvescens*)

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

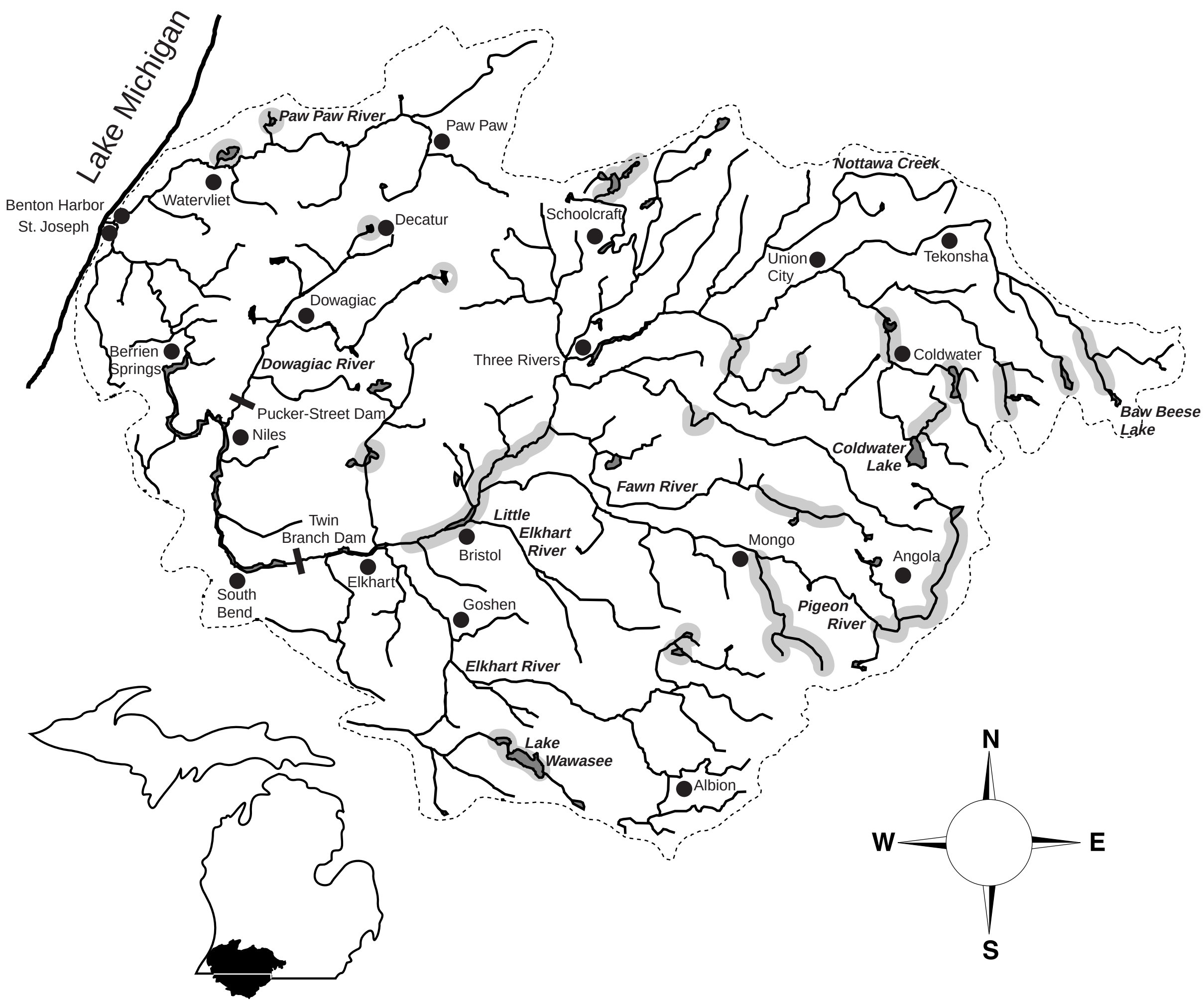


Spotted gar (*Lepisosteus oculatus*)

Habitat:

feeding - quiet clear water in lakes, impoundments, or streams
- aquatic vegetation

spawning - warm shallow water with abundant aquatic vegetation

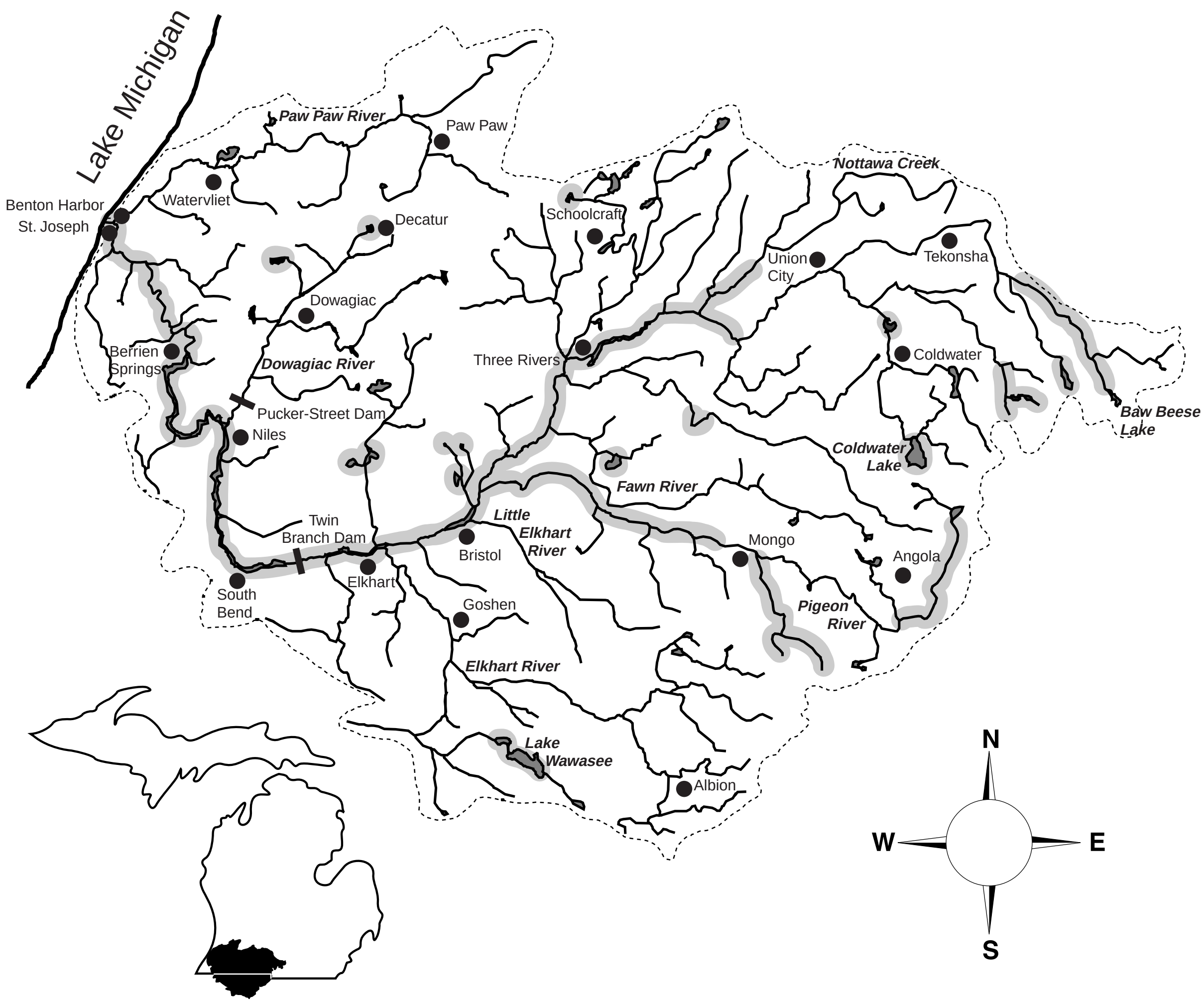


Longnose gar (*Lepisosteus osseus*)

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



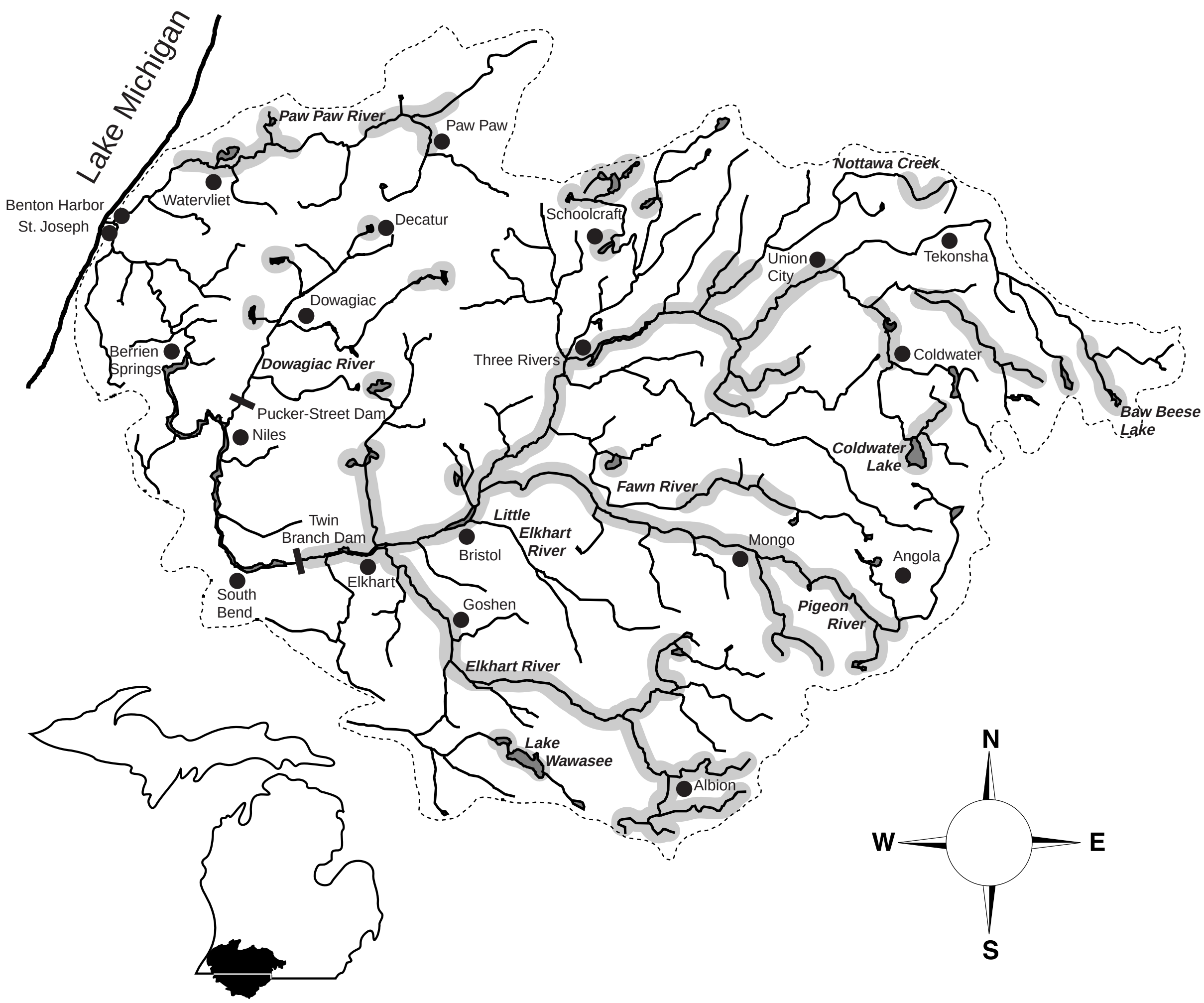
Bowfin (*Amia calva*)

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



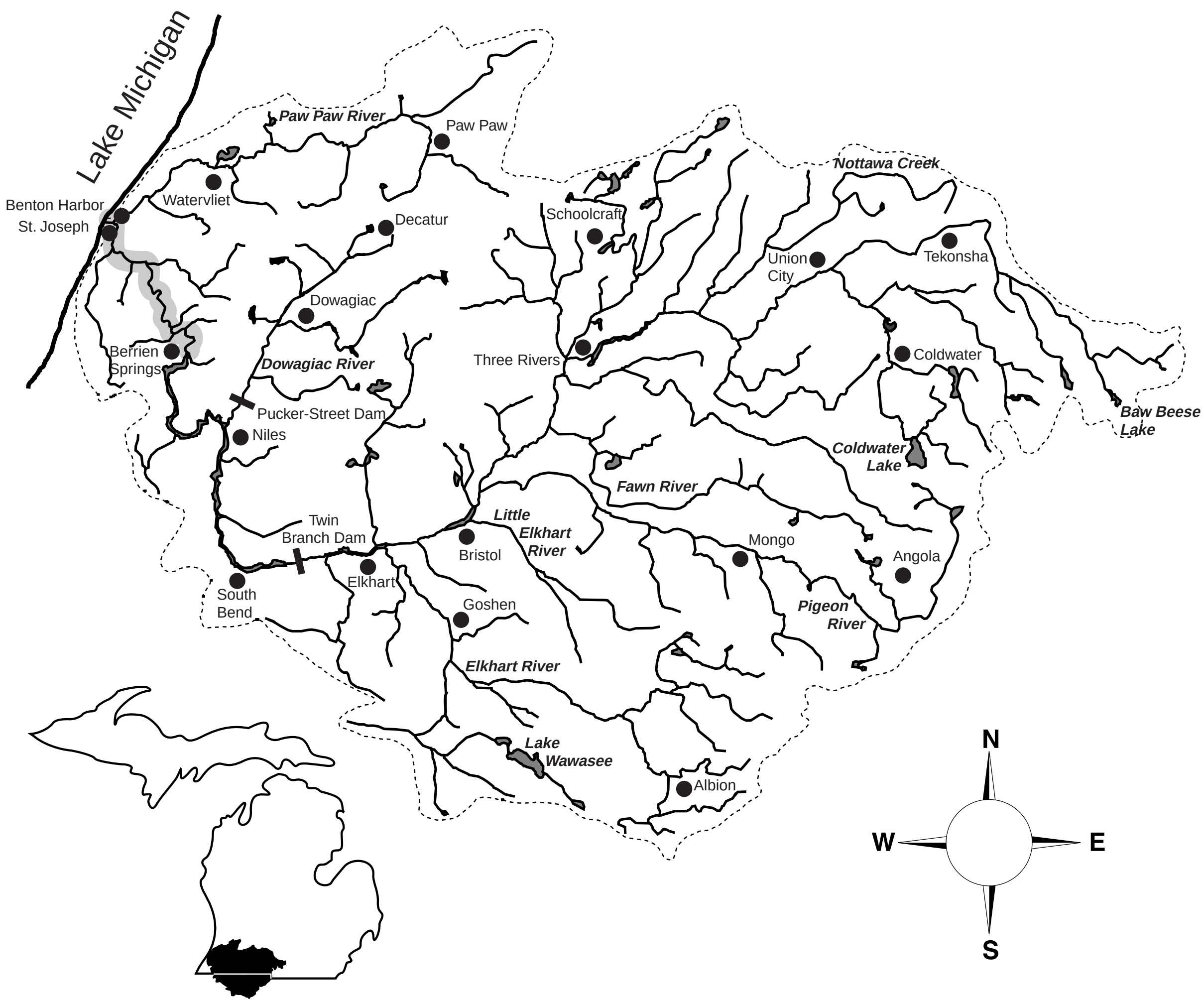
American eel (*Anguilla rostrata*)

Habitat:

feeding - medium to large rivers and Lake Michigan
- must have current
- moderately clear water
- avoid cool spring-fed streams

spawning - catadromous
- occurs in the SW portion of the North Atlantic called the Sargasso Sea

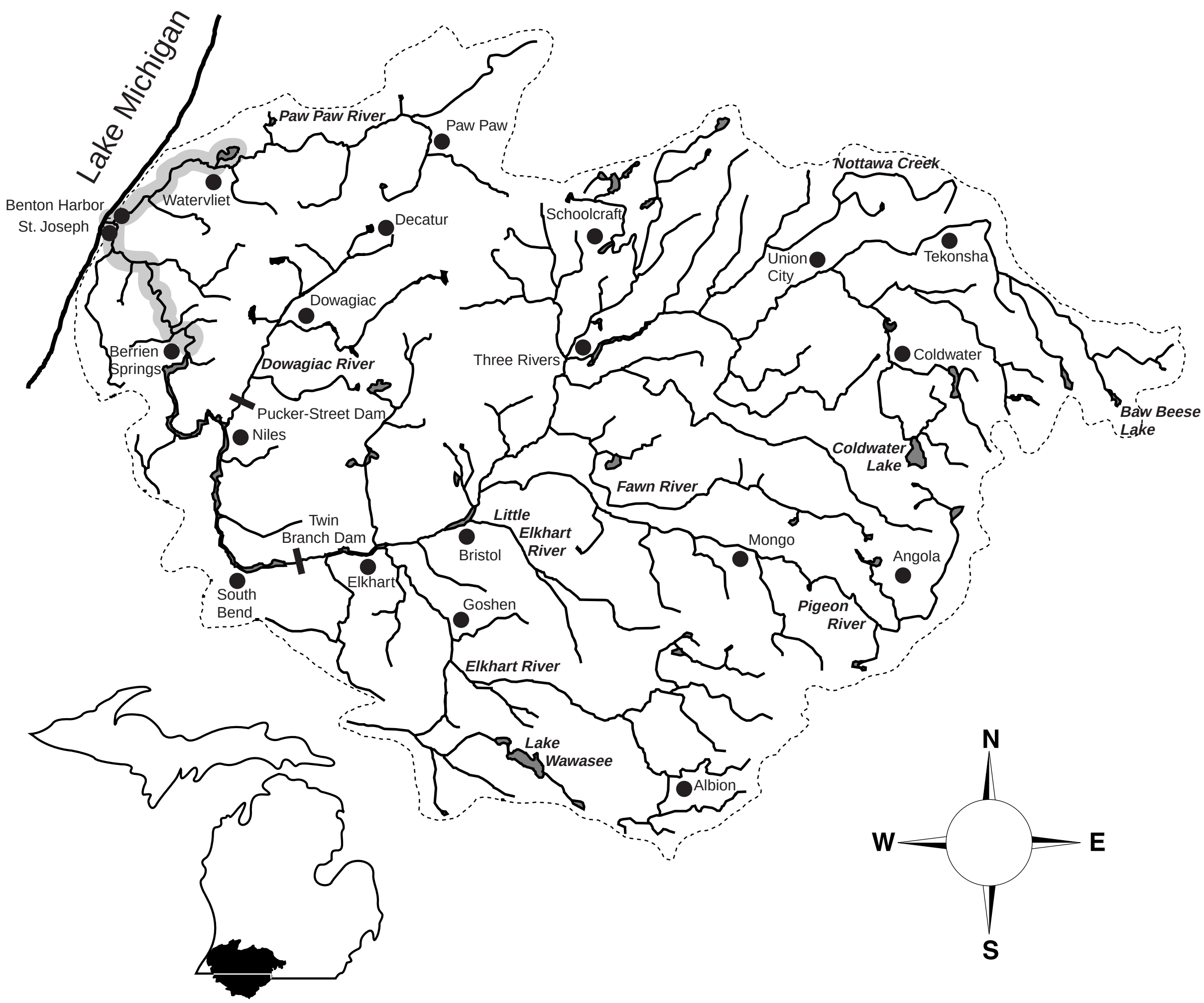
winter refuge - buried in muddy or silty substrate



Alewife (*Alosa pseudoharengus*)

Habitat:

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

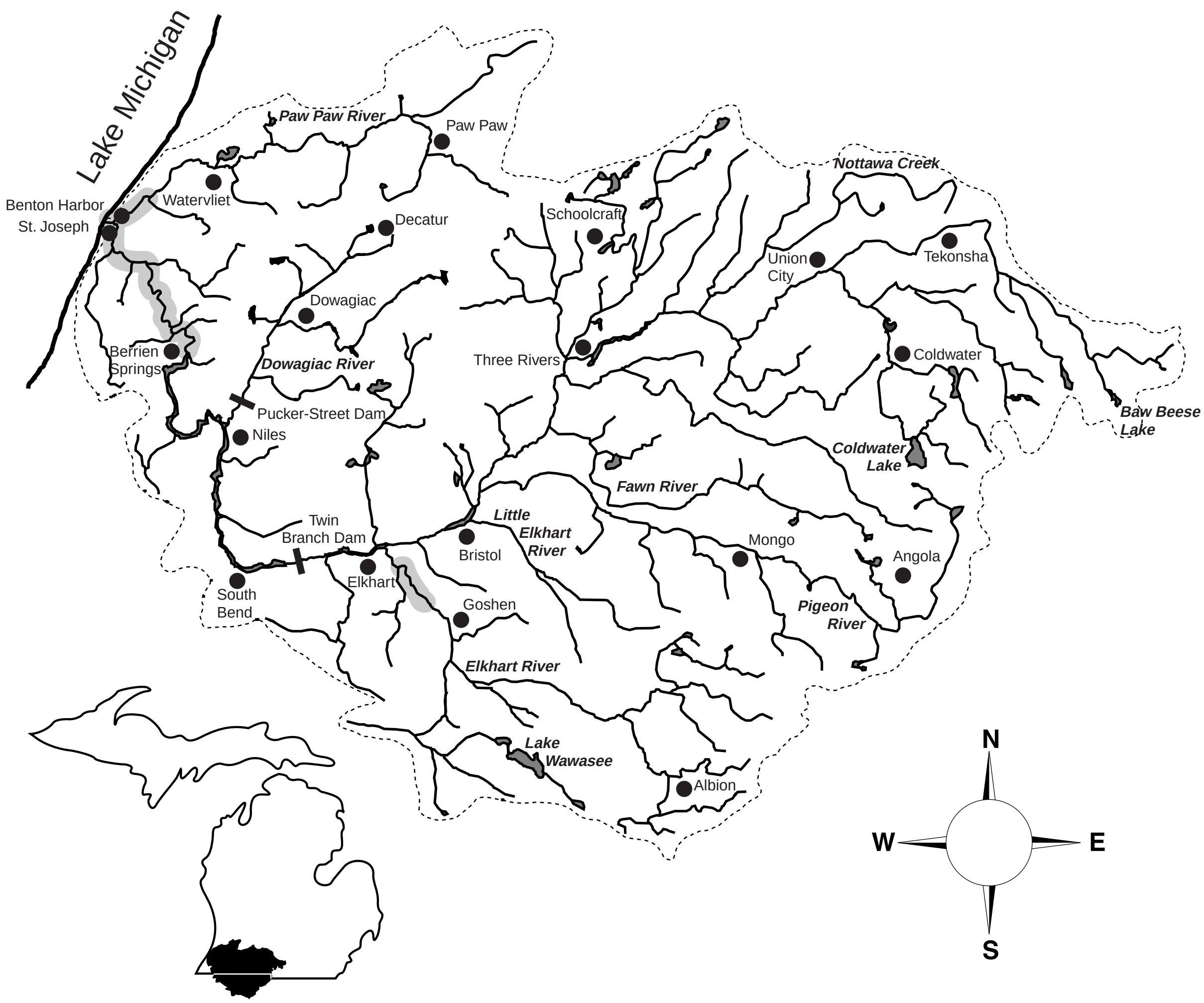


Gizzard shad (*Dorosoma cepedianum*)

Habitat:

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

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

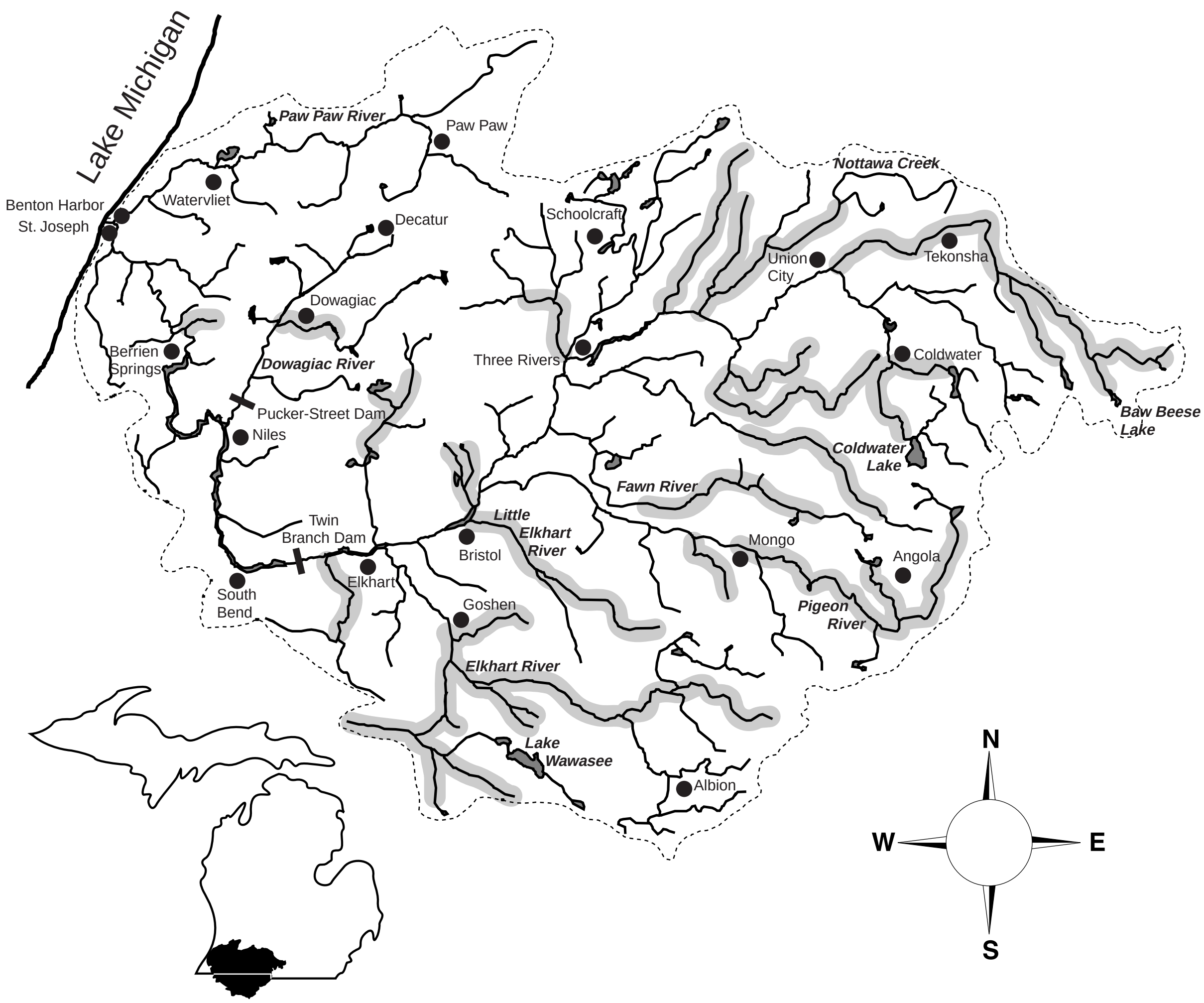


Central stoneroller (*Campostoma anomalum*)

Habitat:

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

spawning
- riffles

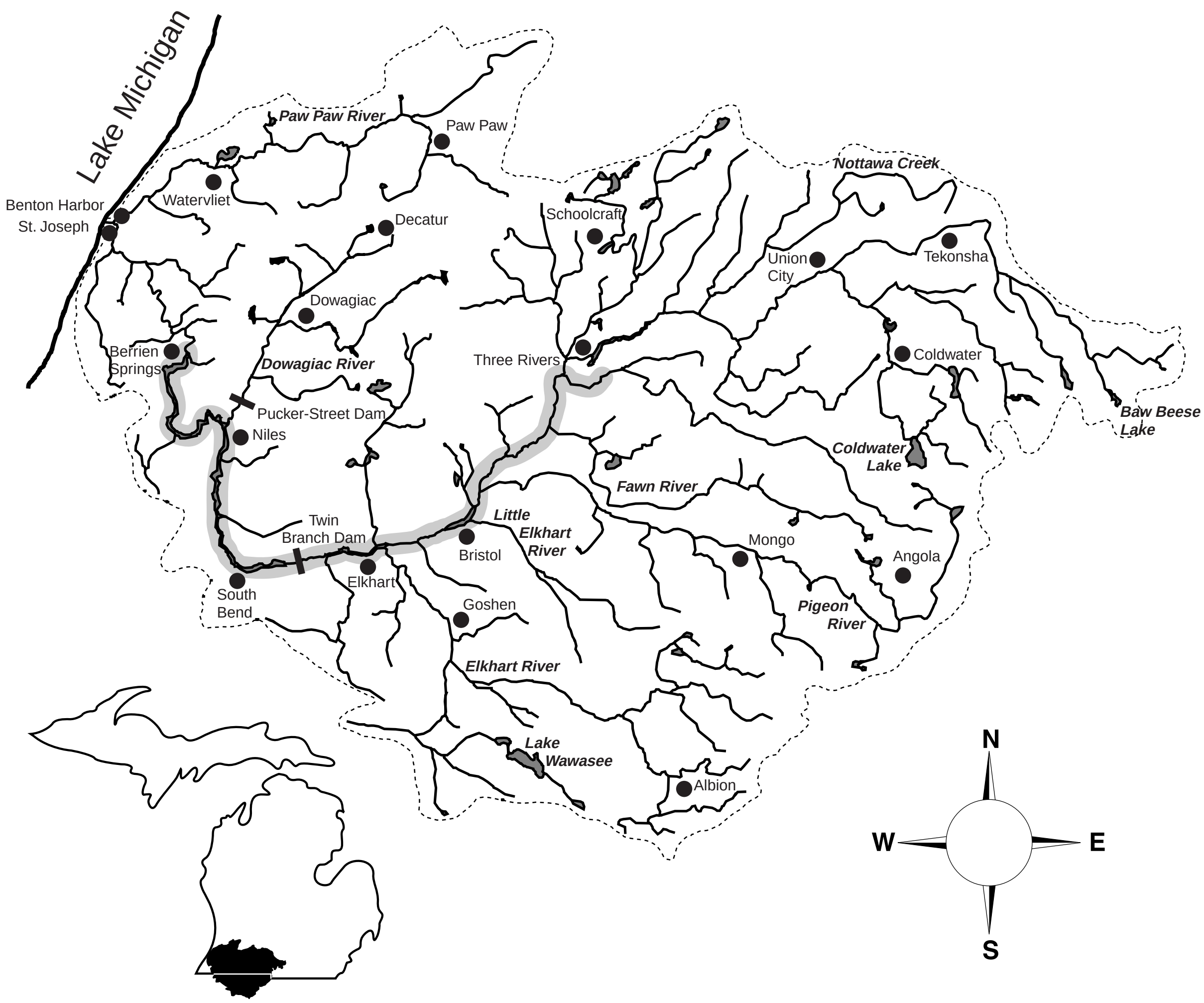


Goldfish (*Carassius auratus*)

Habitat:

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

spawning - warm, weedy shallows

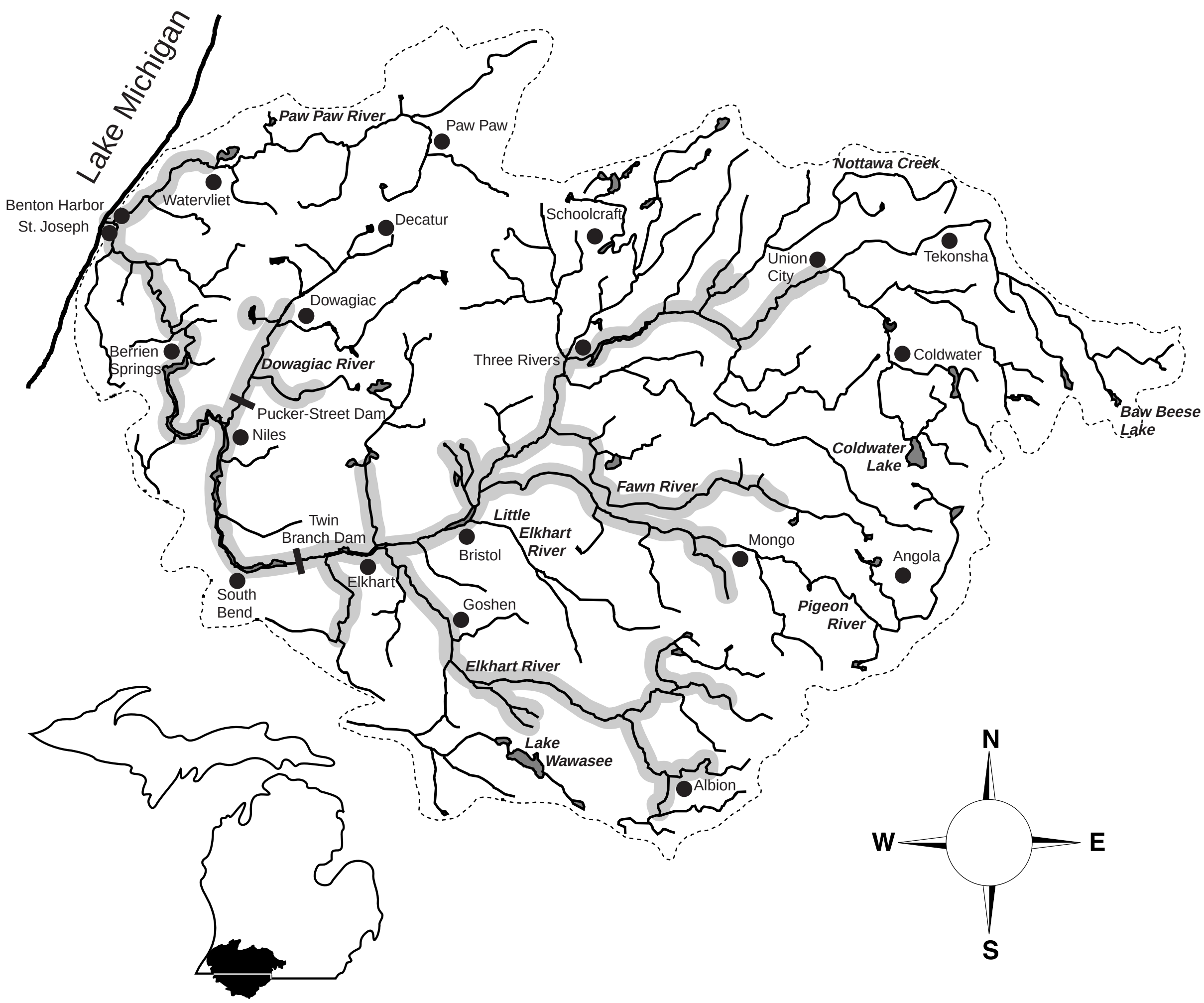


Spotfin shiner (*Cyprinella spiloptera*)

Habitat:

feeding
- clear water tolerant of turbidity and siltation
- some current
- shallow depths
- medium sized streams, lakes, and impoundments
- clear sand or gravel substrate

spawning
- swift current
- crevice spawner or on underside of submerged logs and roots

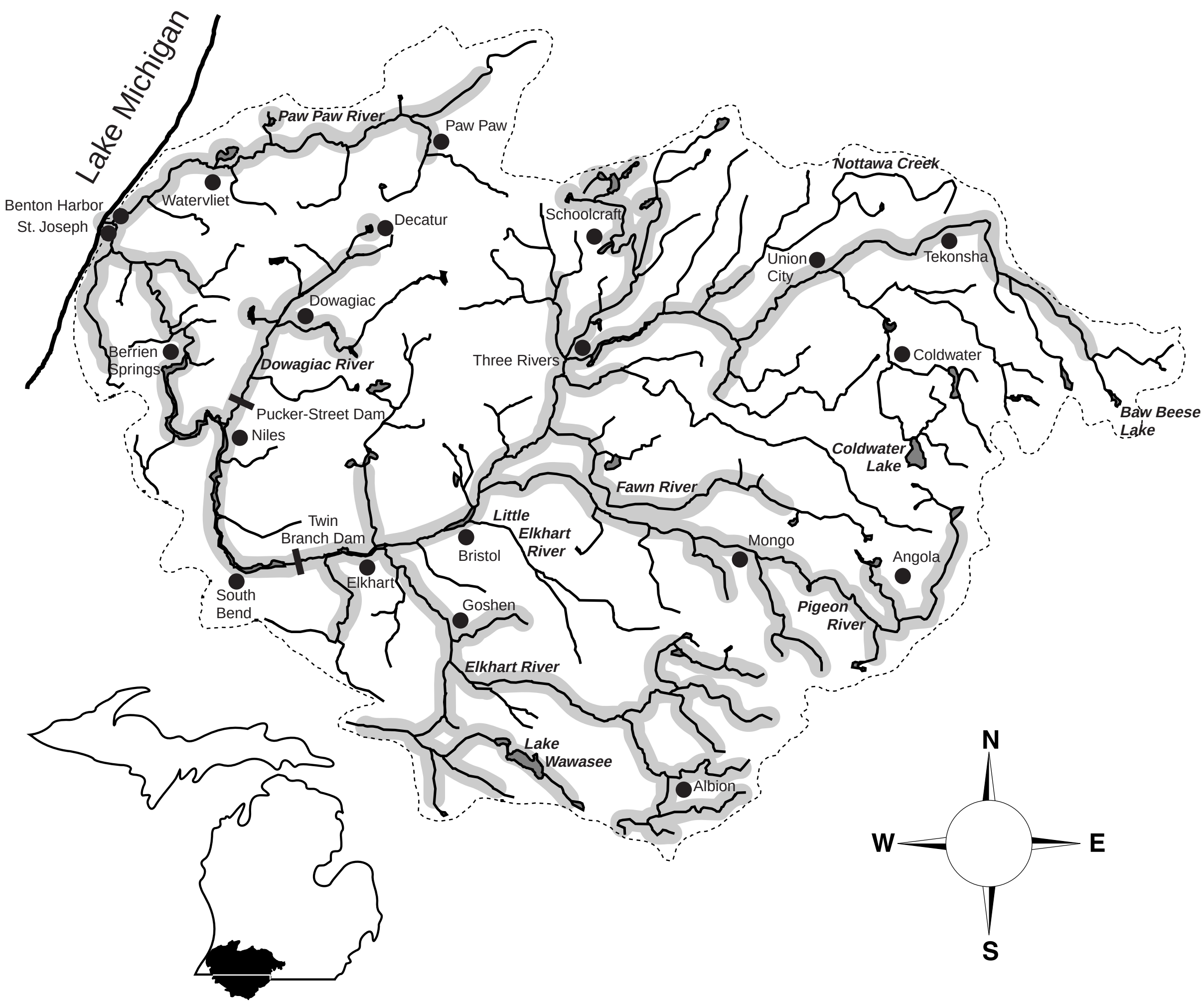


Common carp (*Cyprinus carpio*)

Habitat:

feeding - low gradient fertile streams, rivers, lakes, and impoundments
- abundance of aquatic vegetation or organic matter
- tolerant of all substrates and clear to turbid water

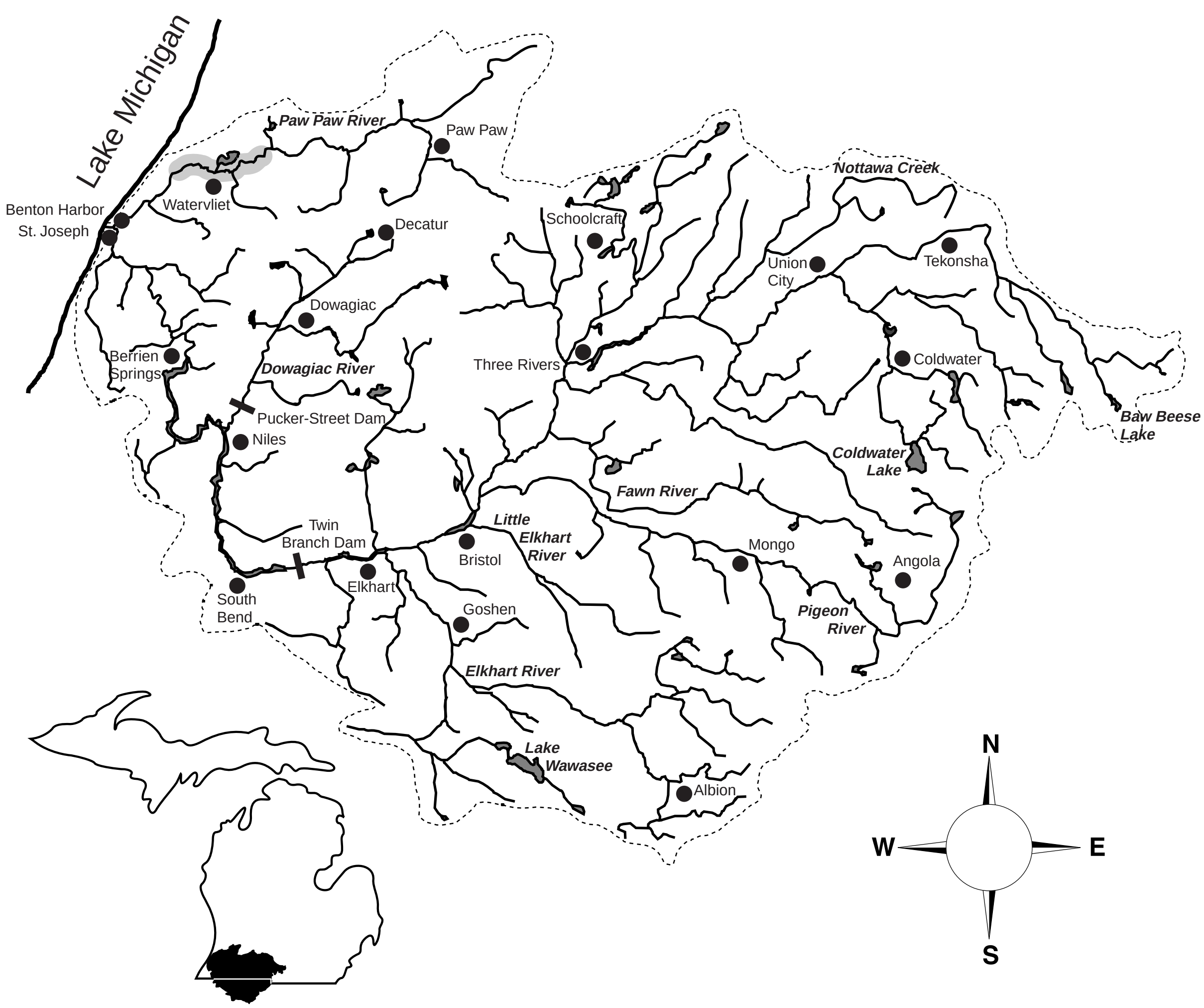
spawning - weedy or grassy shallows



Brassy minnow (*Hybognathus hankinsoni*)

Habitat:

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



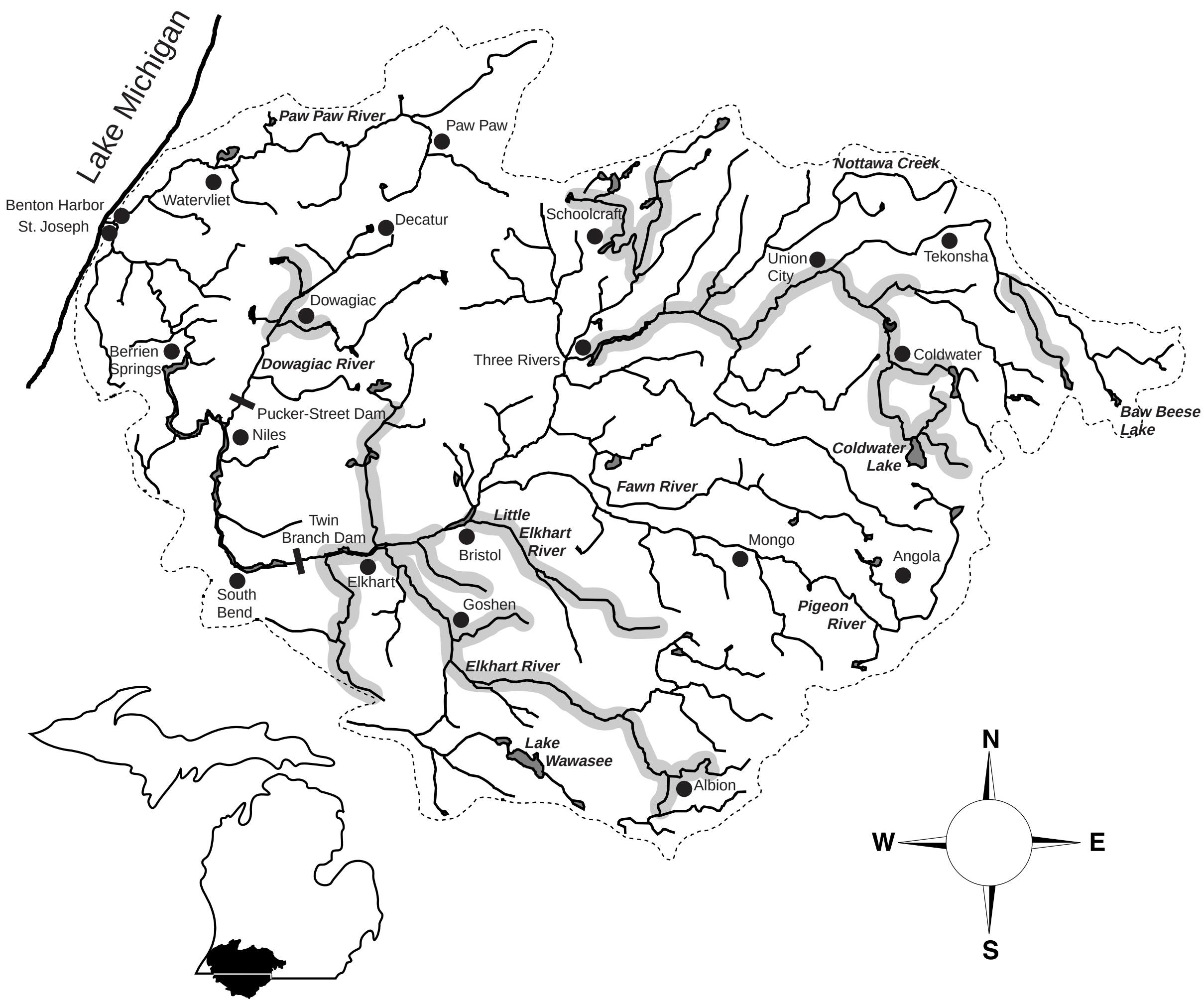
Striped shiner (*Luxilus chrysocephalus*)

Habitat:

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

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

winter refuge - in large deep pools of low gradient rivers

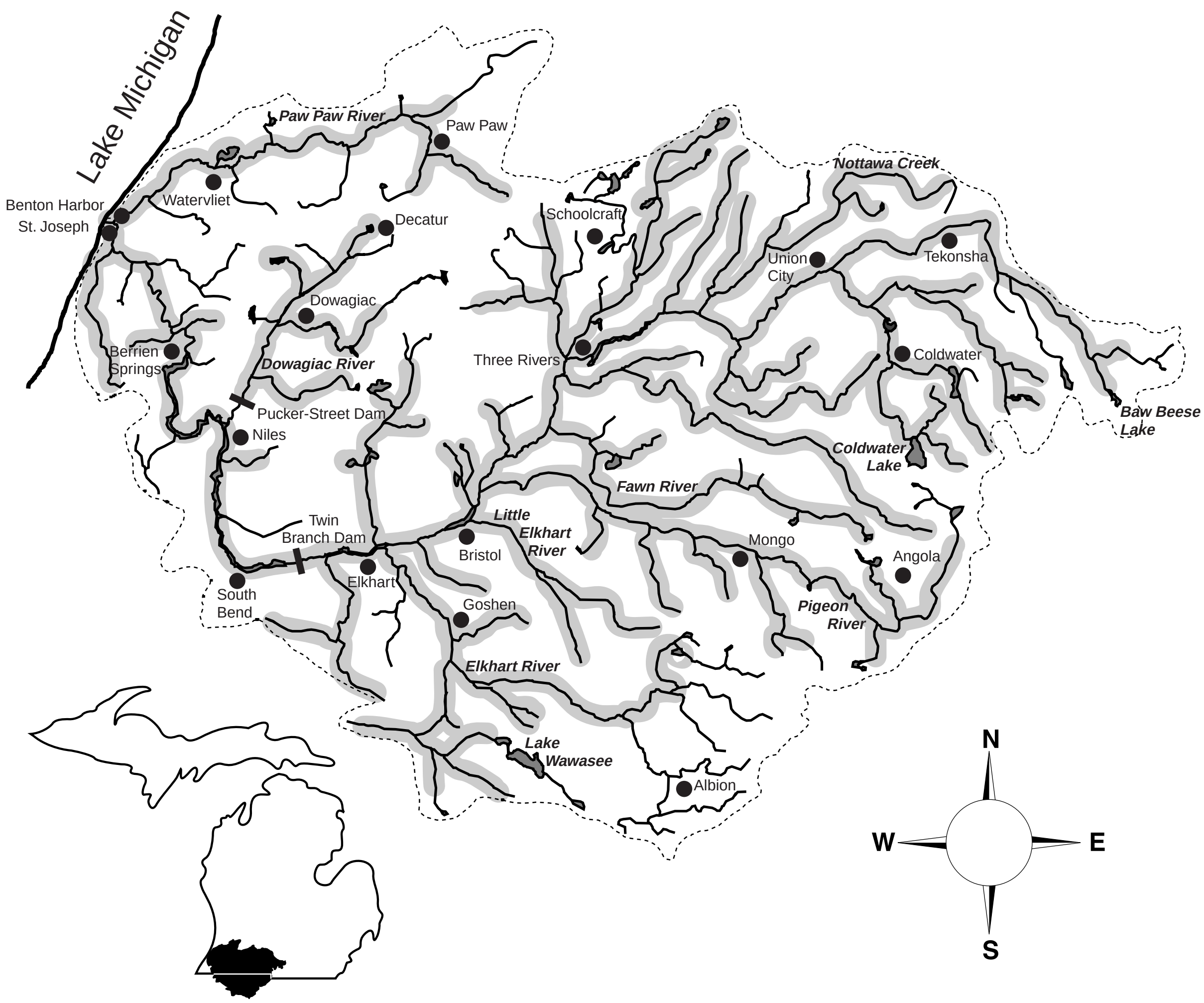


Common shiner (*Luxilus cornutus*)

Habitat:

feeding - small, clear, high-gradient streams and rivers, or shores of clear water lakes and impoundments
- gravel substrate
- can tolerate some submerged aquatic vegetation
- not very tolerant of turbidity or silted waters

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

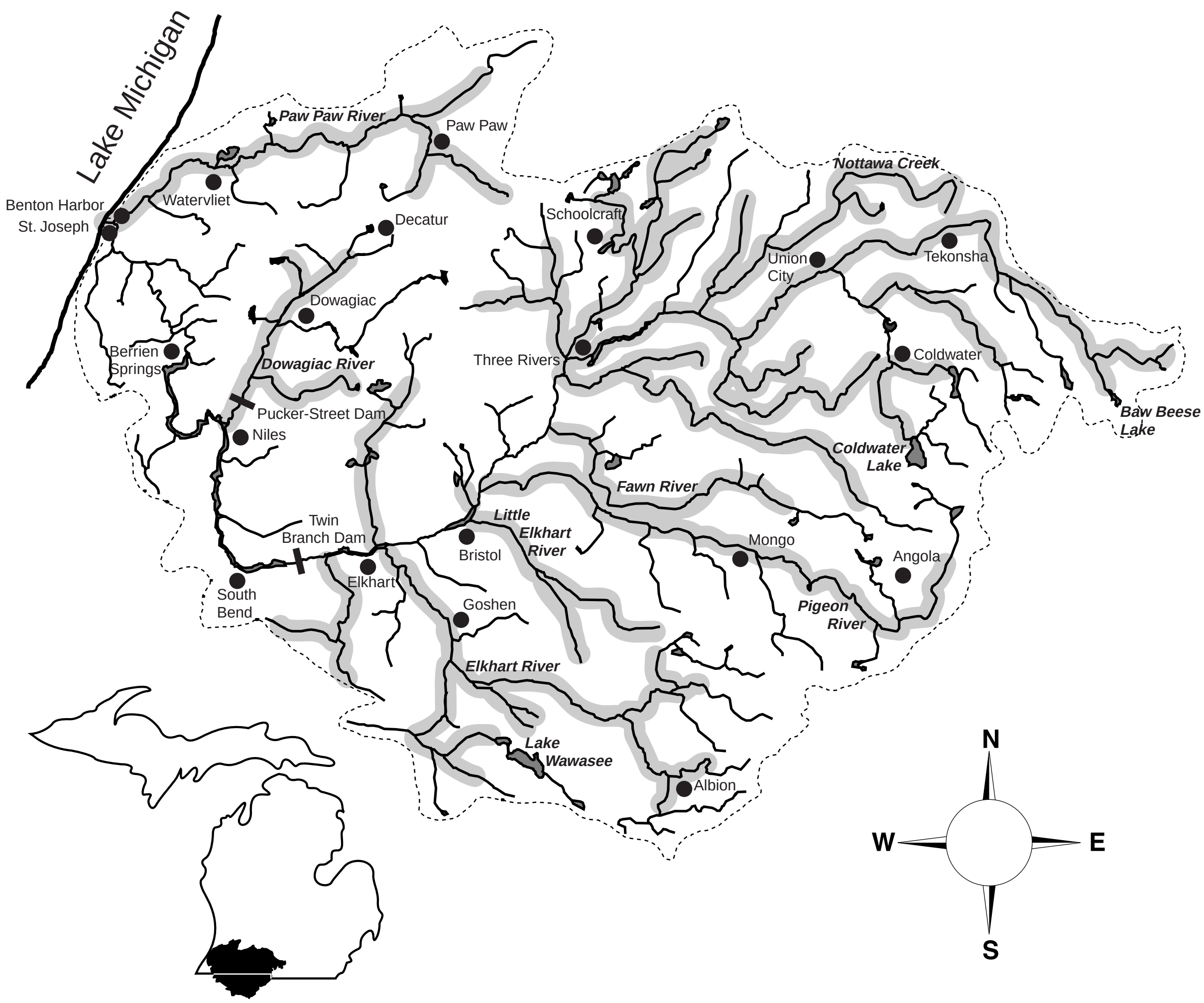


Hornyhead chub (*Nocomis biguttatus*)

