FISHERIES DIVISION

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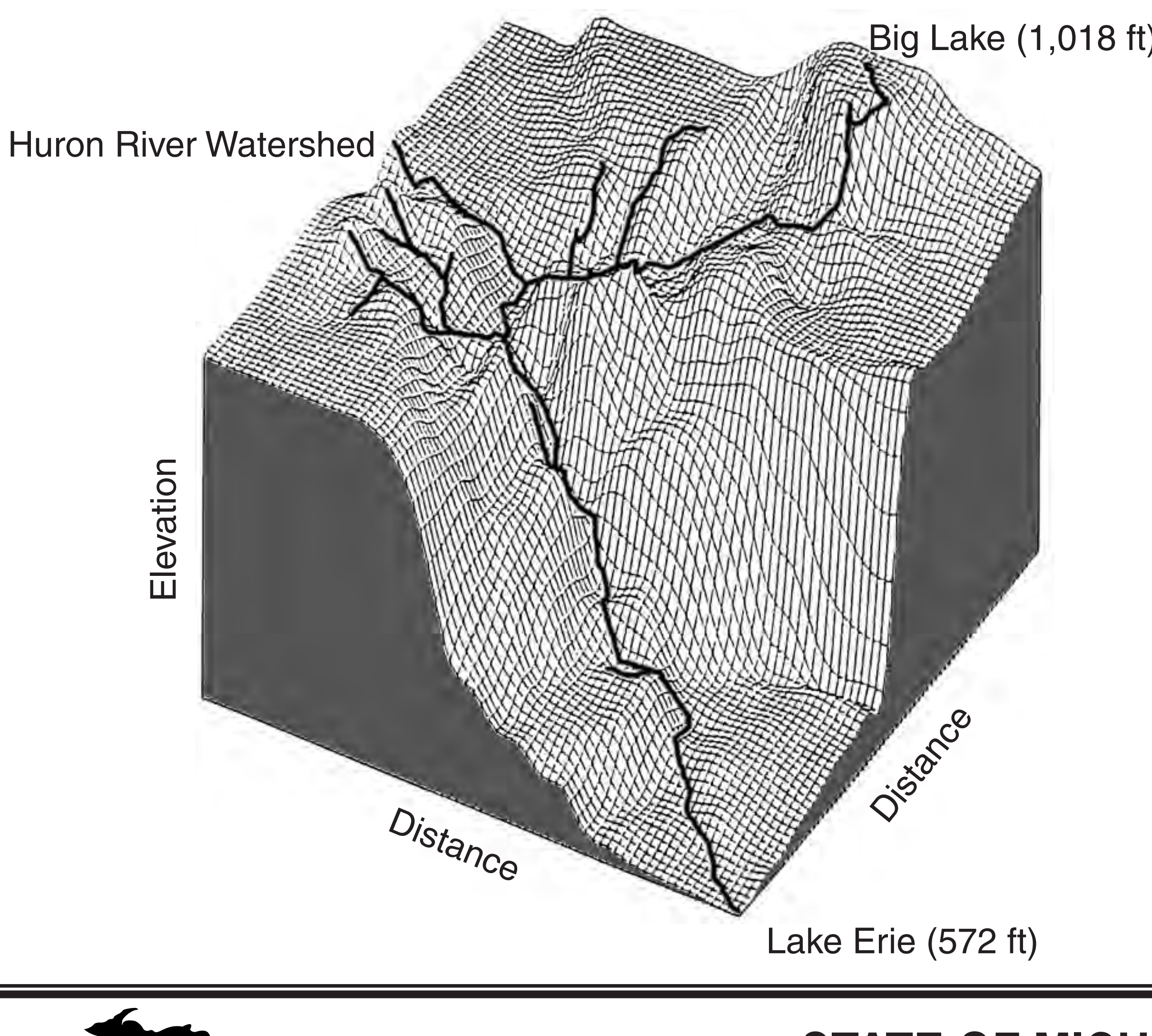
Huron River Assessment

E. M. Hay-Chmielewski
Paul W. Seelbach
Gary E. Whelan
Douglas B. Jester Jr.



DNR

STATE OF MICHIGAN
DEPARTMENT OF NATURAL RESOURCES

MICHIGAN DEPARTMENT OF NATURAL RESOURCES
FISHERIES DIVISION

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COVER: A three dimensional drawing of the area containing the Huron River watershed. It shows how the water flows from the headwaters down the landscape, gathering the contributions from the tributaries, to Lake Erie. The figure is an adaptation of a drawing provided by the Huron River Watershed Council, Ann Arbor.

The significant problems we face cannot be solved at the same level of thinking we were at when we created them.

Albert Einstein

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Acknowledgements

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Executive Summary

This is one of a series of river assessments being prepared by the Fisheries Division of the Michigan Department of Natural Resources (MDNR), for Michigan rivers. This document describes the characteristics of the river and its biological communities. It also describes the unique resources in the Huron River watershed (southeast Michigan).

This assessment's purposes are first, to have an organized approach to identifying opportunities and solving problems of aquatic resources and fisheries values within the watershed. Second, to provide a way for public involvement in fishery management decisions. And third, to provide an organized reference for Fisheries Division personnel, other agencies, and citizens who need information about a particular fishery resource.

This document consists of four parts: an introduction, a river assessment, management options, and public comments and responses. The river assessment is the nucleus of the manuscript. In twelve sections (geography, history, biological communities, geology and hydrology, channel morphology, soils and landuse patterns, special jurisdictions, recreational use, dams and barriers, water quality, fishery management, and citizen involvement) we describe the characteristics of the Huron River and it's watershed.

In the management options we identify a variety of management problems and opportunities. Three types of options for responding to opportunities or problems are proposed. The first are opportunities to protect and preserve existing resources. The second require additional surveys. The third are chances to rehabilitate degraded resources. Opportunities to improve an area or resource, above and beyond the original condition, are listed last. The options listed are not necessarily recommended by Fisheries Division, but are intended to provide a foundation for public discussion and comment and the later selection of objectives for managing the Huron River and its fisheries.

The Huron River is located in southeastern Michigan and empties into the northwest corner of Lake Erie. Its watershed is within portions of seven counties: Oakland, Livingston, Ingham, Jackson, Washtenaw, Wayne, and Monroe. Twenty-four major tributaries flow into the mainstem.

For puroses of discussion, the river it is divided into sections. The first is from Big Lake, Oakland County which is the true headwater of the system, to Commerce Lake, Oakland County. The second is from Commerce Lake through the chain-of-lakes to Baseline (Flook) Dam, Washtenaw County. The third area is from Baseline (Flook) Dam to Barton Impoundment, Washtenaw County. The fourth section is Barton Impoundment to French Landing Dam, Wayne County. The final section is from French Landing Dam to the river mouth at Lake Erie.

More than 90 species of fish are native to the Huron River drainage and the original potamodromous species can be inferred from historical records of neighboring river systems. European settlement of the watershed began in the mid 1700s and this signaled the beginning of many deliberate and inadvertent changes to the river's fish communities. Now the Huron River contains at least 99 fish species. Many native species are still present and abundant; a number have declined severely and are rare; five are considered threatened (silver shiner, redside dace, southern redbelly dace, eastern sand darter, and sauger) and northern madtoms are considered endangered. Two species have been extirpated, channel darter and river darter.

The diversity of fish species is relatively high. The communities appear healthy with a good mix of species requiring various habitats. Fish communities typical of vegetated lake outlet, gravel, and higher gradient habitat have been reduced through loss of such habitats. Other aquatic organisms, the invertebrates, mussels, amphibians, and reptiles have followed similar patterns. Mammals, birds, and plants have also been affected.

Rivers exist only as patterns of water flow. The geology and hydrology of the watershed are the keys to understanding how the systems works. They determine the patterns of water flow over the landscape, reflecting watershed conditions and influenced by climate. Flow stability is a determining factor in ecological and evolutionary processes. Flows are looked at annually, seasonally, and on a daily basis. The most stable streams in Michigan, the AuSable, Manistee, and Jordan rivers rarely flood nor have low flows that are less than 80% of average. The Huron River is fairly stable, but it is easy to pick out trouble spots caused by land use patterns, channelization, and dams. These fluctuations destabilize banks, create abnormally large moving sediment bedloads, disrupt and destroy habitat, strand and kill organisms, and interfere with recreational uses of the river.

The shape of the river channel itself is very dynamic as the unending flow of water is constantly affecting changes. River gradient is the key. Gradient is measured as elevation change in feet per river mile. The average gradient of the mainstem is 2.95 ft/mi. However areas of differing gradient are what is naturally found. These gradients create diverse types of channels and therefore different kinds of habitat for fish and other aquatic life. The best river habitat offers such variety to support different life functions of species. Fish and other aquatic life are typically most diverse and productive in river sections with gradient between 10 and 69.9 ft/mi. Unfortunately, such gradients are rare in Michigan because of the low-relief landscape. Areas of high gradient are also most likely to have been dammed or channelized. The Huron River mainstem contains only 6 mi of 136 mi total (4%) of this desirable area. However, 54 mi (40%) of the river are impounded by dams. The amount channelized is substantial.

In combination with climate, soils and landscape use help decide much of the hydrology and channel form in the river. Changes in land use are often the force that drives change in river habitats. The Huron River watershed is now dominated by agriculture with large urban areas interspersed. Both types of landscape use have dramatic affects on aquatic environments through increased erosion, drainage of wetlands, channelization of streams, destabilization of water flow, and increases in impervious land area that increase surface input, decrease ground water and therefore increase temperature.

The river system is highly fragmented by dams, 96 to date; 19 are on the mainstem and 77 on tributaries. These structures influence flow patterns and channel cross-sections. They block drift and migrations by aquatic organisms, change river temperatures, increase evaporation and reduce streamflow, disrupt downstream transportation of sediment and wood debris, and modify water quality. Dams have degraded fish communities through the inundation of scarce, high gradient reaches and through their cumulative affects on water temperature and flow patterns. They have prevented fish from migrating among critical seasonal (summer, winter, or spawning) habitats within the river.

Water quality and variables that affect aquatic life and uses of the river, such as temperature and a variety of chemical constituents, is generally good. Certain portions suffer degradation through point and non-point source inputs.

The Huron River has tremendous recreational potential being near the population centers of Ann Arbor, Ypsilanti, and the Detroit metropolitan area. A great many people take advantage of the river's opportunities for fishing, canoeing, rowing, motor-boating, wind surfing, sailing, swimming, picnicking, hunting, trapping, nature study, and bird watching. Access to the river is excellent, provided by a series of state and Huron-Clinton (HCMA) lands. The lakes, impoundments, and larger tributary streams provide more limited opportunities as access is not as readily available.

The watershed is now on the edge of the "urban sprawl" of the Detroit metropolitan area. It is projected by the Southeast Michigan Council of Governments that between 1990 and 2010 the population of southeastern Michigan will increase by 6% and the land area in urban use will expand by 40%. Nearly all of this expansion is expected to be in the Huron River watershed, with concentrations in the Portage, Davis, and Mill creeksheds, and near the river between Hamburg and Ann Arbor.

The management options offer a variety of ways for communities to look at the opportunities and problems that are before them now and that will be in the future. Integrated land use planning *throughout the watershed* is crucial if this region is going to maintain the features that made the Huron River watershed such a desirable place to settle and live.

INTRODUCTION

This river assessment is one of a series of documents being prepared by the Fisheries Division (FD), Michigan Department of Natural Resources (MDNR), 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.

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 the surrounding landscape; the amount varies. Therefore each assessment focuses on ecosystem maintenance and rehabilitation. Maintenance involves either slowing or preventing the losses of ecosystem structures and processes. Rehabilitation is putting back some of the structures or processes.

River assessments are based on ten guiding principles of the 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 it's watershed using a standard list of topics. These include:

> **Geography -** a brief description of the location of the river and it's 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 the watershed.
>
> **Biological Communities -** species present historically and today, in and near the river; we focus on fishes, however associated mammals and birds, key invertebrate animals, threatened and endangered species, and pest species are described where possible. This topic is the foundation for the rest of the assessment. Maintenance of biodiversity is an

important goal of natural resource management and essential to many of the goals of fishery management. Species occurrence, extirpation, and distribution are also important clues to the character and location of habitat problems.

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, aside from changes made by people. However, river channels are dynamic, constantly changing as they are worked on by the unending, powerful flow of water. Diversity of channel form affects habitat available to fish and other aquatic life.

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

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

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

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

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

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

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.

A section on Management Options is next. We list alternative actions that will significantly protect, rehabilitate, and enhance the integrity of the river system. These options are intended to provide a foundation for discussion, setting of priorities, and planning the future of the river system. The options follow recommendations of the national river public land policy development project. that stress protection, reconnectiveness, and restoration of headwater streams, riparian areas, and floodplains. The identified options are also consistent with the mission statement of the Fisheries Division. That mission is to protect and enhance the public trust in populations and habitat of fishes and other forms of aquatic life, and promote optimum use of these resources for the benefit of the people of Michigan.

Comments received by the Fisheries Division are summarized in the Public Comment and Response section. Two public meetings were held (Village of Milford July 11, 1994 and City of Ann Arbor July 12, 1994) and written responses were received for 30 days after the second meeting. Comments were either incorporated in the document or responded to in this section.

RIVER ASSESSMENT

Geography

The Huron River is located in southeastern Michigan (Figure 1). The watershed drains about 900 square miles and empties into the northwest corner of Lake Erie. This drainage basin includes portions of Oakland, Livingston, Ingham, Jackson, Washtenaw, Wayne, and Monroe counties. The mainstem, which is about 136 mi long, originates in Big Lake and the Huron Swamp in north-central Oakland county, at an elevation of 1018 ft. From here the river meanders south through a series of wetland complexes and interconnected lakes until it reaches the town of Commerce. Then the Huron flows first westerly and then southwest, continuing through wetlands and several large glacial kettle lakes. Downstream of Portage Lake, the river again flows south briefly before turning southeast for the rest of its journey. The discharge into Lake Erie is at an elevation of 572 ft.

Twenty-four major tributaries flow into the mainstem; in total these comprise 367 linear miles of streams and drains. Above Portage Lake most of the steams joining the river are small. Portage Creek, that enters Portage Lake from the west, is the first of two large creeksheds. Mill Creek is the other large system and is unique in draining an area of loamy soils supporting the primary agricultural area within the basin. The steep, narrow, lower watershed, from Ann Arbor to Lake Erie, contributes only a few small tributaries.

History

The Huron River and its watershed are a result of the retreat of the last glacier (Wisconsin of the Pleistocene Epoch). The river was formed by the melt water of the Saginaw and Huron-Erie lobes of the ice sheet. As the glacier went through several advances and retreats, the direction of flow and the outlet changed numerous times (Russell and Leverett 1915). The present course was settled upon around 16,000 years ago and the modern topography and soils are the result of postglacial erosion and soil formation processes acting on glacial deposits (Albert et al. 1986).

The earliest archeological records of human inhabitants dates to the Paleo-Indian period, more than 10,000 years ago. These were nomadic people who followed herds of game animals. By 500 B.C., there was a change to a more sedentary lifestyle (Archaic period) as people established camps for a season or more and agricultural practices were developed (B. Mead, Michigan Department of State, Archeological Section, personal communication). More recently, the Huron River watershed was of prime importance to the Potawatomi people. By travelling the mainstem up from Lake Erie to a tributary that became known as Portage Creek, it was possible for large canoes to reach within 64 chains (0.8 mi) of a tributary of the Grand River, now called Portage River, that flows into Lake Michigan. Therefore it was possible to cross the southern portion of what is now Michigan with only one land portage of less than one mile. The different tribes of the Potawatomi lived in what is now southern Michigan and were able to travel by this route (Tanner 1986).

The French explorer Rene-Robert Caveier Sieur de La Salle and his party are generally credited as the first Europeans to come into the area in 1680. The Ouendat (Wyandot) Indians, who lived in the lower portion of the river basin called the river "Cos-scut-e-nong sebee", or Burnt District river, meaning the plains or oak openings, lands, or country. However, the French explorers indirectly renamed the river. When they saw the members of this tribe with their 'bristly' hair, it reminded the explorers of the stiff hairs along the spine of the wild boar or hure in French (Anon 1881). From this developed the name Riviere aux Hurons, which is present on maps drawn in 1749 (Jessup 1993). The translation to English followed when most of the settlers spoke that language.

A description of the river and its tributaries from the pre-1750 period could not be found. However, it is reasonable to expect that the area was similar to watersheds in northwest Ohio in the early 1700s. Trautman (1981) described the banks of streams as being covered with woody vegetation that shaded much of the water. Streams were narrow and deep with woody instream structure and little aquatic vegetation in shaded areas. The waters were normally clear, containing little soil in suspension. The stream beds were free of clayey silts and largely composed of sand, gravel, boulders, bedrock, and organic debris. Aquatic vegetation was abundant in quiet unshaded water and especially so in marshes, bays, glacial bogs, and ponds.

By the 1720s, European settlement within the watershed began in earnest. The area was considered highly desirable. The river was described as "a very rapidly flowing stream with a sand bottom" (Jessup 1993) that made it ideal for the construction of dams to create power for saw and grain mills. This lead to the clearing of land and development of agriculture in the basin.

However both the Potawatomi and Wyandot peoples suffered devastating losses of life from diseases brought into the region by settlers. In 1752, most of the Potawatomi died from smallpox. In 1787, the Wyandot people were struck by this illness. When whooping cough arrived in 1813, the few remaining groups were again devastated. The Wyandot who survived this moved to southern Ontario. By 1866, the Potawatomi of the Huron, now numbering less than 100 individuals, moved to Athens, south of Battle Creek. After this, except for isolated members, no North American Indians were left in the watershed (Tanner 1986).

The river was a principal means of transportation until the 20th century. Barges travelled as far as Snow's Landing (presently Rawsonville, where Ford Dam is located). Landings were areas where people had to disembark from barges and continue travel on foot. The reason for this is clear from Table 1 and Figure 2. Continuing upstream from Snow's Landing, the gradient for the next 1.5 mi was 6.8 ft/mi (a rise of 10.2 ft in 1.5 mi) and for 1.1 mi upstream of that the gradient was 8.8 ft/mi, much too difficult for barges to traverse. Other landings, such as French Landing existed downstream from this point. This was also a true landing as defined above. The type of barge determined where "the landing" would be.

The high gradient waters of the Huron system, ideal for the location of dams to generate power for mills, continued to attract more and more settlers into the watershed. The Huron River at Dexter contains 65% of the basin's drainage and drops 195 feet to Rawsonville (Russell and Leverett 1915). Saw, grist, paper, cider, and woolen mills were developed. By 1884, the use of water to produce electricity had begun, a practice that continues today (see also **Dams and Barriers**). In fact in 1914, a study proposed that it would be feasible to operate 10 dams each 21 feet high from Dexter to Rawsonville (Russell and Leverett 1915). Many of these good-gradient areas where mills were located became towns. Commerce, Milford, Delhi, Ann Arbor, and Ypsilanti are examples.

All these historical developments have left traces. Many (492) archaeological sites are listed in the watershed (Table 2) and most were reported independently by residents. Only 19 square miles, about 2 % of the watershed, has been surveyed professionally by archaeologists. They located 115 sites, giving a density of 6 sites per square mile. Therefore it is estimated that over 5,000 archaeological sites exist in the watershed. Unfortunately they are rapidly disappearing as urbanization, deep plowing, expansion of utility corridors, and widespread use of grading on construction projects continue (B. Mead, Michigan Department of State, Archeological Section, personal communication). Two of the more significant archaeological sites in the watershed, Ticknor Farm and Parker Mill Complex, have been listed on the National Register of Historic Places (B. Mead, Michigan Department of State, Archeological Section, personal communication). Forty-seven locations in the watershed are marked with State Historical Markers (Michigan Department of State, Michigan History Division).

More recently, river and land uses have changed in the watershed. Urban development is replacing the agrarian development of the 18th and 19th centuries and the industrialization of the early and mid-20th century. Cities such as Ann Arbor and Ypsilanti continue to grow in population and size, and the Detroit Metropolitan area is expanding into Livingston and western Oakland Counties (Anon 1991a). The future of the river depends on how these changes are directed and the long range goals of the communities in the watershed.

Biological Communities

Original Fish Communities

More than 90 species of fish are known as native to the Huron River drainage. A description of the fish community at the time of European settlement (mid 1700s) is not available, however, a survey completed in 1938 (Brown and Funk 1945) probably provides a good picture of the native community in the upper river and several tributaries. This survey was accomplished by seining and thus certain fishes, notably lampreys and redhorses, are probably under-represented. A description of the original potamodromous fauna can be inferred from historical records of neighboring river systems.

The headwaters, and most tributaries, of the Huron River had fairly stable flows, fairly cool summer temperatures, and clear water. Diverse habitats existed, including stretches with moderate-velocity, riffle-pool sequences, and gravel and sand substrates. Channels were edged with marshes, and in many areas, flow was probably dispersed through marshy areas. Aquatic vegetation was abundant in open areas. In 1938, fish communities in these streams were diverse and reflected these cool, clear, sometimes gravelly, sometimes vegetated, conditions. About 40 species were found in these small streams, with about 20-30 typically present in any one tributary system. An abundance of blacknose dace and mottled sculpin indicated cool temperatures. (All common and scientific names of the species mentioned in this document are listed in Table 3). Gravel- and riffle-associated species were abundant including common shiner, hornyhead chub, blacknose dace, creek chub, northern hog sucker, brindled madtom, rock bass, greenside darter, rainbow darter, fantail darter, and mottled sculpin. Species requiring slow, clear water with submergent or emergent vegetation included central mudminnow, mud pickerel, northern pike, pugnose minnow, blackchin shiner, blacknose shiner, lake chubsucker, yellow bullhead, blackstripe topminnow, brook stickleback, and least darter.

The headwaters of Mill Creek provided similar habitats to other tributaries as evidenced in the 1938 survey. However, the lower two-thirds of this creekshed had naturally more variable flows (see **Geology and Hydrology**), lower summer base flows, and warmer and more variable summer temperatures. Most of these reaches had low gradients, and seasonal and wooded wetlands were extensive. The nature of this lower creekshed was ideal for agricultural development and by 1938 the entire stream had been channelized for use as an agricultural drain. No information is available on the original fish community other than reports that a good fishery existed for northern pike (Brown and Funk 1945).

The fairly stable flows of the headwaters and tributaries provided similar flows in the mainstem Huron River, upstream of what is now Ann Arbor. Summer water temperatures remained cool due to substantial water volumes (thus decreased influence of air temperatures), wooded river banks that provided shade, and local inflow of additional groundwater. Diverse habitats existed, including extensive gravel and cobble riffles, deep pools with cover, channel-side marshes, and flood plain wetlands. In 1938 (Brown and Funk), about 25 fish species were found in this upper river. Higher-gradient stretches with extensive gravel riffles and pools held an abundance of central mudminnow, hornyhead chub, silver shiner, rosyface shiner, common shiner, lake chubsucker, northern hog sucker, golden redhorse, black redhorse, yellow bullhead, stonecat, tadpole madtom, brindled madtom, longear sunfish, rock bass, smallmouth bass, rainbow darter, fantail darter, and greenside darter. Vegetation-dependent mud pickerel, northern pike, blackstripe topminnow, and least darter were also present. Several additional species were most common in slower flowing, low gradient stretches connecting natural lakes, including white sucker, largemouth bass, bluegill, pumpkinseed, johnny darter, logperch, and yellow perch. The 1938 survey did not find muskellunge or walleye in the upper river, but these may have been originally present and extirpated during early settlement. Muskellunge were known to be abundant in Lake Erie and in the nearby Maumee River (Ohio), and in some southern Michigan rivers (Seelbach 1988). Walleye were native to the river (Anon 1890), but were greatly reduced in number by 1938.

The chain of glacial kettle lakes along the mainstem of the Huron River from Strawberry Lake to Baseline Lake were deep and clear, with good water quality and oxygen (even below summer thermoclines). Northern pike, cisco (lake herring), and sunfishes were important in these lakes and noted in the first surveys in 1890 (Anon 1890). Notably, cisco were abundant in Baseline Lake through the 1950s and in Portage Lake through the 1960s. This species requires cold, well-oxygenated waters and is classified as a threatened species in Michigan. The only recent record is of one cisco captured in 1989 in Portage Lake (M. Oemke, Surface Water Quality Division (SWQD), MDNR, personal communication). Latta (1995) concluded that a stable population exists in Portage Lake and that the one in Baseline is extirpated.

From Ann Arbor to Belleville, the river is now a series of seven nearly back-to-back impoundments. The existing dams were built between 1914 and 1932 and there is evidence that dams were present on many of these sites even earlier than this. No data exists on the original fish fauna. This is the highest-gradient stretch of the mainstem (Figure 2) and would have been dominated by swift-flowing rapids and riffles, interspersed with some deep pools. Substrates were probably gravel and cobble, with some boulders. Fish communities were probably similar to those in higher-gradient areas of the upper river, though even more dominated by fishes that prefer faster currents and rockier substrates. Smallmouth bass would have been extremely abundant, as their densities increase dramatically with stream gradient up to 20 ft/mi (Trautman 1942).

The river below Belleville initially has fairly high gradient, with extensive gravel riffles and deep pools. As it enters the glacial lake plain it becomes flat and deeper (Figure 2). This stretch was probably somewhat turbid due to the naturally fine soils of this area. By 1938, this lower section had been negatively affected by sewage and other pollutants, so the Brown and Funk (1945) survey probably does not reflect the original fauna. In 1938, the survey recorded 22 species, whereas, 35-40 species would be expected in a river of this size (Cornejo 1992; Osborn and Wiley 1992). The 1938 fish community reflected both the more "lake-like" nature of this lower stretch and the degraded nature of the system. Common species included northern pike, common carp, goldfish, golden shiner, emerald shiner, bluntnose minnow, white crappie, johnny darter, and yellow perch.

Large numbers of potamodromous fishes undoubtedly entered the Huron River seasonally to spawn in marshes and on riffles, rapids, and bedrock. A historical review has not been completed. Research of early post-European settlement records might provide valuable insights on these populations. The original potamodromous fauna included lake sturgeon (verbal citizen reports; Langlois 1954; they were also in the nearby Clinton River; Zorn and Seelbach 1992), northern pike (originally abundant in Lake Erie), muskellunge (originally abundant in Lake Erie, the nearby Maumee River, and recorded in some southern Michigan rivers; Seelbach 1988), channel catfish, smallmouth bass, yellow perch, white bass, and walleye. Cold-water fishes such as lake trout and whitefishes also spawned in many Great Lakes tributaries and these were originally abundant in Lake Erie.

Factors Affecting Fish Communities

European settlers caused dramatic changes to the Huron River and its watershed, many of which resulted in inadvertent changes in the river's fish communities. The affects of mill and hydropower dams, agricultural and urban land use, point-source discharges, and lake-level controls on the river system are covered in detail in the **Geology and Hydrology, Soils and Land Use Patterns, Dams and Barriers**, and **Water Quality** sections. However, a brief discussion on the affect of settlement is appropriate here.

Fish require several types of habitats throughout their life cycle. Stream species need distinct spawning, feeding and growth, and refuge habitats (Figure 3). 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.

Early construction of dams and draining of wetlands for settlement eliminated spawning areas, or access to them, for all of the original potamodromous fish species. These large fish were concentrated below dams during following spawning runs and heavy harvest quickened their demise (Trautman 1981). Dams also blocked migrations among critical seasonal habitats (summer, winter, or spawning; Figure 4) within the river itself. Dams have degraded fish communities through the inundation of scarce, high gradient reaches and through their cumulative affects on water temperature and flow patterns (see **Dams and Barriers**). These affects have been shown to reduce the fishes present to those few species able to tolerate these harsh conditions; typically large, adult, warmwater fishes (Cushman 1985; Gislason 1985; Nelson 1986; Bain et al. 1988). Most small species and juveniles of larger species are eliminated.

Since early settlement, land drainage for human use (agricultural or urban) has degraded the original, fairly-stable flow regime. Draining wetlands, channelizing streams, and creating new drainage channels all served to decrease flow stability by increasing peak flows and diminishing recharge into groundwater tables. Increased peak flows negatively affects both spawning and survival of young fish of many species. Summer water temperatures have become warmer and more variable due to lower base flows, channel widening and clearing of shading, stream-side vegetation. Both landscape perturbations and increased peak flows accelerated erosion within the basin and increased the sediment load of the river. These sediments contributed to increased turbidity (harmful to certain species) and buried gravel and cobble substrates that served as critical habitat for certain fishes and invertebrates. Critical wetland spawning areas have also been lost due to draining.

With agricultural development came the demand for water for irrigation. No data are available regarding irrigation withdrawals within the watershed but this practice has been increasing in southern Michigan during the past few decades, and this trend is projected to continue (Fulcher et al. 1986). Irrigation withdrawals are mostly for agriculture, golf courses, and homeowners; cumulative affects of the latter can be substantial. Withdrawals reduce summer base flows, causing increased and more-varied temperatures, and decreased channel depth and width. The United States Fish and Wildlife Service (USFWS) and Michigan State University have developed models for the Huron River to predict the responses of fish populations to flow manipulations such as withdrawals (Bovee et. al. 1994).

Urban and suburban development have also altered the hydrologic cycle of the river. In the headwater areas, many homes use well water (groundwater) and then discharge this back to the watershed as surface or sub-surface water. During summer, this water both evaporates and returns to the river at warmer and more varied temperatures than the original groundwater. The City of Ann Arbor takes 20% of their drinking water from ground water sources and 80% dwithdrawn irectly from the river (P. Rentschler, Huron River Watershed Council, personal communication).

The construction of lake-level control structures on nearly all of the lakes in the upper watershed has had a dramatic affect on flow stability, similar to that described above for land drainage. Decreased reproduction for some fish species and increased summer water temperatures and sediment loads have followed. Also movements between stream and lake habitats have been blocked. Critical wetland spawning areas that originally ringed each lake have also been lost.

During early development of the basin, pollution from a variety of point-source discharges (notably sewage) fouled the river, especially from Ann Arbor downstream. Only pollution-tolerant species persisted during these times (Brown and Funk 1938). Since the Federal Clean Water Act in the 1970s, nearly all of these point-source discharges have been brought under control, and water quality has improved greatly. No data are available on the post-1970s status of riverine fishes downstream of Ann Arbor, but recent surveys on other southern Michigan rivers indicate that a return of many less-tolerant forms followed these controls. It is striking that the surveys of the upper river (Oakland and Livingston counties) in 1938 and 1954 did not indicate problems with severe pollution. Point-source discharges from the small communities located along the upper river apparently did not have a major negative affect on this system.

Fish communities have been intentionally altered many times through the stocking of fish or the inadvertent introduction of exotic species (Table 4) (Mills et al. 1993). An overview of fish stockings for 1981-1991 is given in Table 5. Stockings have twice been preceded by treatment of a section of river with a piscicide. This was intended to remove high densities of common carp, considered a pest, before stocking game species. The reach from Proud Lake to Milford Millpond was treated in 1971 with antimycin (Alward 1971). The reach from Delhi to Flat Rock was treated in 1972-74 with rotenone (Spitler 1978; Laarman 1979).

Present Fish Communities

Based on several biological surveys (Brown and Funk 1945; Cooper 1954; Yant and Humphries 1978; Kosek 1993), University of Michigan records, and observations by Fisheries Division personnel and Dr. Gerry Smith (UM), the Huron River is known to contain at least 99 fish species (Table 6). Surveys conducted in 1938 (Brown and Funk 1945) and 1977 (Yant and Humphries 1978) were accomplished by seining, so lampreys and redhorses are probably under-represented due to the selectivity of the gear. The 1954 (Cooper 1954) and 1992 (Kosek 1993) collections were by direct-current electroshocking, which is less selective. The distributions of various species range from small isolated pockets to basin-wide. A map of each species distribution and their preferred habitats is included in Appendix I. Many native species are still present and abundant; a number have declined severely and are now rare (Table 6); others have increased in abundance. Five species are considered threatened (silver shiner, redside dace, southern redbelly dace, eastern sand darter, and sauger) and one is considered endangered (northern madtom) (Table 6). Two species have been extirpated from the drainage, channel darter and river darter.

Twelve non-indigenous fish species have been introduced into the watershed (Table 4). These include unintended and intentional introductions, and migrations. All but brook trout are still present. Brook trout, stocked from 1900 to 1920, did not establish persistent, reproducing populations. The distribution ranges of these species, with the exception of goldfish and common carp, has remained limited (Appendix I).

In 1977 fish communities in the upper river and the major tributaries were diverse and indicated relatively healthy systems (Yant and Humphries 1978). The species present reflected the persistence of fairly cool, clear water and some gravelly substrates. However, two major fish groups had declined (see also Trautman and Gartman 1974; Smith et al. 1981). Many species dependent on clear, heavily-vegetated water had either disappeared or decreased in number (Table 7). These species were often associated with natural lake outlets that have been replaced in many instances with lake-level control structures. Species dependent on clean gravel substrates had similarly disappeared or declined sharply (Table 8). Many of these required gravel for spawning and a flow of clean water to their protected eggs. Species preferring or tolerating silt and sand substrates became more abundant during this time (Table 9). One reason that these species are able to cope with silt is their spawning strategies. For example the male johnny darter picks a nesting site under appropriate substrate and then provides parental care to the eggs, fanning them with his pectoral fins to maintain a flow of oxygen and keeping them free of silt.

In a 1992 survey by SWQD (Anon 1991c), Kosek (1993) scored the fish community as good for 13 of the 15 sites on the mainstem. A good rating indicates that the community is slightly impaired, less optimal than would be expected due to the loss of intolerant species (Anon 1991c). The group most under-represented in the river were insectivores (chubs, minnows, and shiners). Species of redhorse suckers that are intolerant of chemical and habitat degradation, were also sparse. The density of individuals in all fishery groups was low compared to expected densities.

Of the tributaries, Mill Creek shows the most extreme example of changes. Between 1938 and 1977 there was a decline of 15 species (8 lost), including 9 requiring vegetation and 5 requiring gravel. Concurrently, 6 species increased in abundance. Of these, 4 prefer silt and sand substrates (Yant and Humphries 1978). In 1992, Kosek (1993) found that little had changed. Insectivores and piscivores were under-represented as were sunfish species. The latter are sensitive to degradation of pool habitat and loss of in-stream cover (Karr et al. 1986).

As described above, the eight impoundments from Ann Arbor to Flat Rock were treated with rotenone in 1972-74 to remove high densities of common carp. This was followed by stocking an assortment of gamefish species, as soon as waters were non-toxic (Laarman 1979). Present fish communities predominately include a mixture of common carp, sunfishes, and bass that are adapted to the eutrophic condition of these reservoirs. All the reservoirs contain populations of walleye that intermittently reproduce in the upstream riverine section (J. Schneider, FD, personal communication; FD records).

Limited numbers of several potamodromous species now use the river below Flat Rock Dam, including chinook salmon and steelhead (both stocked), gizzard shad, white sucker, channel catfish, white perch, white bass, smallmouth bass, walleye, and freshwater drum (creel census at Flat Rock 1989-1993, FD, MDNR).

Aquatic Invertebrates (except mussels)

There have been no comprehensive invertebrate studies on the river except van der Schalie's (1938) work on mussels and the identification of some species of special concern (Table 10). Invertebrates, which are less mobile than other aquatic species, often provide more direct indications of habitat problems that are affecting fish and other aquatic life. In 1992, a SWQD survey of macroinvertebrates was conducted (Anon 1991c; Kosek 1993). Fifteen locations on the mainstem were surveyed. All sites, except the one furthest upstream, were rated as slightly to moderately impaired. Ten of the downstream sites were less than optimal due to some loss of species that are intolerant to degradation. Many times there was a marked reduction in the number of mayflies and caddisflies. Stonefly abundances were more variable. Four sites, three in Oakland County and one just below Belleville Lake, were more degraded with loss of all intolerant species and reduced numbers of mayflies, caddisflies, and stoneflies.

Sites were also evaluated on some of the tributaries. Hayes Creek (Oakland County), Davis Creek, Ore Creek, Portage Creek, Honey Creek, and the lowest sample site on Mill Creek were all rated as good (some loss of intolerant species). The two uppermost sites on Mill Creek and the one site on Boyden Creek (also known as Loch Alpine Creek) were ranked fair (loss of intolerant forms and reduced abundance of mayflies, stoneflies, and caddisflies).

A more complete inventory of the macroinvertebrate fauna of the Huron River watershed is recommended.

Mussels

An extensive survey of the mussels in the Huron River system was completed in 1931-33 (van der Schalie 1938). This work includes species distribution maps. The diversity and abundance of various mussel species indicated that characteristic ecological assemblages existed (Table 10). Fourteen habitat types are listed, each with a distinct fauna. These included river lakes, land-locked lakes, impounded waters, creeks, and small, medium, and large river zones. In general, the number of species increased with stream size; brooks and creeks had 2 to 9 species, small rivers had about 14 species, and large rivers had about 17 species. At the river mouth, 4 species from Lake Erie were found. This survey is probably representative of the original fauna above Ann Arbor.

Mussel distributions are excellent habitat indicators as they are sessile and reflect both their own tolerances of local environmental conditions (including pollution and siltation) and the tolerances of their host fishes. By the 1930s, from Ann Arbor to Flat Rock, mussel communities were negatively affected by dams and pollution. Downstream of Flat Rock they were negatively affected by variable stream flows, sewage, other pollutants, and clamming (the harvest of mussels for their shells to make pearl buttons); in many areas of this section there were no mussels (van der Schalie 1958; Jessup 1993).

Significant changes in the mussel community occurred during the Second World War (van der Schalie 1958). The industrial effort that went on in southeast Michigan was geared towards production of needed war materials, and little or no thought was given to the negative affects of production on the environment. One example was a laundry at Dexter that cleaned rags used to wipe machinery in plants in Detroit. The sewage disposal system of the town could not handle the amount of waste water produced each day, so a great deal of untreated effluent went into the river. The result was that this plant, operating only during the war (approximately 2 years), nearly wiped out all mussels and aquatic operculates [certain snail species] in the Huron River below Dexter (van der Schalie 1958).

In 1969, when repairs were being made to Argo Dam in Ann Arbor and consequently the water in Argo impoundment had been lowered, van der Schalie sampled some river shoals below Barton Dam in an attempt to determine the original fauna of the river at this point.. During a 1930s survey, 13 species were found in this vicinity, alive and in abundant numbers (van der Schalie 1938). During the 1969 survey, 10 species were taken of which only six species were alive. Of these six, only two species, the pink wartyback (also known as the purple wartyback) and the papershell were present in any appreciable number (van der Schalie 1970). Van der Schalie noted the lack of young specimens and concluded that the ecological changes from a flowing river to an impoundment no longer allowed for the successful completion of the life cycle of riverine species.

The Michigan Natural Features Inventory lists four mussel species as "of concern" (Table 11): wavy-rayed lamp (special concern/proposed threatened); snuffbox (threatened/proposed extinct); purple wartyback (special concern); and northern riffleshell (extinct). The first three were either abundant or common in certain habitats in 1938. A comprehensive survey is needed to determine present mussel populations.

Amphibians and Reptiles

Thirty-four species of amphibians and reptiles that require the river or its associated wetlands (riparian, upland, wooded, seasonal) in some or all of their life history stages, have been found in the watershed (Table 12). Two are questionable records and are being re-examined. The report of the mink frog is based on four juvenile specimens that may have been misidentified. The record of the wood turtle is based on only one specimen recorded early in the century. The Michigan Natural Features Inventory lists four species as "of concern" – three of which are species that require wetland habitat, and a fifth species is considered threatened: Blanchard's cricket frog (special concern), spotted turtle (special concern), massasauga (special concern), eastern fox snake (threatened), and smallmouth salamander (threatened/proposed endangered; Table 11).

Mammals

The river corridor is a critical habitat to many mammalian and bird species. It provides a refuge, a source of water, and in many instances the last undisturbed living space. The presence of this forested corridor is the major reason some animals in the watershed have been able to withstand the intensive development of the landscape (both agricultural and urban) by man.

Mammals in the watershed include raccoon, mink, muskrat, beaver, and otter (R. Anderson, Wildlife Division, MDNR, personal communication). The first three species are present in moderate to very abundant populations, primarily in the river corridor. Low numbers of beaver, found predominately in the headwater areas, are increasing in numbers. Otter are rare; they have possibly been extirpated due to over-harvest. Wildlife Division has plans underway to re-introduce this species in this drainage (E. Kafcas, Wildlife Division, MDNR, personal communication). A species of special concern is the least shrew (threatened; Table 11).

Birds

This watershed is an important area for a variety of waterfowl. As part of the Mississippi Valley Flyway, it is used by Canada geese and many species of ducks (T. Payne, Wildlife Division, MDNR, personal communication). It is also used as a stopover for migrating bald eagles, peregrine falcons, ospreys, and sandhill cranes. Significant rookeries for Great blue heron exist within the watershed. As mentioned above, the presence of the forested river corridor and seasonally flooded uplands are critical for the maintenance of these populations and without it, many of these species would no longer be in this locality. Equally as critical is the river itself, which is a food source for many of these species.

Other Natural Features of Concern

Other natural features (such as insects and plants) that originate within the watershed and whose status is "of concern" are listed in Table 11.

Pest Species

Pest species are defined as those aquatic species that have been introduced, either accidentally or intentionally, and pose a significant threat to native species or their habitat. Most species do not pose any threat unless they are present in high densities.

High densities of fish pest species are not known to be present in the Huron River, its impoundments, or natural lakes. Sea lamprey have not invaded the lower Huron River (Morman 1979) as spawning substrate is not readily available below Flat Rock Dam (D. Lavis, USFW, personal communication). No upstream migration could occur beyond Flat Rock, as two dams block the river at this point.

Pest species of mollusks such as zebra mussels, and crustaceans such as the European spiny water flea, have invaded Lake Erie (Mills et al. 1993), but no colonization in the Huron River has been reported at present. Rusty crayfish have been identified being sold as bait in the Chelsea area, Washtenaw County (P. Seelbach, FD, MDNR, personal communication) and at Flat Rock, Wayne County (G. Towns, FD, MDNR, personal communication). The Asian clam was detected in Whitmore Lake, Washtenaw-Livingston county line.

Zebra mussel veligers were first detected in Belleville Lake, Wayne County in 1993; no adults were reported (Marangelo and Johnson 1993). In 1994 the detection program for zebra mussels was expanded (Marangelo 1994). Veligers were again detected in Belleville Lake and in Kent Lake, Oakland County. As well, three incidental detections of adult populations were confirmed in Barton Pond, Washtenaw County, and in Portage and Whitmore lakes on the Washtenaw-Livingston county line. Secondary downstream dispersal from established inland populations is becoming an important dispersal method along with transient boating activity. Marangelo (1994) believes that secondary downstream dispersal is responsible for the population in Barton Pond, the origins being the Portage Lake population. If this is correct, all seven impoundments down to Flat Rock would become infested.

The known plants species that are considered pests are purple loosestrife, Eurasian milfoil, and curly leaf pondweed. Purple loosestrife, a perennial emergent wetland plant native to Europe and Asia is well established in marshy areas at the mouth of the river, around lake perimeters, and in wetlands throughout the watershed. Unfortunately one of the prime methods of dispersal has been humans, who often move plants into their gardens or waterfronts, attracted by its purple flowers. Dispersal of seeds can be by wind, flowing water, and animals including humans (Skinner et al 1994). This species is particularly dangerous as it can out-compete native wetland plants and take over their habitat. It has no appreciable wildlife food or cover value and replaces species that are important (Eggers and Reed 1987). Eurasian milfoil, a submerged perennial herb, is present in quiet waters of lakes, rivers, and deep marshes. It is dispersed by fragmentation of plant parts and is in the watershed in densities ranging from scarce to nuisance amounts. This species can become a nuisance by forming dense mats that interfere with swimming, fishing, and boating. Curly leaf pondweed, another submergent perennial herb, is also present in scarce to nuisance densities in marshes and lakes. Its methods of dispersal are by plant fragments and turions. It too may form dense mats of near-surface vegetation that interfere with boating, swimming, and fishing activities (Eggers and Reed 1987).

The one terrestrial species that can negatively affect the watershed is the gypsy moth. Damage from this insect is most severe in forested areas that have been under previous stresses (W. Hoppe, Forestry Division, MDNR, personal communication). To date the gypsy moth has only been found in isolated pockets within the watershed.

Geology and Hydrology

Geology

The hydrology of the Huron River is strongly affected by the geology of its basin. The surface geology is described in the Huron River Natural Rivers Report (Anon 1977) as:

> "The surface topography of the watershed was determined by the last continental glacial period, the Wisconsonian. Above Ann Arbor and encompassing the study area, the Huron River watershed widens out from a relatively flat narrow strip into a region of rolling hills

interspersed with flat areas. This "upper basin" of approximately 750 square miles contains a dendritic pattern of tributaries, numerous pothole lakes, and a number of swampy areas.

The watershed is largely a region of end (or recessional) moraines, with associated till plains and outwash deposits. The moraines of the upper basin were formed by the ice being pushed forward while, at the same time its front was melting, resulting in the build-up of deposits into ridges or moraines. This occurred during the period of its final retreat (approximately 10,000 years ago) from what we now know as Michigan. As the ice melted during its final retreat, the drainage patterns changed and the Huron, that formerly drained to the Mississippi and the Gulf of Mexico, gradually altered its course to essentially its present day configuration. At the same time, outwash plains formed with the deposition of coarse sand and gravel materials from water emanating from the melting glacier. The upper basin today contains extensive deposits of this type capable of retaining large amounts of water."

Both outwash and end moraine geologies contain sand and gravel deposits, and are conducive to groundwater inputs to stream systems, with outwash geology streams having higher base flows. Till plains consist of sorted fine sediments and are more conducive to surface runoff into streams and create flows that are more "flashy". Table 13 shows that the watershed above Territorial Road is composed of mostly outwash and moraine, leading to more stable stream flows. Below Territorial Road, the percentage of till increases, decreasing flow stability of the river below this point. Mill Creek has the highest proportion of till of any creekshed and is very flashy. It joins the mainstem at this point.

Climate

The climate of Michigan is controlled by it's latitude and that determines the amount and seasonal contrast of incoming radiation. This accounts for the seasonal changes that are the most important feature of this state's climate (Eichenlaub 1990). The Huron River watershed is in the drier portion of Michigan. It receives an average of 30 in of precipitation per year. This input is equivalent to 2.2 ft^3/s (cfs) per watershed square mile per year. Seasonal patterns of this precipitation are more stable than in northern locations, due to warmer temperatures that hold more moisture in the air. Winter precipitation averages 5-6 in, spring 8-9 in, summer 10-11 in, and autumn 7-8 in. Further, since southern Michigan thaws and re-freezes regularly through most of the winter, the Huron River does not experience as much variability as more northern rivers with its low and high flows.

Evaporation in the watershed is higher than most of Michigan, due to higher temperatures and the slightly drier air found in southeastern Michigan (Sommers 1977). Therefore this area has one of the lowest amounts of total annual runoff in the state.

Annual stream flows

The Huron River watershed drains about 900 square miles. Mean annual flows average 36 cfs at the retired United States Geological Survey (USGS) Commerce gauge station (0.63 cfs per square mile over 57.3 square miles), 214 cfs at USGS Hamburg gauge site (0.69 cfs per square mile over 308 square miles), and 595 cfs at the USGS Ypsilanti gauge station (0.74 cfs per square mile over 807 square miles). All data used cover the period of record; miscellaneous measurements were obtained from Holtschlag and Eagle (1985). Seasonally high flows are generally during March to

May and baseflow conditions are generally during July through October. An example of this is presented in Figure 5, showing the mean monthly discharge through the dam at Kent Lake, both with and without the affect of the storage capacity of the reservoir.

Seasonal flow stability

Flow stability is a determining factor in ecological and evolutionary processes in streams (Poff and Ward 1989; Richards 1990) and is positively related to fish abundance, growth, survival, and reproduction (Coon 1987; Seelbach 1987, 1993). Flow stability has been shown to be an important component of habitat suitability for pink salmon (Raleigh and Nelson 1985), largemouth bass (Stuber et al. 1982c), smallmouth bass (Edwards et al. 1983), walleye (McMahon and Nelson 1984), brook trout (Raleigh 1982), brown trout (Raleigh et al. 1986b), and chinook salmon (Raleigh et al. 1986a).

We used a variety of methods to examine seasonal flow patterns. Flow duration curves show the percentage of days during a period of record when water flows exceed a given level. Since different gauge stations on a river represent different drainage areas, overall flow volume may vary considerably among stations. Therefore, to be able to compare different flow duration curves, they have been scaled by the median flow (50% exceedance) and displayed in figures. Graphs that show high flows tend to obscure the details of low flows, so the flow duration curves above and below the 50% exceedance value are shown separately. The most stable streams in Michigan (AuSable, Manistee, and Jordan rivers) have 5% exceedance (high) flows that are less than twice their median flows, and have 95% exceedance (low) flows that are over 80% of their median flows (Figures 6-9).