Habitat:

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

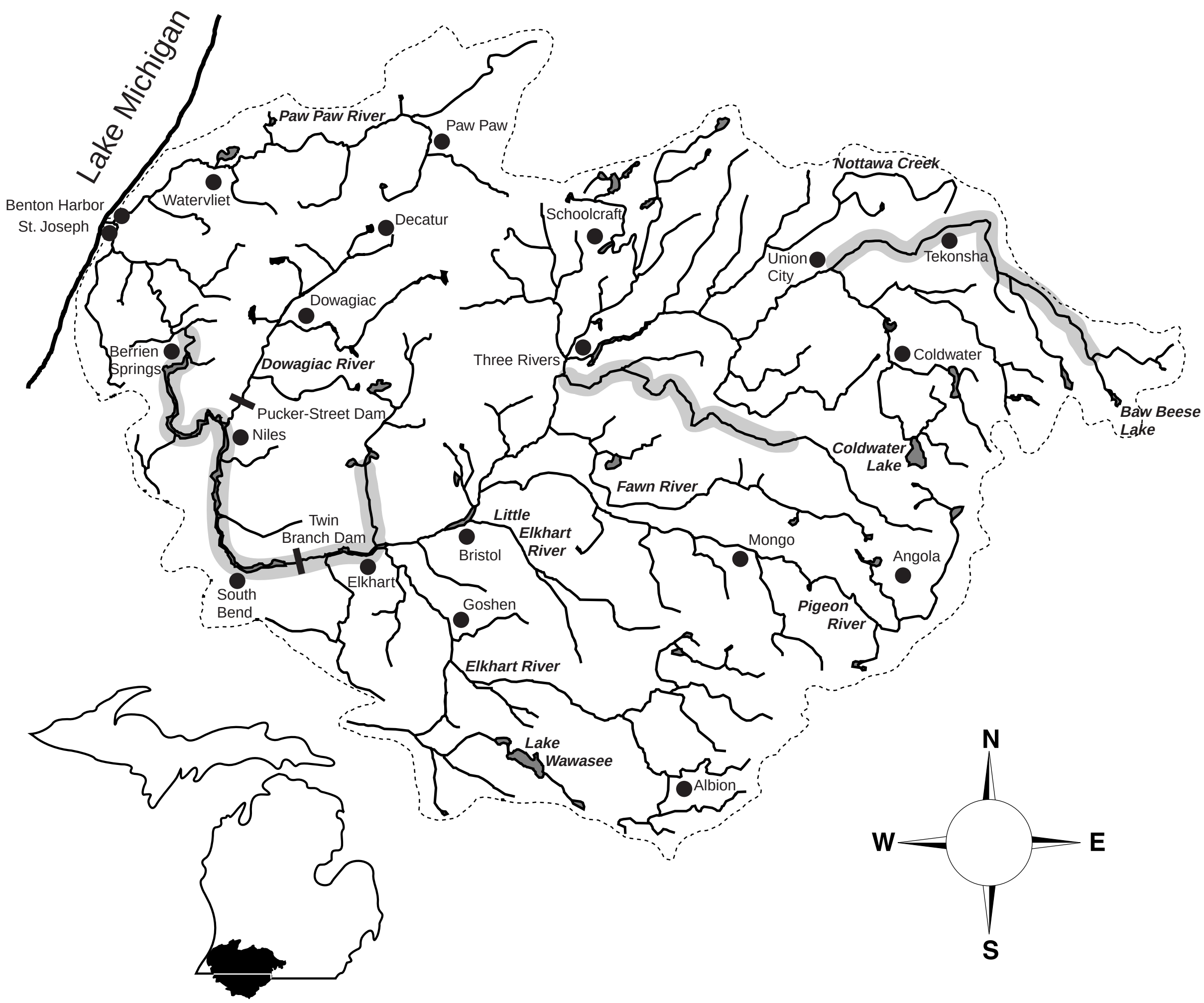
spawning
- large stones and pebbles present
- often below a riffle in shallow water
- gravel substrate



River chub (*Nocomis micropogon*)

Habitat:

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

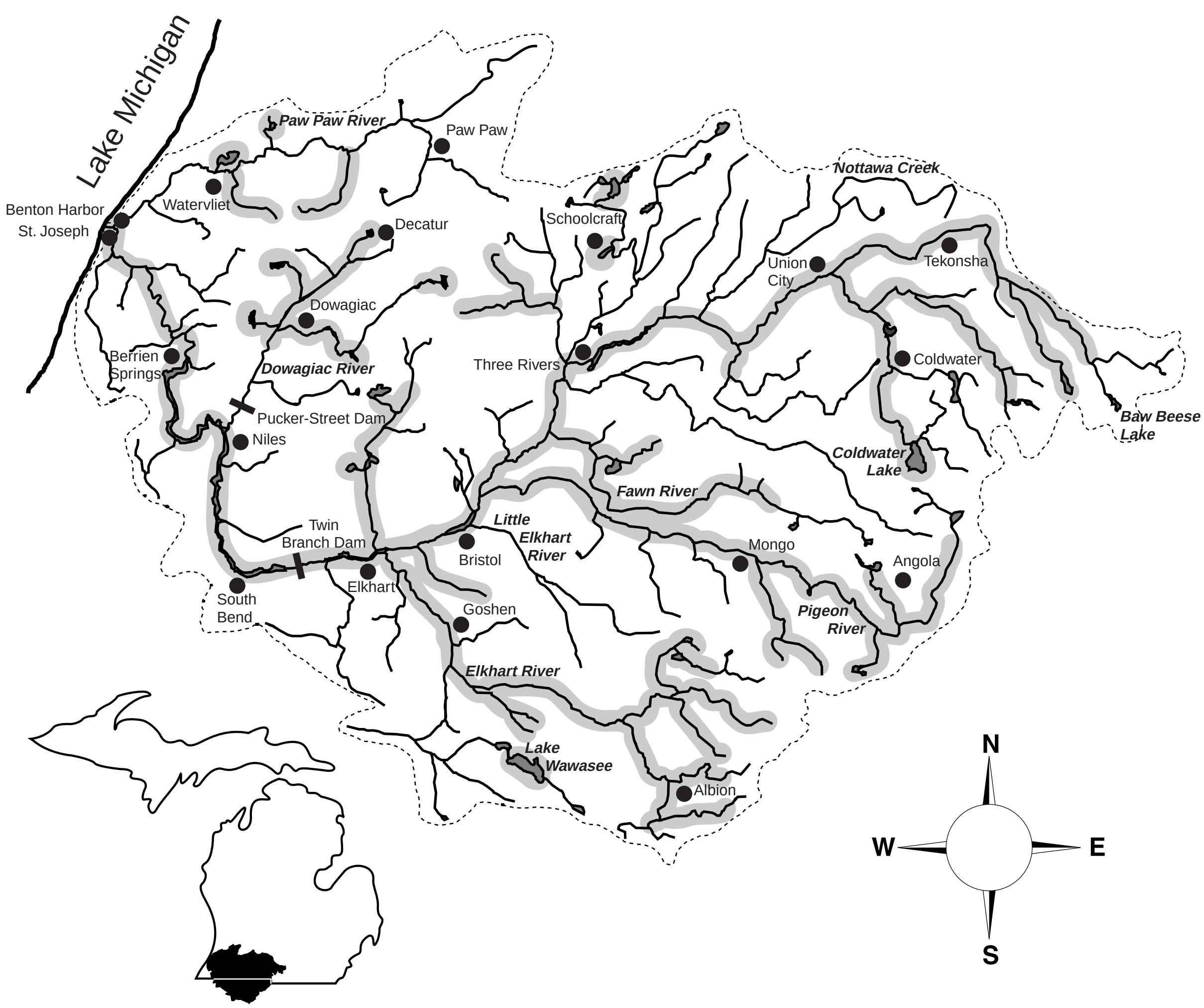


Golden shiner (*Notemigonus crysoleucas*)

Habitat:

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

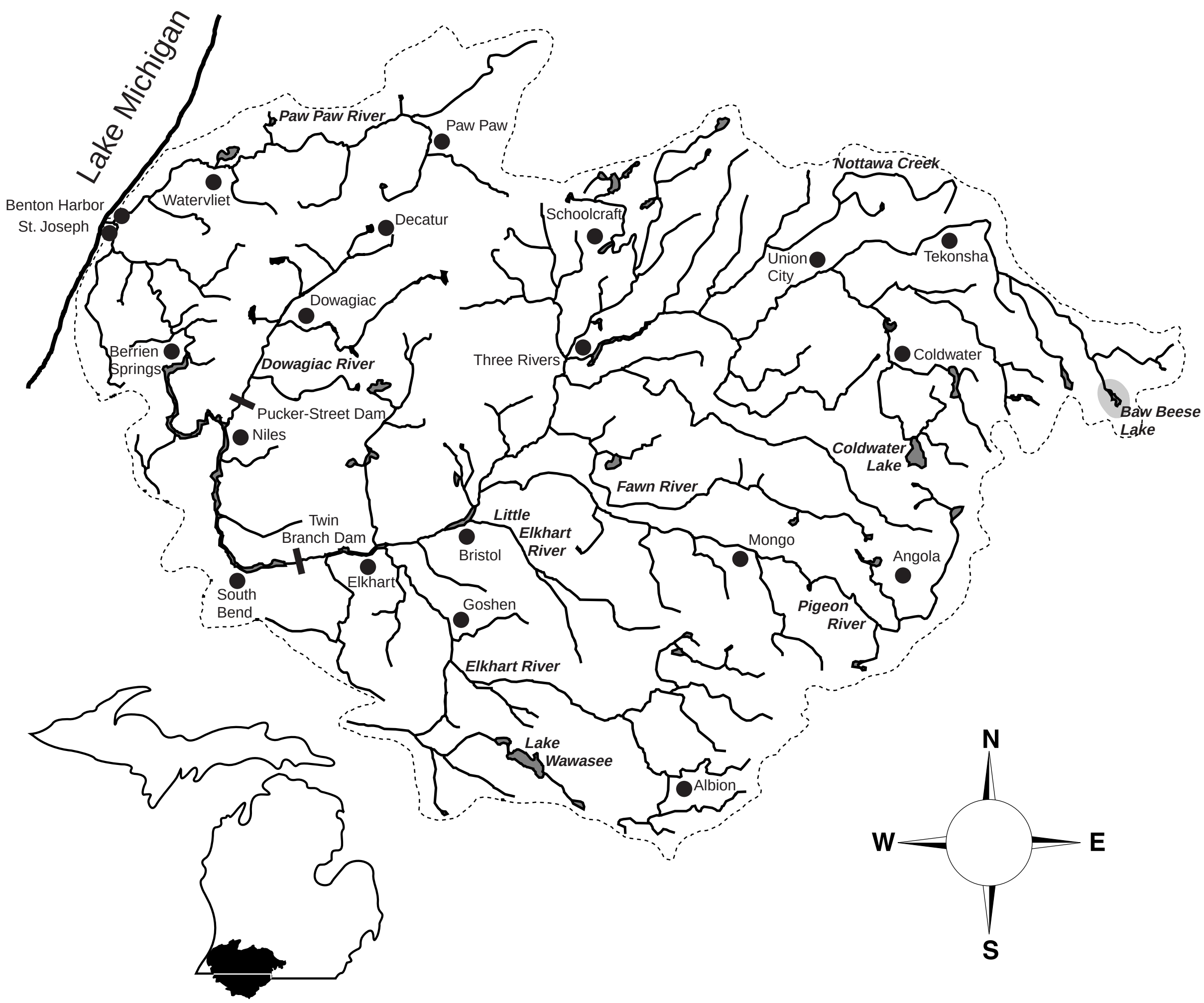
spawning - vegetation



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

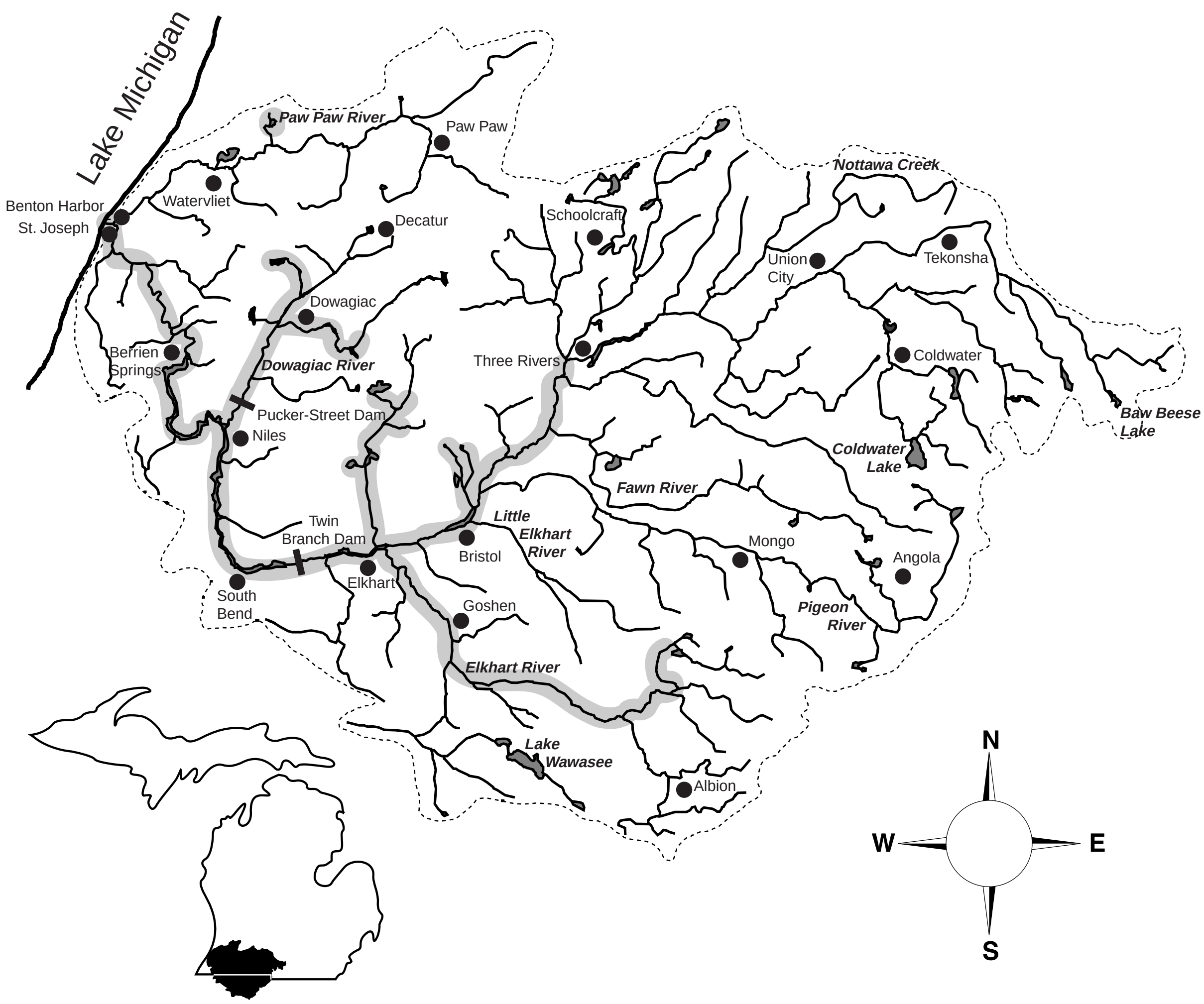


Emerald shiner (*Notropis atherinoides*)

Habitat:

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

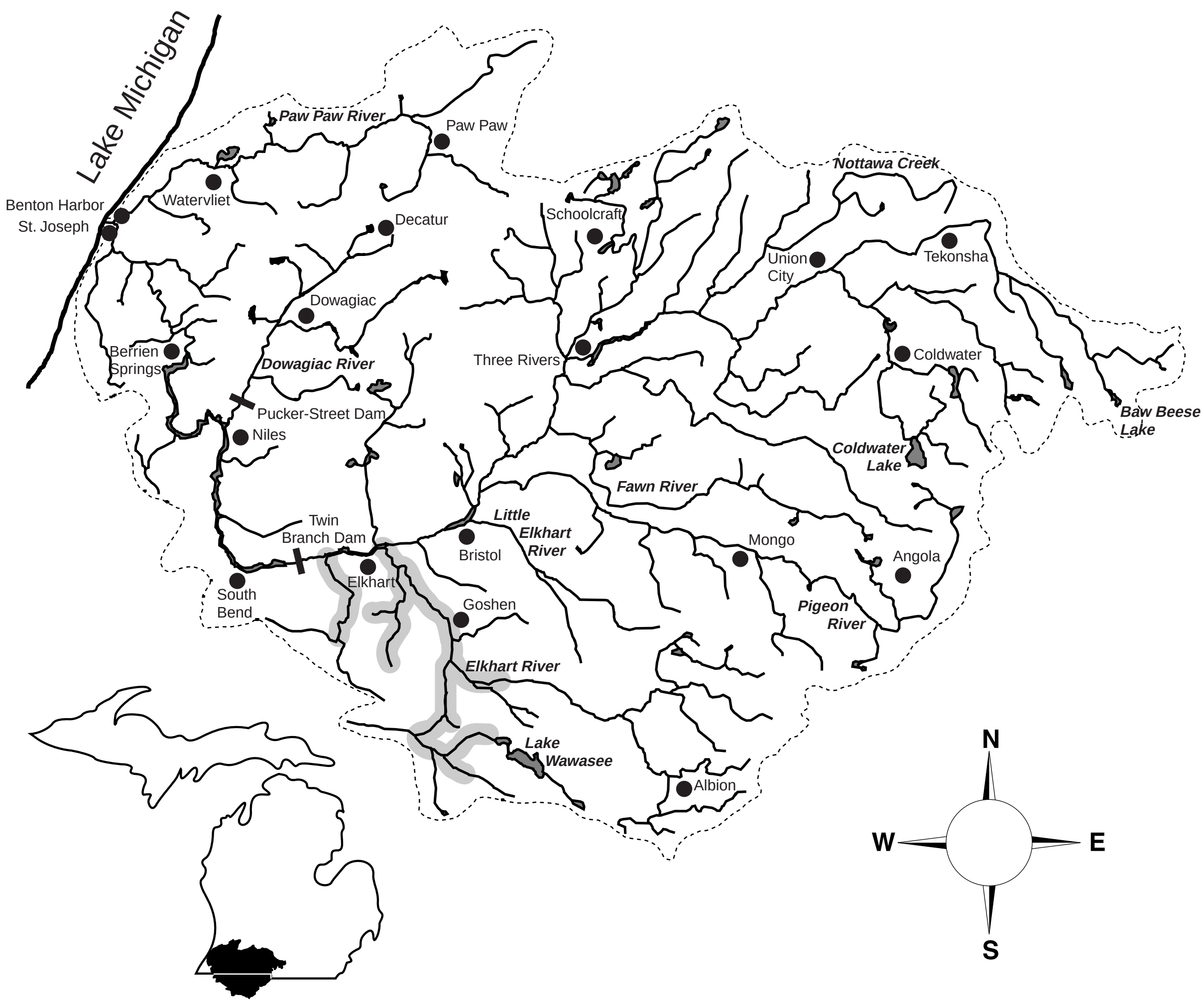
spawning - sand or firm mud substrate or gravel shoals



Silverjaw minnow (*Notropis buccatus*)

Habitat:

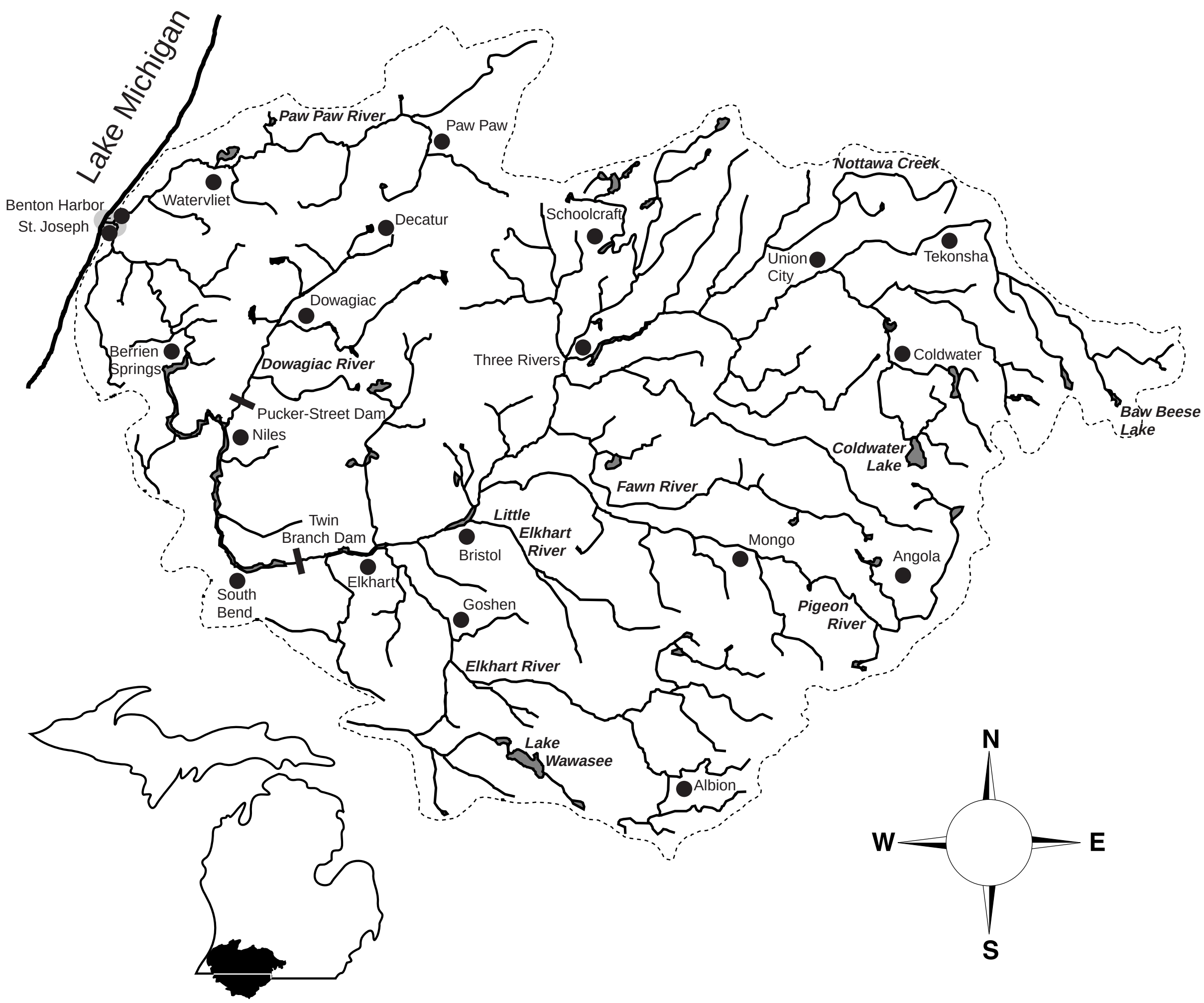
feeding
- small, clear, shallow streams
- sand substrate
- moderate gradient
- high tolerance to turbidity and domestic and industrial pollutants



Blackchin shiner (*Notropis heterodon*)

Habitat:

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

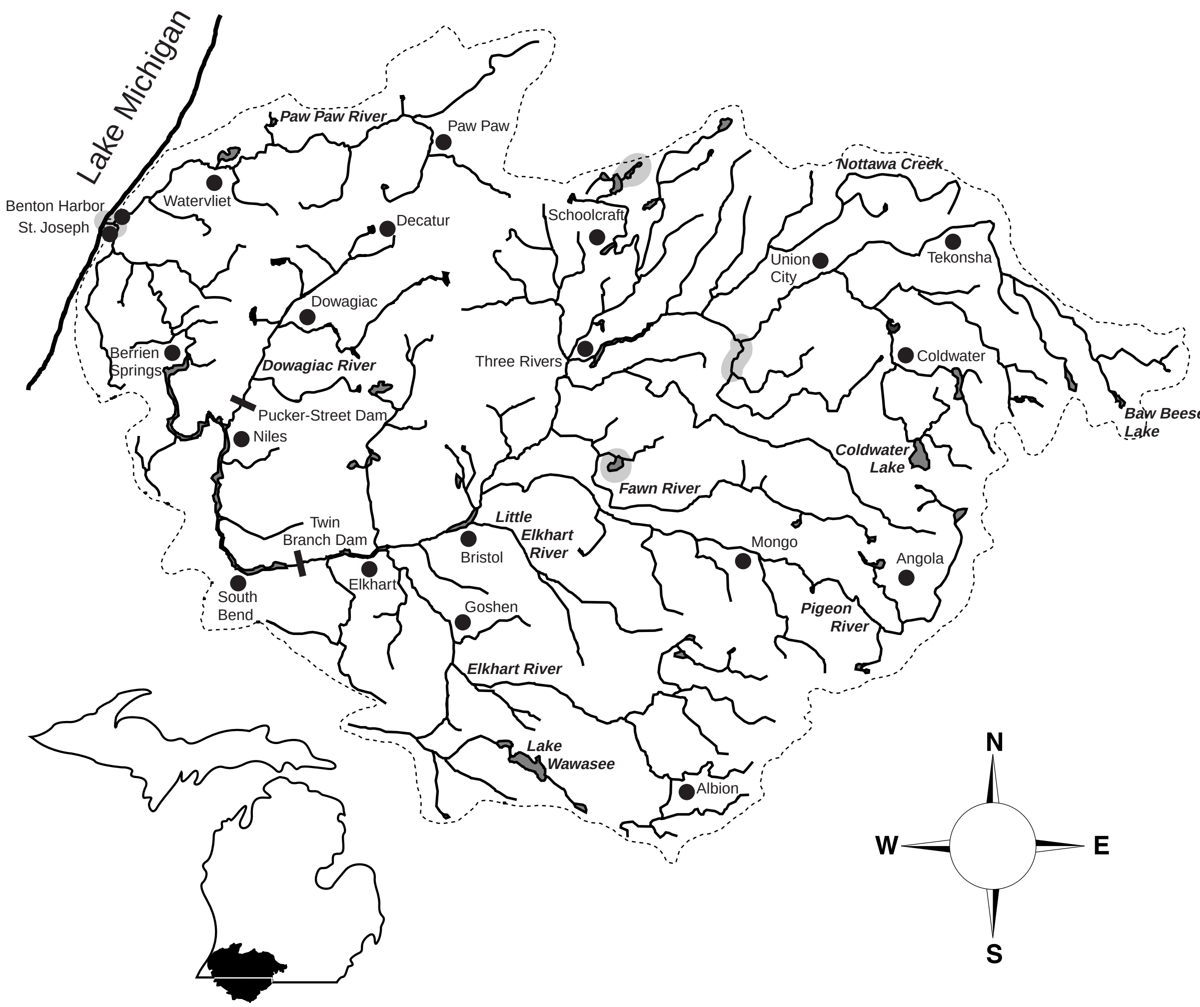


Blacknose shiner (*Notropis heterolepis*)

Habitat:

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

spawning
- sandy substrate

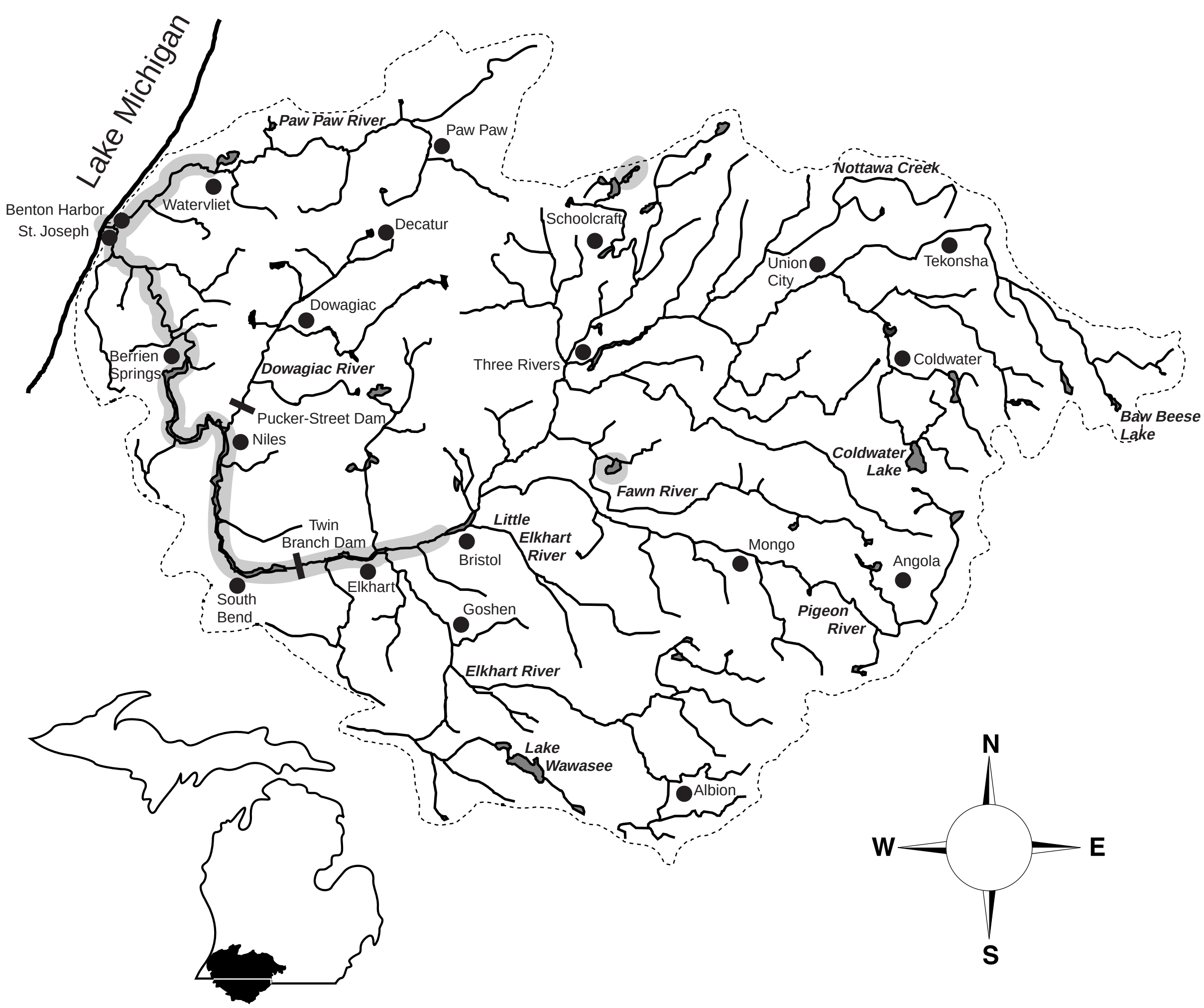


Spottail shiner (*Notropis hudsonius*)

Habitat:

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

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

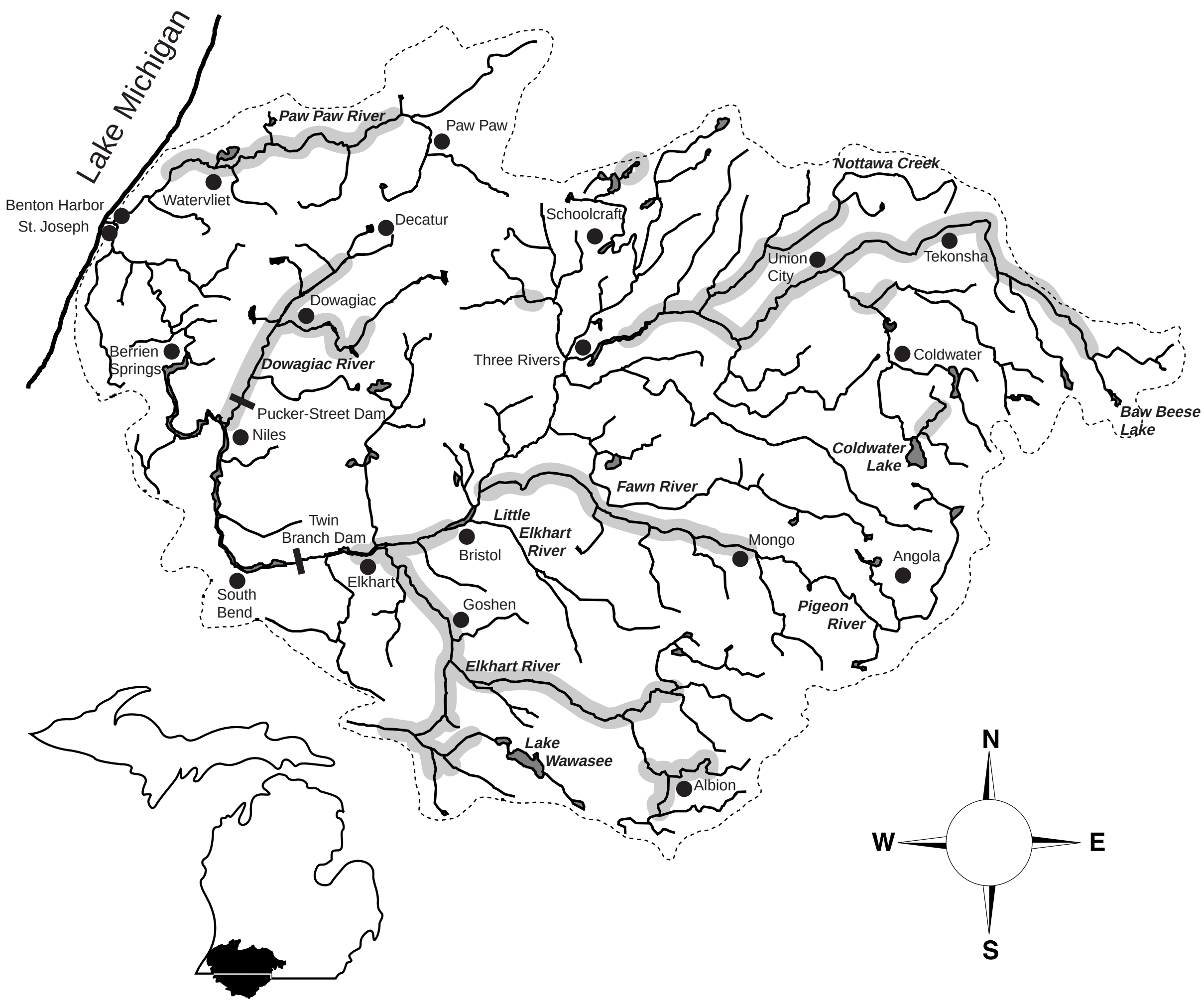


Rosyface shiner (*Notropis rubellus*)

Habitat:

feeding
- moderate sized streams
- moderate to high gradient
- gravel or sand substrate; intolerant of silt substrate
- clear water; intolerant of turbidity

spawning
- on nests of horneyhead chub, chesnut lamprey, and redhorses
- sandy-gravel, gravel or bedrock substrate
- shallow high gradient water

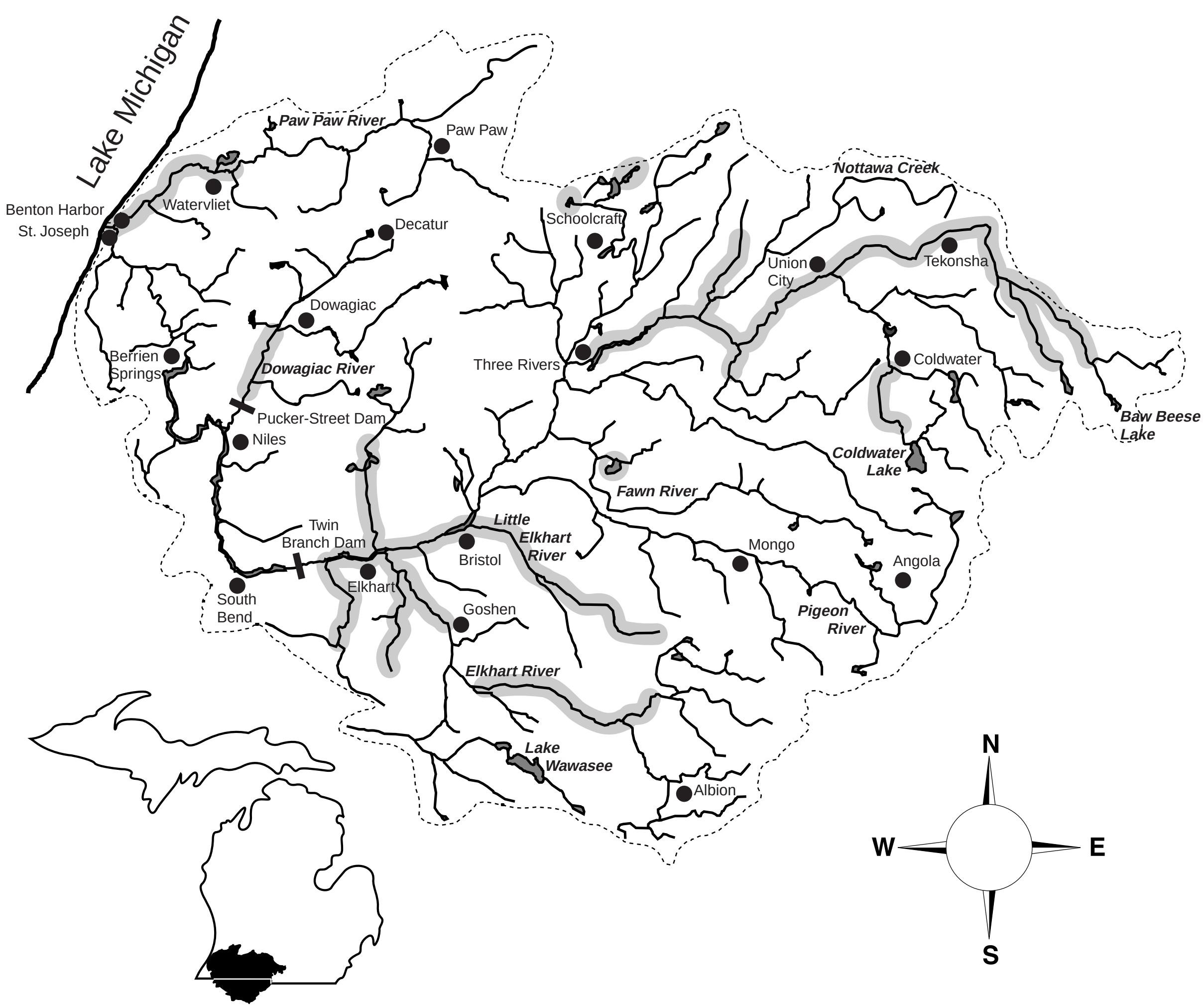


Sand shiner (*Notropis stramineus*)

Habitat:

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

spawning
- clean gravel or sand substrate

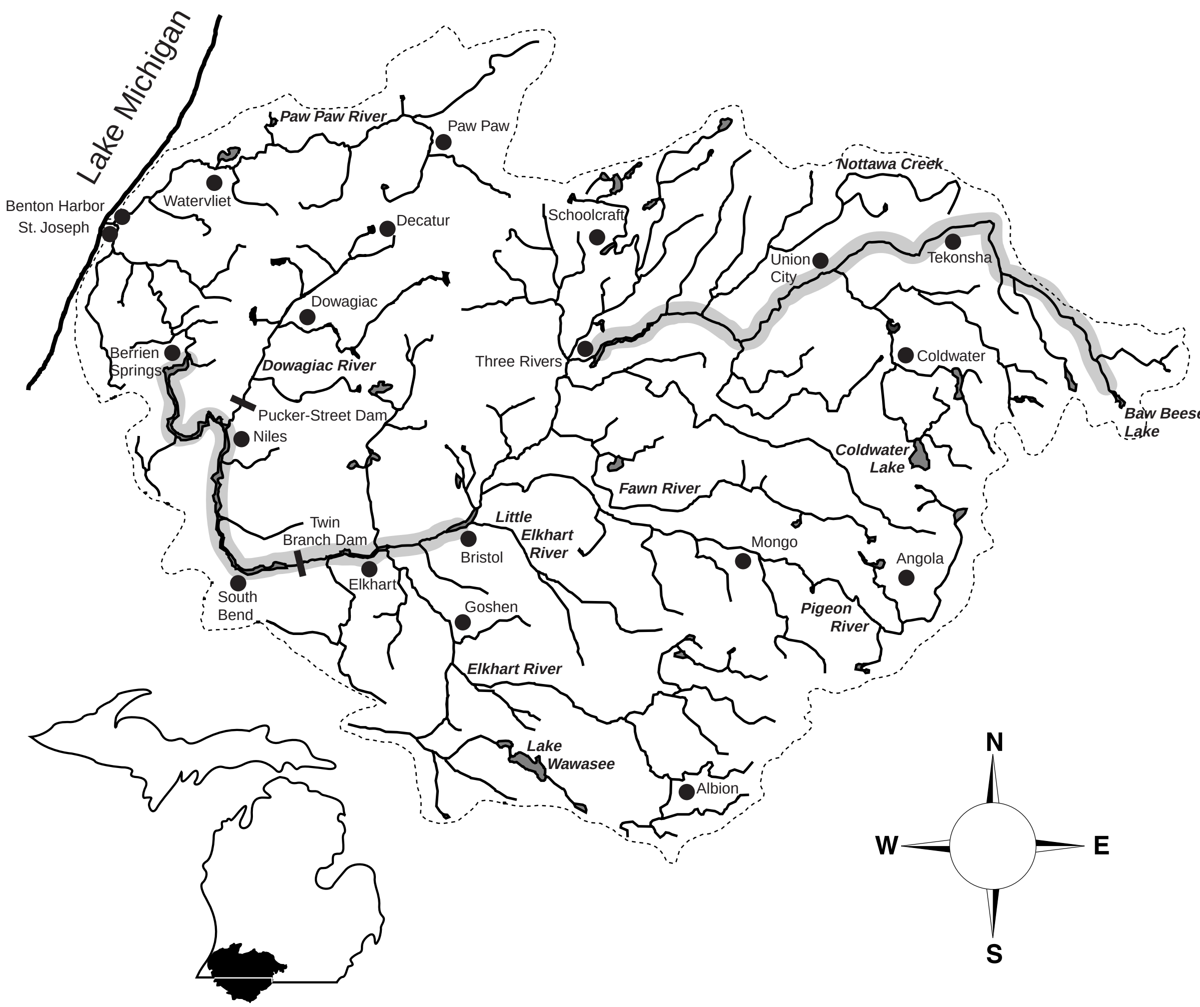


Mimic shiner (*Notropis volucellus*)

Habitat:

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

spawning - aquatic vegetation necessary

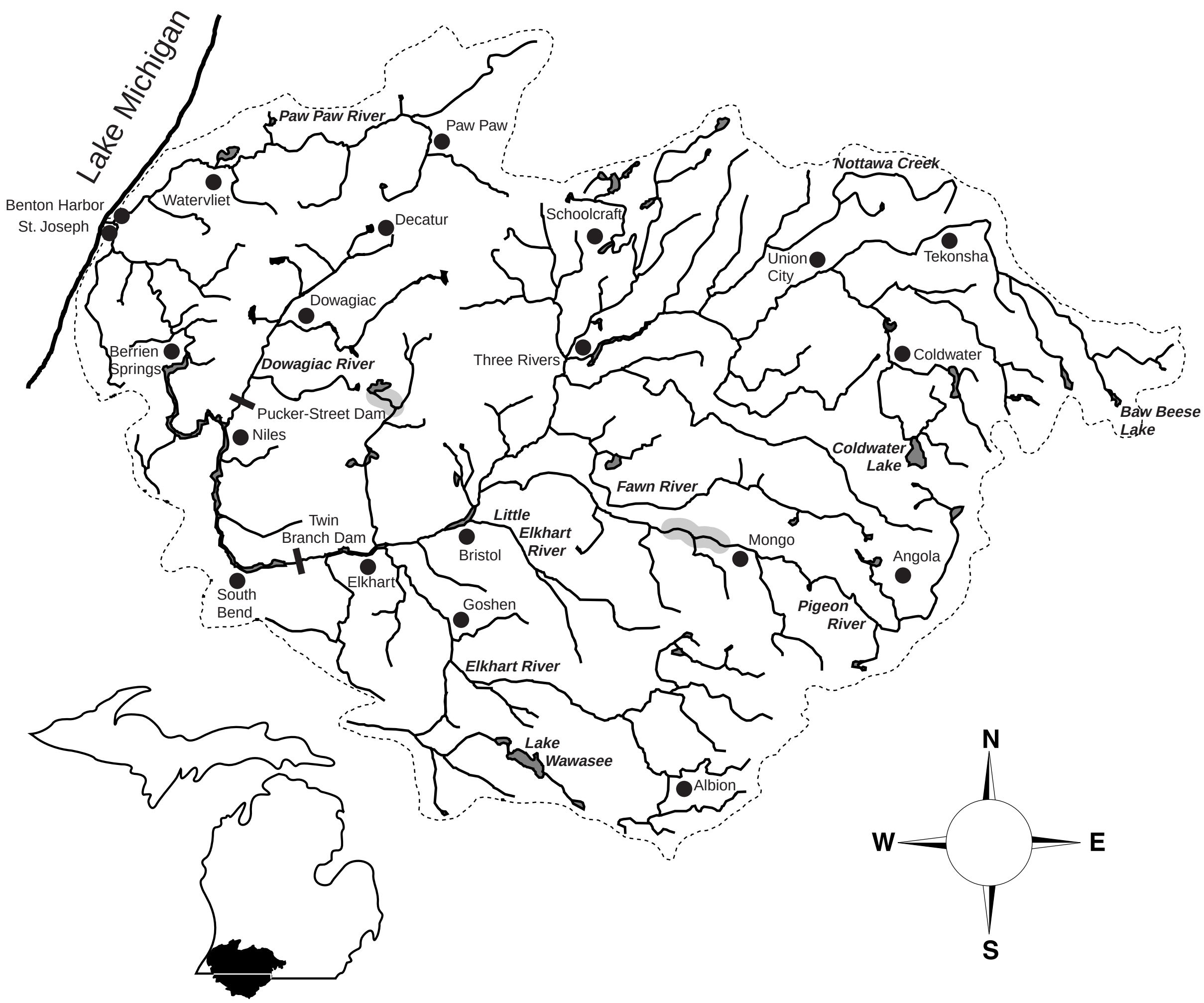


Suckermouth minnow (*Phenacobius mirabilis*)

Habitat:

feeding - riffles
- warm water
- low to moderate gradient, enough to keep gravel riffles free of silt
- turbid water rich in organic material
- absence of aquatic vegetation

spawning - gravelly riffles

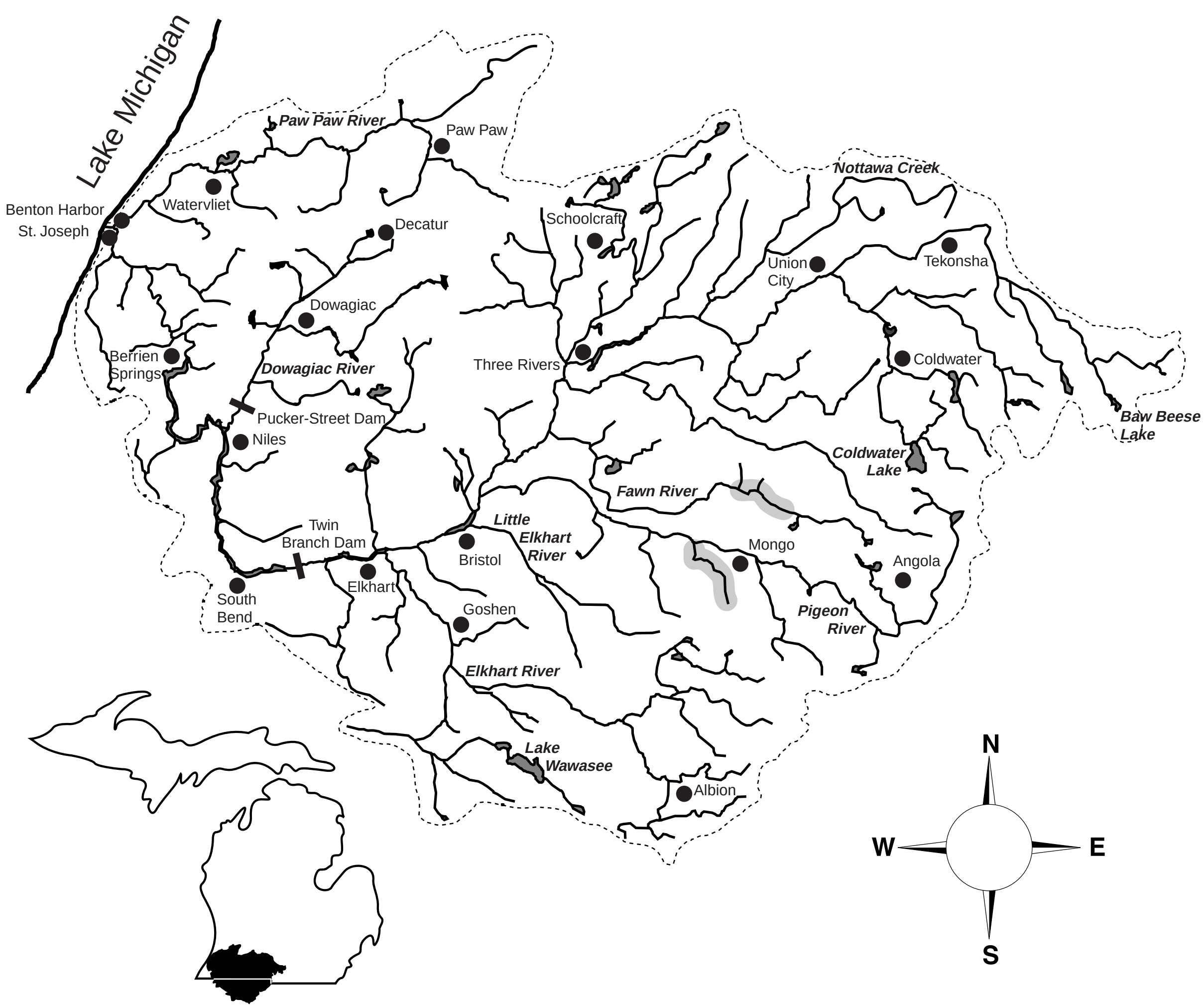


Northern redbelly dace (*Phoxinus eos*)

Habitat:

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

spawning
- filamentous algae needed for egg deposition

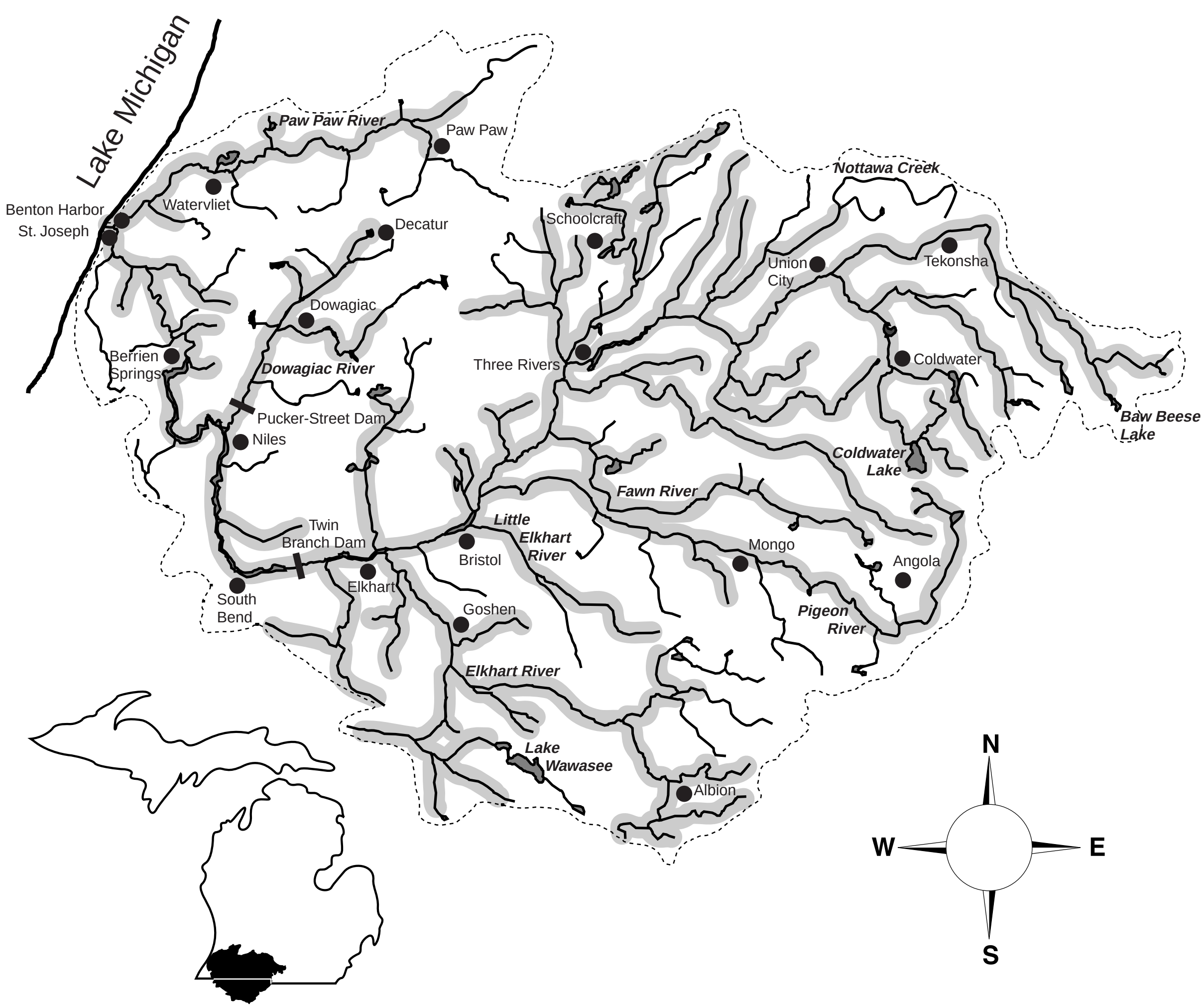


Bluntnose minnow (*Pimephales notatus*)