Figure 6 illustrates the frequency of high flows in four tributaries compared to the frequency of high flows at two locations on the mainstem (Commerce and Ann Arbor). The tributaries show problems with high flows. Hayes Creek is very stable below 15% exceedance but has very large infrequent flood flows, as shown in the steep rise in the curve from 5- 15% exceedence. South Ore Creek is fairly stable with respect to high flows. Portage Creek and Mill Creek are the most unstable. Portage Creek reflects the on/off operation of lake-level control structures and Mill Creek's instability results from channelization and extensive drainage of wetlands.

Figure 7 illustrates the frequency of low flows in the four tributaries. All tributaries regularly suffer extreme low flows. Hayes Creek and Mill Creek have the most stable base flows indicating groundwater input. Portage Creek and South Ore Creek have the most frequent low flows. The problems on Portage Creek are caused by the operation of many lake-level control structures on this creekshed.

Figure 8 shows the high flow duration curves for the mainstem. Upper basin locations (Commerce, Milford, New Hudson, and Hamburg) have similar patterns that are more stable than the lower basin locations (Dexter, Ann Arbor, and Ypsilanti). The lower basin sites reflect the contribution of a number of unstable tributaries, as described above, and changes from outwash geology in the upper basin to till geology. Flooding problems exist in the Ann Arbor and Flat Rock areas, with some flooding attributable to daily flow fluctuations from City of Ann Arbor hydroelectric projects (S. Blumer, USGS, personal communication; D. Hamilton, Land and Water Management Division (LWMD), MDNR, personal communication).

Figure 9 shows the low flow duration curves for the mainstem. In general, the upper basin has more stable flows than the lower basin. Low flows in the Ann Arbor and Dexter stations appear to be influenced by unstable contributions from Portage Creek, and by maintenance of summer lake levels above Flook Dam.

Another index of flow stability, that can be used with short time frame and miscellaneous flow data, is to compare mean monthly highest flow to mean monthly lowest flow for each year. High ratios of these two numbers indicate unstable flows dominated by rainfall runoff, low numbers indicate stable flows dominated by groundwater. These ratios are mapped in Figure 10; very good (1.0-2.0) represents Michigan's trout streams; good (2.1-5.0) is seen in our better warmwater rivers (Seelbach, unpublished data). Extreme stability problems are indicated in the headwaters of the Huron River above Brendal Lake, in the Davis Creek drainage, Horsehoe Lake outlet, Portage Creek, North Fork of Mill Creek, Swift Run Drain, Fleming Creek, and Silver Creek. As discussed below, many of these problems are related to the operation of lake-level control structures or designated drains.

Flow yields per square mile of land in the watershed, calculated from monthly mean values taken at gauge stations, along with the ratio of high:low flows (Figure 11) were used to compare sites on the Huron River with other systems in the state. The yields for low monthly flow (the mean daily flow during the driest month) indicate that the lowest flow yield exists in Portage Creek, while much of the upper river has higher yields. The yields for high monthly flow (the mean daily flow during the wettest month) indicate high flooding in some tributaries. Portage Creek shows this affect the most. Mill Creek, South Ore Creek, and the upper Huron River are similarly affected. Ann Arbor and Ypsilanti show the downstream cumulative affect. The high:low ratio indicates the stability of flows throughout the year; a low ratio shows a stable stream. For example the Au Sable River is well known as a very stable system (Richards 1990) and has a ratio of 1.5. The North Branch of the Kawkawlin River is extremely unstable and has a ratio of 36.5. In comparison, overall the Huron River is fairly stable, with ratios of 2.7-9.3, but it is easy to pick out trouble spots. Portage Creek is the least stable as a result of the on/off operation of lake-level control structures in this creekshed. Mill Creek is also unstable because of extensive channelization and drainage of wetlands within this agricultural sub-basin.

Several dams on the river are operated with seasonal drawdowns and have a significant affect on the hydrology of the watershed. For example, Kent Lake is usually drawn down about 3 ft between October and January. The impoundment is then refilled starting in March-April and is filled by May. This drawdown adds additional flow to the Huron River during October through December and reduces spring flows. The procedure increases the stability of flows immediately below the lake (New Hudson) as compared to above the lake (Milford). However, cumulative negative affects of such manipulations cannot be discerned except through storage modeling of the river system. Such an analysis is needed on the Huron River to determine the aggregate affects of the operations of various dams on river flows.

Daily flow stability

In natural streams, daily flow changes are generally gradual. However some hydroelectrical 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, and interfere with recreational uses of the river. Aquatic production and diversity are profoundly reduced by such daily fluctuations (Cushman 1985; Gislason 1985; Nelson 1986; Bain et al. 1988).

There are many lake-level control structures in the watershed. Many of these structures are strictly operated to meet legal lake-levels and are often operated as on or off structures. When water is above the target lake-level, flows are rapidly increased to bring the lake-level down and when the water level is below the target level, flows are shut off. Investigation is needed to document the operational mode at each structure.

Problems with daily operations have been documented at Kent Lake and Baseline Dam. For example, on November 5-6, 1989 Kent Lake mean daily flows increased from 72 to 206 cfs with no change in inflows to the lake. On July 3-5, 1990 mean daily flows from Kent Lake decreased from 110 to 11 cfs with no change in inflows. On September 18-20, 1977 mean daily flows from Baseline Dam changed from 155 to 281 to 167 cfs. On September 25-27, 1977 mean daily flows from Baseline Dam changed from 167 to 306 to 154 cfs (USGS 1991).

Hydroelectric dams that operate in peaking mode cause significant habitat degradation as summarized by Cushman (1985), Gislason (1985), Nelson (1986), and Bain et al. (1988). These projects generate high flood flows during peak electrical demand (generally 8 am to 8 pm) and drought flows during non-peak periods (generally at night). Historically, all hydroelectric projects on the Huron River operated as peaking projects. Now the four producing hydroelectric dams (Barton, Superior, Ford and French Landing) are licensed by the Federal Energy Regulatory Commission (FERC) as run-of-the-river projects with instantaneous outflow required to equal instantaneous inflow. However, significant fluctuations are still documented at the Ann Arbor gauge. Figure 12 is an example from the period March 21-22, 1990 where water fluctuations averaged 220 $\pm$ 331 cfs during hourly readings and the maximum change was greater than 1500 cfs from one hour to the next. It is unclear whether these fluctuations were from the operation of Barton Hydroelectric Project or from Argo Pond. Such unstable releases cause downstream projects difficulty in meeting their run-of-the-river operating requirements and cause significant downstream fluctuations in water level. The cumulative affect of these fluctuations are dramatic. Below French Landing Dam, erosion is extensive. It is not uncommon for trees on the river bank to have 90% of their root system exposed. Water levels at Flat Rock have been recorded changing as much as 7 in during a 12 hour period (FD, MDNR).

Channel Morphology

Channel gradient

River gradient is another main controlling influence on river habitat. Steeper gradients allow faster water flows with accompanying changes in depth, width, channel meandering, and sediment transport (Knighton 1984). Gradient has been used to describe habitat requirements of smallmouth bass (Trautman 1942; Edwards et al. 1983), flathead catfish (Lee and Terrell 1987), green sunfish (Stuber et al. 1982b), northern pike (Inskip 1982), warmouth (McMahon et al. 1984), white sucker (Twomey et al. 1984), bluegill (Stuber et al. 1982a), black crappie (Edwards et al. 1982), blacknose dace (Trial et al. 1983), and creek chub (McMahon 1982).

Gradient is measured as elevation change in ft/river mi (Figure 13). The average gradient of the mainstem of the Huron River is 2.95 ft/mi. Naturally, some portions of the river are steeper than average, others drop more gradually. 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 in relation to gradient (Whelan, unpublished data) are listed below. In these descriptions, hydraulic diversity refers to the variety of water velocities and depths found in the river. The best river habitat offers such variety to support various life functions 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 (Whelan, unpublished data; Trautman 1942). Unfortunately, such gradients are rare in Michigan because of the low-relief landscape. These areas of high gradient are also most likely to have been dammed or channelized.

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

The mainstem is mostly low-gradient channel with 84 mi (62%) under 3 ft/mi (Figure 14). Gradients between 3 and 9.9 ft/mi constitute 46 mi (34%) of the mainstem. The most desirable gradient, between 10 and 69.9 ft/mi is found in only 6 mi (4%) of the river. However, 54 total mi (40%) of the river are impounded by lake-level control structures or hydroelectric facilities. This includes 24 mi (52.2% of the gradient class between 3 and 9.9 ft/mi) and 2.4 mi (40% of the gradient class between 10 and 69.9 ft/mi) of the highest gradient classes. The free-flowing portions include 2 mi of water influenced by Lake Erie (Great Lakes), 54 mi of low gradient run habitat, 22.4 mi of run-riffle habitat with gradient between 3 and 9.9 ft/mi, and 3.6 mi of the most desirable riffle-pool habitat with gradient between 10 and 69.9 ft/mi. The latter two groups are found in the headwaters, from Portage Lake to Barton Pond, and in small segments between dams in Ann Arbor and Ypsilanti.

River gradients types are not uniformly distributed through the river; they reflect the landform over which the river flows with low gradient across flat areas and higher gradients at the edges of plateaus. The major reaches of the river (Figure 1) are characterized as follows:

<u>Big Lake to Commerce Lake</u> - These 20.7 mi have a smaller portion (50.5%) of low gradient habitat than other reaches. Fair to good gradients characterize 36.5% of the reach and excellent gradients constitute 13% of the reach. However, a large number of lake-level control structures have impounded 30% of the reach, including 30% of the fair to good habitat (3 - 9.9 ft/mi) (Figure 15).

<u>Commerce Lake to Baseline (Flook) Dam</u> - The 37.7 mi of river are almost entirely low gradient habitat. The small amounts of fair to excellent river habitat are impounded by Kent Lake and the millpond dams at Milford and Commerce. 24% of this portion of the river is impounded. The chain-of-lakes, a natural feature, are artificially enhanced through lake-level control structures (Figure 16).

Baseline (Flook) Dam to Barton Impoundment - These 12.8 mi are the longest free-flowing reach in the river and contain some of the best habitat. Only 37% of this reach is low gradient run habitat and the other 63% has fair to excellent gradient. Notably, this reach also has the most diverse fish community and some of the best fishing in the river (Figure 17).

Barton Impoundment to French Landing Dam - This portion, 36.2 mi, originally contained the largest concentration of high gradient channel on the entire river, but it is now mostly (84%) impounded. Small fragments of channel with fair to excellent gradient exists in the other 14% (Figure 18).

French Landing Dam to Lake Erie - These 28.5 mi are dominated by low-gradient, run habitat, with the final 2 mi flooded by Lake Erie. Fair to good gradient is found in 7 mi of this reach, with most of the good gradient impounded by Flat Rock Dam (Figure 19).

Channel cross sections

The description of habitat by gradient presented above assumes normal channel cross sections for such gradients. However, channel cross sections can deviate from these characterizations as discussed by Heede (1980). Unstable flows will create flood channels that are wide and shallow during average flow periods. Abnormal sediment loads (either too much or too little) will modify habitat. Bridges, culverts, bank erosion, channel modifications, and armored substrates will also cause deviations from expected channel form. Thus more detailed observations of channel cross-section in each reach are needed to check for affects of these modifying factors.

Descriptions by Brown and Funk (1945) and unpublished data from FD can be used to describe the channel in each of the reaches. These characterizations provide a clear, qualitative description of the channel. In addition, two quantitative measures of channel characteristics can be determined. First, channel width can be compared to the average width of rivers with the same discharge volume (Leopold and Maddock 1953; Leopold and Wolman 1957). Overly wide channels are probably produced by fluctuating flows or excessive sediment loading. Overly narrow channels are probably produced by bulkheads along the bank or by channel dredging. Second, the hydraulic diversity of a channel can be indexed with the Shannon-Weiner information index (Whittaker 1975). This identifies the diversity of hydraulic conditions in randomly chosen portions of a cross-section. With streams, the more diversity, the more complex a channel, and generally the better the habitat for aquatic organisms.

Width comparisons and diversity indices for each reach of the mainstem and several of its tributaries are displayed in Table 14. These calculations were made from data collected by USGS (1979; 1991; 1992) or MDNR during stream discharge studies. Cross sections that were clear of bridges and most representative of the section were selected where possible. Expected width was estimated from a relation with mean daily discharge (G. Whelan, FD, MDNR, unpublished data). Diversity indices were calculated from counts of cross-section data points in classes of velocity in intervals of 0.5 ft/s and depth in intervals of 0.5 ft. The diversity index ranges from 0.0, representing constant depth and velocity across a channel, such as in a flume, to 5.00, representing a highly variable hydraulic channel. Generally, 1.0 would be a simple box-shaped channel; any value of 2.5 or greater would indicate a complex channel.

The reaches of the river and its tributaries have cross sections as characterized below:

Big Lake to Commerce Lake - This reach of the Huron River has a narrow, simple channel typical of dredged channels. Brown and Funk (1945) described the section from Big Lake to Fox Lake as mostly run habitat with few pools or riffles although many spring seeps were found below Pontiac Lake. Bottom substrate was mostly gravel and detritus, with a small amount of rubble. Fish cover was sparse.

The section from Fox Lake to Commerce Lake was first dredged in 1864 with later modifications in 1923 and 1938 (Brown and Funk 1945). Additional modifications have not been determined. This section is mostly run habitat with no pools and only one riffle above Commerce Lake. Bottom substrate is a combination of gravel and rubble with some sand. Fish cover and shading are sparse in this reach.

Cross-section data from the Teggerdine Road area above Pontiac Lake showed channel width of 13 ft at a discharge of 17 cfs. The expected width would be 22.5 ft. The diversity index for this cross-section was only 1.6; this indicates hydraulic diversity similar to a ditch.

Commerce Lake to Baseline (Flook) Dam - This reach suffers atypical channel form, with some areas showing the narrowing affects of dredging and others showing widening affects of sedimentation or local flow fluctuations. The reach is mostly run habitat with few pools, no riffles, sparse cover, and little shade. The section above Milford was dredged in 1923 (Brown and Funk 1945). Additional modifications have not been determined. The bottom substrate is silt, marl, and sand down to Proud Lake Dam; mostly gravel and sand from Proud Lake Dam to Strawberry Lake; and marl and sand in the short reach between Strawberry Lake and Baseline (Flook) Dam.

Cross-section data from below Commerce Dam showed channel width of 33.5 ft at a discharge of 37 cfs. This is close to the expected width of 33.2 ft. Cross-section data from near Milford showed a channel width of 45 ft at a discharge of 104 cfs. This is narrower than the expected width of 55.8 ft and is probably due to dredging. Cross-section data from near Hamburg showed a channel width of 132 ft at a discharge of 212 cfs. This is wider than the expected channel width of 79.6 ft and is probably due to some combination of discharge fluctuations and sedimentation. Cross-section data from New Hudson, just below Kent Lake, showed width of 74 ft at a discharge of 106 cfs. This is wider than the expected width of 56.4 ft and is probably due to flow fluctuations. Hydraulic diversity indices in this reach range from 1.03 to 1.90, indicating a simple channel.

Baseline (Flook) Dam to Barton Impoundment - This reach has the best habitat in the mainstem, but apparently suffers from sedimentation and perhaps flow fluctuations. Cover and shading are less than optimal from Flook to North Territorial Road, but are fair to good for cover and good for shade in the remainder of the reach (J. Schneider, FD, MDNR, personal communication). These upstream conditions probably arise from loss of forest cover near the river and consequent erosion, bank destabilization, and reduced inputs of woody debris. This reach has the highest channel complexity in the river, as would be expected from its gradient and absence of impoundments. It has extensive sequences of riffle-run-pool habitat. Composition of the channel is about 19% slow run habitat, 25% fast run-riffle habitat, 29% riffle habitat and 27% pool habitat. Bottom substrate is mostly cobble and gravel with lesser amounts of boulders, sand, and marl. Fish cover is the most abundant of any reach in the mainstem, but it is still insufficient.

Average cross-sections of the entire reach show a mean width of 142.4 ft at a mean discharge of 358 cfs. This is wider than the expected width of 102.7 ft, indicating problems with flow stability. The mean hydraulic diversity index is 2.3, which approaches values expected for a complex channel.

Barton Impoundment to French Landing Dam - Little remains of the original channel in this reach. The few remaining small free-flowing reaches have fair to excellent gradient with fair to excellent habitat complexity in mostly riffle-run habitats. The bottom is composed primarily of cobble and boulders with some gravel. Cover is sparse.

Below Argo Dam, the channel is 142 ft wide at a discharge of 437 cfs. This is somewhat wider than the expected width of 114 ft and is probably due to flow fluctuations and the armored bottom. At Ypsilanti, the river cross-section showed a width of 106 ft at a discharge of 389 cfs. This is close to the expected width of 108 ft. This is expected as widening of the channel to dissipate power only happens at fairly low gradients. This particular reach contains some of the highest gradient in the system and is therefore expected to be relatively narrow. Hydraulic diversity of the channel below Argo Dam is 1.74; the diversity index is 2.03 in Ypsilanti. These data indicate that the river channel below Argo Dam suffers from affects of fluctuating flows. The channel in Ypsilanti is simple but in fairly good condition.

French Landing Dam to Lake Erie - This reach of the river potentially has much attractive habitat, if flows were stabilized. Also, Flat Rock Dam inundates important high gradient bedrock habitat that is a unique and rare resource in Michigan. Streams with this type of habitat are necessary for some spawning fish species. The Raisin River contains stretches of bedrock and produces 3 times the number of 9 in and larger smallmouth bass and 6 times the number of young-of-the-year smallmouth bass, as do similar rivers without this substrate (P. Seelbach, FD, MDNR, unpublished data). Bedrock shelves are also known to be prime spawning sites for walleye in the Thames River, Ontario, and the Maumee River, Ohio (R. Haas, FD, MDNR, personal communication). This reach of the Huron River has mostly run habitat with riffle-pool habitat in a few higher gradient areas. The bottom is composed mostly of gravel with some cobble and boulders overlaying clay. Cover is limited as it is swept away by fluctuating water levels. The area below Rockwood is entirely run habitat with bottom substrate of sand and clay and little instream cover.

Cross-section data from below French Landing Dam show a channel width of 88.5 ft at 810 cfs. This is much narrower than the expected width of 155.3 ft. At lower flows of 129 cfs, this channel has a width of 88 ft, which is wider than the expected width of 62.2 ft. This "U" shaped channel form is typical of fluctuating flows affects in a constrained channel. In this section of the river, the erosion-resistant clay banks direct the water's force to downcutting the substrate, lowering the channel. The dam's discharge, which is more powerful than an open river, aids this downcutting. Cross-section data below Flat Rock Dam show a width of 114 ft at a discharge of 191 cfs. This is much wider than the expected width of 76 ft and is a result of the water eroding the clay banks which, though resistant, are less so than the bedrock substrate. Hydraulic diversities range from 2.34 to 2.57, providing higher diversity than most other reaches of the river; however, the sections from French Landing Dam to I-275 and below Rockwood are less complex.

Major tributaries of the Huron River - Most of the major tributaries have been dredged and channelized. Cross-sectional data, where available are consistent with descriptive information. Cross-sectional data are presented in Table 14. Most tributaries have low habitat diversity. Those in agricultural areas lack adequate vegetative buffers. All suffer from comprehensive channelization, lack of cover, and large flow fluctuations as a result of efforts to accelerate drainage through these streams.

Pettibone Creek - The lower reaches of the creek were channelized before 1938. The creek is dominated by run habitat with few pools. The bottom substrate consists mainly of sand and gravel with some marl, silt and detritus.

Mann Creek - Run habitat is the dominant channel type in this stream.

Woodruff Creek - This creek is comprised of riffles and fast run habitat with no pools. The bottom substrate is gravel and sand.

Davis Creek - Lower reaches are mostly run habitat with no pools. The bottom substrate is sand and gravel.

South Ore Creek - Upper reaches are mostly run habitat with silty substrates. Lower reaches have sand, gravel, and rubble substrates with some riffle habitat. The creek has few pools. This creek is wider than expected during average flow periods.

Horsehoe Lake Outlet - The entire stream has been dredged and channelized.

Arms Creek - Most of the creek has been channelized.

Honey Creek near Baseline Lake - Stream sections near Pinckney were dredged by 1920. The creek is now characterized by run habitat with no pools. Lower reaches have sand and gravel substrates and upper reaches have silty substrates.

Joslin Lake Outlet - This stream is nearly all run habitat with no pools. Bottom substrate is mainly gravel and sand.

Portage Creek - Most of the lower reach has been channelized. Habitat is predominantly runs with sand and gravel substrate. Flow fluctuations due to the operation of lake-level control structures are a major problem.

Mill Creek - This creek has been channelized since 1903-1913 and contains very few pools. Substrate is primarily silt and sand, with some gravel and rubble. The silt and sand is from farm fields adjacent to the creek that do not have buffer strips. This sediment continues downstream and has completely filled the impoundment at Dexter. The creek is wider than expected for its flow, due to flow instability and lack of a riparian corridor (**see also Soils and Land Use Patterns**).

Honey Creek near Ann Arbor - The entire stream has been dredged and it now contains very few pools. Most of the substrate is silt with some gravel near the confluence with the mainstem.

Fleming Creek - Fair habitat diversity with mostly riffle-pool sequences is present. Bottom substrate is mostly boulders, rubble, and gravel. Fleming Creek is narrow because of its steep gradient.

South Branch Huron River - Lower reaches are mostly run habitat with no pools. The bottom substrate is sand and gravel. Most of the upper reaches and tributaries have been dredged and channelized.

Silver Creek near Rockwood - The creek has mostly deep run habitat with instream fish cover.

Soils and Land Use Patterns

The soils of the watershed are described in the Huron River Natural Rivers Report (Anon 1977) as:

> "The majority of soils in the upper watershed above Ann Arbor are sandy loams or friable sand-clay mixtures. Soils of the Fox-Oshtemo-Plainfield association are located mostly near the river and streams in upland plains, broken by large basin depressions and valleys containing lakes, swamp, and marsh. Areas away from the river and streams become more rolling and hilly highlands and contain soils of the Bellefontains-Hillside-Coloma association. An area around Ann Arbor contains soils of the Miami-Hillsdale-Conover association. The principle soil is the Miami type including the loam, underlaid by the more friable clay, and the more silty loam, underlaid by tight permeable clay.
>
> The watershed below Ann Arbor narrows considerably and the river passes through a variety of soil associations. From Ann Arbor to Belleville, soils are generally clay to clay loam types of the Conover-Napance-Brookston association. These soils include the highest proportion of naturally better-drained land when considering clay soils in southeastern Michigan, from Belleville to New Boston, the soils consist of the Berrien-Plainfield association which are mostly dry sands in relatively thin layers over pebbly and bouldery till clay. The sands in this type are finer in texture, and more loamy and moist than those of other divisions. Soils in the lower river area are of the Macomb-Brookston-Berrien association which vary from wet, clay soils in close association with wet and dry sands."

The historical landscape cover of the watershed was predominantly deciduous forest with intermixed prairies (Albert et al. 1986). The landscape is now dominated by agriculture with large urban areas interspersed. Land use (P. Seelbach, FD, MDNR, unpublished data 1978) is approximately:

Urban and suburban	8.2%
Agricultural	66.5%
Deciduous Forest	12.4%
Lakes and Streams	1.9%
Forested Wetlands	10.0%
Non-forested Wetlands	0.6%
Barren	0.3%

The sandy-loamy (about 90%) soils and rolling topography of most of the basin above Ann Arbor (excluding the Mill Creek drainage) have resulted in a patchwork of landscape uses, with about 61% of the land in agriculture, 6% in urban development concentrated on the river and larger tributaries, 19% in deciduous forest, and 14% in forested wetland (Seelbach, unpublished data). The forests and forested wetlands are scattered throughout the watershed. One very critical part of this timberland component is the forested corridor adjacent to most of the river (W. Hoppe, Forest Management Division, MDNR, personal communication). Much of this is protected within state and metropark lands (Figure 20), and has served to protect floodplain resources.

The Mill Creek creekshed is unique in having nearly 100% loam and silty-loam soils over medium-textured glacial till. These poorly-drained soils were, once drained, excellent farmland. About 80% of this sub-basin is in agricultural use. About 4% is in deciduous forest with 14% in forested wetland; these forests are predominantly in the headwaters, where there are more sandy moraine soils. About 2% is in urban use (Seelbach, unpublished data). Unfortunately in the push to crate as much usable agricultural land as possible, most of the riparian corridor was destroyed. This has had a major negative affect on both the land and the creek, as detailed below.

The narrow, lower portion of the watershed, from Ann Arbor to the mouth, has poorly-drained, wet-loamy soils over clay. These have been drained and used primarily for agricultural and urban development along the river.

The Huron River watershed is now on the edge of the "urban sprawl" of the Detroit metropolitan area. It is projected that between 1990 and 2010 the population of southeastern Michigan will increase by only 6% (a slowdown from previous years) but land area in urban use will expand by 40% (Anonymous 1991a; Anonymous 1991b). Nearly all of this expansion will be in the Huron River watershed, with concentrations in the Portage, Davis, and Mill creeksheds, and near the river between Hamburg and Ann Arbor.

Landscape development for agricultural use has dramatic affects on aquatic environments. Tillage of soils increases erosion and sediment inputs to streams. These sediments bury gravel and cobbles critical to reproduction and survival of many fish species. Frequently, land is drained for use through deepening and straightening of existing streams, digging new drain channels, and constructing underground drainage systems (such as tile drains). Wetlands, important as spawning and living areas for many species and important to the water quality of the system, are destroyed. The resulting loss of storage during wet periods destabilizes flow in the river by increasing peak flows downstream. Flow destabilization also increases the frequency and magnitude of flood flows and increases water temperature during low flow periods (Dunne and Leopold 1978). Channelization destroys the natural channel diversity (diversity of depths, velocities, and substrates) of existing stream systems, eliminating many habitats critical to reproduction and survival of many aquatic species. The resulting shallow, uniform channel causes increased and more variable water temperatures. Woody debris is removed from the channel and riparian vegetation is often discouraged, limiting instream cover for organisms, and channel diversity, and again contributing to increased water temperatures.

Agricultural land use produces increased loadings of nutrients, pesticides, and herbicides to the river system. Nutrients affect stream productivity and excessive amounts can alter aquatic communities. Pesticides and herbicides are toxic to many organisms. Water withdrawals for irrigation may also lower base flows (Fulcher et al. 1986).

Landscape development for urban use also has dramatic affect on the aquatic environment (Leopold 1968; Anon 1991a; Booth 1991; Toffaleti and Bobrin 1991). Development noticeably increases the percentage of impervious land area, resulting in more water reaching the stream channel more quickly as surface runoff. Urban and higher-density suburban areas typically have 50-100% and 25-45% impervious surface areas (Toffaleti and Bobrin 1991). Impervious surfaces include pavement (roads and parking lots) and roofs of buildings. These have runoff co-efficients 6-14 times greater than for undisturbed land (Toffaleti and Bobrin 1991). Engineered stormwater runoff systems also speed surface runoff. Increased runoff causes greater peak flows, harmful to reproduction and survival of many aquatic organisms, more erosion, decreased groundwater recharge and thus base flow, increased summer temperatures, and decreased available habitat (Leopold 1968; Booth 1991). Development that brings the construction of wells reduces groundwater tables and stream summer base flows, with the resulting increase in water temperature and decrease in available stream habitat.

Temporary sediment loads that erode from unprotected construction sites are frequently 500 times those of undisturbed lands (Toffaleti and Bobrin 1991). Sediments that reach stream channels clog and bury clean gravel and cobble substrates critical for many invertebrates and fish species. Sediment loads from improperly placed or maintained road crossings can also be a major input to the system. Runoff from impervious surfaces carries pollutants including nutrients, bacteria, metals, litter, oil and grease, herbicides and pesticides, and salts. Osborne and Wiley (1992) have shown that urbanization is the primary cause of increasing summer nutrient concentrations in rivers.

Special Jurisdictions

Jurisdictions regarding the river and the riparian zones are controlled by federal and state laws, county and township ordinances, and city and town by-laws. Some federal laws and many state statutes are administrated by the Michigan Department of Natural Resources (MDNR), LWMD (Table 15). In the watershed, the two major activities that are regulated by LWMD are loss of wetlands and control of stormwater.

Navigability

The entire mainstem is navigable, as are larger tributaries that have lakes on them. The smaller tributaries are all presumed navigable. Therefore, the Huron River is public and subject to public trust protection. The river downstream of Flat Rock is controlled by the federal government as stated in Section 10 of the River and Harbor Act, 1899.

Federal Energy Regulatory Commission

The Federal Energy Regulatory Commission is authorized under the Federal Power Act of 1920, as amended, to license and regulate hydroelectric facilities that meet one or more of the criteria pursuant to Section 23 (b) (1) of the Act: 1) the project is located on a navigable water of the United States; 2) the project occupies lands of the United States; 3) the project utilizes surplus water or water power from a governmental dam; or 4) the project is located on a body of water over which Congress has Commerce Clause jurisdiction, project construction was on or after August 26, 1935, and the project affects the interests of interstate or foreign commerce. Now when a project is being licensed or re-licensed, power and non-power aspects of a project are balanced by FERC and the resulting license contains specific articles to protect the natural resources in the project area. The licenses are administered and enforced by FERC with MDNR having a consultation role in both the licensing and enforcement proceedings. In general, most FERC licenses are for a 35-year period unless a FERC exemption is issued. The FERC exemption is a perpetual license that contains a mandatory Article 2 letter from MDNR and the US Fish and Wildlife Service (USFWS) detailing protective measures for the natural resources in the project area.

FERC licenses the operations of four projects on the Huron River. These are the Barton, Superior, Ford, and French Landing dams. The Barton and Superior dams have FERC exemptions. The Ford and French Landing dams have FERC licenses (Table 16).

County Drain Commissioners

County drain commissioners have authority to establish designated drain systems under the Drain Code (PA 40, 1956). This allows for construction or maintenance of drains, creeks, rivers, and watercourses and their branches for flood control and water management. A designated drain may be cleaned out (all in-stream structures removed), straightened, widened, deepened, extended, consolidated, relocated, tiled, and connected to improve the flow of water.

Designated drains in the watershed are listed by county and township (Table 17). We were unable to obtain information on Wayne County drains. The listed drains number 489; this does not include some drain branches, nor does it include private drains. Significant portions of many tributaries are designated drains. They are typically narrow and simple channels, with accelerated flows in channelized areas, but wide and shallow in other sections. They have little hydraulic diversity.

Drain commissioners are also responsible for the maintenance and operation of many lake-level control structures. Each one is individually operated to maintain a lake at legally set summer and winter elevation levels. Methods of operation are at the discretion of each drain commissioner.

Natural River Designations

Portions of the Huron River are designated as "country-scenic river" under the Michigan Natural Rivers Act (PA 231, 1970), including 27.5 mi of mainstem and 10.5 mi of tributaries (Anon.1977). A Natural Rivers District was established from 400 ft either side of the ordinary high water mark. On private lands (these constitute 44% of this area) zoning requires 125 ft building setbacks on the mainstem and 50 ft setbacks on tributaries. The minimum lot width for new construction is 150 ft, with 125 ft septic setback, and a 50 ft natural vegetation strip along the river. On public lands the restrictions are the same with one exception; the natural vegetation strip width is increased to 100 ft. Within the Natural Rivers District, no new commercial or industrial development or any new mineral exploration or development (sand/gravel, oil/gas) is permitted within 300 ft of the river.

The river sections designated are:

> Huron River from just downstream of Kent Lake (Livingston County) to the western edge of Section 32 of Hamburg Township, excluding Strawberry, Gallagher, Loon, and the two Whitewood lakes;

Huron River from Baseline (Flook) Dam downstream to Scio-Ann Arbor township line, excluding the village of Dexter;

Davis Creek from the outflow of Sandy Bottom Lake to its confluence with the Huron River;

Arms Creek from the confluence of the two branches in Section 10, Webster Township to its confluence with the Huron River;

Mill Creek from Parker Road downstream to the incorporate village limits of Dexter.

No other portions of the river are proposed for designation.

State and Huron-Clinton Metropolitan Authority Parklands

Large portions of the mainstem flow through public recreation lands owned by the State of Michigan or the Huron-Clinton Metropolitan Authority (Figure 20). These include Pontiac Lake, Proud Lake, and Island Lake state recreation areas; and Indian Springs, Kensington, Huron Meadows, Hudson Mills, Dexter-Huron, Delhi, Lower Huron, Willow, and Oakwoods units of the Huron-Clinton Metropolitan Authority. Point Mouillee State Game Area surrounds the mouth of the Huron River at Lake Erie. Portions of tributaries flow through Highland Recreation Area, Brighton Recreation Area, Gregory State Game Area, Pinckney Recreation Area, Unadilla Wildlife Area, Chelsea State Game Area, and Waterloo Recreation Area. These lands provide important recreational areas and bring large amounts of upland and riparian land under public management.

Recreational Use

The Huron River has tremendous recreational potential because it is near the population centers of Ann Arbor, Ypsilanti, and the Detroit metropolitan area. A great many people take advantage of the river's opportunities for fishing, canoeing, rowing, motor-boating, wind surfing, sailing, swimming, picnicking, hunting, trapping, hiking, nature study, and bird watching. Access to the river is exceptional, provided by the series of state, municipal, and Huron-Clinton Metropolitan lands (Figure 20).

The headwaters of the river above Commerce and the major tributaries, include many in- and off-channel lakes, and medium to large streams (width about 10 ft) that are wadable. The lakes provide excellent opportunities for swimming, boating, and fishing. Many are ringed with homes and are private, but some have public lands and developed access sites (Table 18). Notable is Pontiac Lake which is bordered on one side by Pontiac Lake State Recreation Area. An estimated 47,000 angler hours per year were spent on Pontiac Lake in 1980 fishing for northern pike, yellow perch, largemouth bass, bluegill, rock bass, pumpkinseed, black crappie, and bullheads (Ryckman and Lockwood 1985; estimates of angler hours in various areas are shown in Figure 21).

The larger tributary streams above Commerce provide limited opportunities for canoeing and fishing. Most stream-frontage property is private and access is restricted. The main river is the exception, with access and varied recreation opportunities available at Pontiac Lake State Recreation Area and Indian Springs Metropark. The latter is the first of nine metroparks located on the Huron River that provide access and a variety of recreational opportunities.

The river from Commerce to Kent Lake is about 20-50 ft wide and is wadable. This reach provides pleasant canoeing and fair fishing for northern pike, rock bass, smallmouth bass, largemouth bass, and sunfishes. Legal-size rainbow and brown trout are stocked by Fisheries Division, each spring in 1.5 mi of river between Moss Lake Dam and Wixom Road, and provide excellent spring fishing. During April and May, 1987, over 10,000 angler hours were spent fishing for trout (Ostaszewski 1990). Proud Lake State Recreation Area provides excellent river access and opportunities for picnicking, hiking, hunting, and other outdoor activities.

Kent Lake is a large (1200 acre), fairly shallow (40 ft maximum depth) reservoir that provides good fishing and boating opportunities. During the 1980 open-water season an estimated 191,000 angler hours were recorded on Kent Lake; anglers caught good numbers of northern pike, yellow perch, smallmouth bass, largemouth bass, bluegill, pumpkinseed, and black crappie (Ryckman and Lockwood 1985).

Below Kent Lake the river runs for several miles with a fair gradient (Table 1) and then flattens for the rest of its run to Strawberry Lake. This stretch provides good canoeing and fishing for northern pike, rock bass, smallmouth bass, largemouth bass, and other sunfishes. Excellent river access and other recreational opportunities are provided through much of this reach by Island Lake State Recreation Area and Huron Meadows Metropark.

The Strawberry-to-Baseline chain-of-lakes includes seven lakes that provide excellent swimming and boating, and good fishing for northern pike, largemouth bass, walleye, and panfish. These lakes are ringed with homes and access is private except for one public site on Portage Lake.

From Baseline Lake to Barton Impoundment near Ann Arbor, the river is about 100 ft wide and wadable. This reach has good gradient (Table 1), with an associated gravel-cobble bottom and some extensive riffles. This stretch offers good canoeing and some kayaking at Delhi rapids. Fishing is very good (and popular) for smallmouth bass and rock bass. In recent years an estimated 10,000 angler hours were spent per year on a 10 mi stretch; about 14,000 smallmouth bass (legal- plus sublegal-sized) and 1,700 rock bass were estimated to have been caught each year (Merna 1990). A special "no-kill" regulation for smallmouth bass is in effect on this stretch as a means for preventing overharvest and increasing recreational opportunity (Merna 1990). Access is extensive through Hudson Mills, Dexter-Huron, and Delhi Metroparks.

From Ann Arbor through Belleville, the river is essentially a series of seven impoundments: Barton, Argo, Geddes, Superior, Peninsula, Ford, and Belleville. Short segments of river are found within Ann Arbor and Ypsilanti. The natural channel here is about 100-124 ft wide and mostly wadable. The gradient is high (Table 1) and originally, this reach would have been the recreational "heart" of the river with 38 mi of gravel-cobble-boulder substrate characterized by sizable riffles and rapids and interspersed with deep pools. This reach would have provided outstanding canoeing and kayaking, excellent fishing for smallmouth bass and walleye (and potamodromous fishes returning to spawn), and beautiful scenery.

The upper five impoundments provide limited-to-fair boating and fair fishing for smallmouth bass, northern pike, walleye, largemouth bass, panfish, carp, suckers, and channel catfish (G. Towns, FD, MDNR, personal communication). During 1972-76, immediately after the rotenone procedure and restocking of these upper five impoundments, nearly 80,000 angler hours per year were spent on fishing (Laarman 1979). Although fishing pressure in restocked impoundments generally decreases after the first few years as the fish community reaches a balance, these are well fished areas where access is available; shorefishing access to Barton, Superior, and Peninsula impoundments is limited, but good at Argo and Geddes impoundments.

Ford and Belleville impoundments provide extensive boating and fishing opportunities. Public boat launches are available on both reservoirs. Many townhouse and condominium complexes have been built to take advantage of the impoundment's recreational attractions. Fishing has been good for walleye, largemouth bass, smallmouth bass, panfish, white bass, and catfish; during 1974-77 about 295,000 angler hours per year were logged on these waters (Spitler 1978; Laarman 1979). However, these estimates were calculated after a rotenone treatment and are probably higher than a longer-term average. Recent surveys (FD, MDNR, 1993) show that Ford impoundment continues to have an exceptional bluegill and black crappie population, a good walleye, smallmouth bass and largemouth bass population, and fair numbers of channel catfish. Belleville Lake (FD, MDNR, 1992) is undergoing major changes in its fish community structure after an extended drawdown that ended in the spring of 1988, although fishing remains fair (see **Fishery Management**). Shorefishing opportunities are limited on both impoundments.

On the short riverine fragments in this reach, access is limited. Local parks maintained by the cities of Ann Arbor and Ypsilanti are almost the only access available. In these sections canoeing and fishing are possible although they are limited by fluctuating flows at the dams (see **Dams and Barriers**) and by their fragmented nature. Activities such as picnicking, bird watching, and walking are popular at these high-gradient rocky riffle stretches.

The reach below Belleville to Flat Rock Impoundment has a low gradient and provides pleasant canoeing and fishing for northern pike, largemouth bass, smallmouth bass, and panfish. River access is extensive through Lower Huron, Willow, and Oakwoods metroparks.

Flat Rock Impoundment floods what was originally high gradient bedrock. This area would have provided outstanding smallmouth bass fishing and recreational canoeing. Flat Rock Impoundment is very shallow as a result of sediment accumulation and provides relatively poor fishing. The Oakwoods Metropark nature center is located on this impoundment.

The reach from Flat Rock to Lake Erie is flat. Very little boating takes place on this stretch, other than those Lake Erie boaters who harbor their vessels in the river mouth. Fishing is good within the first mile of river downstream from Flat Rock Dam (a city park). Summertime fishing is good for panfish; spring and fall fishing is good and popular for potamodromous fishes including steelhead (stocked by the state), chinook salmon, and white bass; nearly 50,000 angler hours were spent each year during 1989-1991 pursuing potamodromous fishes (Seelbach et al. 1994). Shoreline access is good at local parks in Flat Rock and Rockwood. Boat access is limited.

Dams and Barriers

There are 96 dams in the watershed (Table 19), with 19 on the mainstem and 77 on tributaries (Figure 4). The first dams were constructed in the 1820s on Fleming and Mill Creeks; the first hydropower facility, at Geddes, was built in 1884 (Jessup 1993). Since 1910, there have been three phases of dam construction in this watershed.

The first, from 1910 to 1940, produced most of the mainstem dams built for power generation. Construction for this purpose ceased as building costs increased 250%, steam-generated electricity became economically competitive, and regional population growth rendered the amount of water-produced electricity insignificant. As well, water flow in the mainstem had been altered by clearing and draining the surrounding land and this produced seasonal runoff that was so rapid that the dams could not contain the water, and therefore it had to be released immediately and not used for power production. Also this rapid seasonal runoff meant that less water flowed during dryer seasons, making it difficult to store enough water to generate power (Jessup 1993).

The second phase of dam construction, from 1945 to 1970, was when most dams were built for recreational and waterfront housing development on the mainstem and major tributaries. The third phase, since 1970, is composed mainly of dams that have been constructed as water retention ponds in urban areas.

Except for Pettibone Pond Dam, all of the dams are considered to be safe. Fourteen dams are of hazard type 1 (dam failure would cause loss of life), 15 are of hazard type 2 (dam failure would cause severe property damage), and the remaining 69 dams are of hazard type 3 (in a remote area or having very low head). Eleven of the dams are retired hydroelectric facilities. Barton, Superior, Ford, and French Landing dams, all on the mainstem, are operating hydroelectric facilities (LWMD, MDNR, unpublished data).

Dams have a variety of affects on river ecosystems. As described earlier, they influence flow patterns and channel cross-sections. They also block drift and migrations by aquatic organisms, change river temperatures, increase evaporation and reduce streamflow, disrupt downstream transportation of sediment and woody debris, and modify water quality. The Huron River shows all of these affects, although detailed investigations of all aspects are not available.

Many fish species migrate long distances within rivers as part of their life history strategy. Dam's affects on potamodromous fish migrations are the most obvious negative consequence. However, what is often overlooked is that resident species may also need to migrate within the river (Figure 3). They typically require spawning habitat that is very different from their normal feeding habitat. They often need to move to find tolerable temperatures at different times of the year. Many aquatic organisms, especially insects, drift downstream as larvae until desirable habitats are found. After maturation, adult insects fly upstream to reproduce. Upstream and downstream migrations by fish, and downstream drift by small aquatic organisms, are generally blocked by dams. Upstream movement is blocked physically. Downstream movement by organisms that require stream conditions may be inhibited by slow-moving, warm lake water behind dams. Some of the organisms that pass downstream through dams are injured or killed in the process. This is especially true when organisms pass through hydropower turbines. None of the 96 dams provide up-stream or down-stream fish passage facilities.

The affects of fragmentation of the river by dams are difficult to document without detailed aquatic community composition data before and after dam construction and without detailed mapping of habitat and migration patterns. Such data are not available for the Huron River, but the possible scope of this problem may be seen by examining Appendix I. Many of the species found in the Huron River normally show migratory behavior. These include potamodromous fish that are blocked in their migrations upstream from Lake Erie by Flat Rock Dam. Some of the resident fishes migrate seasonally into tributaries or connecting wetlands, and populations have become less abundant as this movement was restricted by dams.

Dams have variable affects on water temperatures. The larger surface area in impounded portions of the river enhances heat transfer between the water and the air. Summer warming of the Huron River can create unacceptable temperature ranges for some indigenous species. Other species may be favored by these warmer temperatures. Winter cooling may create conditions where anchor ice coats the stream bottom harming fish and other aquatic organisms. In winter, impoundments supply water of a constant temperature (about 4 degrees Celsius), that provides a warming affect downstream. Flow manipulations at dams often cause varying temperature conditions downstream. Low-flow water releases reduce water volume downstream, increasing the warming affects of air temperatures. High-flow water releases may supply either warm or cold discharge depending on whether water is drawn from the surface or the bottom of the impoundment.

The higher surface areas and temperatures caused by dams can increase evaporation from a river. Average pan evaporation in the Huron River basin is about 7.3 in/month in midsummer (Eichenlaub 1990). Assuming that evaporation from a reservoir is about 75% of the pan evaporation, this implies loss of 0.0076 cfs of stream flow per surface acre of water impounded. On the average, the 7363 acres of impoundments on the Huron River may reduce July discharge as much as 55.96 cfs or 21 percent at the mouth.

Dams are a trap for sediments, woody debris, and other materials that are normally transported downstream by rivers. Stream velocities slow as a river enters the reservoir behind a dam. Sediment particles settle out and are deposited in the upper areas of the reservoir. Woody debris may continue to float but is usually blocked by the dam itself, where it will gradually become water-logged and sink. These processes deprive the downstream river of sediments and woody debris (Maser and Sedell 1994). When water is discharged from the dam without its normal load of sediment, it is out of equilibrium. To compensate for this, the river picks up more sediment in the downstream reach than it normally would. This erosion either greatly deepens the river or causes it to become over-wide. The type of erosion depends on the surrounding soils. For example, in the Huron River below French Landing Dam, the expected width was 155.3 ft and the actual width is 88.5 ft (Table 14). This is a result of the water eroding the softer bottom substrate instead of the hard clay soils of the bank (see also **Soils and Land Use Patterns**). The loss of woody debris to the downstream reach reduces the amount that would otherwise be found in that part of the river. Woody debris normally creates instream flow resistance and cover, so reduced amounts decrease the diversity of hydraulic conditions and the amount of habitat available for fish. As a result, the abundance of species such as smallmouth bass is often reduced in reaches below dams.

The sediment transport throughout the watershed has been severely disrupted by dams. One important consequence is that cumulative sediment deposition at the mouth of the Huron River has been substantially reduced. This deposition created Point Mouillee and the barrier islands. Disruption of the deposition process is one of the main reasons for the erosion of Point Mouillee and its protective barrier islands.

Dams and the impoundments behind them may also modify water quality downstream of the dam. Downstream ecosystems normally function through processing of nutrients and energy bound up in organic materials that can be filtered or captured out of the stream flow. Lake and reservoir ecosystems tend to convert these nutrients to smaller particles and dissolved constituents. Streams are usually well-mixed so that oxygen in the water is in equilibrium with the atmosphere and the oxygen-consuming life processes in the river. Water in lakes and deep reservoirs may be vertically stratified by temperature or suspended solid gradients, so the water in the lower part of a lake often has much lower concentrations of oxygen than water near the surface. Dissolved oxygen and temperature in the discharge from a dam are strongly influenced by the lake depth from which the water is withdrawn. Most of the dams on the Huron River are shallow, so that their main affect on water quality is warming and conversion of nutrients from particulate to dissolved form, but a few of the dams may have other affects.

The dams on the Huron River and its tributaries are listed in Table 19. The known or probable problems in each reach of the river and in tributaries are discussed below.

Big Lake to Commerce Lake - All six of the dams in the upper reach are either recreational impoundments or raise the level of existing lakes. They are all owned and operated by the Oakland County drain commission. River flow is destabilized by their use as lake-level control structures with on/off modes of operation. These large reservoirs on the upper part of the river probably reduce river flow by as much as 10 percent during summer. Nearly all of these dams inundate critical high-gradient habitat, and all block fish migrations. This part of the Huron River lacks normal amounts of woody debris. These dams probably cause water quality problems but they have not been investigated.

Commerce Lake Dam to Baseline (Flook) Dam - The four dams on this reach include one retired hydroelectric dam and three recreational impoundments. Flow is known to be destabilized by Kent and Baseline (Flook) dams, and probably is by the other two. These are large impoundments relative to the flow of the river and probably cause increased temperatures and evaporation by 15 percent of the July flow. The Kent Lake impoundment dampens spring floods and increases winter discharge (Figure 5). This part of the Huron River lacks normal amounts of woody debris. These dams probably cause water quality problems but they have not been investigated.

Baseline (Flook) Dam to Barton Impoundment - This reach contains no mainstem dams or barriers.

Barton Impoundment to French Landing Dam - Nearly this entire reach is impounded by seven dams. All were constructed as hydroelectric projects, but only four (Barton, Superior, Rawsonville (Ford), and French Landing) are producing power. Operating conditions imposed by FERC for each of these dams are summarized in Table 16. Flow fluctuations are significant below Argo Dam, either because of operation of Barton Dam or because the large tainter gates at Argo overcompensate for headwater levels and create wide oscillations in dam releases. These flow waves continue downriver and cause flow fluctuation problems down to Flat Rock. These dams inundate the largest section of high gradient stream in the Huron River. Affects of these dams on warming, evaporation, and water quality are probable but have not been evaluated.

Fish mortalities at the turbines of the French Landing project were estimated by Bohr (1990). Annual estimated turbine losses are 162,623 fish. This includes 123,513 black crappie, 28,774 bluegills, 2,542 pumpkinseed sunfish, 2009 gizzard shad, and 1,068 white bass and white perch. The annual cost of this fish loss is conservatively estimated at $1,582,249.42. Turbine mortalities have not been estimated at other hydroelectric operations.

Concerns about non-compliance with FERC license conditions at these dams include the flow fluctuations described above, failure to fulfill recreational access provisions at French Landing, Barton, and Superior projects, and problems with mandated shoreline erosion projects at French Landing.

French Landing Dam to Lake Erie - Flat Rock Dam and the low-head barrier immediately downstream are the only dams in this reach. Flat Rock Dam inundates important high-gradient bedrock habitat that is a unique and rare resource. Impoundments are a major sink for sediment, sediment that would, in this case, otherwise be transported to Point Mouillee. The low-head barrier is the first dam upstream of the mouth of the river and blocks the migration of many fish species, such as walleye and white bass. Flat Rock Dam blocks further migrations upriver of other potamodromous fishes that may be able to negotiate the first low-head barrier.

Tributaries - There are 77 dams on 29 tributaries of the Huron River. The dams affect on these tributaries have not been evaluated. The alterations listed below do not reflect absence of other problems, nor do they indicate fundamental priorities. They simply reflect the information available to the Fisheries Division.

Chilson Creek - This small stream (with a baseflow of less than 10 cfs) has 5 dams, three of which are lake-level control structures. Extremely low discharges have been documented on this creek, probably from the operation of these lake-level control structures.

Horseshoe Lake Outlet - The Horseshoe Lake lake-level control structure creates flow instabilities.

Inchwagh Lake Outlet - The Inchwagh Lake control structure creates flow instabilities.

Pettibone Creek - There are a total of seven dams on this one small tributary. Most of this stream, including its higher gradient areas, has been affected by dam flooding or discharge instabilities.

South Ore Creek - Four dams are on this creek. They are probably responsible for the flow fluctuations described above. Since they are large for a stream of this size, they are responsible for warming the water considerably.

Dams on other tributary streams need to be examined for the full range of problems that are caused by dams.

Water Quality

Most areas of the river system have good water quality. Some sections have identifiable degradation. Surface and ground water contamination comes from both point source and non-point source inputs. The pH averages 8.2 which indicates that the water is slightly alkaline. Alkalinity ranges between 155 to 205 mg/l.

Point source inputs are governed by the Clean Water Act (see **Special Jurisdiction**). These inputs are regulated by the National Pollution Discharge Elimination System (NPDES) permits that are issued by SWQD, MDNR. There are 80 permits in this watershed for such activities as wastewater control facilities, industrial discharges, and combined sewer overflows (Figure 22, Table 20). The majority of these facilities are in compliance with their permits and do not cause severe degradation of water quality beyond the mixing zone at their outfall. One area of exception is the mainstem downstream from Flat Rock, where combined sewer outflows in both Flat Rock and Rockwood create water quality problems (Anon 1990a).

Nonpoint source inputs are defined as pollutant loadings that do not originate at a specific point of discharge. Nonpoint source loads enter surface water through either atmospheric deposition or water transport. As they are diffuse and often intermittent, they are difficult to identify or quantify. Typical airborne pollutants are picked up and carried by winds and then deposited in watercourses directly or precipitated out during rain or snow storms. Sources of waterborne pollutants include agricultural lands (pollutants include eroded soils, fertilizers, pesticides, and animal wastes), silvicultural practices, streambank erosion, transportation development, urban development, golf courses, resource extraction, septic systems, and construction projects (Anon 1990a; Peterson et al. 1993).

Much of the mainstem Huron River is affected by moderate nutrient enrichment and turbidity; these increase from the confluence of Mill Creek to the mouth (Anon 1990a; M. Cromwell, SWQD, MDNR, personal communication). Turbidity problems are apparent in Mill Creek, an agricultural watershed. Most tributaries that drain agricultural lands carry abnormal turbidities and high nutrient loads; this affect is seen in the lower reaches of the river as well (Vandecar Drain, and Port, Smith, and Silver creeks). Other nonpoint pollutants come from construction site and stormwater runoff. These problems have been documented in Honey Creek, Allen Drain, Traver Creek, Fleming Creek, Pittsfield Drain, Swift Run Drain, North Campus Drain, and Owen Drain (SWQD, MDNR).

The lakes in the watershed are also affected by nutrient enrichment. Elevated levels of phosphorus contribute to increased algae growth particularly in lakes with extensive shoreline development that is serviced by septic systems. Ford Lake and to a lesser extent Belleville Lake have well documented problems (SWQD, MDNR). Portage Lake is the only system known to have a management strategy to deal with this issue (Anon 1990b). This strategy includes the elimination of old septic systems through the installation of a sewer system and recommendations for changes in landscape use practices such as using lawn fertilizers without phosphorus.

Nonpoint source issues are being addressed state-wide through best management practices recommended by SWQD (Peterson et al. 1993) and phosphorus reduction strategies encouraged by Soil Conservation Districts. Local units of government are also preparing their own strategies; one such project has been completed by the Office of the Washtenaw County Drain Commissioner (Toffaleti and Bobrin 1991). In addition, the Huron River Watershed Council's Adopt-a-Stream program has been instrumental in raising public awareness and concern for the Huron River watershed.

Another source of pollution to the river is contaminated groundwater. Groundwater quality is generally excellent through out the state, although a large number of localized areas have been adversely affected by a variety of past and present human activities. These include point sources such as leaking underground storage tanks, spills, or leaks of liquid products or wastes, at industries and businesses or during their transportation, leaking solid waste management facilities such as landfills, and improperly constructed or operated wastewater treatment and disposal facilities. Nonpoint sources include excessive or improper application of agricultural fertilizers, animal wastes, and pesticides (Anon 1990a).

Another concern has been the increasing number contaminated land sites in Michigan. These areas vary and can include leaking storage barrels, gas stations, landfills, manufacturing sites to list a few. In response to this problem, the Michigan Environmental Response Act (PA 307, 1982) was created. As of 1992, 131 sites were listed for the watershed (Table 21). This table does not contain locations that are known to have little or no negative affect on the river system. The most affected county is Washtenaw, with 74 sites.

Due to generally good water quality in the watershed, fish populations have not been subject to any specific fish consumption advisories, other than the general statewide advisory regarding mercury for all inland lakes. The mercury advisory applies to all inland lakes in Michigan due to widespread mercury contamination throughout the north-central United States and Canada. It states that no one should eat more than one meal a week of the following kinds and sizes of fish: rock bass, perch, or crappie over 9 in; largemouth and smallmouth bass, walleye, northern pike, or muskellunge of any size. Nursing mothers, pregnant women, women who intend to have children, and children under the age of 15 should not eat more than one meal per month of the fish species listed above. Since humans excrete mercury over time, visitors or residents who eat these fish for 1-2 weeks per year can safely consume several meals during that period.

In 1964, FD classified water quality throughout Michigan for the purpose of fishery management. This classification must be assumed to be out of date and should be reviewed, but it is useful in considering water quality with respect to fishery uses. This classification is illustrated in Figure 23. No top-quality trout waters are found in the watershed. However, portions in northern Washtenaw County are designated second quality trout water, indicating they could sustain significant trout populations, but are appreciably limited by factors that prevent natural reproduction.

The entire mainstem, other than the one second-quality trout section mentioned above, was classified as top-quality warmwater (contains good self-sustaining warmwater fish populations). The section from French Landing Dam to the mouth should be re-classified as second quality warmwater stream (contains significant populations of warmwater fish that are appreciably limited by turbidity, competition, lack of cover, or habitat). All tributaries, except for Mill Creek, are listed as second-quality warmwater areas. Mill Creek was classified as top-quality warmwater, but probably should be re-classified as second quality, based on previous and recent sampling (Kosek 1993). Temperature data that would be useful in re-evaluating the classification system are lacking.

Fishery Management

The diversity of fish species present in the Huron River and its tributaries is relatively high (see **Biological Communities**). The fish communities are healthy in most parts of the river, with a good mix of species requiring various habitats. However, as noted in the **Biological Communities** section, fish communities typical of natural lake outlets, heavily-vegetated water, gravel, and higher gradient habitats have been reduced through loss of such habitats.

Fishing conditions for gamefish species vary among reaches of the watershed:

<u>Big Lake to Commerce Lake</u> - There are few gamefish in this portion of the river due to it's shallow simple channel. It is classified as a first-quality warmwater stream. Due to marginal habitat conditions and poor public access, there has not been any fish stocking. The lakes generally have good warmwater gamefish communities.

<u>Commerce Lake to Baseline (Flook) Dam</u> - There are few gamefish in this portion of the river. Public access is available on state recreation lands and HCMA parks. However, the river contains little large structural habitat (or woody debris) and much of the channel has been

dredged. Smallmouth bass probably would do well in much of this section of the river, if enough cover were available.

Since the mid 1970s, FD has stocked adult brown and rainbow trout each year, below Proud Lake at the beginning of April. These fish provide a catch-and-release, flies-only fishery followed by (on the opening day of trout season) a harvesting fishery. This is a popular event that lasts about 2 months, until the fish are caught out or the water gets too warm for trout survival.

Kent Lake provides excellent shore and boat fishing opportunities. Walleye, northern pike, largemouth bass, crappies, panfish, and carp are populations are good. Kent Lake has an international reputation for its carp fishery, annually attracting anglers from Europe looking for trophy fish (E. Hay-Chmielewski, FD, MDNR, personal communication).

The chain-of-lakes, Strawberry Lake to Portage Lake, located at the lower end of this section, provides opportunities to catch both coolwater and warmwater fish. All of these lakes have excellent bluegill populations and good populations of other species. These lakes have probably always had walleye populations, as both Orr and Big Portage lakes have recorded catches of walleyes in 1890 (Anon.). Fingerling walleye were stocked in 1984 and 1985 (Table 5) in an attempt to increase the population of this species. Little public demand for a walleye fishery and insufficient hatchery fingerling production resulted in the end of this program (G. Towns, FD, MDNR, personal communication).

<u>Baseline (Flook) Dam to Barton Impoundment</u> - This river section has the healthiest fish community structure and fishing. Smallmouth bass are the principal piscivorous fish. In most of this reach, populations of larger fishes appear limited by a shortage of large woody debris and vegetated banks that would provide cover. Nonetheless, smallmouth bass and rock bass provide good fishing throughout. The area from Mast Road bridge in Dexter, downstream to Delhi Road bridge, is under catch-and-release regulations. Studies were recently completed on fishing regulations (FD, MDNR) and on Instream Flow Incremental Methodology (US Fish and Wildlife Service and Michigan State University) within this section. Good riverine fishing extends downstream almost to Barton Impoundment.

<u>Barton Impoundment to French Landing Dam</u> - This portion is largely impounded, so river fish communities and riverine fishing are limited by the small reaches available. In 1972-74, the system, including both the river and impoundments, from Barton Impoundment to Flat Rock was treated by Fisheries Division with the piscicide rotenone. This treatment removed virtually all fish, targeting the predominant carp and sucker populations. The impoundments were subsequently restocked with bass, bluegill, northern pike, perch, walleye, and other species to establish a more desirable sport fish community.

The success of the rehabilitation effort was generally good for the impoundments. Barton and Argo reservoirs, with their more lake-like clear waters, have developed good gamefish populations of small- and largemouth bass, black crappie, walleye, channel catfish, and bluegill. Geddes impoundment, which is more shallow and turbid, has good populations of channel catfish and fair populations of bass and panfish. However, it also has a high proportion of species that are generally termed rough fish. Superior and Peninsula Paper impoundments are small, relatively inaccessible systems, separated by high dams. The sport fish community in these reservoirs is fair and they contain large numbers of rough fish (G. Towns, FD, MDNR, personal communication).

Ford Lake has a good gamefish community of bluegill, walleye, black crappie, and largemouth and smallmouth bass (FD, MDNR, 1993). These populations are self-sustaining and require little management. Tiger muskellunge are stocked bi-annually and provide a limited trophy fishery (G. Towns, FD, MDNR, personal communication).

Belleville Lake has a fair gamefish community. However, an extended drawdown of the reservoir for dam repairs in 1987 and 1988, caused many changes in the fish community structure. In a 1992 survey (FD, MDNR), 33% of the fish caught were white perch and gizzard shad. Before the drawdown, they had not been found in the reservoir. White bass are no longer present. Black and white crappies are still dominant (39% of survey caught fish), although not to the extent seen in previous surveys. Bluegill populations have decreased. Largemouth bass and smallmouth bass numbers appear good. Significant numbers of walleye, tiger muskellunge, and channel catfish have not been seen since the drawdown. Stocking of these three species will begin in 1994, in an attempt to increase top predators that will both control and use the large forage base and provide a better sport fishery.

French Landing Dam to Lake Erie - This section lacks cover for larger piscivorous fishes and does not support a good fishery for resident fish. Potamodromous fish have been stocked by FD below Flat Rock Dam to create a fishery over the spawning run. Stocking with coho salmon was unsuccessful. Steelhead trout have been fairly successful and efforts to build this fishery are ongoing. A few chinook salmon migrate into the river during autumn, but their origin is unknown. Walleye runs, that were historically important, are now small due to loss of spawning habitat beneath Flat Rock impoundment. White bass populations can be found in the lower river but are not abundant enough to provide a highly desirable fishery.

Tributaries - No tributaries support large populations of piscivores or substantial fisheries.

In summary, populations of gamefish are limited in the majority of the river. Most of the tributaries and mainstem that could sustain good smallmouth bass and rock bass populations lack good gradient and woody debris and other cover that these species require. Only the section from Baseline (Flook) Dam to Barton Impoundment, that still has a good gradient, sustains a good fishery for these species. The river system is highly fragmented, restricting spawning migrations between the mainstem and tributaries. Potamodromous species, especially steelhead and white bass, could provide significant fisheries in the lower river. However, public access is limited below Flat Rock and fish are restricted from the public access and spawning areas further upriver by Flat Rock Dam.

In the lentic waters of the headwater lakes, chain-of-lakes, and the impoundments, populations of gamefish range from poor to very good, depending on location. Lack of public access remains a problem in the lower impoundments.

Citizen Involvement

Most citizen involvement with management of the Huron River appears to be intermediated by government agencies, including the Michigan Department of Natural Resources, Southeast Council of Governments (SEMCOG), soil conservation districts, county drain commissioners, community governments, and the Huron-Clinton Metropolitan Authority. These agencies are primarily involved with managing water flows, water quality, animal populations, landscape use, and recreational opportunities; all of these topics are addressed to some degree in this assessment.

Other organizations that FD has contact with, who have an interest in and actively work on aspects of the Huron River, are listed in Table 22. These organizations are largely oriented toward fishing, hunting, and recreation, except the Huron River Watershed Council which has broad environmental interests similar in scope to those addressed in this report.

MANAGEMENT OPTIONS

Compared to many rivers affected by urbanization, the Huron River is a fairly healthy system. Nonetheless, there are fishery-related problems that need attention. The management options presented in this assessment are an attempt to address the most important problems that are now understood and to establish priorities for further investigation.

These options follow the recommendations of Dewberry (1992), who outlined measures necessary to protect the health of the nation's public riverine ecosystems. Dewberry stressed protection and restoration of headwater streams, riparian areas, and floodplains. Streams and floodplains need to be reconnected where possible. We must view the 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 the FD. This mission is to protect and enhance the public trust in populations and habitat of fishes and other forms of aquatic life, and promote optimum use of these resources for the benefit of the people of Michigan. In particular, the division seeks to: protect and maintain healthy aquatic environments and fish communities and rehabilitate those now degraded; provide diverse public fishing opportunities to maximize the value to anglers; and foster and contribute to public and scientific understanding of fish, fishing, and fishery management.

We convey three 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 the rehabilitation of degraded resources. Opportunities to improve an area or resources, above and beyond the original condition, are listed last.

Biological Communities

Species diversity remains high, but certain problems require attention. Fish species that require clean gravel or clear, heavily-vegetated water at some point in their life history have declined significantly. Those that tolerate silty conditions have increased. This change in community structure is a result of changes to certain habitats within the river. Most significant has been the loss of aquatic vegetation by dredging and construction of lake-level control structures or dams. Gravel substrate has mostly been lost to impounding of high gradient areas behind dams, channelization of tributaries to enhance drainage, or sediment deposition in low-gradient stretches. The other significant change to the fish community has been the loss of potamodromous species that historically used the river for spawning.

Mussel species have declined as large portions of the mainstem have gone from a free-flowing river to one with many impoundments. Amphibians and reptiles are suffering from the loss of wetlands available to them. The status of aquatic invertebrate communities is unknown.

Option: Preserve vegetated headwater lake outlets by identifying any remaining ones, and prohibiting dredging and construction of lake-level control structures at these areas. The area most affected by this is from Big Lake to Baseline (Flook) Dam.

Option: Preserve stream margin habitats, including floodplains and wetlands, by requiring setbacks in zoning regulations and controlling development in the stream corridor.

Option: Preserve remaining high gradient and naturally-graveled habitats. This is mostly the area from Baseline (Flook) Dam to French Landing Dam, although other short stretches exist on the mainstem and on tributaries.

Option: Survey the historic record to determine the pre-settlement fish fauna in the watershed.

Option: Survey distribution and status of aquatic invertebrate and fish fauna.

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

Option: Survey distribution and status of species of concern and develop protection and recovery strategies for those species.

Option: Rehabilitate rare, high-gradient areas and fragmented habitats by removal of unnecessary dams (ex. removal of the Dexter Dam would reconnect the entire Mill Creek system to the mainstem).

Option: Rehabilitate gravel habitats through reduction of sediment loads by stringent enforcement of local construction codes and implementing nonpoint source best management practices.

Option: Rehabilitate populations of potamodromous fish by removal of the Flat Rock low-head barrier and Dam and restoration of spawning habitats .

Option: Rehabilitate migration ability of fish by installing upstream and downstream passage at dams and barriers.

Geology and Hydrology

The Huron River has moderately stable flows. Many reaches, however, have less stable flows than expected or desirable. The most severe flow problems are caused by operations of the complex of dams in the Ann Arbor-Ypsilanti area, the on/off operations of many lake-level control structures, and the management of the various tributaries as drains.

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, with emphasis on riparian areas.

Option: Protect critical groundwater recharge areas by identifying these and developing a strategy to protect them. Also identify any major removal of groundwater.

Option: Protect and rehabilitate flow stability by developing an operational 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 although various alternatives to be examined and drive future planning processes by providing fundamental information critical for proactive landscape and stormwater management planning.

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

Option: Survey historical records to determine pre-settlement river flow patterns.

Option: Rehabilitate mainstem run-of-the-river flows by linking the operation of the seven Ann Arbor-Ypsilanti dams to a single telemarked upstream-flow gauge. This will reduce errors in dam operations.

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

Option: Rehabilitate headwater summer base flows by establishing minimum flow requirements downstream of all lake-level control structures. These levels might 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 stormwater management.

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

Option: Rehabilitate flow stability by amending the Lake-level Control Act to disallow on/off operations.

Channel Morphology

The channel of the Huron River has been adversely altered. Most high-gradient reaches have been impounded. Early dredging, increased flood peaks, and current erratic dam operations have resulted in most of the remaining river and its tributaries being generally over-wide, shallow, simple, lacking diversity, or lacking woody structure.

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

Option: Survey the historical record to determine pre-settlement channel form.

Option: Rehabilitate rare high-gradient habitats by removing dams no longer used for their original purpose (example retired hydroelectric facilities), dams that are a safety hazard, and dams serving little purpose.

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. don't tear it all out).

Option: Rehabilitate channel form by lowering flood peaks through addressing hydrologic concerns discussed in the Geology and Hydrology section.

Option: Rehabilitate river banks below French Landing Dam to preserve the woody vegetation in this corridor that is in eminent danger of destruction.

Soils and Land Use Patterns

Agricultural and urban land uses have altered the river system, however, extensive undeveloped lands in the upper watershed have buffered these changes. Projected urban sprawl threatens the integrity of this buffer.

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

Option: Protect developed lands through land-use planning and zoning guidelines that emphasize protection of critical areas, minimizing impervious surfaces, and improved quality and quantity of stormwater management.

Option: Protect and rehabilitate the functions of wetlands and floodplains.

Option: Protect and rehabilitate the forested corridor along the river and its tributaries.

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

Option: Rehabilitate Mill Creek by developing a creekshed strategy that addresses controlling urban development, minimizing sediment inputs from agriculture and developed lands, creating a riparian corridor that includes floodplain/wetlands for flow stabilization, encouraging sustainable agricultural practices, and reconnecting this system to the mainstem by removing Dexter dam.

Special Jurisdictions

The Federal Energy Regulatory Commission licenses four active hydropower facilities within this basin. County drain commissioners have authority over designated drains and many lake-level control structures. The State of Michigan and the Huron-Clinton Metropolitan Authority control large amounts of riparian land and many dams.

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: Survey and review management of land and dams owned by the State of Michigan and the Huron Clinton Metropolitan Authority.

Option: Survey stream road crossings, identify negative affects, and implement best management practices.

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

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

Recreational Use

The watershed provides extensive recreational opportunities in large public-owned areas. Present impoundments in the high-gradient mainstem reach from Barton Impoundment to French Landing Dam provide poor-to-good opportunities. This reach has the potential to provide exceptional riverine fishing, canoeing, kayaking, and sightseeing. Portions of the river not in public ownership have little public access.

Option: Rehabilitate attractive, high-gradient reaches by removing retired hydroelectric dams in the Ann Arbor-Ypsilanti area (e.g. Argo and Paper Peninsula dams) and in other high gradient reaches (e.g. Dexter Dam). This should occur in conjunction with development of parks on the reclaimed landscape, especially within communities.

Option: Improve small-scale public access where lacking through MDNR, county, township, and other municipal recreation departments, as well as private organizations.

Option: Improve public access at hydropower facilities under FERC relicensing agreements.

Dams and Barriers

The 96 dams within the watershed impound most high-gradient habitat, eliminate vegetated stream habitat at lake outlets, create flow fluctuations, trap sediments and woody debris, fragment habitat for resident fishes, and block potamodromous fishes from much of the river.

Option: Protect the 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.

Option: Survey and develop an inventory of barriers to fish passage, such as culverts.

Option: Survey and develop a watershed list of the 20 most environmentally damaging dams and barriers to the river with recommendations to mitigate the damage.

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

Option: Rehabilitate free-flowing river conditions by removing dams.

Option: Rehabilitate natural river flows by requiring dam owners to operate at run-of-the-river flows.

Option: Rehabilitate natural river flows by physically modifying dams to permit run-of-the-river flows.

Options: Rehabilitate natural river flows by modifying all possible dams to fixed-crest structures.

Options: Rehabilitate natural river flows by operating dams based on river inflows, not impoundment levels.

Option: Rehabilitate natural river flows by amending the Lake-level Control Act.

Water Quality

Water quality is good in most parts of the watershed. The mainstem is affected by moderate nutrient enrichment and turbidity. The presence of many Act-307 pollution sites raises concerns about future loadings of toxic materials in the river.

Option: Protect the river by implementing improved stormwater and nonpoint-source best management practices.

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

Option: Survey loadings of nutrients and sediments to the river and develop strategies to reduce identified problems.

Option: Rehabilitate water quality by supporting Act 307 site cleanups.

Option: Rehabilitate the integrity of Mill Creek by implementing land use and drain management changes to reduce sediment loads.

Option: Rehabilitate water quality downstream of Flat Rock by eliminating combined sewer overflow problems in Flat Rock and Rockwood.

Option: Rehabilitate the quality of existing degraded wetlands by rigorous enforcement of Act 346 and local building ordinances.

Fishery Management

Fishing is good in headwater lakes and in the river system from the chain-of-lakes downstream to Barton Impoundment. However, gamefish populations appear reduced by a lack of woody structure and habitat fragmentation. Fishing ranges from poor to good through the seven mainstem impoundments. An attractive potamodromous fishery exists downstream of Flat Rock. Further development of this fishery is limited by Flat Rock Dam and weir.

Option: Rehabilitate habitat continuity by removing unnecessary dams. Require upstream and downstream fish passage at those dams that remain.

Option: Rehabilitate in-stream habitat for smallmouth bass and rock bass in the middle portions of the Huron River and its larger tributaries. This includes increasing cover and channel diversity.

Option: Rehabilitate rare, bedrock spawning habitat for potamodromous fishes by removing Flat Rock Dam and weir.

Option: Rehabilitate historic potamodromous fish runs, through stocking if needed. The original species that are best suited are walleye, white bass, muskellunge, and lake sturgeon.

Option: Improve angling opportunities in the impoundments and chain-of-lakes by continued improvement and acquisition of public access.

Citizen Involvement

The Huron River Watershed Council coordinates citizen involvement in watershed planning and protection.

Option: Protect and rehabilitate watershed integrity by supporting the watershed council in its efforts to build public support.

Option: Protect and rehabilitate watershed integrity by encouraging and supporting watershed- based development practices by other agencies.

Option: Improve and implement strategies to educate the community as to the benefits of riverine ecosystems, wetlands, and floodplains.

PUBLIC COMMENT AND RESPONSE

Comments were received on the draft of this assessment from when it was first distributed in May, 1994, until September, 1994. Two public meetings were held requesting input on the draft document. The first was on July 11, 1994 at the Township Hall in the Village of Milford. The second was July 12, 1994 in the New Center Building, Ann Arbor.

Copies of the draft assessment were placed in eleven libraries at Milford, South Lyon, Brighton, Hamburg, Pinckney, Dexter, Ann Arbor, Ypsilanti, Flat Rock, and Rockwood. These draft assessments were kept in the reference section of the library so they would be available at all times. Copies for distribution were available at Livonia, Jackson, and Shiawassee district offices, Lansing Fisheries Division office, and the Institute for Fisheries Research, Ann Arbor of the Michigan Department of Natural Resources, and the Huron River Watershed Council offices in Ann Arbor. A copy was sent to any individual or group requesting one.

Public notices were sent to local newspapers in the watershed stating that a draft of the assessment was available and comments on it were requested. Notices were also sent out regarding the public meetings.

All comments received were considered. The suggested change was either incorporated into the assessment or listed with the reason it was not included.

Comment: The report does not contain ecosystem diagrams presenting the important components and their functional relationship.

Response: This is true. This report is an assessment of the Huron River from a fisheries perspective and is not meant to be an ecosystem report; therefore that level of detail was not included.

Comment: While I find the cover interesting, it is very confusing and does not perform the function of a cover picture which is to invite the uninformed reader inside. The cover is great! I never knew how much gradient was in the Huron River, what a neat picture. What in on the front page? Is the Huron River watershed square?

Response: The cover diagram drew a variety of comments. The diagram was choosen because it shows the actual landscape through which the river flows and the tremdous gradient that is present. It was hoped that this diagram would help readers begin to visualize the river and watershed in its entirity and in three dimensions. The success of that intent is obviously mixed.

Comment: Dams in the watershed should be removed; dams should not be removed; specific examples of both included Argo, Geddes, Dexter, Flat Rock, and Peninsula dams and lake-level control structures.

Response: This issue drew various comments depending on the location of the dam or lake-level control structure and the individual's view of the river. The comments were definite, coming out strongly on one side or the other. It is felt that a reasonable balance must have been achieved on this controversial issue for both sides to be so represented.

Comment: The assessment needs an index.

Response: Time constraints prevent the addition of this feature. It has not been common practice to include indices in reports and because of the manageable size of the document and thoroughness of the table of contents and sections headings, we believe it is easy to locate information.

Comment: Need a cross-divisional MDNR watershed coordinating committee to ensure that the recommendations of the assessment are pursued. The assessment will be ineffective without a plan to guide the MDNR and other organizations toward actively saving and improving the river.

Response: As of December 1994, a committee of Fisheries Division, Surface Water Quality Division, and Land and Water Management Division people are looking at ways to co-ordinate and co-operate with each others water management programs. The purpose is to devise a more integrated approach than presently exists. The next step in the process of watershed management is to begin implementation of the best options from this assessment. This assessment is not meant only for MDNR use, but for anyone who lives in the Huron River watershed. It is hoped that the Huron River Watershed Council, local units of government, drain commissioners, Huron-Clinton Metropolitan Authority, and others will use this document for a source of information and as a guide for their future direction.

Comment: The information on water quality is limited and should include more on problems with urban sewage treatment, storm sewer runoff, and agricultural runoff.

Response: This report is intended to look at the river from a fisheries perspective. Many things affect the river and the intent was to address each subject. However this is intended to be a fisheries document and therefore in-depth coverage of areas such as water quality are not as detailed as they could be.

Comment: More attention needs to be paid to access around French Landing Dam.

Response: This issue is being currently being addressed by the Federal Energy Regulatory Commission that is responsible for the re-licensing of the French Landing facility.

Comment: Too difficult to get a copy

Response: Copies of the draft assessment were placed in 11 libraries in the watershed, 3 MDNR district offices, and the Huron River Watershed Council office. Public notices were sent to all local newspapers stating that the document was available and public comment on it desired. Copies were also obtainable from the Fisheries offices in Lansing and Ann Arbor. Regrettably not all who wished to receive a copy were able to. Suggestions on how to further distribute draft assessments and make their availability known would be appreciated.

Comment: More emphasis upon preservation, enhancement, restoration, or possible creation of wetlands habitat needed. A map of critical wetlands is needed.

Response: More discussion of wetlands and the importance of their roles in the watershed has been included. A map of the critical wetland has not been included as one does not currently exist. Should one become available, it would be included in future revisions of this document.

Comment: More emphasis on protecting high quality forested flood plain habitat.

Response: It is our hope that the issue is more clearly stated in this version.

Comment: More surveys of plants and animals needed, especially within the floodplain and adjacent upland areas. More on threatened and endangered flora.

Response: These activities are beyond the scope of Fisheries Division. They are administered by the Natural Features Section, Wildlife Division. They may be contacted directly at PO Box 30444, Lansing, Michigan 48909.

Comment: More coverage on aquatic invertebrates, an appendix listing species and where.

Response: This information was not listed in this document although it is referenced. Copies of the SWQD report with the detailed information is available to anyone wishing a copy and may be obtained from any district MDNR office or by writing Surface Water Quality Division, 2nd Floor, Knapps Centre, Box 30273, Lansing, Michigan 48909.

Comment: Who are the options directed at? identify them. When will the options be considered and acted upon?

Response: The options are directed at a variety of agencies. Specific entities were not named as the number are broad. Options listed in the draft assessment are already being acted upon by a number of agencies, for example the Village of Dexter has passed a resolution for removal of the Dexter Dam and rejoining of Mill Creek to the Huron River, and the Huron River Watershed Council in its strategic planning is using many of the recommendations of the assessment to guide its future.

Comment: Add in GIS soils and land use maps.

Response: This was attempted, however with the limitations of black and white figures, reproductions of these color images turned out very indistinct and difficult to interpret. If color printings are possible in the future, these will be included.

Comment: The study pays attention to and solicits responses from sports and environmental groups and there did not appear to be similar attention to the businesses that have settled along the river.

Response: As much information as possible was requested during the data collection phase of this assessment. Throughout the process of writing this document, material was constantly being included. Also through the public comment period new pertinent items were added. Those who feel that an area was slighted are welcome to submit specific examples to be include in updates of this assessment.

Comment: The use of hydro electric power is a non-pollutable type of electrical power which we should propagate.

Response: The use of hydro-power is frequently stated in terms of benefits to the surrounding community. Although there are benefits, this report points out that there are also costs. The costs include fragmentation of the river, loss of riverine species in the impounded area, change of the land use, changes to water quality and temperature, and loss of rare high-gradient habitats. Both benefits and costs need to be considered when addressing the question of hydro-power.

Comment: Guidelines should be developed that would assist communities with Act 307 clean-ups to minimize the unintended impacts of clean-up plans (for example warming of water before discharge, altering of groundwater recharge of surface waters).

Response: This falls under the Environmental Response Divisions responsibilities. They may be contacted directly at Knapps Centre, PO Box 30426, Lansing, Michigan 48909.

Comment: In the channel gradient section it would be useful to specifically state what length and percentage of the most desirable gradient classes would be rehabilitated with each individual dam removal.

Response: This information is available in Table 1.

Comment: Table 1 is confusing and difficult to follow.

Response: This table has been significantly reworked since the draft version.

Comment: There is no information on the issue of water removal from the river by cities/towns for drinking water or by agricultural usage.

Response: Water removal by cities for drinking purposes has now been included. Agricultural use of water was mentioned in the draft, but has been reworded to make it clearer.

GLOSSARY

agrarian - relating to agriculture

antimycin - an antibiotic that is used as a fish toxicant

base flow - the groundwater discharge to the system

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

centrarchid - species of fish that are in the centrarchidae family, generally the sunfishes, crappies, and basses

deciduous - vegetation that sheds its foliage annually

dendritic - a branching tree-like pattern

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

emergent vegetation - rooted aquatic plants that grow in shallow water, with most of the plant protruding above the water surface

esocid - species of fish that are in the esocidae family, generally the pike, muskellunge, and pickerels

eutrophic - a body of water rich in nutrients

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

extirpation - to make extinct, remove completely

fauna - the animals of a specific region or time

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

flowage - the unaltered outflow of a lake to a river

friable - easily crumbled or crushed into powder

gradient frequency - a representation of the amount of each gradient class found in the watershed or river reach

hydrology - the science of water

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

insectivores - those animals that rely primarily on insects for food

lake affects - affects on something, such as land, that is caused by the lake; for example lake-affect snows

macroinvertebrates/macroscopic invertebrate species - animals without a backbone that are visible by the human eye

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

operculate - the horned plate serving to close the shell of a mussel when the animal is retracted

pan evaporation - a measurement of the amount or rate of evaporation in a watershed

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

perturbations - disturbances

piscivores - fish that eat other fish

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 Huron River from Lake Erie

riparian - adjacent to, or living on, the bank of a river

rotenone - a natural substance found in roots of plants of the pea family; it is used as toxicant to all gill breathing animals; it is not toxic to air breathing animals

run habitat - fast non-turbulent water

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

Shannon-Weiner information index- a probability statistic that measures the number of groups of information within all of the information

silviculture - the art of cultivating a forest

storage modeling - a series of mathematical equations that simulate the operation of dams in the watershed

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

surficial - referring to something on or at the surface

tainter gates - a type of water control device that is used to pass discharges at a dam telemarked - the ability to dial into a USGS gauge and obtain either instantaneous or short term gauge records

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 - an unstratified, unsorted glacial drift of clay, sand, boulders, and gravel

turbidity - water that has large amounts of suspended sediments in the water column

turion - a detached winter bud, used by some submergent plant species as a method to survive winter

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 sufficient to support types of vegetation typically adapted for life in saturated soil; includes swamps, marshes, and bogs.

young-of-the-year - the offspring of fish that were born this calendar year

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Appendix 1 is published as a separate volume.

Table 1. Huron River gradient (ft/mi) from the headwaters to the mouth of the river (Fisheries Division, Michigan Department of Natural Resources, unpublished data). Class codes are GL=Great Lakes, L=natural lakes, R=river, I=impoundment, and H=hydro.

River mile	Class codes	Distance (mi)	Gradient (ft/mi)	Contour	Description
135.93	L			1016	Big Lake Dam
135.40	R	0.53	11.21	1010	Hillsboro Rd
135.04	R	0.36	28.09	1000	
134.24	R	0.80	12.48	990	Meyer Lake Outlet
132.96	R	1.29	7.78	980	Crosby Lake Road, White Lake Road
132.15	R	0.80	12.47	970	
130.92	R	1.23	5.85	962	Pontiac Lake (Teggerdine Road)
130.06	I	0.87	5.17	958.3	Pontiac Lake - Old River Channel
129.42	I	0.63	7.89	953.3	Pontiac Lake - Old River Channel
129.41	I	0.02	320.51	948.3	Pontiac Lake - Old River Channel
128.98	I	0.42	0.00	948.3	Pontiac Lake - Old Flowage
128.71	I	0.27	9.26	945.8	Pontiac Lake Dam
125.78	R	2.93	0.96	943	Oxbow Lake (M59, upper)
125.75	I	0.03	30.30	942	Oxbow Lake - Old River Channel
125.30	I	0.45	0.00	942	Oxbow Lake - Old Flowage
125.24	I	0.06	16.98	941	Oxbow Lake Dam
125.10	R	0.14	7.19	940	Union Lake Road
124.27	R	0.83	7.20	934	Cedar Island Lake
122.99	I	1.28	0.00	934	Cedar Island Lake Dam
122.21	R	0.78	1.28	933	Mud Lake (Oxbow Lake Road)
122.07	L	0.14	0.00	933	Mud Lake Flowage
119.62	R	2.45	1.22	930	Cedar Is Rd, Oxbow Lk Rd
119.01	R	0.61	4.96	927	Sugden Lk Outlet (Cooley Lk Rd)
118.39	I	0.62	4.83	924	Fox Lake/Fox Lake Dam
117.30	R	1.09	3.68	920	Commerce Road
117.20	R	0.11	93.46	910	Sleeth Road (USGS Gaging Station Site)
116.86	R	0.33	9.01	910	Commerce Lake
116.85	I	0.01	20.00	906.8	Commerce Lake-Old River Channel
116.34	I	0.52	0.00	906.8	Commerce Lk-Old North Lake Flowage
116.29	I	0.05	19.38	905.8	Commerce Lake-Old River Channel
115.27	I	1.02	0.00	905.8	Commerce Lk-Old South Lake Flowage
115.22	I	0.05	0.00	904.8	Commerce Dam
114.18	R	1.04	0.00	904.7	Proud Lake (Benstein Road, upper)
112.67	I	1.51	0.50	904	Proud Lake and Moss Lake
108.72	R	3.95	1.01	901	Hubbell Impoundment (Milford)
107.84	I	0.88	16.99	885	Hubbell Dam
105.88	R	1.96	1.02	883	Kent Lake (General Motors Rd, upper)
104.30	I	1.59	3.15	878	Kent Lake (middle)
100.57	I	3.73	1.34	873	Kent Lake (lower)
99.31	I	1.26	3.97	868	Kent Lake Dam
94.01	R	5.30	1.51	860	Kensington Road
83.62	R	10.39	0.77	852	Strawberry Lake (McCabe Road, US23)

Table 1. (con't)

River mile	Class codes	Distance (mile)	Gradient (ft/mi)	Contour	Description
82.10	L	1.53	0.00	852	Strawberry Lake (lower)
81.30	L	0.80	1.25	851	Gallagher Lake
79.65	L	1.64	0.00	850	Whitewood Lake
79.10	L	0.56	1.79	846	Baseline Lake
77.56	L	1.54	2.60	846	Baseline (Flook) Dam
76.02	R	1.53	3.92	840	
71.62	R	4.40	2.27	830	N. Territorial Rd, Gauging Station
68.50	R	3.12	3.20	820	Dexter
66.58	R	1.92	5.20	810	Zeeb Road
65.11	R	1.47	6.79	800	Delhi Road
64.75	R	0.36	8.40	797	Barton Impoundment
63.57	H	1.18	4.24	792	Barton Impoundment (upper)
62.77	H	0.80	6.25	787	Barton Impoundment (middle)
62.30	H	0.47	10.64	782	Barton Impoundment (middle)
60.88	H	1.42	3.52	777	Barton Impoundment (middle)
60.69	H	0.19	10.53	775	Barton Impoundment (lower)
59.98	H	0.71	1.41	774	Barton Dam
59.65	R	0.33	1.54	773.5	Argo Impoundment (upper)
57.83	I	1.82	3.85	766.5	Argo Impoundment (lower)
57.06	I	0.77	4.55	763	Argo Dam
55.34	R	1.73	7.54	750	Broadway/ Fuller Rd
54.99	R	0.35	7.18	747.5	Geddes Impoundment (upper)
53.81	I	1.18	2.54	744.5	Geddes Impoundment (middle)
52.96	I	0.85	5.88	739.5	Geddes Impoundment (lower)
52.11	I	0.85	8.82	732	Geddes Dam
51.52	R	0.59	2.54	730.5	Superior Impoundment (Dixboro Road)
51.31	H	0.21	9.52	728.5	Superior Impoundment (middle)
50.27	H	1.04	4.81	723.5	Superior Impoundment (middle)
49.39	H	0.88	5.68	718.5	Superior Impoundment (lower)
49.22	H	0.17	26.47	714	Superior Dam
47.97	I	1.25	6.60	705.8	Peninsula Impoundment
47.43	I	0.54	20.65	695	Peninsula Paper Dam
47.20	R	0.24	2.13	694.6	LeForge Road
46.72	R	0.48	10.44	690	
45.10	R	1.62	3.09	685	Michigan Ave
44.80	R	0.30	3.32	684	Ford Impoundment (I-94)
44.09	H	0.71	2.82	682	Ford Dam Impoundment (middle)
42.95	H	1.14	8.77	672	Ford Dam Impoundment (middle)
41.48	H	1.47	6.80	662	Ford Dam Impoundment (lower)
39.63	H	1.85	1.62	659	Ford Dam Dam
36.74	H	2.89	2.42	652	French Landing Impoundment (upper)
35.15	H	1.59	6.29	642	French Landing Impoundment (middle)
29.98	H	5.17	1.93	632	French Landing Impoundment (lower)

Table 1. (con't)

River mile	Class codes	Distance (mile)	Gradient (ft/mi)	Contour	Description
28.52	H	1.46	8.56	620.5	French Landing Dam
28.10	R	0.42	1.20	620	
23.86	R	4.24	1.18	615	Griggs Drain
22.30	R	1.56	3.20	610	
19.16	R	3.13	3.19	600	New Boston, Huron River Drive
17.09	R	2.08	214	595	I-275, Hale Drain
12.47	R	4.62	0.22	594	Flat Rock Impoundment
10.41	I	2.06	5.34	583	Flat Rock Dam
9.96	R	0.45	6.73	580	Telegraph Road
6.89	R	3.08	1.63	575	
1.96	R	4.93	0.61	572	Lake Erie Influence (I-75, Rockwood)
0.0	GL	1.96	0.00	572	river mouth at Lake Erie

Table 2. Archaeological sites in the Huron River watershed, listed by township. Information provided by B. Mead, Michigan Department of State, Archaelogical Section.

County	Township	Number of sites
Oakland	Lyon	8
	Milford	13
	Commerce	12
	West Bloomfield	1
	Highland	3
	White Lake	12
	Rose	6
Livingston	Unadilla	4
	Putnam	7
	Hamburg	10
	Oak	17
	Brighton	12
	Hartland	1
Washtenaw	Lyndon	3
	Dexter	9
	Webster	10
	Northfield	4
	Salem	1
	Sylvan	9
	Lima	5
	Scio	14
	Ann Arbor	39
	Superior	13
	Freedom	4
	Pittsfield	25
	Ypsilanti	22
Jackson	Brighton	12
Wayne	Van Buren	25
	Romulus	4
	Sumpter	1
	Huron	121
	Brownstone	48
Monroe	Ash	4
Monroe/Wayne	Berlin/Rockwood	23

Table 3. List of common and scientific names of species referred to in text. Names are placed in phylogenetic order.

Common name	Scientific name
Fish	
Sea lamprey	*Petromyzon marinus*
Lake sturgeon	*Acipenser fulvescens*
Gizzard shad	*Dorosoma cepedianum*
Goldfish	*Carassius auratus*
Redside dace	*Clinostomus elongatus*
Common carp	*Cyprinus carpio*
Common shiner	*Luxius cornatus*
Hornyhead chub	*Nocomis bigutatus*
Golden shiner	*Notemigonus crysoleucas*
Emerald shiner	*Notropis atherinoides*
Blacknose shiner	*Notropis heterolepis*
Blackchin shiner	*Notropis heterodon*
Silver shiner	*Notropis photogenis*
Rosyface shiner	*Notropis rubellus*
Pugnose minnow	*Opsopoeodus emiliae*
Southern redbelly dace	*Phoxinus erythrogaster*
Bluntnose minnow	*Phimephales notatus*
Blacknose dace	*Rhinichthys atratulus*
Creek chub	*Semotilus atromaculatus*
White sucker	*Catostomus commersoni*
Lake chubsucker	*Erimyzon sucetta*
Northern hogsucker	*Hypentelium nigricans*
Black redhorse	*Moxostoma duquesnei*
Golden redhorse	*Moxostoma erythrurum*
Yellow bullhead	*Ameiurus natalis*
Channel catfish	*Ictalurus punctatus*
Stonecat	*Noturus flavus*
Tadpole madtom	*Noturus gyrinus*
Brindled madtom	*Noturus miurus*
Northern madtom	*Noturus stigmosus*
Mud pickerel	*Esox americanus vermiculatus*
Northern pike	*Esox lucius*
Muskellunge	*Esox masquinongy*
Tiger muskellunge	*Esox lucius x E. masquinongy*
Central mudminnow	*Umbra limi*
Cisco	*Coregonus srtedi*
Lake whitefish	*Coregonus clupeaformis*
Coho salmon	*Oncorhynchus kisutch*
Rainbow trout (steelhead)	*Oncorhynchus mykiss*
Chinook salmon	*Oncorhynchus tshawytscha*
Brown trout	*Salmo trutta*
Brook trout	*Salveninus fontinalis*
Lake trout	*Salvelinus namaycus*
Blackstripe topminnow	*Fundulus notatus*

Table 3. (con't)

Common name	Scientific name
Brook stickleback	*Culaea inconstans*
White perch	*Morone americana*
White bass	*Morone chrysops*
Rock bass	*Ambloplites rupestris*
Pumpkinseed	*Lepomis gibbosus*
Bluegill	*Lepomis macrochirus*
Longear sunfish	*Lepomis megalotis*
Smallmouth bass	*Micropterus dolomieui*
Largemouth bass	*Micropterus salmoides*
White crappie	*Pomoxis annularis*
Black crappie	*Pomoxis nigromaculatus*
Eastern sand darter	*Ammocrypta pellucida*
Greenside darter	*Etheostoma blennioides*
Rainbow darter	*Etheostoma caeruleum*
Fantail darter	*Etheostoma flabellare*
Least darter	*Etheostoma microperca*
Johnny darter	*Etheostoma nigrum*
Yellow perch	*Perca flavescens*
Logperch	*Percina caprodes*
Channel darter	*Percina copelandi*
River darter	*Percina shumardi*
Sauger	*Stizostedion canadense*
Walleye	*Stizostedion vitreum vitreum*
Freshwater drum	*Aplodinotus grunniens*
Aquatic Invertebrates	
European spiny water flea	*Bythotrephes cederstroemi*
Rusty crayfish	*Orconectes rusticus*
Stoneflies	Plecoptera
Mayflies	Ephemeroptera
Caddisflies	Trichoptera
Mussels	
Zebra mussels	*Dreissena polymorpha*
Wavy-rayed lamp	*Lampsilis fasciola*
Papershell	*Anodonta grandis*
Snuffbox	*Dysnomia triquetra*
Purple (pink) wartyback	*Cyclomaias tuberculata*
Northern riffleshell	*Sysnomia torulosa rangiana*
Asian clam	*Corbicula fluminea*

Table 3. (con't)

Common name	Scientific name
Amphibians and Reptiles	
Smallmouth salamander	*Ambystoma texanun*
Blanchard's cricket frog	*Acris crepitans blanchardi*
Mink frog	*Rana septentrionalis*
Spotted turtle	*Clemmys guttata*
Wood turtle	*Clemmys insculpta*
Eastern fox snake	*Elaphe vulpina gloydi*
Massausaga	*Sistrurus catenatus*
Mammals	
Least shrew	*Cryptotis parva*
Beavers	*Castor canadensis*
Muskrat	*Ondatra zibethica*
Racoons	*Procyon lotor*
Otter	*Lutra canadensis*
Mink	*Mustela vuison*
Avians	
Great blue heron	*Ardea herodias*
Canada goose	*Branta canadensis*
Bald eagle	*Haliaeetus leucocephalus*
Osprey	*Pandion haliaetus*
Peregrine falcon	*Falco peregrinus*
Sandhill crane	*Grus canadensis*
Insects	
Gypsy moth	*Portheiria dispir*
Plants	
Curly leaf pondweed	*Potamogeton crispus*
Purple loosestrife	*Lythrum salicaria*
Eurasian milfoil	*Myriophyllum sp.*

Table 4. Non-indigenous fish species in the Huron River watershed (Fisheries Division, Michigan Department of Natural Resources, unpublished data).