Habitat:

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

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

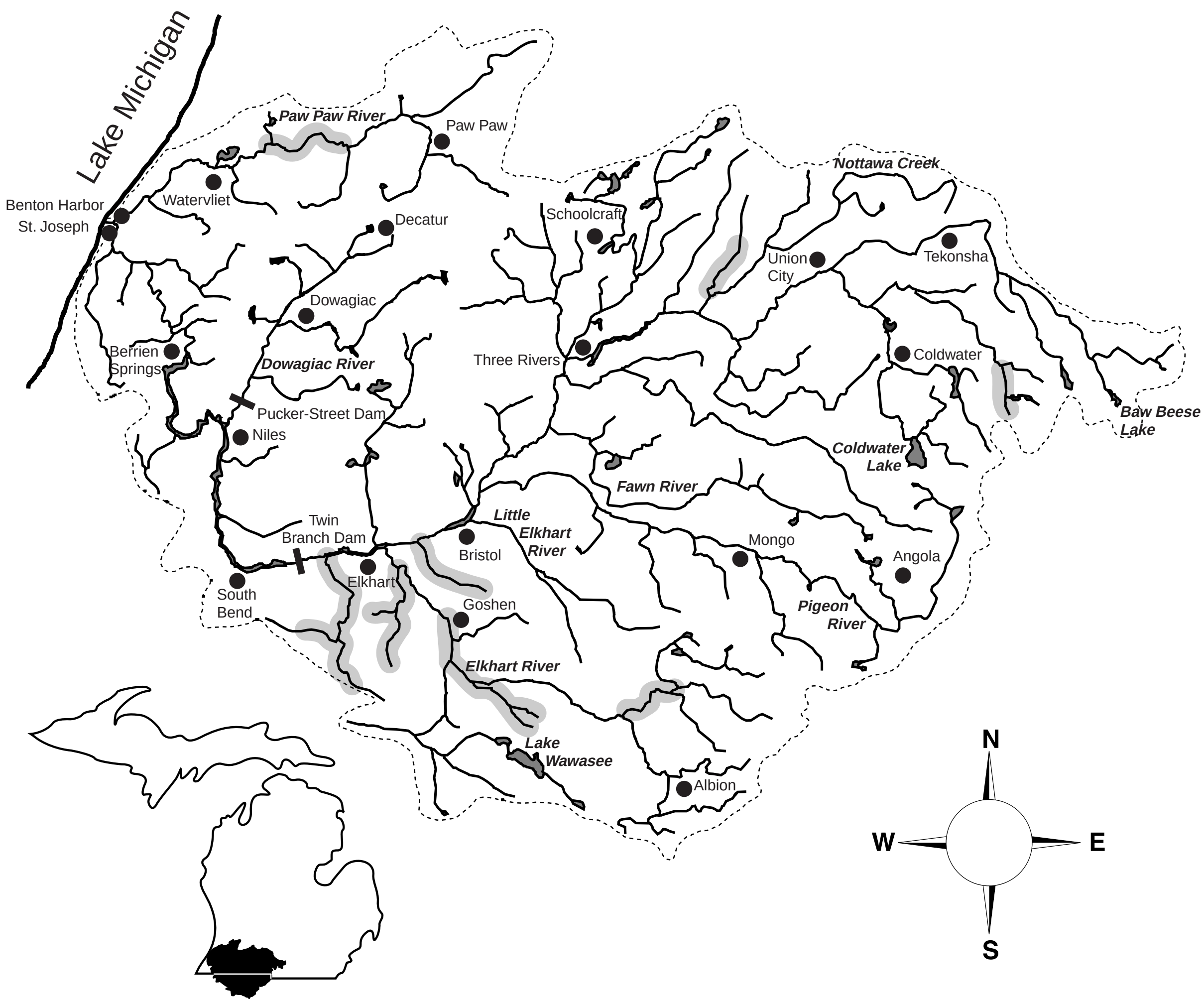


Fathead minnow (*Pimephales promelas*)

Habitat:

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

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



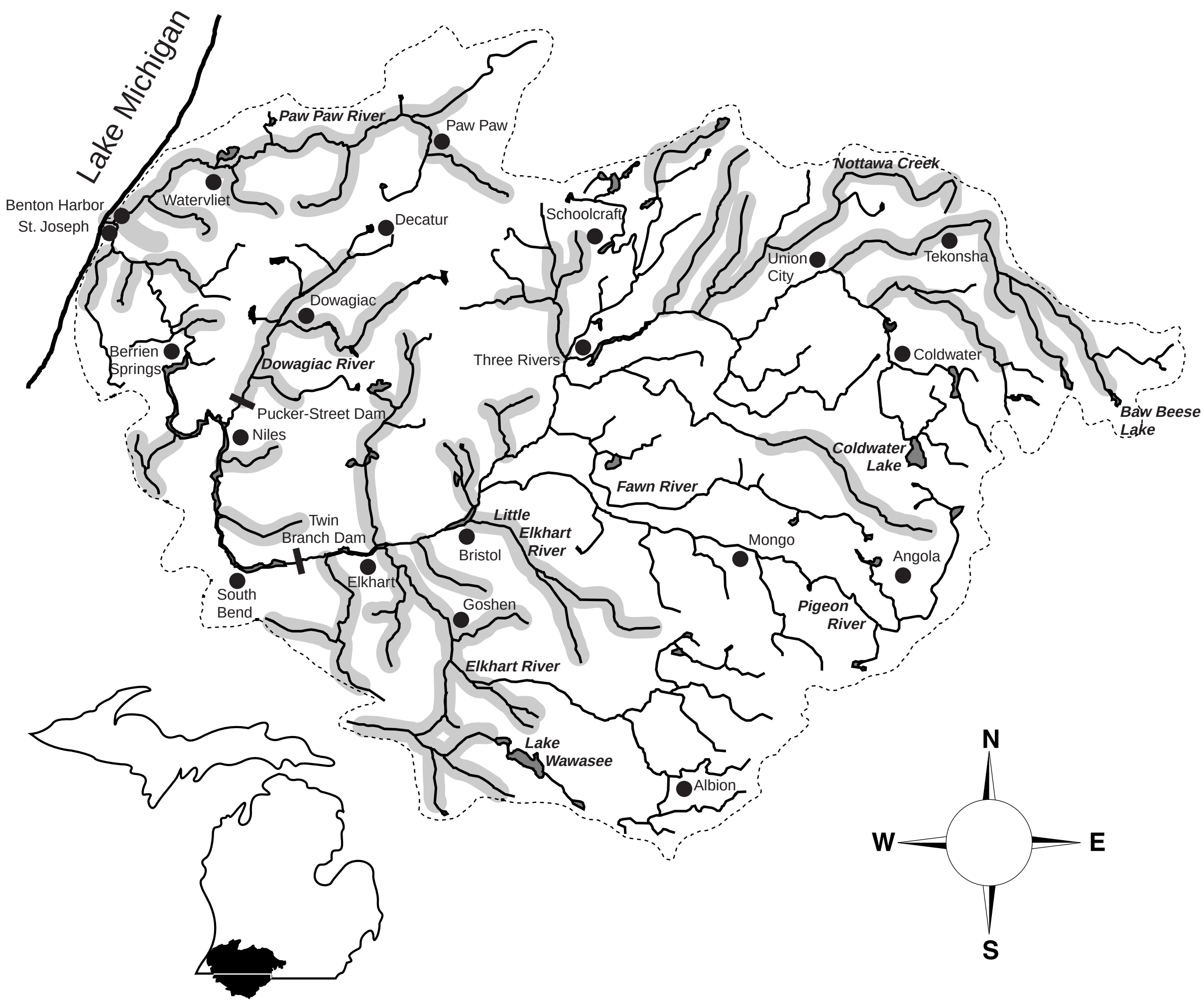
Blacknose dace (*Rhinichthys atratulus*)

Habitat:

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

spawning - riffles with gravel substrate and fast current

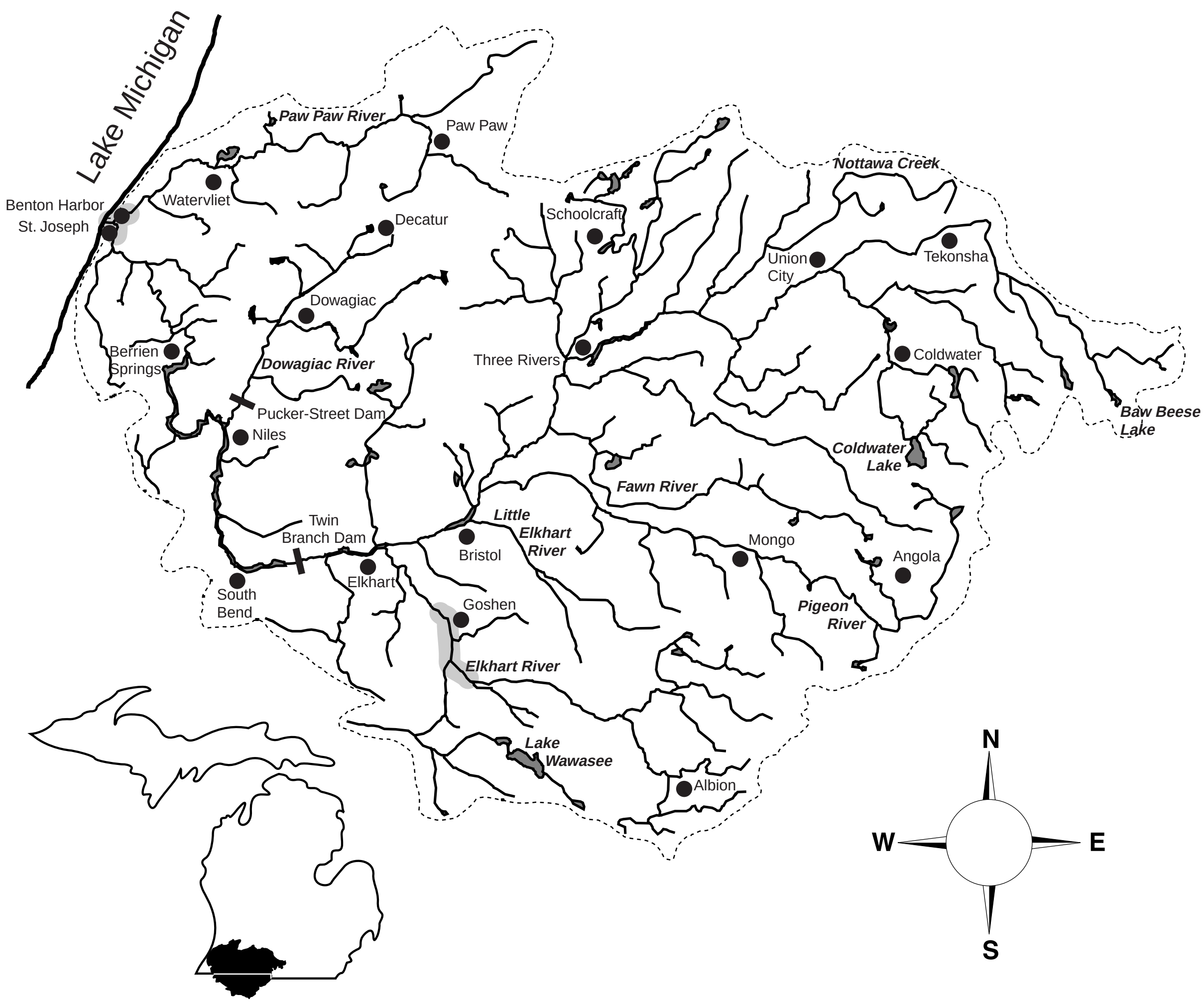
winter refuge - larger waters



Longnose dace (*Rhinichthys cataractae*)

Habitat:

feeding - lakes and streams
- high gradient
- gravel or boulder substrate



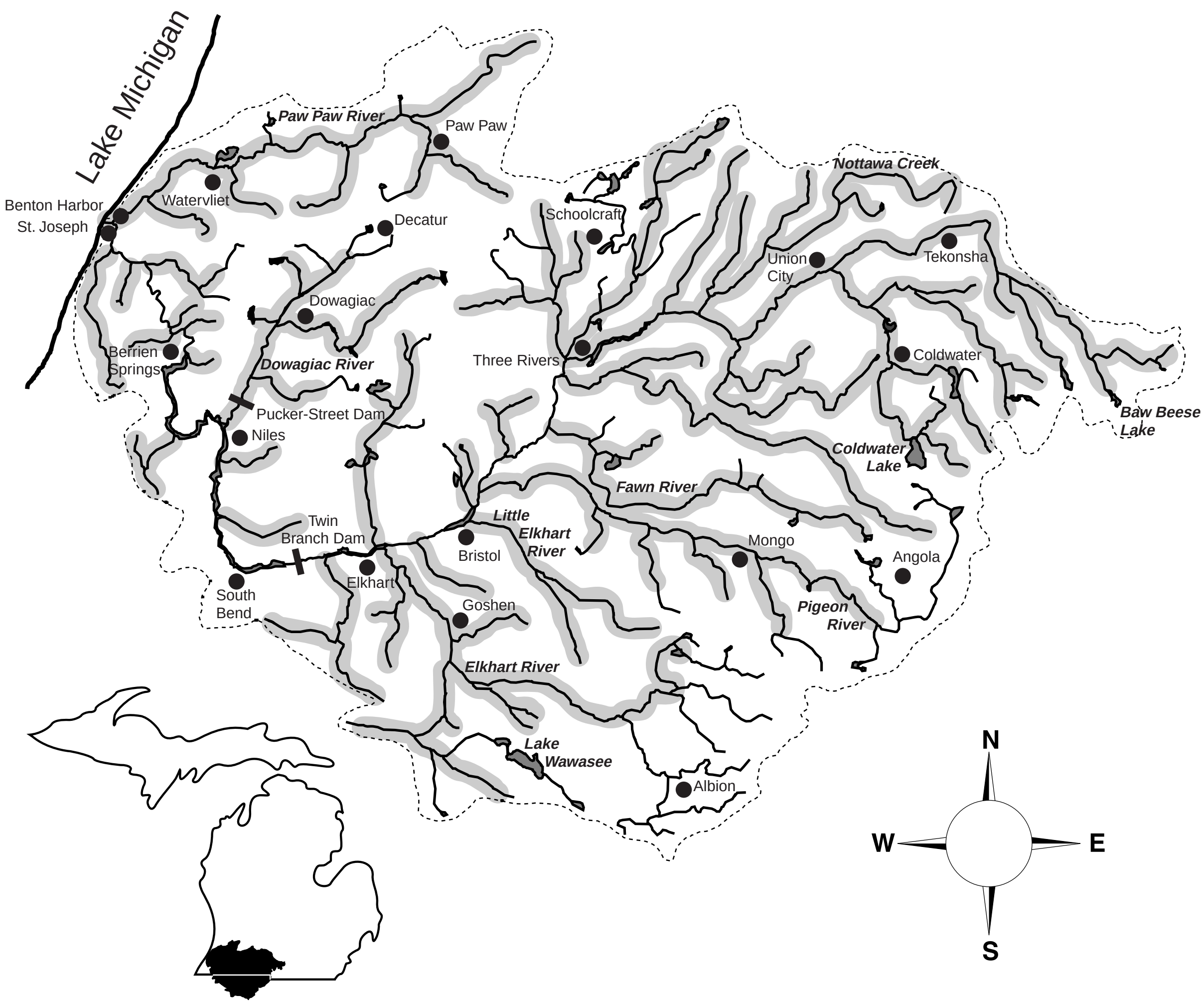
Creek chub (*Semotilus atromaculatus*)

Habitat:

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

spawning - gravel nests
- low current

winter refuge - deeper pools and runs

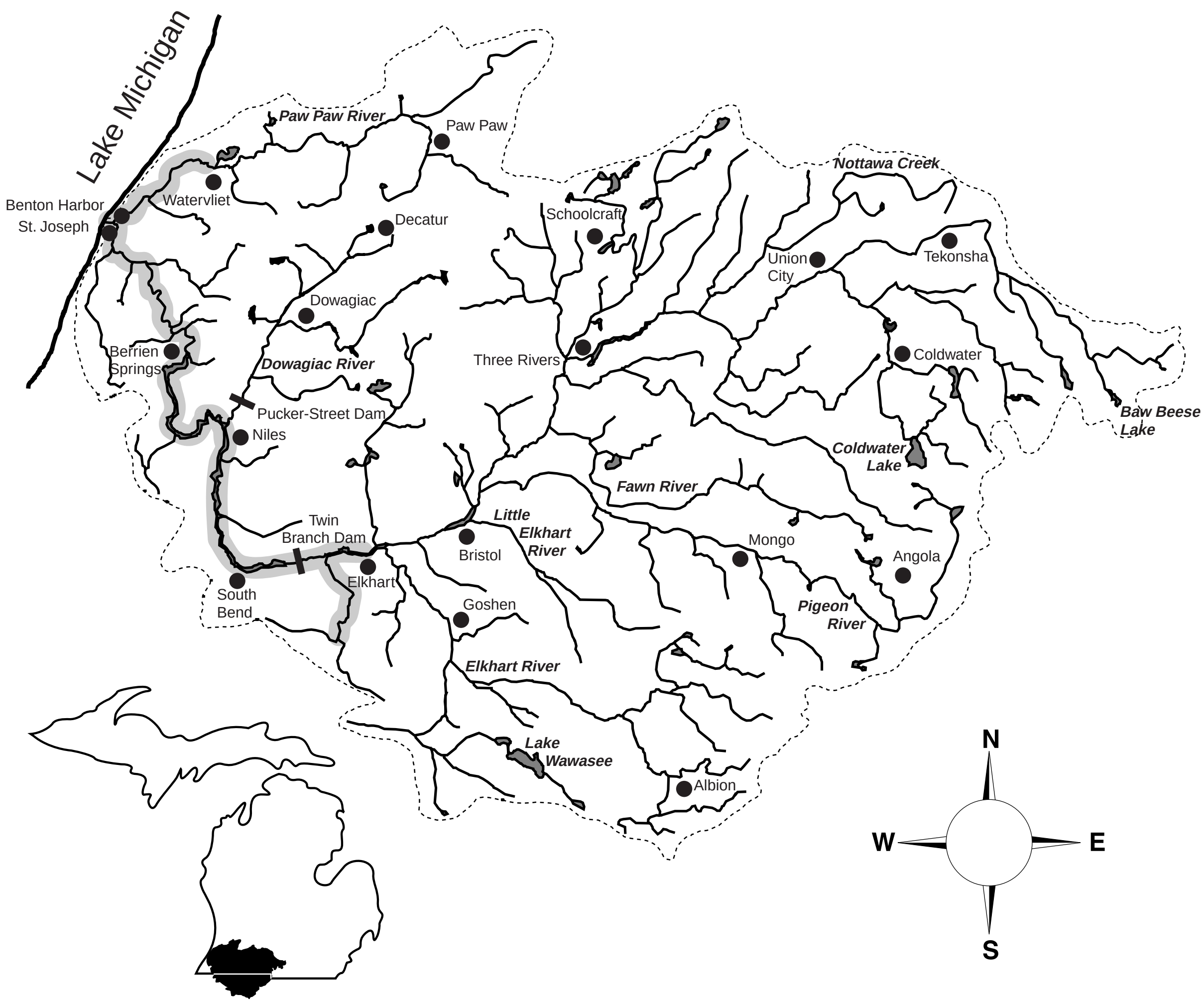


Quillback (*Carpoides cyprinus*)

Habitat:

feeding
- clear to turbid water
- Lake Michigan
- sand, sandy gravel, sandy silt, or clay-silt substrate
- medium- to low-gradient rivers and streams; also lakes and sloughs

spawning
- streams or overflow areas of bends of rivers or bays of lakes
- scatter eggs over sand or mud substrate

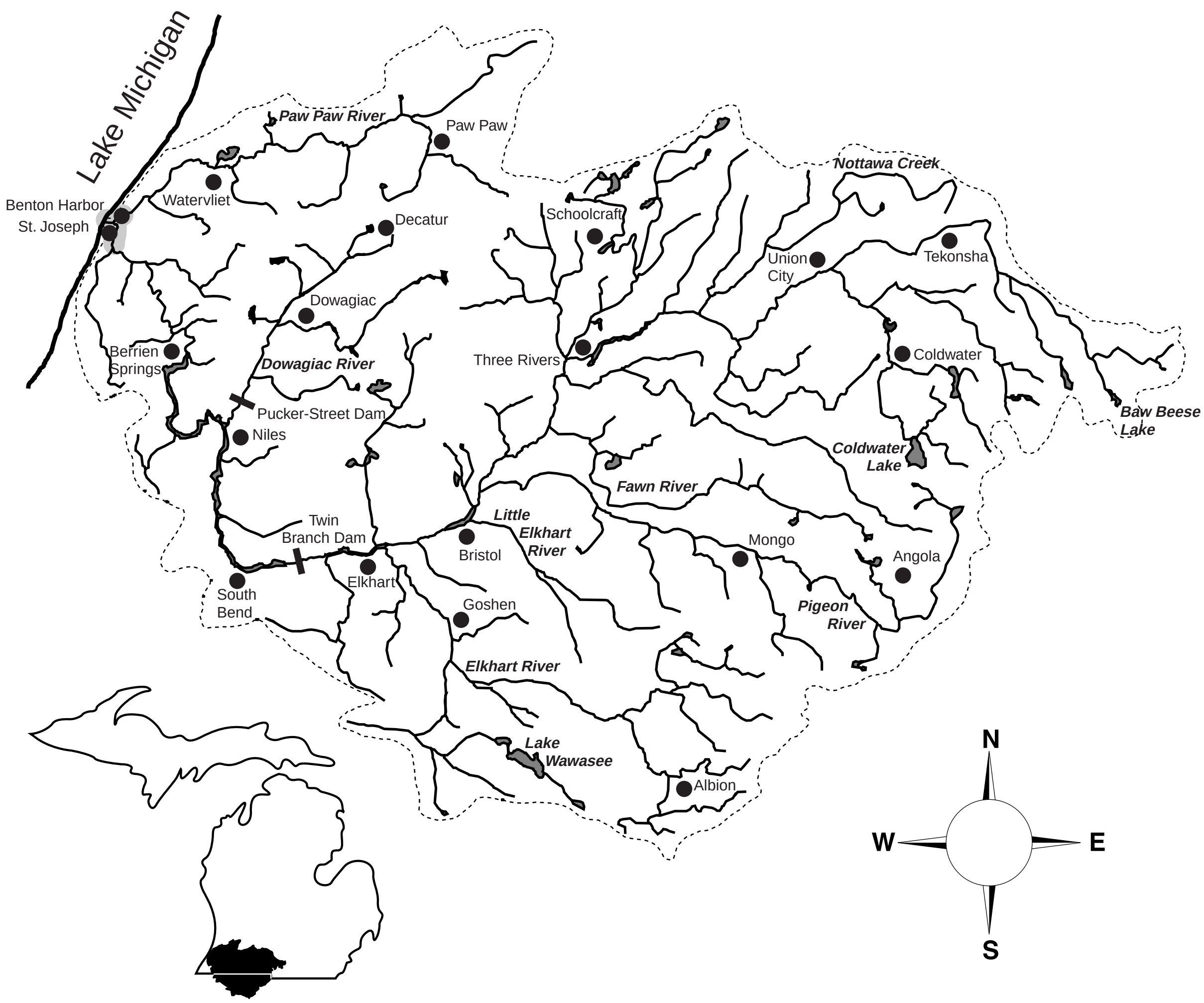


Longnose sucker (*Catostomus catostomus*)

Habitat:

feeding - clear, cold rivers and lakes

spawning - in streams or lake shallows
- current
- gravel substrate

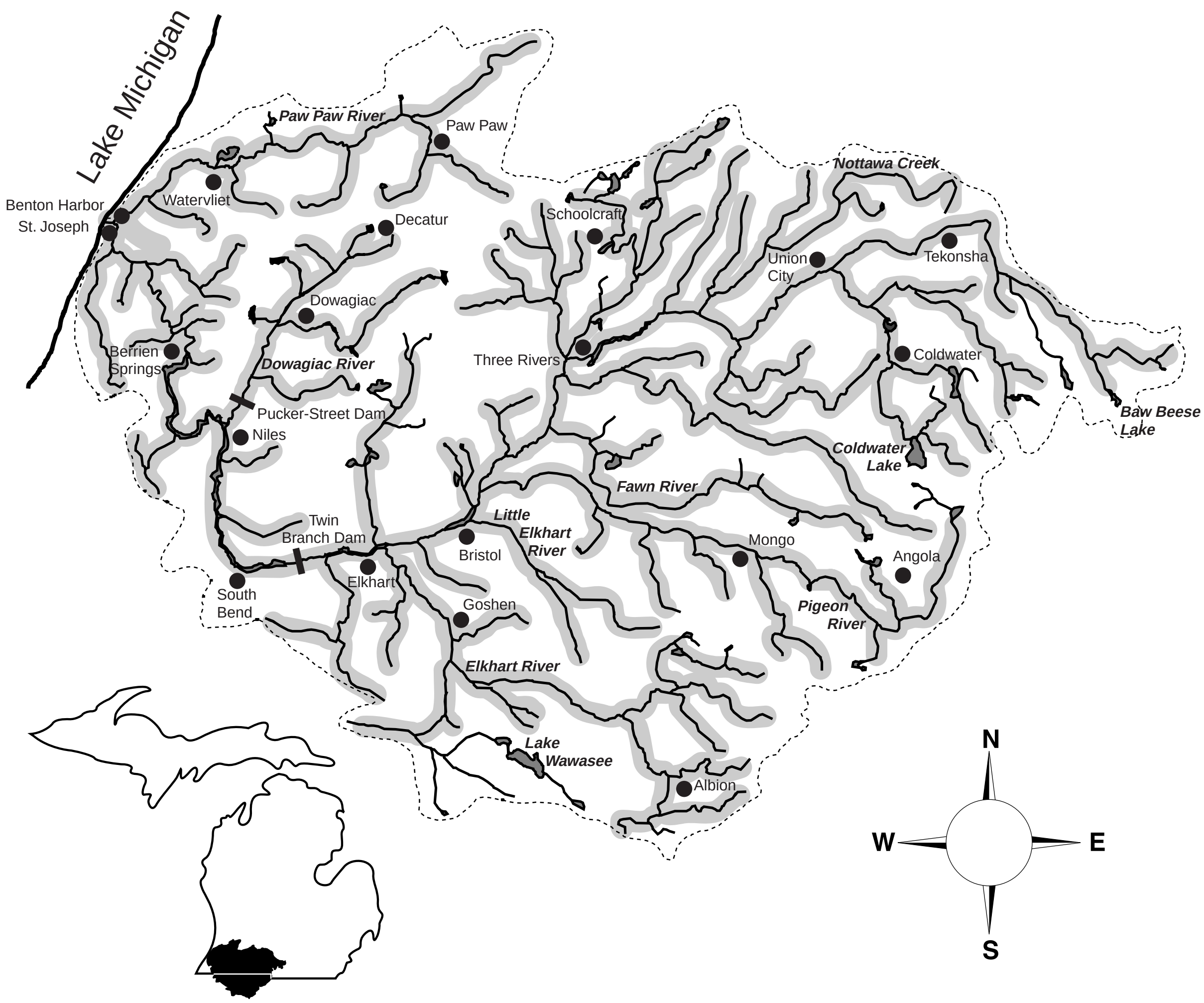


White sucker (*Catostomus commersoni*)

Habitat:

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

spawning - quiet gravelly shallow areas of streams



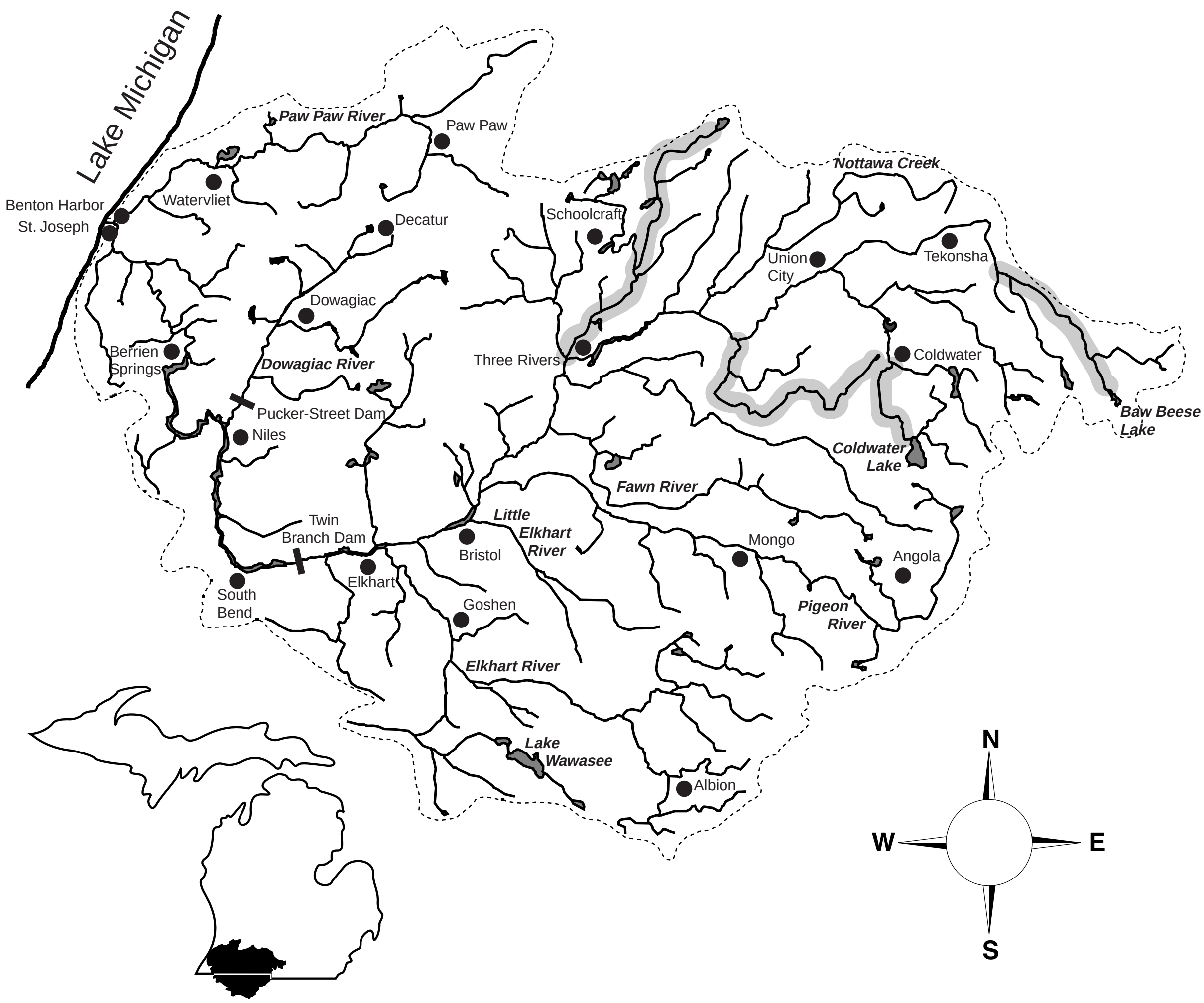
Creek chubsucker (*Erimyzon oblongus*)

Habitat:

feeding - clear quiet waters with thick submergent vegetation
- sand, gravel, or silt mixed with organic debris substrate
- in deeper more sluggish pools, protected inlets, and overflow ponds
- moderate and high gradient

spawning - gravelly shoals of streams, riffles, or lake outlets

winter refuge - larger creeks

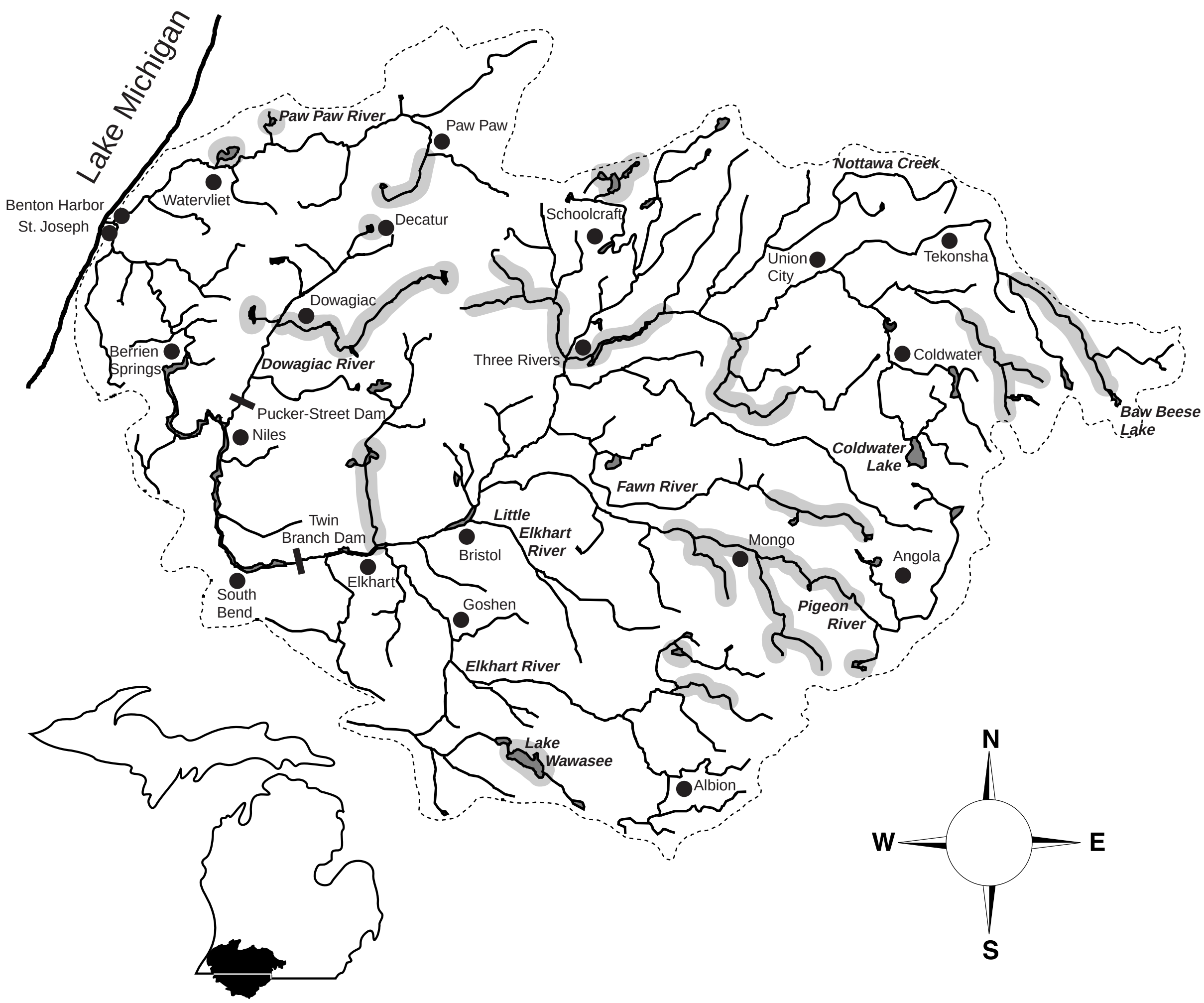


Lake chubsucker (*Erimyzon sucetta*)

Habitat:

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

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



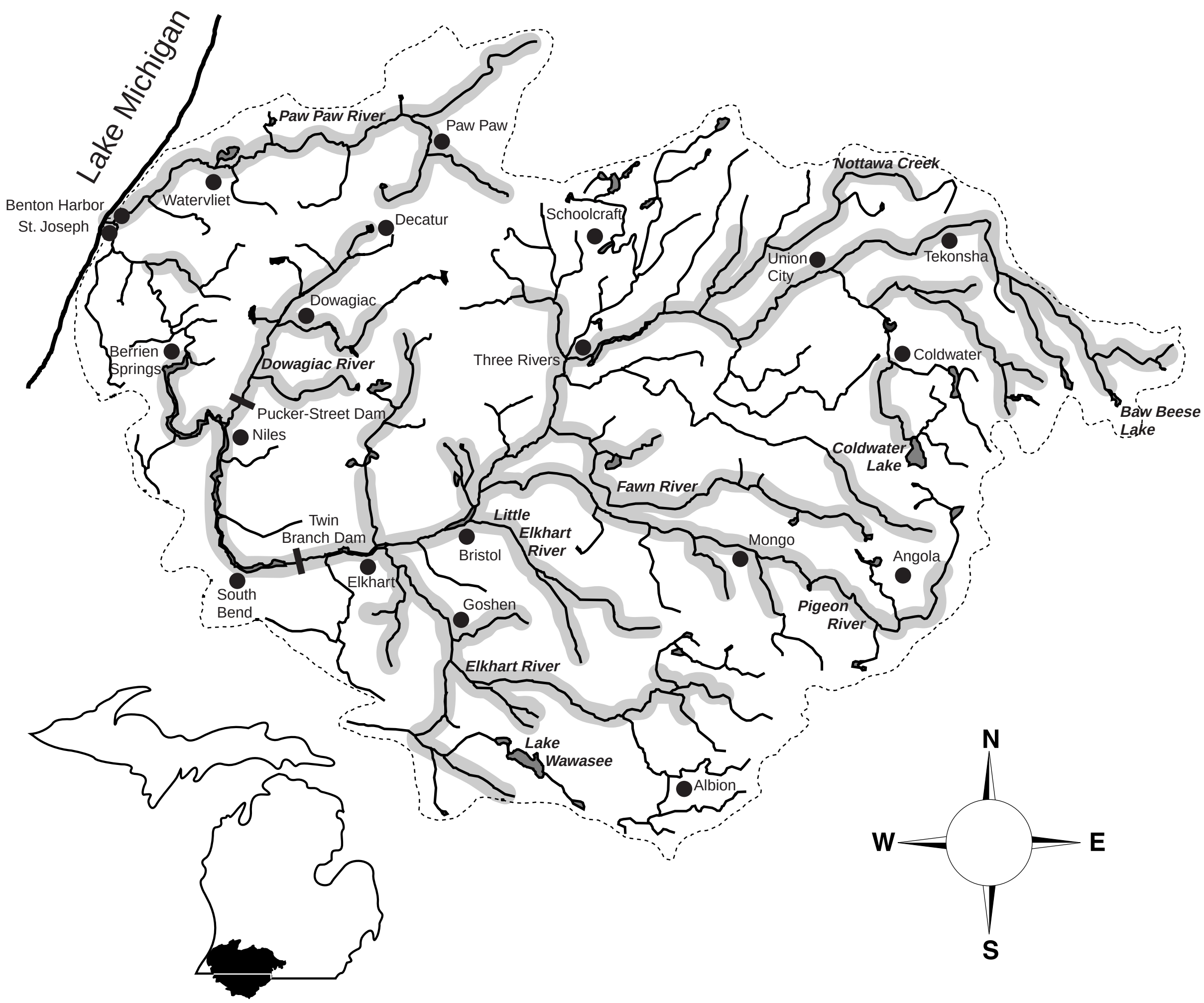
Northern hog sucker (*Hypentelium nigricans*)

Habitat:

feeding
- gravel or rubble substrate
- riffles and adjacent pools of warm shallow streams
- clear water
- doesn't like turbidity or siltation
- avoids profuse amounts of aquatic vegetation

spawning
- riffles
- shallow gravel substrate
- high gradient

winter refuge
- deeper quieter pools

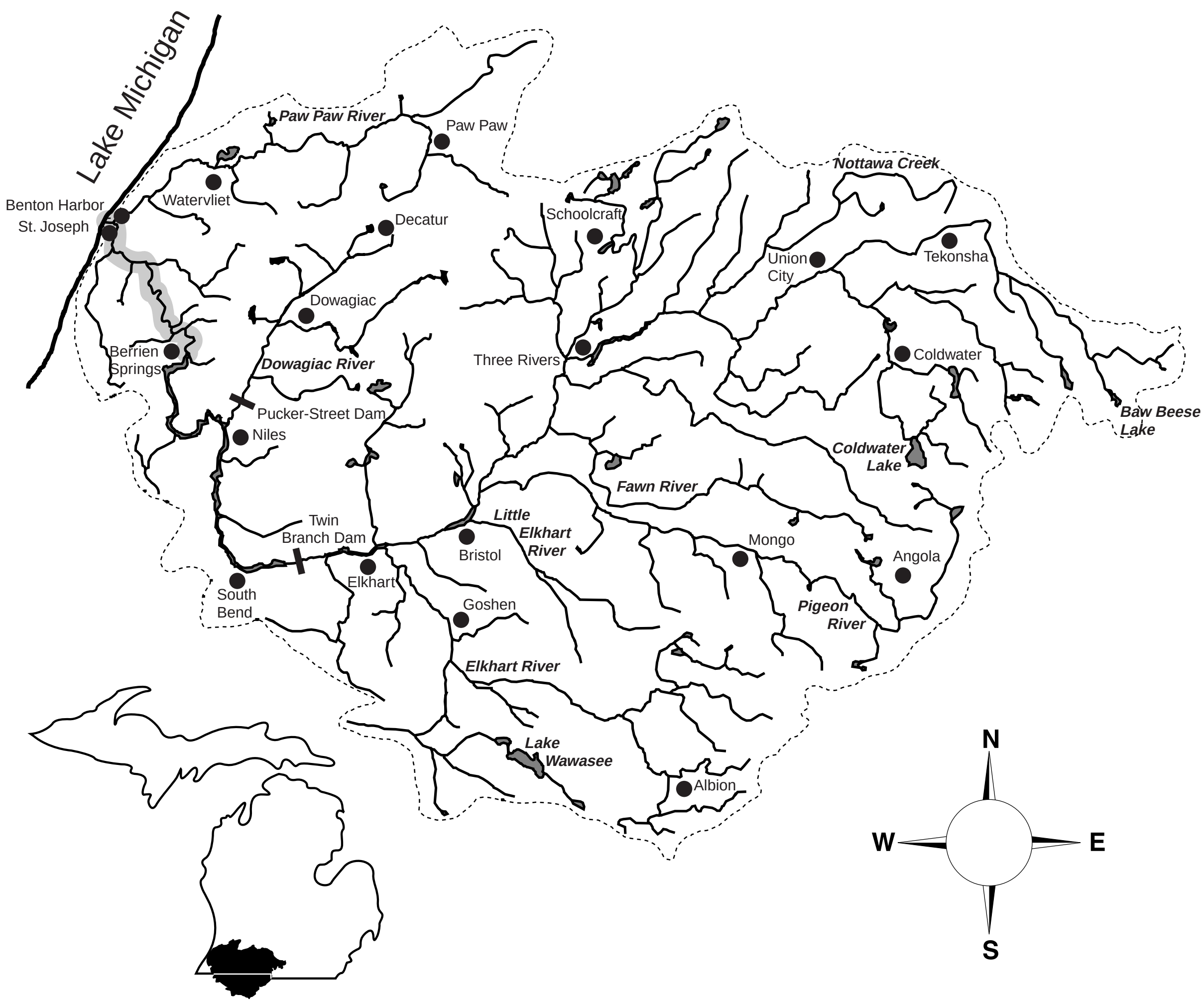


Black buffalo (*Ictiobus niger*)

Habitat:

feeding
- large rivers
- deep fast riffles
- occasionally shallow overflow ponds and sloughs
- varying turbidity over various substrates

spawning
- shallows
- sometimes flooded areas

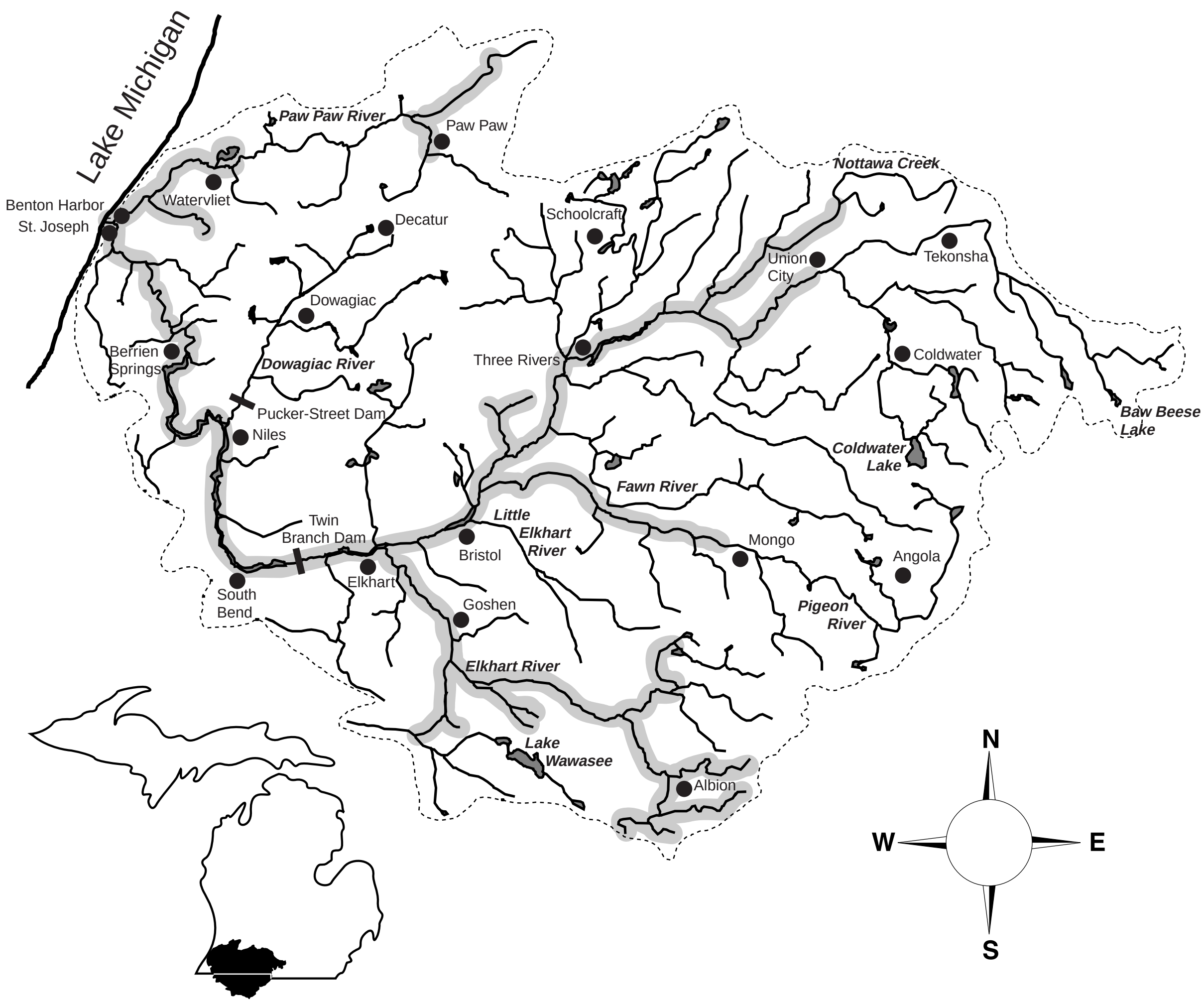


Spotted sucker (*Minytrema melanops*)

Habitat:

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

spawning
- riffles

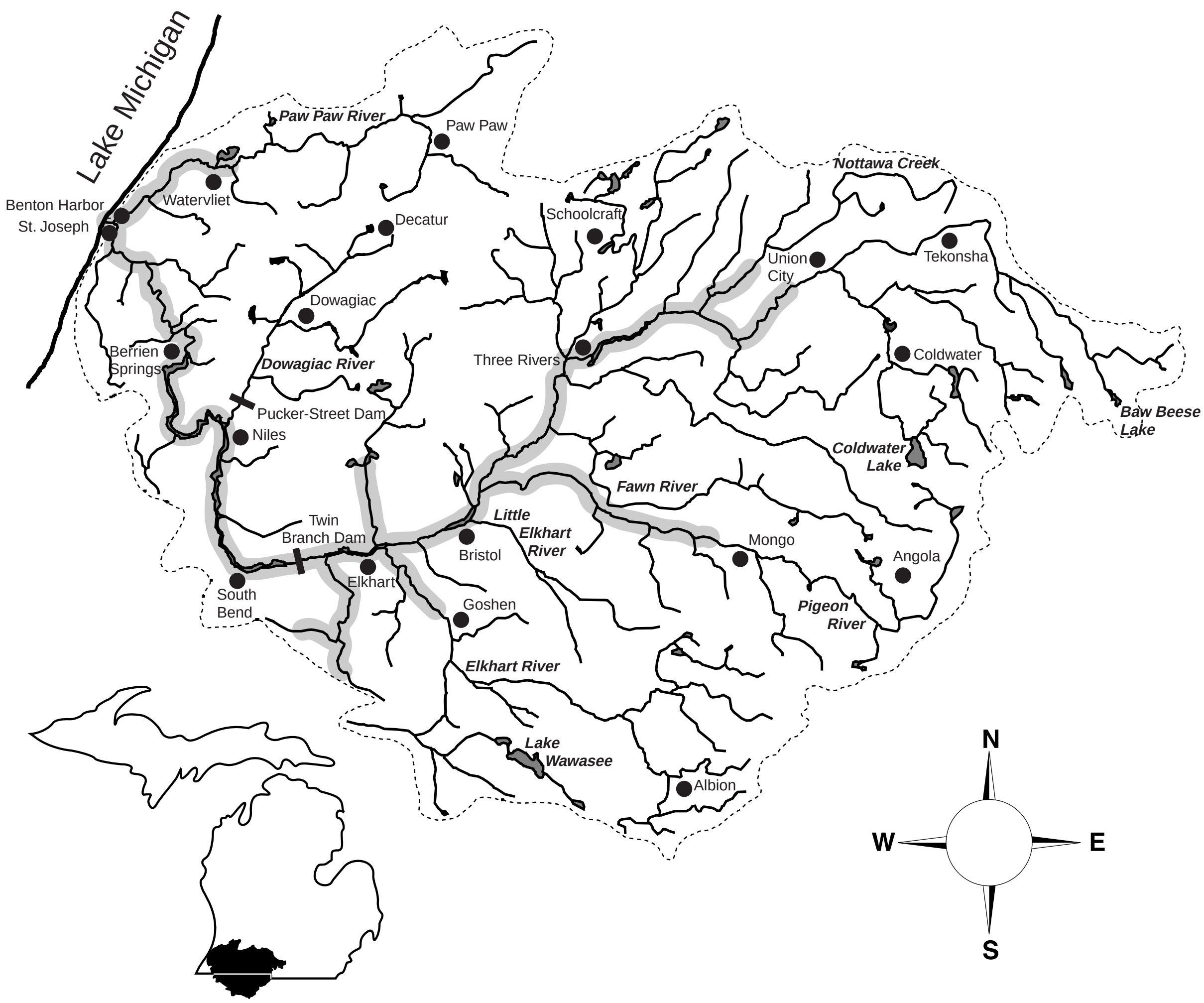


Silver redhorse (*Moxostoma anisurum*)

Habitat:

feeding
- streams, rivers, lakes, and impoundments
- low current
- pollution and turbidity intolerant

spawning
- swift current in rivers, do not spawn in tributaries
- males territorial
- gravel to rubble substrate