Common name	Scientific name
Sea lamprey	*Petromyzon marinus*
Alewife	*Alosa pseudoharengus*
Goldfish	*Carassius auratus*
Common carp	*Cyprinus carpio*
Bigmouth shiner	*Notropis dorsalis*
Rainbow trout	*Oncorhynchus mykiss*
Coho salmon	*Oncorhynchus kisutch*
Chinook salmon	*Oncorhynchus tshawytscha*
Brook trout	*Salvelinus fontinalis*
Brown trout	*Salvelinus trutta*
White perch	*Morone americana*
Redear sunfish	*Lepomis microloplus*

Table 5. Fish stocking in the Huron River watershed, 1981-1991 (Fisheries Division, Michigan Department of Natural Resources). County names are are in bold print.

Common name	Stocking location	Years	Numbers	Comments
Wayne County				
Coho Salmon	Huron R. Metropark	81-85, 88	679,103	no run established
Coho Salmon	Huron R. Flat Rock	86, 87, 89	464,684	no run established
Rainbow Trout	Huron R. Metropark	81-88	227,131	no run established
Rainbow Trout	Huron R. Flat Rock	89-91	47,791	on-going program
Washtenaw County				
Bluegill	Ford Lake	90	11,500	to augment the fishery
Brown Trout	Arms Creek	83-88	2,848	stopped, marginal stream
Channel Catfish	Argo Pond	87-91	6,700	on-going program
" "	Barton Pond	87-91	17,500	on-going program
" "	Geddes Pond	87-91	13,700	on-going program
" "	Ford Lake	87-91	71,000	on-going program
Largemouth Bass	Barton Pond	85	3,030	mitigation for drawdown
" "	Geddes Pond	84	5,048	mitigation for drawdown
Northern Pike	Four Mile Lake	83-85	8,500	fishery did not develop
" "	Pickeral Lake	83-91	12,719	good lake
Rainbow Trout	Blind Lake	83-85	16,000	little access for anglers
" "	Sylvan Pond	81, 88	600	pond no longer exists
" "	South Lake	83,84	22,200	fishery did not develop
Redear Sunfish	Big Silver Lake	91	40,000	on-going program
" "	Bruin Lake	90, 90	22,025	on-going program
" "	Four Mile Lake	87, 91	39,400	on-going program
" "	Halfmoon Lake	87	23,600	fishery did not develop
" "	Independence Lk	91	16,000	on-going program
" "	Mill Lake	90, 91	23,862	on-going program
" "	North Lake	91	28,800	on-going program
Smallmouth Bass	Argo Pond	85	2,200	mitigation for drawdown
Splake	Blind Lake	81, 82	6,000	no access to anglers
Tiger Muskie	Barton Pond	81-85	21,521	fishery did not develop
" "	Geddes Pond	81-83, 85	13,762	fishery did not develop
" "	Ford Lake	81-83,85-87,89,91	45,495	on-going program
" "	Big Portage Lake	82, 84, 86	5,620	fishery did not develop
" "	Big Silver Lake	81-81, 85	3,020	fishery did not develop
" "	Whitmore Lake	8,3,5,7,9,91	9,300	on-going program
Walleye	Big Portage Lake	82,83,85,87	91,300	lack of available fish
"	Halfmoon Lake	86	11,394	fishery did not develop
"	South Lake	86	15,700	fishery did not develop
"	Argo Pond	85	2,230	lack of available fish
"	Ford Lake	82, 85	5 million	excess fry

Table 5. (con't)

Common name	Location	Years	Numbers	Comments
Livingston County				
Bluegill	Hiland Lake	83	100	creating fishery
Brown Trout	Spring Mill Pond	84,86,88,89,91	966	to create a fishery
Channel Catfish	Woodland Lake	88,89	10,200	fishery did not develop
Largemouth Bass	Hiland Lake	84	800	creating fishery
Northern Pike	Hiland Lake	84	1,500	creating fishery
Rainbow Trout	Appleton Lake	81-91	52,386	on-going, fair-good fishery
" "	Lime Lake	81-83	8,100	fishery did not develop
" "	Murray Lake	81-83,85,91	8,100	on-going, fair-good fishery
" "	Spring Mill Pond	84-91	2,667	excess broodstock
Tiger Muskie	Woodland Lake	81,83,85,87-91	7,630	on-going program
Walleye	Chain of Lakes	84-85	772,300	insufficient fish raised
Yellow Perch	Hiland Lake	83	25	creating fishery
Oakland County				
Black Crappie	Pontiac Lake	82	3,789	restock after winterkill
Bluegill	Pontiac Lake	2	2,159	restock after winterkill
Brown Trout	Huron River	81-4,86,88-9,91	8,008	to create a fishery
" "	Union Lake	84	14,000	substitute for splake
Channel Catfish	Pontiac Lake	82	938	restock after winterkill
Fathead Minnow	Pontiac Lake	82	355,256	restock after winterkill
Lake Trout	Union Lake	88,89	10,600	excess fish/federal hatchery
Largemouth Bass	Pontiac Lake	82,83	6,106	restock after winterkill
Northern Pike	Kent Lake	81-88,90	79,800	spawning area not available
" "	Pontiac Lake	82,86	1,204,289	restock after winterkill
" "	Wolverine Lake	82-84,88,90	21,700	on-going program
Rainbow Trout	Union Lake	81-90	210,940	fishery did not develop
" "	Proud Lake	81-91	51,786	to create a fishery
Splake	Union Lake	81,2,5,6,8,90	90,810	fishery did not develop
Tiger Muskie	Big Lake	83,85,87	2,502	stopped for research work
Walleye	Big Lake	90	3,225	input for BG research study
"	Kent Lake	83,84,86,88,90	211,683	on-going program
"	White Lake	81,2,4,5,8,9,91	96,678	on-going program
"	Wolverine Lake	88-91	2,000	private plant
"	Pontiac Lake	90	122,979	on-going program
"	Union Lake	86,88,89,91	57,181	on-going program
Yellow Perch	Pontiac Lake	82	164	restock after winterkill

Table 6. List of fishes in the Huron River watershed. Compiled by G.R. Smith, University of Michigan and E.M. Hay-Chmielewski, Fisheries Division, Michigan Department of Natural Resources. Common family names are in bold print. Designations in parenthesis are species status determined by Michigan's Endangered Species Act (PA 203, 1974).

Common name	Scientific name
Lampreys	
Northern brook lamprey	*Ichthyomyzon fossor* (rare)
Silver lamprey	*Ichthyomyzon unicuspis* (rare)
American brook lamprey	*Lampetra appendix*
Sea lamprey	*Petromyzon marinus*
Gars	
Spotted gar	*Lepisosteus oculatus* (rare)
Longnose gar	*Lepisosteus osseus*
Bowfin	
Bowfin	*Amia calva*
Mooneyes	
Mooneye	*Hiodon tergisus* (endangered)
Herrings	
Alewife	*Alosa pseudoharengus*
Gizzard shad	*Dorosoma cepedianum*
Minnows	
Central stoneroller	*Campostoma anomalum*
Goldfish	*Carassius auratus*
Redside dace	*Clinostomus elongatus* (threatened)
Spotfin shiner	*Cyprinella spilotera*
Common carp	*Cyprinus carpio*
Striped shiner	*Luxilus chrysocephalus*
Common shiner	*Luxilus cornatus*
Redfin shiner	*Lythrurus umbratilis* (rare)
Silver chub	*Macrhybopsis storeriana* (rare)
Hornyhead chub	*Nocomis bigutatus*
River chub	*Nocomis micropogon*
Golden shiner	*Notemigonus crysoleucas*
Pugnose shiner	*Notropis anogenus* (rare)
Emerald shiner	*Notropis atherinoides*
Silverjaw minnow	*Notropis buccatus* (rare)
Bigmouth shiner	*Notropis dorsalis* (rare)
Blacknose shiner	*Notropis heterolepis*
Blackchin shiner	*Notropis heterodon*
Spottail shiner	*Notropis hudsonius*
Silver shiner	*Notropis photogenis* (threatened)
Rosyface shiner	*Notropis rubellus*

Table 6. (con't)

Common name	Scientific name
Sand shiner	*Notropis stramineus*
Mimic shiner	*Notropis volucellus*
Pugnose minnow	*Opsopoeodus emiliae* (rare)
Northern redbelly dace	*Phoxinus eos* (rare)
Southern redbelly dace	*Phoxinus erythrogaster* (threatened)
Bluntnose minnow	*Phimephales notatus*
Fathead minnow	*Pimephales promelas*
Blacknose dace	*Rhinichthys atratulus*
Creek chub	*Semotilus atromaculatus*
Suckers	
White sucker	*Catostomus commersoni*
Lake chubsucker	*Erimyzon sucetta*
Northern hogsucker	*Hypentelium nigricans*
Spotted sucker	*Minytrema melanops*
Black redhorse	*Moxostoma duquesnei* (declining)
Golden redhorse	*Moxostoma erythrurum*
Shorthead redhorse	*Moxostoma macrolepidotum*
Greater redhorse	*Moxostoma valenciennesi* (rare)
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* (declining)
Northern madtom	*Noturus stigmosus* (endangered)
Pikes	
Grass pickerel	*Esox americanus vermiculatus*
Northern pike	*Esox lucius*
Mudminnows	
Central mudminnow	*Umbra limi*
Trouts	
Cisco (lake herring)	*Coregonus artedi*
Coho salmon	*Oncorhynchus kisutch*
Rainbow trout	*Oncorhynchus mykiss*
Chinook salmon	*Oncorhynchus tshawytscha*
Brown trout	*Salmo trutta*
Brook trout	*Salvelinus fontinalis* (locally extinct)

Table 6. (con't)

Common name	Scientific name
Trout-perches	
Trout-perch	*Percopsis omiscomaycus*
Killifishes	
Banded killifish	*Fundulus diaphanus*
Blackstripe topminnow	*Fundulus notatus*
Silversides	
Brook silversides	*Labidesthes sicculus*
Sticklebacks	
Brook stickleback	*Culaea inconstans*
Sculpins	
Mottled sculpin	*Cottus bairdi*
Temperate basses	
White perch	*Morone americana*
White bass	*Morone chrysops*
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 dolomieui*
Largemouth bass	*Micropterus salmoides*
White crappie	*Pomoxis annularis*
Black crappie	*Pomoxis nigromaculatus*
Perches	
Eastern sand darter	*Ammocrypta pellucida* (threatened)
Greenside darter	*Etheostoma blennioides*
Rainbow darter	*Etheostoma caeruleum*
Iowa darter	*Etheostoma exile*
Fantail darter	*Etheostoma flabellare*
Least darter	*Etheostoma microperca*
Johnny darter	*Etheostoma nigrum*
Yellow perch	*Perca flavescens*
Logperch	*Percina caprodes*
Channel darter	*Percina copelandi* (locally extinct)
Blackside darter	*Percina maculata*

Table 6. (con't)

Common name	Scientific name
River darter	*Percina shumardi* (locally extinct)
Sauger	*Stizostedion canadense* (threatened)
Walleye	*Stizostedion vitreum vitreum*
Drums	
Freshwater drum	*Aplodinotus grunniens*

Table 7. Increases (++) or decreases (d) in range between 1938 and 1977 of vegetation-dependent species (those fish that require vegetation at some point in their life history) on the mainstem of the Huron River and three major tributaries. Information from Brown and Funk (1945) and Yant and Humphries (1978). Blank spaces indicate that no data was available.

		Range shift			
Common name	Scientific name	Huron R	Mill Cr	Portage Cr	Davis Cr
Central mudminnow	*Umbri limi*	d	d	d	
Grass pickerel	*Esox americanus*	d	d	d	d
Northern pike	*Esox lucius*	d	d	d	d
Muskellunge	*Esox masquinongy*	locally extinct in watershed			
Pugnose minnow	*Notropis anogenus*	locally rare in watershed			
Blackchin shiner	*Notropis heterodon*	d	d		
Blacknose shiner	*Notropis heterolepis*			d	
Lake chubsucker	*Erimyzon sucetta*	d	d	d	d
Yellow bullhead	*Ameiurus natalis*	d	d	d	d
Tadpole madtom	*Noturus gyrinus*	d	d	d	
Banded killifish	*Fundulus diaphanus*		d		
Blackstripe topminnow	*Fundulus notatus*	++		d	++
Brook stickleback	*Culaea inconstans*	d			
Pumpkinseed	*Lepomis gibbosus*			d	
Warmouth	*Lepomis gulosus*			d	
Black crappie	*Pomoxis nigromaculatus*	*	++	++	++
Least darter	*Etheostoma microperca*	d	d	d	d

* not collected in the mainstem Huron River during these surveys

Table 8. Increases (++) or decreases (d) in range between 1938 and 1977 of gravel-dependent species (thoses fish that require gravel at some point in their life history) on the mainstem of the Huron River and three major tributaries. Information from Brown and Funk (1945) and Yant and Humphries (1978). Blank spaces indicate that no data is available.

		Range Shift			
Common name	Scientific name	Huron R	Mill Cr	Portage Cr	Davis Cr
N. brook lamprey	*Ichthyomyzon fossor*	rare			
Silver lamprey	*Ichthyomyzon unicuspis*	rare			
Am. brook lamprey	*Ichthyomyzon appendix*				
Sea lamprey	*Petromyzon marinus*				
Lake sturgeon	*Acipenser fulvescens*	locally extinct in the watershed			
Rainbow trout	*Onchorhynchus mykiss*				
Coho salmon	*Onchorhynchus kisutch*				
Chinook salmon	*Oncorhynchus tshaqytscha*				
Central stoneroller	*Campostoma anomalum*	d	d	d	d
Striped shiner	*Luxilus chrysocephalus*				
Common shiner	*Luxilus cornutus*	d			
Rosyface shiner	*Notropis rubellus*				
Creek chub	*Semotilus atromaculatus*			++	
Northern hog sucker	*Hypentelium nigricans*	++	++	++	++
Black redhorse	*Moxostoma duquesnei*				
Golden redhorse	*Moxostoma erythrurum*				
Shorthead redhorse	*Moxostoma macrolepidotum*				
Stonecat	*Noturus flavus*				
Northern madtom	*Noturus stigmosus*	d	endangered species		
Rock bass	*Ambloplites rupestris*	d			
Longear sunfish	*Lepomis megalotis*	d	d	d	d
Smallmouth bass	*Micropterus dolomieu*				
Greenside darter	*Etheostoma blennoidides*	d	d		
Rainbow darter	*Etheostoma caeruleum*	d	d	d	d
Fantail darter	*Etheostoma flabellare*	d	d	d	d

Table 9. Increases (++) or decreases (d) in range between 1928 and 1977 of silt-dependent species (those fish that require silt at some point in their life history) on the mainstem of the Huron River and three of its tributaries. Information from Brown and Funk (1945) and Yant and Humphries (1978). Blank spaces indicate that no data was available.

		Range Shift			
Common name	Scientific name	Huron R	Mill Cr	Portage Cr	Davis Cr
Spotfin shiner	*Cyprinella spilopters*	++		++	
Common carp	*Cyprinus carpio*				
Silverjaw minnow*	*Notropis buccatus*	rare species			
Sand shiner	*Notropis stramineus*	++		++	
Redfin shiner*	*Lythrurus umbratilis*	rare species			
Bluntnose minnow	*Pimephales notatus*	++	++	++	
White sucker	*Catostomus commersoni*	++	++	++	++
Black bullhead	*Ameiurus melax*				
Green sunfish	*Lepomis cyanellus*	++	++	d	++
White crappie	*Pomoxis abbularis*				
Sand darter*	*Ammocrytpa pellucida*	++	threatened species		
Iowa darter	*Etheostoma exile*	d	d		d
Johnny darter	*Etheostoma nigrum*		++	++	
Blackside darter	*Percina maculata*	d		d	

*These species are at the edge of their range.

Table 10. Synoptic table showing the distribution of Naiades [mussels] by collecting stations in the Huron River. Data from van der Schalie (1938). x represents locations where species are found; blanks indicate that the species was not at that location.

Mussels / **Collecting Station**	*Quadrula pustulosa*	*Cyclonaias tuberculata*	*Elliptio dilatatus*	*Strophitus rugosus*	*Anodonta grandis*	*Anodonta imbecillis*	*Anodontoides ferrussaciana*	*Lasmigona compressa*	*Lasmigona costata*	*Lasmigona complanata*	*Alasmidonta calceolus*	*Alasmidonta marginata*	*Ptychobranchus fasciolare*	*Obovaria subrotunda*	*Actinonaias carinata*	*Micromya iris*	*Micromya fabalis*	*Ligumia recta latissima*	*Lampsilis fasciola*	*Lampsilis siliquoidea*	*Lampsilis ventricosa*	*Truncilla truncata*	*Dysnomia triquetra*	*Fusconaia flava*	*Carunoulina parva*
Monroe County																									
East Rockwood					x										x					x		x			
Rockwood	x	x	x						x				x	x	x			x	x	x	x	x	x		
1/2 mile above Rockwood	x	x	x	x	x	x						x	x	x	x	x		x				x	x	x	x
Wayne County																									
Flat Rock		x	x		x	x			x				x		x	x	x				x				
1 mile E. of Willow		x				x	x		x	x		x	x		x	x	x	x			x			x	x
2 mile E. of Willow															x										
Near Willow Rd., New Boston		x	x						x				x		x		x				x				
Huron River Park		x	x										x	x	x	x	x								
Below dam, French Landing			x												x		x								
Above dam, French Landing						x				x											x				x
Just above Belleville						x	x			x										x	x				x
Mud flats, 2 miles above Belleville						x	x			x	x							x			x				x
Washtenaw County																									
Below new Ford dam		x	x	x	x	x	x		x	x		x				x		x	x		x				
2 miles below Ypsilanti		x		x					x																
Ann Arbor		x	x	x	x				x		x	x	x			x			x	x	x			x	
Delhi		x	x					x			x	x	x			x			x						
Outlet of Loch Alpine		x			x			x			x														
Dexter		x	x		x						x	x	x			x			x						
2 miles NW. of Dexter		x	x								x		x			x		x	x		x				
Dover		x	x	x							x	x	x			x			x		x				
Portage L.			x	x	x								x			x				x	x		x		
Mouth of Base Line L.			x		x															x					
Whitmore L.					x															x					
Independence L.				x	x						x					x				x					
North L.																				x					
Wild Goose L.					x															x					
Pleasant L.					x															x					
Cedar L.					x															x					
Cavanaugh L.																				x					
Silver L.																				x					
Fleming Cr.				x			x	x			x														
Mill Cr. mouth at Dexter		x	x								x	x	x						x		x				
Mill Cr. millrace at Dexter		x	x	x							x					x			x		x				
Mill Cr. below dam at Dexter				x												x			x						
Mill Cr. 1 1/2 miles S. of Dexter			x	x			x	x			x	x				x									
Mill Cr. 2 miles S. of Dexter			x				x				x					x									
Mill Cr. 3 miles S. of Dexter			x	x			x				x					x									
Arms Cr.			x								x					x									
Livingston County																									
Base Line L.			x		x															x	x		x		
Between Base Line L. and Whitewood L.			x	x	x				x			x	x			x			x	x	x		x		
Whitewood L.					x															x					
Between Whitewood L. and Gallagher L.			x	x	x				x				x			x				x					
Gallagher L.			x		x															x	x				
Between Gallagher L. and Strawberry L.			x	x	x								x					x	x	x	x				
Strawberry L. discharge			x		x															x					
Strawberry L.				x	x											x				x					
Zukey L.			x	x	x											x				x	x				
Near RR. bridge above Strawberry L.			x	x								x				x			x	x			x		
NW. of Buck L.			x		x							x	x			x			x	x	x		x		

Table 10. (con't)

Collecting Station / Mussels	*Quadrula pustulosa*	*Cyclonaias tuberculata*	*Elliptio dilatatus*	*Strophitus rugosus*	*Anodonta grandis*	*Anodonta imbecillis*	*Anodontoides ferrussaciana*	*Lasmigona compressa*	*Lasmigona costata*	*Lasmigona complanata*	*Alasmidonta calceolus*	*Alasmidonta marginata*	*Ptychobranchus fasciolare*	*Obovaria subrotunda*	*Actinonaias carinata*	*Micromya iris*	*Micromya fabalis*	*Ligumia recta latissima*	*Lampsilis fasciola*	*Lampsilis siliquoidea*	*Lampsilis ventricosa*	*Truncilla truncata*	*Dysnomia triquetra*	*Fusconaia flava*	*Carunoulina parva*
Bend E. of Buck L.			x	x								x	x			x			x	x	x		x		
Below bridge 1 mile N. of Hamburg			x									x	x			x		x	x	x	x		x		
1 mile E. of Ore L.				x							x	x	x			x			x	x	x		x		
3 miles N. of Whitmore L.																				x	x				
Below Sandy Bottom L.			x	x	x							x	x			x			x		x		x		
Fish L.				x	x															x					
Greenoak L.					x															x					
River at Greenoak L.				x	x				x		x	x	x			x		x	x	x	x		x		
4 miles below entrance of Woodruff Cr.			x					x												x	x				
1 mile below entrance of Woodruff Cr.							x		x							x					x				
1 mile below Kent L.			x									x				x			x						
Below Kent L.			x	x									x			x		x							
Portage River 2 miles N. of Portage L.			x	x							x	x	x			x			x				x		
Portage River 2 miles SW. Pinckney			x	x				x				x	x			x			x	x	x		x		
Portage River near Hiland L.			x	x		x							x			x			x	x					
Portage Cr. at Williamsville			x	x	x						x					x			x	x					
Portage Cr. N. of Williamsville L.								x																	
Honey Cr. below Pinckney				x			x	x			x					x			x	x					
Honey Cr. branch 2 miles NW. of Pinckney								x																	
Davis Cr. above Crooked L.				x				x								x					x				
Ingham County																									
Lowe L.					x															x	x				
Oakland County																									
Kent L. outlet			x		x	x							x						x						
Above Kent L.					x															x					
1 1/2 miles NW. of New Hudson			x	x	x		x	x			x	x	x			x			x	x	x				
2 miles NW. of New Hudson			x	x	x							x							x		x				
3 miles NW. of New Hudson			x	x	x		x	x			x	x				x			x	x	x		x		
2 miles SW. of Milford			x	x			x	x			x	x	x			x			x		x		x		
1 mile SW. of Milford			x	x			x	x			x	x	x			x			x	x	x				
2 miles N. of Wixom				x	x	x	x	x					x			x			x	x	x				
At bridge below Proud L.					x											x				x	x				
2 miles below Commerce L.				x	x											x			x		x				
1/4 mile below Commerce L.				x	x											x				x					
Outlet of Commerce L.					x											x				x	x				
Commerce L.			x	x	x											x				x					
Above Commerce L.			x								x	x				x			x		x				
Union L. at mouth of Hayes Cr.				x	x			x								x				x					
Union L.				x	x															x	x				
Long L.																				x					
Cooley L.					x															x					
Sugden L.																				x					
Oxbow L.					x															x					
Pettibone Cr.					x																				
Grass L.					x															x					
Br. at Alderman L.					x											x									
Duck L.					x															x					
White L.				x	x															x					
Harvey L.					x																				
Wolverine L.					x																				
Reed L.				x	x															x					
Lower Straits L.					x															x	x				
Middle Straits L.					x															x	x				
Upper Straits L.					x															x	x				

Table 11. Natural features of the Huron River corridor. Information from Michigan Department of Natural Resources, Wildlife Division, Natural Features Inventory, July 1991. Status Codes: E=endangered, T=threatened; SC=Special Concern (rare, may become E or T in future); C2=E or T may be appropriate but more information is needed; 3C=not currently being considered for listing; P=proposed status; X=probably extirpated. Blanks indicate that none of the status categories are applicable.

Common name	Scientific name or feature	State status	Federal status
Livingston Co , Putnam Twp			
Blanchard's cricket frog	*Acris crepitans blanchardi*	SC	
Southern redbelly dace	*Phoxinus ertyhrogaster*	T	
Least shrew	*Cryptotis parva*	T	
Spotted turtle	*Clemmys guttata*	SC	
Massasauga rattlesnake	*Sistrurus catenatus*	SC	C2
Alkaline shrub/herbacious fen	Prairie Fen		
Regal fern borer	*Papaipema speciosissima*	SC	
Blazing star borer	*Papaipema beeriana*	SC	
Tamarack tree cricket	*Oecanthus laricis*	SC	C2
Wavy-rayed lamp-mussel	*Lampsilis fasciola*	SC/PT	
Hairy angelica	*Angelica venenosa*	SC	
Red mulberry	*Morus rubra*	SC	
Prairie fringed orchid	*Platanthera leucophaea*	E	T
Livingston Co, Hamburg Twp			
Blanchard's cricket frog	*Acris crepitans blanchardi*	SC	
Eastern snad darter	*Ammocrypta pellucida*	T	C2
Spotted turtle	*Clemmys guttata*	SC	
Massasauga rattlesnake	*Sistrurus catenatus*	SC	C2
Snuffbox mussel	*Dysnomia triquetra*	T/PE	
Way-rayed lamp-mussel	*Lampsilis fasciola*	SC/PT	
Water-willow	*Justicia Americana*	T	
Mat muhly	*Muhlenbergia richardsonis*	T	
Washtenaw Co, Dexter Twp			
Pugnose shiner	*Notropis anogenus*	SC	
Brindled madtom	*Noturus miurus*	SC	
Northern madtom	*Noturus stigmosus*	E	
Least shrew	*Cryptotis parva*	T	
Spotted turtle	*Clemmys guttata*	SC	
Massasauga rattlesnake	*Sistrurus catenatus*	SC	C2
American burying beetle	*Nicrophorus americanus*	E	E
Snuffbox mussel	*Dysnomia triquetra*	T/PE	
Edible valerian	*Valeriana ciliata*	T	
Yellow cyperus	*Cyperus flavescens*	SC	
Spike-rush	*Eleocharis caribaea*	T	
White lady-slipper	*Cypripedium candidum*	T	3C
Orange /Yellow fringed orchid	*Platanthera ciliaris*	T	
Bog bluegrass	*Poa paludigena*	T	C2

Table 11. (con't)

Common name	Scientific name or feature	State status	Federal status
Washtenaw Co, Webster Twp			
Redside dace	*Clinostomus elongatus*	T	
Least shrew	*Gryptotis parva*	T	
Massasauga rattlesnake	*Sistrurus catenatus*	SC	C2
Alkaline shrub/herbacious fen	Paririe fen		
Tallgrass prairie	Wet-mesic prairie		
Purple wartyback mussel	*Cyclonaias tuberculata*	SC	
Wavy-rayed lanp-mussel	*Lampsilis fasciola*	SC/PT	
	Great blue heron rookery		
Spike-rush	*Eleocharis radicans*	X	
Clinton's Bulrush	*Scirpus clintonii*	SC/PT	
White Laky-Slipper	*Cypripedium candidum*	T	
Orange/Yellow fringed orchid	*Platanthera ciliaris*	T	
Washtenaw Co, Scio Twp			
Smallmouth salamander	*Ambystoma texanum*	T/PE	
Blanchard's cricket frog	*Acris crepitans blanchardi*	SC	
Water-willow	*Justicia americana*	T	
Washtenaw Co, Ann Arbor Twp			
Least shrew	Cryptotis parva	T	
Midwest type	Wet prairie		
Alkaline shrub/herbacious fen	Prairie fen		
Purple wartyback mussel	*Cyclonaias tuberculata*	SC	
Snuffbox mussel	*Dysnomia triquetra*	T/PE	
Gravel pyrg	*Pyrgulopsis letsoni*	SC	
Least pinweed	*Lechea minor*	SC	
Jacob's ladder	*Polemonium reptans*	T	
Yellow cyperus	*Cyperus flavescens*	SC	
Clinton's bulrush	*Scirpus clintonii*	SC/PT	
Tall nut-rush	*Scleria triglomerata*	SC	
White lady-slipper	*Cypripedium candidum*	T	3C
Mat muhly	*Muhlenbergia richardsonis*	T	
Bog bluegrass	*Poa paludigena*	T	C2
Wild rice	*Zizania aquatica*	T	
Washtenaw Co, Lodi Twp			
Smallmouth salamander	*Ambystoma texanum*	T/PE	
Least shrew	*Cryptotis parva*	T	
Swamp/Black cottonwood	*Populus heterophylla*	T/PE	
Washtenaw Co, Ypsilanti Twp			
Southern redbelly dace	*Phoxinus erythrogaster*	T	
Alkaline shrub/herbacious fen	Prairie fen		

Table 11. (con't)

Common name	Scientific name or feature	State status	Federal status
Yellow cyperus	*Cyperus flavescens*	SC	
	Southern floodplain forest		
Purple wartyback mussel	*Cyclonaias tuberculata*	SC	
Northern riffleshell clam	*Sysnomia torulosa rangiana*	E	C2
Wayne Co, Huron Twp			
Water-willow	*Justicia americana*	T	
Monroe/Wayne Co, Berlin/Rockwood Twps			
Channel darter	*Percina copelandi*	T	
Eastern fox snake	*Elaphe vulpina gloydi*	T	
Round hickorynut	*Obovaria subrotunda*	T/PE	
Bean villosa	*Villosa fabalis*	E	C2
Water-willow	*Justicia americana*	T	
Sedge	*Carex hyalinolepis*	SC	
Sedge	*Carex squarrosa*	SC	
Prairie fringed orchid	*Plantanthera leucophaea*	E	T

Table 12. List of amphibians and reptiles in the Huron River watershed that require the aquatic environment. Information provided by Greg Schneider (University of Michigan, personal communication). Common family names are in bold print. (?) denotes a questionable record.

Common name	Scientific name
Salamanders	
Blue-spotted hybrid	*Ambystoma laterale*
Small-mouthed salamander	*Ambrystoma texan*
Spotted salamander	*Ambrystoma maculatum*
Tiger salamander	*Ambystoma tigrinum*
Tremblay's salamander	*Ambystoma tremblayi*
Mudpuppy	*Necturus maculosus*
Red-spotted newt	*Notophthalmus viridescens*
Frogs	
Cricket frog	*Acris crepitans*
American toad	*Bufo americanus*
Fowler's toad	*Bufo woodhousii*
Spring peeper	*Hyla crucifer*
Gray tree frog	*Hyla versicolor/chrysoscelis*
Chorus frog	*Pseudacris triseriata*
Bullfrog	*Rana catesbiana*
Green frog	*Rana clamitans*
Leopard frog	*Rana pipiens*
Pickerel frog	*Rana palustris*
Wood frog	*Rana sylvatica*
Mink frog (?)	*Rana septentrionalis*
Turtles	
Softshell	*Apalone spinifera*
Snapping turtle	*Chelydra serpentina*
Painted turtle	*Chrysemys picta*
Spotted turtle	*Clemmys guttata*
Wood turtle (?)	*Clemmys insculpta*
Blanding's turtle	*Eydoidea blandingii*
Map turtle	*Graptemys geographica*
Stinkpot	*Sternotherus oforata*
Snakes	
Kirtland's water snake	*Clonophis kirtlandi* (rare)
Water snake	*Nerodia sipedon*
Queen snake	*Regina septemvittata*
Massasauga	*Sistrurus catenatus*
Butler's garter snake	*Thamnophis butleri*
Ribbon snake	*Thamnophis sauritus*
Garter snake	*Thamnophis sirtalis*

Table 13. Surface geology types in the Huron River watershed. Calculated from the Quaternary Geology of Michigan (Michigan Department of Natural Resources, Geological Survey Division, 1984).

	Percent by type			
Huron River watershed	Till	Outwash	End Moraine	Other
Headwaters to Territorial Rd.	16	51	32	1
Headwaters to Ypsilanti	24	40	36	0
Overall	23	38	31	8
Mill Creek creekshed	49	25	26	0

Table 14. Huron River and tributary cross section data summary (US Geological Survey and Fisheries and Land and Water Management Divisions, Michigan Department of Natural Resources). Expected width was calculated using average width of rivers with the same discharge volume (data from Leopold and Makkock, 1953 and Leopold and Wolman, 1957). Hydraulic diversity index was calculated using the Shannon-Weaver information statistic.

River	Location	Actual width (ft)	Median daily discharge (cfs)	Expected width (ft)	Hydraulic diversity index
Huron	Teggerdine Rd.	13.0	17	22.46	1.60
Huron	Commerce Lk outlet	33.5	37	33.22	1.03
Huron	Milford	45.0	104	55.83	1.90
Huron	Hamburg	132.0	212	79.63	1.39
Huron	New Hudson	74.0	106	56.36	1.44
Huron	Hudson Mills	170.0	314	96.85	1.95
Huron	Hudson Mills	135.6	314	96.85	2.48
Huron	Hudson Mills	141.4	314	96.85	2.40
Huron	Hudson Mills	166.3	290	93.08	2.30
Huron	Hudson Mills	132.5	202	77.73	2.56
Huron	Dexter	122.5	387	107.48	2.19
Huron	Dexter	125.3	395	108.58	2.30
Huron	Dexter	123.5	414	111.16	2.71
Huron	Dexter	157.4	477	119.29	2.15
Huron	Dexter	149.5	473	118.79	1.97
Huron	mean of HM/D	142.4	358	102.70	2.30
Huron	Ann Arbor	142.0	437	114.19	1.74
Huron	Ypsilanti	106.0	389	107.76	2.03
Huron	below Bellevile Lk	88.5	810	155.32	2.47
Huron	below Belleville Lk	88.0	129	62.16	2.57
Huron	Flat Rock	114.0	191	75.63	2.34
Davis Creek	Doane Road	16.0	7	14.85	1.35
Fleming Creek	Geddes Road	26.0	43	36.11	1.77
Mill Creek	Jerusalem Road	31.0	25	27.43	1.86
Mill Creek	Dexter	42.0	31	30.73	1.78
N. F. Mill Creek	Old US 12	21.5	8	15.25	0.82
Pettibone Creek	Milford	28.0	22	25.86	2.21
Portage River	Tiplady Road	28.5	19	23.67	2.09
Portage River	Portage Lk outlet	46.5	19	23.93	
S. Ore Creek	Hamburg Road	24.5	5	12.63	1.25

Table 15. Statutes administered by Land and Water Management Division, Michigan Department of Natural Resources that affect the aquatic resource.

State of Michigan Acts:	Amendments to Aquatic Nusiance Control Act (PA 86, 1977)
	Inland Lake Level Act (PA 146, 1961)
	Floodplain Regulatory Authority (PA 167, 1968)
	Dam Construction Approval Act (PA 184,1963)
	Wetland Protection Act (PA 203, 1979)
	Irrigation District Act (PA 205,1967)
	Natural River Act (PA 231, 1970)
	Shorelands Protection and Management Act (PA 245,1970)
	Great Lakes Submerged Lands Act (PA 247, 1955)
	Dam Safety Act (PA 300, 1989)
	Inland Improvement Act (PA 345, 1966)
	Inland Lakes and Streams Act (PA 346, 1972)
	Soil Erosion and Sedimentation Control Act (PA 347,1972)
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 404 (PL 95-217)
	River and Harbor Act, Section 10 (1899)
	Coastal Energy Impact Program (PL 92-538)

Table 16. Conditions imposed on operating hydroelectric facilities on the Huron River by the Federal Energy Regulatory Commission (FERC).

Barton Dam

FERC License No. 3142, City of Ann Arbor, Exempted license, Perpetual
i) Operation: run-of-river
ii) Fish passage: upon Michigan Department of Natural Resources request
iii) Recreation: sufficient public access to include an impoundment boat launch

Superior Dam

FERC License No. 3152, City of Ann Arbor, Exempted License, Perpetual
i) Operation: run-of-river
ii) Fish passage: upon Michigan Department of Natural Resources request
iii) Recreation: sufficient public access to include an impoundment boat launch

Ford Dam

FERC license No. 5334, Ypsilanti Township/Cameron Gas & Electric Company
License expires October, 2003.
i) Operation: run-of-river
ii) Recreation: sufficient free public access according to FERC and can be reopened to add facilities; recreation facilities were outlined in plan filed with license
iii) Soil Erosion: soil erosion plan
iv) Gauging: gauging plan and US Geological Survey gauge to verify run-of-river
v) License reopener: allows the license to be modified to include additional measures to protect the environment (ie. fish passage)

French Landing Dam

FERC License No. 9951, Van Buren Township/STS Hydropower Ltd.
License expires May, 2017.
i) Operation: run-of-river
ii) Recreation: impoundment shoreline fishing access and pier, picnic area and restrooms, parking, canoe portage, and tailwater fishing access
iii) Shoreline erosion plan to include inventory and control measures
iv) Soil erosion plan to prevent any soil erosion from any project constuction activities
v) Continuous monitoring of dissolved oxygen and temperature and measures to alleviate any problems with dissolved oxygen are in place.
vi) Turbine mortality study and mitigation for any damages
vii) Plan measures to protect downstream fish habitat
viii) Monitoring of sediments to determine contamination levels
ix) License reopener - allows the license to be modified to include additional measures to protect the environment (ie. fish passage)

Table 17. Designated drains in the Huron River watershed, by county and township. Information provided by each county drain office. Counties are in bold print; townships in italics.

Oakland County

Commerce Township
Branch No. 1 Drain
Branch No. 2 Drain
Branch No. 3 Drain
Greenaway Drain
Holden Drain
Norton Drain
Norton Drain extension
Sibley Drain
Taylor-Ladd Drain
Webb Drain
Wessinger Drain
Wixom Drain

Highland Township
Chatfield Drain
Finney Drain
White and Duck Lake Drain

Independence Township
none

Lyon Township
Blakwood Drain
Branch No. 1 Drain
Branch No. 2 Drain
Lyon No.1 Drain
New Hudson Drain
New Hudson Drain No. 1
New Hudson No. 1 Branch
Norton Drain
Novi-Lyon Drain
Sayres Drain
Sinclair Drain
South Lyon Drain No. 1
Underhill Drain
Yerkes Drain

Milford Township
Arthur Drain
Holden Drain
Norton extension Drain
Wessinger Drain

Novi Township
Norton Branch Drain
Norton Drain
Novi-Lyon Drain
Patton Drain

Rose Township
none

Springfield Township
none

Waterford Township
none

West Bloomfield Township
Dayon Drain
Dayon Drain extension
Montante Drain

White Lake Township
none

Livingston County

Brighton Township
Brighton No. 4 Drain
Brighton No. 5 Drain
Carter Drain
Taylor Drain
plus private drains

Genoa Township
Genoa No. 1 Drain
Genoa No. 5 Drain (br #1)
plus several private drains

Green Oak Township
Green Oak No. 1 Drain
Green Oak No. 2 Drain
Green Oak No. 3 Drain
Green Oak No. 4 Drain
Green Oak No. 6 Drain

Hartland Township
Hartland County Drain
Hartland County Dr (#1 br)
plus several private drains

Hamburg Township
none

Marion Township
one private drain

Putnam Township
Anderson County Dr(br#1)
Anderson County Dr(br#2)
Anderson County Dr(br#3)
Honey Creek Drain
Honey Creek Drain(br#1)
Honey Creek Drain(br#2)
Honey Creek Drain(br#3)
Livingston No. 12 Drain
Livingston No. 12 Drain
Portage Creek Drain
plus several private drains

Unadilla Township
plus several private drains
Anderson County Drain
Anderson County Drain(br#1)
Anderson County Drain(br#2)
Anderson County Drain(br#3)
Anderson County Drain(br#4)
Gregory Village Drain
Gregory Village Drain(br#1)
Portage Creek Drain
Stockbridge Drain
Stockbridge Drain (br#1)
Stockbridge Drain (br#2)
Stockbridge Drain (br#3)
Unadilla- Stockbridge Drain
Woodburn Creek Drain
Woodburn Cr Dr (br#1)
Woodburn Cr Dr (br#2)
Woodburn Cr Dr (br#3)
Woodburn Cr Dr (br#4)
Woodburn Cr Dr (br#5)
Woodburn Cr Dr (br#1 of br#2)
Woodburn Cr Dr (br #2 of br#2)
Woodburn Cr Dr (br#4 of br #2)
Woodburn Cr Dr (br#5 of br#2)
Woodburn CD(br#1ofbr#5ofbr#2)

Table 17. (con't)

Wastenaw County

Ann Arbor Township
Allen Creek (4)
Allen Creek & brs (20)
Cooch
County Farm & brs (20)
Earhart West Sub
Foxfire Sub
Garden Homes Sub (20)
Geddes Avenue
Matthaei Farms Sub
Murray-Washington St.
Orchard
Pittsfield #3
PAAD (4)
PAAD, Ext, brs (20)
Solent Acres Sub
Swift Run (20)
Traver Creek (20)
Watershed Sub
Welch
W Pk-Fairground & Ext
W Pk-Miller Ave

Dexter Township
Carriage Hills #3 Sub
Dexter #1
Dexter #3
Doan & Ferris
Four Mile Lake Drain
Hidden Lakes Estate Sub
Huron Creek Farms Sub
Stonehenge Sub
Wandering Hills Sub

Freedom Township
Dower
E Br Pleasant Lake
Grau
Haas
Lambart
Pleasant Lake Ext
Zahn

Lima Township
Downer
Finkbeiner
Four Mile Lake Drain
Frey-Fitzsimmons
Haas
Lima & Sylvan
Luick
Mill Creek
Mill Creek Consolidated
Mill Lake
Palmer Baldwin
Pleasant Lake Extension

Lodi Township
Frey-Fitzsimmons
Jedele

Lyndon Township
Clark's Lake Drain

Northfield Township
Catholic Ch/Horseshoe Lake
Clement
Coule
Groves 7 Horseshoe Lake
Horseshoe Lake Outlet
Lincoln Drive
Maurer
McCarty #2
North Pointe Estates
O'Conner
Walker
Willow Marsh

Salem Township
John Wagner Drain
Laraway Drain
Nelson Drain
Salem Farm Estates Drain
South Branch Walker Drain
Walker Drain

Pittsfield Township
Airport
Cooch
County Fram & br (20)
Darlington Sub
Ellsworth Rd (20)
Hannah
Jewett Avenue
Oak Park/Washtenaw Heights
Pittsfield #3
PAAD (4)
PAAD, Ext, brs (20)
Rosewood St.
Runway Plaza Workcenter
Springwater Sub
Swift Run (20)
Swift Run Ext & br (20)
Varsity Ind Pk
Walden Woods br PAAD
Waterworks Plaza Dev't

Scio Township
Buss & Tuomy
Frey-Fitzsimmons
Honey Creek
Jedele
Kaercher Tile
Maple Meadows Ext Sub
Pineview #2
Saginaw Hills
Scio Hills Sub
Sisters Lakes
U of M Lake
Wagner
Welch
W P-Fairgrd & Ext
Whispering Pines Sub
Wing
Indian Hills Sub
Saginaw Greens
Vienna Woods

Table 17. (con't)

Washtenaw County (con't)

Sharon Township
Comstock
Feldkamp
Pleasant Lake Ext.

Superior Township
Fleming Creek
Geer
Lambie Tile
Creekside Sub
Geddes Glen Sub
Matthaei Farms Sub
Snidecor
Superior
Superior #1 br
Tanglewood Sub
YTD 14

Sylvan Township
Clark's Lake
E Br of Wilkinson
Looney & Welsh
Mill Creek Consolidated
Mill Creek Ext.
Mill Lake
Pleasant Lake Ext.
Sibley Tile
Sugar Loaf Lake Drain
Young

Webster Township
Boyden
Brookwater
Coyle
Glen Devon Condos
Maple Meadows Ext. Sub
Pineview
Scadin Lake Drain
Hidden Brook Sub
Welch

Ypsilanti Township
Bennet Tile
Beyer & brs
br of Horner
Brock
Deauville Parish Sub
Derbyshire
Eaton
Ford Lake Heights
Gault Farms Sub
Gault Village Sub (20)
Huron Ctr Comm & Off P
Huron Dam Sub
Jerome Street
Nancy Park #3 Sub
Nicholls
Owen
Owen Extension
Owen Outlet
Owen Relief
Rawson
Rawsonville Rd (20)
Shady Knolls Sub
Smokler-Testile
Spruce Falls Sub
West br Owen
Willow Run Ext. #1 & brs
YTD #1
YTD #3
YTD #5
YTD #6
YTD #7
YTD #7 Ext.
YTD #8
YTD #11
YTD #12
YTD #13
YTD # 13 Ext.

Table 17. (con't)

Monroe County		
Ash Township	*Berlin Township*	*South Rockwood Township*
Baker & Green Drain	Baker & Green Drain	none
Carter Drain	Bancroft Moles Drain	
Smith Drain	Carter Drain	
Van Houtin Drain	Wagner & Pink Drain	
Vizard Drain		
Wagner Drain		
Ingham County		
Stockbridge Township	*White Oak Township*	
Branch Drain	none	
Brownell Drain		
Cosgray Drain		
Lindsay Drain		
M.M. Rose Drain		
Polliwog Drain		
Portage Drain		
Unadilla & Stockbridge Dr		
Jackson County		
Grass Lake Township	*Waterloo Township*	
none	none	
Wayne County		
no data available		

Table 18. State maintanined boat access in the Huron River watershed (Recreation Division, Michigan Department of Natural Resources). SGA=State game area; RA=recreation area. Ramp types: 1=hard surface, deep water 2=hard surface, limited water 3=gravel surface 4=no ramp, carry-down site. Parking is number of vehicle spaces.

Waterbody	County	Ramp type	Pier	Toliets	Parking	Size(ac)	Handicap
E. Crooked Lake	Livingston	3	-	-	18	252	-
Woodland Lake	Livingston	1	Y	Y	30	290	Y
Whitmore Lake	Livingston	2	Y	Y	50	677	-
Duck Lake (Gregory SGA)	Livingston	4	-	-	20	12	-
Bishop Lk Cpgd (Brighton RA)	Livingston	2	-	Y	20	119	-
Chenango Lake (Brighton RA)	Livingston	3	-	-	10	29	-
Chilson Pond (Brighton RA)	Livingston	3	-	-	2	100	-
Hiland Lake (Pickney RA)	Livingston	3	-	-	8	123	-
Gosling Lake (Pickney RA)	Livingston	3	-	-	8	12	-
Mouillee Creek	Monroe	3	-	Y	10	N/A	-
Union Lake	Oakland	1	Y	Y	32	465	-
Pontiac Lake 1) Tackles Drive	Oakland	4	-	Y	20	640	-
2) Pontiac RA		1	Y	Y	80	640	-
Wolverine Lake	Oakland	1	-	-	15	241	-
White Lake	Oakland	1	Y	Y	14	540	-
Big Lake	Oakland	3	-	-	15	200	-
Long Lake	Oakland	1	Y	Y	15	146	-
Cedar Island Lk	Oakland	1	-	-	6	134	-
Alderman Lake (Highland RA)	Oakland	4	-	Y	15	40	-
Moore Lake (Highland RA)	Oakland	4	-	-	10	92	-
L. Pettibone Lk (Highland RA)	Oakland	3	-	-	15	89	-
Teeple Lake (Highland RA)	Oakland	3	-	-	30	49	-
Middle Straits Lk	Oakland	3	-	Y	10	171	-
Proud Lake (Proud Lk RA)	Oakland	1	-	Y	25	104	-
Bruin Lake (Pickney RA)	Washtenaw	2	-	Y	8	145	-
Half-Moon Lake (Pickney RA)	Washtenaw	2	-	Y	34	244	-
Ford Lake	Washtenaw	1	Y	Y	50	1050	Y
Joslin Lake (Pickney RA)	Washtenaw	2	-	-	14	180	-
North Lake (Pickney RA)	Washtenaw	2	-	Y	10	200	-
Geddes Pond	Washtenaw	2	Y	Y	57	261	-
South Lake (Pickney RA)	Washtenaw	2	-	Y	4	193	-
Crooked Lake (Waterloo RA)	Washtenaw	2	-	Y	6	113	-
Pickerel Lake (Pickney RA)	Washtenaw	4	-	-	12	24	-
Independence Lake	Washtenaw	2	-	Y	10	203	-
Mill Lake (Waterloo RA)	Washtenaw	3	-	Y	12	142	-
Cedar Lake (Waterloo RA)	Washtenaw	2	-	-	8	76	-
Green Lake (Waterloo RA)	Washtenaw	3	-	-	10	95	-
Doyle Lake (Waterloo RA)	Washtenaw	4	-	-	6	18	-
Four Mile Lake (Chelsea SGA)	Washtenaw	3	-	-	15	256	-
Portage Lake	Washtenaw	1	Y	Y	25	644	-
Huron R. (Pte. Mouillee SGA)	Wayne	2	Y	Y	60	N/A	-
Belleville Lake	Wayne	1	Y	Y	120	1270	-

Table 19. Information on Huron River watershed dams and impoundments (Land & Water Management Division, Michigan Department of Natural Resources). LCS=lake level control structure; Date=construction year; AvDepth= average increase of depth in feet by impounding. Blanks indicate data was unavailable.