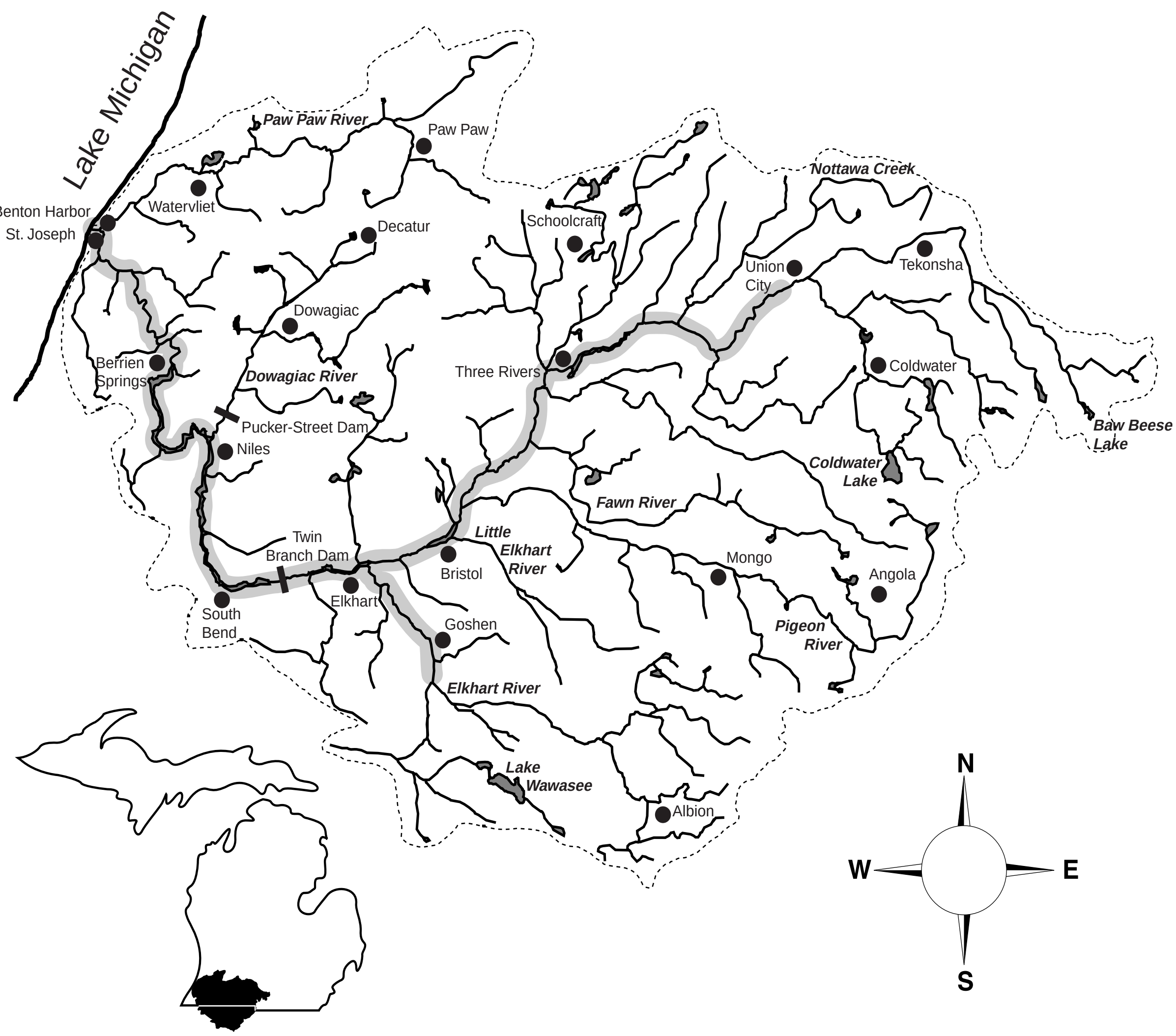


River redhorse (*Moxostoma carinatum*)

Habitat:

feeding
- hard silt-free substrate such as gravel and rubble
- moderate to fast current
- large rivers, lower portions of main tributaries, reservoirs, and pools

spawning
- moves into upper portions of main tributaries
- gravel or rubble substrate
- 2-4 ft. water



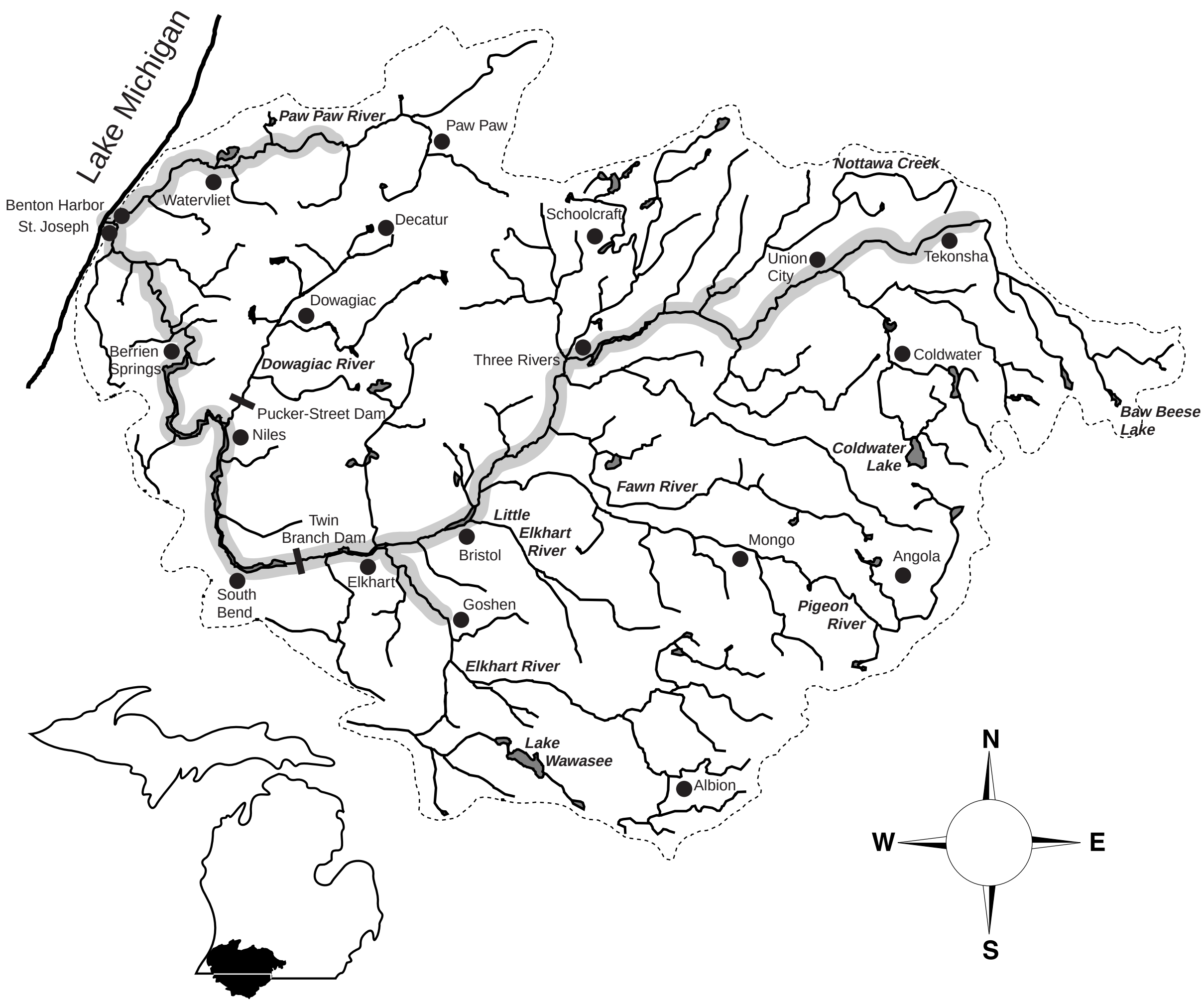
Black redhorse (*Moxostoma duquesnei*)

Habitat:

feeding
- gravel substrate
- clear water, intolerant of siltation, turbidity, and low gradients
- medium size streams
- cooler swifter streams and short rocky pools with current

spawning
- gravelly riffles

winter refuge
- deeper holes



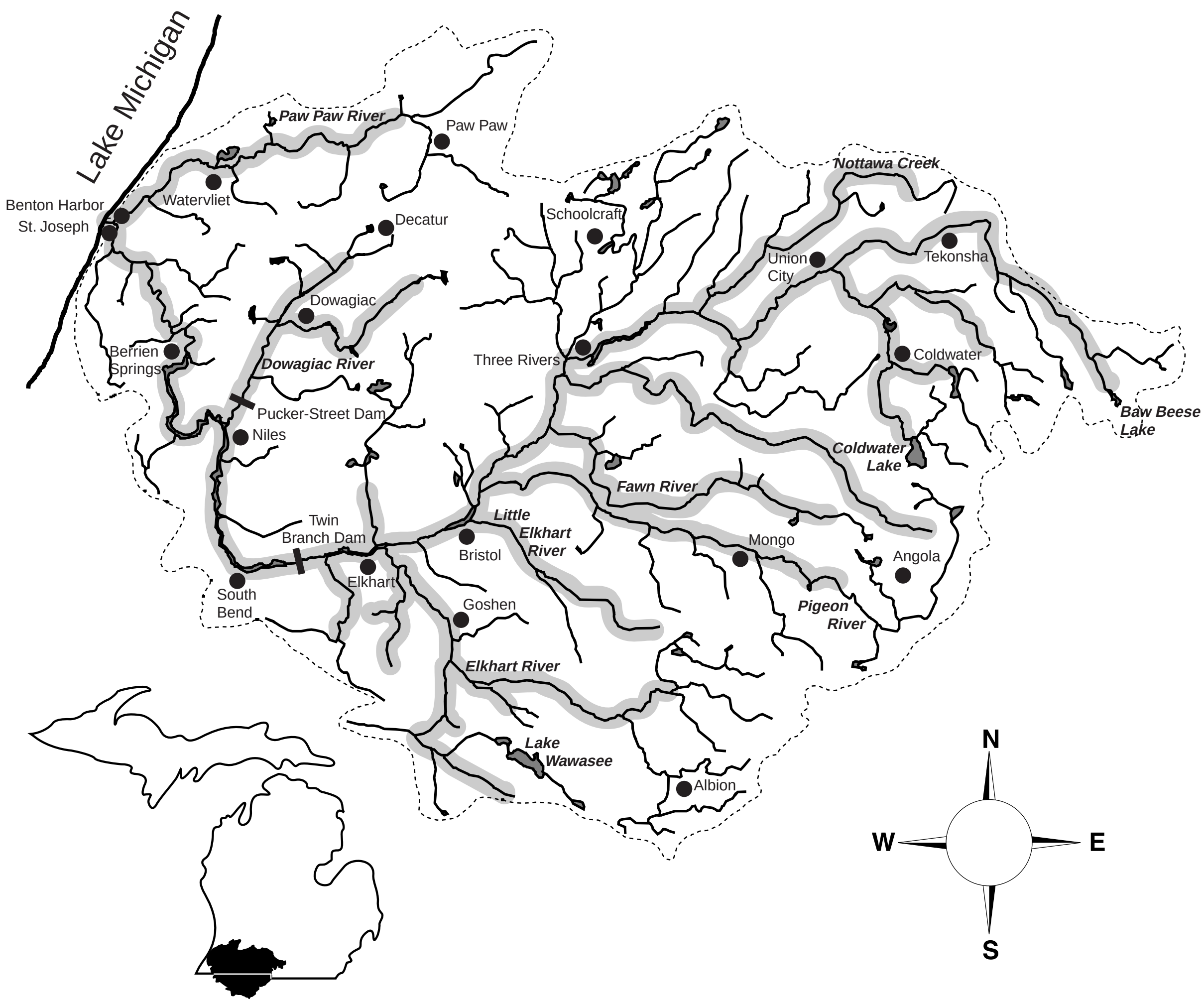
Golden redhorse (*Moxostoma erythrurum*)

Habitat:

feeding - warm medium gradient streams and rivers
- clear riffly streams
- medium size streams and rivers
- tolerates some turbidity and silt

spawning - shallow gravelly riffles

winter refuge - larger streams

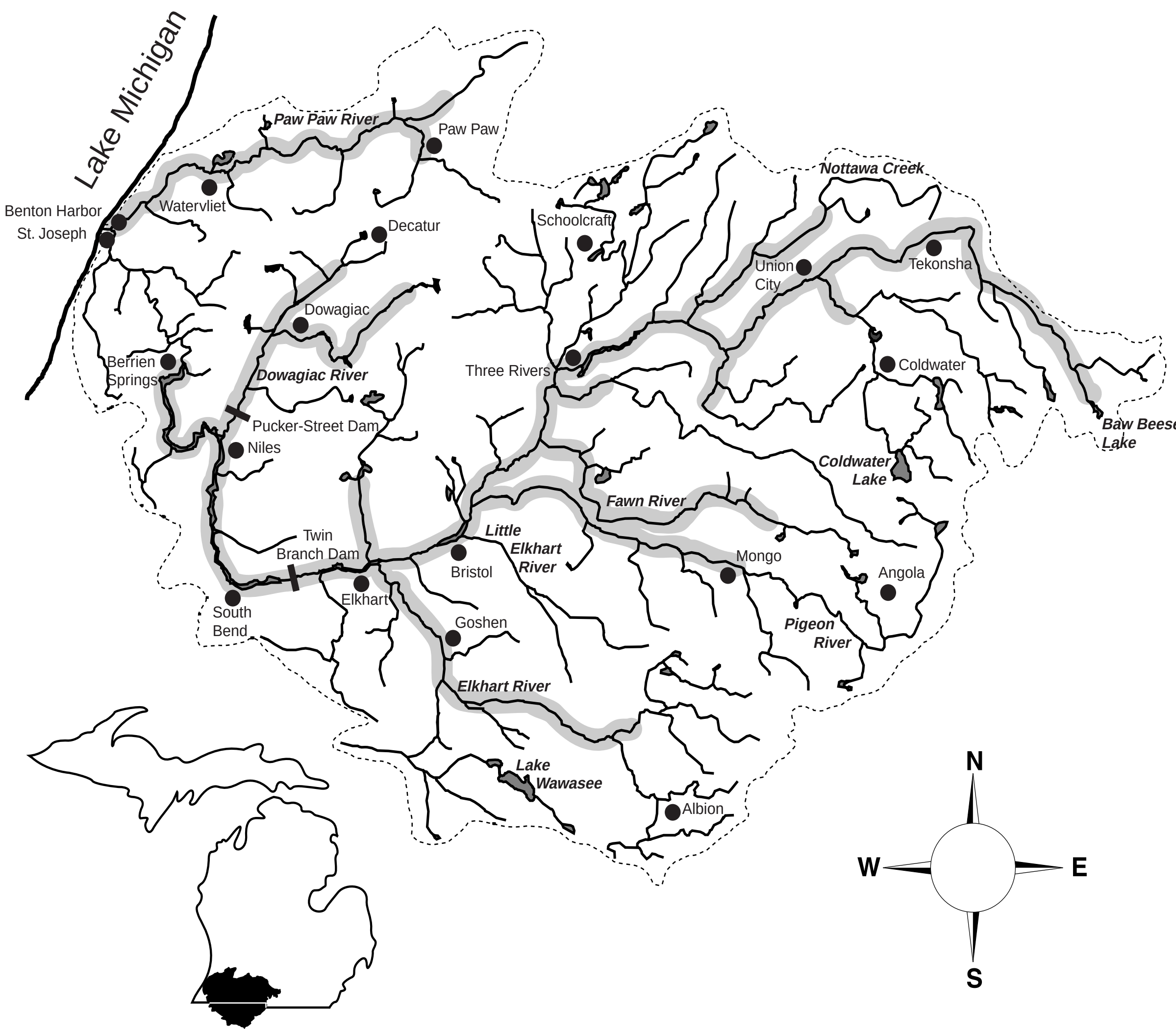


Shorthead redhorse (*Moxostoma macrolepidotum*)

Habitat:

feeding
- downstream sections of large rivers, lakes, and impoundments
- rocky substrates
- swift water near riffles
- clear to slightly turbid water

spawning
- gravelly riffles in smaller feeder streams

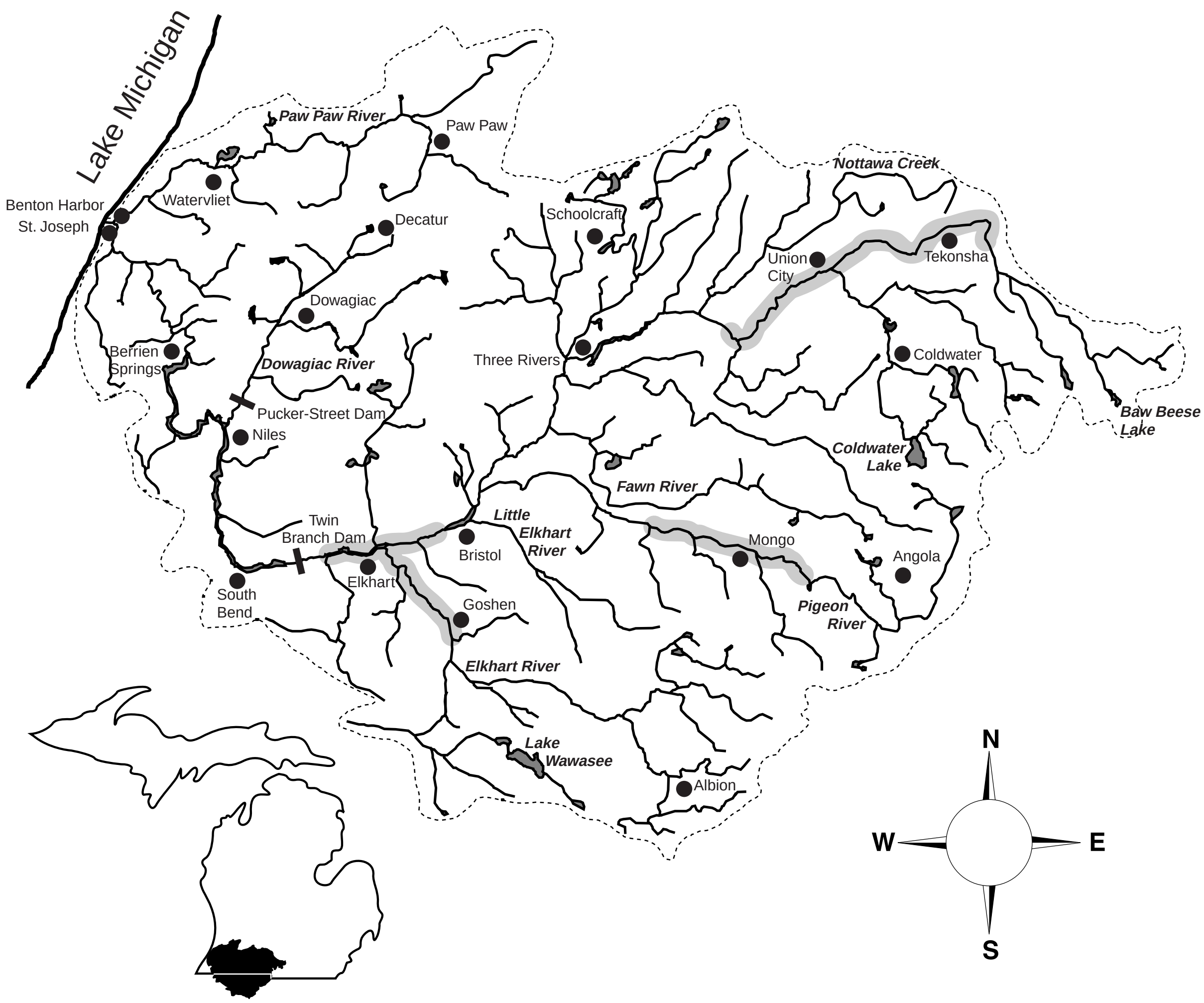


Greater redhorse (*Moxostoma valenciennesi*)

Habitat:

feeding - large clear streams
- clean sand, gravel, or boulder substrate
- intolerant of excessive turbidity and chemical pollutants

spawning - moderately rapid current

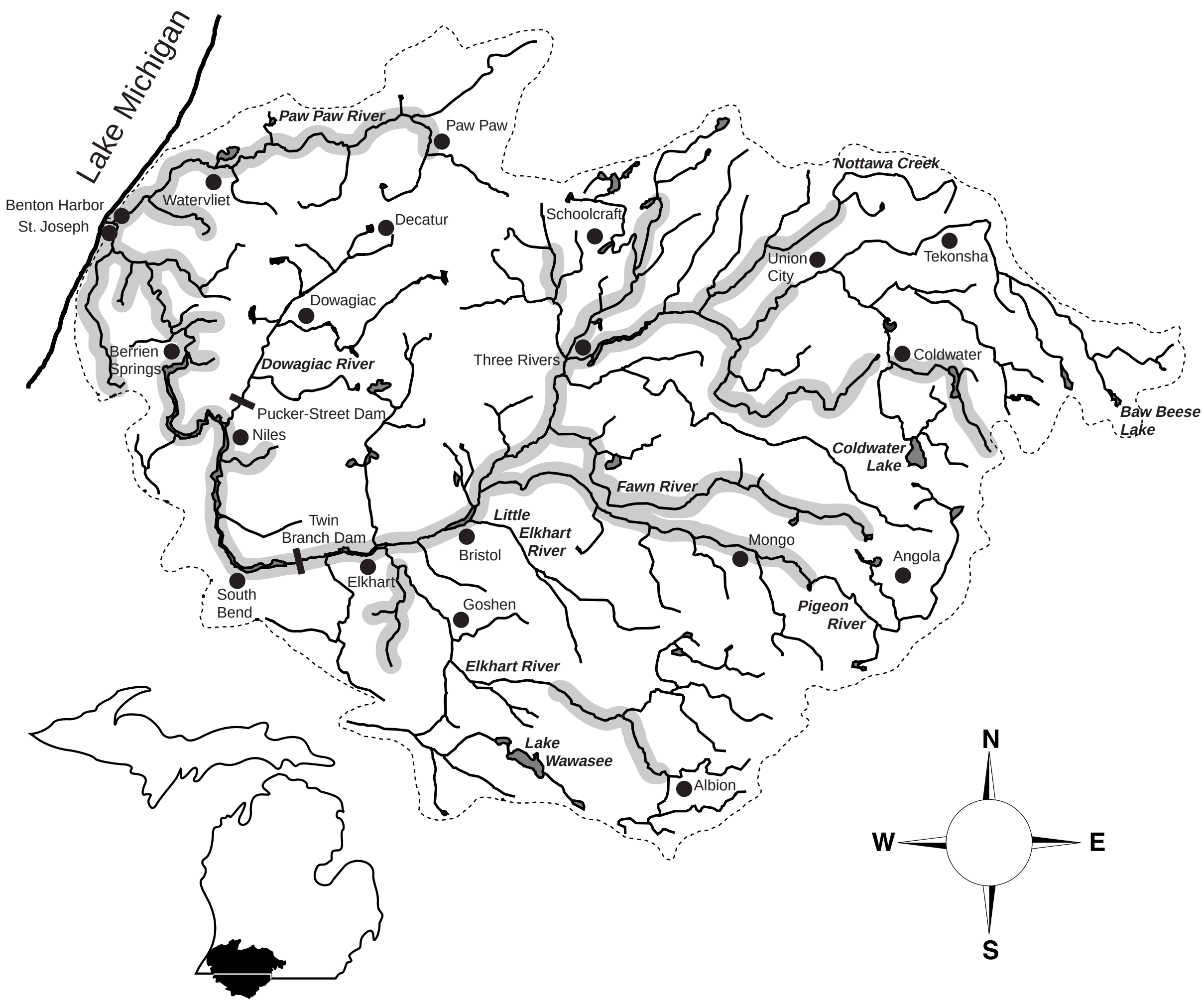


Black bullhead (*Ameiurus melas*)

Habitat:

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

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

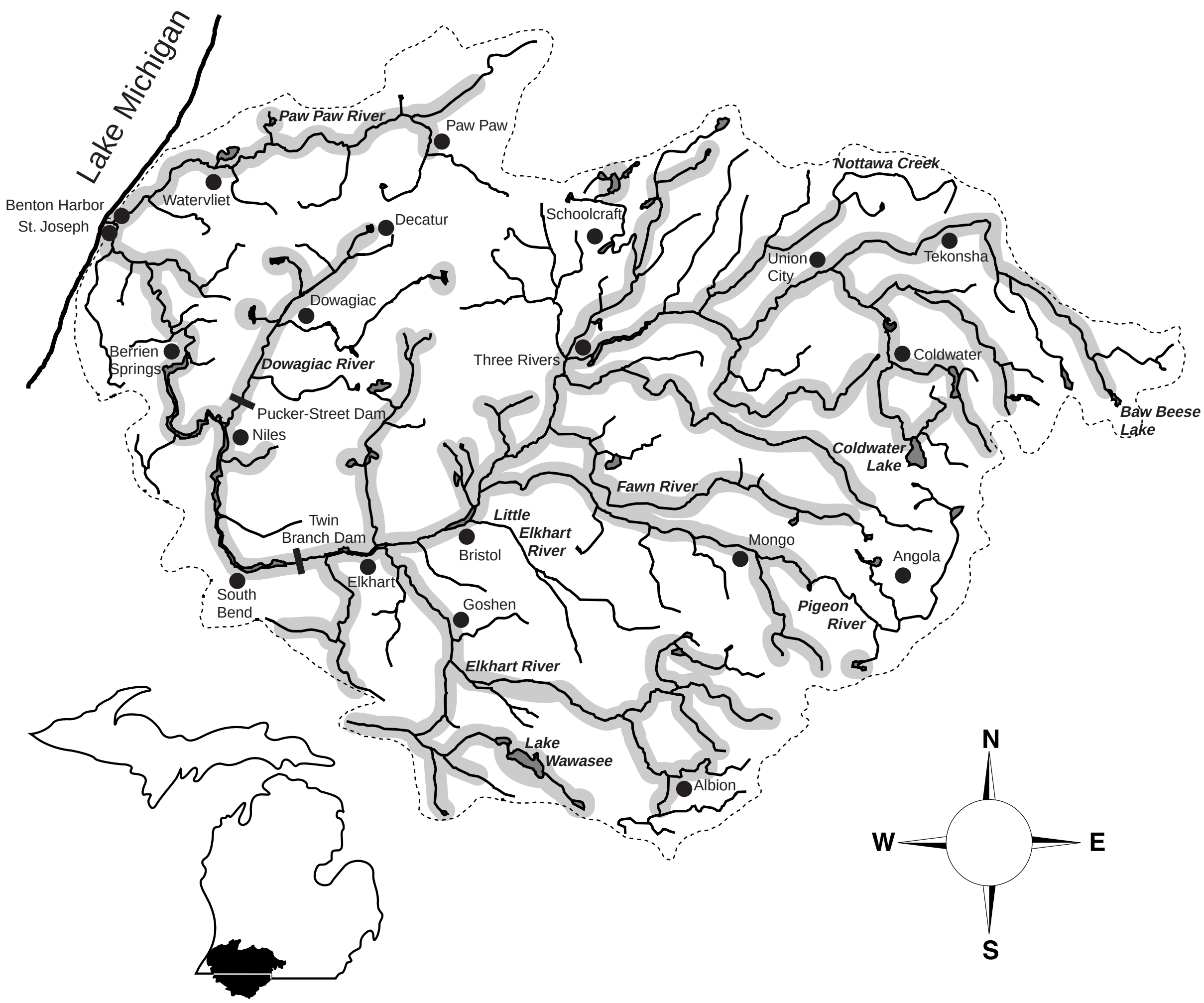


Yellow bullhead (*Ameiurus natalis*)

Habitat:

feeding - clear flowing water
- heavy vegetation
- low gradient streams, lakes, and impoundments
- tolerant of low oxygen

spawning - nest under a stream bank or near stones or stumps



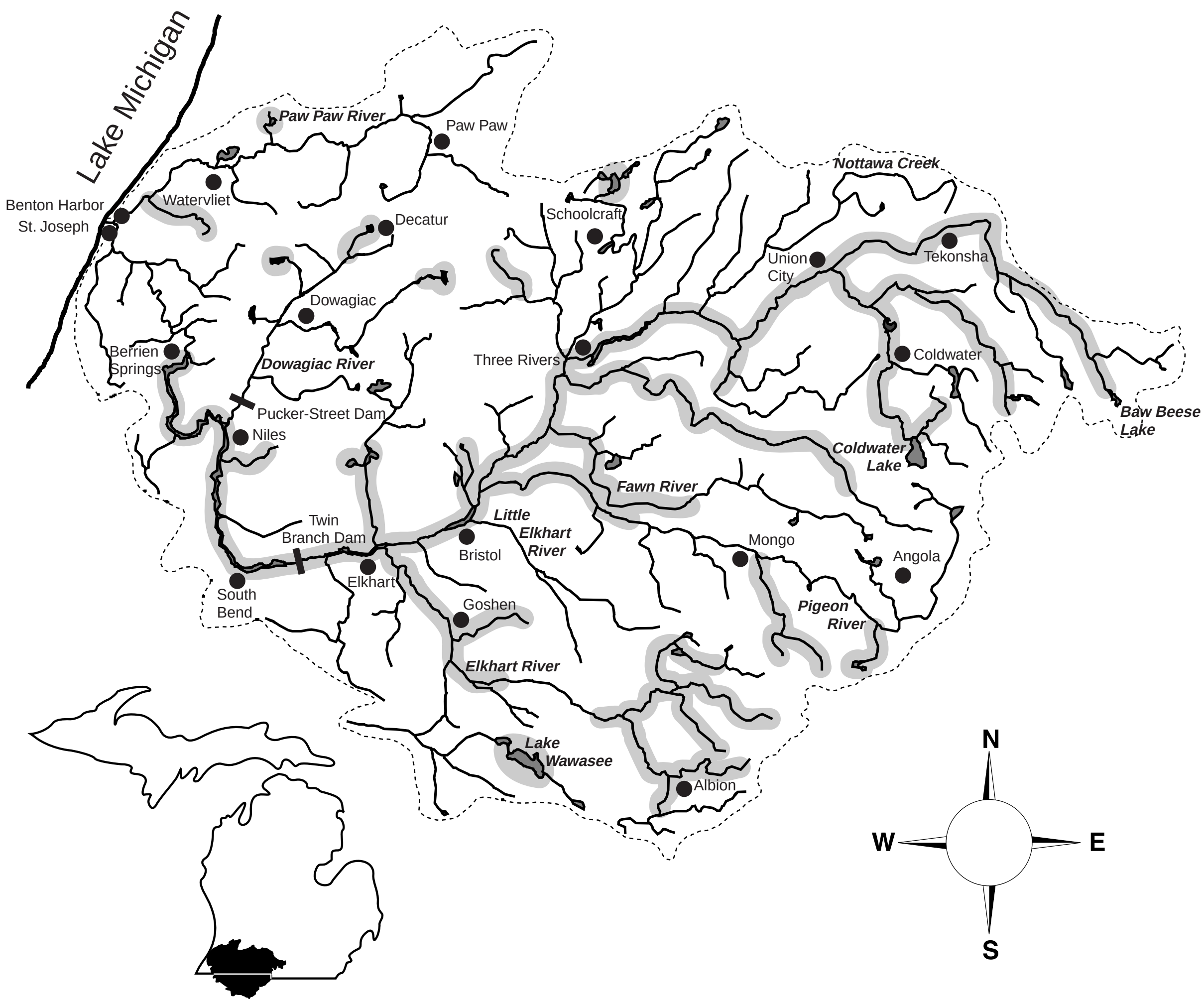
Brown bullhead (*Ameiurus nebulosus*)

Habitat:

feeding - larger streams and rivers, lakes and impoundments
- clear cool water with little clayey silt
- moderate amounts of aquatic vegetation
- sand, gravel, or muck substrate
- not tolerant of turbid water
- tolerant of warm water and low oxygen

spawning - nest in mud or sand substrate among rooted aquatic vegetation usually near a stump, tree, or rock

winter refuge - in muddy bottoms

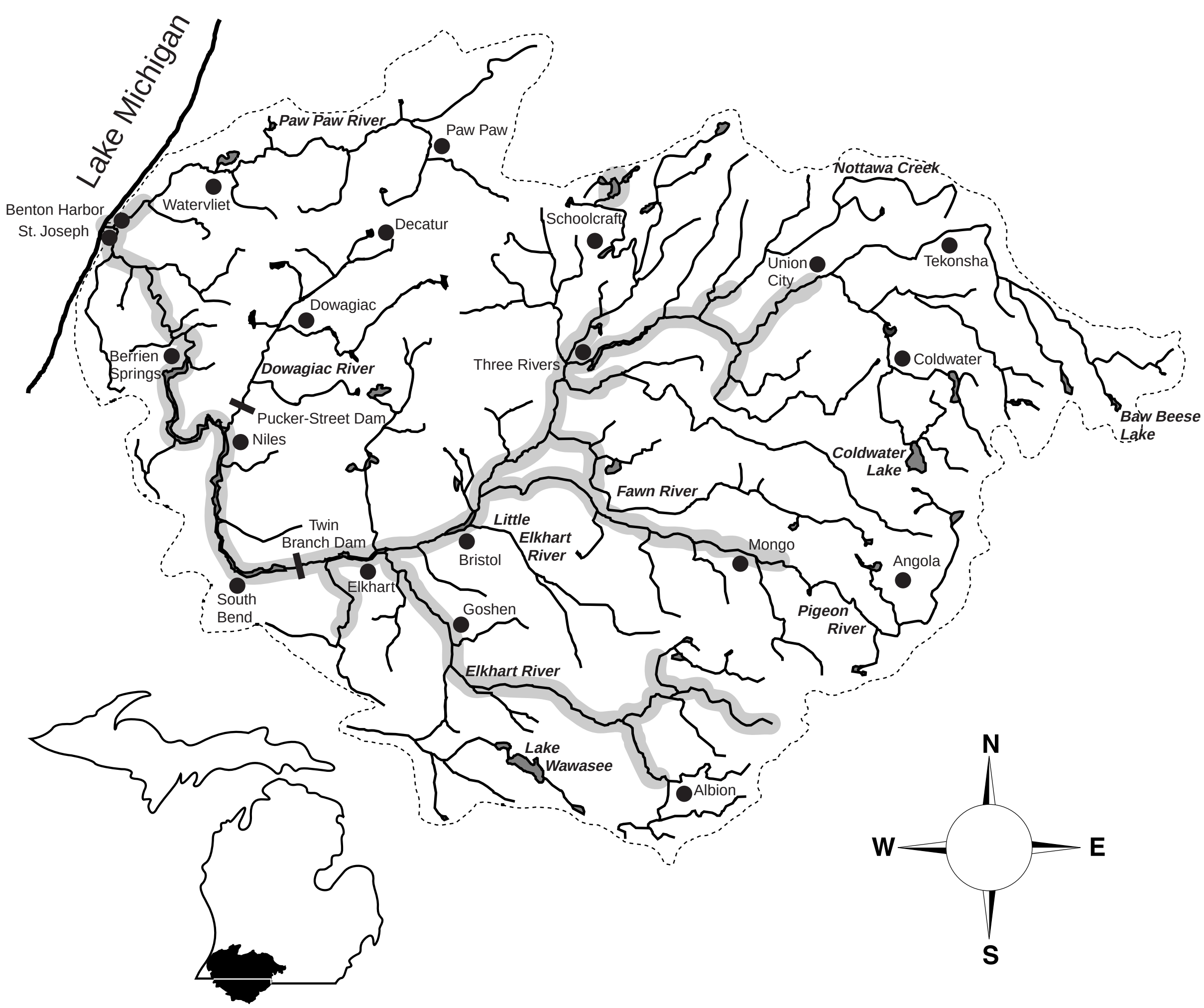


Channel catfish (*Ictalurus punctatus*)

Habitat:

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

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

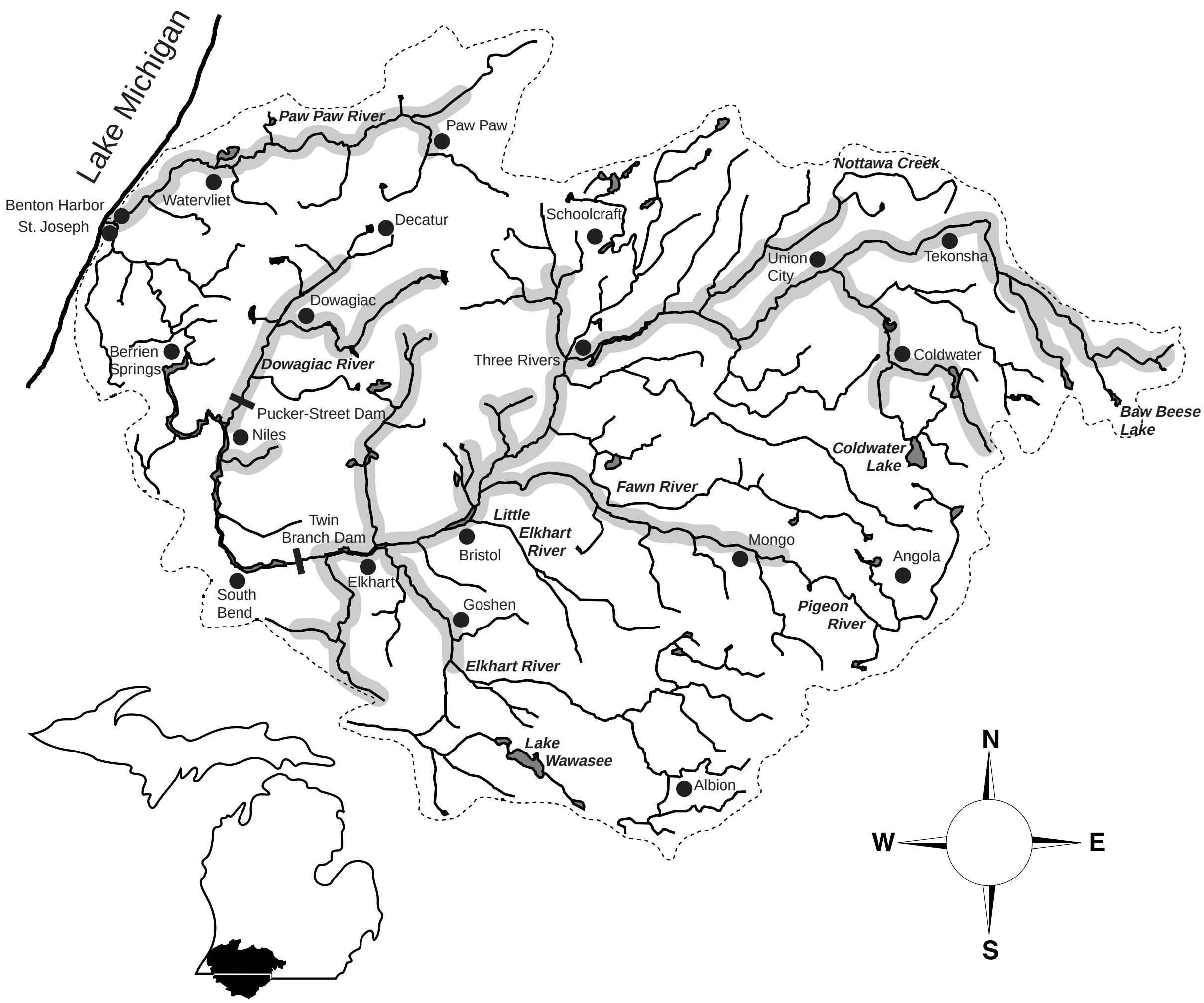


Stonecat (*Noturus flavus*)

Habitat:

feeding - consistent low to moderate gradient flowing water
- rocky riffles of larger streams and smaller rivers
- not tolerant of silt
- tolerant of low oxygen and pollution

spawning - eggs deposited beneath stones
- shallow rocky areas of streams or lakes

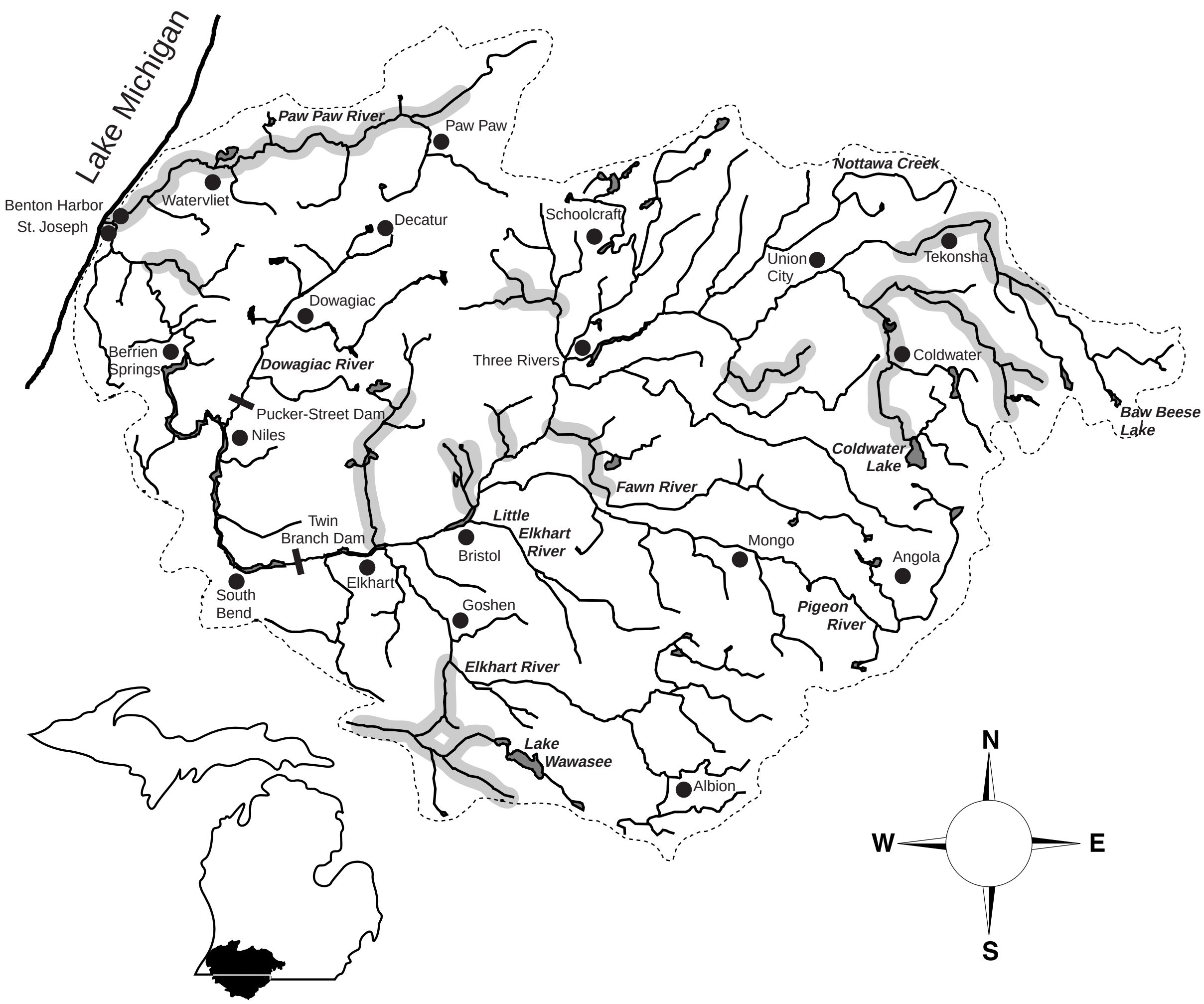


Tadpole madtom (*Noturus gyrinus*)

Habitat:

feeding - vegetative cover in low-moderate current waters
- muddy substrate with extensive vegetation
- clear waters of streams, rivers, and lakes

spawning - mostly in rivers, sometimes shallows of lakes
- nests in dark cavities (ex: beneath boards, logs, crayfish burrows)

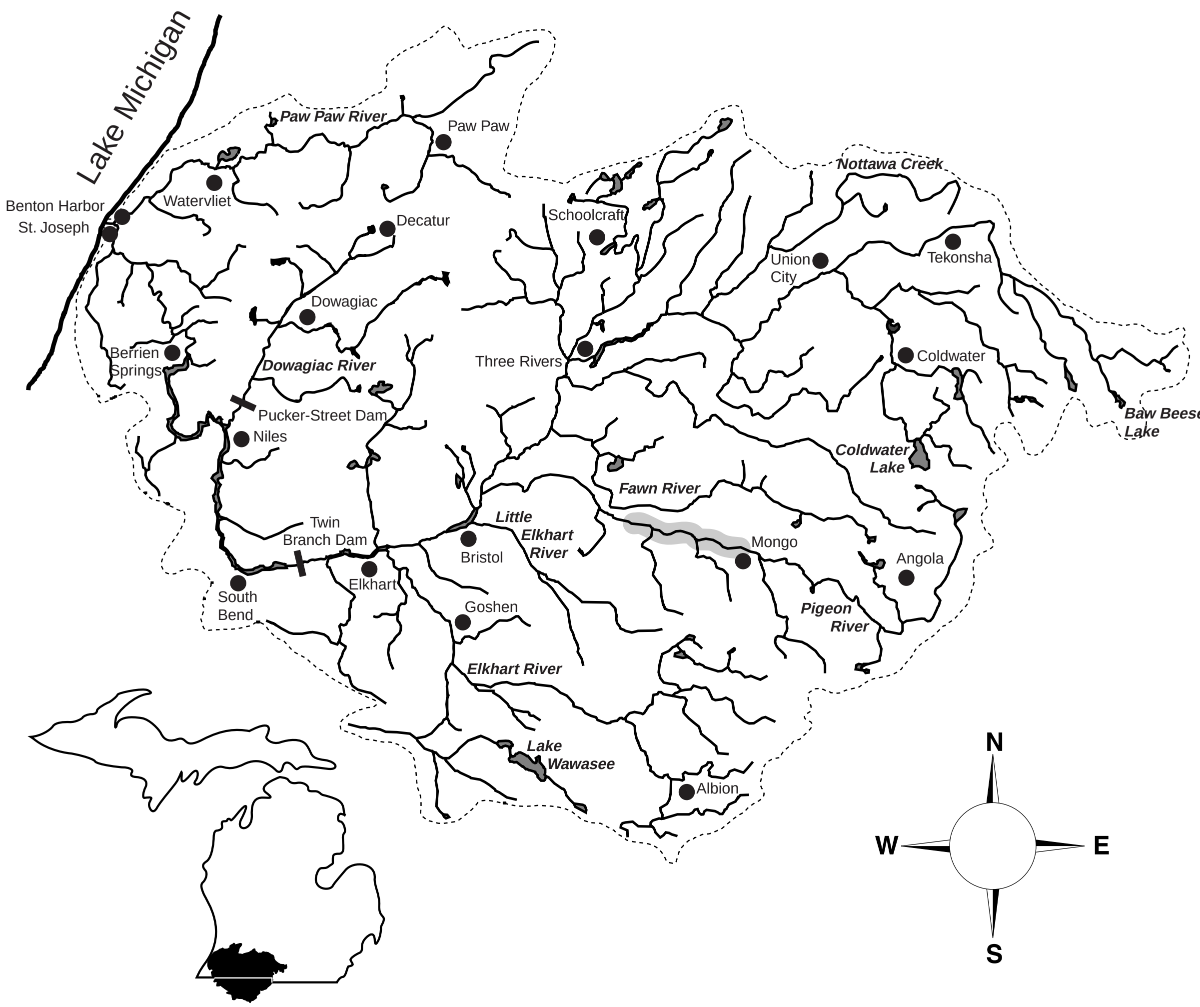


Brindled madtom (*Noturus miurus*) - special concern

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

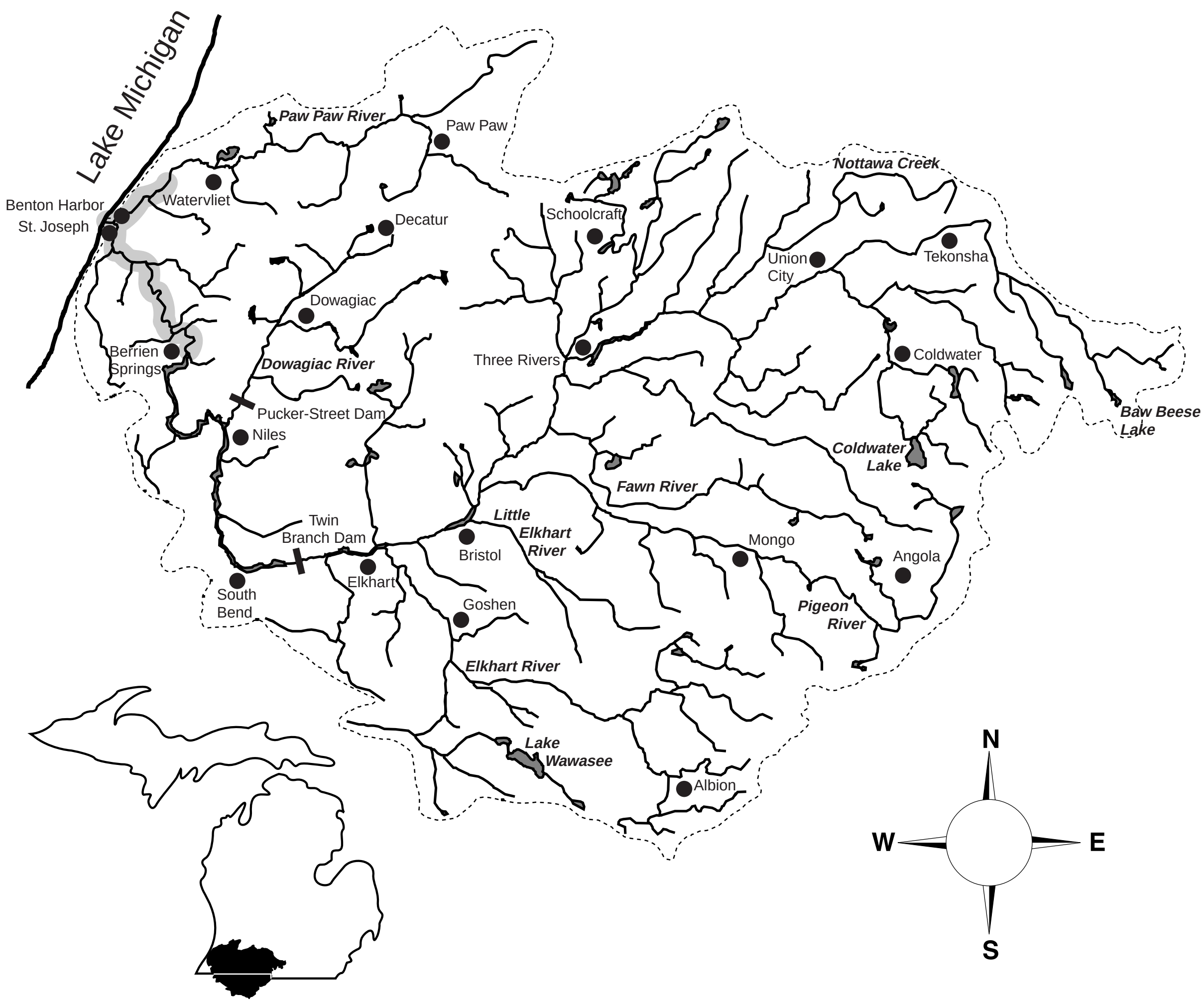
spawning - silt or mud substrate
- emergent vegetation



Flathead catfish (*Pylodictis olivaris*)

Habitat:

feeding	-	(young) shallow riffles in fast current
	-	deep pools with a lot of woody cover
	-	deep riffles
	-	low gradient and current
	-	prefer silt-free substrate
	-	sometimes feed on shallow riffles
spawning	-	secluded shelters or dark places
	-	gravel or silt-free substrate
winter refuge	-	muddy holes in deep water

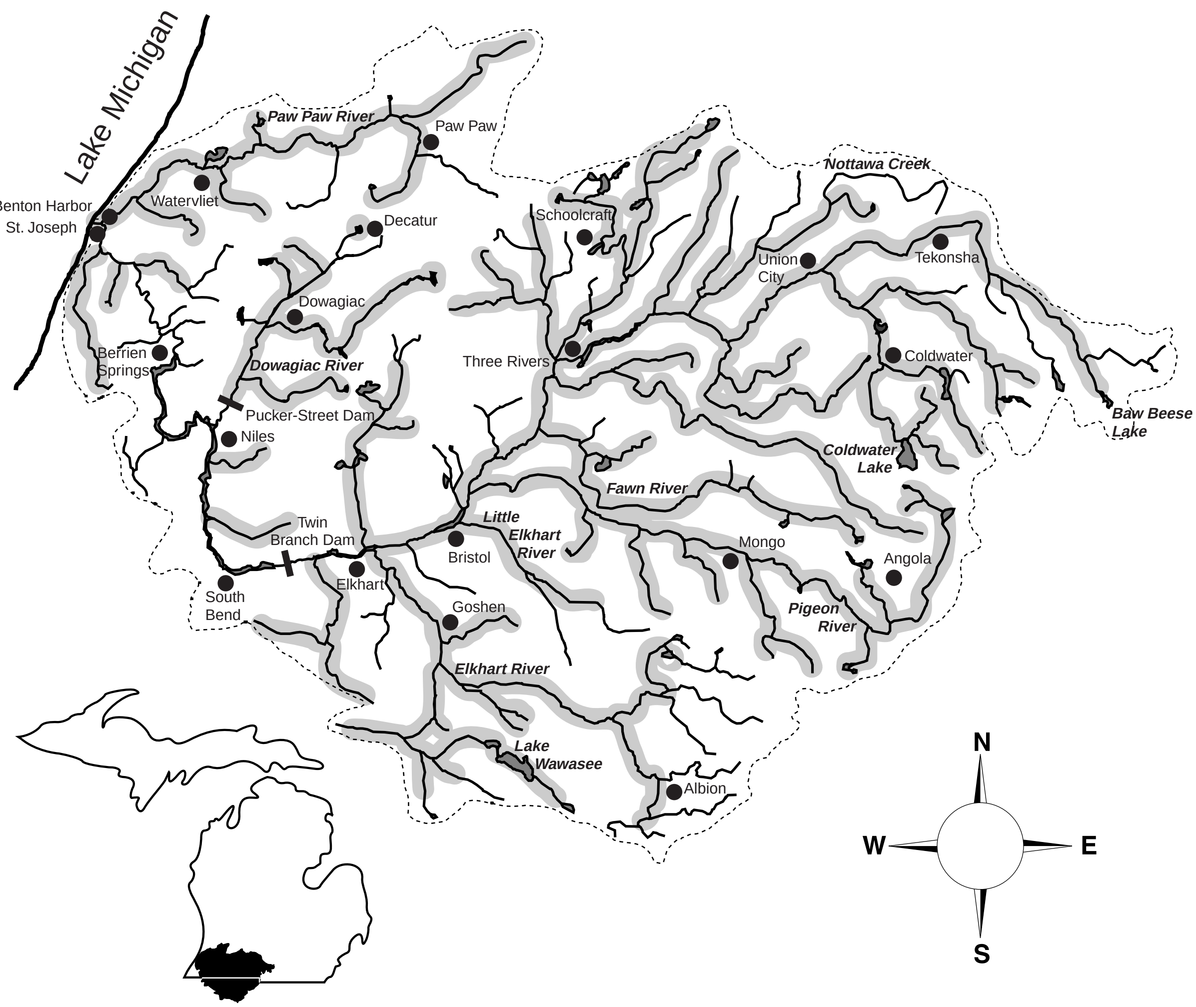


Grass pickerel (*Esox americanus vermiculatus*)