Dam	River	Date	Head (ft)	Owner	Surface acres	Storage (acre-feet)	AvDepth (ft)
Wiltse	Arms Creek Trib	1950	4	Private	20	0	0.0
Susterna Lake	Belleville Lake Trib		15	Private	1	3	3.0
Lake Neva	Cedar Creek	1955	13	Private	47	288	6.1
Haven Hill Lake	Cedar Creek	1960	5	MDNR	69	115	1.7
Pettysville Mill	Chilson Creek	1840	14	Private	5	36	7.2
Chilson Pond #1	Chilson Creek	1948	5	MDNR	55	10	0.2
Lower Chilson Pd	Chilson Creek	1961	8	MDNR	55	80	1.5
Caroga Lk LCS	Chilson Creek	1970	1	MDNR	119	40	0.3
Wolverine Lake	Commerce Lk Trib	1925	10	City	241	960	4.0
Crooked Lake	Crooked Lk Outlet		2	MDNR	50	0	0.0
Lower Willow Run	E Willow Run Trib		8	City	5	0	0.0
Whittaker & Goodding	Fleming Creek		1	Private	10	0	0.0
Fishbeck	Fl. Ck Offstream	1973	11	Private	6	37	6.2
Waterland Trucking Ser.	Fleming Creek Trib		1	Private	2	0	0.0
Geddes Ridge Storm Ret	Foster Drain Trib		10	Private	7	26	3.7
Unknown	Griggs Drain		10				
Bass Lk LCS	Hay Creek	1964	1	County DC	141	0	0.0
Gregory SGA #2	Honey Creek Trib	1965	5	MDNR	12	75	6.3
Gregory SGA #3	Honey Creek Trib	1965	6	MDNR	80	90	1.1
Wildlife Flooding	Honey Creek Trib	1980	4	MDNR	5		0.0
Marsh Unit No. 4	Honey Creek Trib		2	MDNR	5		0.0
Horseshoe Lk LCS	Horseshoe Lk Outlet		2	Private	90	70	0.8
Peninsula Paper	Huron River	1914	14	City	177	500	2.8
Barton	Huron River	1915	26	City	302	6362	21.1
Commerce Lk LCS	Huron River	1915	3	County DC	262	600	2.3
Geddes	Huron River	1919	16	City	261	4250	16.3
Argo Dam	Huron River	1920	11	City	92	929	10.1
Pontiac Lake	Huron River	1920	15	County DC	640	2900	4.5
Superior	Huron River	1920	16	City	93	2081	22.4
Flat Rock	Huron River	1924	13	City	316	1642	5.2
Flat Rock weir	Huron River		4	City	1		4.0
French Landing	Huron River	1925	30	City	1270	17780	14.0
Rawsonville	Huron River	1932	32	City	1050	25600	24.4
Hubble Pond	Huron River	1939	15	City	77	800	10.4
Kent Lake	Huron River	1946	14	County PC	1200	9600	8.0
Proud Lake	Huron River	1962	1	MDNR	104	25	0.2
Oxbow Lake	Huron River	1964	8	County DC	290	2100	7.2
Cedar Island Lake	Huron River	1965	1	County DC	134	0	0.0
Flook Dam	Huron River	1965	1	County DC	769	4000	5.2
Fox Lk LCS	Huron River	1965	4	County DC	26	45	1.7
Big Lk LCS	Huron River	1969	2	County DC	300	160	0.5

Table 19. (con't)

Dam	River	Date	Head (ft)	Owner	Surface acres	Storage (acre-feet)	AvDepth (ft)
L. Geddes Lk Sub	Huron River Trib	1914	9	Private	4	15	3.8
Henes Dam	Huron River Trib	1948	6	Private	1	0	0.0
Green Oak Lake	Huron River Trib	1960	17	Private	19	80	4.2
Huron River	Huron River Trib	1962	1	MDNR	100	40	0.4
Bridgeway Lake	Huron River Trib	1968	14	Private	15	80	5.3
Towsley Farms Det.	Huron River Trib	1989	2	Private	1	0	0.0
Cunningham	Huron River Trib		1	Private	3	0	0.0
U. Geddes Lk Sub	Huron River Trib		13	Private	6	15	2.5
Lower Pond	Huron River Trib		2	County PC	1	0	0.0
Middle Pond	Huron River Trib		1	County PC	1	0	0.0
Newport West Detention	Huron River Trib		16	Private	30	1	0.03
Upper Pond	Huron River Trib		2	County PC	1	0	0.0
Lake of the Pines	Huron River Trib	1960	2	Private	89	500	5.6
Inchwagh Lake	Inchwagh Lk Outlet	1830	11	Private	130	250	1.9
Unadilla Wildlife Fl.	Livermore Creek Trib		2	MDNR	32	26	0.8
Traver Lake #5	M. Branch Traver Creek	1971	34	Private	2	30	15.0
General Motors	Mann Creek	1926	3	Private	69	360	5.2
Moraine Lake	Mann Creek	1970	13	Private	25	130	5.2
Baker	Mill Creek	1826	1	Private	10	0	0.0
Dexter	Mill Creek	1910	9	City	22	80	3.6
Sutton Lake	Mill Creek Trib	1959	1	Private	64	500	7.8
Dexter B & R Detention	Mill Creek Trib	1989	14	Private	2	0	0.0
Lower Sutton	Mill Creek Trib			Private	8	15	1.9
Wexford Mews Det. Pd.	Norton Creek Trib	1979	4	Private	6	9	1.5
Winegar Lake	Pettibone Creek	1928	6	Private	26	125	4.8
Moore Lake	Pettibone Creek	1936	6	MDNR	92	210	2.3
Pettibone Creek #1	Pettibone Creek	1938	6	City	6	30	5.0
Pettibone Creek #2	Pettibone Creek	1938	21	Private	2	80	40.0
Pettibone Pond	Pettibone Creek	1940	8	MDNR	4	15	3.8
Alderman Lake	Pettibone Creek	1954	9	MDNR			
Duck Lk LCS	Pettibone Creek Trib	1953	4	County DC	253	463	1.8
Pittsfield-Ann Arbor # 1	Pittsfield-Ann Arbor	1978	5	County DC	3	10	3.3
Pittsfield-Ann Arbor # 2	Pittsfield-Ann Arbor	1978	5	County DC	4	10	2.5
Green Lake	Portage River	1981	7	MDNR			
Hiland Lake Dam	Portage River	1882	4	Cty DPW	527	740	1.4
Unadilla Mill Dam	Portage River	1860	6	Private	13	50	3.9
Winnewanna Impound.	Portage River	1956	9	MDNR	570	2000	3.5
Washago Pond	Reagan Drain	1979	10	County PC	13	55	4.2
Traver Creek #4	S. Branch Traver Creek		1	Private	2	0	0.0
Traver Creek #5	S. Branch Traver Creek		1	Private	2	0	0.0
Traver Creek #6	S. Branch Traver Creek		1	County DC	5	0	0.0
Lake Sherwood	Sherwood Creek	1957	15	Private	181	2800	15.5

Table 19. (con't)

Dam	River	Year	Head (ft)	Owner	Surface acres	Storage (acre-feet)	AvDepth (ft)
Brighton Mill Pond	South Ore Creek	1878	5	City	612	60	0.1
Woodland Lake	South Ore Creek	1928	16	Private	290	2896	10.0
Brighton Lake	South Ore Creek	1929	10	Private	600	2330	3.9
Long Lake LCS	South Ore Creek Trib	1951	4	Private	146	296	2.0
Upper Straits Lk LCS	Straits Lake Outlet	1964	1	County DC	323	0	0.0
Middle-Low. Str Lk LCS	Straits Lake Outlet	1965	2	County DC	406	190	0.5
Upper Sylvan Trout Pd	Sugarloaf Lake Trib	1987	5	MDNR	1	0	0.0
Traver Creek Retention	Traver Creek	1981	13	County DC	2	0	0.0
Traver Creek #1	Traver Creek		1	Private	2	0	0.0
Traver Creek #2	Traver Creek		1	Private	2	0	0.0
Traver Creek #3	Traver Creek				2	0	0.0
Tyler	Willow Run Creek	1942	20	City	23	200	0.0
Riopelle Pond	Woodruff Creek Trib		7	Private	4	14	0.0

Table 20. National Pollution Discharge Elimination System permits issued by Surface Water Quality Division, Michigan Department of Natural Resources in the Huron River watershed. Numbers represent each permit and these are used in Figure 23 to show the location of each permit in the watershed.

Numbers	Permitee	Watercourse
1	Detroit Toledo & Tronton RR Co.	Smith Ck & Flowers Dr
2	Michigan Silica Co.	Huron R via Silver Ck
3	Quarex Corp-Mich Seamless Tube	Yerkes Dr
4	GM Proving Grounds-Milford	Mann Ck
5	CPCO-Freedom Gas Co	Pleasant Lake
6	Federal-Mogul Corp-Tech Center	Ann Arbor Pittsfield Dr
7	Motor Wheel Corp	Huron R
8	Johnson Controls-Whitmore Lake	Horseshoe Lk Outlet
9	Ford-Rawsonville Plant	Ford Lake
10	Ford-Ypsilanti Plant	Ford Lake
11	James River-Ypsilanti	Huron R
12	Belleville Plating Co	Huron R
13	G T Products Inc	Huron R via storm sewers
14	Chelsea WPP	Letts Ck
15	South Lyon WWTP	Yerkes Dr
16	Chelsea WWTP	Letts Ck
17	Brighton WWTP	South Ore Ck
18	Rockwood WWTP	Huron R
19	Ann Arbor WWTP	Huron R
20	Dexter WWTP	Mill Ck
21	Milford WWTP	Huron R
22	Northfield Township WWTP	Horseshoe Lk Outlet
23	Oakland Co DPW-Sub Knolls WWTP	Oxbow Lk
24	Loch Alpine SA-Scio-Web WWTP	Huron R
25	Oakland Co DPW Wixom WWTP	Norton Ck
26	Ford-Wixom	Congoon & Norton Dr
27	Americana MMP WWTP	Carter Dr
28	Huron River MMP & marina	Huron R
29	K H Corporation	Mcbride Dr
30	Bellevile CSO	Belleville Lake
31	Dexter Automatic Products	Mill Ck
32	Culligan-Ann Arbor	Huron R via storm sewer
33	Thetford Corp-Dexter	Mill Ck via unnamed drain
34	YCUA-Willow Run Airport	Willow Run Ck
35	Ann Arbor WFP	Huron R via unnamed drain
36	MDNR-Trap & Skeet Facility	Lautenschlager Dr
37	Dexter WFP	Huron R
38	Deco-Fermi 2	Swan Ck
39	Independent Heat Treat Co	Four Mile Lk
40	Rawsonville Woods Mobile Estate	Bird Marsh Dr
41	Darice MFG	Yerkes Dr
42	NTH Technical Center	Huron R via storm sewers

Table 20. (con't)

Numbers	Permitee	Watercourse
43	Barrington Chemical Co	Spring Mill Ck
44	Federal Mogul Corp-Seal Prod	Huron R via storm sewer
45	YCUA Regional WWTP	Willow Ck
46	Stockbridge WWTP	Low Lake Dr
47	Country Meadows MMP	Wagner & Pink DR
48	North Arbor Park MMP WWTP	Travers Dr
49	GM-Hydramatic Div-Ypsilanti	Willow Run Ck
50	R&B Manufacturing	Huron R
51	GM-GMAD Willow Run-Ypsilanti	Willow Run Ck
52	Eastern Mich University-Steam Plant	Huron R via storm drain
53	Sylvania Silica Co Ltd	Laudenschlager Dr
54	Edwards Brothers Inc	Huron R via unnamed ditch
55	MDNR-Bruin Lake CG WWST	Watson Lake
56	Central Wayne Co Sanitary Auth LF	Wagner & Pink Dr
57	Mazda-Ann Arbor R & D Plant	Fleming Ck
58	Universit Microfilms Intl	Honey Ck
59	Whitmore Lake Schools	Huron R via unnamed trib
60	Sweepster Jenkins Equipment Co	Huron R
61	CSX Transport-New Boston	Hosmer Dr via open ditch
62	McPherson Oil Co	Mill pond
63	Chrysler-Chelsea Proving Grounds	Mill and Letts Ck
64	USDI-Ann Arbor Great Lakes Lab	Huron
65	Dexter Automactic Prod	Mill Ck
66	Shell Oil Co-Ypsilanti	Huron R via storm sewer
67	UM Power Plant	Huron R
68	Tarital Power Services Inc	Traver Ck
69	Brighton WTP	Worden Lake
70	E & L Transport	Brownstown Ck
71	Vector Research Inc	Huron R
72	Ann Arbor News	Huron R
73	Farmers Petroleum-Highland	Pickerel Lake
74	Pittsfield Products-ACO Division	Honey Ck via storm sewers
75	Nugget Restaurant-Brighton	Mud Lake via storm sewer
76	Dandy Oil Co-Brighton	Huron R via storm sewer
77	Shell Oil Co-Union Lake	Cooley Lake
78	Total Petroleum Inc-Ann Arbor	Huron R
79	Illi's Auto Service	Allen Ck Dr

Table 21. Act 307 sites in the watershed, by county, as of 1992 (Environmental Response Division, Michigan Department of Natural Resources). Acronyms: BTEX=benzene, toluene,ethylbenzene, xylene; BTX=benzene, toluene, xylene; DCA=dichloroethane; 1,1 DCA=isomer of previous; 1,2 DCA=isomer of previous; cis-1,2-DCA=isomer of previous; DCE=dichloroethylene; DDD=dichlorodiphenyldichloroethane; MEK=methyl ethyl ketone; MTBE=methyl(tert)butylether; PAH=polyaromatic hydrocarbon; PCB=polychlorinated biphenyls; PCE or PERC=perchloroethylene; TCA= trichloroethane; 1,1,1 TCE=isomer of previous; TCE=trichloroethylene. Blanks indicated that data was not listed.

Common site name	Pollutant	Resource affected
Oakland County		
By Rite Oil Company	petroleum product	groundwater, soil
Shell Oil, Union Lk. Rd.	gasoline	groundwater, soil
Ford Motor Company	lead, zinc, chromium,cadium	groundwater
Oscar Larson Company	benzene, toluene, ethylbenzene, xylenes	groundwater, soil
GM Proving Ground	benzene, toluene, ethylbenzene, xylenes	soil
Quantex Corporation	fuel oil	soil
Fisher Cleaners & Laundry	tetrachloroethylene	
BP Station #54521	toluene,xylenes, ethylbenzene, MTBE, benzene	soil
Res. well, Sable Rd.	BTEX, PCE, 1,2 DCA	
Old Marlow landfill	PCB's,TCE, lead, chromium, zinc	
RGCW Disposal	lead, arsenic,cyanide	
Springfield Twp Dump Site	PCB, BTEX, PCE, TCE, phthalates	
Hi Mill Manufacturing	chromium, arsenic, cadium, lead	
Milford Rd., Highland Area	benzene, TCE, PCE	
Unocal Station, Wixom	BTEX	
Highland Precision Plant	PCB's	
Village of Milford wells	cis-1,2-DCE	
E. Livingston Rd. site	benzene, MTBE, 1,1,1 TCA	
Numatics Inc	PCE	
Lyons Twp dump site	TCE, PCE, BTEX, 1,1,1 TCA	
Village of Milford	domestic, commercial	
Livingston County		
Main St. wells, Pickney	PERC	groundwater
Green Oak fire station	xylene, toluene, benzene, ethylbenzene	grdwater, res well
Brighton Cameron	zinc, lead, chromium, phthalates	surface water, soil
R & B Manufacturing	dichloroethene, trichloroethane, methylene chloride	groundwater
Kelsey Hayes	tetrachloroethene	soil
MDOT	salt	grdwater, res well
Canoe Camp well	xylene, ethylbenzene	grdwater, res well
Winters Quick Clean	perchloroethylene	groundwater
Union 76, Pickney	gasoline	groundwater, soil
Thermofil property	trichloroethylene, dichloroethylene	groundwater, soil
Woodland Utility Trailer	paint solvents	soil
Kidd dump	domestic, commercial	
Driver dump	domestic, commercial	
US 23-I 96 interchange	salt	groundwater
Hamburg Unadilla Rds.	dichloroethylene, trichloroethylene	

Table 21. (con't)

Common site name	Pollutant	Resource affected
Rasmussens dump	chlorobenzene, BTEX	
Grossman Ideal Steel	PCB's, arsenic, PBWE, TCE, chromium, nickel	
Total Gas, Pinckney	BTEX, carbon tetrachloride, 1,1 DCA	
Spiegelberg landfill	arsenic, 1,1DCA, zinc, paints	
Brighton Twp dump	lead, PCB's	
Washtenaw County		
Washtenaw Co. Rd. Comm.	salt, oils, ethylene glycol	wetland, flora, groundwater, soil
Arbor Hills landfill	benzene, toluene, dichloroethane, trichloroethylene	soil, groundwater
Mich. Con., Beaskes St.	heavy metals, cyanide, PAH's, phthalates	groundwater, soil
Chelsea Sanitary landfill	vinyl chloride, dichloroehene, chromium	groundwater
Manchester Plastics	formaldehyde	groundwater, soil
Armens Cleaners	PERC	groundwater, soil
Anspec Company	DCA, DCE, TCA, cobalt, zinc, toluene, dioxane	grdwater, comm well
3D Sales and Service	copper, iron, zinc, xylenes, styrene, ethylbenzene, lead,	surface water, soil, wetland
Ann Arbor Sanitary landfill	DDD, toluene, trichloroethane, benzene	groundwater
Mobile Station, Chelsea	gasoline	soil
Independent Heat Treatment	cyanide, fuel oil, chromium	surface water, soil
AvFuel Bulk Facility	kerosene	soil
Farr View Mi, Carpenter Rd	toluene, benzene,xylene	groundwater, soil
Mobil Oil, Zeeb Rd.	TCE, DCE, benzene, toluene, xylenes, ethylbenzene	surf & grdwater, soil
Ford Lake	heavy metals, oil	surf water, sediment
Old Ford landfill	heavy manufacturing	
Spencer Elementary School	toluene, benzene, xylene, ethylbenzene	groundwater, soil
Wolverine Disposal	heavy amnufacturing	surface water, soil
Hi Fy Station, Michigan Av	benzene, toluene, xylene, ethylbenzene	groundwater
Ford Motor Co., Ypsilanti	benzene, toluene, xylene	groundwater
Wiards Surplus Store	fungicide, chromium	soil
Merritt Rd herbicide spill	alachlor, atrazine, chlorobenzene	soil, flora
Motor Wheel Corp	heavy manufacturing	
Stop & Go, Huron R Dr.	gasoline	groundwater, soil
Factory St. pump stat, Ypsi	chromium	groundwater, soil
Astro Manufacturin	acetone, MEK, peroxide	soil
Ford Rawsonville Plant	oils	groundwater, soil
14th District Court	gasoline	groundwater, soil
Det. Edison Superior Sub.	fuel oil	soil
Territorial Marathon	benzene, toluene, ethylbenzene, xylene	groundwater, soil
Mobil Oil, Stadium Blvd.	benzene, toluene, ethylbenzene, xylene	groundwater
EMU, School of Business	gasoline	groundwater, soil

Table 21. (con't)

Common site name	Pollutant	Resource affected
UM Hospital, Fuller Rd.	nitrates	groundwater
Gallup Silkworth Bulk fact.	petroleum	soil
Walton Shell	gasoline	soil
Shell, Packard Rd.	benzene, xylene, ethylbenzene	groundwater, soil
Illis Service	BTEX	groundwater, soil
Apollo Lincoln Mercury	benzene, toluene, ethylbenzene, xylenes	groundwater soil
Fox Lakewood Sunoco	gasoline	soil
Gallup Silkwood Station	gasoline	soil
UPS, Ypsilanti	benzene, toluene, xylenes	groundwater, soil
Amoco, Washtenaw/Statium	gasoline	groundwater, soil
Total, Ypsilanti	gasoline	soil
Washtenaw Comm. College	benzene, toluene, ethylbenzene, xylenes	groundwater, soil
Old Chelsea dump	domestic, commercial	groundwater, soil
Superamerica, Statium Rd.	benzene, toluene, ethylbenzene, xylenes	groundwater, soil
Hopin, Chelsea	benzene, toluene, xylene	groundwater, soil
Hopin, Ypsilanti	benzene, toluene, xylenes	groundwater, soil
Lansky scrapyard	PCB's, PNA's, metals, diesel fuel	soil
Old Ypsi Twp sludge disp.	domestic, commercial, heavy manufacturing	soil
Washtenaw Co Rd Comm	diesel fuel	soil
Bacon Acres	nitrates	surf water, wetland
Allen Creek drain	chlorobenzene, ethylbenzene, MTP, xylene, o-xylene	sediment, grdwater
Rampy Chevy	oil	soil
Chrysler Proving Grounds	calcium chloride	groundwater
Ypsilanti Twp landfill	domestic, commercial, heavy manufacturing	groundwater
Barrel dump, Dino Dr.	light industry	
Mich Con, Broadway St.	arsenic, nickel, lead, cyanide, zinc	
Arkona Rd. landfill	nickel, chromium, 1,1 DCA, 1,1,1 TCA	
Gelman Sciences Inc	1,4 dioxane	
Gm Hydramatic	PCB's, pertroleum products	
Silverstone Plating Co.	cadium, chromium, lead, nickel, copper	
Staebler Rd. contamination	benzene, 1,1,1 TCA, TCE, dioxane	groundwater
Sweepster jenkins Inc	TCE, benzene, TCA, DCE, DCA	
residental well, Nancy Dr.	chloroform, 1,1,1 TCA, cis-1,2-DCA	
14 E Michigan Ave.	paint, waste oil	
Burton St. contamination	1,1,1 TCA, dioxane, tetrahyfuran	groundwater
Cooch Drain	petroleum products	
American Transmissions	oils	
Wayne County		
Oaksville Waltz Rd disp.site	PCB's, toluene, benszene	soil
Van Dusen Airport Service	cyanide, jet fuel	sediment, soil, surface water

Table 21. (con't)

Common site name	Pollutant	Resources affected
Mich Environmental Services Inc.	PCB's	surface water, soil, wetland
Thorton landfill	chromium, nickel	soil
Huron Quarry San. landfill	mercury, manganese,arsenic	groundwater
E. & Vivian Brown landfill	domestic, commercial	soil
Petroleum Specialties	BTX, PCB's, lead, asbestos	
Shevrovich Transmission	petroleum products	
Ingham County		
Stockbridge Manufacturing	oil, grease, cyanide, dichloroethane	soil
BBM Sign	methyl, ethyl, ketone, toluene, caustic soda	soil
Monroe County		
Moo Lee landfill	domestic, commercial, heavy manufacturing	surface water

Table 22. Other organizations with interests in the Huron River watershed.

Ann Arbor Chapter of Trout Unlimited
Avid Bass Anglers
Chelsea Rod and Gun Club
Flat Rock Sportsmens Association
Howell Gun Club
Huron River Community Coalition
Huron River Interest Group
Huron River Sports Shop
Huron River Watershed Council
Huron Valley Citizens Association
Huron Valley Conservation Association
Huron Valley Steelheaders
Livinston County Conservation and Sports Association
Livingston County Wildlife Club
Metro Bass Anglers
Metro West Steelheaders
Michigan Fly Fishing Club
Monroe Rod and Gun Club
Multi-Lakes Conservation Club
Michigan United Conservation Club District #1
Michigan United Conservation Clubs District #2
Michigan United Conservation Clubs District #7
Quandrant Conservation League

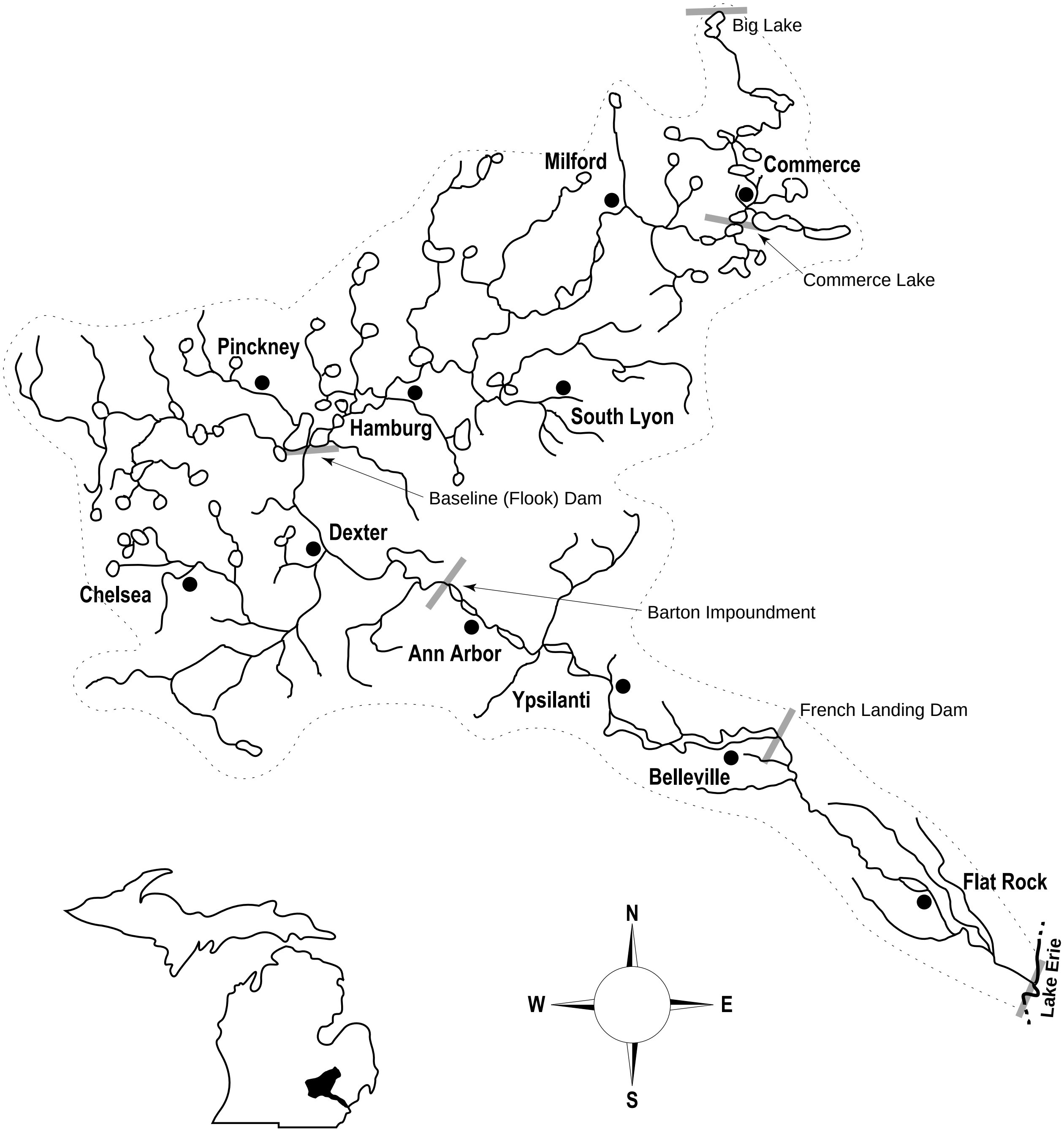


Figure 1.—The Huron River watershed in Southeastern Michigan. The major reaches of the Huron River mainstem. Reach #1 - Big Lake to Commerce Lake; Reach #2 - Commerce Lake to Baseline (Flook) Dam; Reach #3 - Baseline (Flook) Dam to Barton Impoundment; Reach #4 - Barton Impoundment to French Landing Dam; Reach #5 - French Landing Dam to Lake Erie.

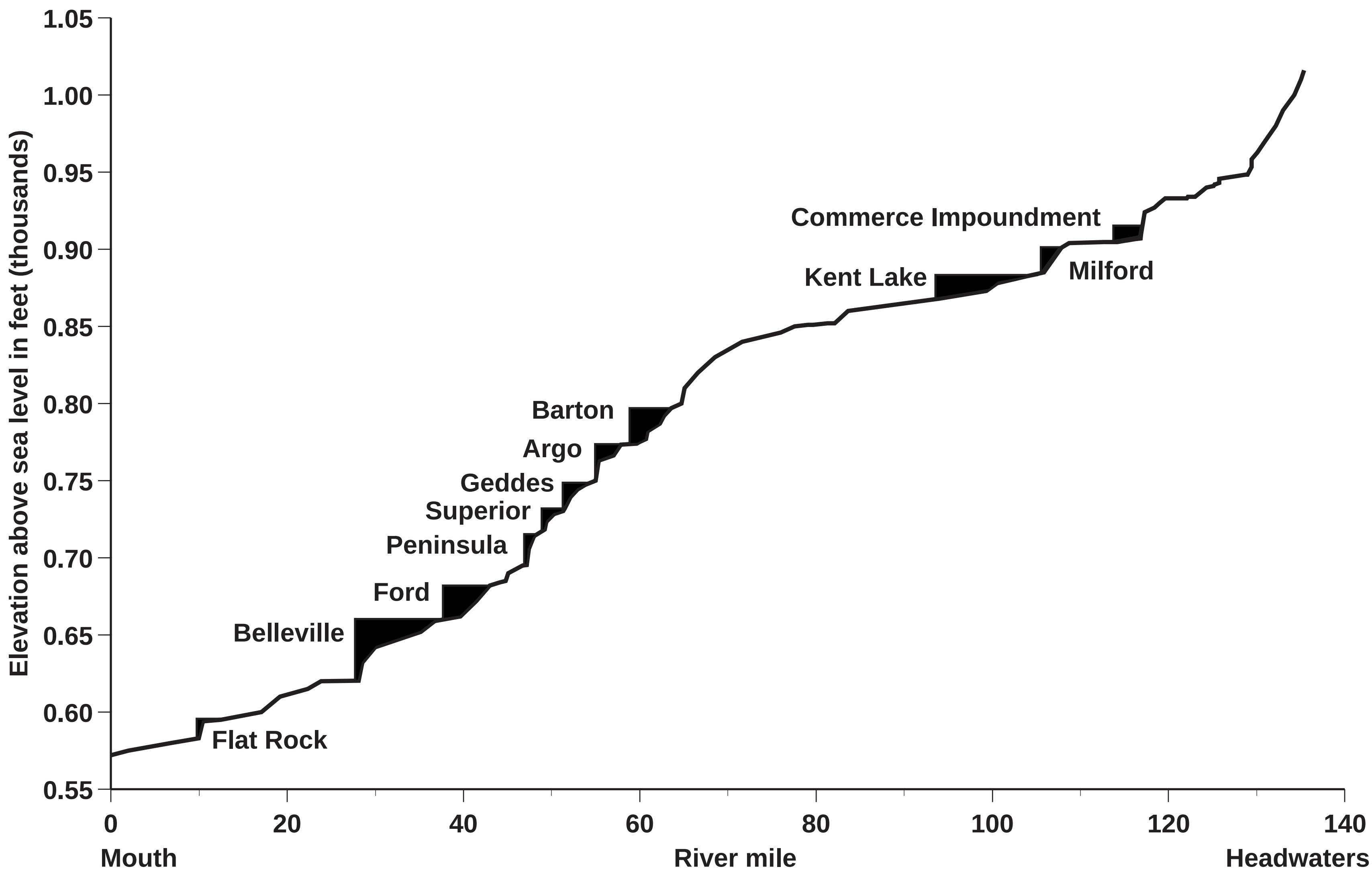


Figure 2.—Elevation changes, by river mile, from the headwaters to the mouth of the Huron River. Major mainstem dams and the impoundments they create are shown.

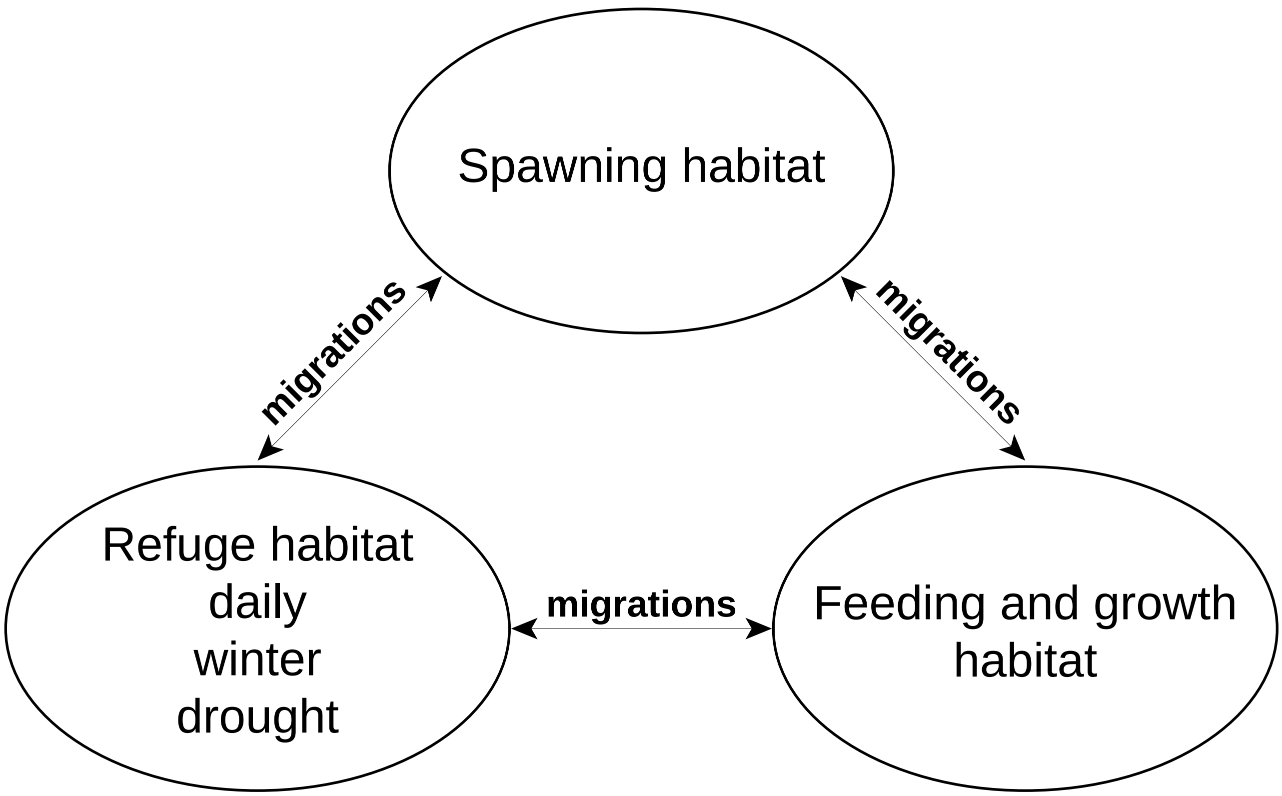


Figure 3.—The basic life cycle of stream fish with respect to habitat use (modified from Schlosser 1991).

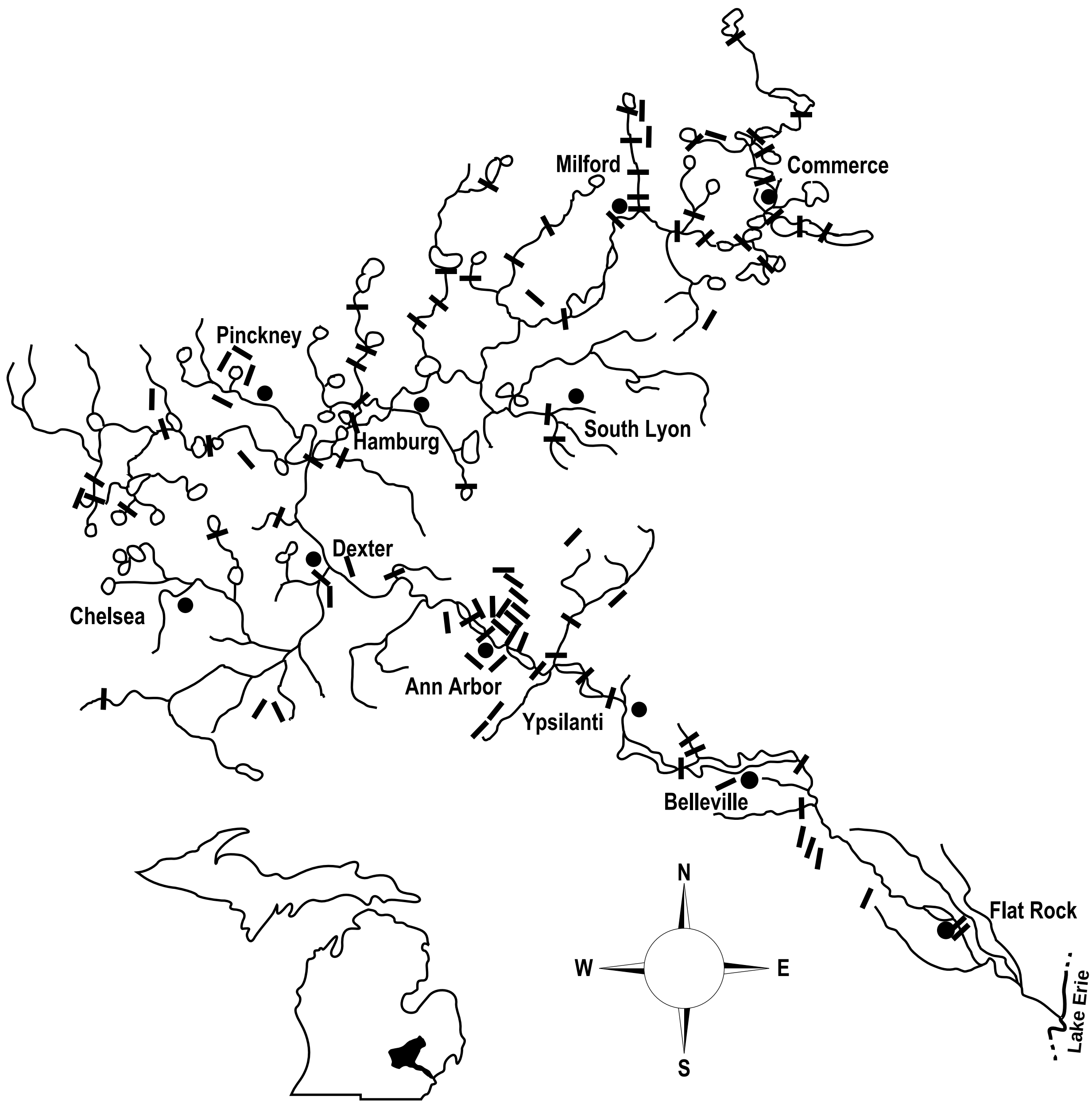


Figure 4.—Approximate locations of dams in the Huron River watershed.

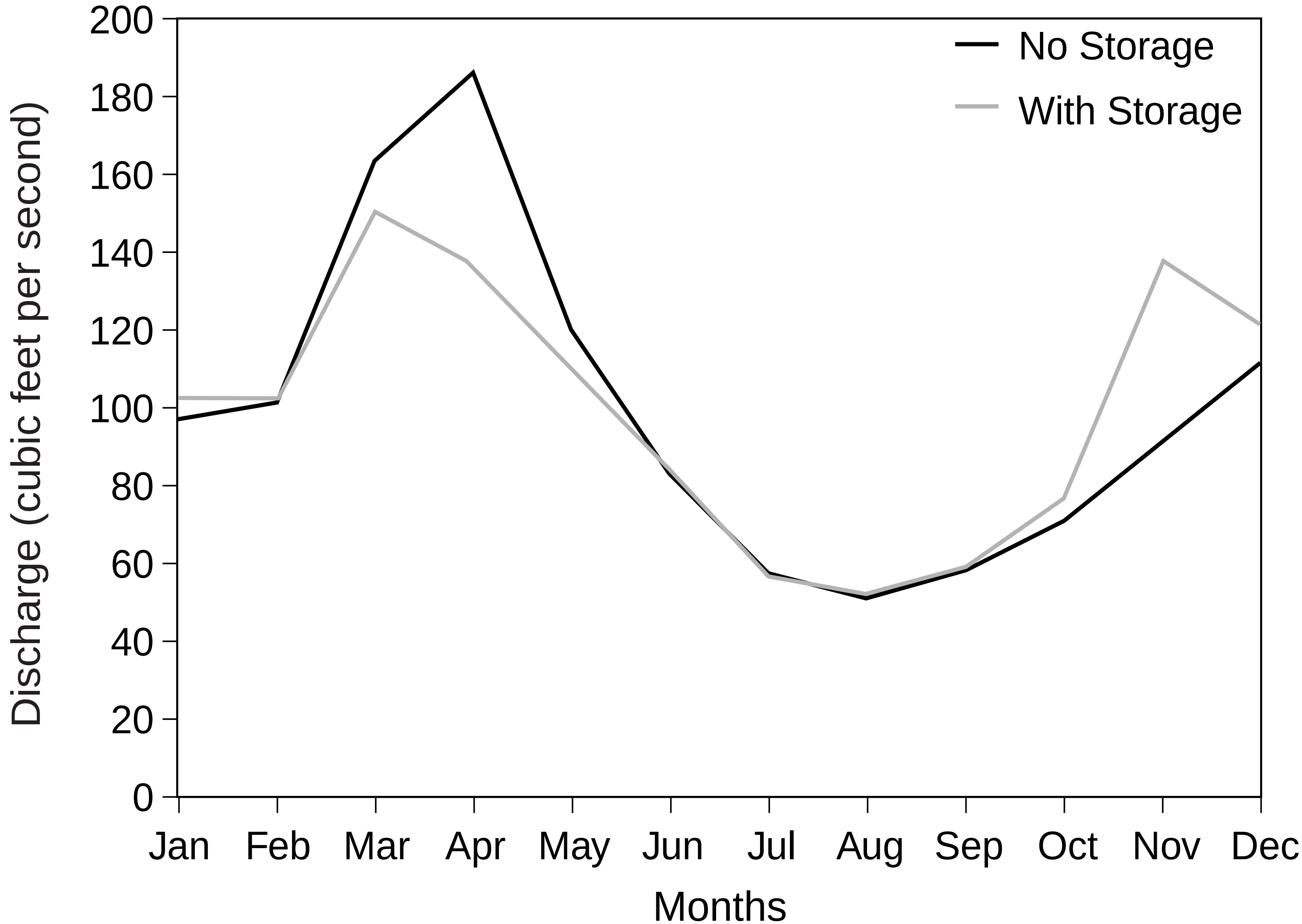


Figure 5.—Median monthly Huron River discharge from Kent Lake, with and without the effect of Kent Lake reservoir.

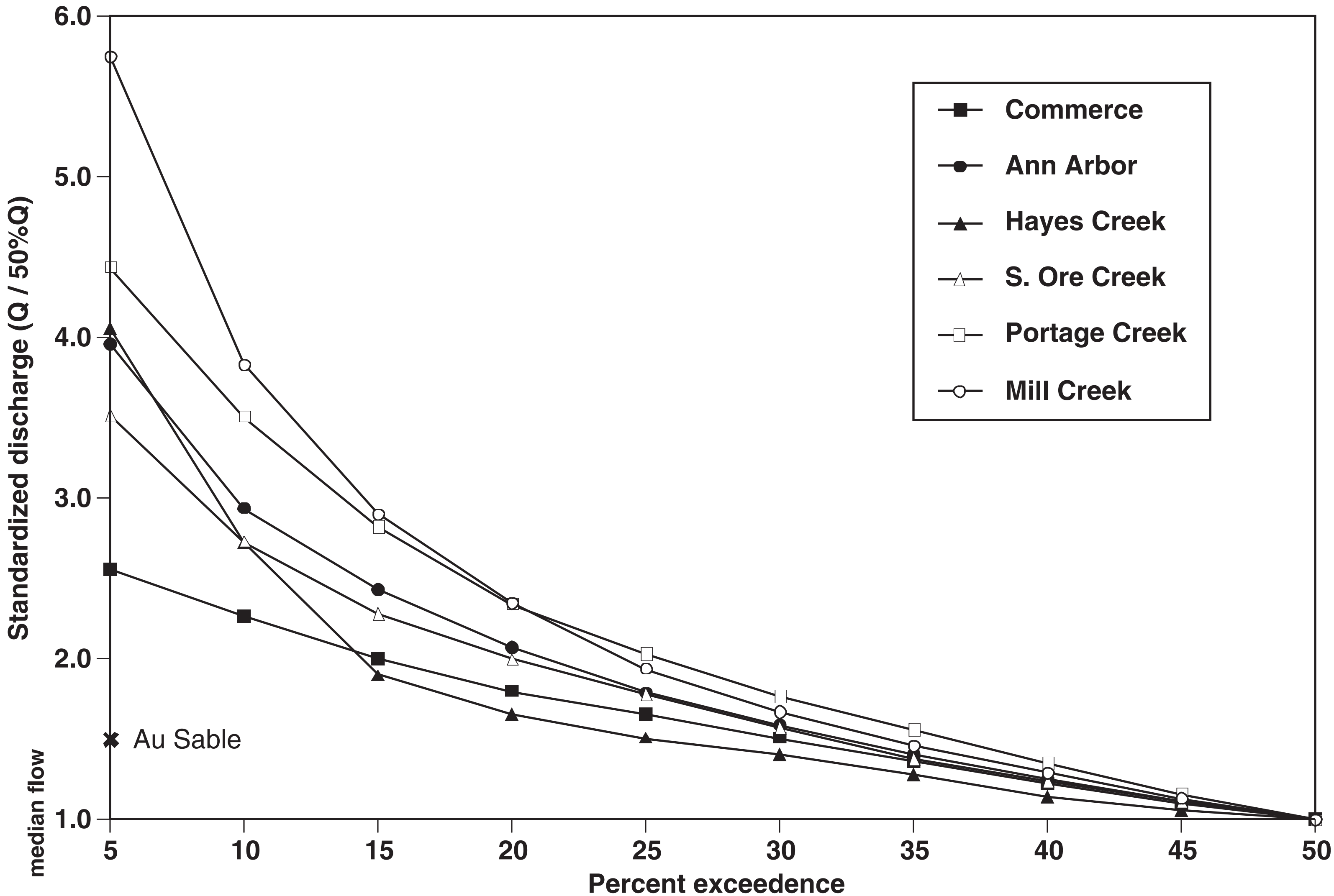


Figure 6.—Standardized high flow exceedence curves for the mainstem Huron River at Commerce and Ann Arbor and for four major tributaries. Information from US Geological Survey gauge stations for period of record. **Q** is the discharge; **50%Q** is the median discharge.

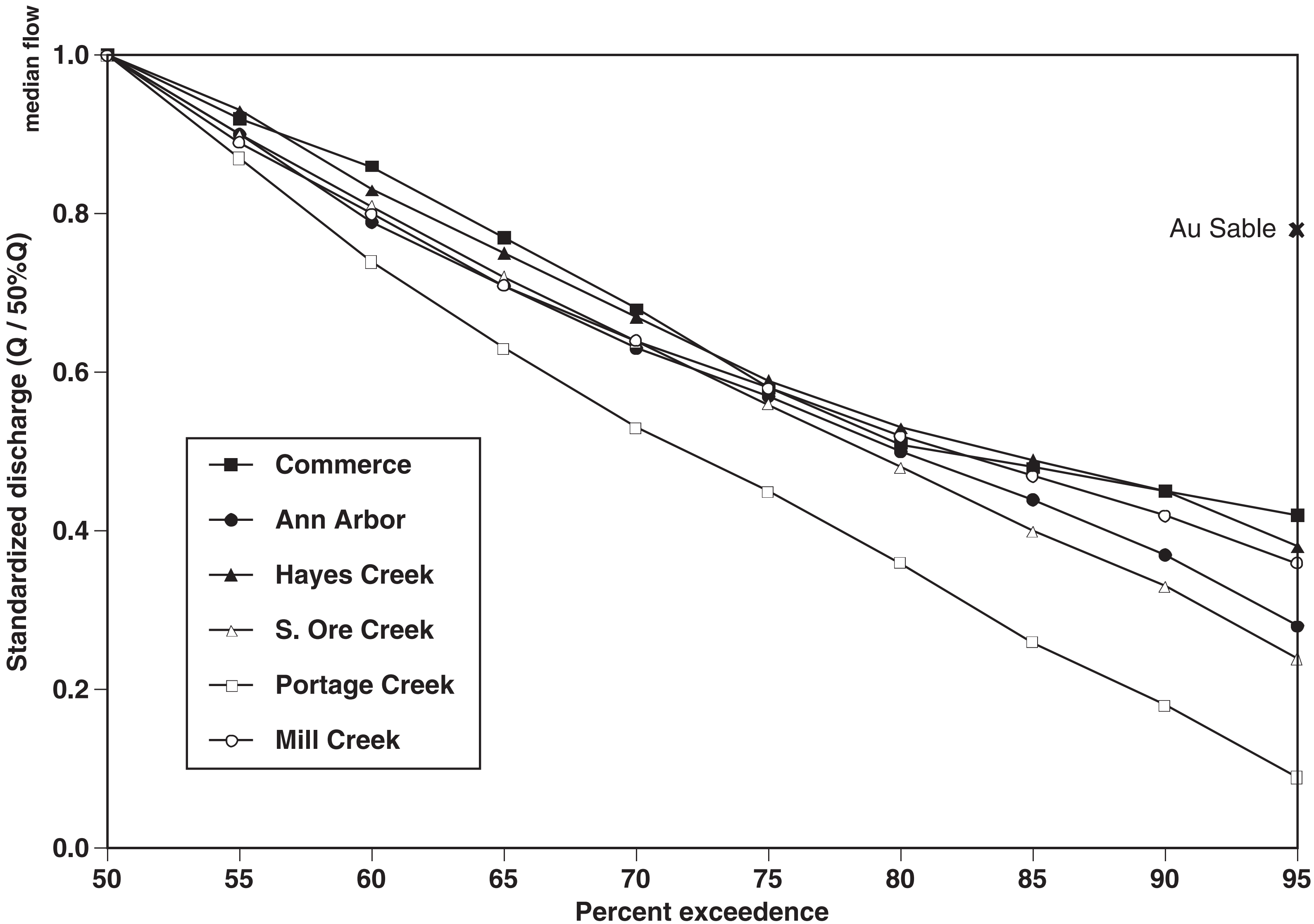


Figure 7.—Standardized low flow exceedence curves for the mainstem Huron River at Commerce and Ann Arbor and for four major tributaries. Information from US Geological Survey gauge stations for period of record. **Q** is the discharge; **50%Q** is the median discharge.

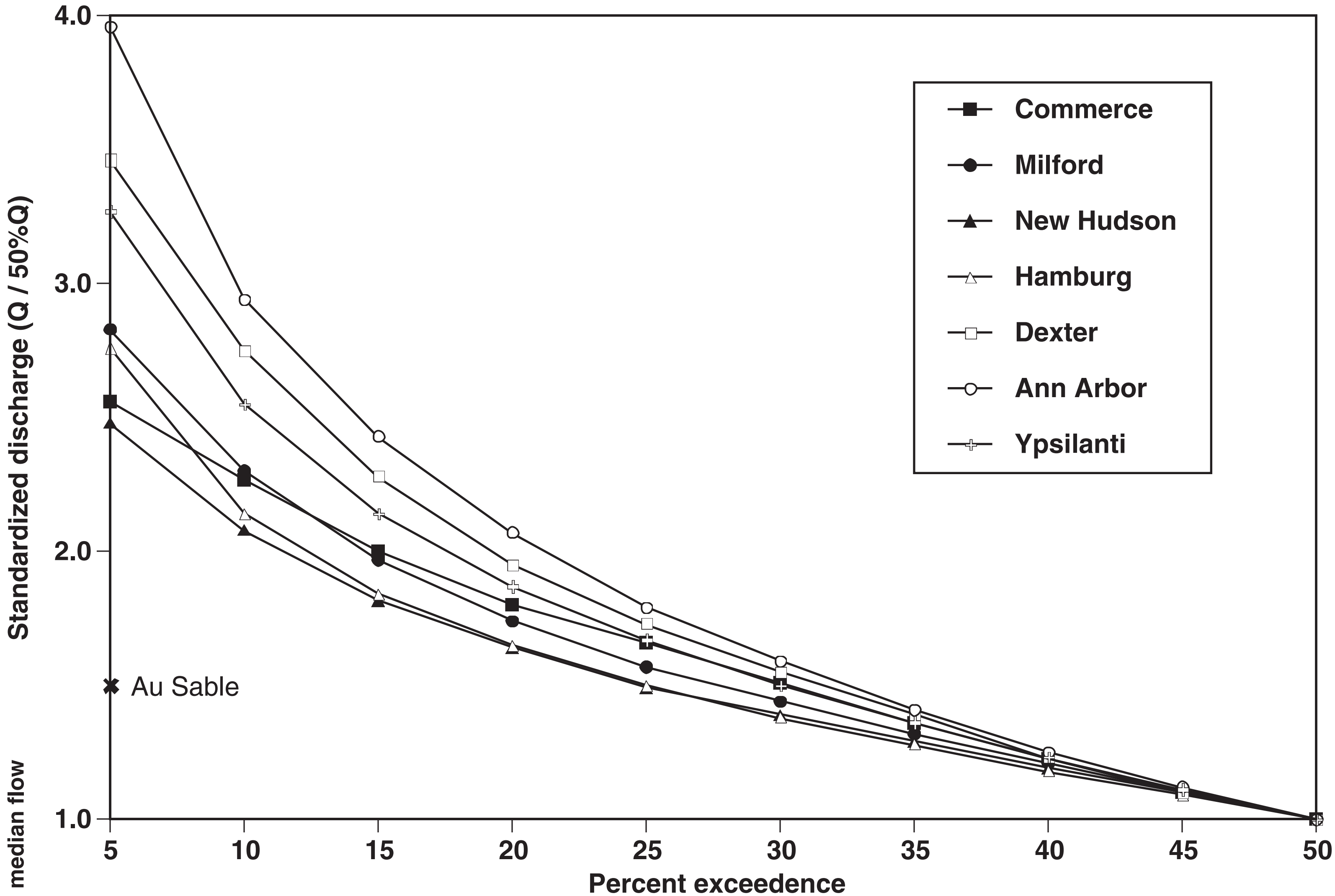


Figure 8.—Standardized high flow exceedence curves for seven locations on the Huron River. Information from US Geological Survey gauge stations for period of record. **Q** is the discharge; **50%Q** is the median discharge.

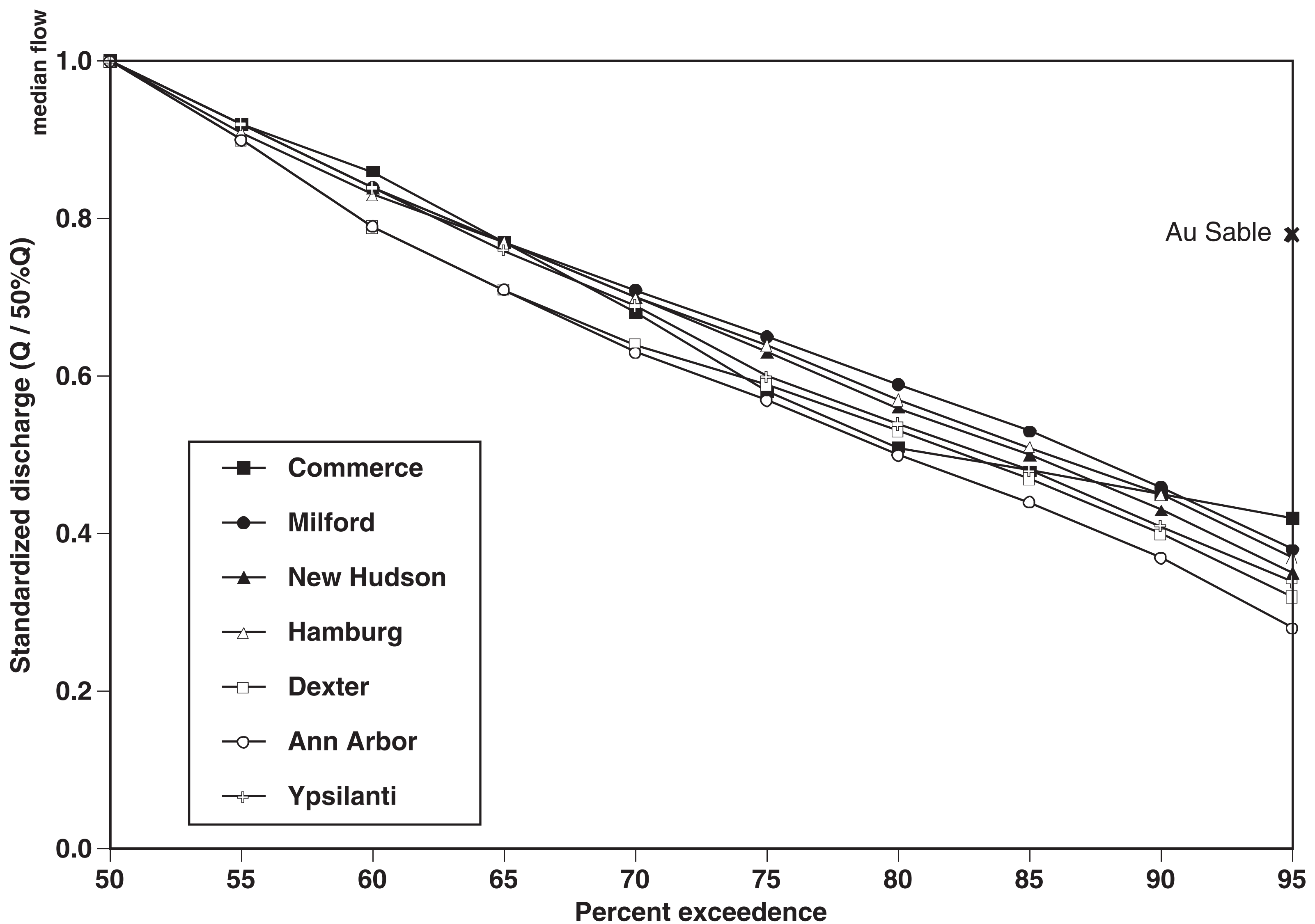


Figure 9.—Standardized low flow exceedence curves for seven locations on the Huron River. Information from US Geological Survey gauge stations for period of record. **Q** is the discharge; **50%Q** is the median discharge.

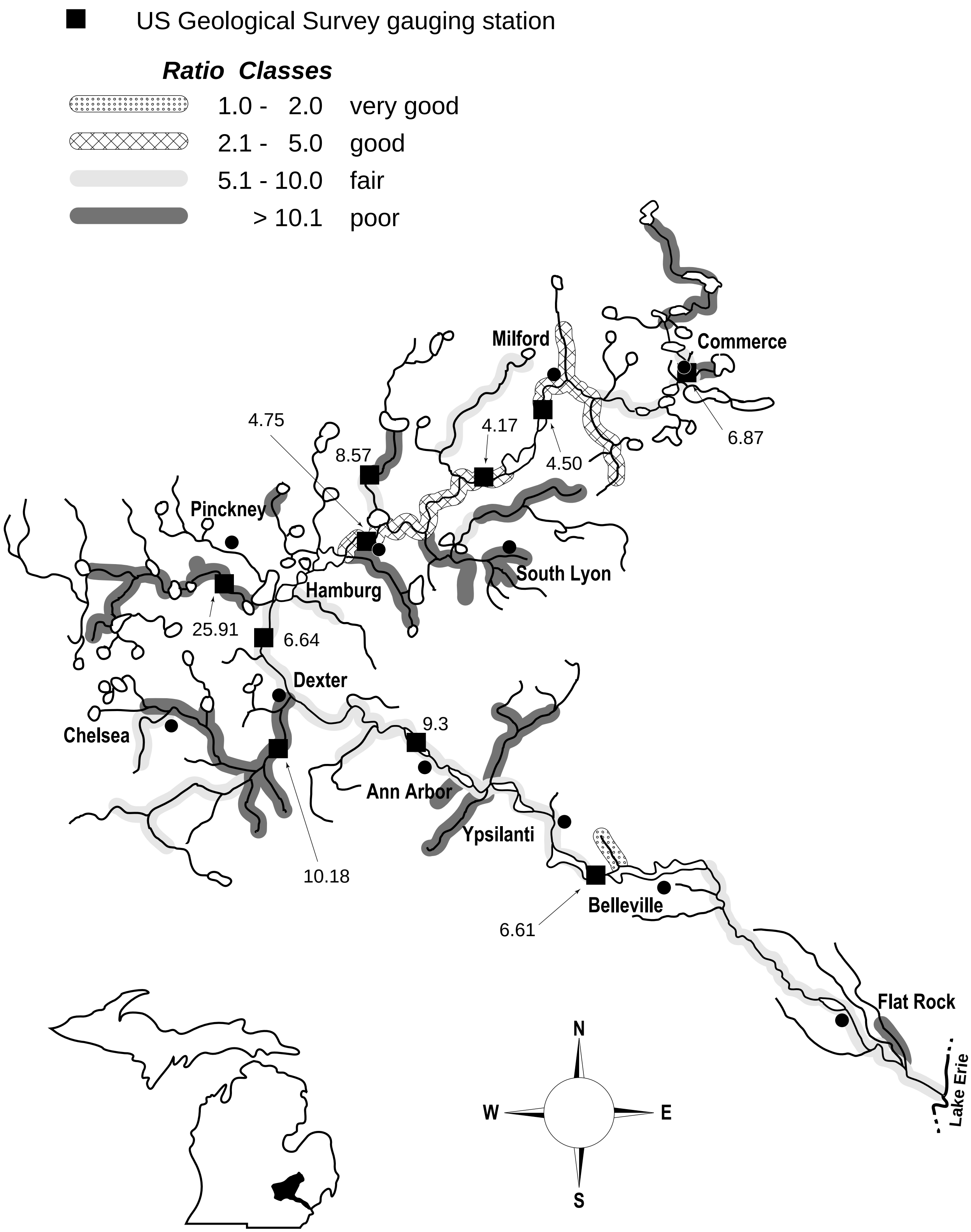


Figure 10.—Flow stability patterns in the Huron River watershed, calculated from miscellaneous and short-time frame data from the US Geological Survey. Specific ratios for each gauge station are indicated.

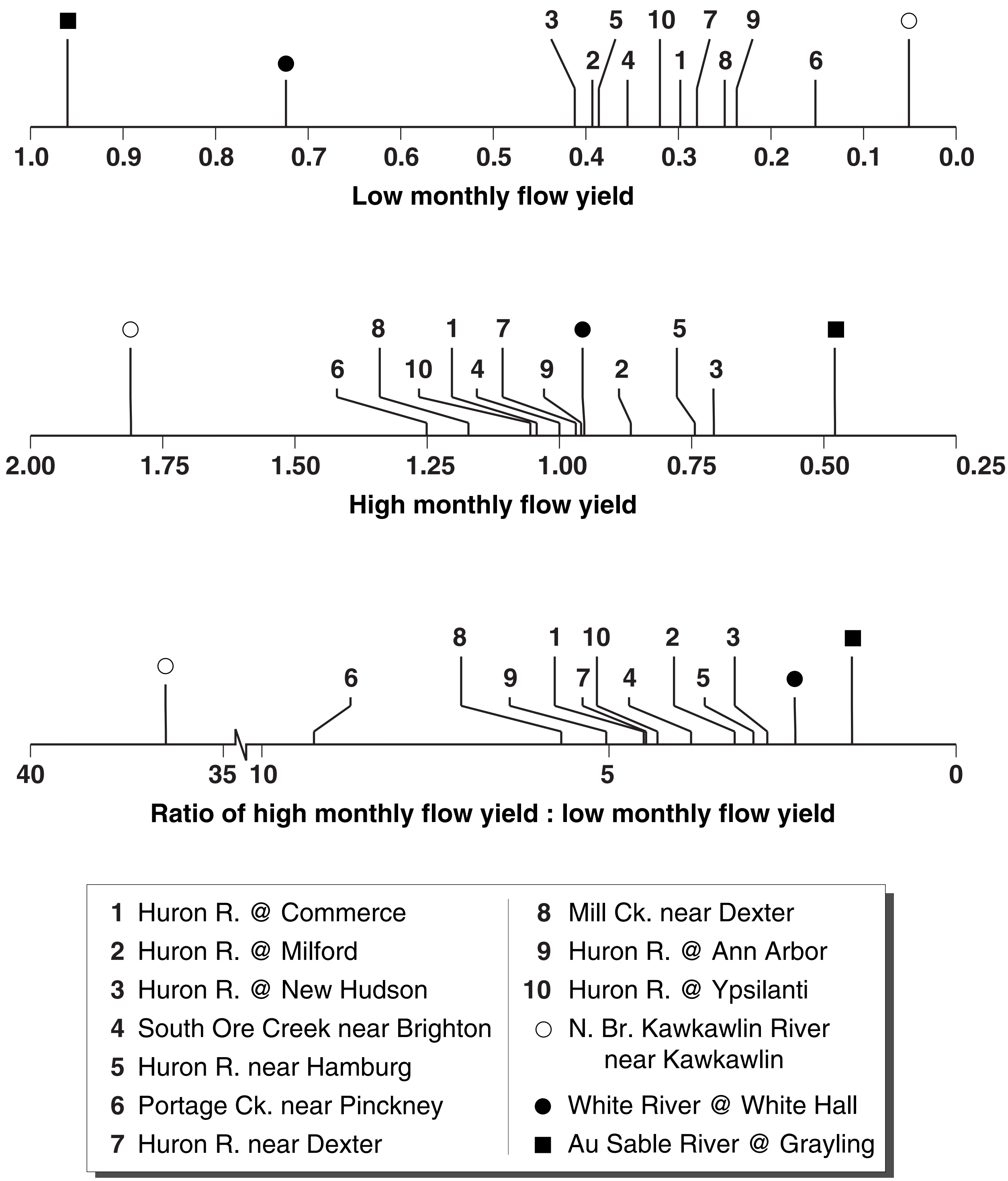


Figure 11.—Low and high monthly flow yields and their ratios for 10 sites in the Huron River watershed and the north branch of the Kawkawlin River, the White River, and the Au Sable River. Solid symbols indicate trout stream.

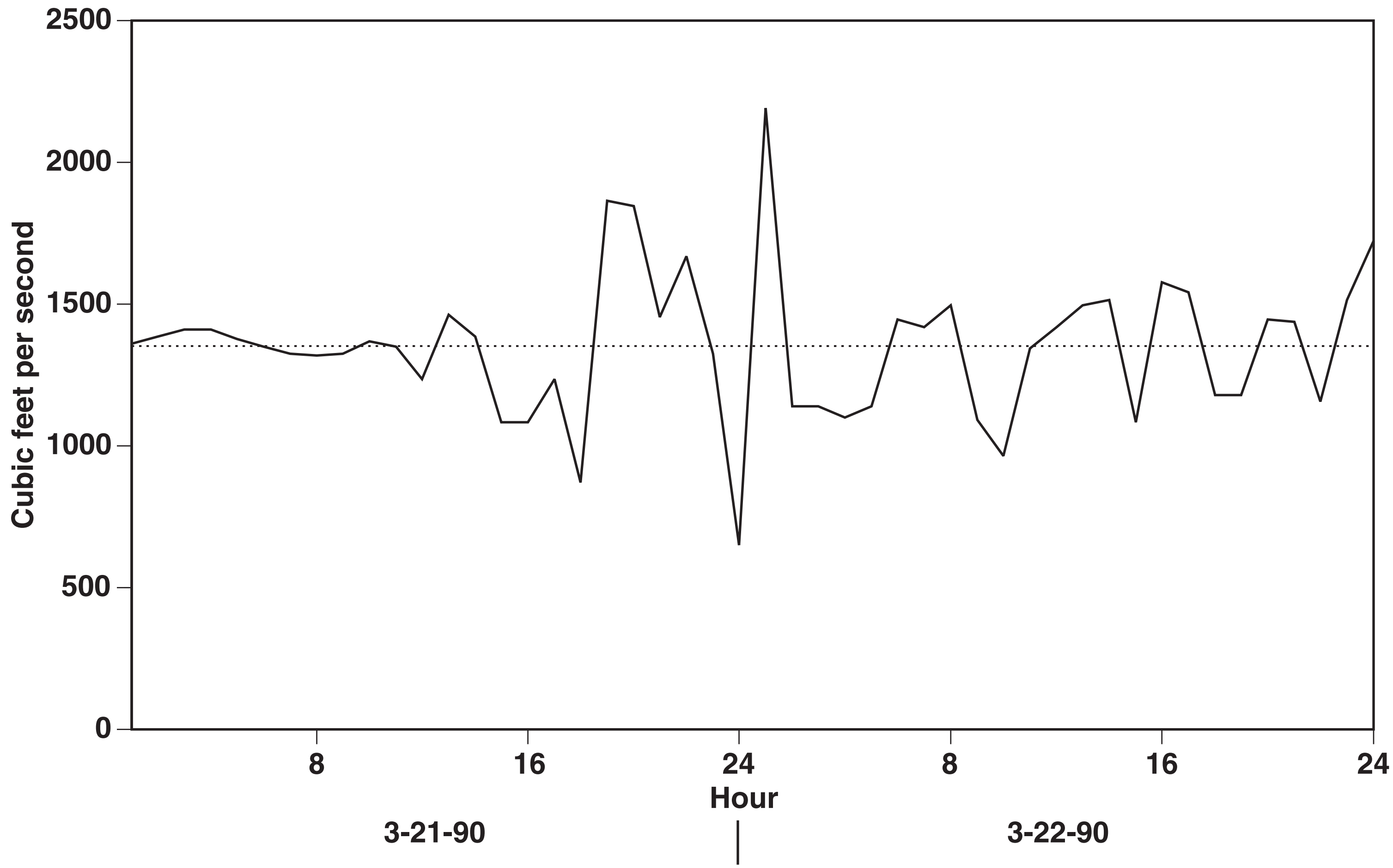


Figure 12.—Daily discharge patterns at Ann Arbor, downstream of Argo Dam, for March 21-22, 1990 (data from US Geological Survey) illustrating flow instability at this location. Straight line is the two-day average discharge at this gauge.

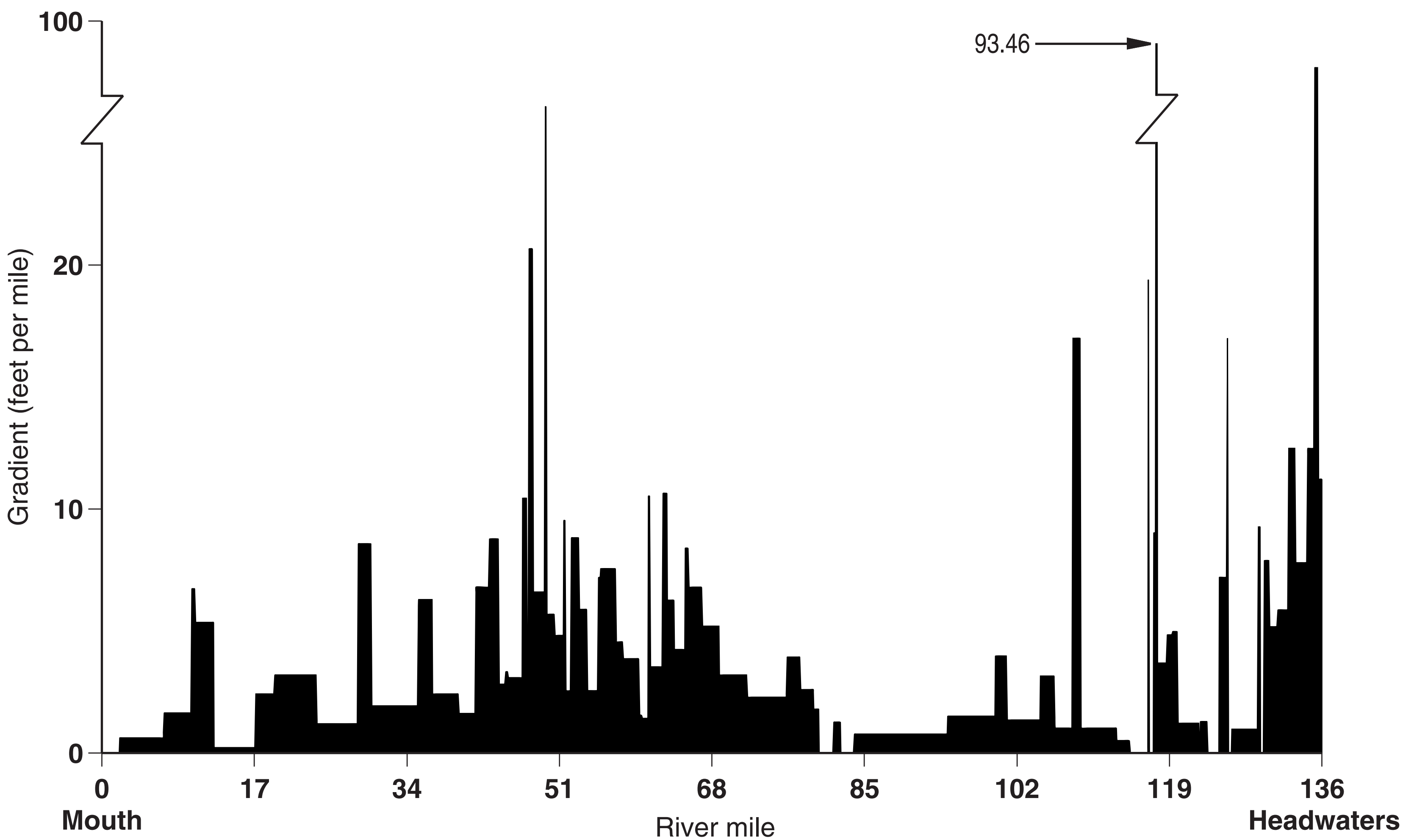


Figure 13.—Gradient (elevation change in feet per mile) of the Huron River. Gradient is shown without existing dams or lake-level control structures.

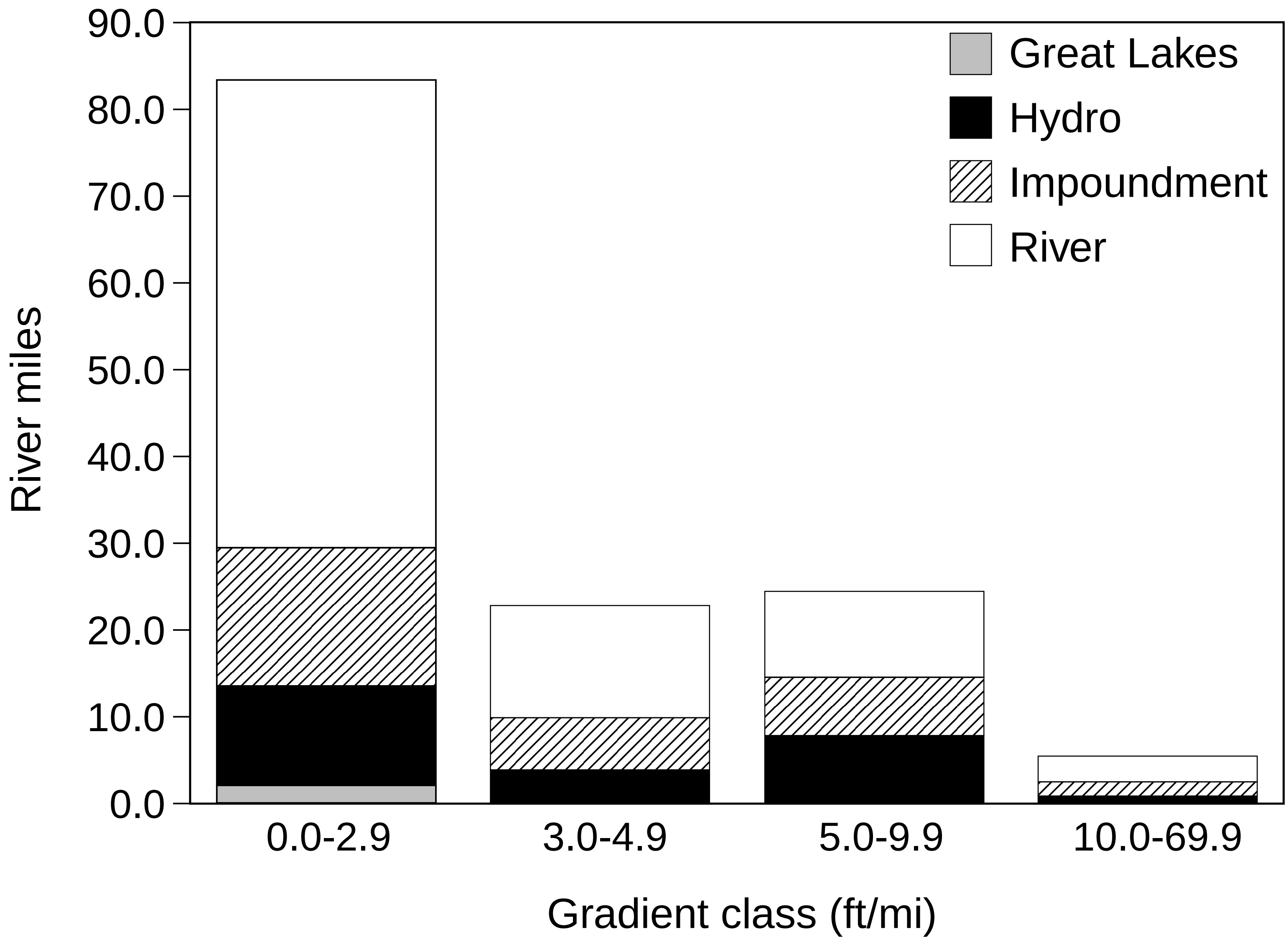


Figure 14.—Gradient classes and length of river in each, separated by water type, for the Huron River.

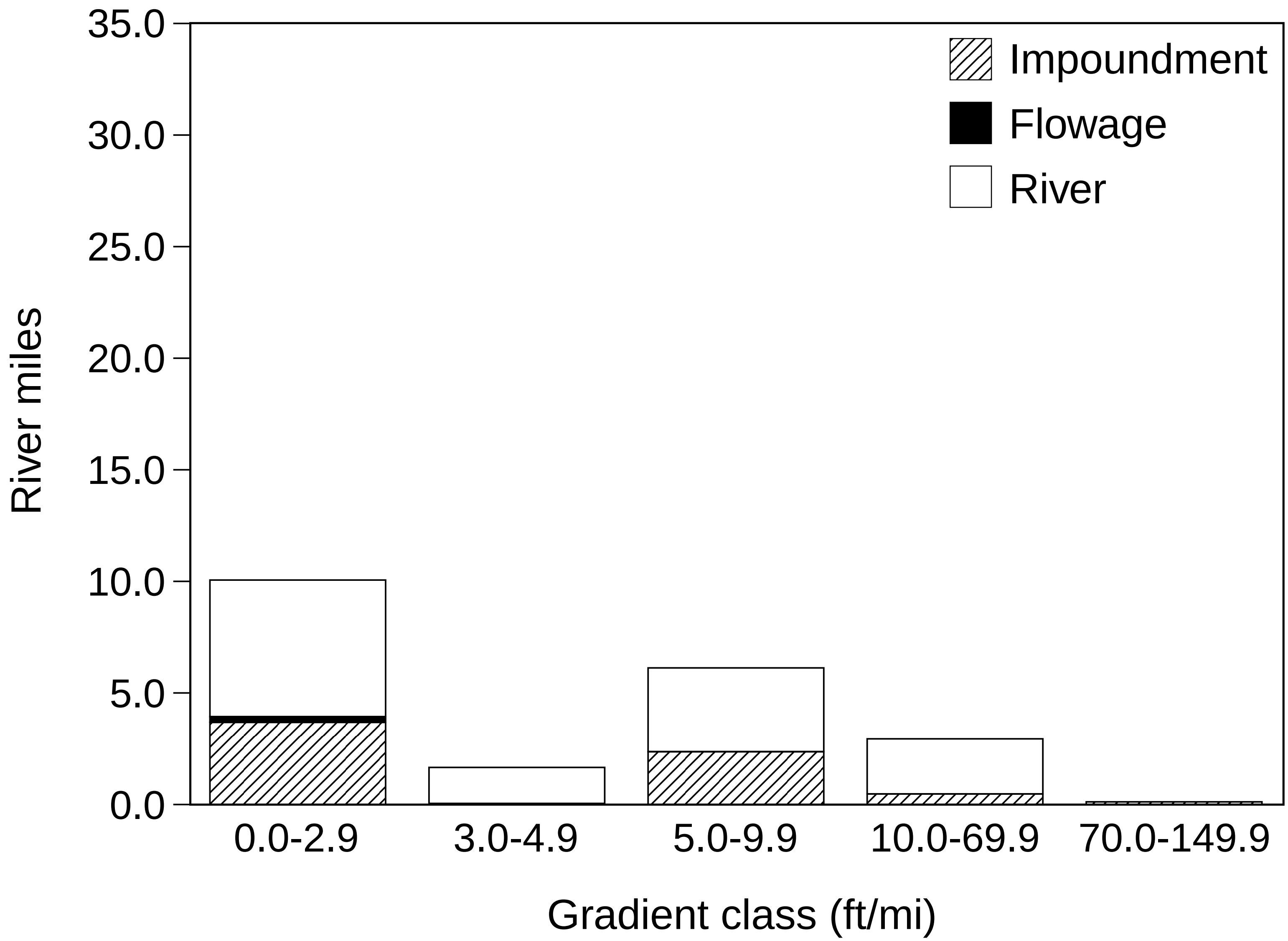


Figure 15.—Gradient classes and length of river in each, separated by water type, for the Huron River mainstem from Big Lake to Commerce Lake.

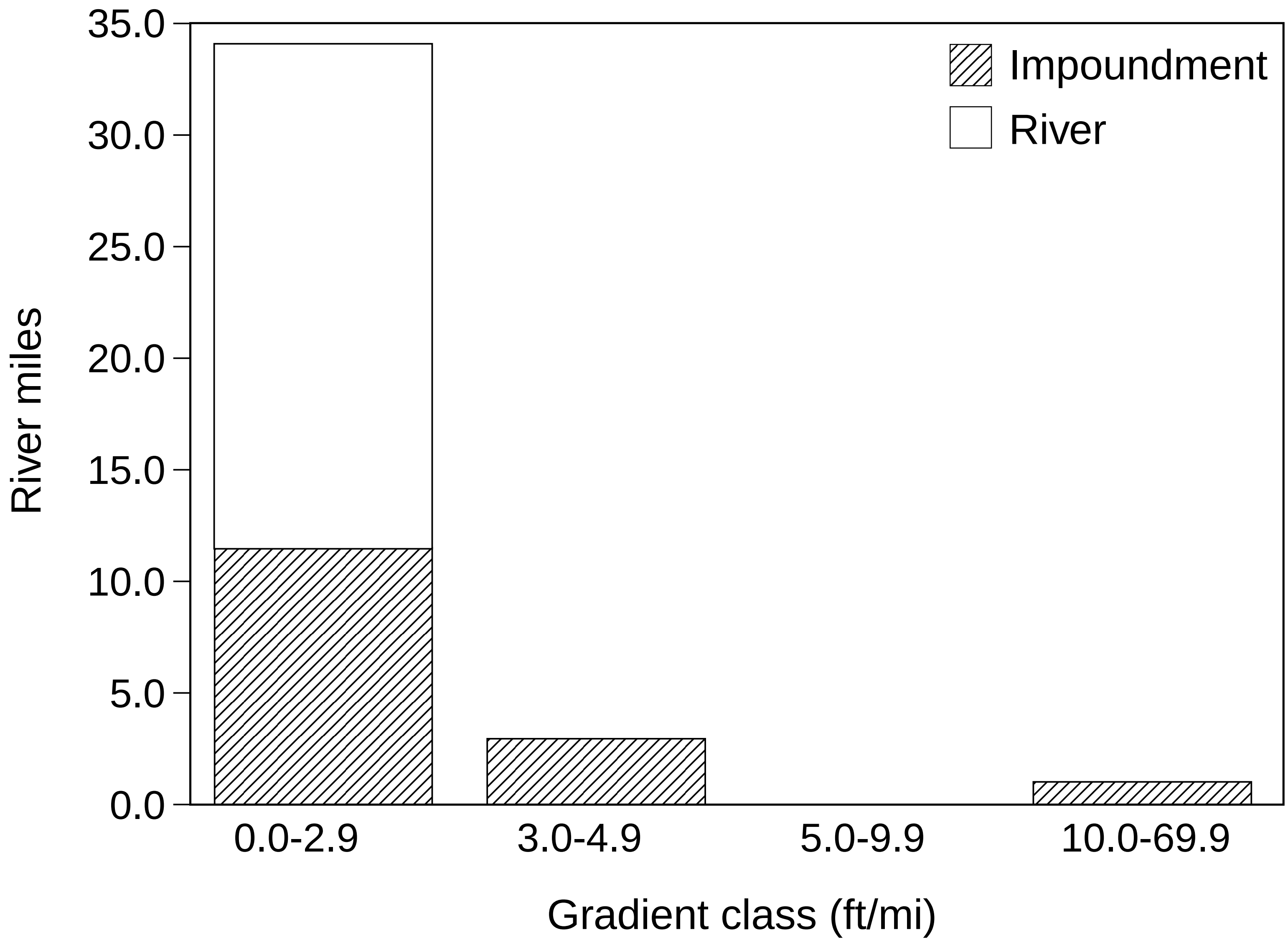


Figure 16.—Gradient classes and length of river in each, separated by water type, for the Huron River mainstem from Commerce Lake to Baseline (Flook) Dam.

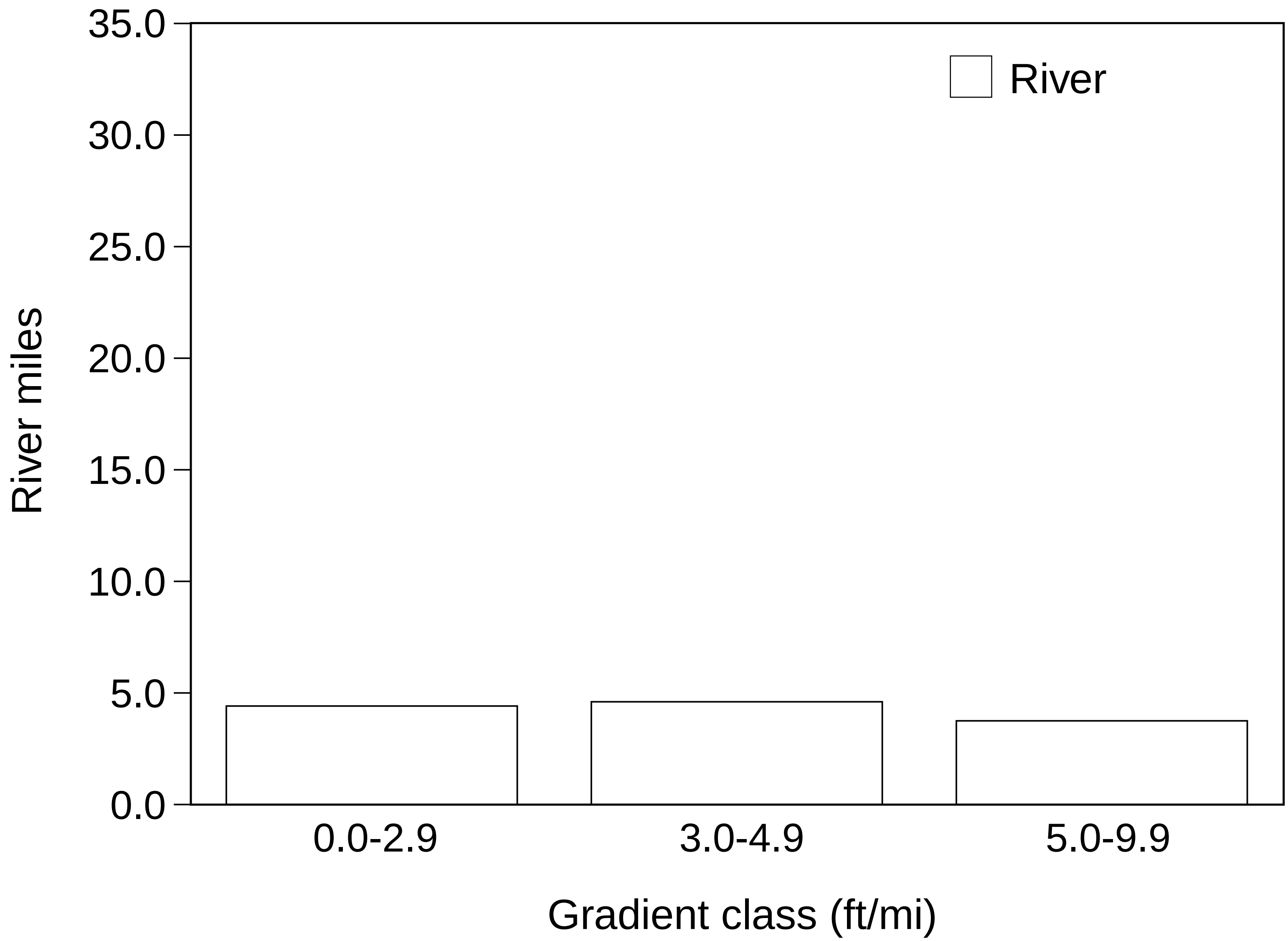


Figure 17.—Gradient classes and length of river in each, separated by water type, for the Huron River mainstem from Baseline (Flook) Dam to Barton Impoundment.

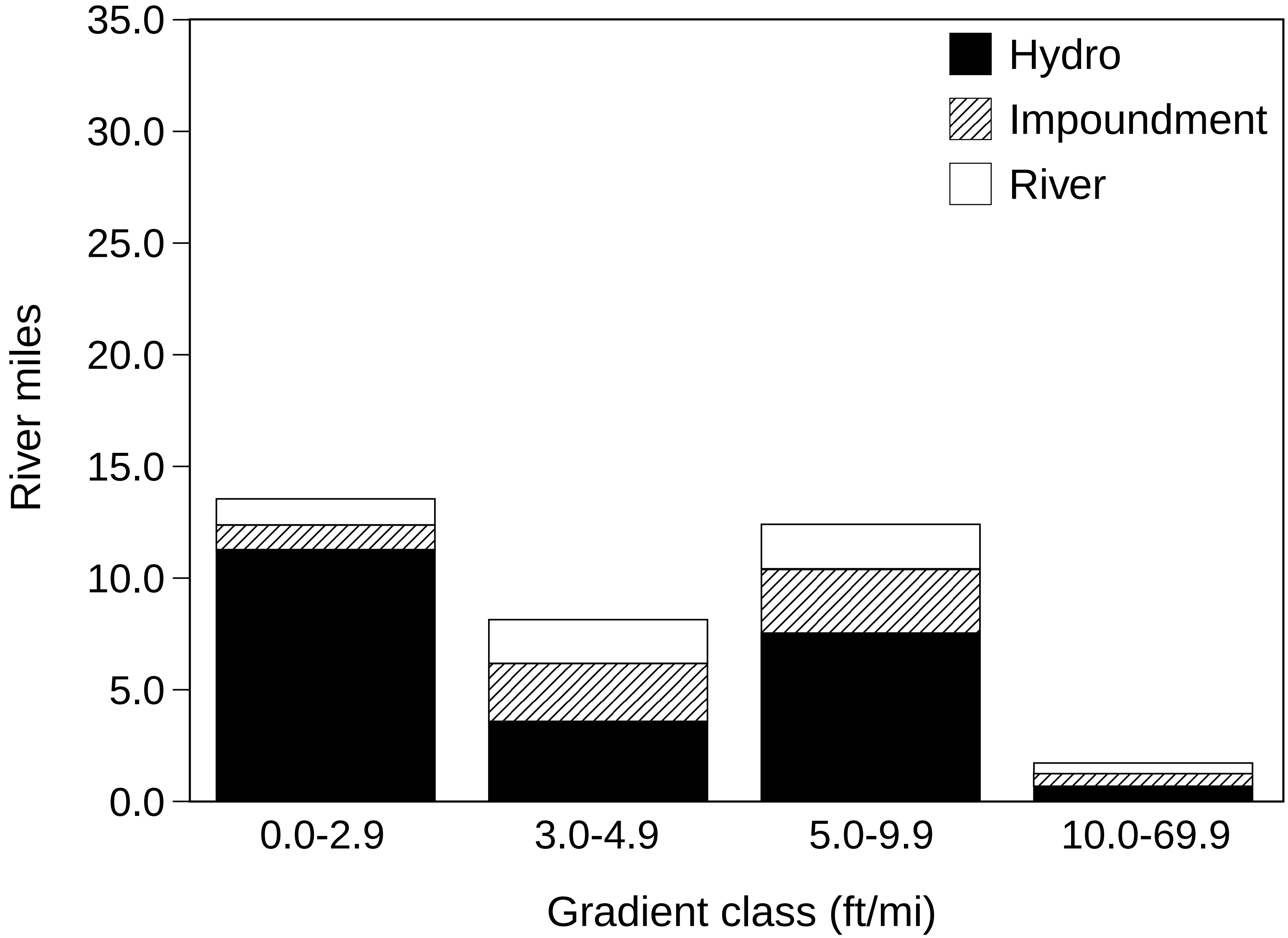


Figure 18.—Gradient classes and length of river in each, separated by water type, for the Huron River mainstem from Barton Impoundment to French Landing Dam.

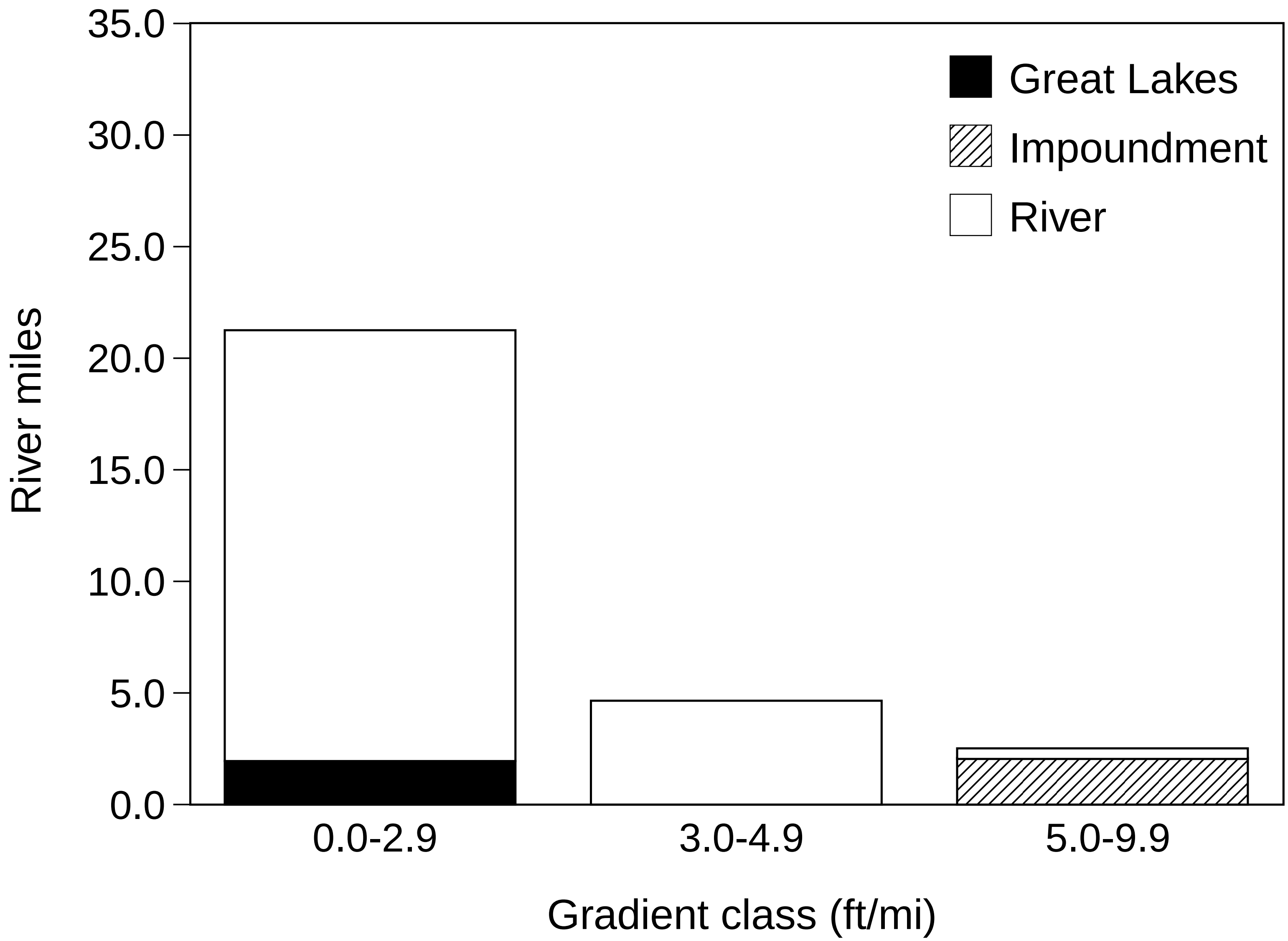


Figure 19.—Gradient classes and length of river in each, separated by water type, for the Huron River mainstem from French Landing Dam to Lake Erie.