Habitat:

feeding
- juveniles: along shore
- adults: in deeper portions of streams, rivers, lakes, and impoundments
- clear water, little current, dense vegetation
- tolerates low oxygen concentrations

spawning
- broadcast spawner over submerged vegetation

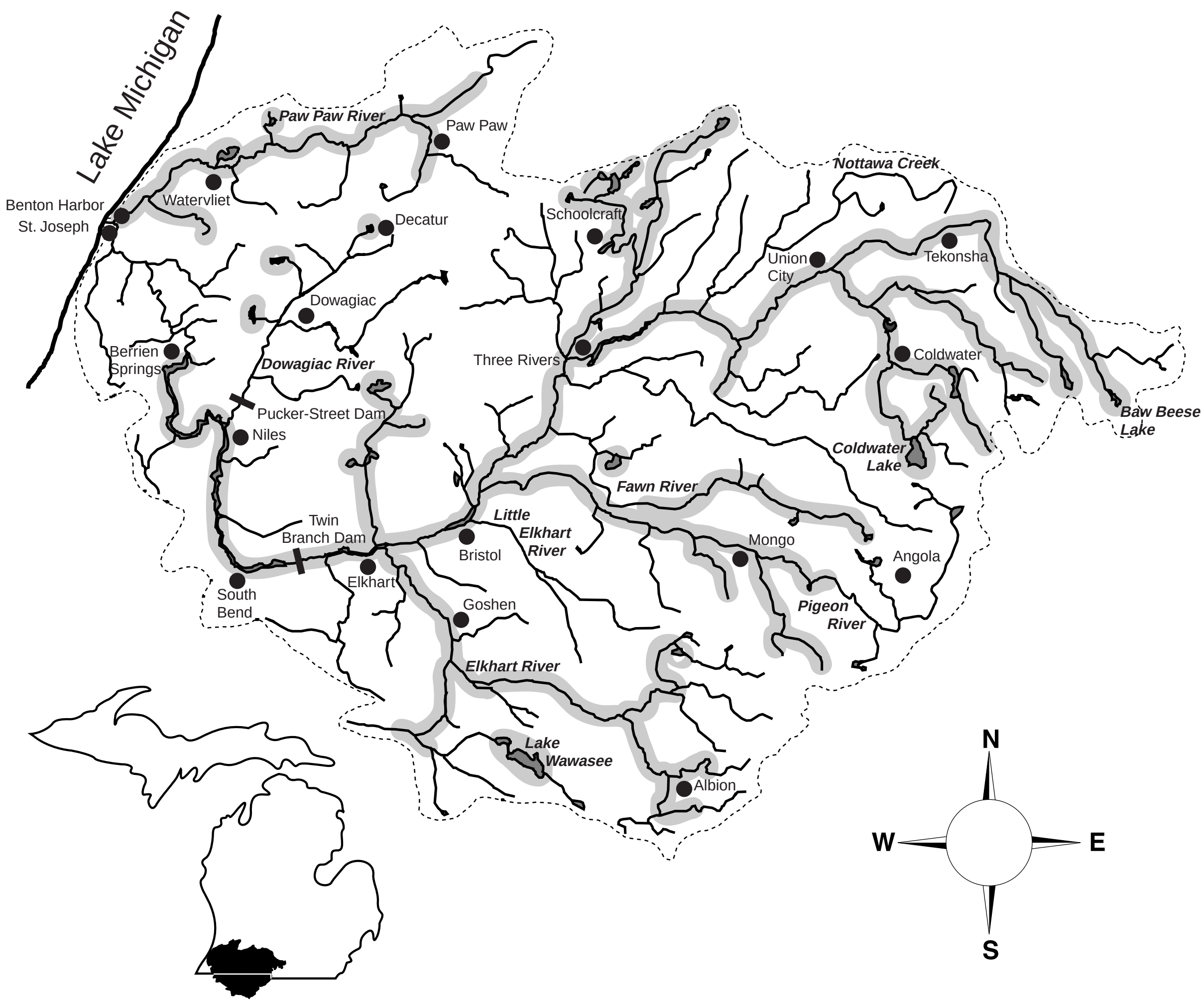


Northern pike (*Esox lucius*)

Habitat:

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

spawning - submerged vegetation with slow current in shallow water

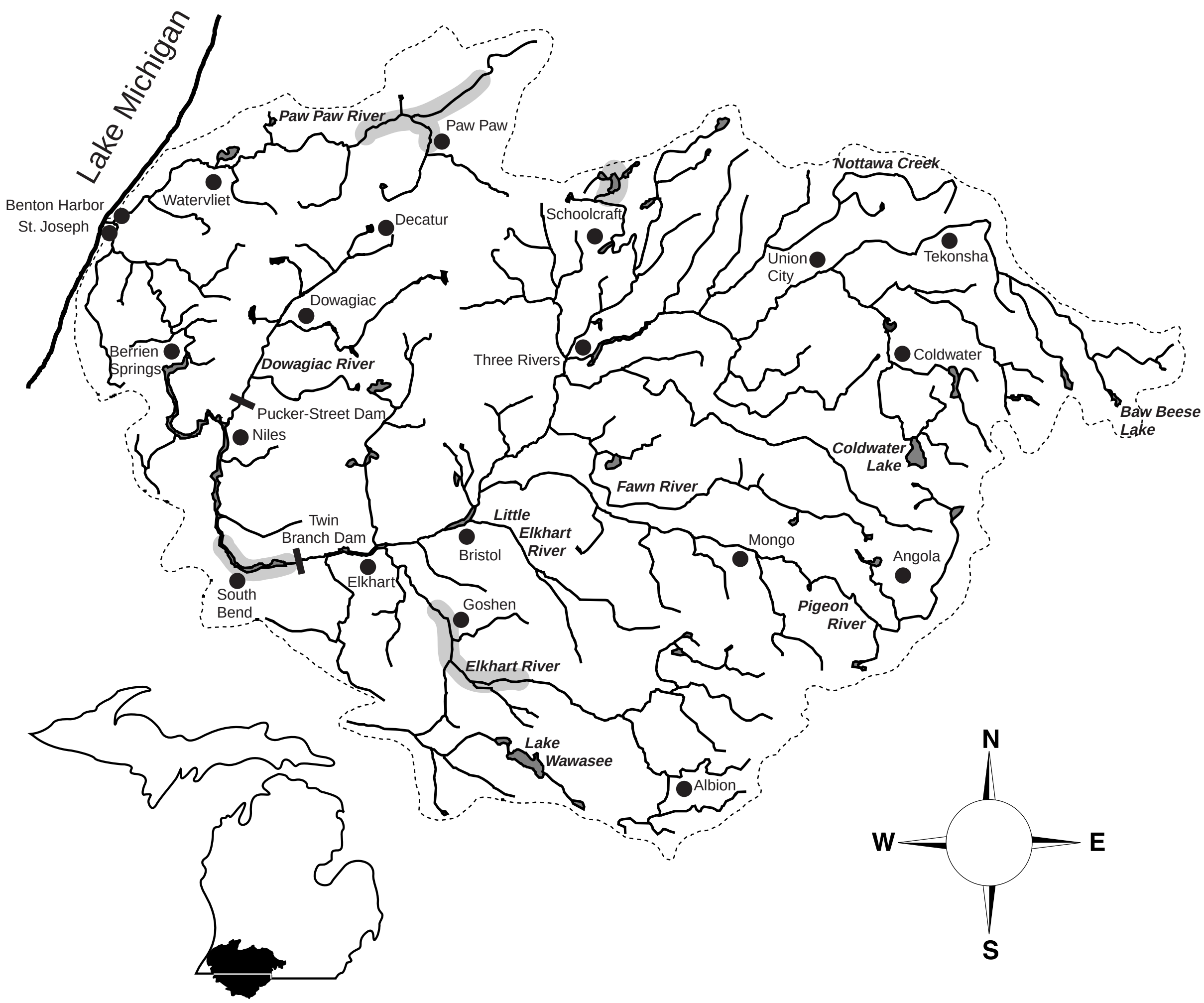


Tiger muskellunge (*Esox masquinongy* x *E. lucius*)

Habitat:

feeding - intermediate between muskellunge and northern pike

spawning - hybrid species; muskellunge x northern pike
- occasionally produced in wild, but most often from hatcheries
- males are sterile, females may be fertile

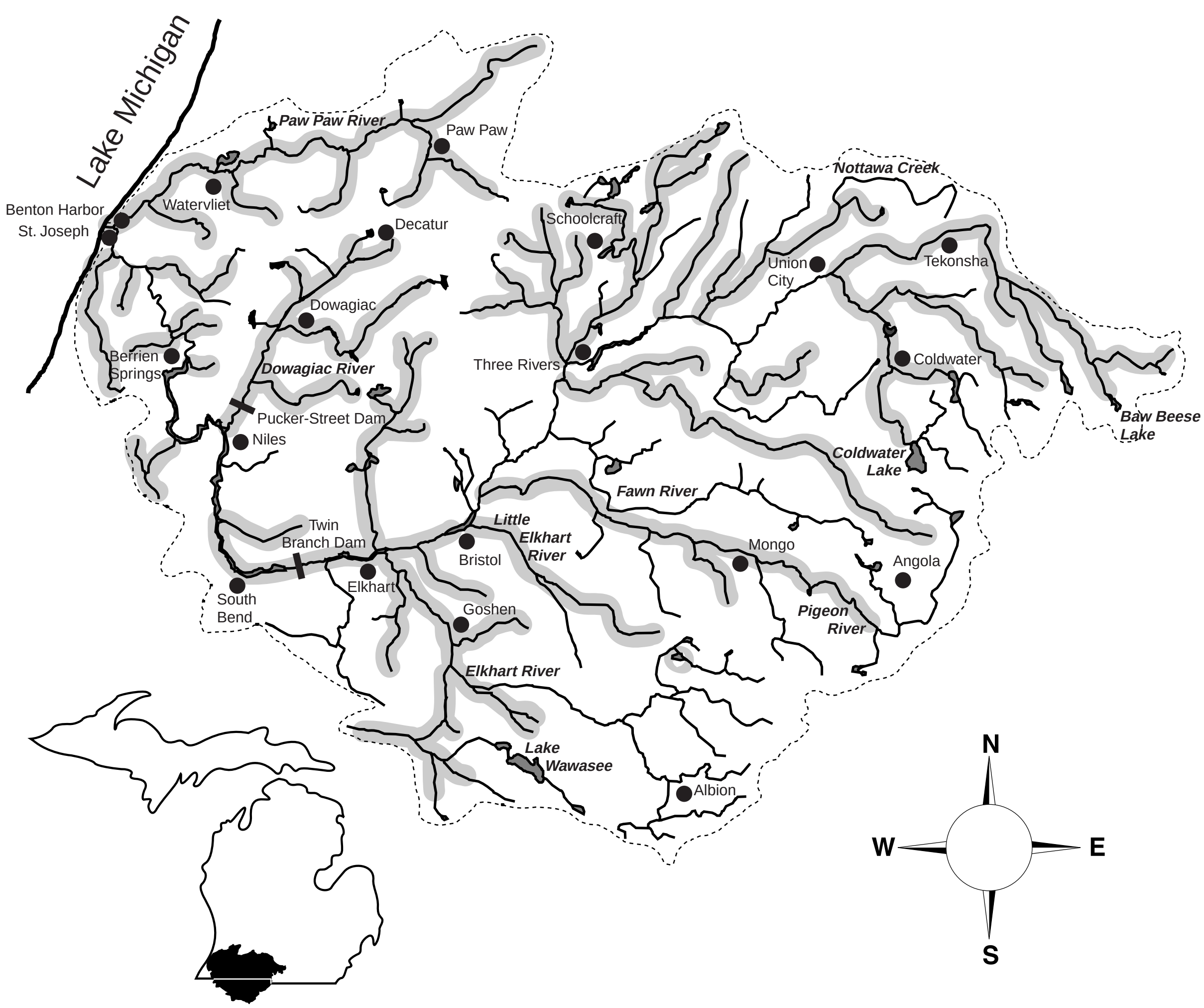


Central mudminnow (*Umbra limi*)

Habitat:

feeding - undisturbed clear, low-gradient streams or rivers and lakes and impoundments
- organic debris, muck, or peat substrates
- aquatic vegetation

spawning - floodplain areas, on vegetation

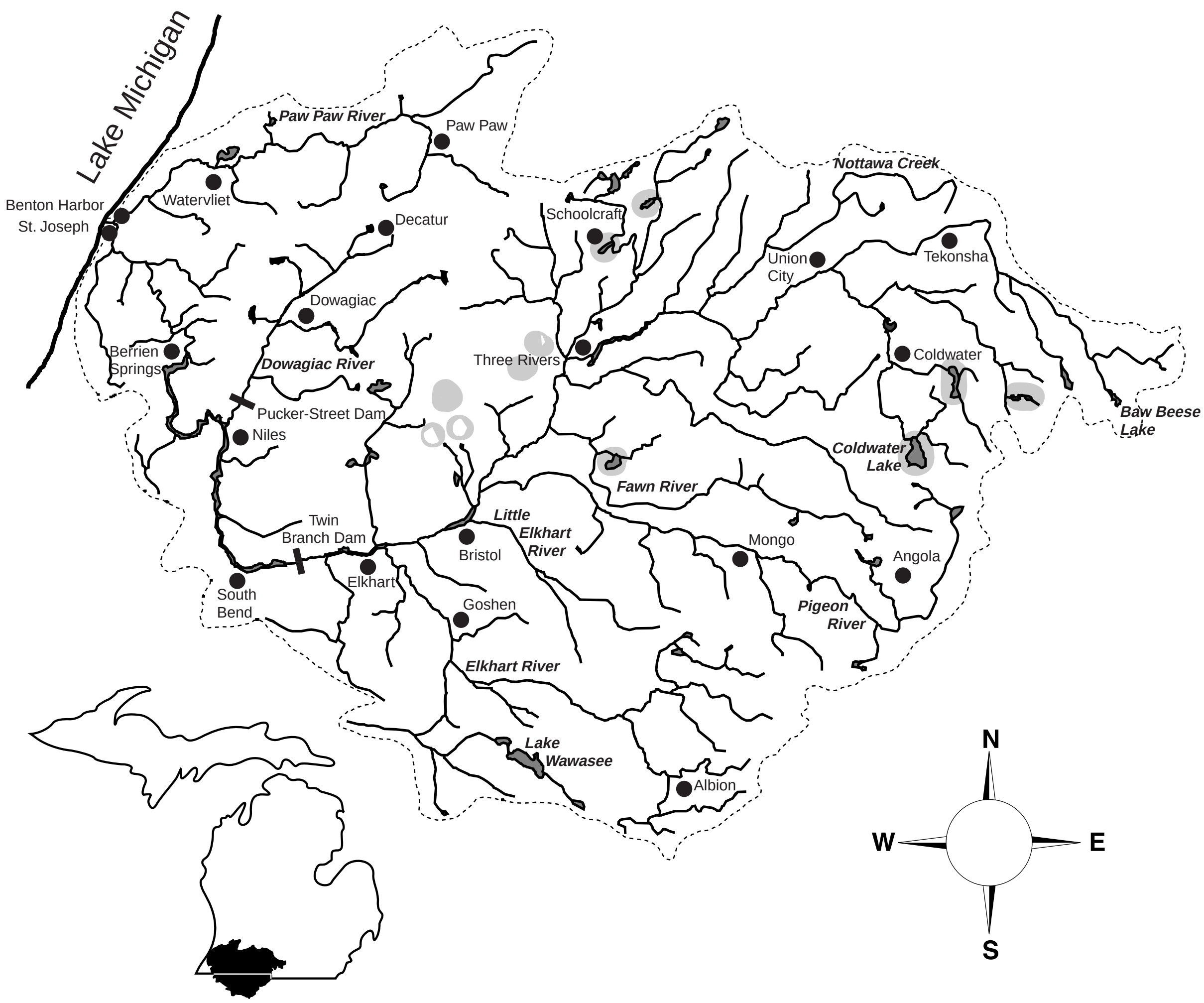


Cisco {Lake herring} (*Coregonus artedi*)

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

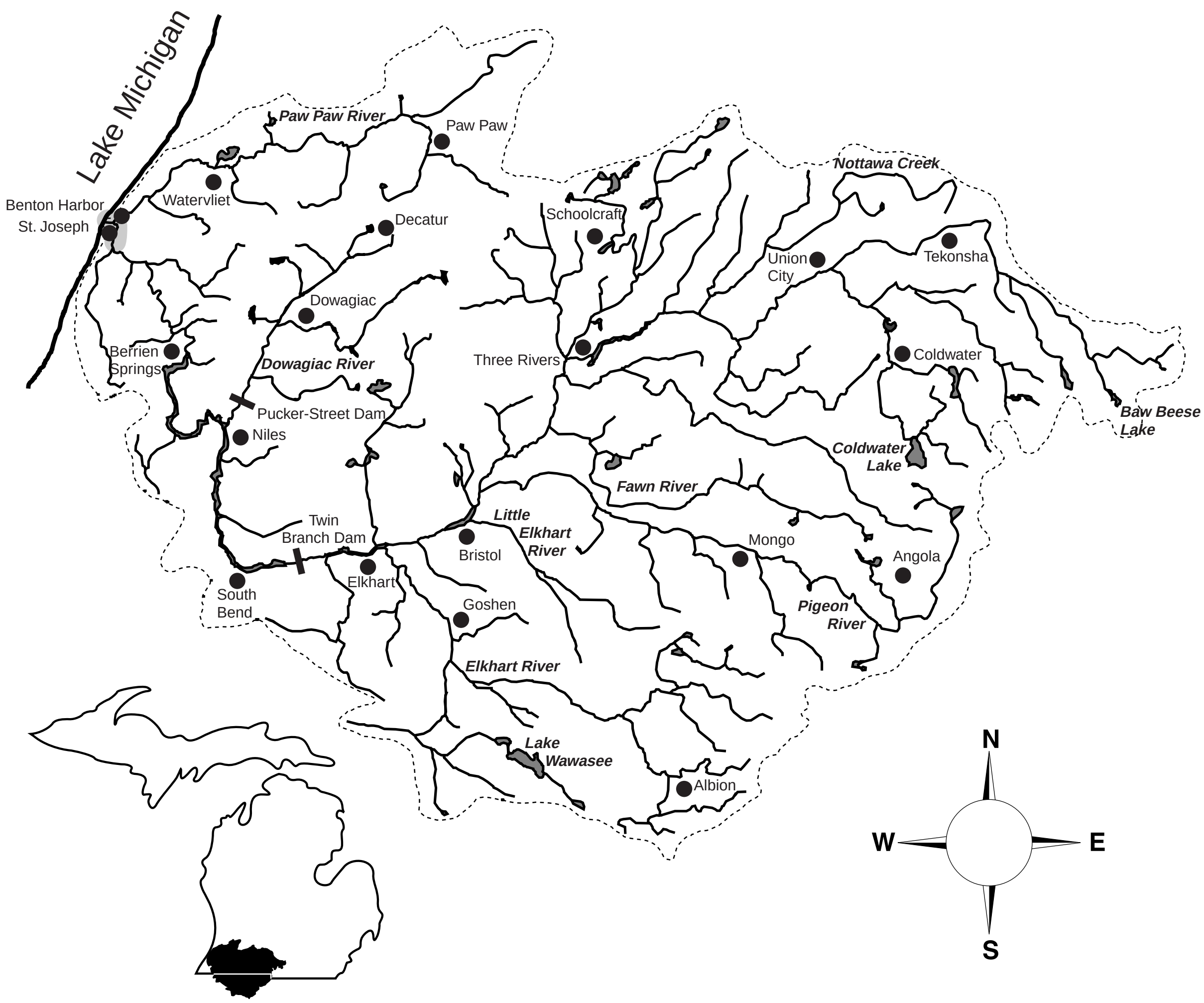


Lake whitefish (*Coregonus dupeaformis*)

Habitat:

feeding - cold deep lakes; Lake Michigan

spawning - shallow water (<25 feet)
- hard or stony substrate

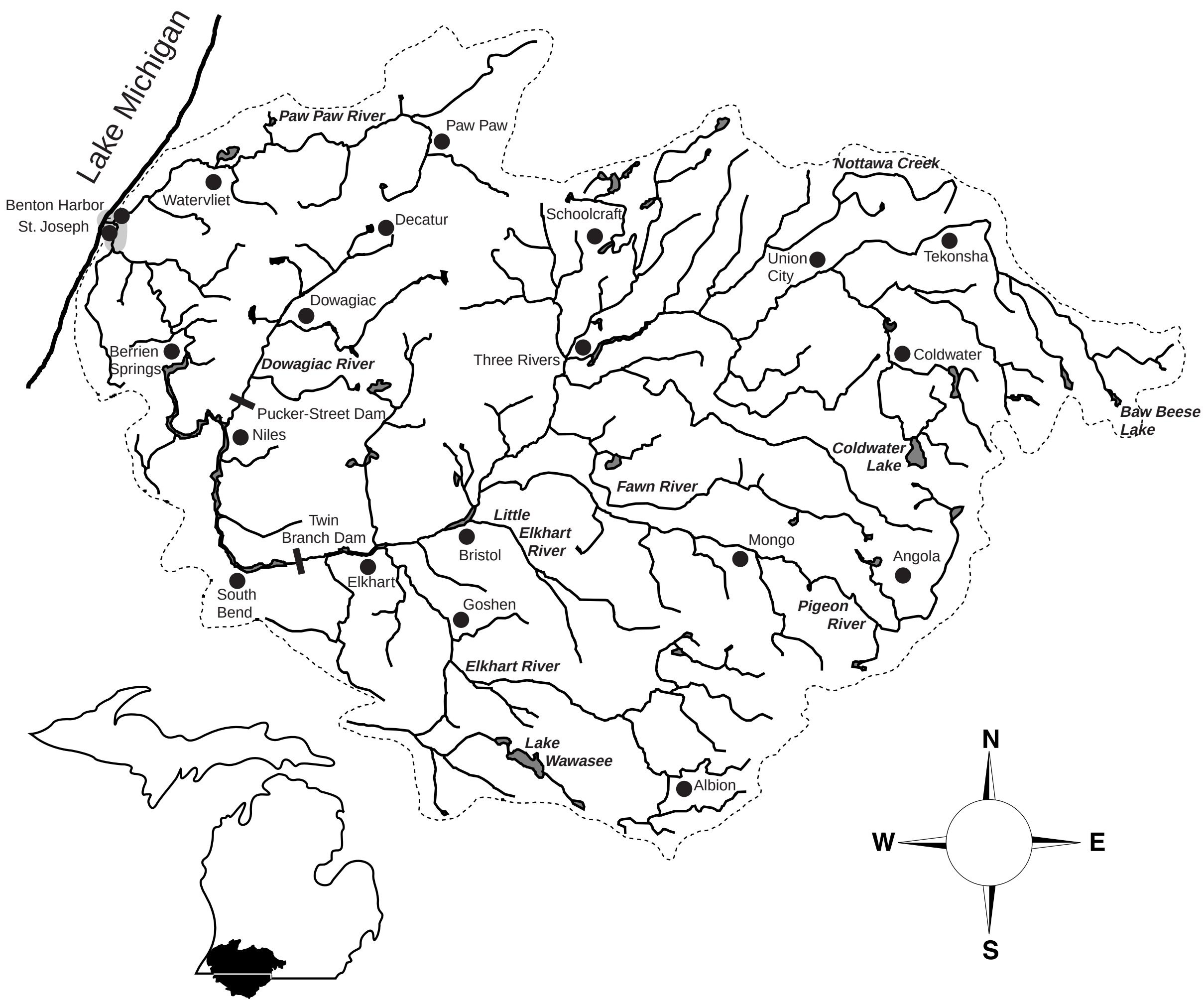


Pink salmon (*Oncorhynchus gorbuscha*)

Habitat:

feeding - large cold deep lakes - Lake Michigan

spawning - gravel substrate in rivers
- female prepares and guards nest until death

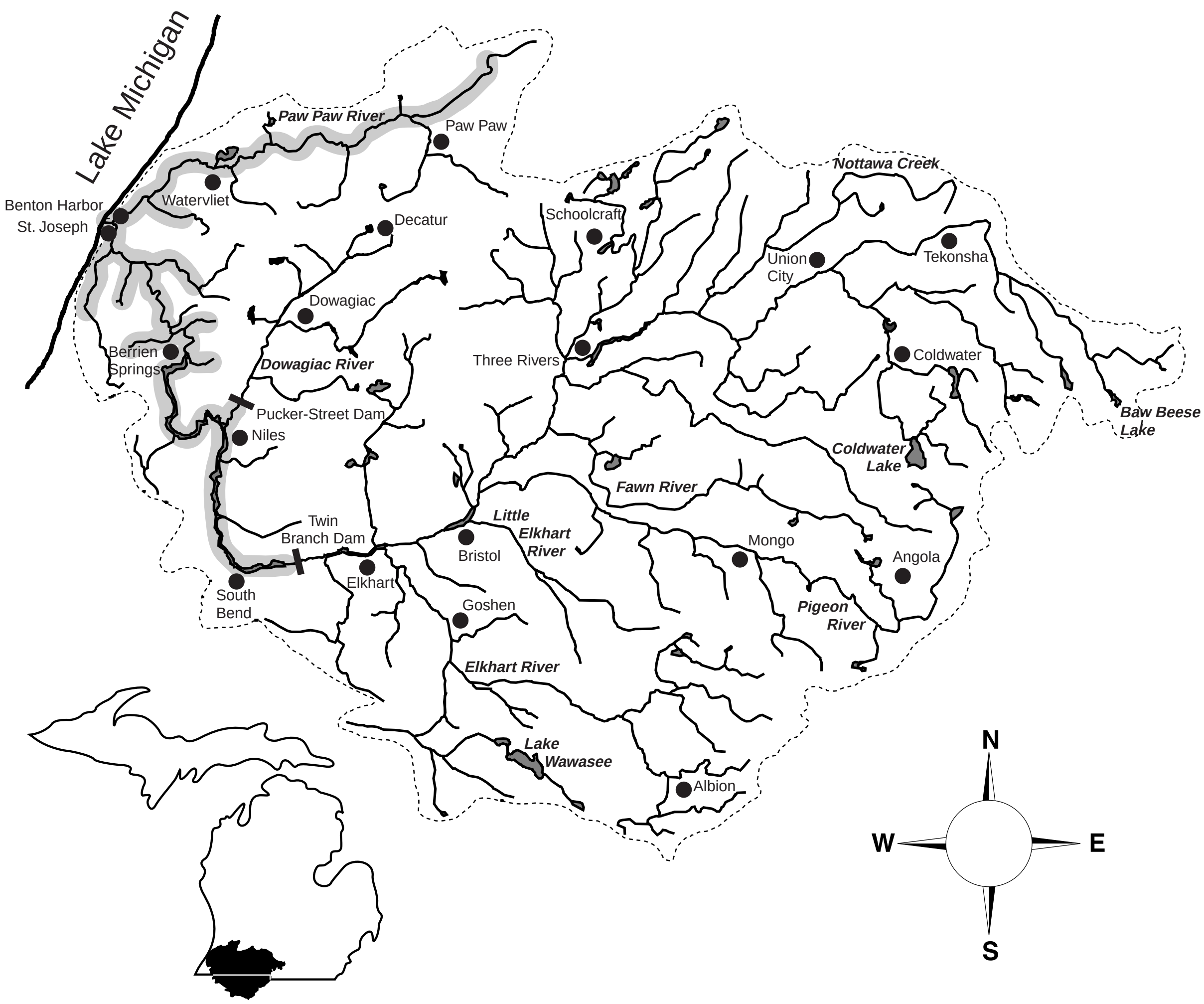


Coho salmon (*Oncorhynchus kisutch*)

Habitat:

feeding - adults: Lake Michigan
- young: shallow gravel substrate in cold streams, later into pools

spawning - cold streams and rivers
- swifter water of shallow gravelly substrate

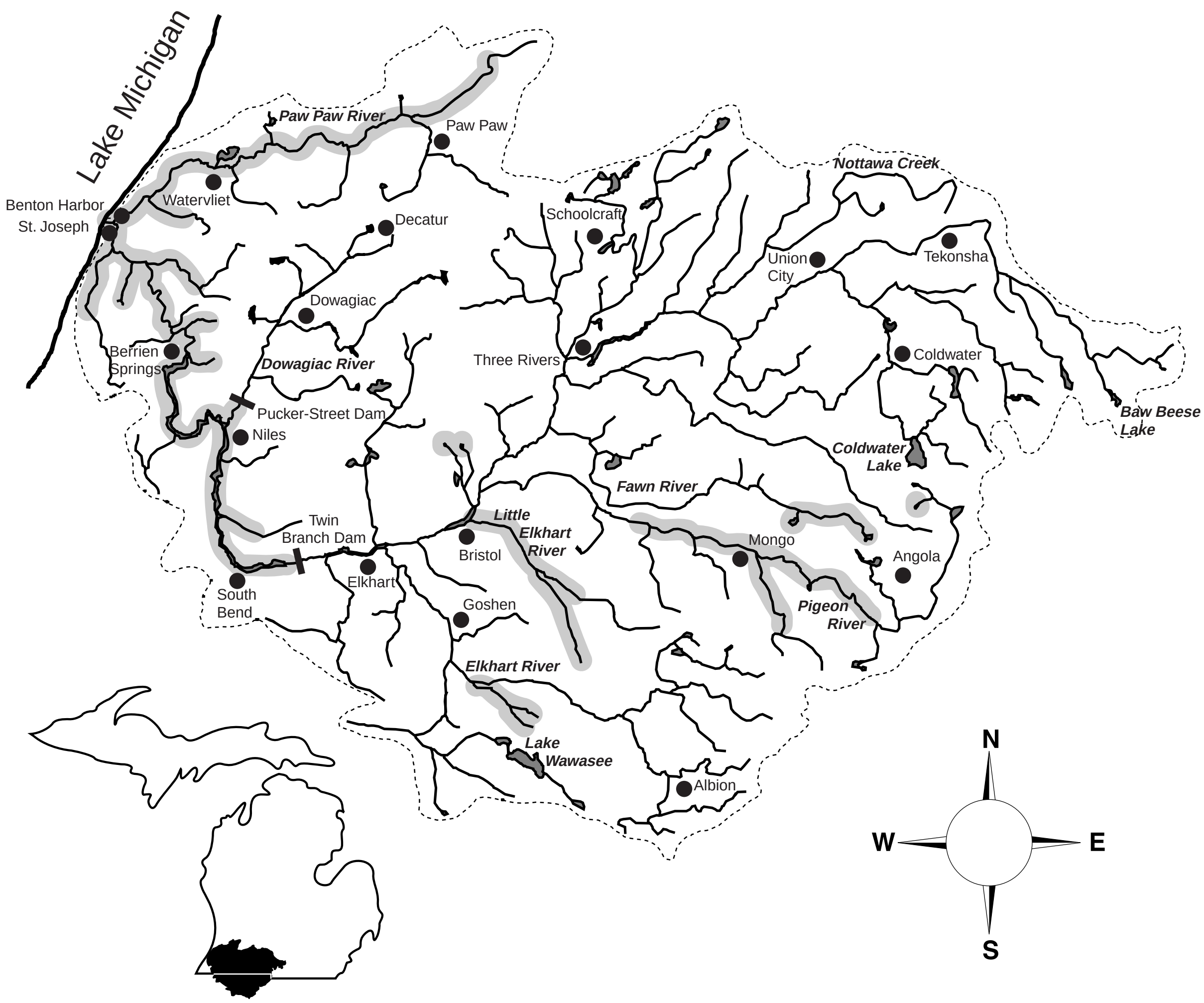


Rainbow trout (*Oncorhynchus mykiss*)

Habitat:

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

spawning - gravelly riffles above a pool
- smaller tributaries

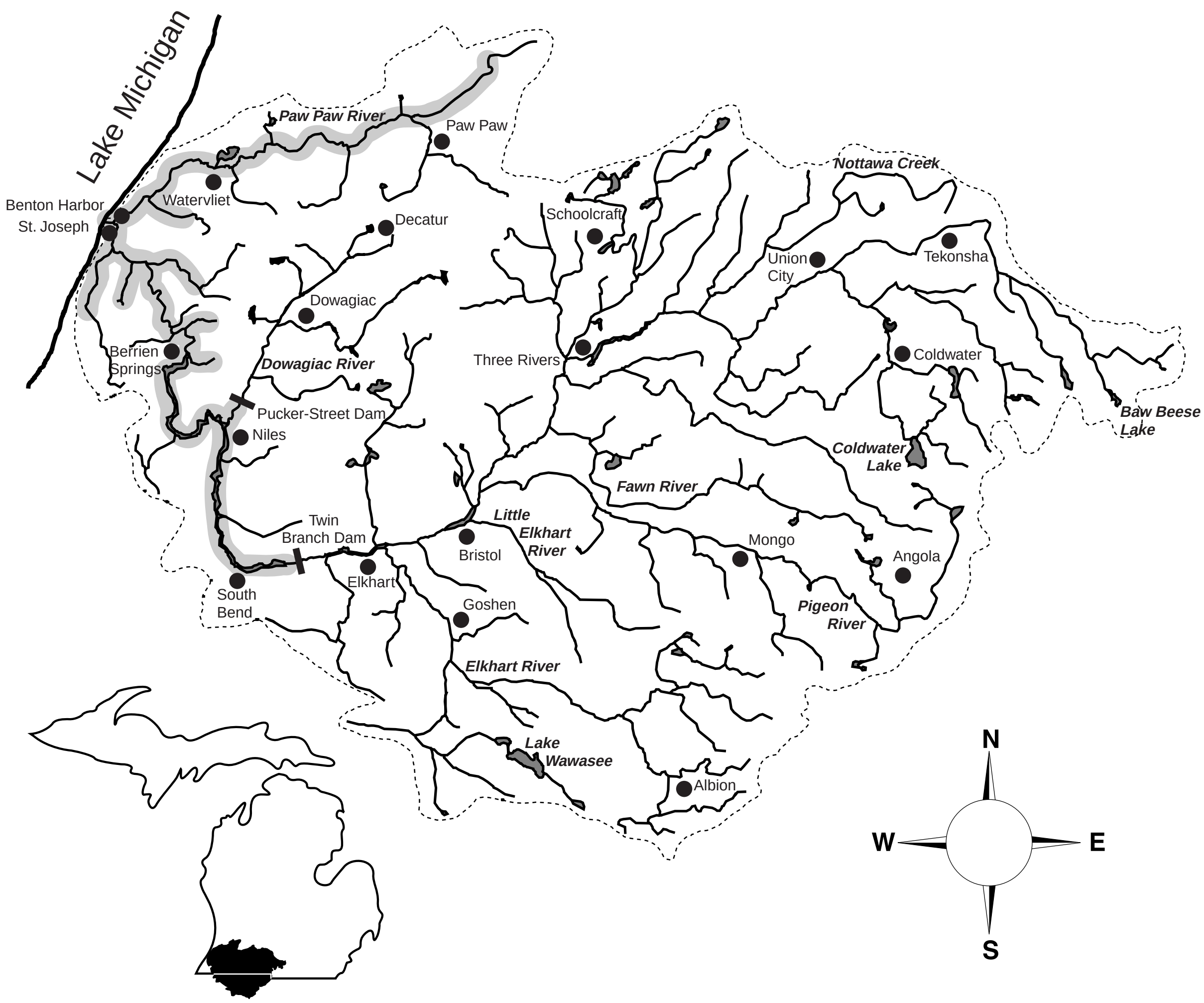


Chinook salmon (*Oncorhynchus tshawyscha*)

Habitat:

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

spawning - gravelly substrate in cool streams

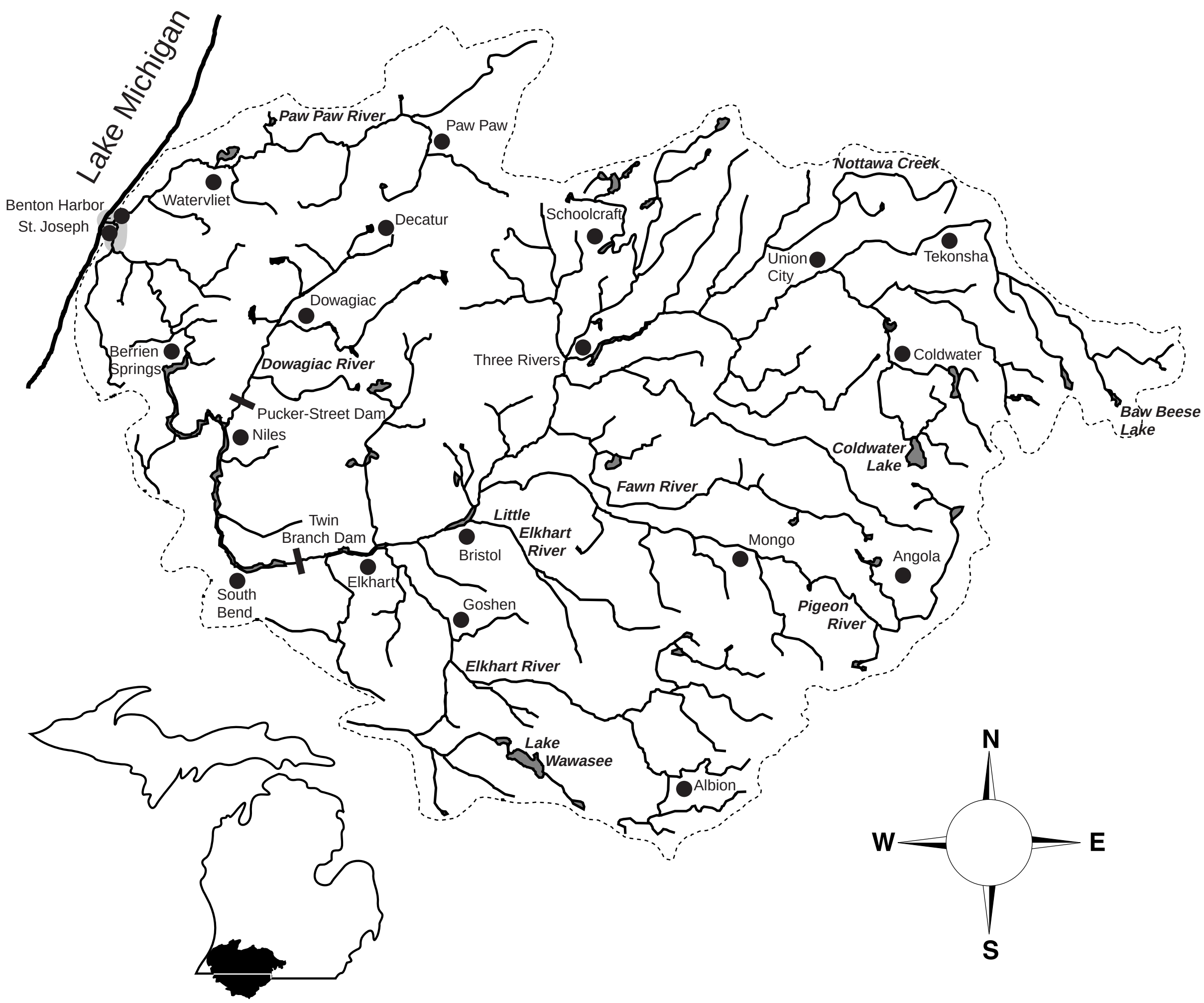


Round whitefish (*Prosopium cylindraceum*)

Habitat:

feeding - lakes, rivers, and streams

spawning - shallows of lakes and rivers
- gravel or rock substrate

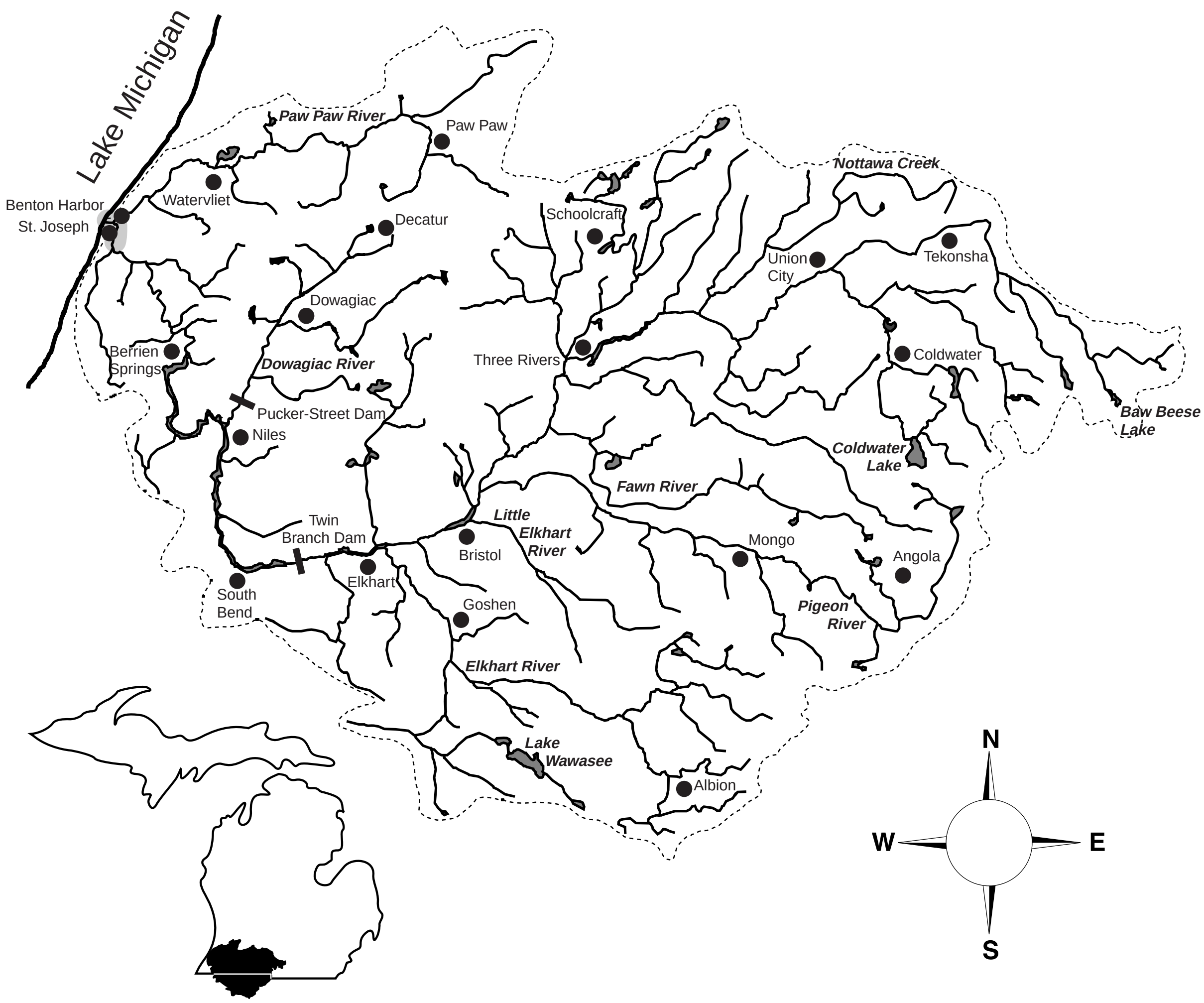


Atlantic salmon (*Salmo salar*)

Habitat:

feeding
- young: gravel substrate streams
- adults: Lake Michigan

spawning
- streams and rivers
- nests in gravel substrate
- swift current

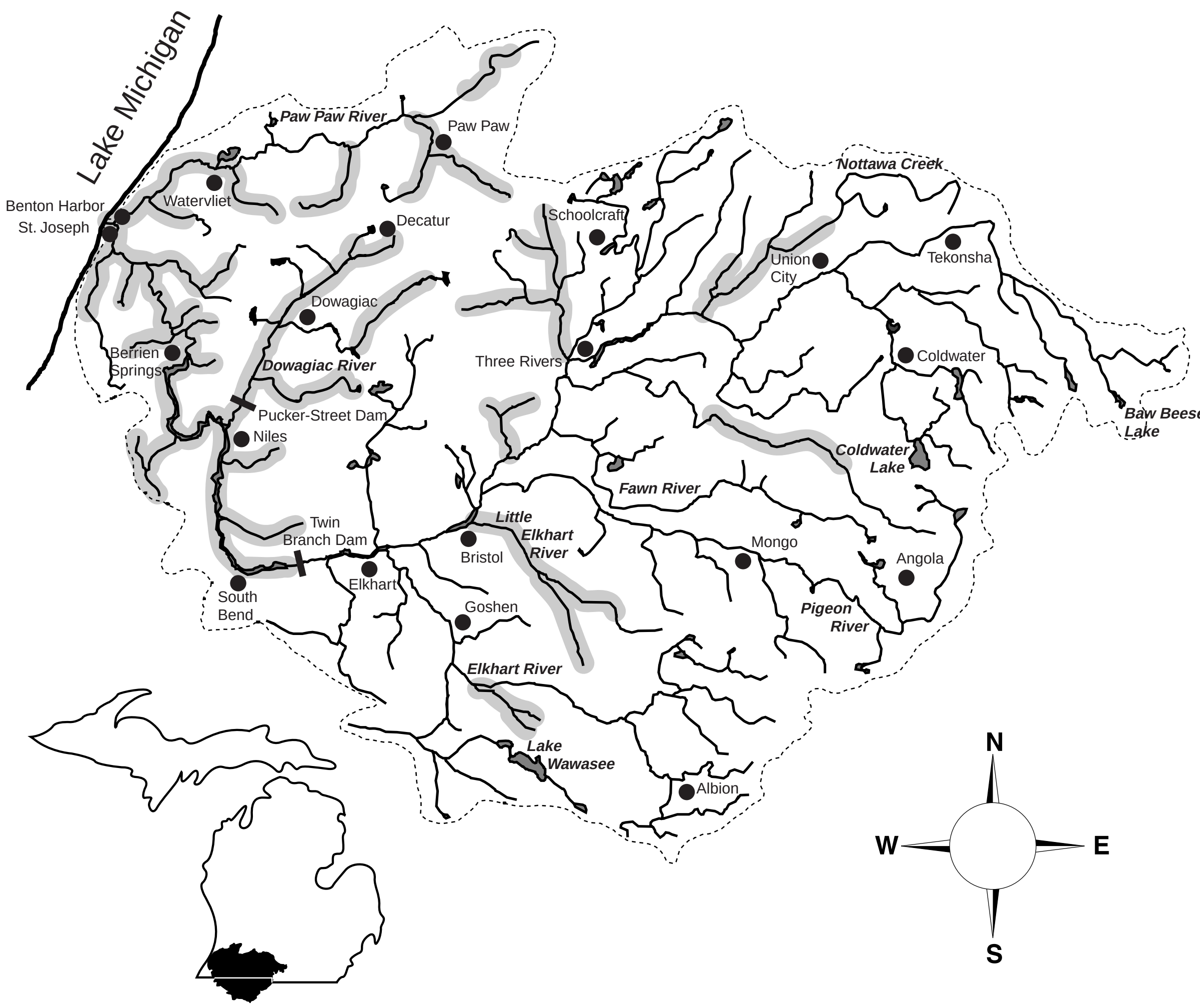


Brown trout (*Salmo trutta*)

Habitat:

feeding - cold, clear streams, rivers, and lakes (not >72˚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

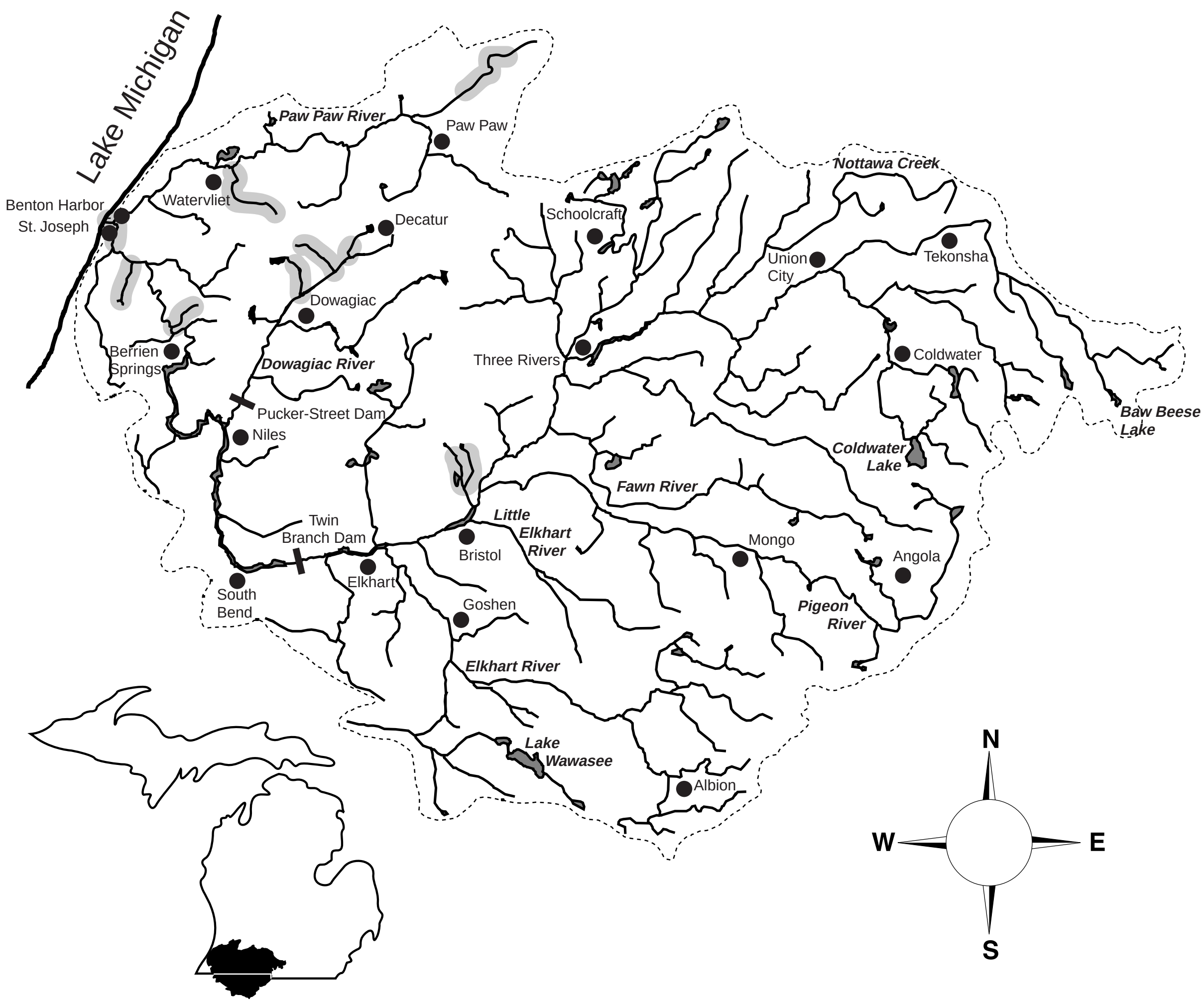


Brook trout (*Salvelinus fontinalis*)

Habitat:

feeding - cold, clear streams, rivers, and lakes (not >72˚F)
- low current
- well oxygenated water

spawning - gravelly riffles; shallow or headwater streams

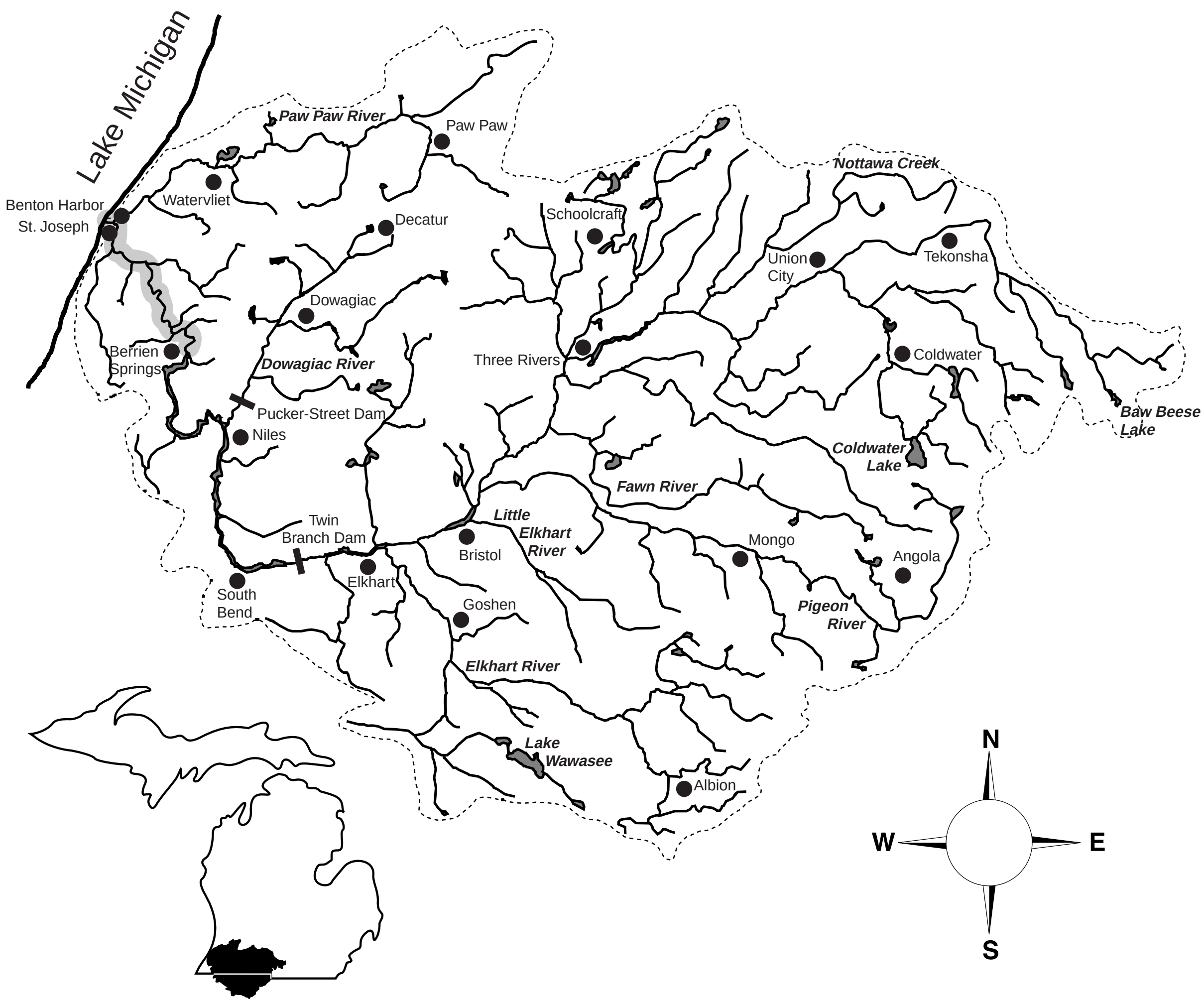


Lake trout (*Salvelinus namaycush*)