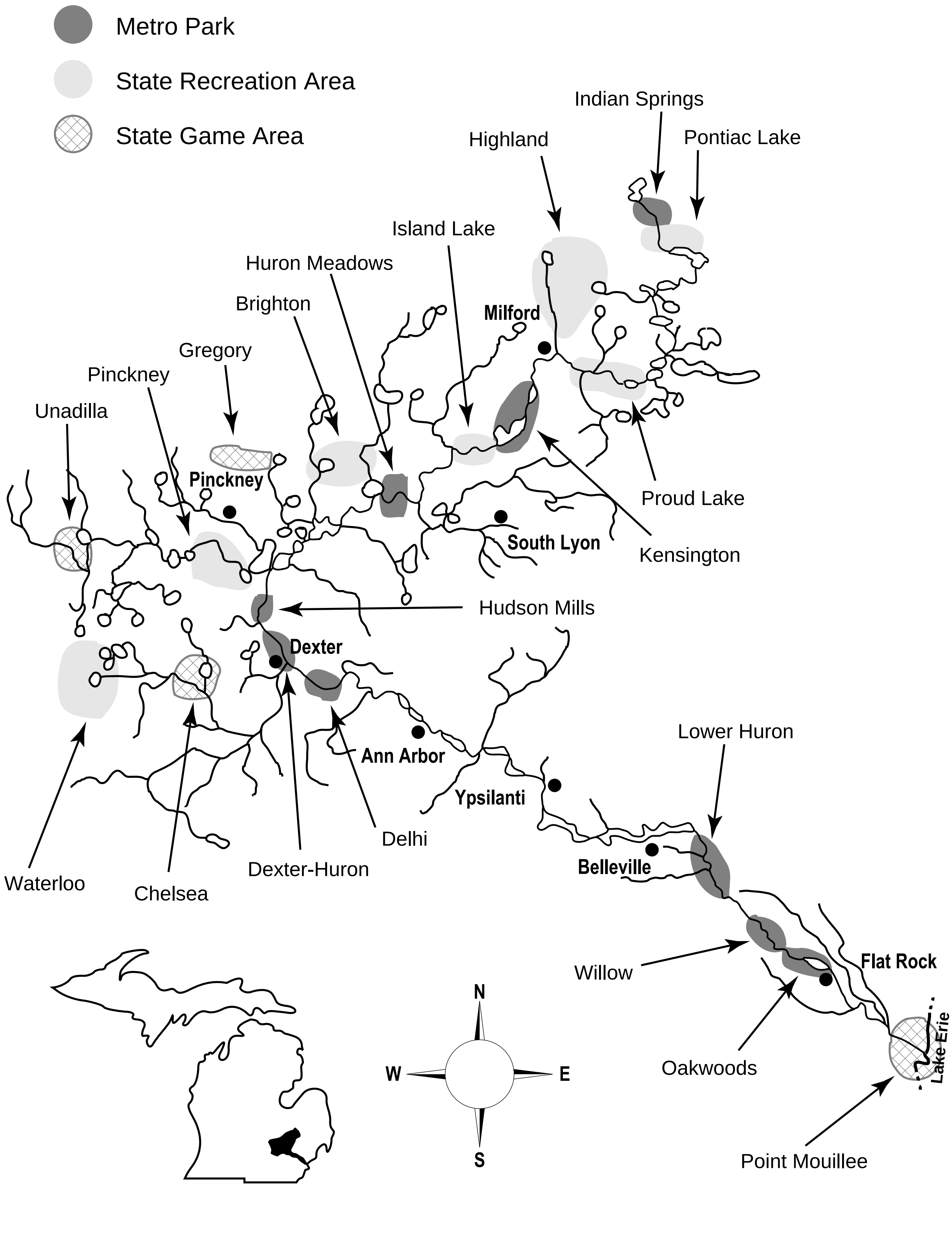


Figure 20.—State of Michigan and Huron-Clinton Metropolitan Authority lands in the Huron River watershed.

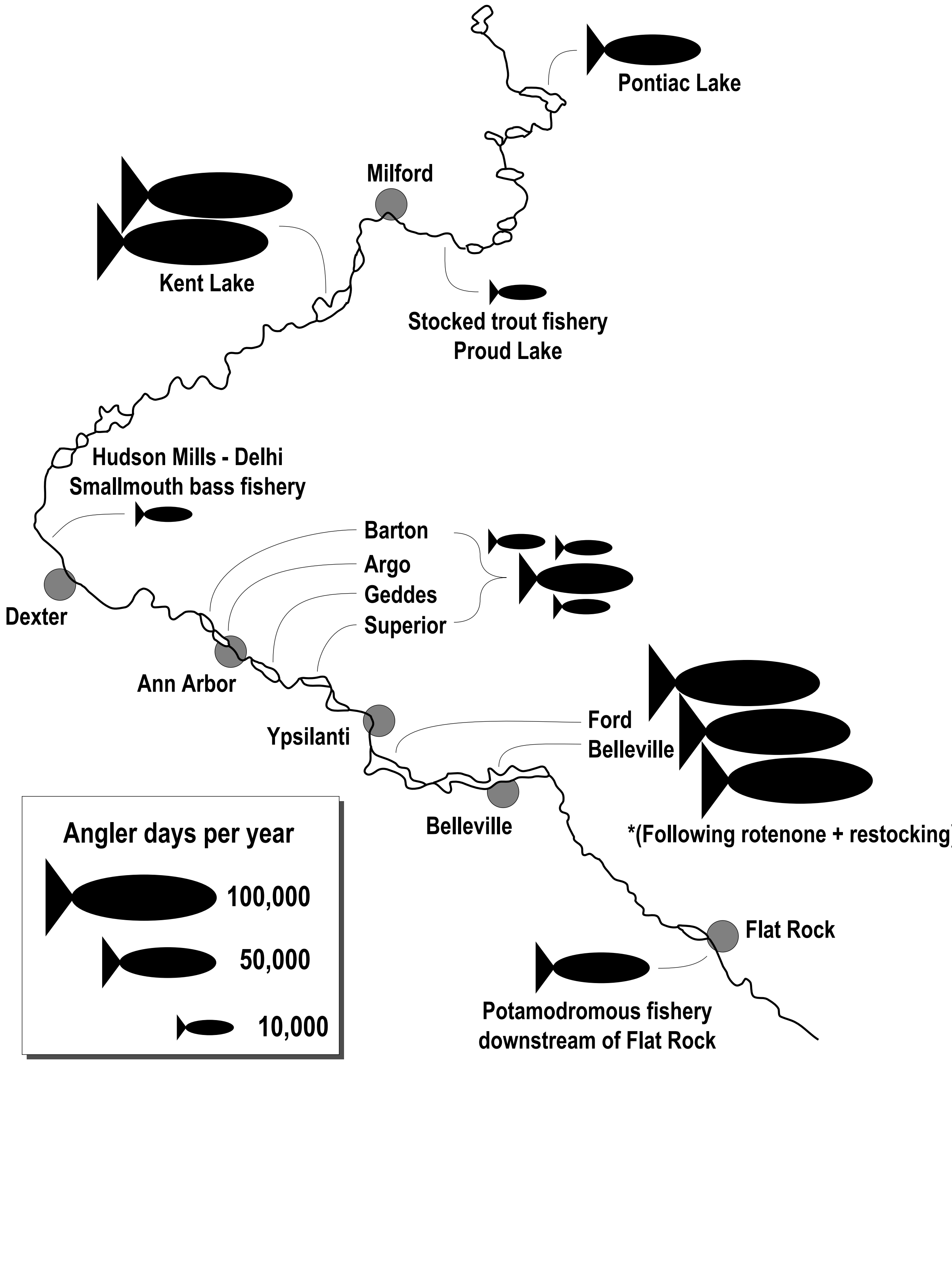


Figure 21.—Fishing pressure along the Huron River. Data from Michigan Department of Natural Resources, Fisheries Division, creel census.

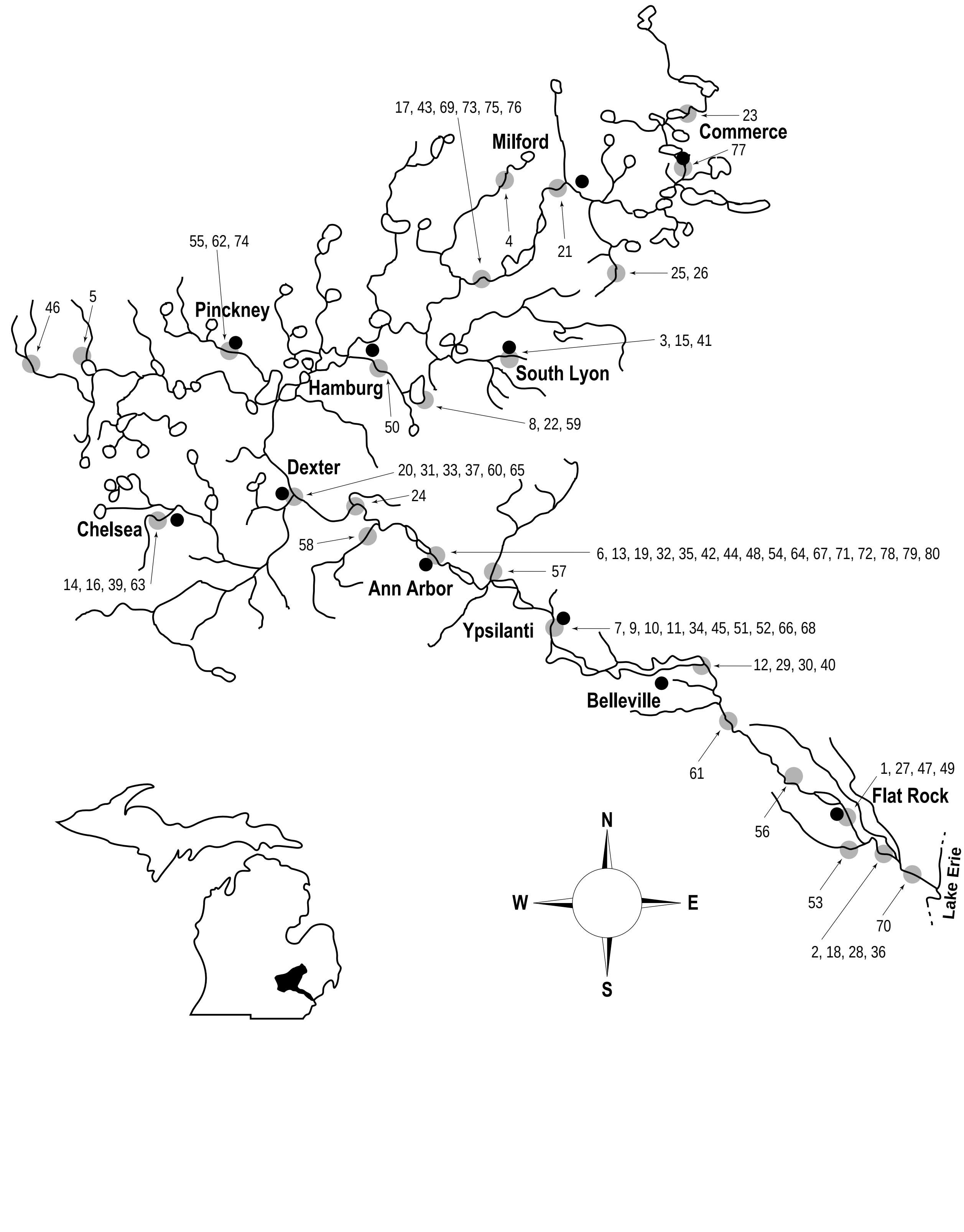


Figure 22.—Locations of point source discharges subject to National Pollution Discharge Elimination System (NPDES) permits. Numbers correspond to the companies listed in Table 21.

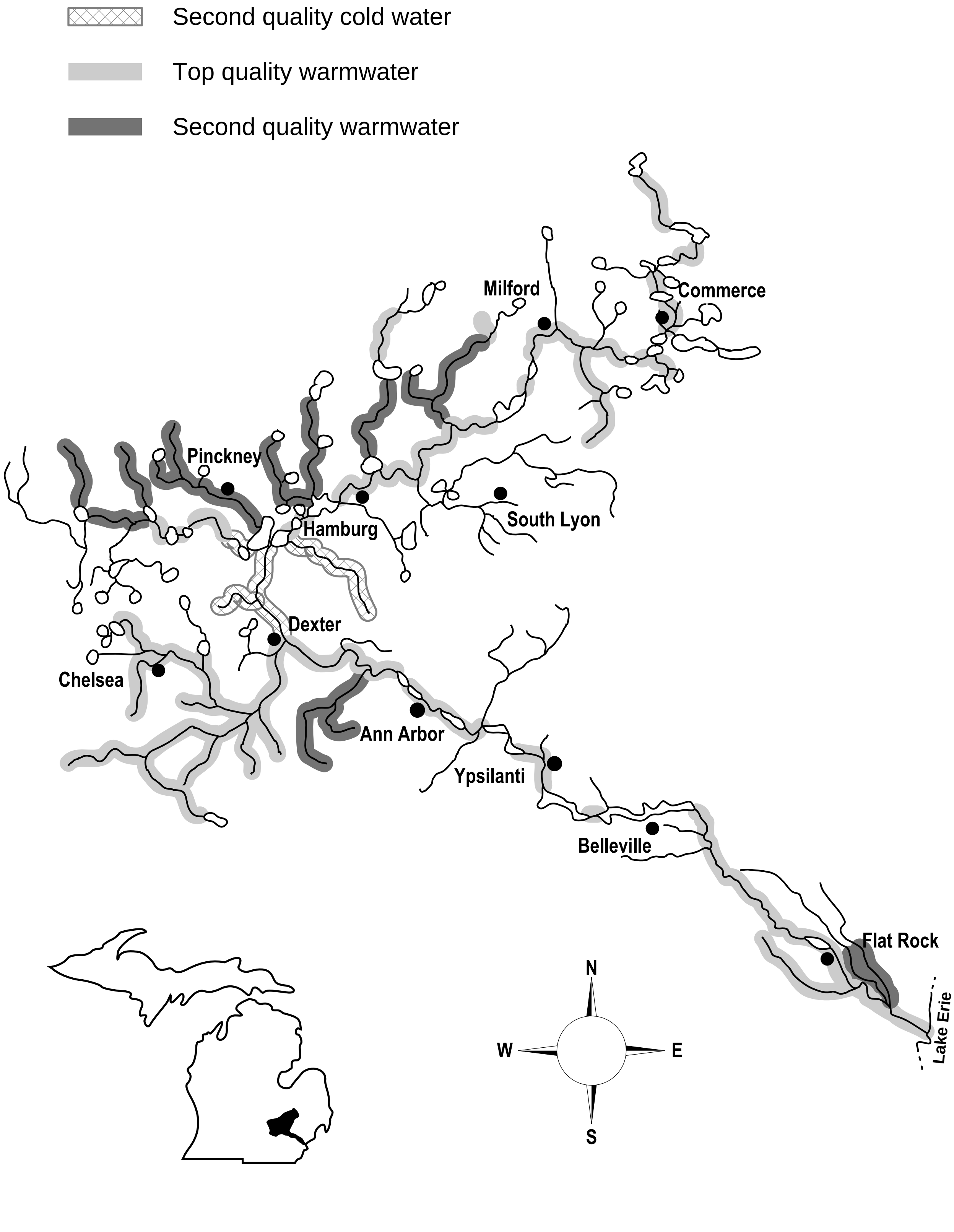


Figure 23.—Fisheries Division, Michigan Department of Natural Resources, stream classifications,

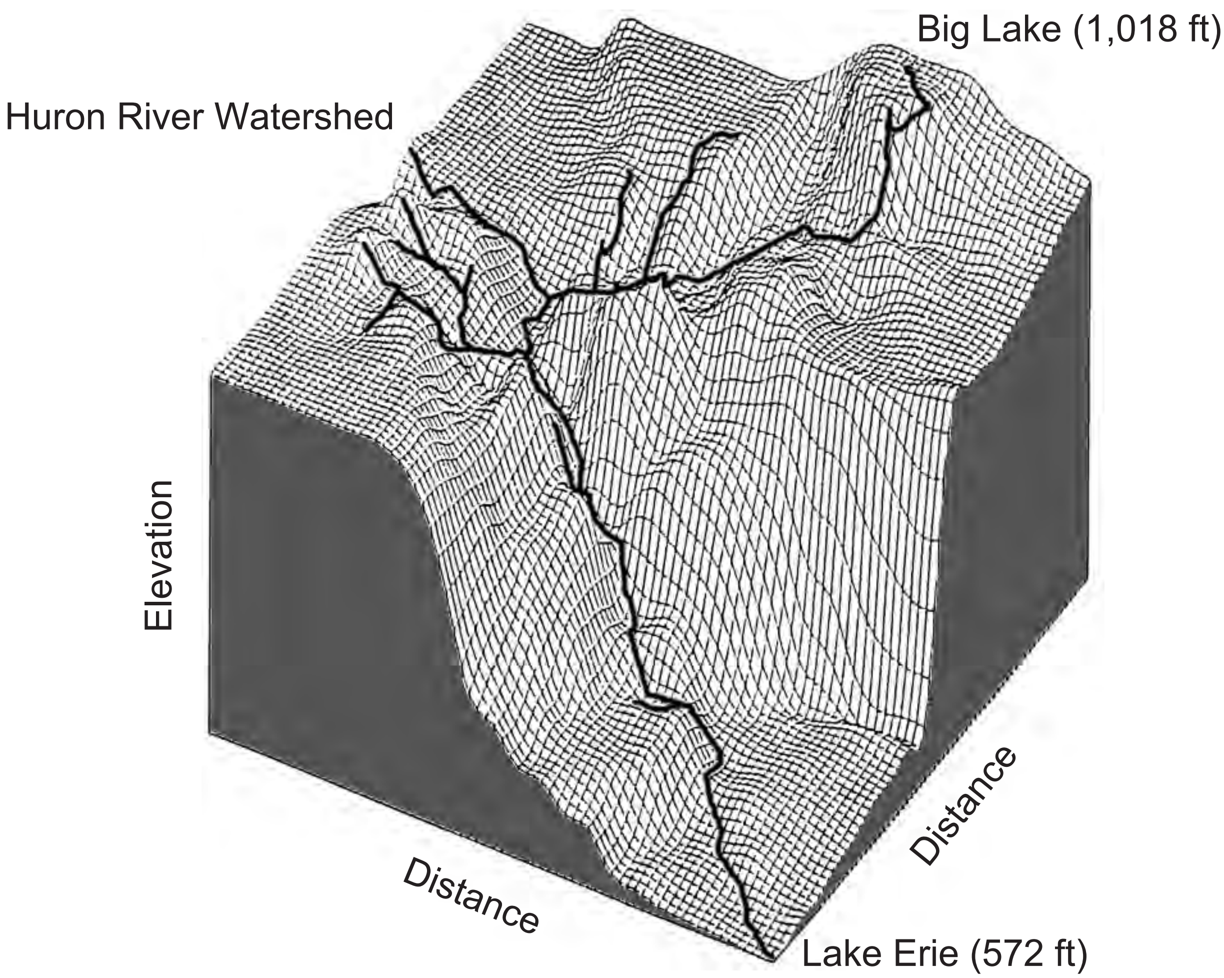
FISHERIES DIVISION

SPECIAL REPORT

Number 16 April, 1995

Huron River Assessment Appendix

E. M. Hay-Chmielewski
Paul W. Seelbach
Gary E. Whelan
Douglas B. Jester Jr.



STATE OF MICHIGAN
DNR DEPARTMENT OF NATURAL RESOURCES

MICHIGAN DEPARTMENT OF NATURAL RESOURCES
FISHERIES DIVISION

Fisheries Special Report No. 16
April, 1995

HURON RIVER ASSESSMENT
APPENDIX

E. M. Hay-Chmielewski
Paul W. Seelbach
Gary E. Whelan
Douglas B. Jester Jr.

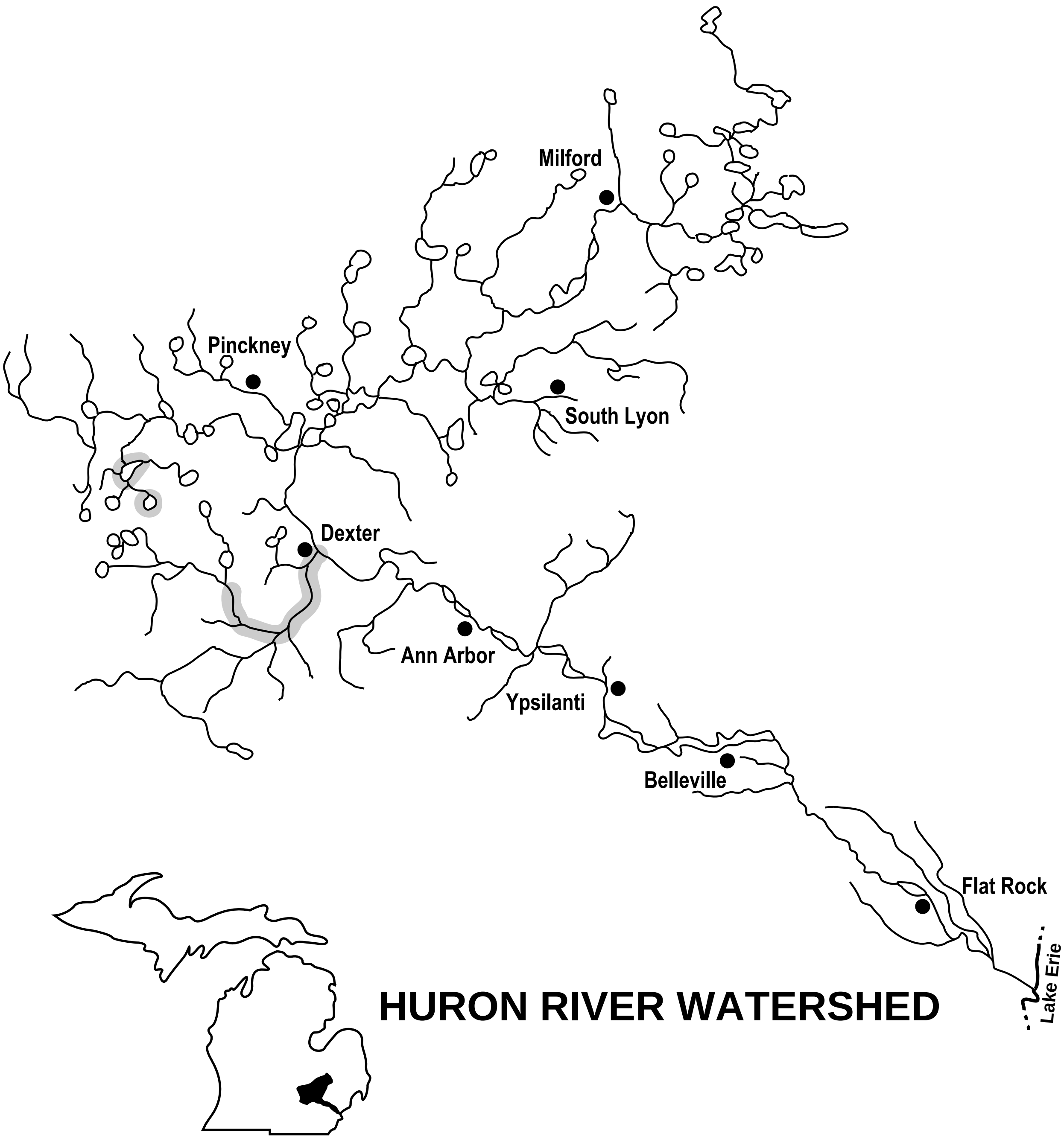
COVER: A three dimensional drawing of the area containing the Huron River watershed. It shows how the water flows from the headwaters down the landscape, gathering the contributions from the tributaries, to Lake Erie. The figure is an adaptation of a drawing provided by the Huron River Watershed Council, Ann Arbor.

Northern brook lamprey (*Ichthyomyzon fossor*) - rare

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



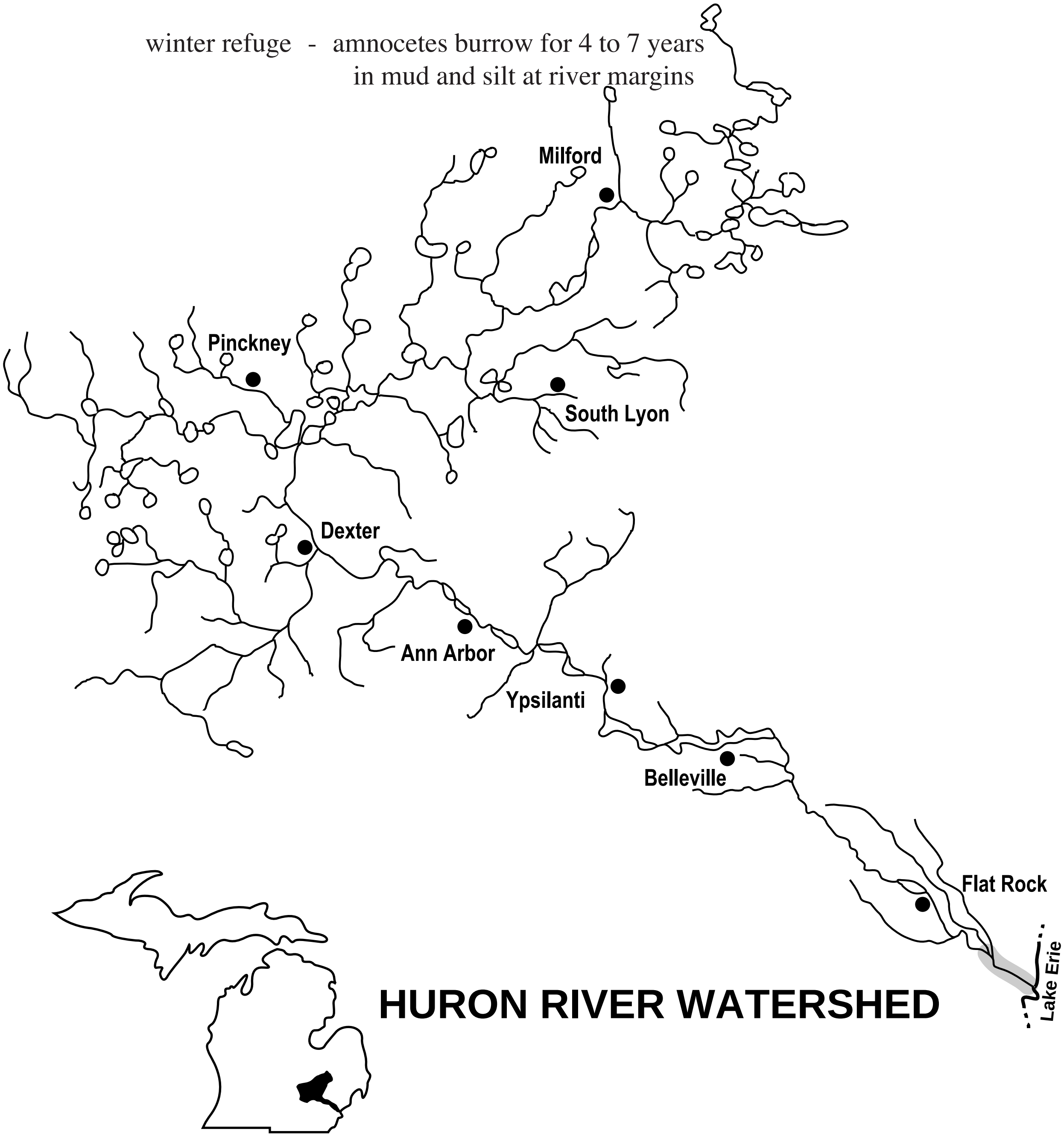
Silver lamprey (*Ichthyomyzon unicuspis*) - rare

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



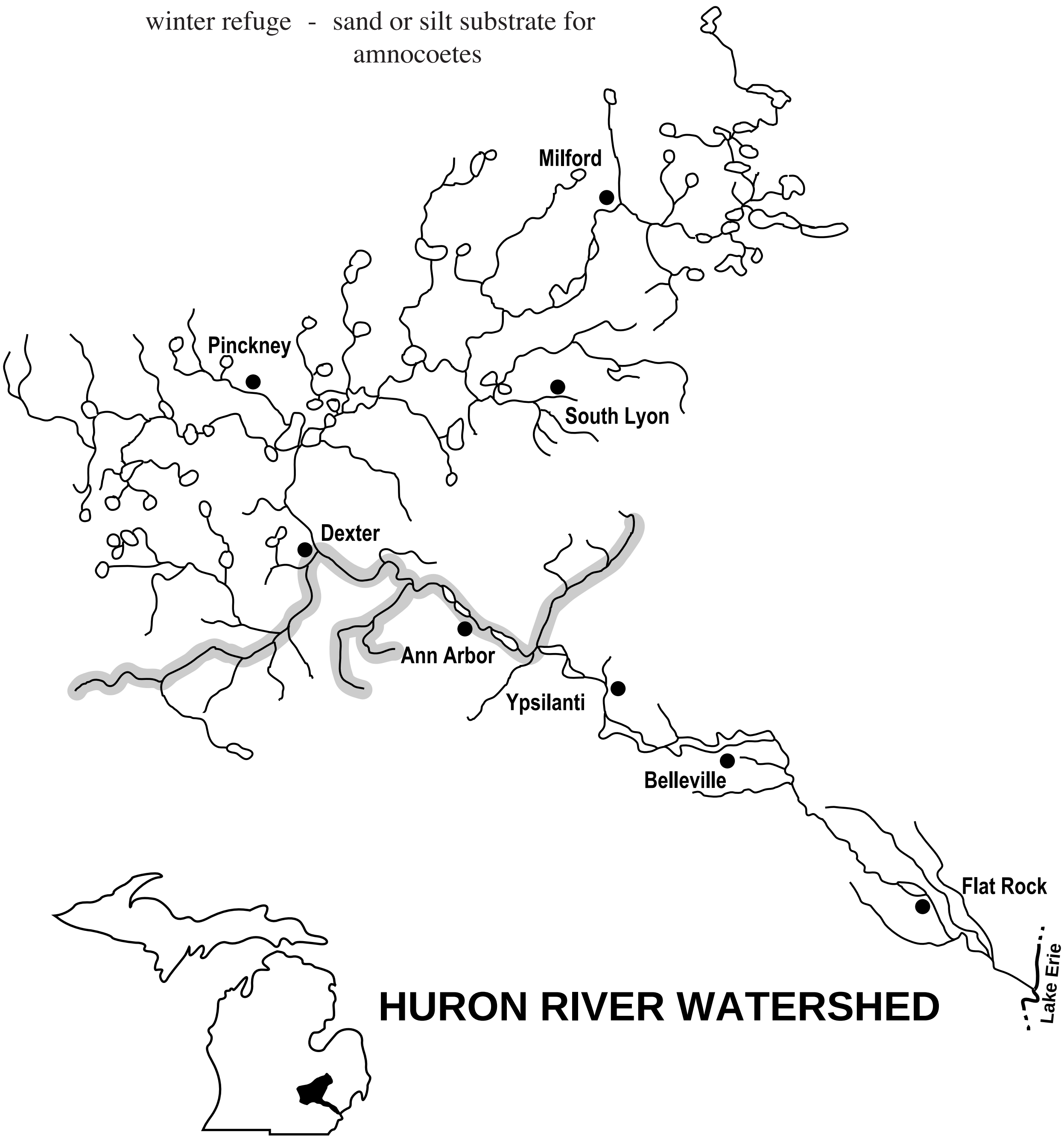
American brook lamprey (*Lampetra appendix*)

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

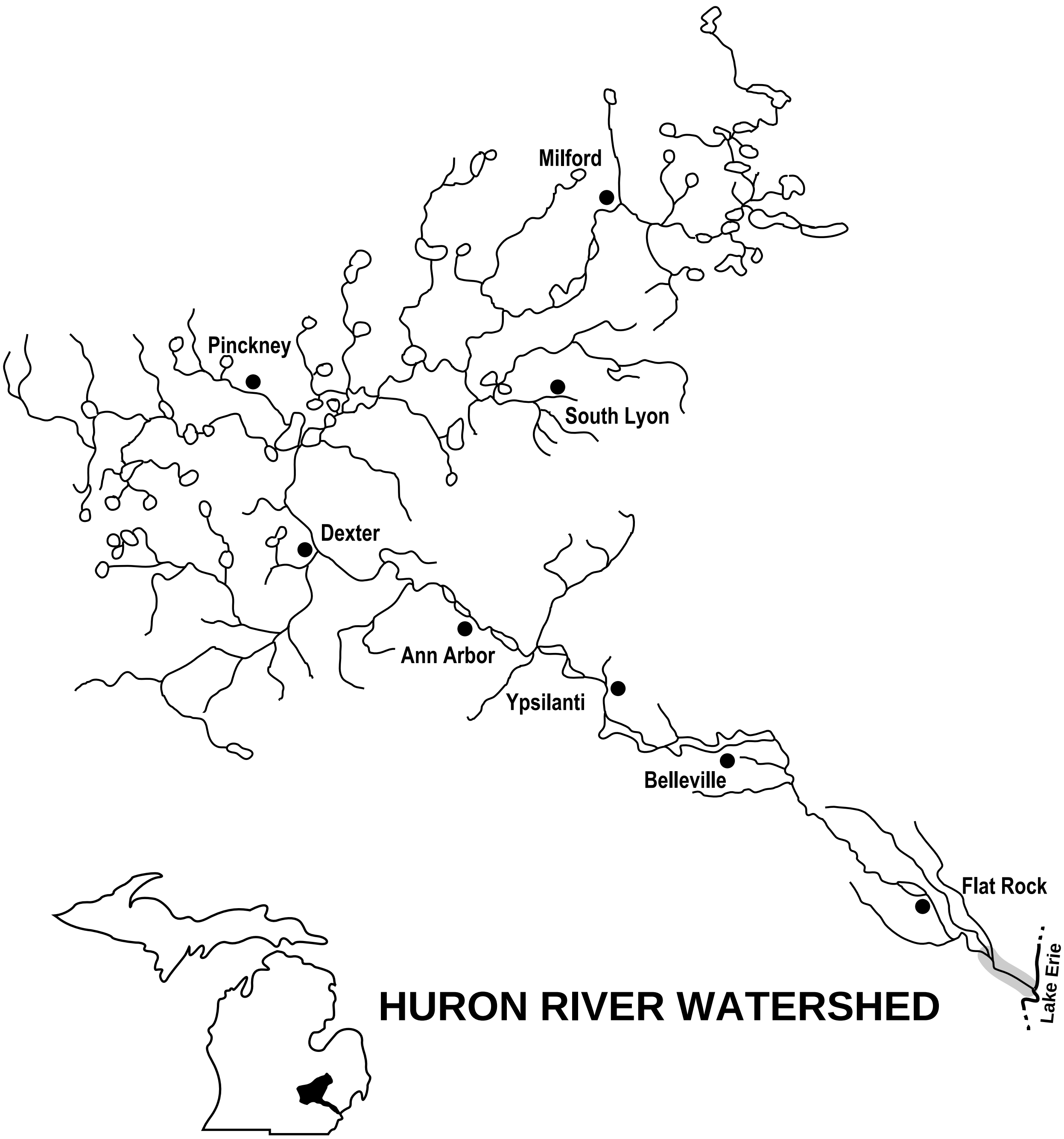


Sea lamprey (*Petromyzon marinus*)

Habitat:

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

spawning - no dams
- riffles with sand and gravel substrates

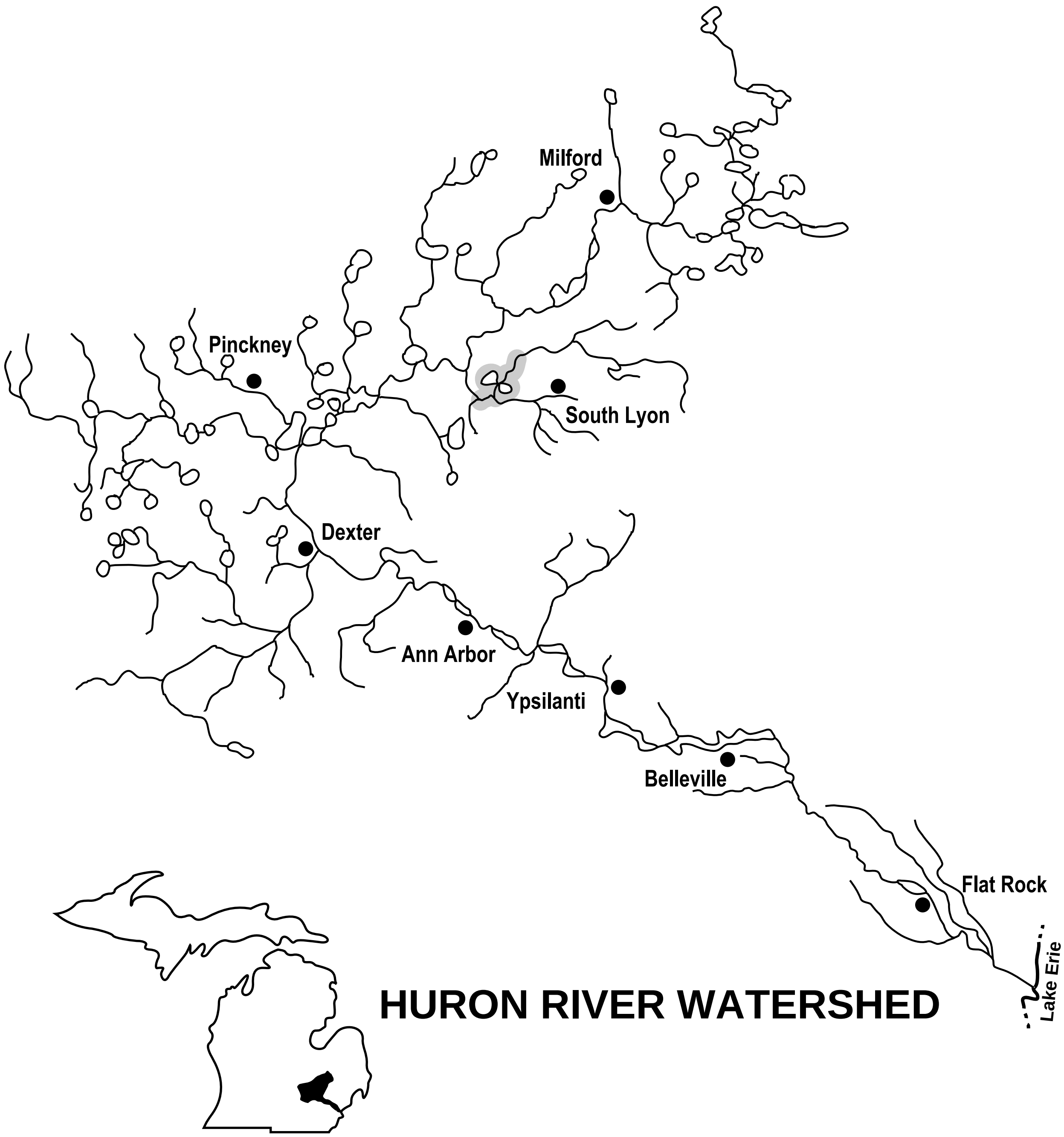


Spotted gar (*Lepisosteus oculatus*) - rare

Habitat:

feeding - quiet clear water in lakes, impoundments, or streams
- aquatic vegetation

spawning - warm shallow water with abundant aquatic vegetation

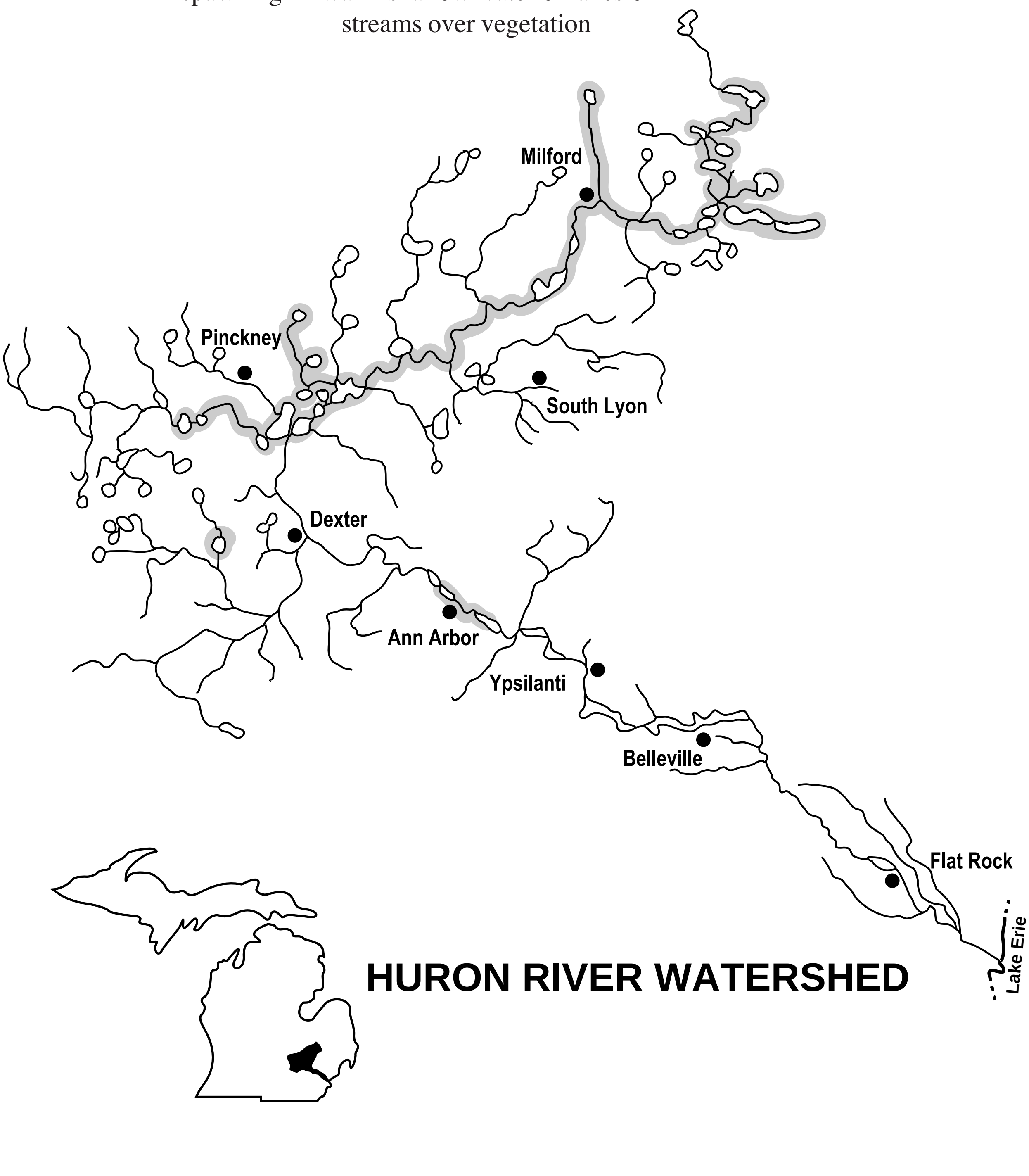


Longnose gar (*Lepisosteus osseus*)

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



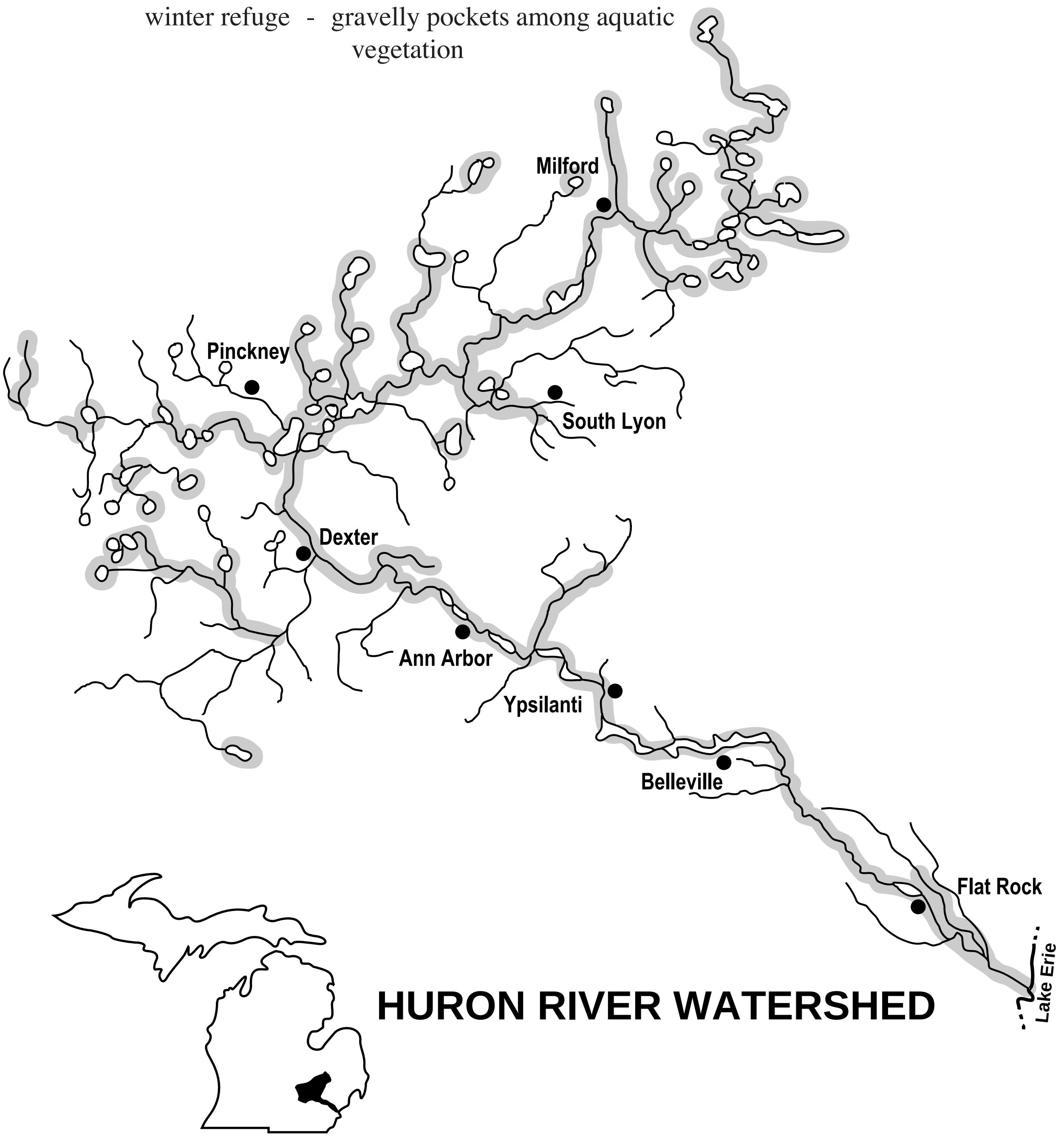
Bowfin (*Amia calva*)

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

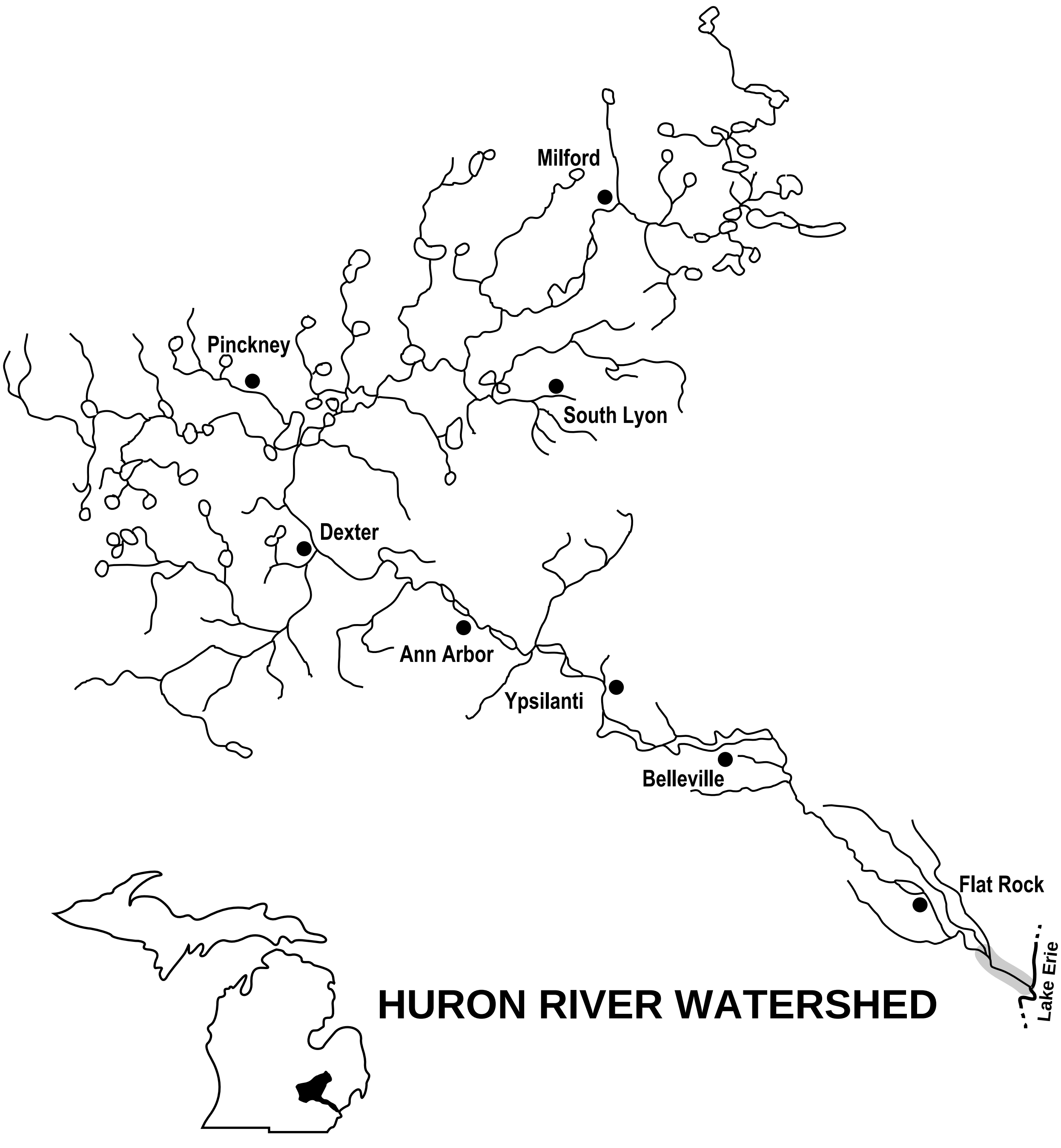
winter refuge - gravelly pockets among aquatic vegetation