Habitat:

feeding - cold lakes and rivers

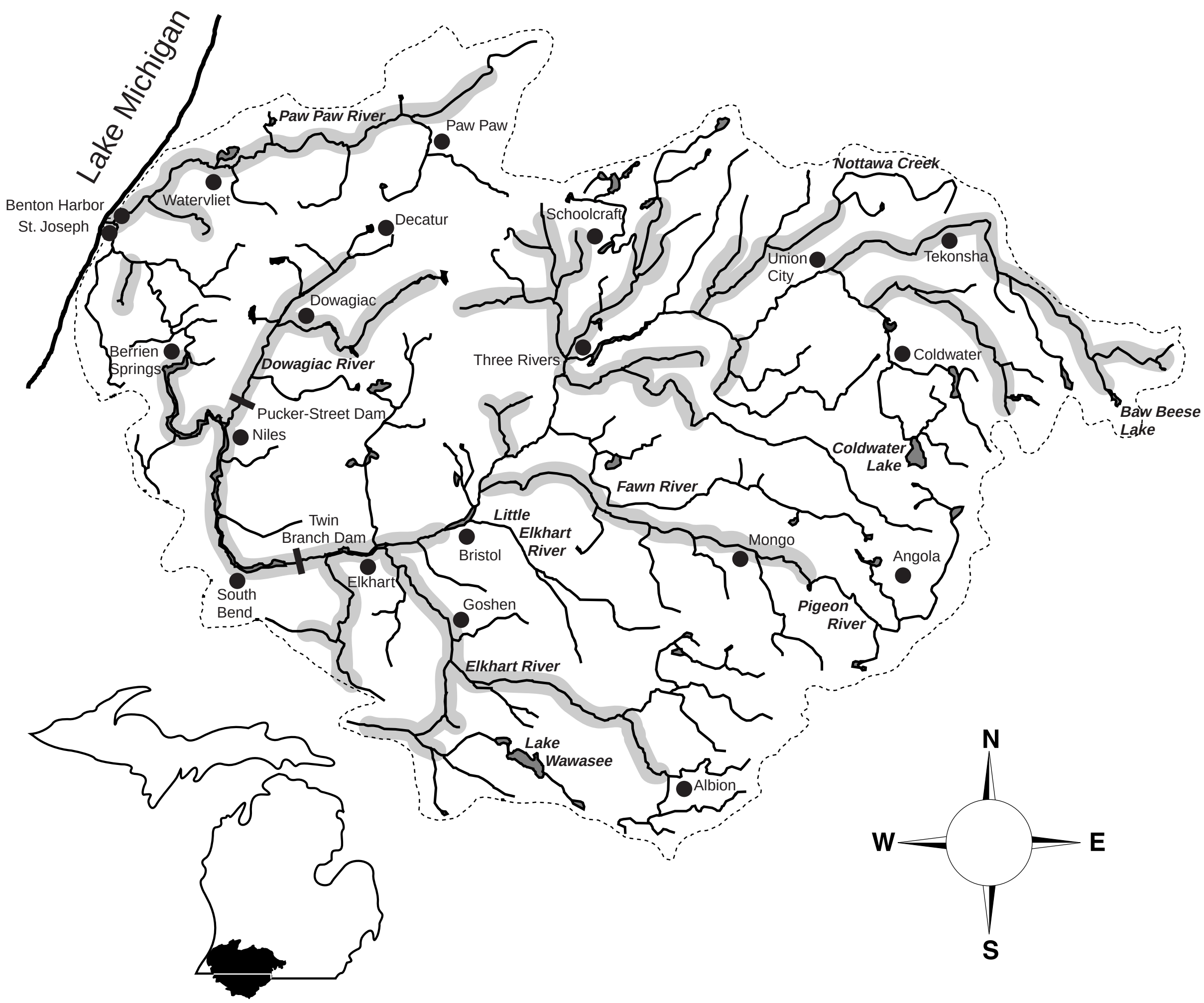
spawning - large boulder or rubble substrate
- shallow water of lakes and rivers



Pirate perch (*Aphredoderus sayanus*)

Habitat:

feeding
- oxbows, overflow ponds, marshes, estuaries, pools
- medium to large rivers
- low gradient, less than 3ft/mi
- sand or muck substrates covered with organic debris
- pools bordered by emergent aquatic vegetation
- clear, warm, quiet water

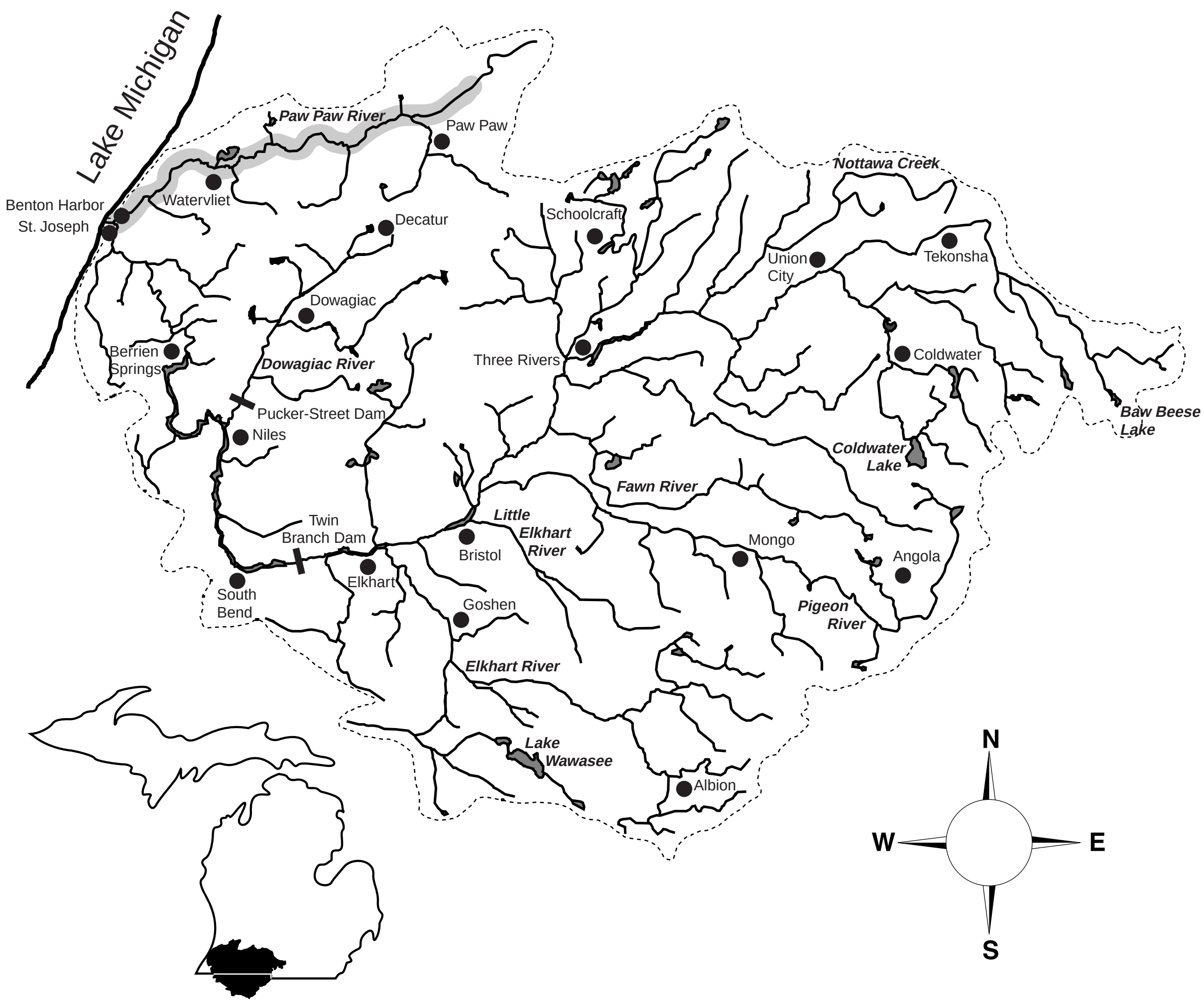


Burbot (*Lota lota*)

Habitat:

feeding - deep cold lakes and large cool rivers
- mud, sand, rubble, boulder, silt, and gravel substrates

spawning - in 1 to 4 feet of water in shallow bays or on shoals 5-10 feet deep usually in lakes, sometimes rivers
- over sand or gravel substrate
- under ice

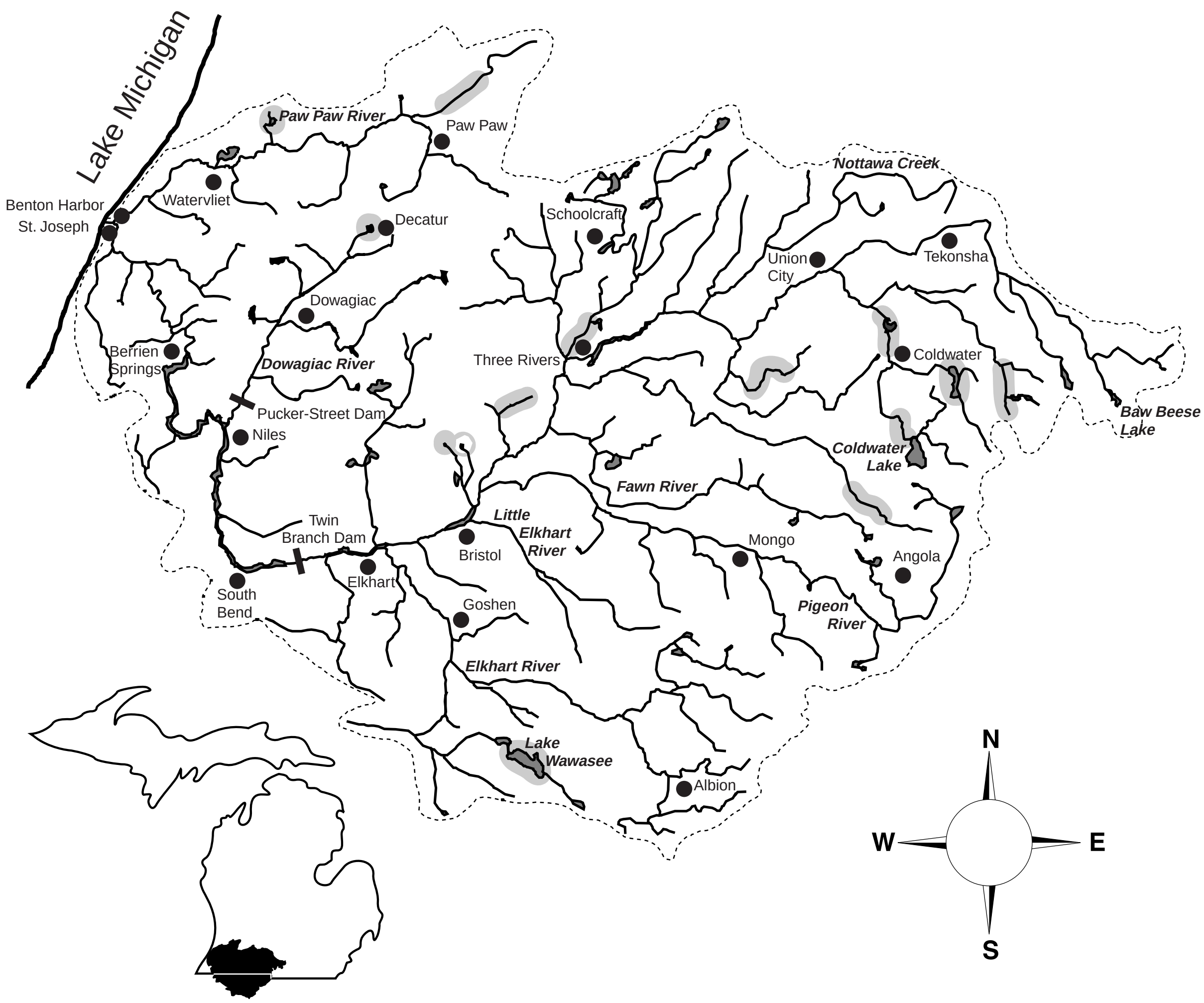


Banded killifish (*Fundulus diaphanus*)

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

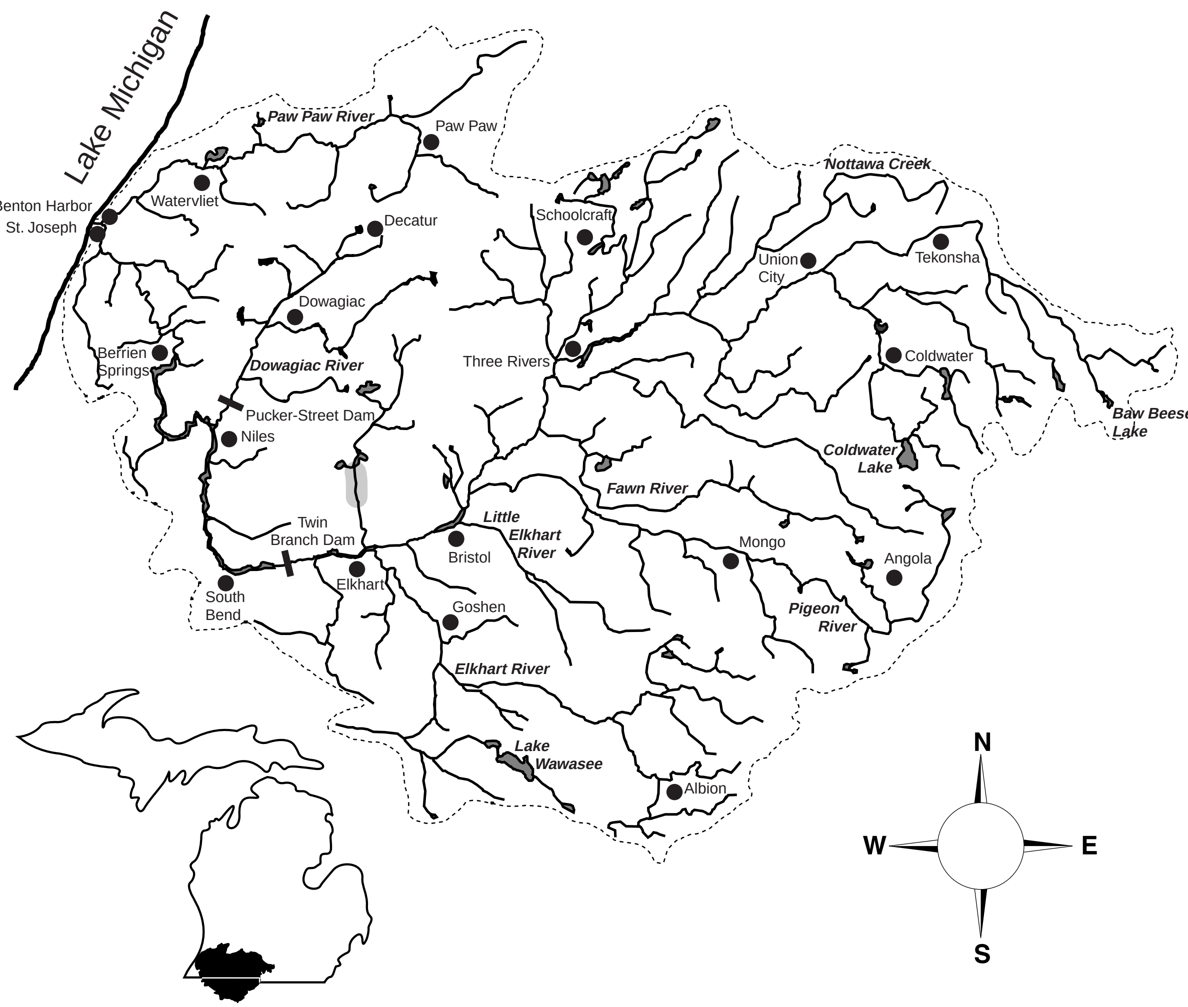


Starhead topminnow (*Fundulus dispar*)

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



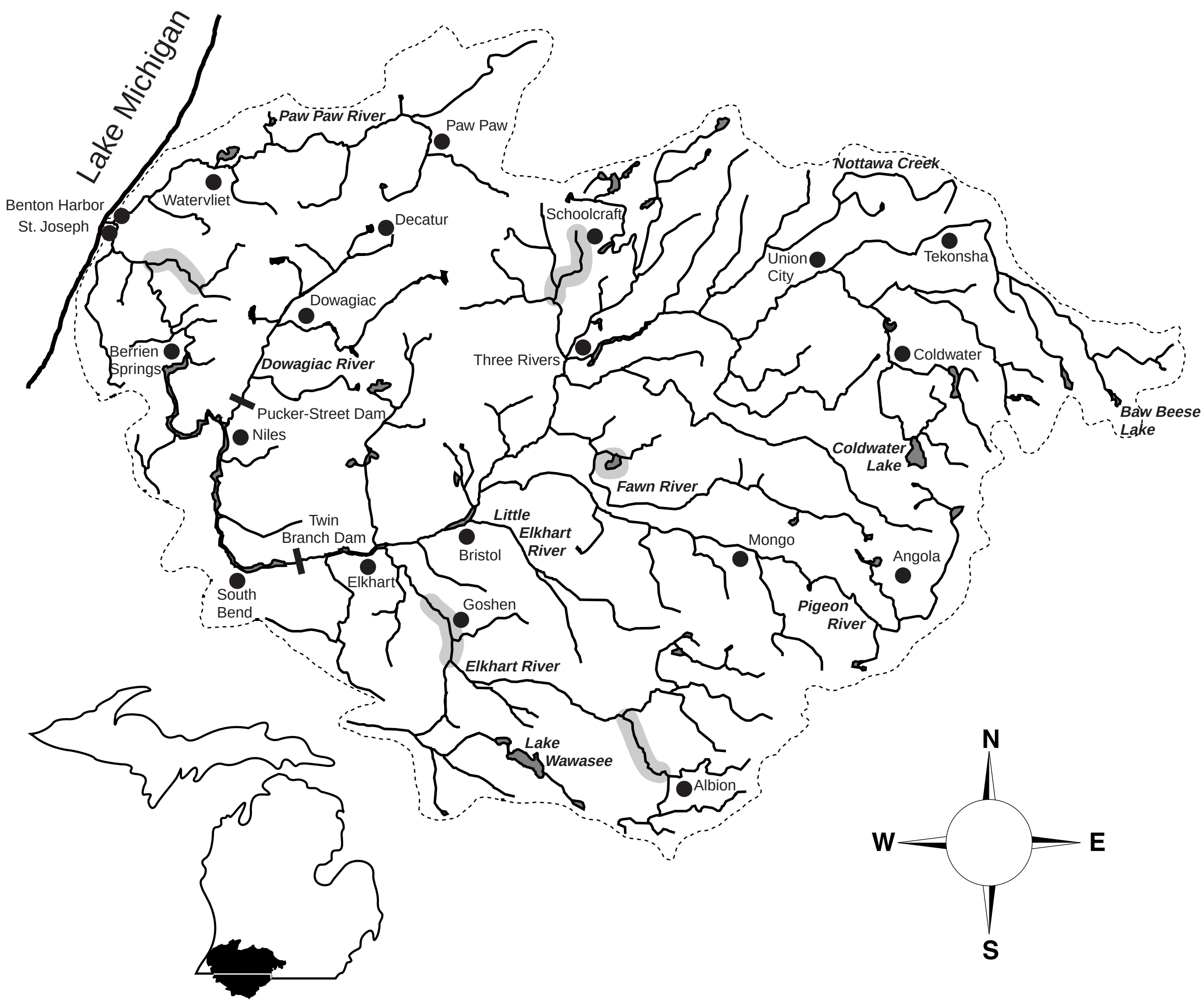
Blackstripe topminnow (*Fundulus notatus*)

Habitat:

feeding - clear waters of lakes, impoundments and in low-gradient streams
- aquatic or submerged land vegetation
- somewhat tolerant of turbid water

spawning - in vegetation or algae

winter refuge - in deeper water with bottom vegetation

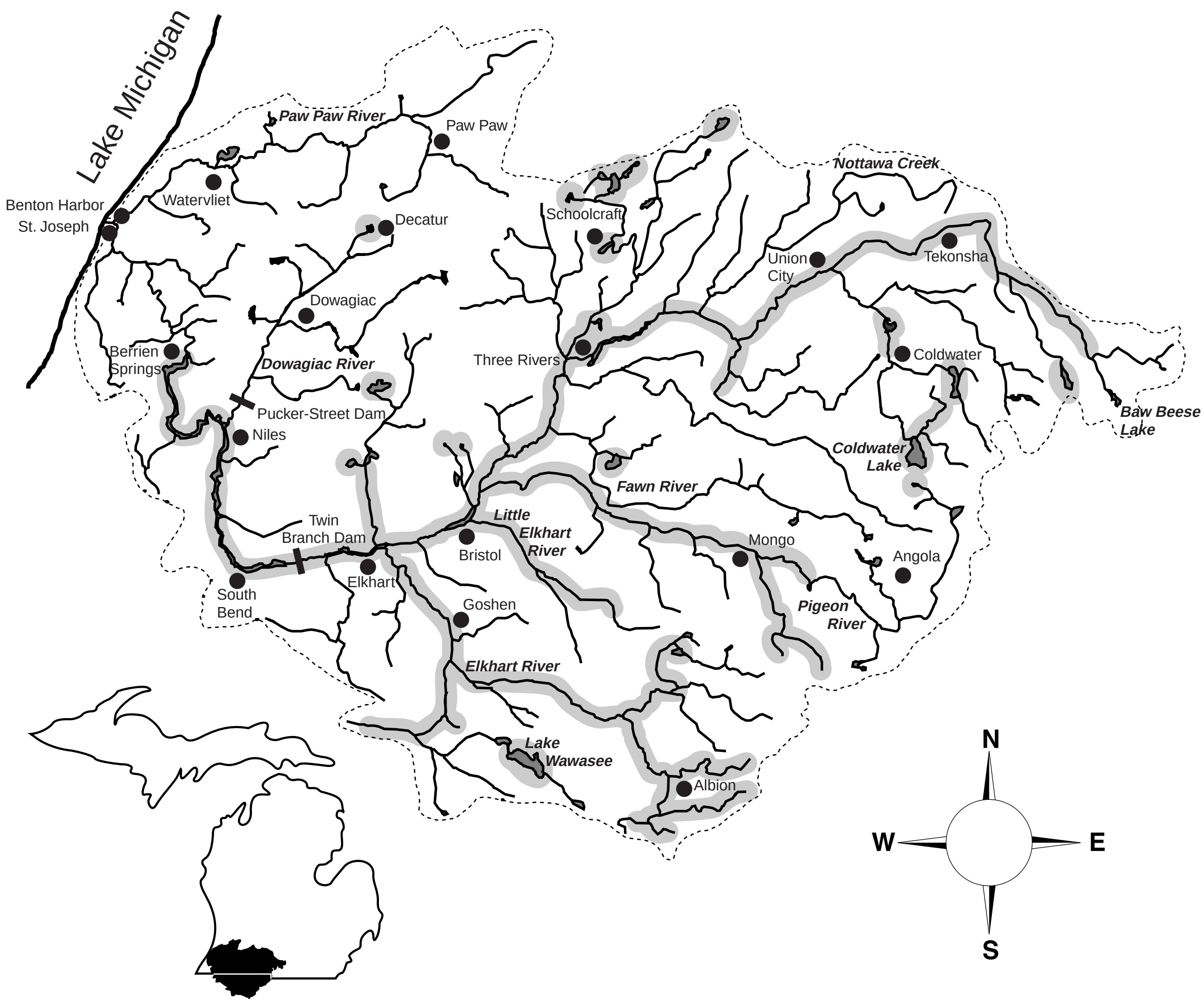


Brook silverside (*Labidesthes sicculus*)

Habitat:

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

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

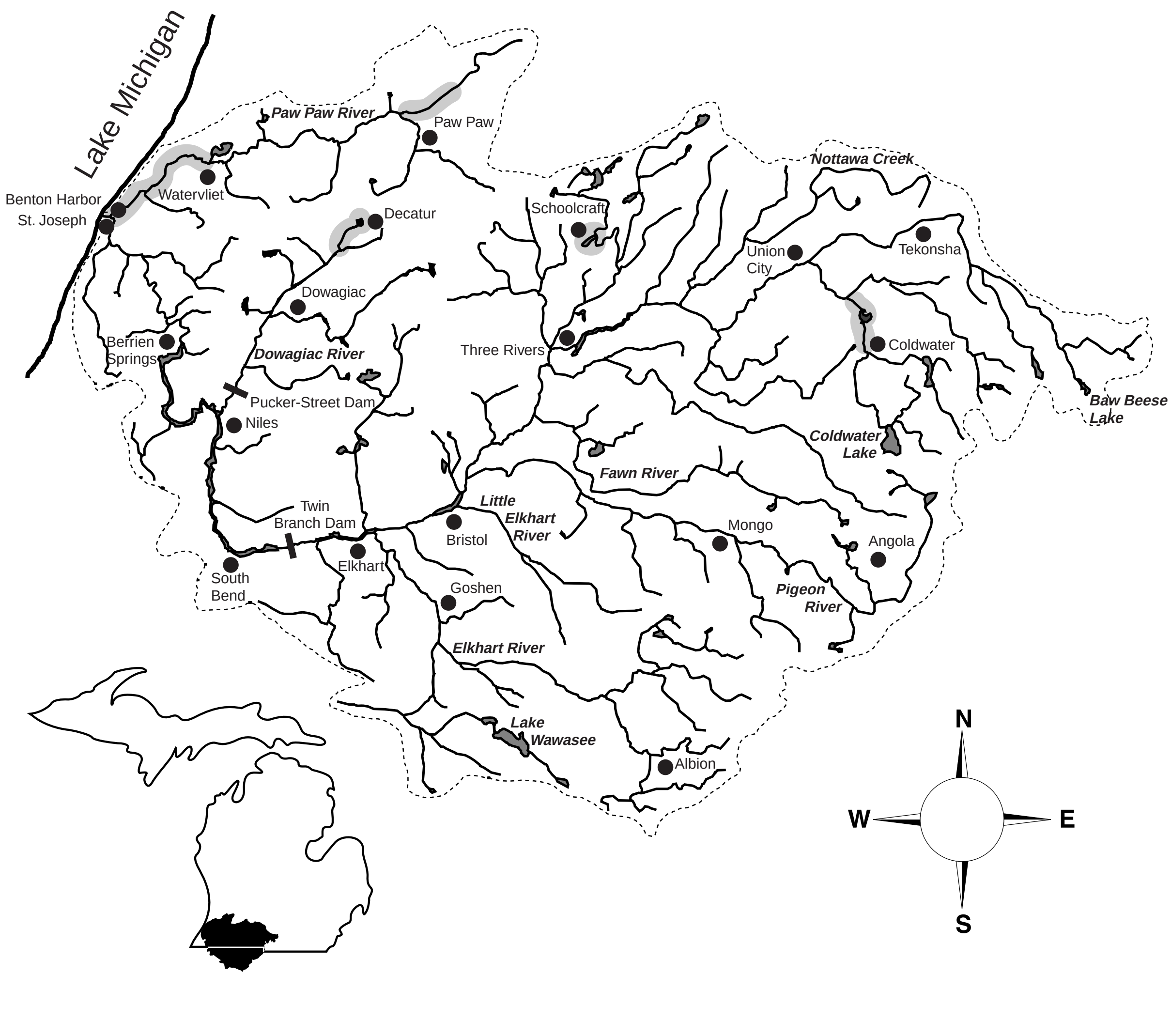


Brook stickleback (*Cluaea inconstans*)

Habitat:

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

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

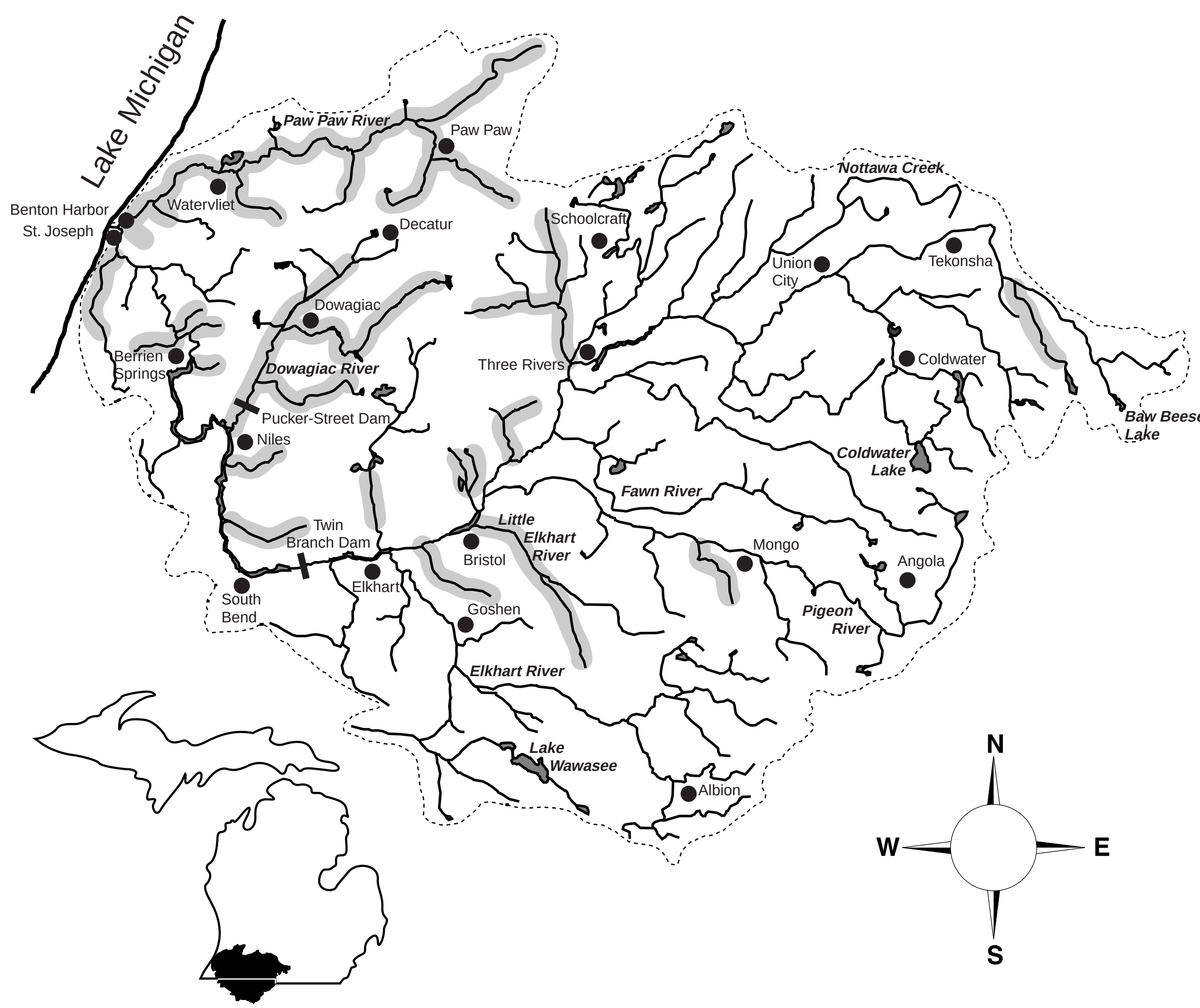


Mottled sculpin (*Cottus bairdi*)

Habitat:

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

spawning - nests under logs or rock

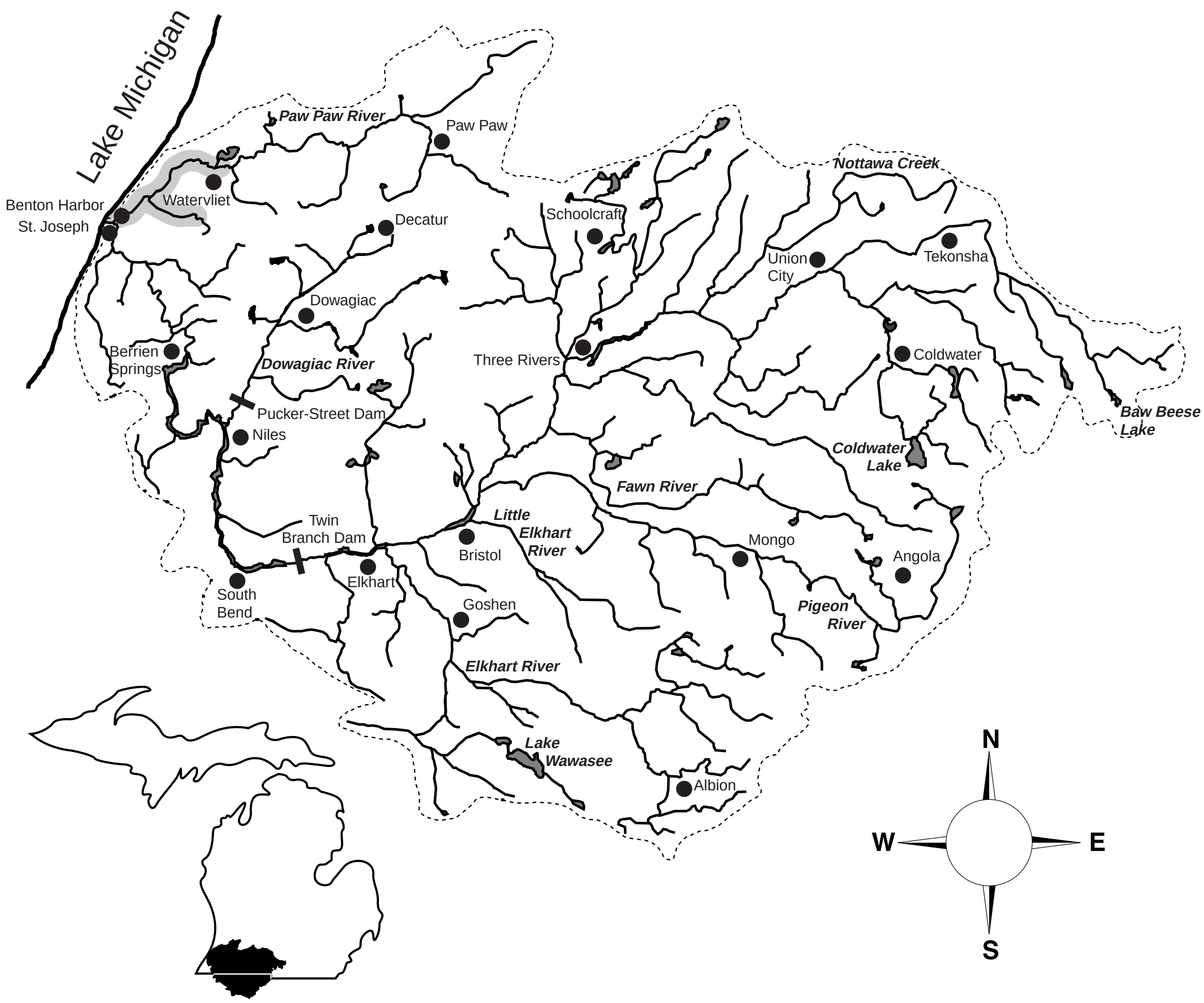


Slimy sculpin (*Cottus cognatus*)

Habitat:

feeding
- cool lakes, impoundments, rivers, and streams
- gravel or rock substrate

spawning
- nest in shallow areas of lakes
- gravel substrate or rock ledge
- male parental care



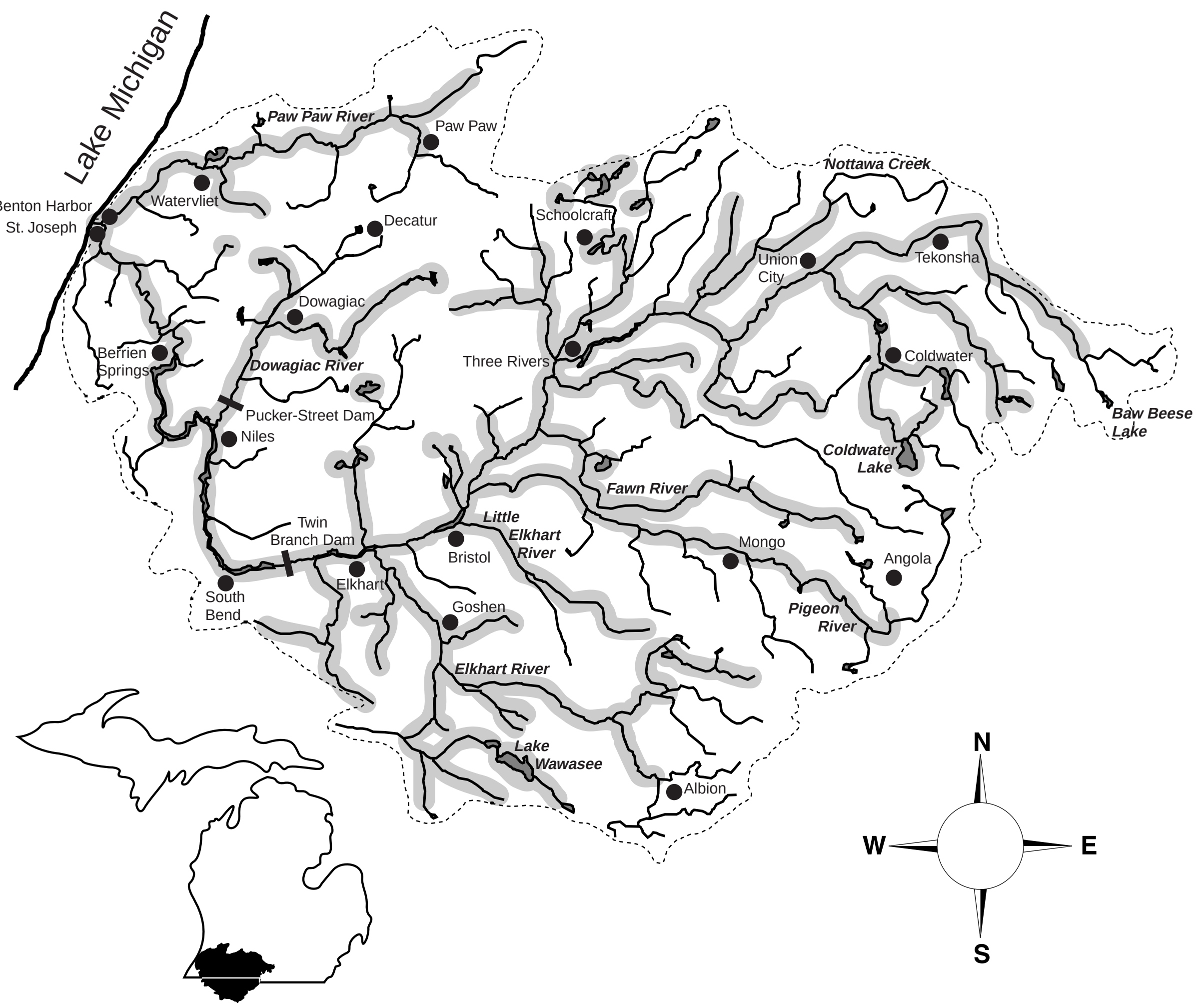
Rock bass (*Ambloplites rupestris*)

Habitat:

feeding - clear, cool streams, rivers, and lakes
- rocky to sand substrate
- woody or vegetative cover

spawning - sand or gravel nests
- shallow water

winter refuge - deep water

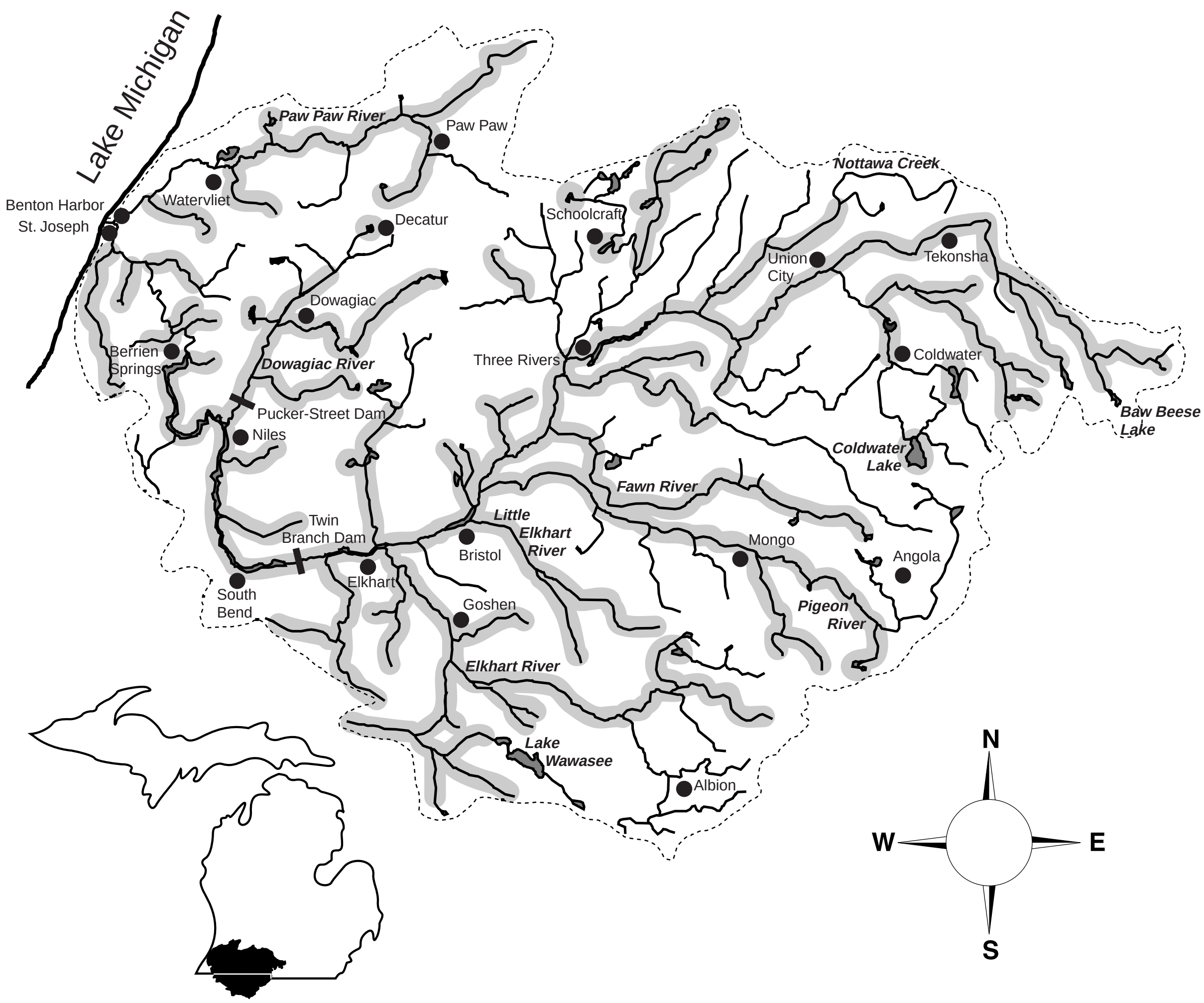


Green sunfish (*Lepomis cyanellus*)

Habitat:

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

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

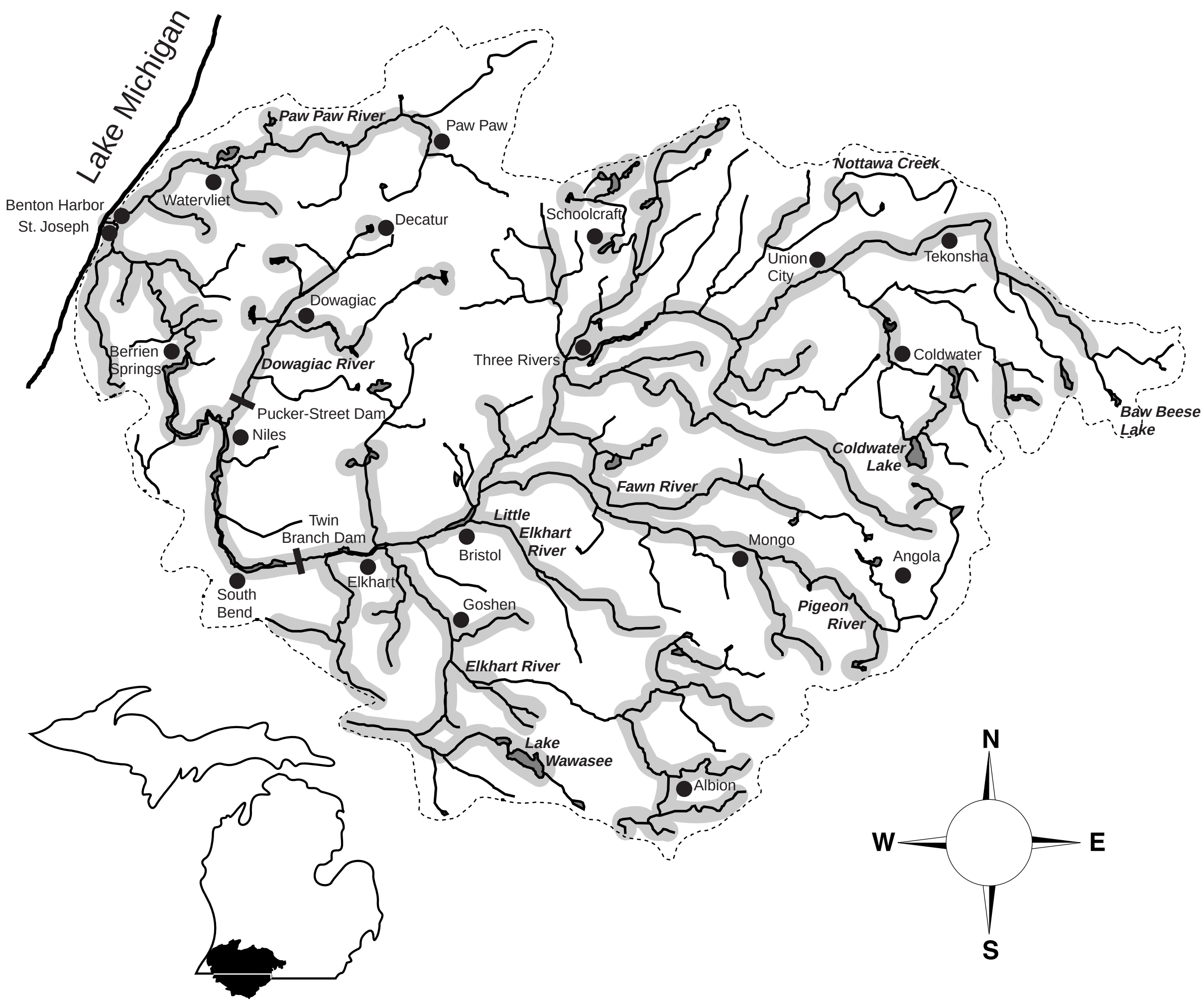


Pumpkinseed sunfish (*Lepomis gibbosus*)

Habitat:

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

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

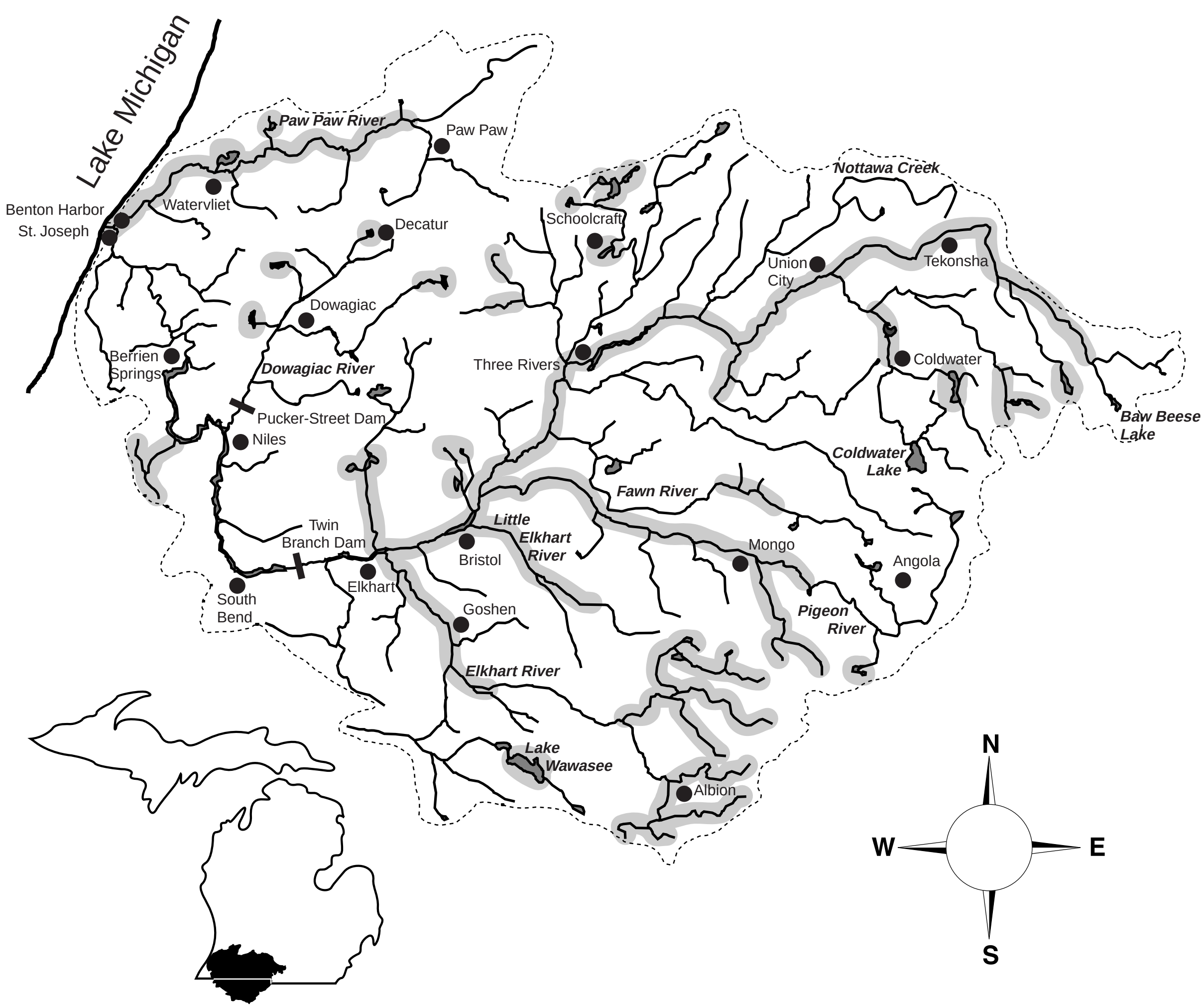


Warmouth (*Lepomis gulosus*)

Habitat:

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

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



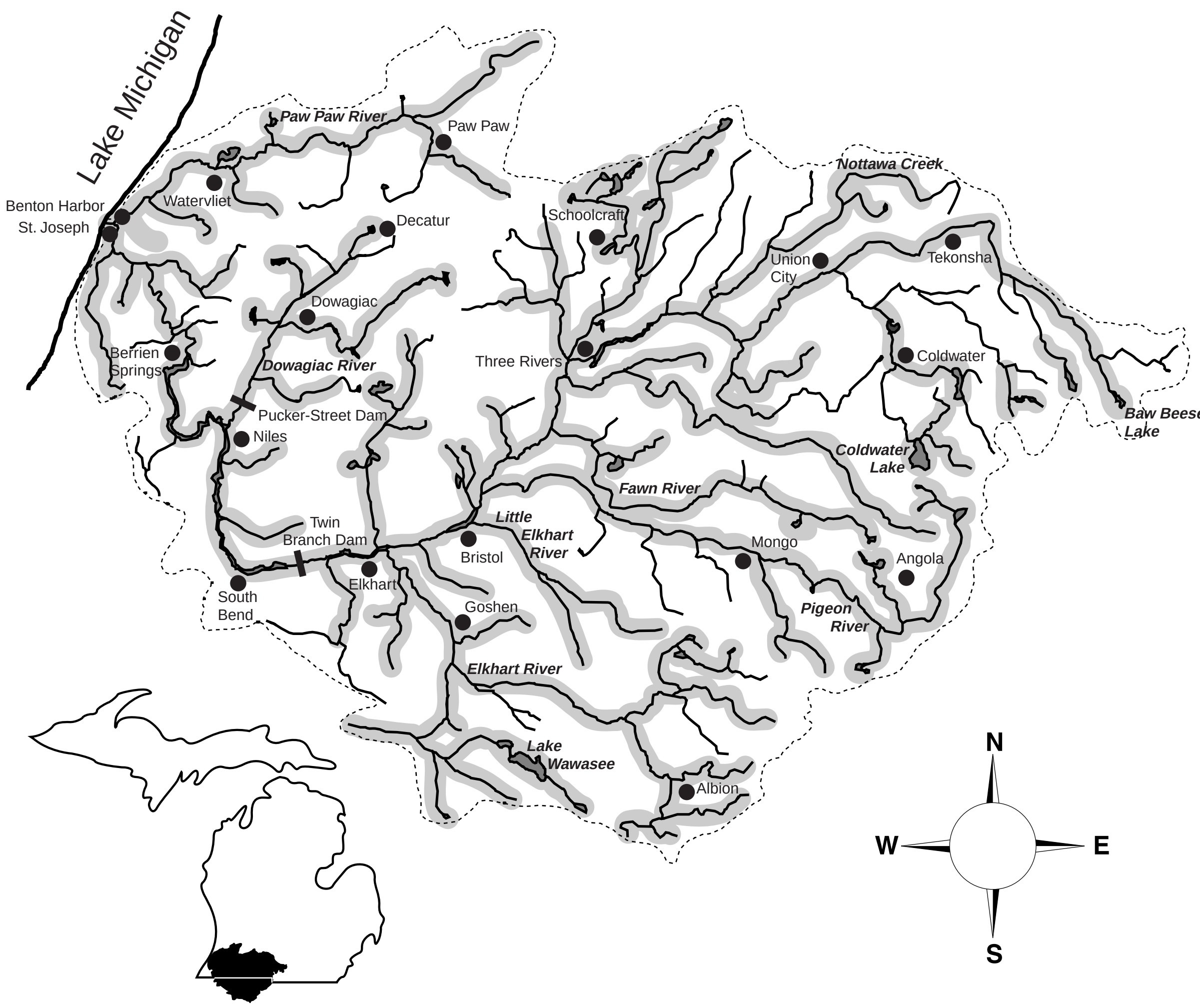
Bluegill (*Lepomis macochrius*)

Habitat:

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

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

winter refuge
- deep water

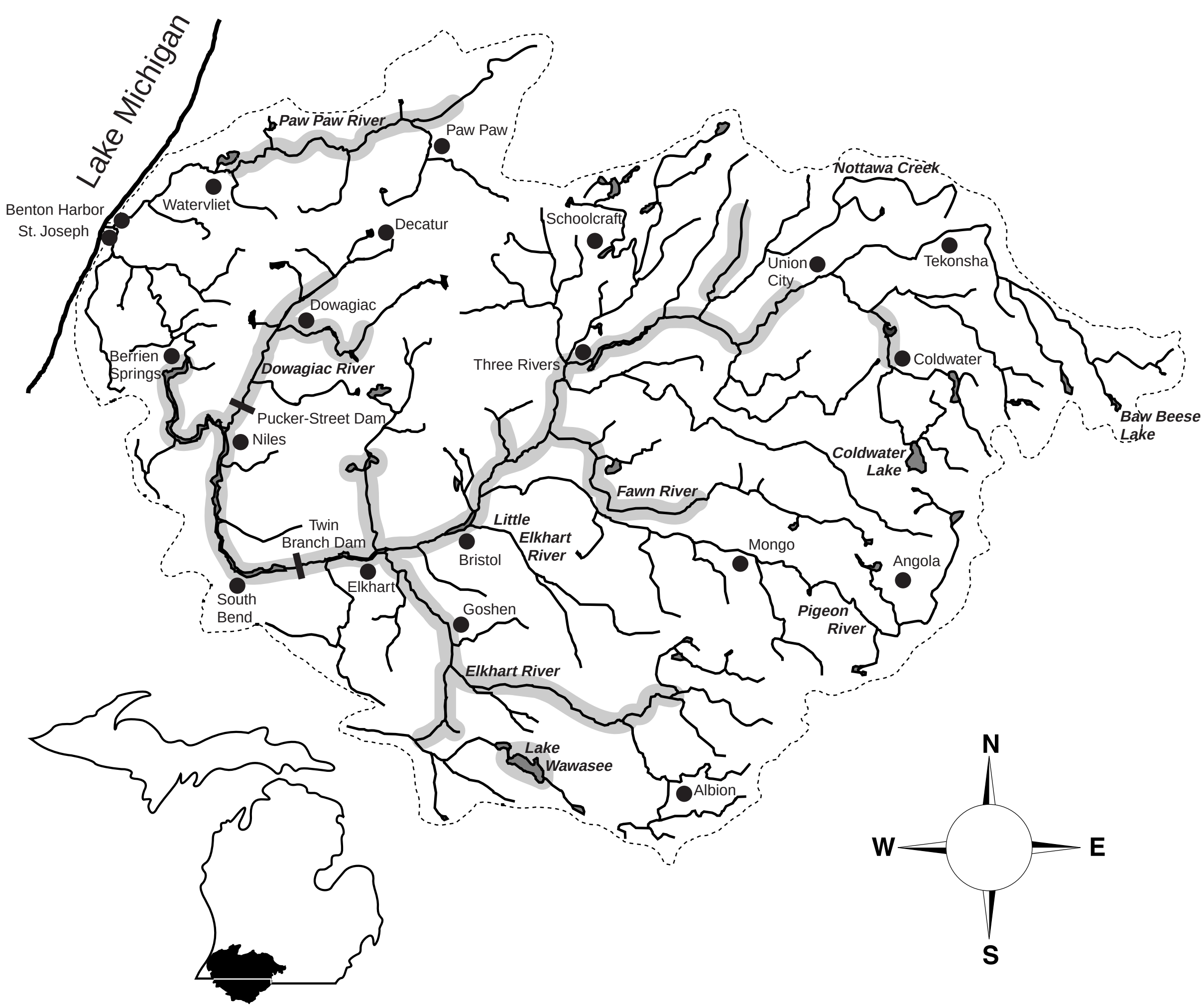


Longear sunfish (*Lepomis megalotis*)

Habitat:

feeding - clear moderate-sized shallow streams with moderate vegetation
- rocky substrates
- little to no current

spawning - nests in gravel, sand, or hard rock substrate

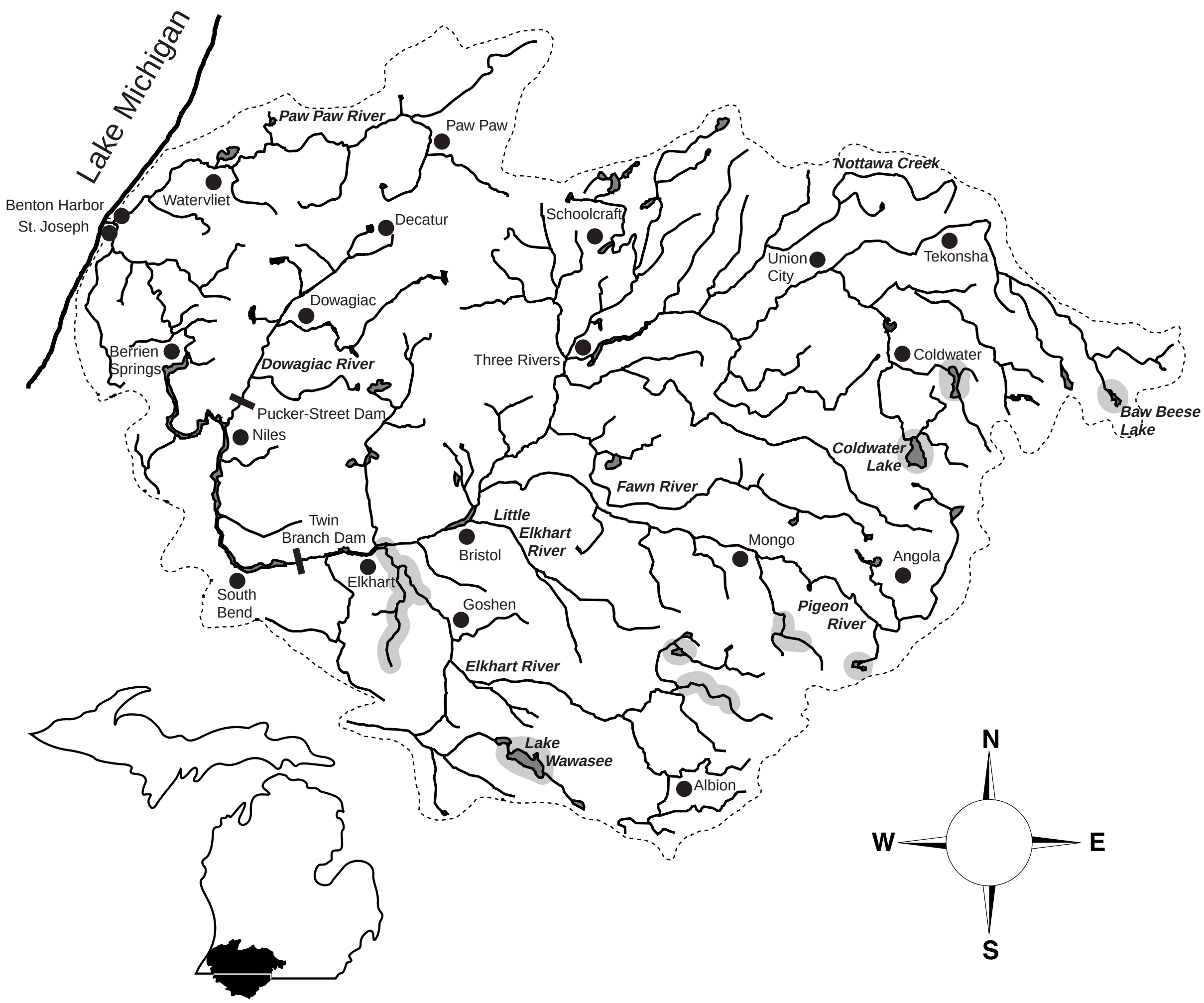


Redear sunfish (*Lepomis microlophus*)

Habitat:

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

spawning - nest in silt or gravel substrate



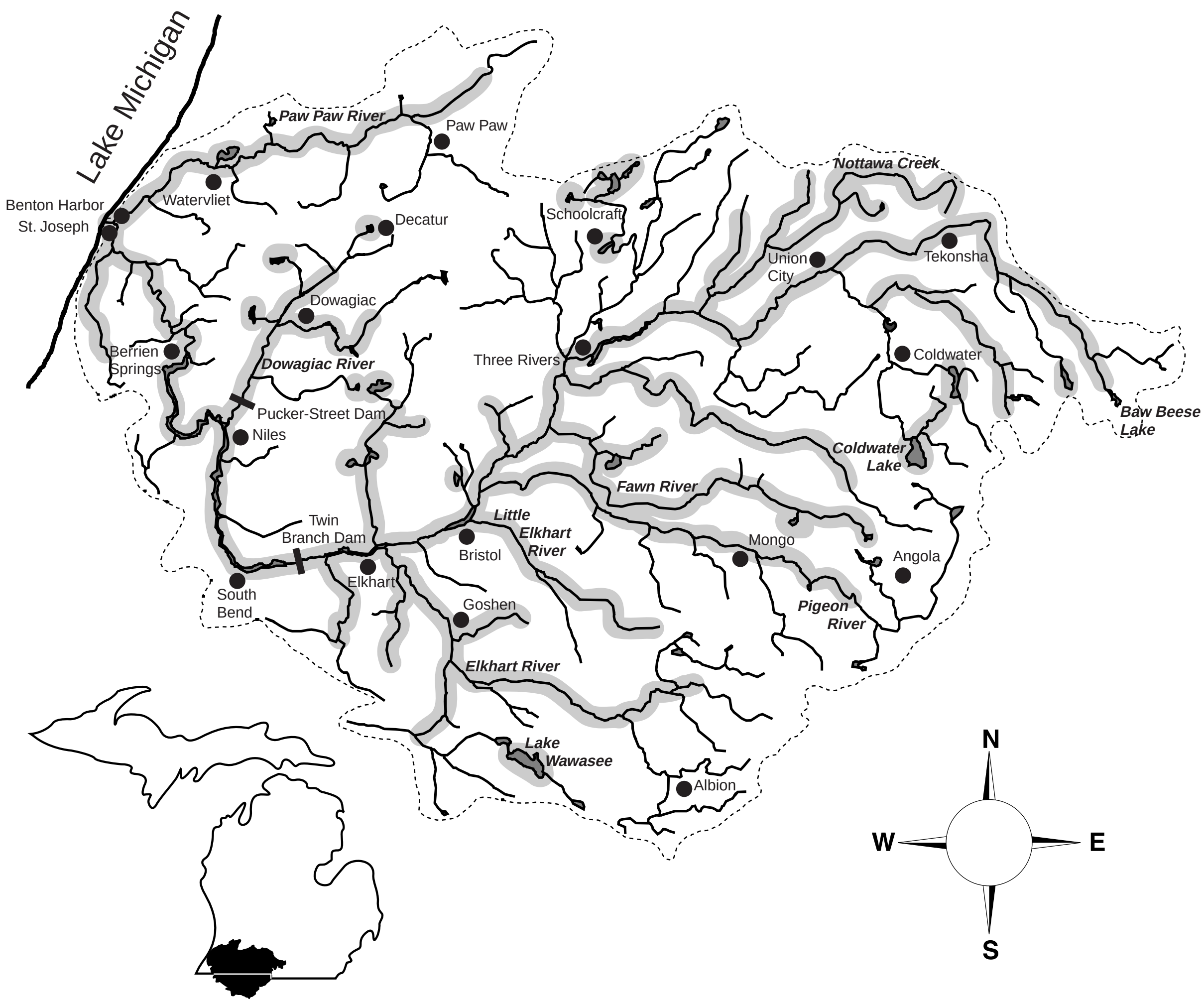
Smallmouth bass (*Micropterus dolomieu*)

Habitat:

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

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

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

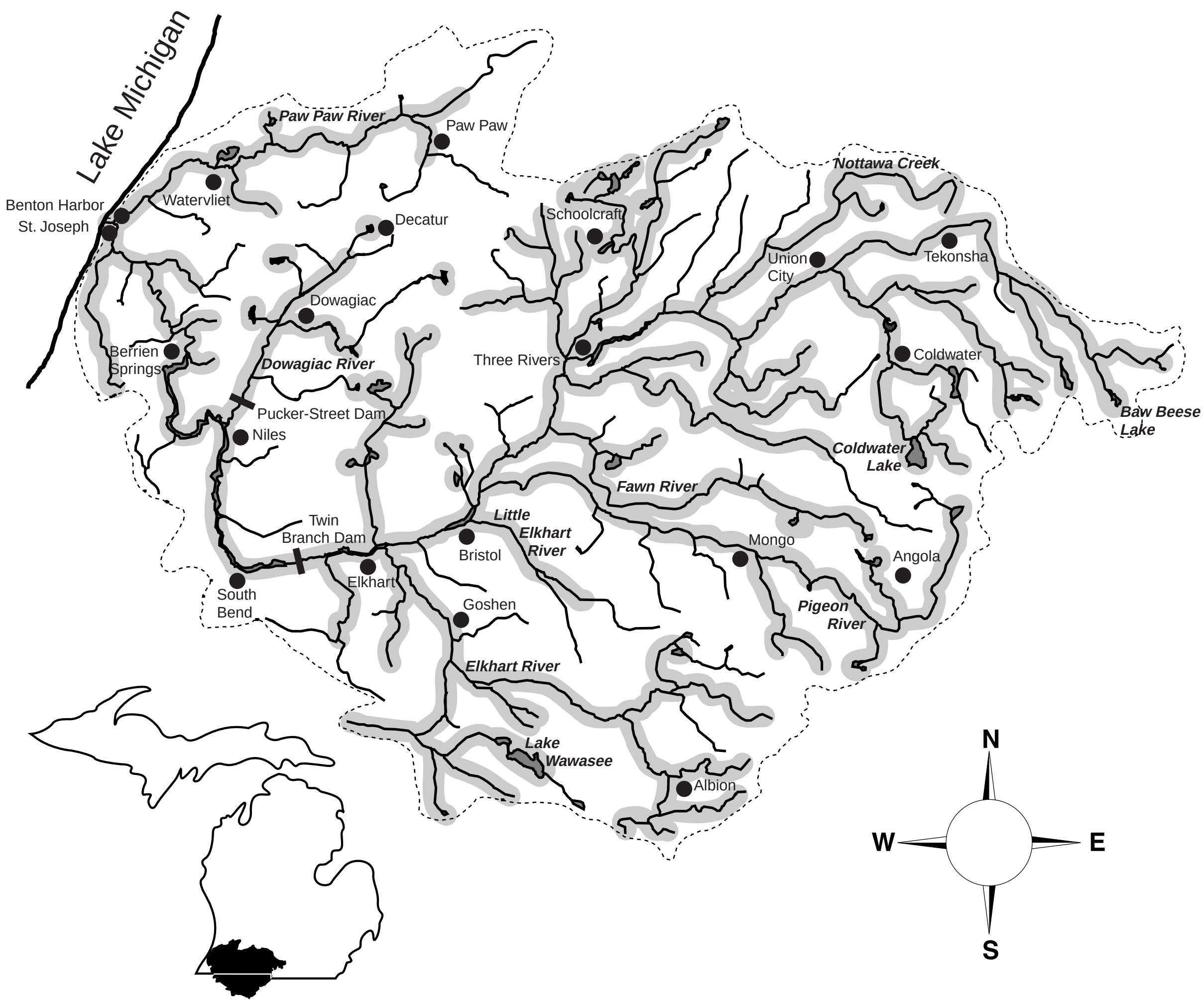


Largemouth bass (*Micropterus salmoides*)

Habitat:

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

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

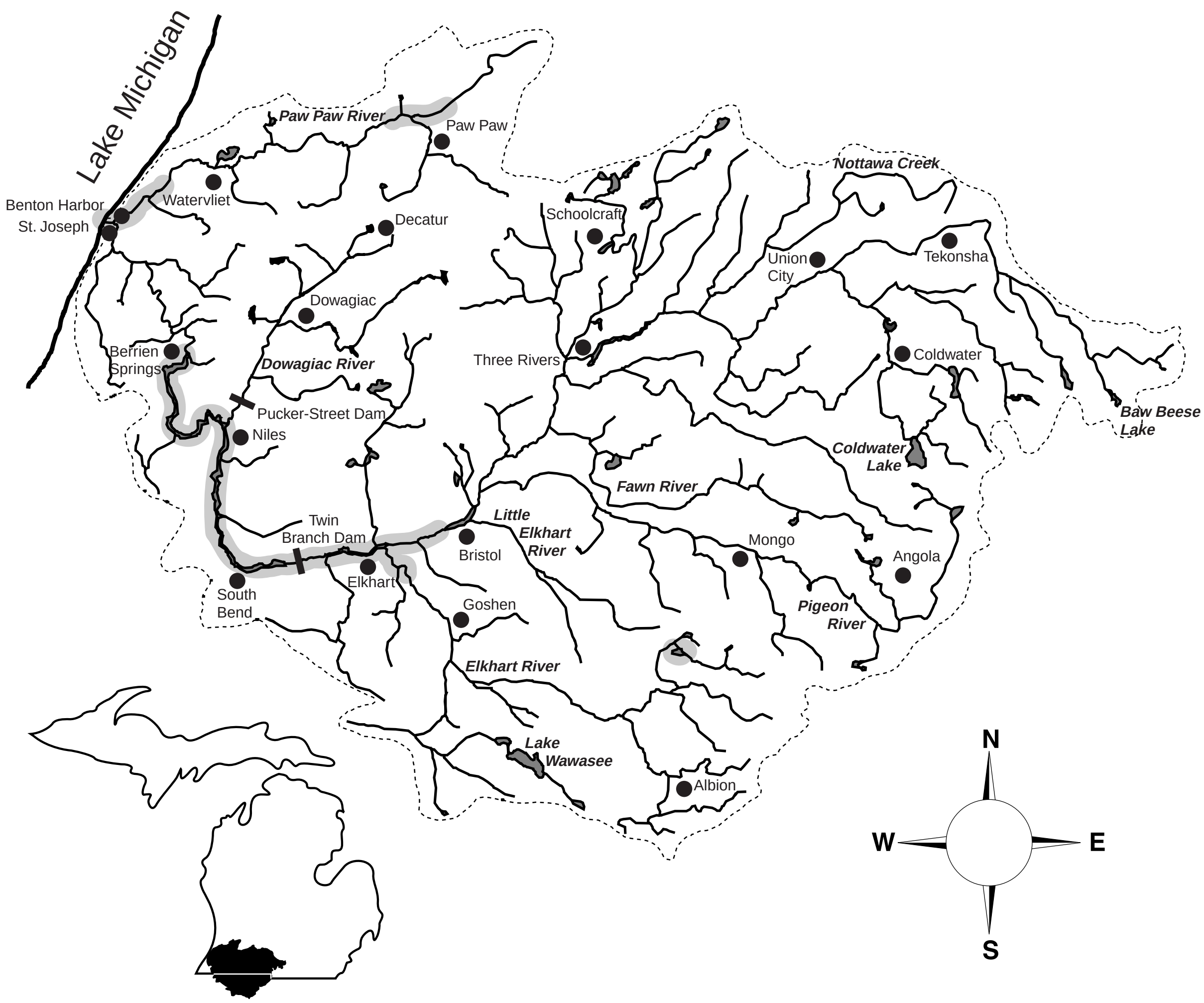


White crappie (*Pomoxis annularis*)

Habitat:

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

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

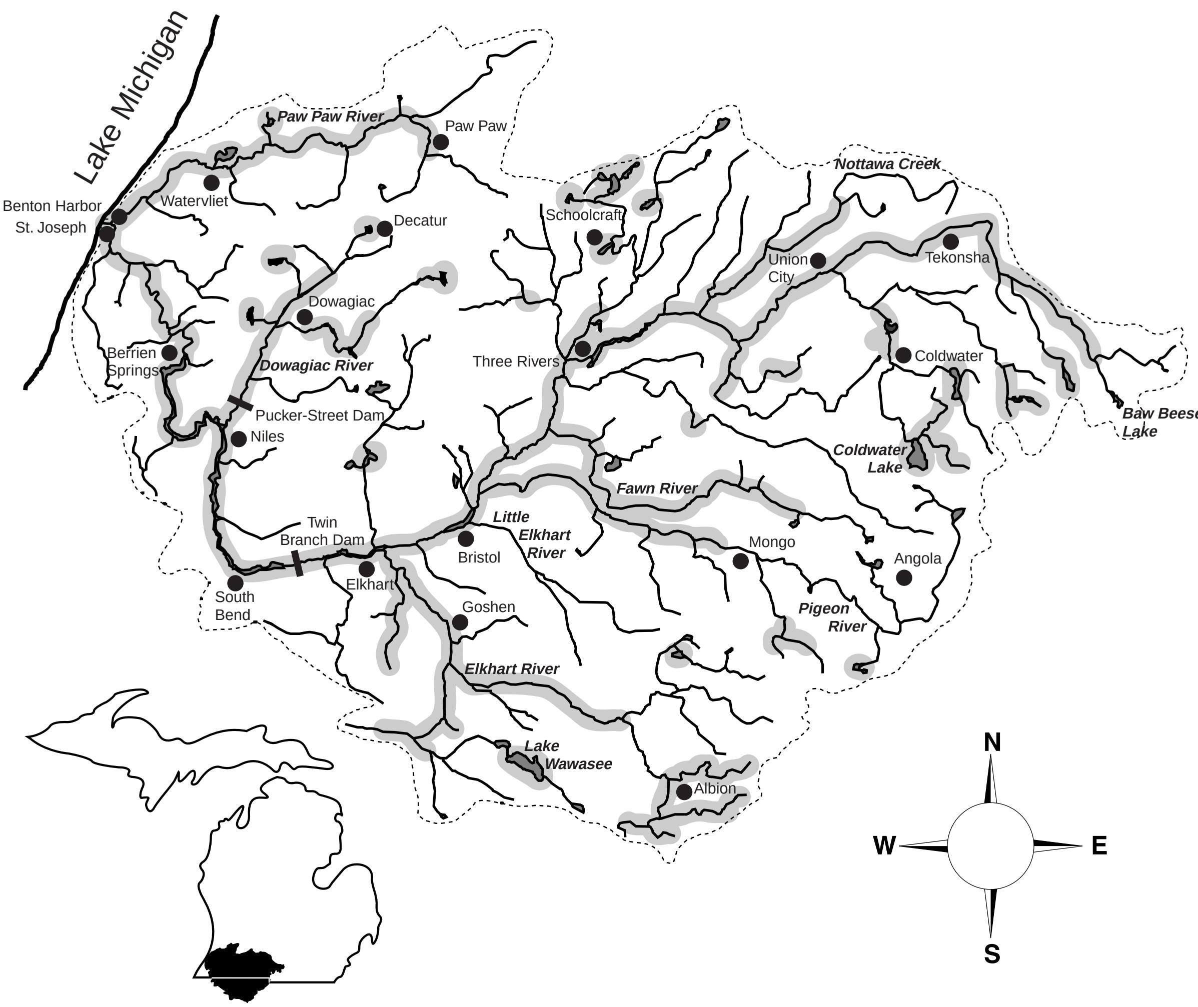


Black crappie (*Pomoxis nigromaculatus*)

Habitat:

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

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

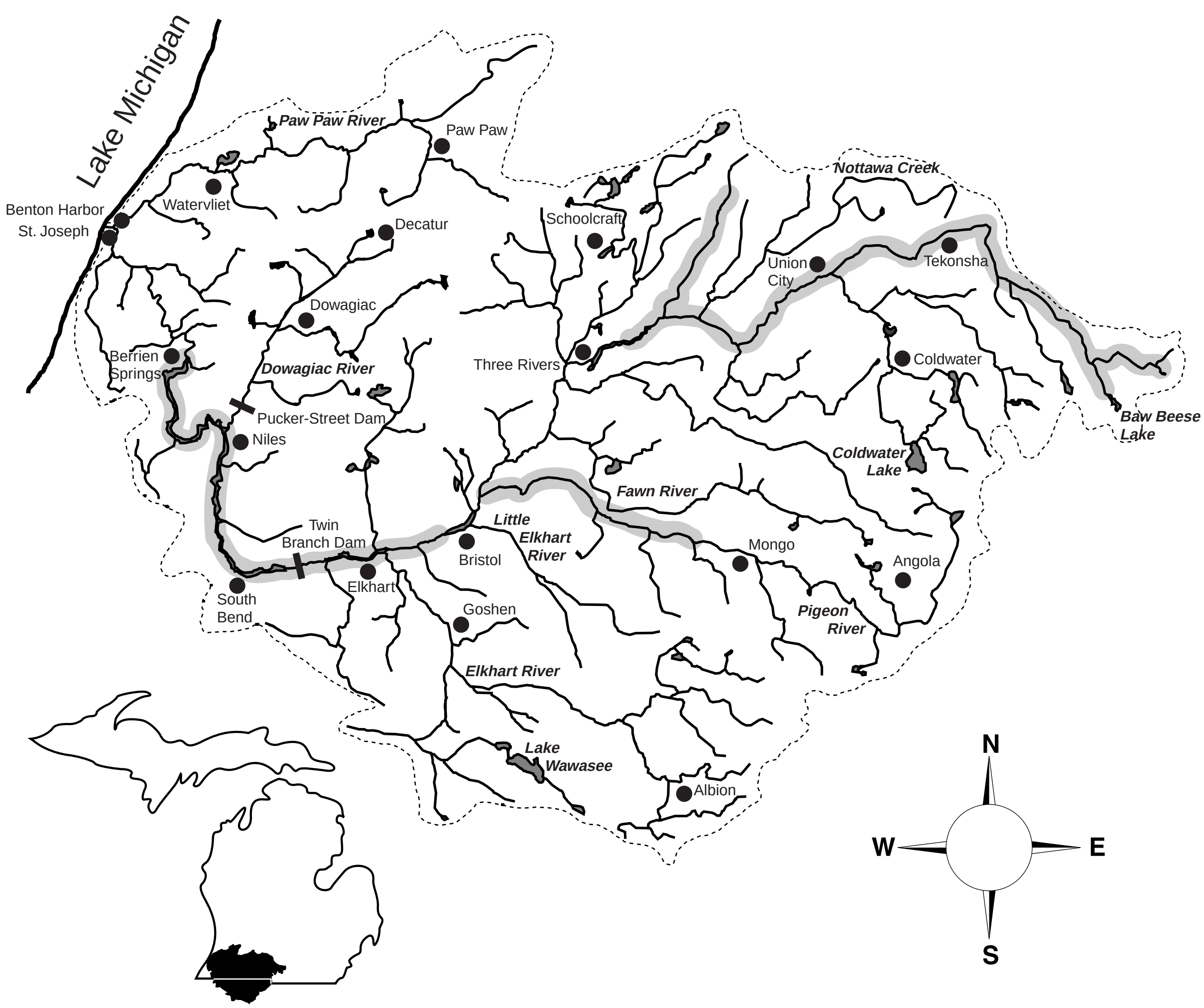


Greenside darter (*Etheostoma blennioides*)

Habitat:

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

spawning - filamentous algae necessary for egg deposition

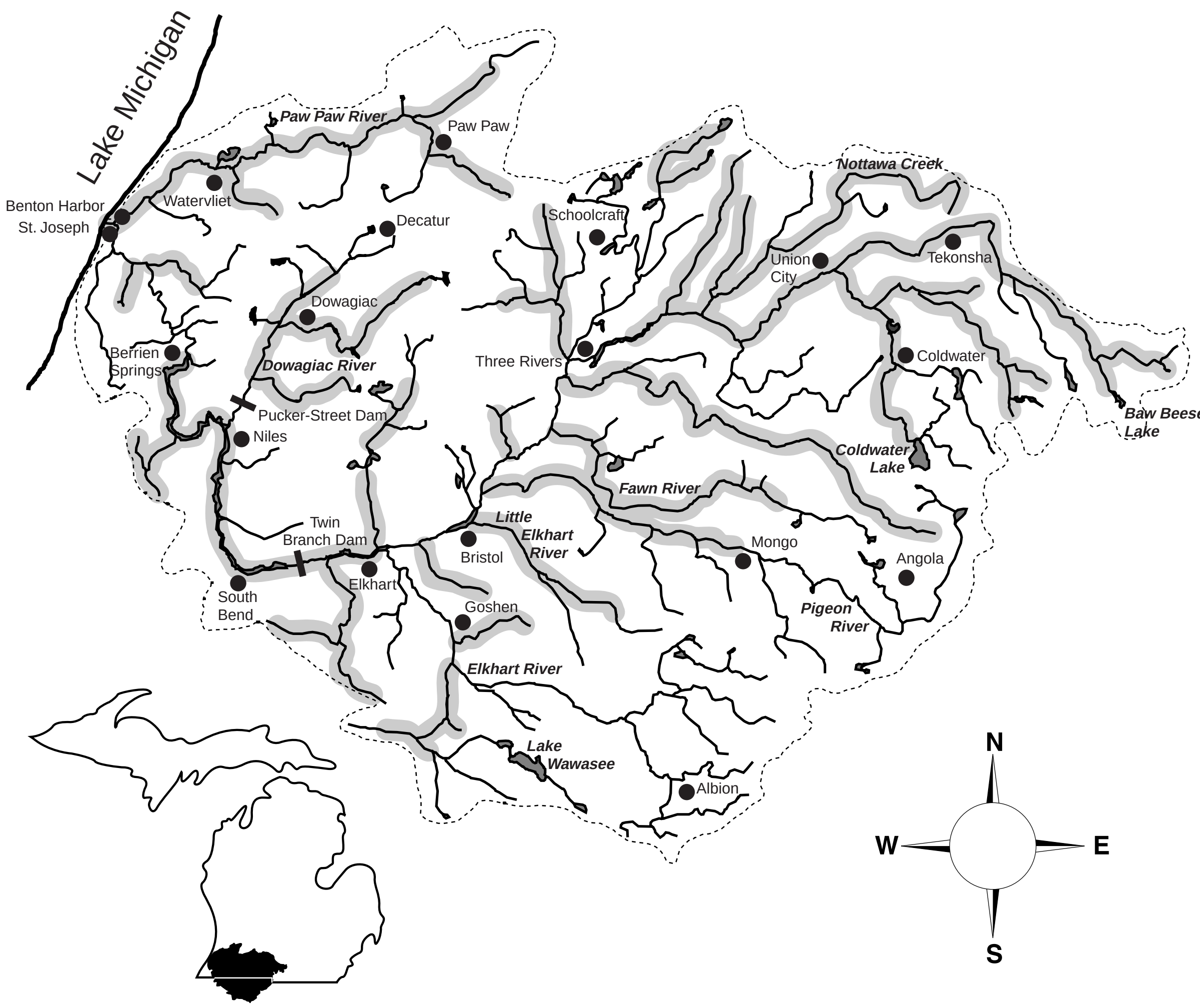


Rainbow darter (*Etheostoma caeruleum*)

Habitat:

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

spawning - gravel or rubble riffles

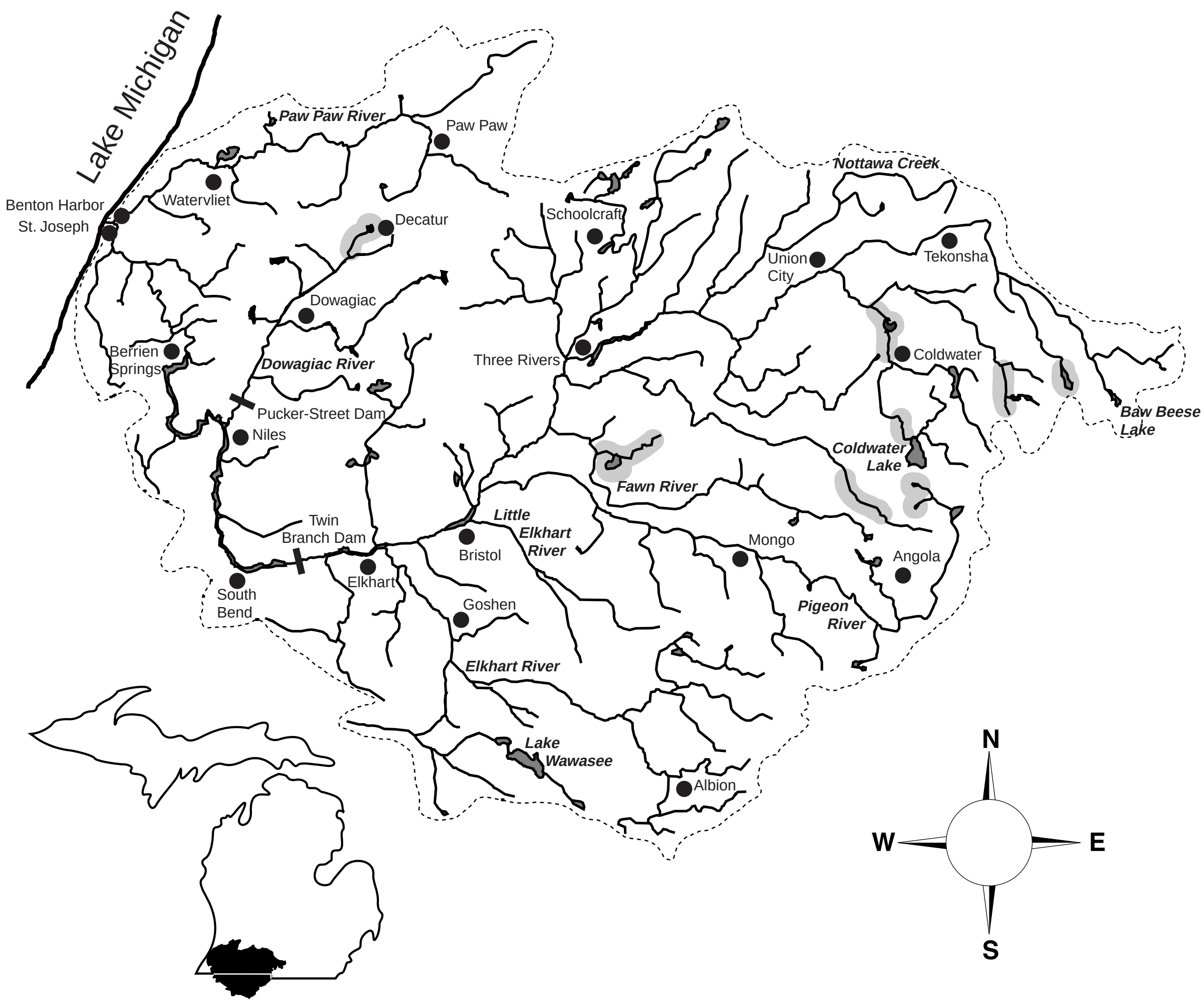


Iowa darter (*Etheostoma exile*)

Habitat:

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

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



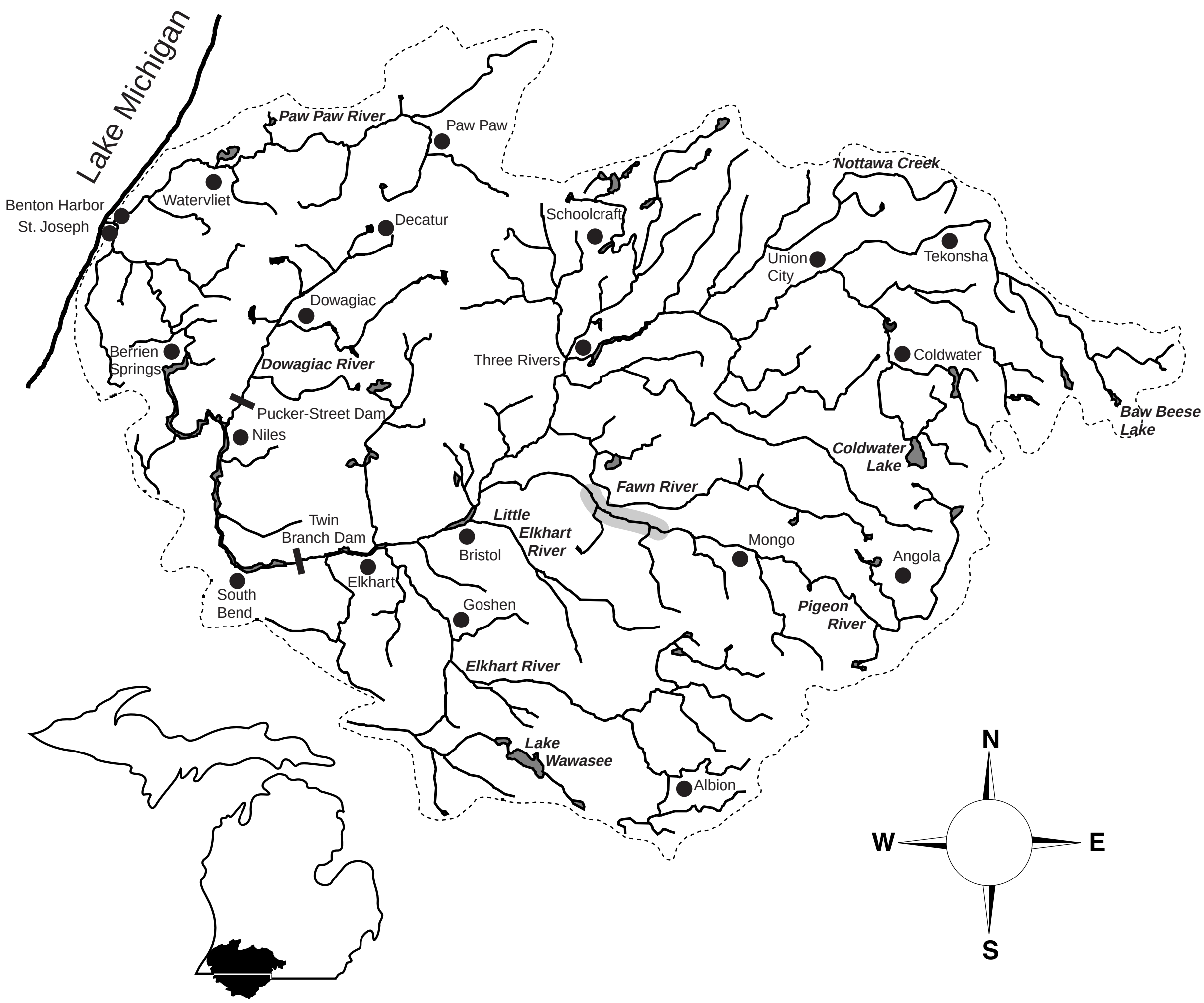
Fantail darter (*Etheostoma flabellare*)

Habitat:

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

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

winter refuge
- moves downstream to larger and deeper waters

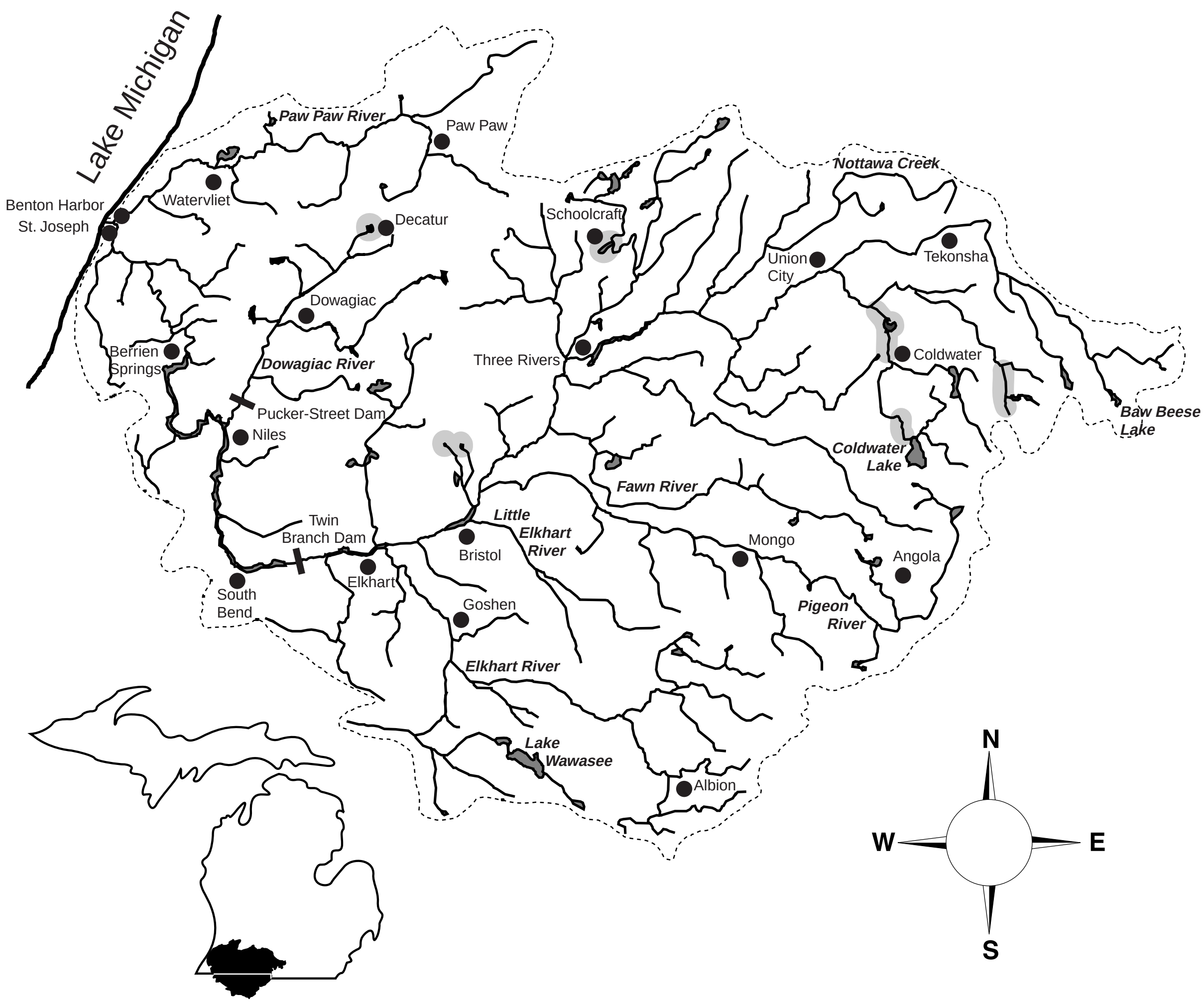


Least darter (*Etheostoma microperca*)

Habitat:

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

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

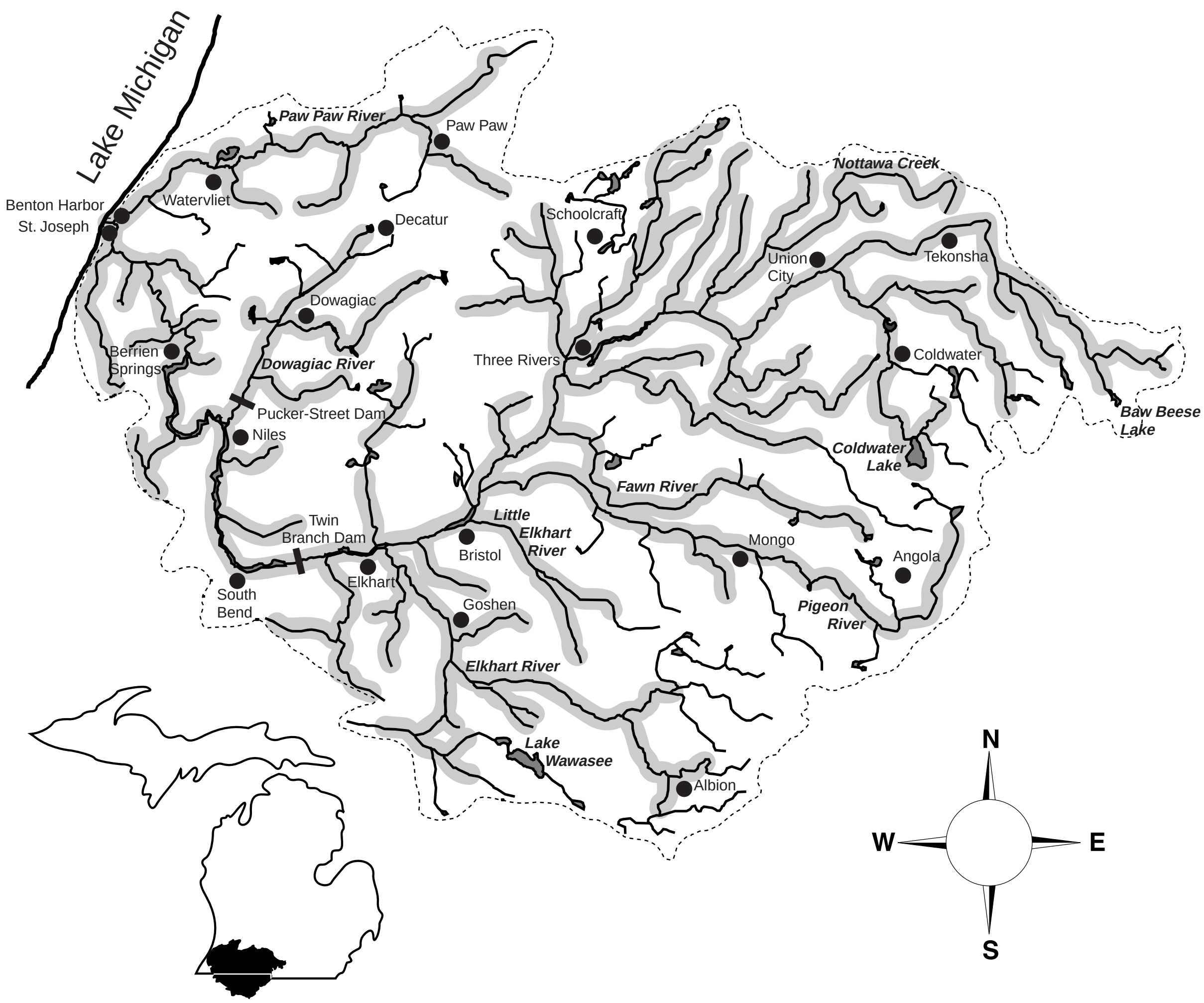


Johnny darter (*Etheostoma nigrum*)

Habitat:

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

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

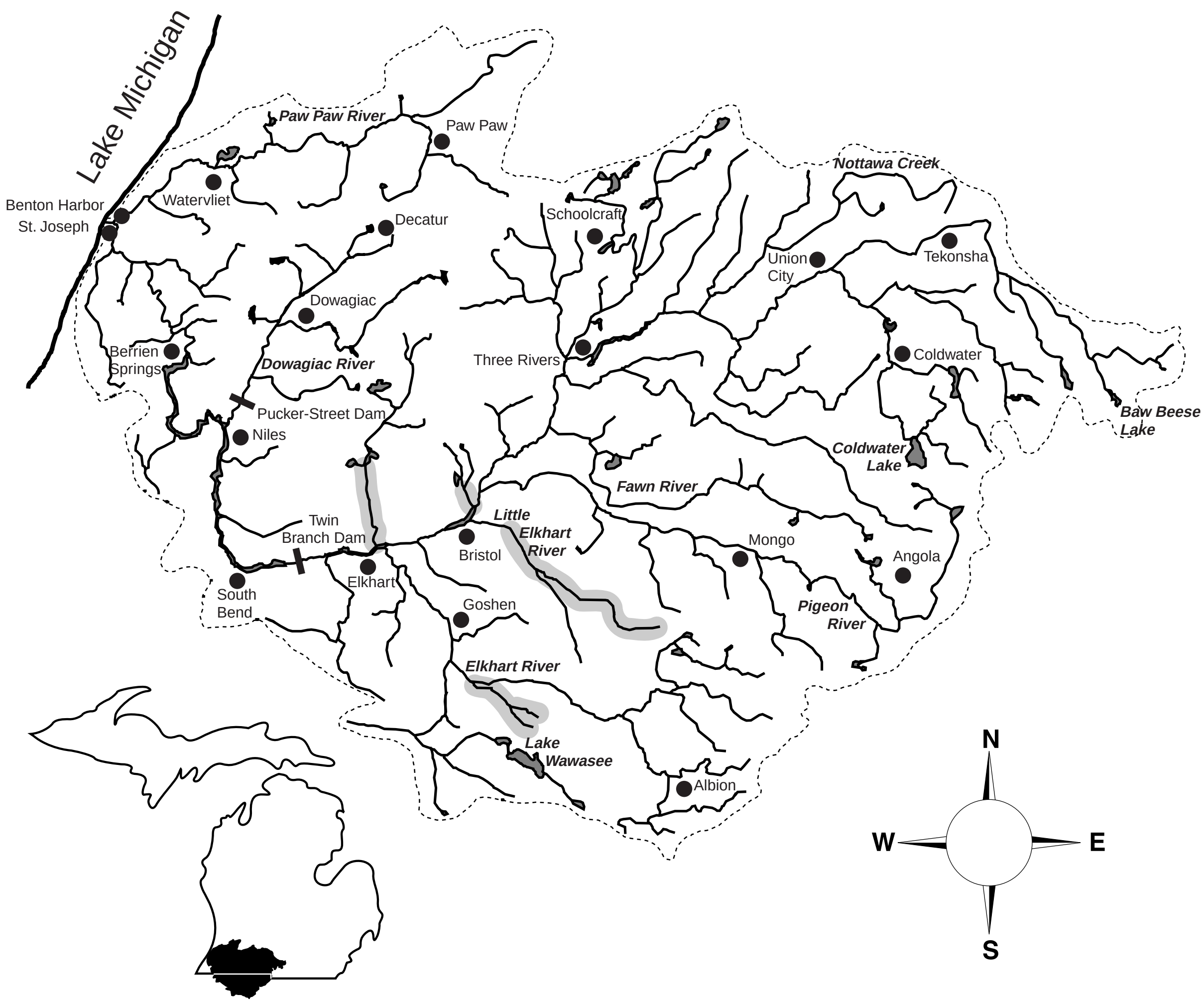


Orangethroat darter (*Etheostoma spectabile*)

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 of turbidity
- low to moderate gradient

spawning
- gravel riffles
- slow current

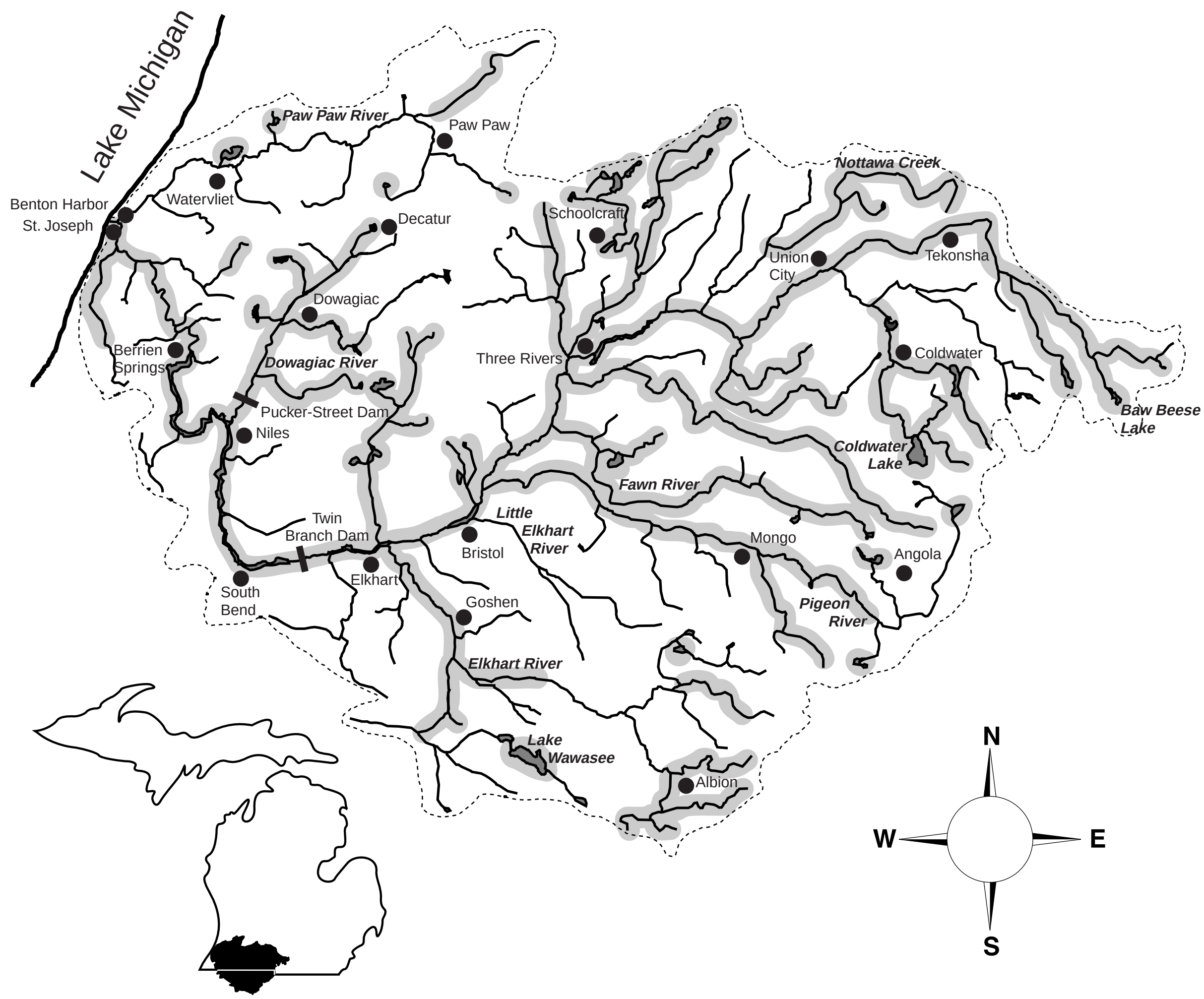


Yellow perch (*Perca flavescens*)

Habitat:

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

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

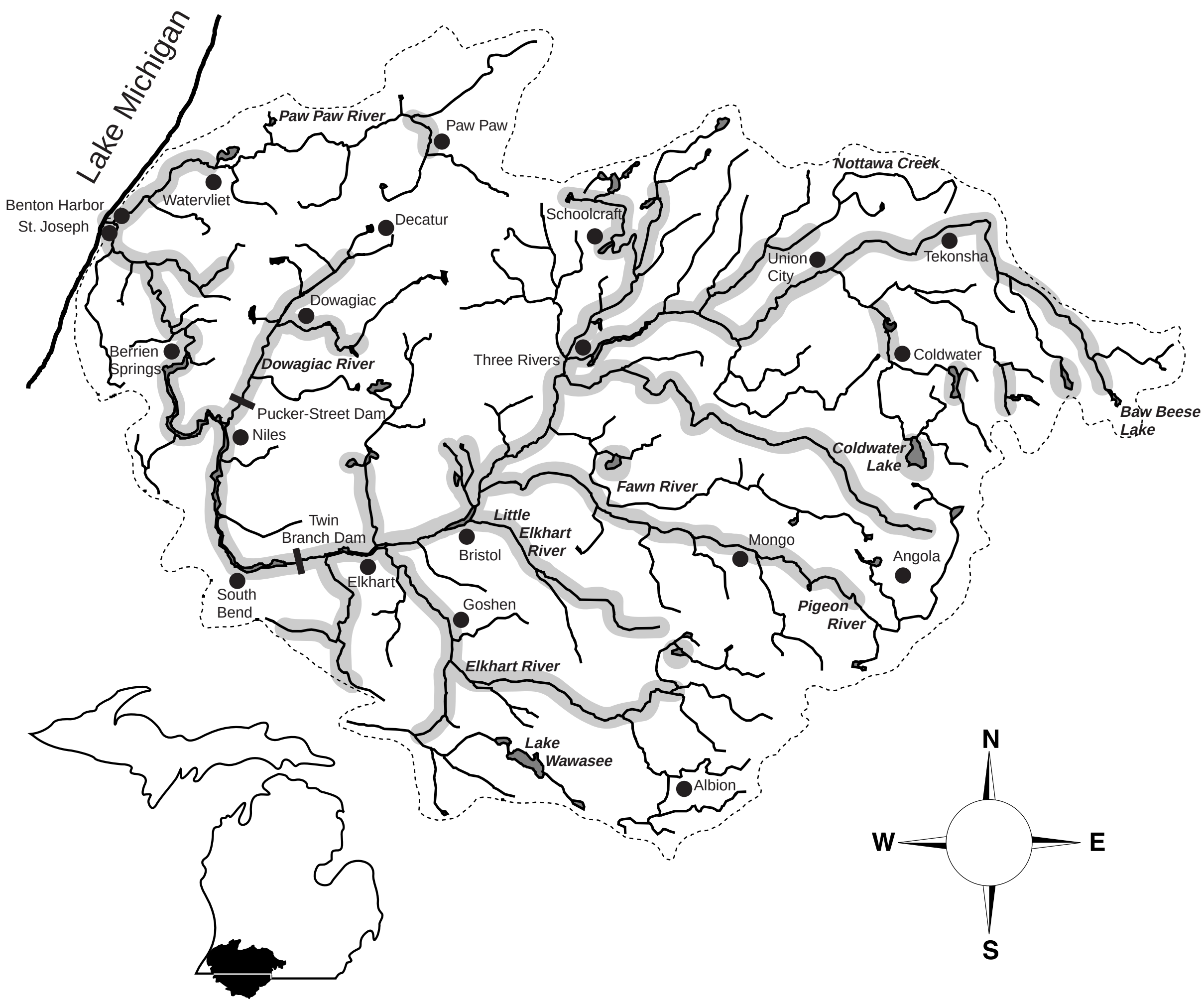


Logperch (*Percina caprodes*)

Habitat:

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

spawning - riffles or sandy in-shore shallows

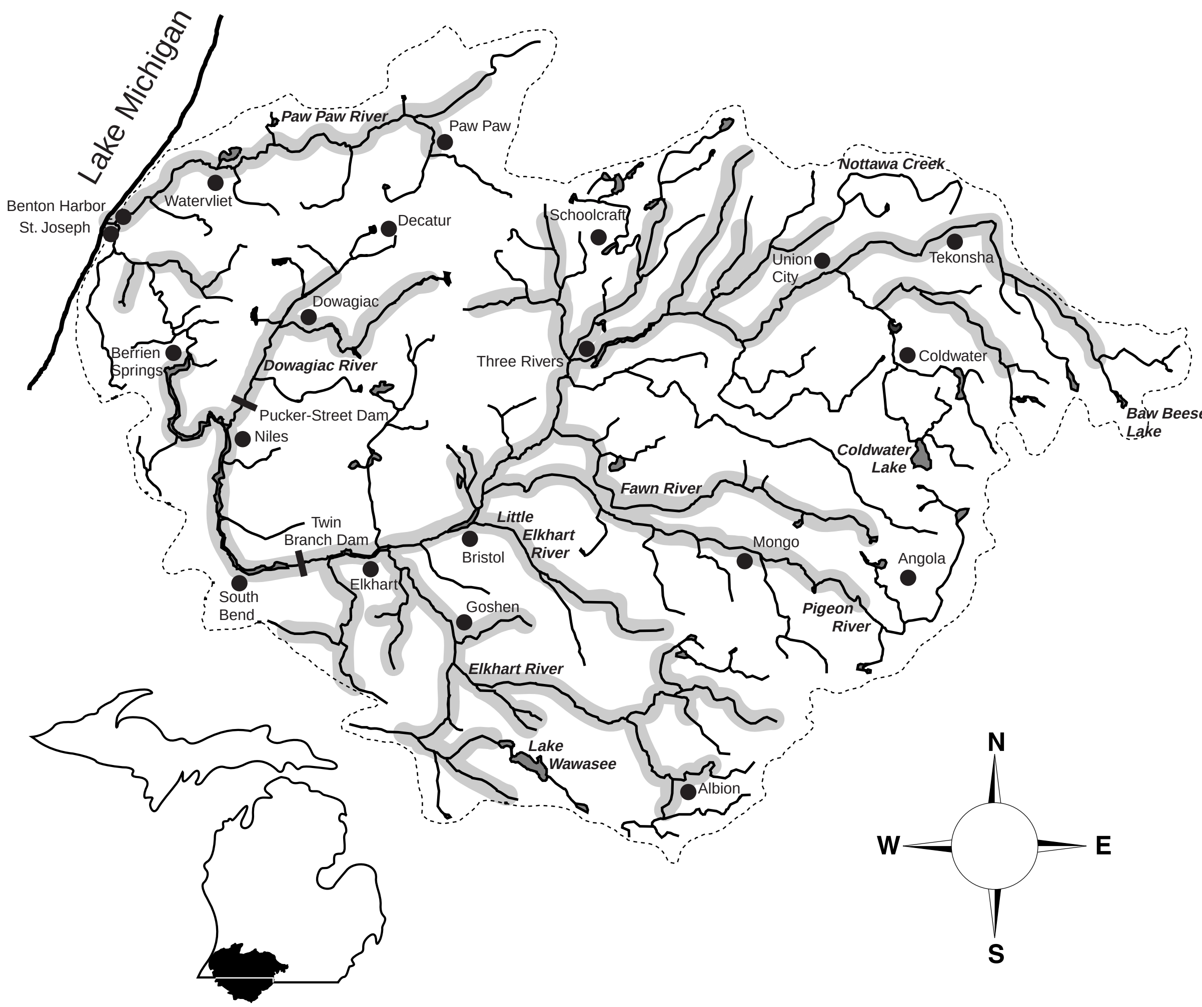


Blackside darter (*Percina maculata*)

Habitat:

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

spawning - gravel and sand substrate



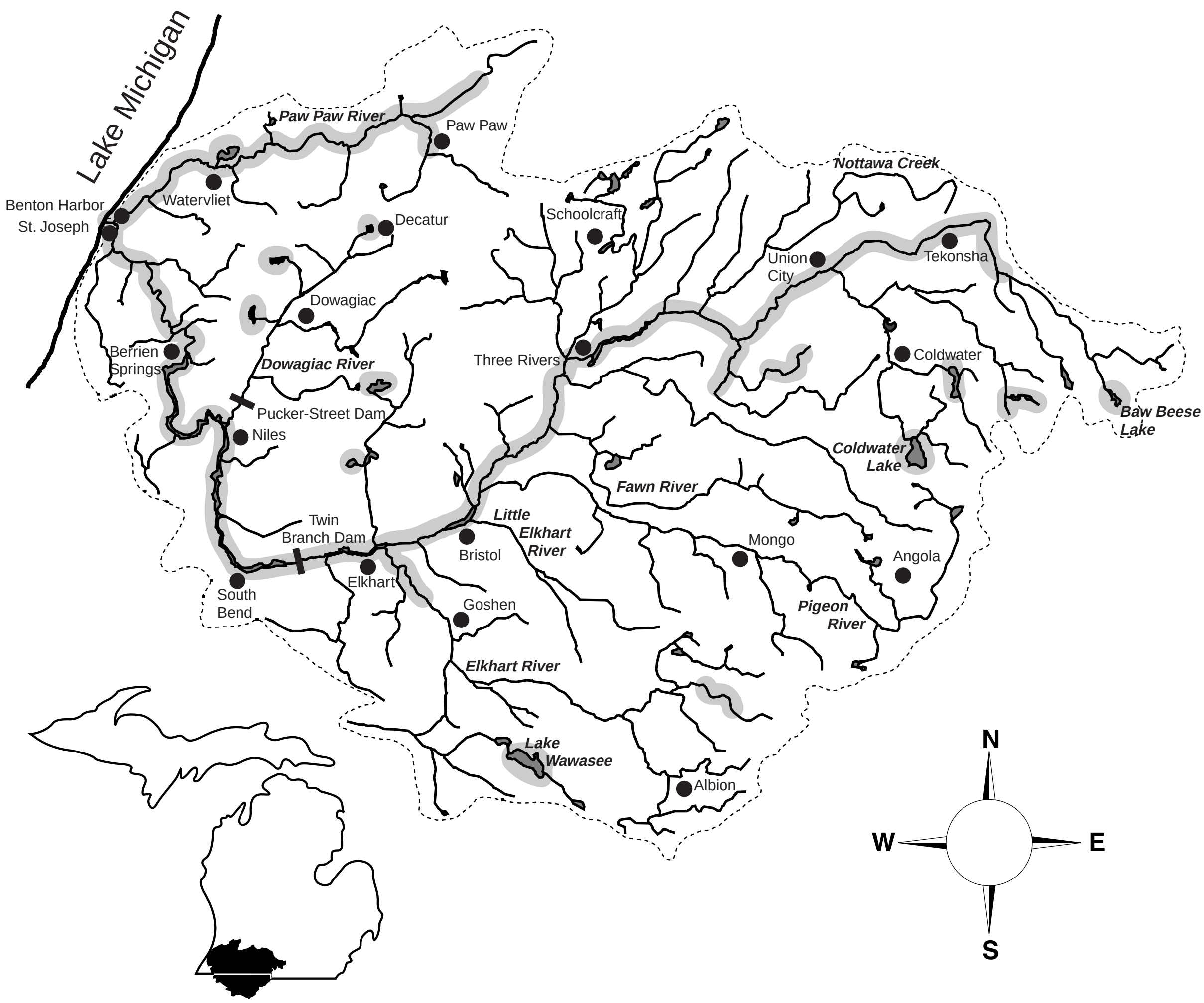
Walleye (*Stizostedion vitreum*)

Habitat:

feeding
- larger, deeper streams and in large, shallow, turbid lakes and impoundments; also Lake Michigan
- gravel, bedrock, and firm substrates preferred
- does not tolerate a lot of turbidity or low oxygen

spawning
- rocky substrates in high gradient water in rivers
- boulder to coarse gravel shoals in lakes

winter refuge
- avoids strong currents

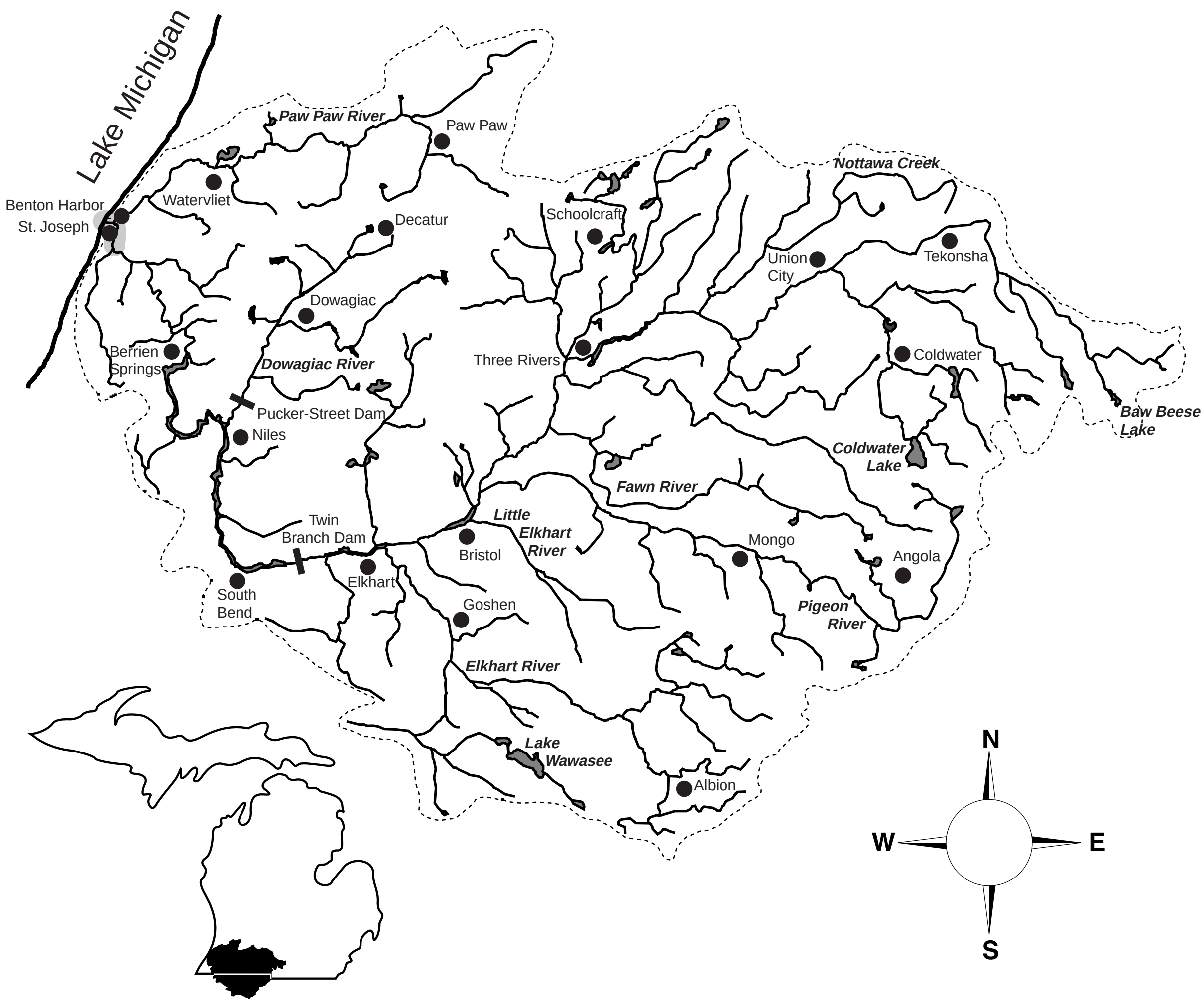


Freshwater drum (*Aplodinotus grunniens*)

Habitat:

feeding
- deeper pools of rivers and Lake Michigan
- in shallows
- prefers clear waters and clean substrates
- can adapt to high turbidity levels

spawning
- pelagically, in open water, over sand or mud substrate
- occurs in bays or lower portions of marshes



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Appendix 2

Miscellaneous Historical Creel Data

This appendix contains miscellaneous creel data from 1928-1964 for the St. Joseph River and tributaries. Angler hours, catch by species, total catch, catch per effort (CPE) by species, and total catch per effort were summarized by year for each waterbody. All reported catch was harvest. These data were compiled from general creel census records (Ryckman 1981) located at Michigan Department of Natural Resources, Institute for Fisheries Research. Catch rates were calculated using ratio-of-means estimator for complete fishing trips: CPE = total catch/total hours (Lockwood et al. 1999). Table shows precision to only one decimal place.

References

Lockwood, R.N., D.M. Benjamin, and J.R. Bence. 1999. Estimating angling effort and catch from Michigan roving and access site angler survey data. Michigan Department of Natural Resources, Fisheries Division, Research Report 2044, Ann Arbor, Michigan.

Ryckman, J.R. 1981. Creel census methods in general. Appendix VI-A-9 *in* J.W. Merna, J.C. Schneider, G.R. Alexander, W.D. Alward, and R.L. Eshenroder, editors. Manual of fisheries survey methods. Fisheries Management Report No. 9, Michigan Department of Natural Resources, Lansing, Michigan.

Appendix 2.

Segment and stream	Year	Angler hours	Total #'s Fish	Total CPE	Brook Trout		Brown Trout		Rainbow Trout		Smallmouth Bass		Largemouth Bass		Bluegill		Pumpkinseed		Rock Bass		Black Crappie		Yellow Perch		Walleye		Northern Pike		Bullhead		Carp		Sucker		Channel Catfish		Bowfin	
					Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE
Headwaters																																								
Beebe Creek	1953	14	28	2.0																													28	2.0				
St. Joseph River	1937	18	20	1.1																									1	0.1			19	1.1				
St. Joseph River	1939	19	62	3.3																			10	0.5					5	0.3	17	0.9	30	1.6				
St. Joseph River	1945	18	2	0.1																							2	0.1										
St. Joseph River	1946	6	1	0.2																							1	0.2										
St. Joseph River	1951	2	8	4.0													6	3.0			2	1.0																
St. Joseph River	1952	23	48	2.1													4	0.2	10	0.4							1	0.0					33	1.4				
St. Joseph River	1953	82	32	0.4																							4	0.0					28	0.3				
St. Joseph River	1954	80	17	0.2																							1	0.0					16	0.2				
St. Joseph River	1957	45	11	0.2					11	0.2																												
Upper																																								
Bear Creek	1946	11	16	1.5																									16	1.5								
Coldwater River	1928	2	0	0.0																																		
Coldwater River	1930	6	2	0.3									2	0.3																								
Coldwater River	1932	17	38	2.2							10	0.6	19	1.1	2	0.1			7	0.4																		
Coldwater River	1934	5	21	4.2									2	0.4	7	1.4	4	0.8	5	1.0			3	0.6														
Coldwater River	1937	39	55	1.4									18	0.5	23	0.6	12	0.3					2	0.1														
Coldwater River	1938	73	97	1.3							4	0.1	17	0.2	51	0.7	3	0.0	13	0.2			8	0.1					1	0.0								
Coldwater River	1944	39	39	1.0															27	0.7					1	0.0	6	0.2	3	0.1			2	0.1				
Coldwater River	1946	64	39	0.6									4	0.1	25	0.4			3	0.0	1	0.0					1	0.0	5	0.1								
Coldwater River	1949	10	15	1.5											10	1.0	2	0.2	3	0.3																		
Coldwater River	1953	1	0	0.0																																		
Coldwater River	1962	13	24	1.9							1	0.1			15	1.2	8	0.6																				
Coldwater River	1963	21	21	1.0											4	0.2	3	0.1	13	0.6			1	0.0														
Hog Creek	1944	48	33	0.7																							1	0.0					32	0.7				
Hog Creek	1946	12	0	0.0																																		
Hog Creek	1953	8	2	0.3																													2	0.3				
Nottawa Creek	1929	3	1	0.3																							1	0.3										
Nottawa Creek	1936	3	14	4.7															14	4.7																		
Nottawa Creek	1943	4	19	4.8																									19	4.8								
Nottawa Creek	1945	42	18	0.4							17	0.4	1	0.0																								
Nottawa Creek	1946	82	59	0.7											4	0.0	2	0.0			1	0.0									3	0.0	48	0.6			1	0.0
Nottawa Creek	1947	26	24	0.9									3	0.1	11	0.4	4	0.2	6	0.2																		

Appendix 2.–Continued.

Segment and stream	Year	Angler hours	Total #'s Fish	Total CPE	Brook Trout		Brown Trout		Rainbow Trout		Smallmouth Bass		Largemouth Bass		Bluegill		Pumpkinseed		Rock Bass		Black Crappie		Yellow Perch		Walleye		Northern Pike		Bullhead		Carp		Sucker		Channel Catfish		Bowfin	
					Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE
Upper (continued)																																						
Nottawa Creek	1950	8	13	1.6																			11	1.4			2	0.3										
Nottawa Creek	1951	14	3	0.2			3	0.2																														
Nottawa Creek	1953	34	14	0.4	1	0.0	2	0.1	11	0.3																												
Nottawa Creek	1954	46	9	0.2			2	0.0	1	0.0											4	0.1											2	0.0				
Nottawa Creek	1956	24	30	1.3									2	0.1	14	0.6	6	0.3	7	0.3	1	0.0																
Pine Creek	1945	12	11	0.9																													11	0.9				
St. Joseph River	1930	17	94	5.5																											8	0.5	71	4.2			15	0.9
St. Joseph River	1931	8	17	2.1							1	0.1			5	0.6	7	0.9	4	0.5																		
St. Joseph River	1932	2	2	1.0									2	1.0																								
St. Joseph River	1933	109	283	2.6							24	0.2	1	0.0	201	1.8	6	0.1	25	0.2	14	0.1	2	0.0					10	0.1								
St. Joseph River	1934	43	212	4.9							8	0.2			196	4.6			8	0.2																		
St. Joseph River	1937	198	1233	6.2							1	0.0	11	0.1	1092	5.5	17	0.1	30	0.2	10	0.1	1	0.0			1	0.0					69	0.3			1	0.0
St. Joseph River	1938	31	13	0.4							3	0.1	6	0.2			1	0.0									3	0.1										
St. Joseph River	1943	77	144	1.9									1	0.0	137	1.8			6	0.1																		
St. Joseph River	1944	3	3	1.0																													3	1.0				
St. Joseph River	1945	46	46	1.0											41	0.9			2	0.0							1	0.0					2	0.0				
St. Joseph River	1946	46	17	0.4											5	0.1			7	0.2							1	0.0	4	0.1								
St. Joseph River	1949	40	40	1.0											18	0.5	5	0.1	1	0.0	13	0.3					3	0.1										
St. Joseph River	1952	3	4	1.3															4	1.3																		
St. Joseph River	1953	1	0	0.0																																		
St. Joseph River	1954	30	64	2.1											39	1.3	13	0.4			7	0.2									5	0.2						
St. Joseph River	1962	16	18	1.1							1	0.1			6	0.4	10	0.6	1	0.1																		
St. Joseph River	1964	38	22	0.6							2	0.1			20	0.5																						
Swan Creek	1930	18	82	4.6																											46	2.6					36	2.0
Swan Creek	1944	13	33	2.5																													3	0.2			30	2.3
Swan Creek	1954	23	9	0.4																													9	0.4				
Middle																																						
Christiana	1954	12	7	0.6					7	0.6																												
Curtis Creek	1933	10	21	2.1	12	1.2	1	0.1	8	0.8																												
Curtis Creek	1944	11	4	0.4	4	0.4																																
Curtis Creek	1945	17	21	1.2	21	1.2																																
Curtis Creek	1946	24	13	0.5	13	0.5																																
Curtis Creek	1950	10	17	1.7	17	1.7																																

Appendix 2.–Continued.

Segment and stream	Year	Angler hours	Total #'s Fish	Total CPE	Brook Trout		Brown Trout		Rainbow Trout		Smallmouth Bass		Largemouth Bass		Bluegill		Pumpkinseed		Rock Bass		Black Crappie		Yellow Perch		Walleye		Northern Pike		Bullhead		Carp		Sucker		Channel Catfish		Bowfin	
					Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE
Middle (continued)																																						
Curtis Creek	1953	14	8	0.6	8	0.6																																
Curtis Creek	1963	5	2	0.4	2	0.4																																
Fawn River	1934	4	2	0.5																							2	0.5										
Fawn River	1943	6	27	4.5											3	0.5							18	3.0							6	1.0						
Fawn River	1944	3	7	2.3															1	0.3			6	2.0														
Fawn River	1945	5	3	0.6									1	0.2							2	0.4																
Fawn River	1947	7	4	0.6									3	0.4													1	0.1										
Fawn River	1958	8	27	3.4											14	1.8	3	0.4			10	1.3																
Fawn River	1962	10	17	1.7															10	1.0			2	0.2							3	0.3	2	0.2				
Flowerfield Creek	1933	2	4	2.0	3	1.5	1	0.5																														
Flowerfield Creek	1934	29	61	2.1	60	2.1	1	0.0																														
Flowerfield Creek	1950	3	8	2.7			2	0.7	6	2.0																												
Flowerfield Creek	1953	27	30	1.1			9	0.3	21	0.8																												
Flowerfield Creek	1954	60	71	1.2			17	0.3	54	0.9																												
Flowerfield Creek	1963	50	63	1.3			26	0.5	37	0.7																												
Flowerfield Creek	1964	38	3	0.1			1	0.0	2	0.1																												
Kegon Creek	1930	39	36	0.9	31	0.8	5	0.1																														
Kegon Creek	2028	25	29	1.2	29	1.2																																
Mill Creek	1934	13	17	1.3	15	1.2			2	0.2																												
Pigeon River	1930	5	2	0.4																							2	0.4										
Pigeon River	1945	5	4	0.8																							4	0.8										
Pigeon River	1947	28	36	1.3							13	0.5			7	0.3	5	0.2	1	0.0									9	0.3			1	0.0				
Portage River	1929	8	9	1.1											3	0.4	1	0.1									3	0.4					2	0.3				
Portage River	1930	1	1	1.0																					1	1.0												
Portage River	1933	1	14	14									2	2.0	10	10.0																	2	2.0				
Portage River	1934	2	25	13											25	12.5																						
Portage River	1940	6	5	0.8											5	0.8																						
Portage River	1941	4	1	0.3																							1	0.3										
Portage River	1943	67	46	0.7							12	0.2	4	0.1	1	0.0	1	0.0	19	0.3			5	0.1			2	0.0	2	0.0								
Portage River	1944	6	7	1.2							4	0.7							3	0.5																		
Portage River	1945	4	0	0.0																																		
Portage River	1946	1	6	6.0															1	1.0	2	2.0							3	3.0								
Portage River	1947	3	1	0.3							1	0.3																										
Portage River	1949	7	21	3.0									1	0.1	8	1.1	5	0.7	7	1.0																		

Appendix 2.–Continued.

Segment and stream	Year	Angler hours	Total #'s Fish	Total CPE	Brook Trout		Brown Trout		Rainbow Trout		Smallmouth Bass		Largemouth Bass		Bluegill		Pumpkinseed		Rock Bass		Black Crappie		Yellow Perch		Walleye		Northern Pike		Bullhead		Carp		Sucker		Channel Catfish		Bowfin	
					Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE
Middle (continued)																																						
Portage River	1959	10	21	2.1							7	0.7					3	0.3	11	1.1																		
Portage River	1961	6	2	0.3																							2	0.3										
Prairie River	1928	5	1	0.2																					1	0.2												
Prairie River	1929	23	24	1.0											2	0.1	1	0.0	9	0.4			2	0.1			3	0.1			1	0.0	6	0.3				
Prairie River	1932	2	11	5.5	11	5.5																																
Prairie River	1943	12	12	1.0	2	0.2			4	0.3																					6	0.5						
Prairie River	1944	6	7	1.2			1	0.2	6	1.0																												
Prairie River	1945	34	61	1.8	28	0.8	23	0.7	10	0.3																												
Prairie River	1946	55	56	1.0	52	0.9			4	0.1																												
Prairie River	1949	280	159	0.6	57	0.2	8	0.0	94	0.3																												
Prairie River	1950	32	12	0.4	3	0.1	5	0.2	4	0.1																												
Prairie River	1951	162	35	0.2	11	0.1	13	0.1	11	0.1																												
Prairie River	1952	104	62	0.6	21	0.2	35	0.3	6	0.1																												
Rocky River	1928	27	65	2.4	65	2.4																																
Rocky River	1929	25	41	1.6											15	0.6			3	0.1							1	0.0	1	0.0			21	0.8				
Rocky River	1933	14	39	2.8							1	0.1	28	2.0	9	0.6											1	0.1										
Rocky River	1934	24	26	1.1							1	0.0	21	0.9													4	0.2										
Rocky River	1938	6	10	1.7																													10	1.7				
Rocky River	1939	40	16	0.4															16	0.4																		
Rocky River	1943	5	9	1.8			1	0.2	8	1.6																												
Rocky River	1944	7	2	0.3					2	0.3																												
Rocky River	1945	24	49	2.0			18	0.8	13	0.5			2	0.1	4	0.2	2	0.1	10	0.4																		
Rocky River	1946	20	11	0.6			2	0.1	9	0.5																												
Sherman Mills Creek	1954	26	37	1.4					37	1.4																												
St. Joseph River	1928	224	176	0.8							25	0.1	48	0.2	59	0.3			12	0.1			4	0.0	3	0.0	5	0.0	20	0.1								
St. Joseph River	1929	112	174	1.6							2	0.0	3	0.0	75	0.7	9	0.1	19	0.2			15	0.1			35	0.3	4	0.0			12	0.1				
St. Joseph River	1930	196	268	1.4							1	0.0	7	0.0	136	0.7	24	0.1	14	0.1	23	0.1	34	0.2			20	0.1	8	0.0	1	0.0						
St. Joseph River	1931	74	154	2.1											118	1.6					26	0.4	7	0.1					3	0.0								
St. Joseph River	1932	4	8	2.0							8	2.0																										
St. Joseph River	1933	7	21	3.0									4	0.6	17	2.4																						
St. Joseph River	1934	32	75	2.3							9	0.3			49	1.5			15	0.5			2	0.1														
St. Joseph River	1936	180	365	2.0							17	0.1	47	0.3	258	1.4	38	0.2									5	0.0										
St. Joseph River	1938	5	2	0.4																							2	0.4										
St. Joseph River	1940	19	44	2.3									2	0.1	33	1.7	6	0.3									3	0.2										

Appendix 2.–Continued.

Segment and stream	Year	Angler hours	Total #'s Fish	Total CPE	Brook Trout		Brown Trout		Rainbow Trout		Smallmouth Bass		Largemouth Bass		Bluegill		Pumpkinseed		Rock Bass		Black Crappie		Yellow Perch		Walleye		Northern Pike		Bullhead		Carp		Sucker		Channel Catfish		Bowfin	
					Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE
Middle (continued)																																						
St. Joseph River	1941	474	376	0.8							21	0.0	15	0.0	100	0.2	22	0.0	37	0.1	38	0.1	101	0.2			22	0.0			16	0.0	1	0.0	1	0.0	2	0.0
St. Joseph River	1942	142	118	0.8							1	0.0	2	0.0	76	0.5	2	0.0	24	0.2	1	0.0	7	0.0			2	0.0	2	0.0			1	0.0				
St. Joseph River	1943	770	485	0.6							9	0.0	42	0.1	196	0.3	33	0.0	16	0.0	13	0.0	45	0.1			47	0.1	54	0.1	15	0.0	15	0.0				
St. Joseph River	1944	158	134	0.9							3	0.0	3	0.0	30	0.2	2	0.0	23	0.1	36	0.2	2	0.0			6	0.0	16	0.1			13	0.1				
St. Joseph River	1945	461	201	0.4							2	0.0	7	0.0	65	0.1	7	0.0	18	0.0	5	0.0					33	0.1	27	0.1			37	0.1				
St. Joseph River	1946	1028	497	0.5							2	0.0	21	0.0	165	0.2	14	0.0	51	0.0	89	0.1	39	0.0			96	0.1	9	0.0			10	0.0			1	0.0
St. Joseph River	1947	472	280	0.6							1	0.0	3	0.0	211	0.4	13	0.0	11	0.0	5	0.0	7	0.0			4	0.0	22	0.0			3	0.0				
St. Joseph River	1948	273	226	0.8							1	0.0	1	0.0	198	0.7	10	0.0	8	0.0	4	0.0	4	0.0														
St. Joseph River	1949	684	952	1.4									20	0.0	479	0.7	130	0.2	47	0.1	199	0.3	42	0.1			32	0.0	1	0.0			2	0.0				
St. Joseph River	1950	742	588	0.8							15	0.0	7	0.0	306	0.4	43	0.1	67	0.1	6	0.0	30	0.0			84	0.1					30	0.0				
St. Joseph River	1951	148	81	0.6							1	0.0	4	0.0	76	0.5																						
St. Joseph River	1952	272	200	0.7							4	0.0	8	0.0	57	0.2	28	0.1	2	0.0	88	0.3	7	0.0			6	0.0										
St. Joseph River	1953	44	191	4.3											185	4.2	3	0.1					3	0.1														
St. Joseph River	1954	203	409	2.0							15	0.1	40	0.2	177	0.9	61	0.3	19	0.1	11	0.1	19	0.1			23	0.1	27	0.1	9	0.0	8	0.0				
St. Joseph River	1955	314	307	1.0							6	0.0	3	0.0	202	0.6	29	0.1	24	0.1	33	0.1	1	0.0							4	0.0			5	0.0		
St. Joseph River	1956	400	425	1.0							2	0.0	14	0.0	218	0.5	53	0.1	17	0.0	26	0.1	36	0.1			3	0.0	10	0.0	13	0.0	33	0.1				
St. Joseph River	1957	72	104	1.4							9	0.1	2	0.0	77	1.1	8	0.1	3	0.0	4	0.1					1	0.0										
St. Joseph River	1958	255	104	0.4							1	0.0	23	0.1	50	0.2			13	0.1	10	0.0	5	0.0			2	0.0										
St. Joseph River	1959	327	558	1.7							2	0.0	52	0.2	348	1.1	82	0.3	7	0.0	22	0.1	42	0.1			2	0.0					1	0.0				
St. Joseph River	1960	224	1698	7.6											1638	7.3	30	0.1					30	0.1														
St. Joseph River	1961	327	667	2.0							7	0.0	22	0.1	510	1.6	28	0.1	7	0.0	17	0.1	42	0.1			1	0.0	1	0.0	19	0.1	12	0.0	1	0.0		
St. Joseph River	1962	261	255	1.0							10	0.0	5	0.0	123	0.5	18	0.1	12	0.0	18	0.1	1	0.0			1	0.0	10	0.0	26	0.1	30	0.1	1	0.0		
St. Joseph River	1963	308	464	1.5									3	0.0	292	0.9	51	0.2	7	0.0	51	0.2	36	0.1			6	0.0	4	0.0	6	0.0	8	0.0				
St. Joseph River	1964	242	292	1.2									6	0.0	117	0.5	54	0.2	21	0.1	61	0.3	31	0.1			1	0.0	1	0.0								
Swan Creek	1945	5	17	3.4																									17	3.4								
Swan Creek	1947	3	12	4.0											7	2.3	3	1.0					2	0.7														
Thorpe Creek	1930	55	70	1.3	52	0.9	17	0.3	1	0.0																												
Thorpe Creek	1928	32	69	2.2	42	1.3			27	0.8																												
Lower																																						
Brandywine Cr.	1928	53	161	3.0	161	3.0																																
Brandywine Cr.	1930	133	162	1.2	110	0.8	32	0.2	20	0.2																												
Brandywine Cr.	1931	4	3	0.8	3	0.8																																
Brandywine Cr.	1932	8	6	0.8	6	0.8																																

Appendix 2.–Continued.

Segment and stream	Year	Angler hours	Total #'s Fish	Total CPE	Brook Trout		Brown Trout		Rainbow Trout		Smallmouth Bass		Largemouth Bass		Bluegill		Pumpkinseed		Rock Bass		Black Crappie		Yellow Perch		Walleye		Northern Pike		Bullhead		Carp		Sucker		Channel Catfish		Bowfin	
					Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE
Lower (continued)																																						
Brandywine Cr.	1933	1	0	0.0																																		
Brandywine Cr.	1935	37	49	1.3	49	1.3																																
Brandywine Cr.	1939	2	5	2.5	3	1.5	2	1.0																														
Brandywine Cr.	1944	16	1	0.1					1	0.1																												
Brandywine Cr.	1945	21	4	0.2	3	0.1			1	0.0																												
Brandywine Cr.	1947	7	3	0.4			3	0.4																														
Brandywine Cr.	1948	7	0	0.0																																		
Brandywine Cr.	1955	8	5	0.6					5	0.6																												
Dowagiac Creek	1935	30	14	0.5			13	0.4	1	0.0																												
Dowagiac Creek	1939	4	7	1.8							3	0.8			4	1.0																						
Dowagiac Creek	1949	46	11	0.2			10	0.2																			1	0.0										
Dowagiac Creek	1958	28	8	0.3	4	0.1	2	0.1	2	0.1																												
Dowagiac Creek	1959	75	50	0.7			45	0.6	5	0.1																												
Dowagiac Creek	1962	31	31	1.0			10	0.3	3	0.1																							18	0.6				
Dowagiac Creek	1963	18	24	1.3			21	1.2	3	0.2																												
Dowagiac Creek	1964	10	9	0.9					8	0.8									1	0.1																		
Dowagiac River	1933	2	1	0.5					1	0.5																												
Dowagiac River	1934	95	182	1.9	33	0.3	93	1.0	55	0.6			1	0.0																								
Dowagiac River	1939	12	7	0.6	3	0.3	4	0.3																														
Dowagiac River	1943	44	35	0.8					35	0.8																												
Dowagiac River	1944	29	6	0.2					6	0.2																												
Dowagiac River	1945	155	40	0.3			10	0.1	30	0.2																												
Dowagiac River	1946	46	2	0.0	1	0.0			1	0.0																												
Dowagiac River	1947	193	19	0.1			10	0.1	9	0.0																												
Dowagiac River	1948	210	79	0.4	14	0.1	37	0.2	28	0.1																												
Dowagiac River	1953	7	20	2.9																													20	2.9				
Dowagiac River	1954	243	84	0.4			69	0.3	15	0.1																												
Dowagiac River	1955	100	83	0.8	1	0.0	82	0.8																														
Dowagiac River	1957	38	14	0.4			5	0.1	9	0.2																												
Dowagiac River	1958	59	53	0.9					53	0.9																												
Dowagiac River	1959	123	146	1.2	7	0.1	18	0.1	121	1.0																												
Dowagiac River	1960	212	114	0.5	22	0.1	31	0.1	61	0.3																												
Dowagiac River	1962	268	255	1.0	78	0.3	82	0.3	95	0.4																												
Dowagiac River	1963	130	86	0.7	6	0.0	44	0.3	36	0.3																												

Appendix 2.–Continued.

Segment and stream	Year	Angler hours	Total #'s Fish	Total CPE	Brook Trout		Brown Trout		Rainbow Trout		Smallmouth Bass		Largemouth Bass		Bluegill		Pumpkinseed		Rock Bass		Black Crappie		Yellow Perch		Walleye		Northern Pike		Bullhead		Carp		Sucker		Channel Catfish		Bowfin	
					Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE
Lower (continued)																																						
Dowagiac River	1964	336	197	0.6	14	0.0	74	0.2	109	0.3																												
Glenwood Creek	1928	7	23	3.3	23	3.3																																
Glenwood Creek	1929	33	67	2.0	63	1.9	2	0.1	2	0.1																												
Glenwood Creek	1943	3	2	0.7					2	0.7																												
Glenwood Creek	1947	55	82	1.5	82	1.5																																
Glenwood Creek	1948	32	18	0.6	18	0.6																																
Glenwood Creek	1963	20	21	1.1	14	0.7	6	0.3	1	0.1																												
Kimmerlee Creek	1944	10	5	0.5	5	0.5																																
Lemon Creek	1931	28	8	0.3	7	0.3			1	0.0																												
Love Creek	1930	4	6	1.5	6	1.5																																
Love Creek	1931	13	15	1.2	14	1.1			1	0.1																												
Love Creek	1939	2	4	2.0	4	2.0																																
McCoy Creek	1930	2	2	1.0																													2	1.0				
McCoy Creek	1931	4	12	3.0					4	1.0																							8	2.0				
McCoy Creek	1944	5	0	0.0																																		
McCoy Creek	1945	48	22	0.5	3	0.1			19	0.4																												
McCoy Creek	1946	3	0	0.0																																		
McCoy Creek	1954	45	42	0.9	42	0.9																																
McCoy Creek	1955	21	33	1.6	32	1.5	1	0.0																														
McKenzie Creek	1934	17	66	3.9	5	0.3	37	2.2	15	0.9	9	0.5																										
McKenzie Creek	1935	7	8	1.1	8	1.1																																
McKenzie Creek	1938	5	6	1.2	1	0.2	1	0.2	4	0.8																												
McKenzie Creek	1939	2	3	1.5			3	1.5																														
McKenzie Creek	1943	14	7	0.5			7	0.5																														
McKenzie Creek	1944	16	8	0.5			8	0.5																														
McKenzie Creek	1947	13	9	0.7			7	0.5	2	0.2																												
McKenzie Creek	1948	83	36	0.4			19	0.2	17	0.2																												
McKenzie Creek	1949	10	8	0.8	2	0.2	2	0.2			2	0.2	2	0.2																								
McKenzie Creek	1954	94	135	1.4	4	0.0	13	0.1	118	1.3																												
McKenzie Creek	1955	125	91	0.7			6	0.0	85	0.7																												
McKenzie Creek	1956	26	9	0.4													1	0.0											1	0.0			7	0.3				
McKenzie Creek	1957	99	87	0.9			40	0.4	47	0.5																												
McKenzie Creek	1958	72	56	0.8			9	0.1	47	0.7																												
McKenzie Creek	1962	2	0	0.0																																		

Appendix 2.–Continued.

Segment and stream	Year	Angler hours	Total #'s Fish	Total CPE	Brook Trout		Brown Trout		Rainbow Trout		Smallmouth Bass		Largemouth Bass		Bluegill		Pumpkinseed		Rock Bass		Black Crappie		Yellow Perch		Walleye		Northern Pike		Bullhead		Carp		Sucker		Channel Catfish		Bowfin	
					Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE
Lower (continued)																																						
McKenzie Creek	1963	95	92	1.0			15	0.2	75	0.8													2	0.0														
Osborn Drain	1934	25	19	0.8	19	0.8																																
Osborn Drain	1948	4	0	0.0																																		
Peavine Creek	1935	3	3	1.0	3	1.0																																
Pipestone Creek	1933	5	14	2.8	11	2.2	3	0.6																														
Pipestone Creek	1939	15	15	1.0			6	0.4	7	0.5																							2	0.1				
Pipestone Creek	1944	16	0	0.0																																		
Pipestone Creek	1945	1	1	1.0					1	1.0																												
Pipestone Creek	1946	32	17	0.5			1	0.0	16	0.5																												
Pokagon Creek	1934	4	3	0.8			2	0.5	1	0.3																												
Pokagon Creek	1944	19	7	0.4	1	0.1			6	0.3																												
Pokagon Creek	1945	18	24	1.3	3	0.2			21	1.2																												
Pokagon Creek	1948	25	12	0.5	5	0.2	6	0.2	1	0.0																												
Pokagon Creek	1949	6	0	0.0																																		
Pokagon Creek	1954	29	35	1.2	13	0.4	22	0.8																														
Pokagon Creek	1955	35	14	0.4	3	0.1	11	0.3																														
St. Joseph River	1929	1	2	2.0																					2	2.0												
St. Joseph River	1931	1	4	4.0	3	3.0																					1	1.0										
St. Joseph River	1934	12	1	0.1																											1	0.1						
St. Joseph River	1946	310	75	0.2											3	0.0	1	0.0					14		26	0.1	3	0.0	3	0.0	5	0.0	18	0.1			2	0.0
Townsend Creek	1933	11	4	0.4	4	0.4																																
Walton Creek	1930	0.5	1	2.0	1	2.0																																
Mouth																																						
Hayden Creek	1947	13	6	0.5	2	0.2	4	0.3																														
Ritter Creek	1929	25	22	0.9	22	0.9																																
Ritter Creek	1930	3	1	0.3	1	0.3																																
Ritter Creek	1931	4	1	0.3	1	0.3																																
Ritter Creek	1939	1	1	1.0	1	1.0																																
Ritter Creek	1947	20	11	0.6	10	0.5	1	0.1																														
Blue Creek	1929	1	2	2.0	2	2.0																																
Blue Creek	1930	33	50	1.5	50	1.5																																
Blue Creek	1931	33	63	1.9	61	1.8	2	0.1																														
Blue Creek	1933	27	19	0.7	2	0.1	13	0.5	4	0.1																												

Appendix 2.–Continued.

Segment and stream	Year	Angler hours	Total #'s Fish	Total CPE	Brook Trout		Brown Trout		Rainbow Trout		Smallmouth Bass		Largemouth Bass		Bluegill		Pumpkinseed		Rock Bass		Black Crappie		Yellow Perch		Walleye		Northern Pike		Bullhead		Carp		Sucker		Channel Catfish		Bowfin	
					Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE
Mouth (continued)																																						
Blue Creek	1938	13	25	1.9	14	1.1	3	0.2	8	0.6																												
Blue Creek	1944	38	17	0.5			4	0.1	13	0.3																												
Blue Creek	1945	178	160	0.9	53	0.3	52	0.3	55	0.3																												
Blue Creek	1946	128	38	0.3	4	0.0	5	0.0	29	0.2																												
Blue Creek	1948	22	17	0.8	1	0.0	10	0.5	6	0.3																												
Brush Creek	1938	9	4	0.4			4	0.4																														
Brush Creek	1954	25	28	1.1	28	1.1																																
Brush Creek	1961	39	54	1.4	31	0.8	19	0.5	4	0.1																												
Brush Creek	1963	39	17	0.4	4	0.1	13	0.3																														
Brush Creek	1964	98	33	0.3	4	0.0	1	0.0	28	0.3																												
Campbell Creek	1929	24	16	0.7	16	0.7																																
Campbell Creek	1930	8	3	0.4	3	0.4																																
Campbell Creek	1938	22	22	1.0	22	1.0																																
Campbell Creek	1939	13	31	2.4	31	2.4																																
Campbell Creek	1939	5	2	0.4	1	0.2	1	0.2																														
Campbell Creek	1941	185	69	0.4	28	0.2	37	0.2	4	0.0																												
Campbell Creek	1947	14	3	0.2			2	0.1	1	0.1																												
Campbell Creek	1963	48	26	0.5	20	0.4			6	0.1																												
Campbell Creek	1964	33	15	0.5	1	0.0	1	0.0	13	0.4																												
E. B. Paw Paw	1930	13	1	0.1			1	0.1																														
E. B. Paw Paw	1931	1	0	0.0																																		
E. B. Paw Paw	1936	40	5	0.1	1	0.0	3	0.1	1	0.0																												
E. B. Paw Paw	1938	10	9	0.9	1	0.1	1	0.1	7	0.7																												
E. B. Paw Paw	1939	8	6	0.8			6	0.8																														
E. B. Paw Paw	1943	26	17	0.7	1	0.0	1	0.0	15	0.6																												
E. B. Paw Paw	1944	74	71	1.0	60	0.8			11	0.1																												
E. B. Paw Paw	1947	38	2	0.1			2	0.1																														
E. B. Paw Paw	1961	33	22	0.7	3	0.1			19	0.6																												
E. B. Paw Paw	1963	31	20	0.7	5	0.2	15	0.5																														
E. B. Paw Paw	1964	72	9	0.1			2	0.0	7	0.1																												
E. B. Paw Paw	1965	33	28	0.9																													28	0.8				
Lawton Drain	1938	6	0	0.0																																		
Lawton Drain	1939	10	3	0.3	1	0.1			2	0.2																												
Lawton Drain	1941	2	5	2.5					5	2.5																												

Appendix 2.–Continued.

Segment and stream	Year	Angler hours	Total #'s Fish	Total CPE	Brook Trout		Brown Trout		Rainbow Trout		Smallmouth Bass		Largemouth Bass		Bluegill		Pumpkinseed		Rock Bass		Black Crappie		Yellow Perch		Walleye		Northern Pike		Bullhead		Carp		Sucker		Channel Catfish		Bowfin	
					Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE
Mouth (continued)																																						
Lawton Drain	1944	11	5	0.5	2	0.2	2	0.2	1	0.1																												
Mattawan Drain	1929	13	2	0.2			2	0.2																														
Mattawan Drain	1930	8	2	0.3			2	0.3																														
Mattawan Drain	1938	12	3	0.3	1	0.1	2	0.2																														
Mattawan Drain	1939	4	22	5.5	22	5.5																																
Mattawan Drain	1941	2	8	4.0	8	4.0																																
Mentha Drain	1934	13	21	1.6	3	0.2			18	1.4																												
Mentha Drain	1943	14	2	0.1			2	0.1																														
Mill Creek	1930	3	5	1.7	1	0.3	2	0.7																									2	0.7				
Mill Creek	1930	2	15	7.5	5	2.5	5	2.5	5	2.5																												
Mill Creek	1931	6	16	2.7	16	2.7																																
Mill Creek	1944	9	1	0.1					1	0.1																												
Olson Creek	1964	17	1	0.1					1	0.1																												
Paw Paw River	1929	19	42	2.2							7	0.4					1	0.1					23	1.2			11	0.6										
Paw Paw River	1931	35	32	0.9													17	0.5									4	0.1					11	0.3				
Paw Paw River	1938	6	0	0.0																																		
Paw Paw River	1939	73	25	0.3	2	0.0	5	0.1	18	0.2																												
Paw Paw River	1946	22	5	0.2			4	0.2																									1	0.0				
Paw Paw River	1957	5	0	0.0																																		
Paw Paw River	1961	8	4	0.5																					4	0.5												
S. B. Paw Paw	1929	3	4	1.3	4	1.3																																
S. B. Paw Paw	1930	11	8	0.7	3	0.3	2	0.2	3	0.3																												
S. B. Paw Paw	1936	17	6	0.4			5	0.3	1	0.1																												
S. B. Paw Paw	1939	22	15	0.7	2	0.1	2	0.1	11	0.5																												
S. B. Paw Paw	1941	12	24	2.0			19	1.6	5	0.4																												
S. B. Paw Paw	1943	25	3	0.1					3	0.1																												
S. B. Paw Paw	1944	43	42	1.0	29	0.7	8	0.2	5	0.1																												
St. Joseph River	1943	10	7	0.7																													7	0.7				
St. Joseph River	1943	3	2	0.7																					2	0.7												
St. Joseph River	1943	10	1	0.1																													1	0.1				
St. Joseph River	1943	17	1	0.1																					1	0.1												
St. Joseph River	1946	7	0	0.0																																		
St. Joseph River	1954	6	0	0.0																																		
St. Joseph River	1962	9	11	1.2																															11	1.2		

Appendix 2.–Continued.

Segment and stream	Year	Angler hours	Total #'s Fish	Total CPE	Brook Trout		Brown Trout		Rainbow Trout		Smallmouth Bass		Largemouth Bass		Bluegill		Pumpkinseed		Rock Bass		Black Crappie		Yellow Perch		Walleye		Northern Pike		Bullhead		Carp		Sucker		Channel Catfish		Bowfin	
					Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE	Catch	CPE
Mouth (continued)																																						
St. Joseph River	1962	16	5	0.3																															5	0.3		
St. Joseph River	1962	25	16	0.6																															16	0.6		
W. B. Paw Paw	1939	23	3	0.1					3	0.1																												
W. B. Paw Paw	1947	33	5	0.2	1	0.0	4	0.1																														
W. B. Paw Paw	1957	6	6	1.0					6	1.0																												
W. B. Paw Paw	1963	11	4	0.4	2	0.2	2	0.2																														