Mooneye (*Hiodon tergisus*) - endangered

Habitat:

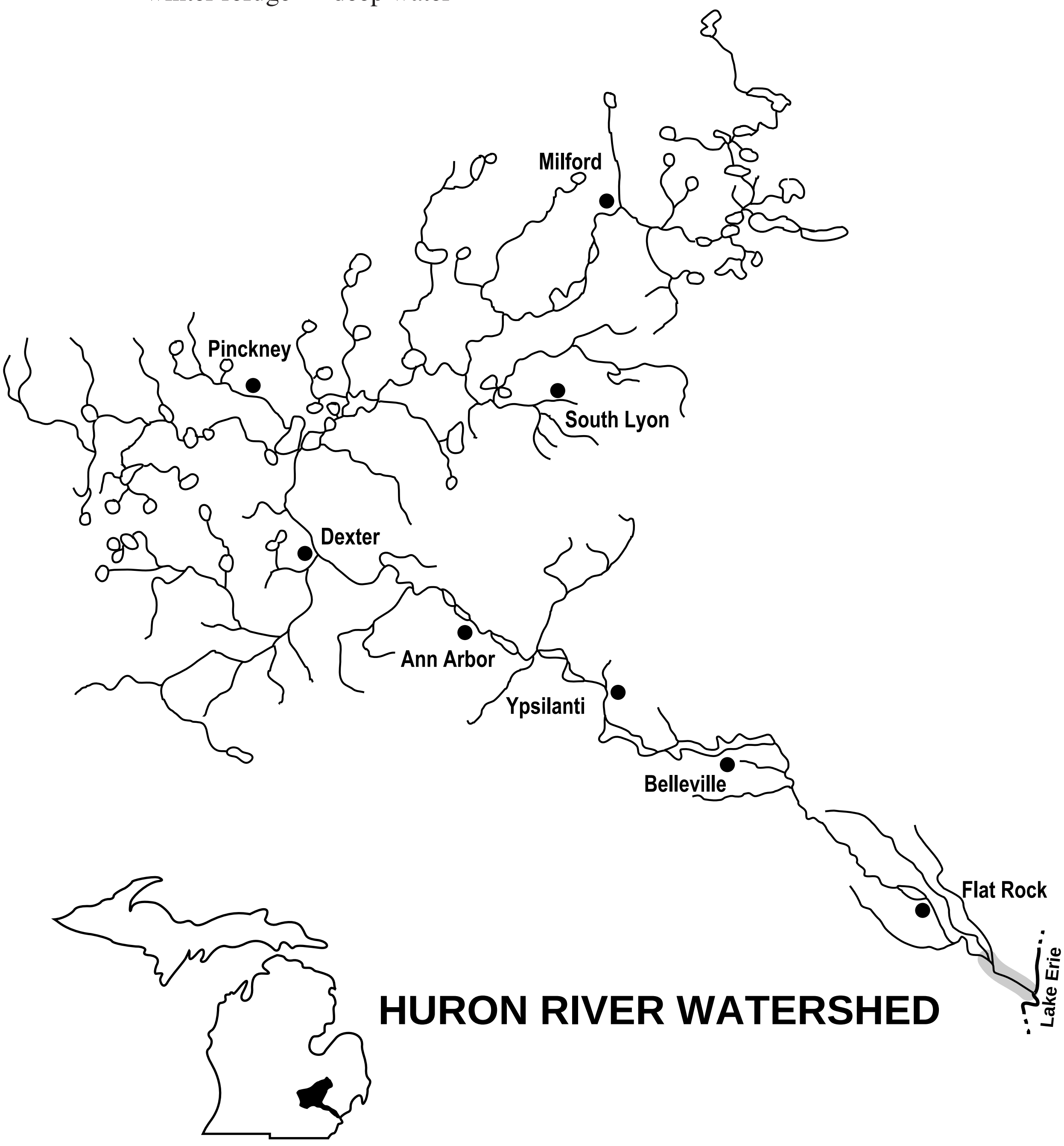
feeding - clear large rivers and Lake Erie
- feeds in swift water
- grows in non-flowing water



Alewife (*Alosa pseudoharengus*)

Habitat:

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

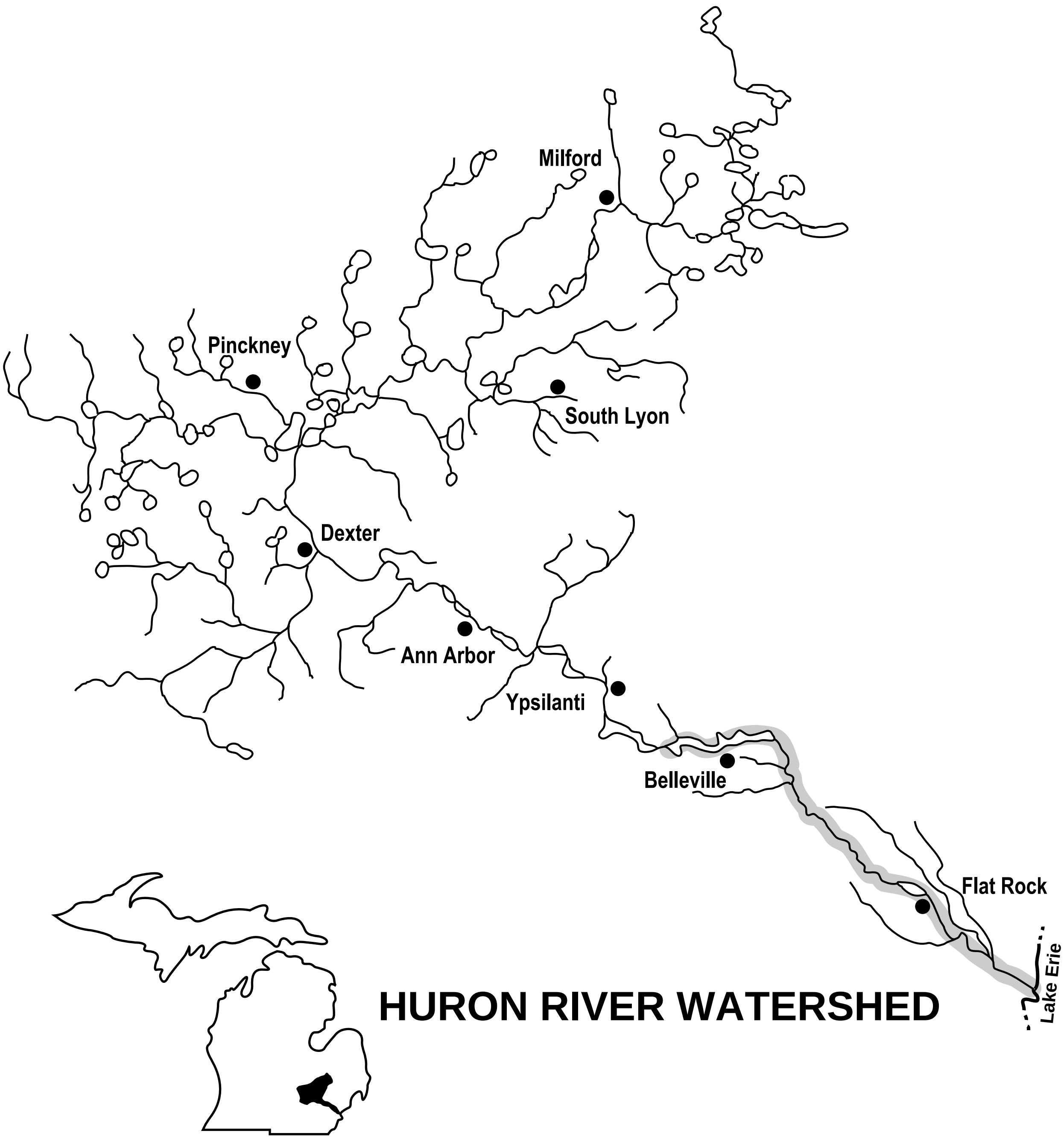


Gizzard shad (*Dorosoma cepedianum*)

Habitat:

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

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

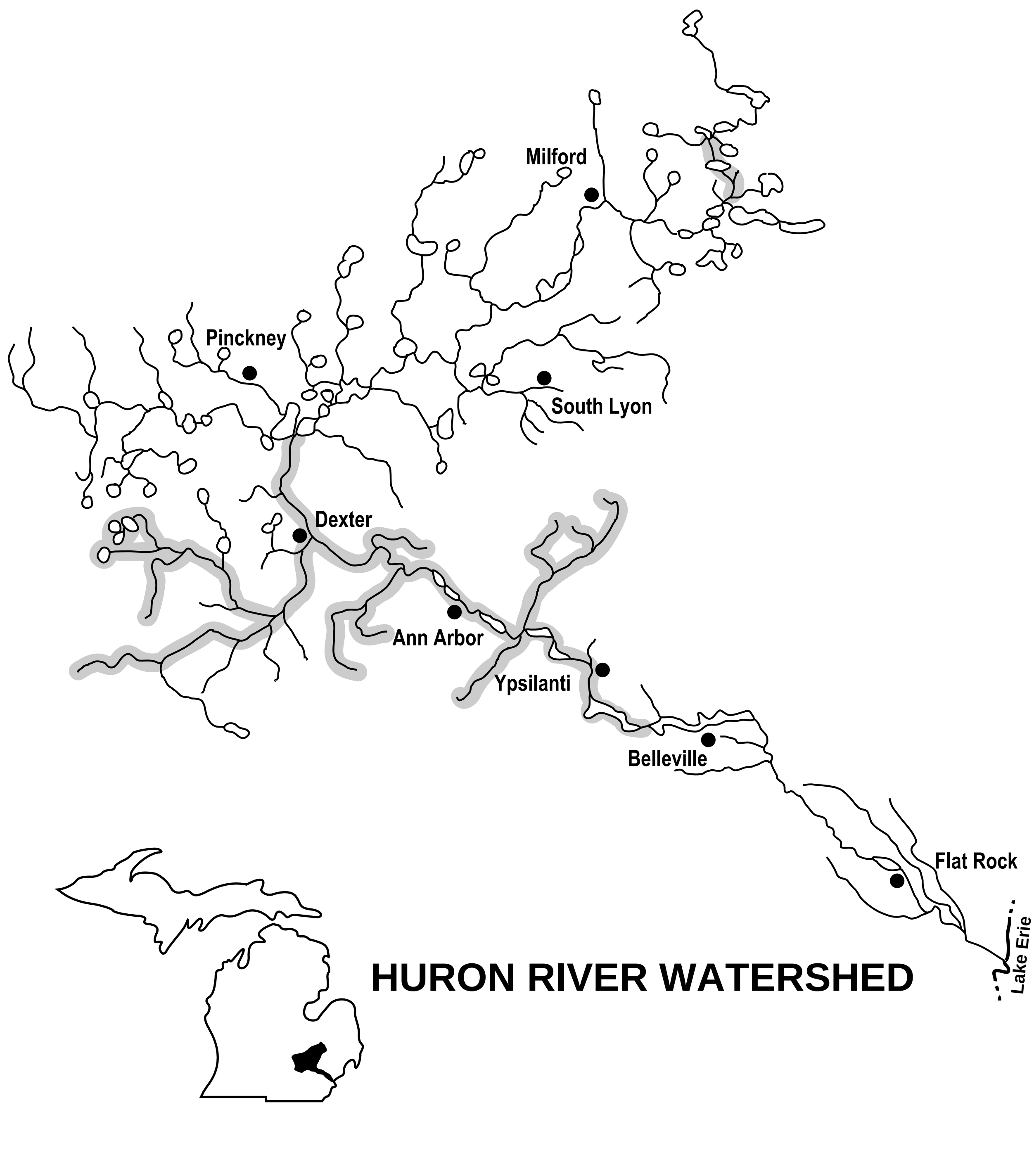


Central stoneroller (*Campostoma anomalum*)

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

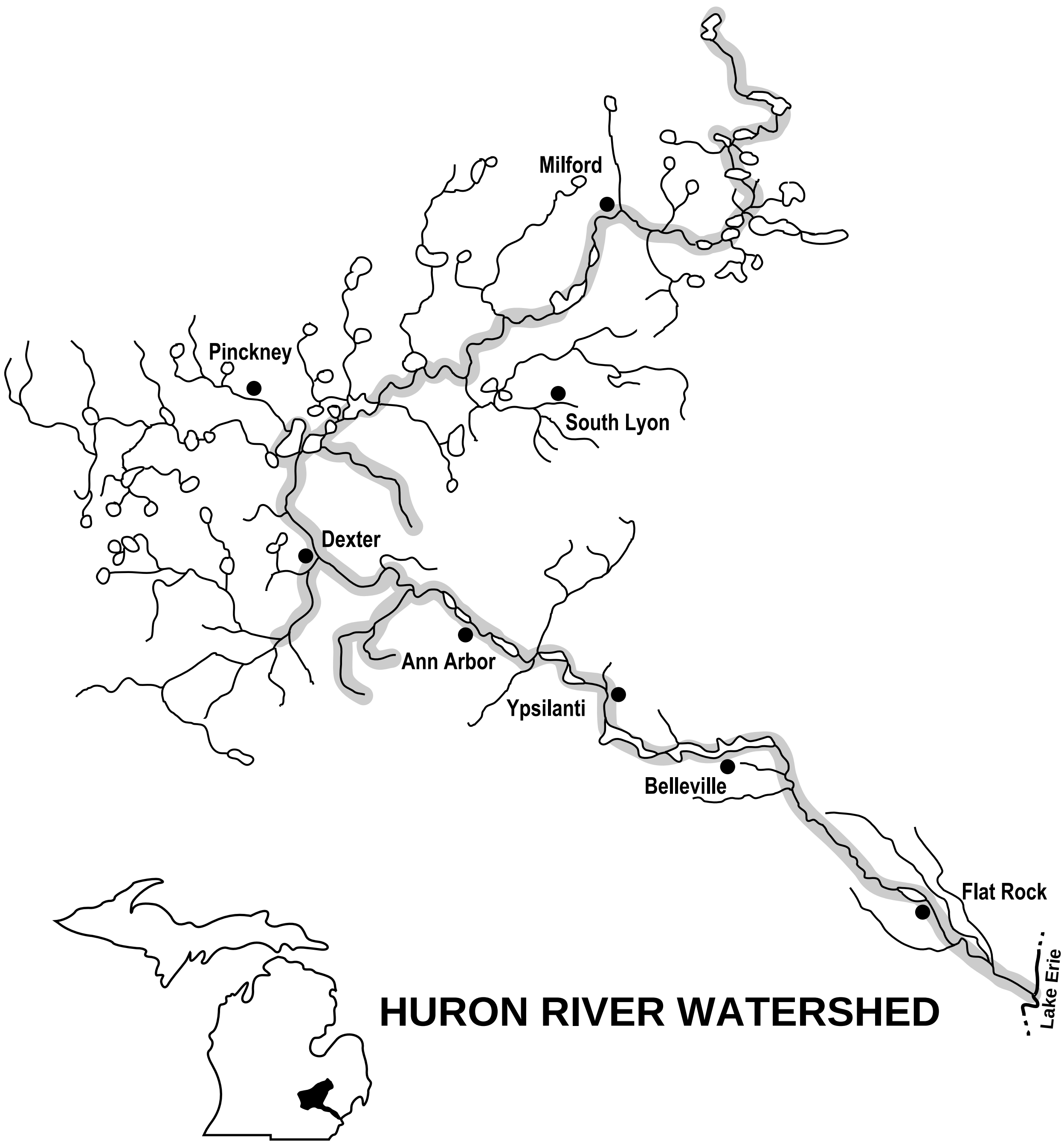


Goldfish (*Carassius auratus*)

Habitat:

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

spawning - warm, weedy shallows

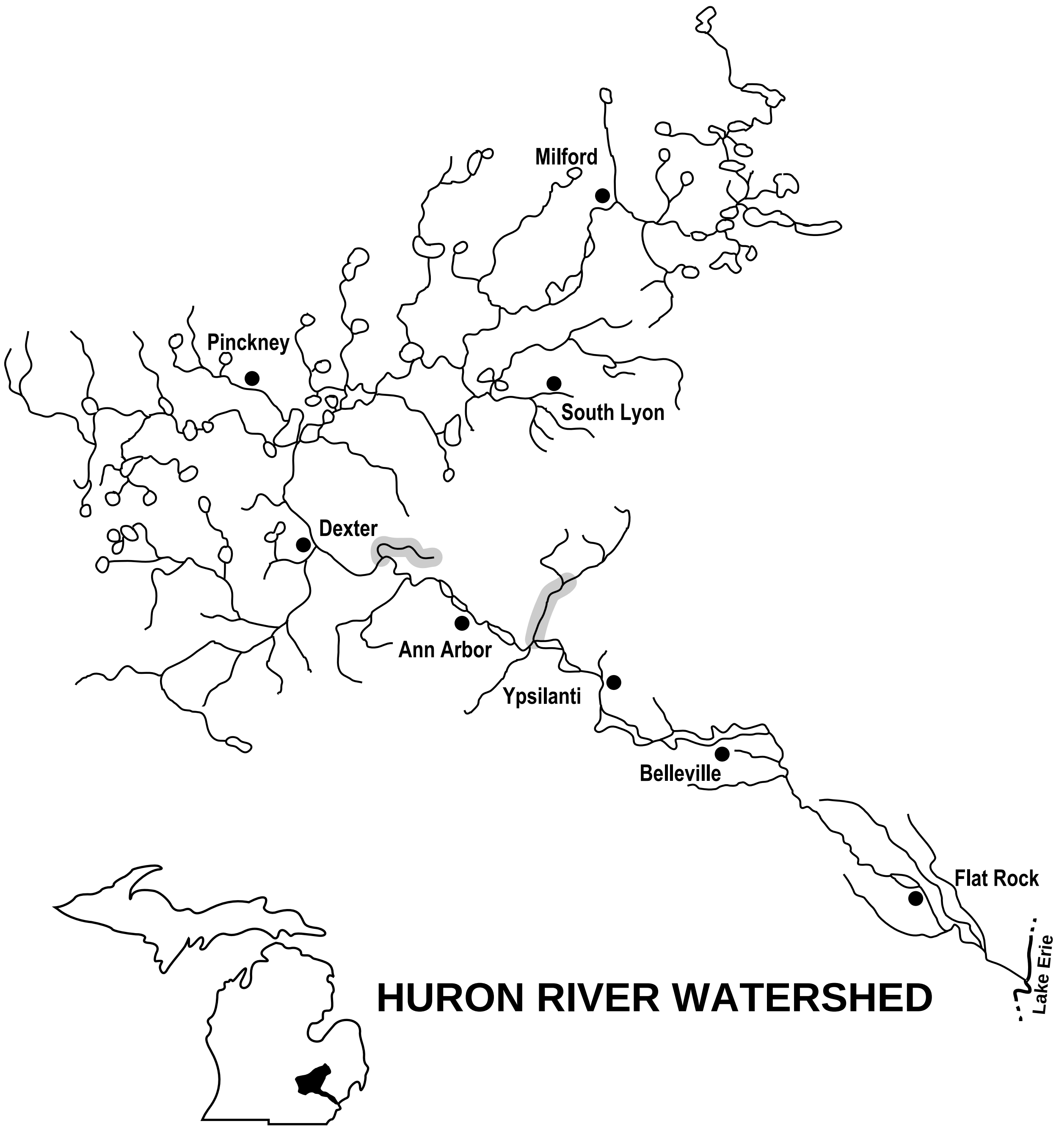


Redside dace (*Clinostomus elongatus*) - rare

Habitat:

feeding - small clear, cooler headwater streams with moderate to high gradient
- overhanging grassy vegetation
- clean sand, gravel, or bedrock substrate
- does not tolerate clayey silt

spawning - uses gravelly nests of creek chub

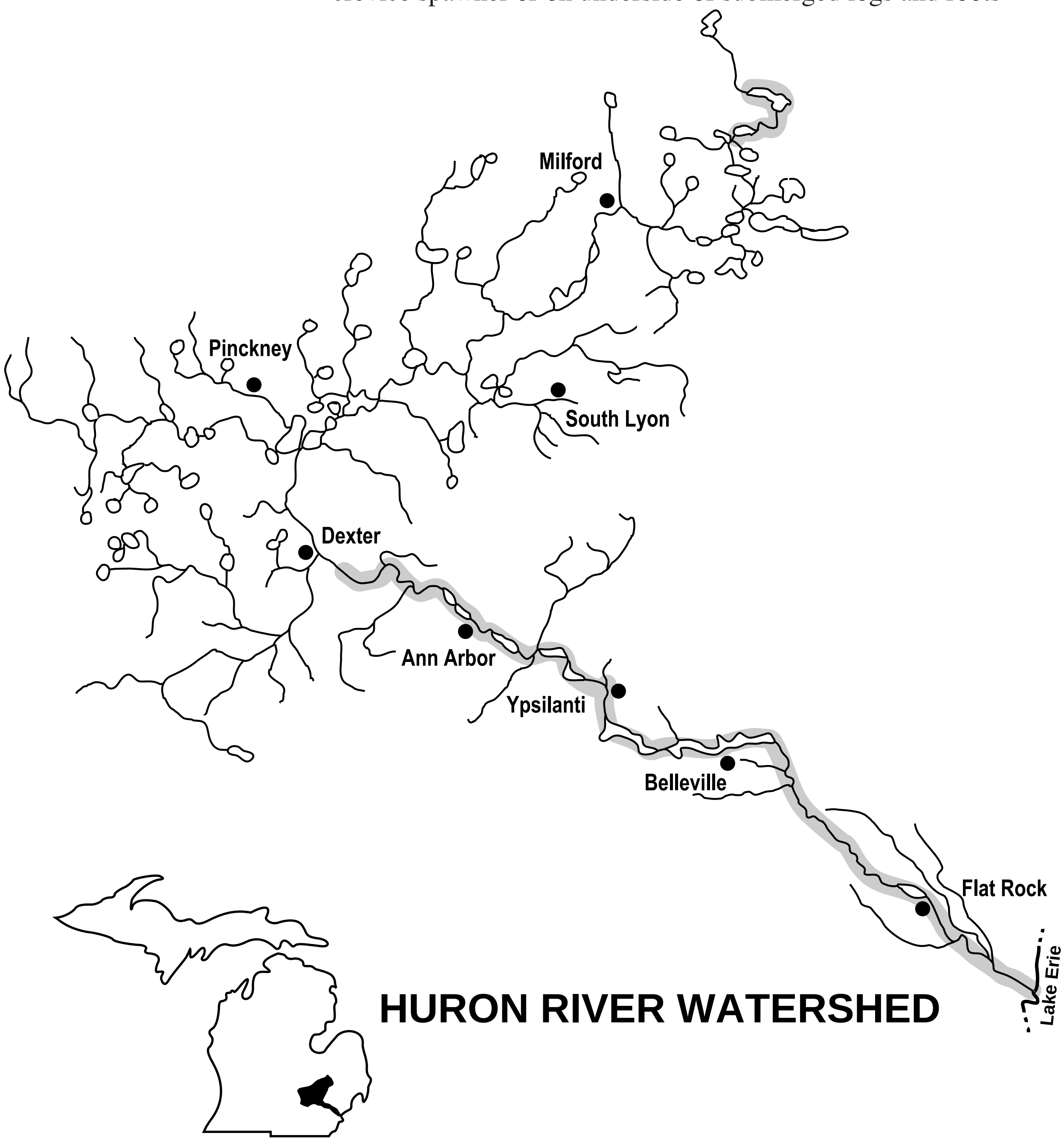


Spotfin shiner (*Cyprinella spiloptera*)

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

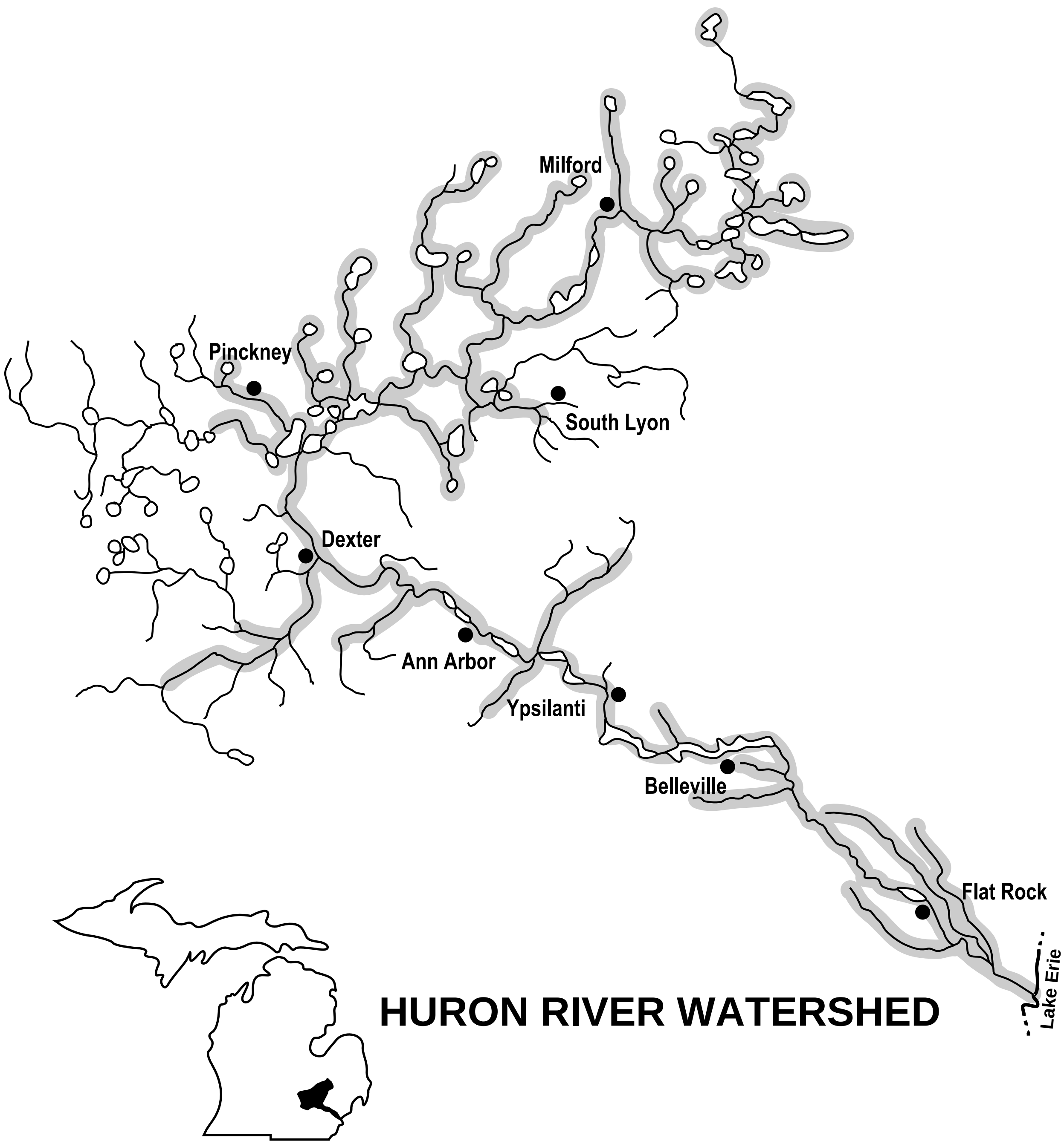


Common carp (*Cyprinus carpio*)

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

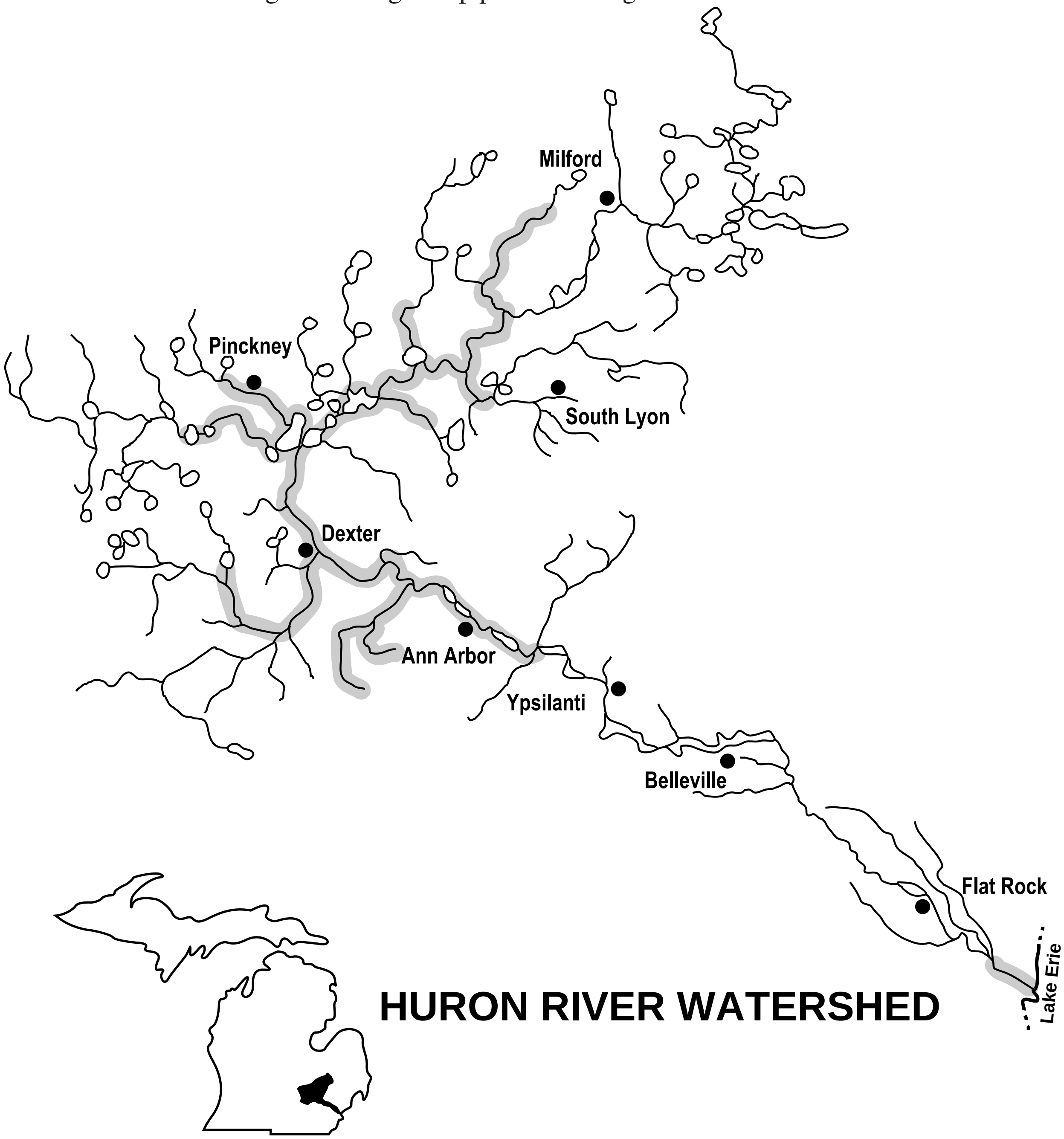
spawning - weedy or grassy shallows



Striped shiner (*Luxilus chrysocephalus*)

Habitat:

feeding	-	clear to slightly turbid streams and rivers
	-	gravel substrate
	-	low gradient
spawning	-	gravel, boulder, bedrock, or sand substrate
	-	clear water in small streams with moderate to high gradient
winter refuge	-	in large deep pools of low gradient rivers

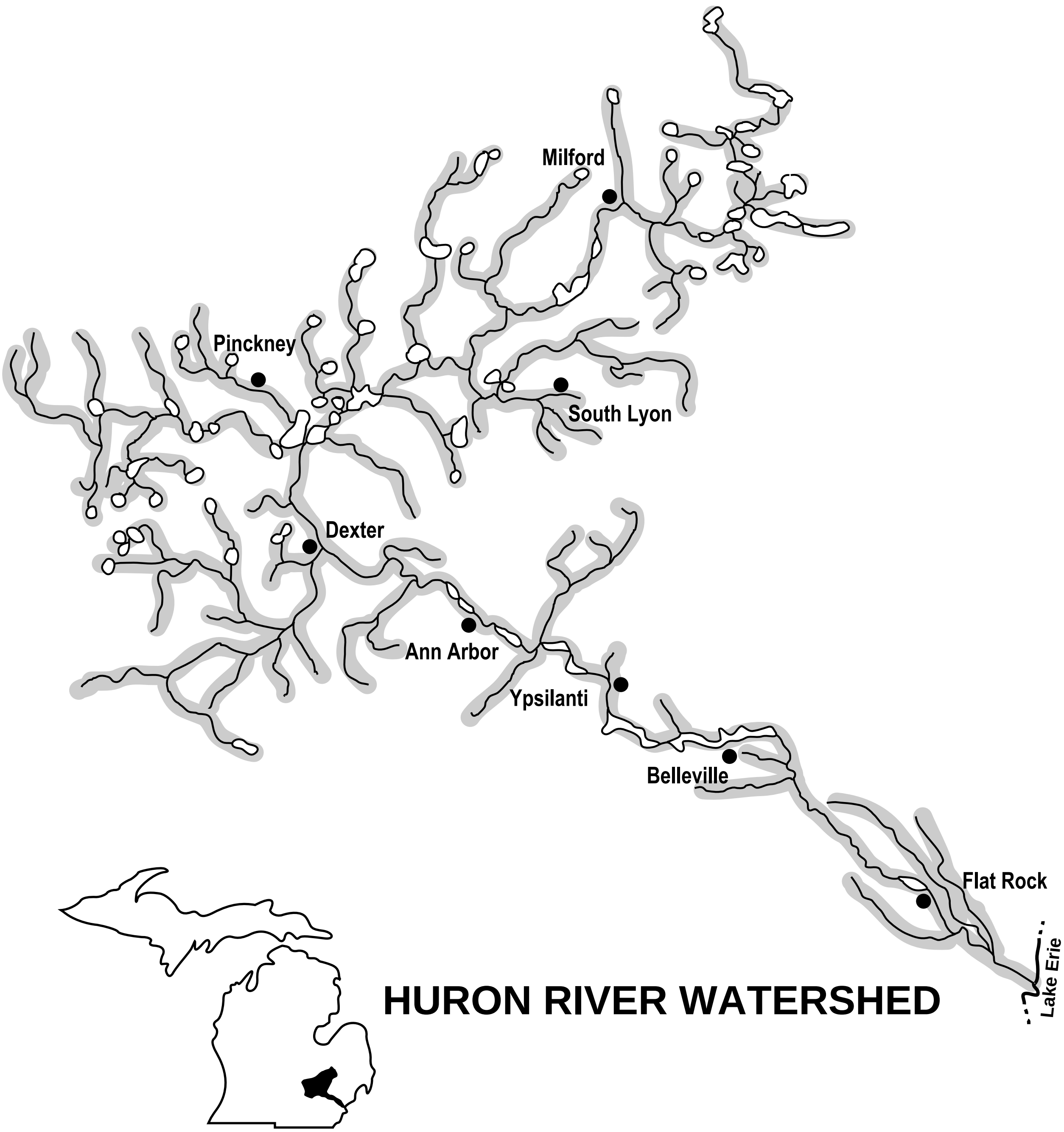


Common shiner (*Luxilus cornutus*)

Habitat:

feeding - small, clear, high-gradient streams and rivers, or shores of clear water lakes and impoundments
- gravel substrate
- can tolerate some submerged aquatic vegetation
- not very tolerant of turbidity or silted waters

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

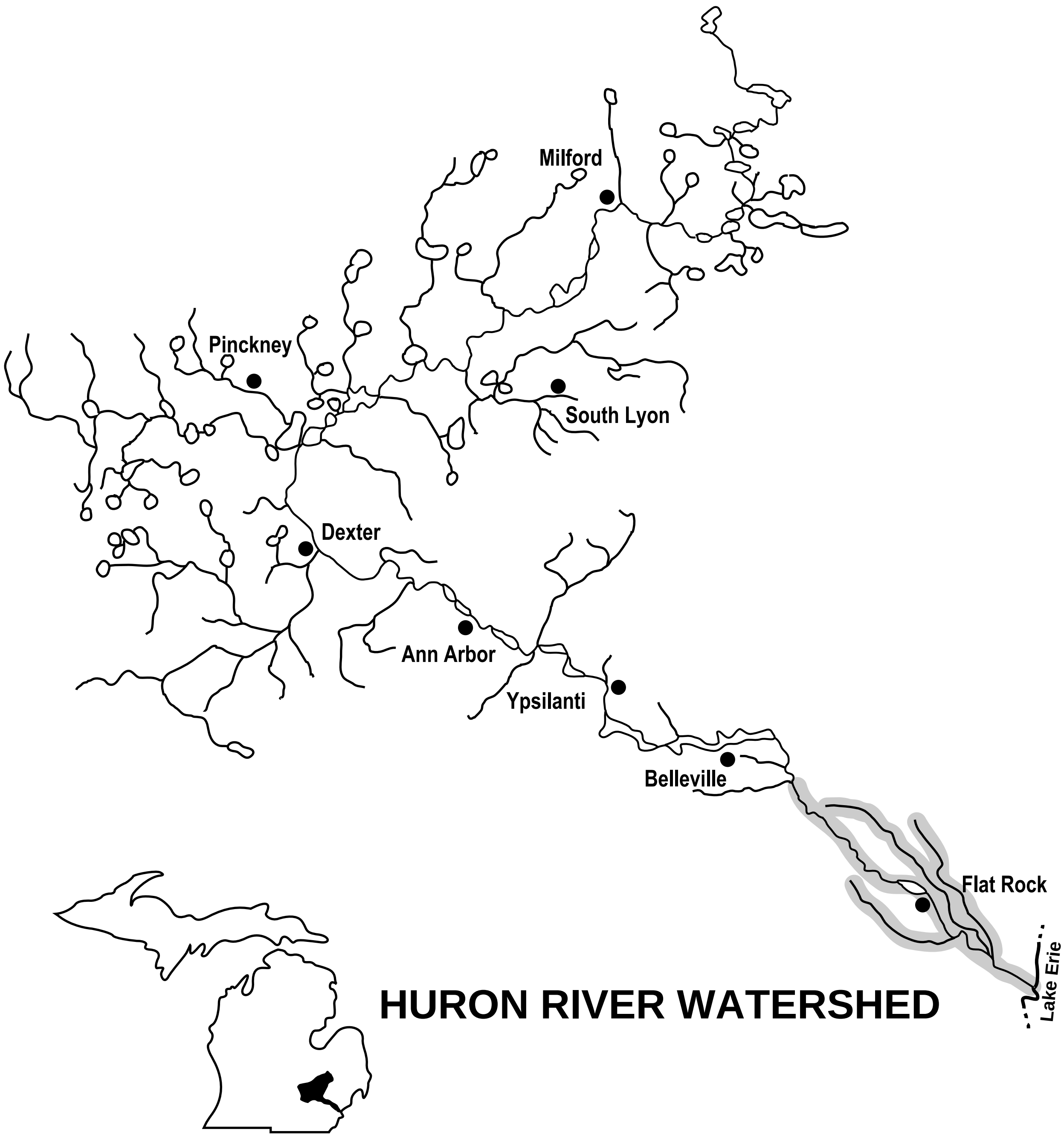


Redfin shiner (*Lythrurus umbratilis*) - rare

Habitat:

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

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

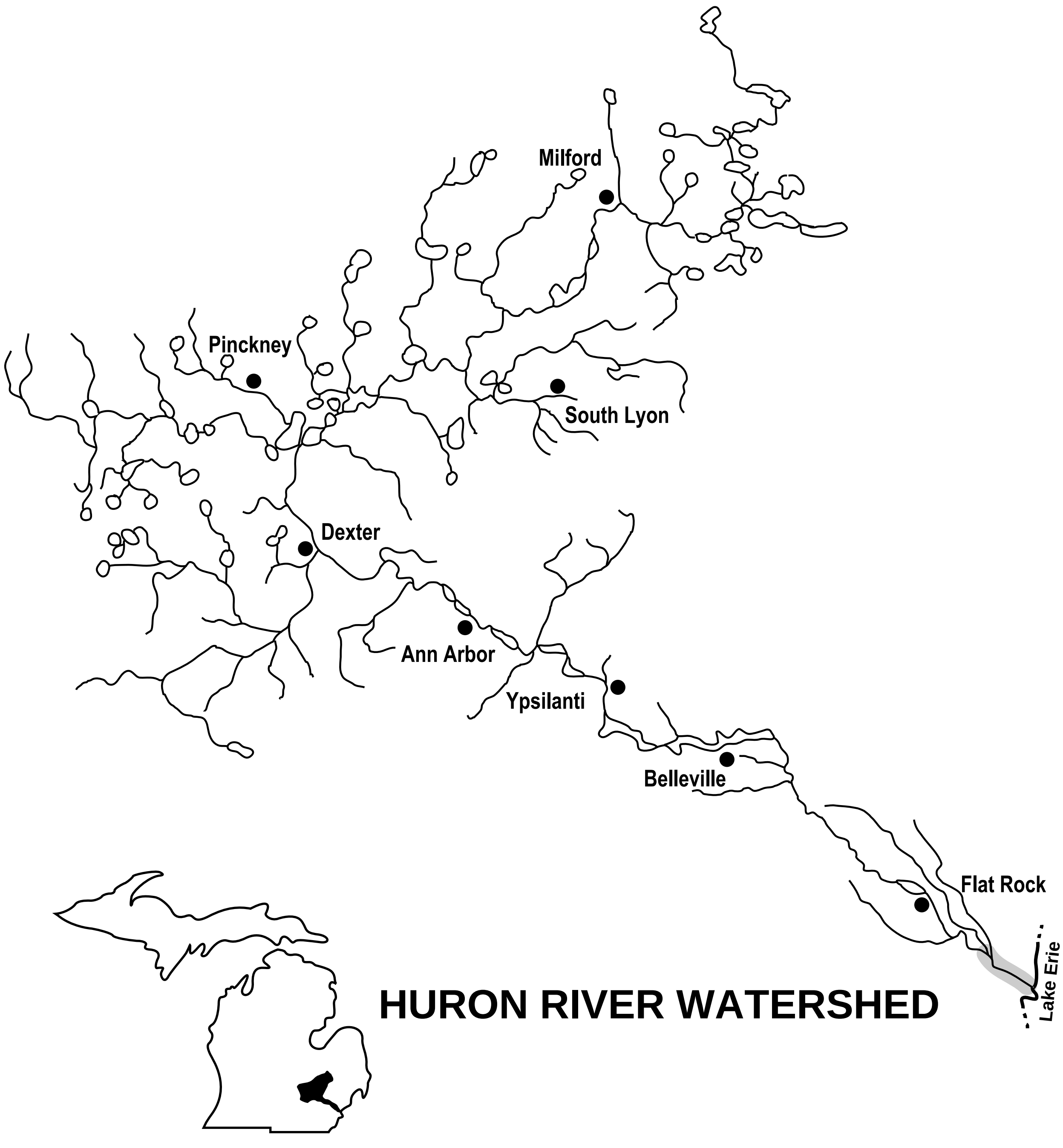


Silver chub (*Macrhybopsis storeriana*) - rare

Habitat:

feeding - large deep rivers with low gradient
- clean gravel or sand substrate
- cannot tolerate turbidity or silt

spawning - thought to occur in open water

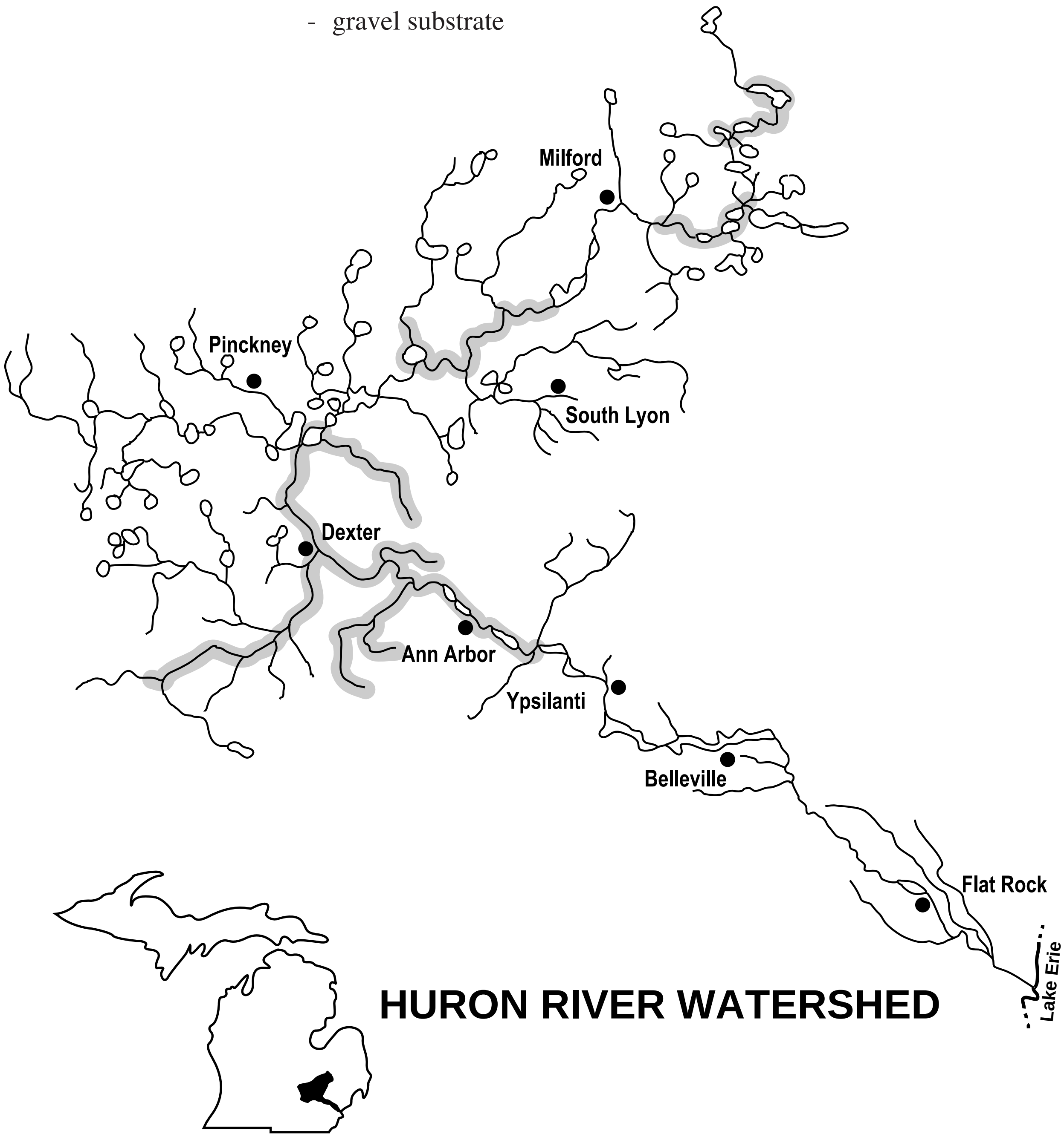


Hornyhead chub (*Nocomis biguttatus*)

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

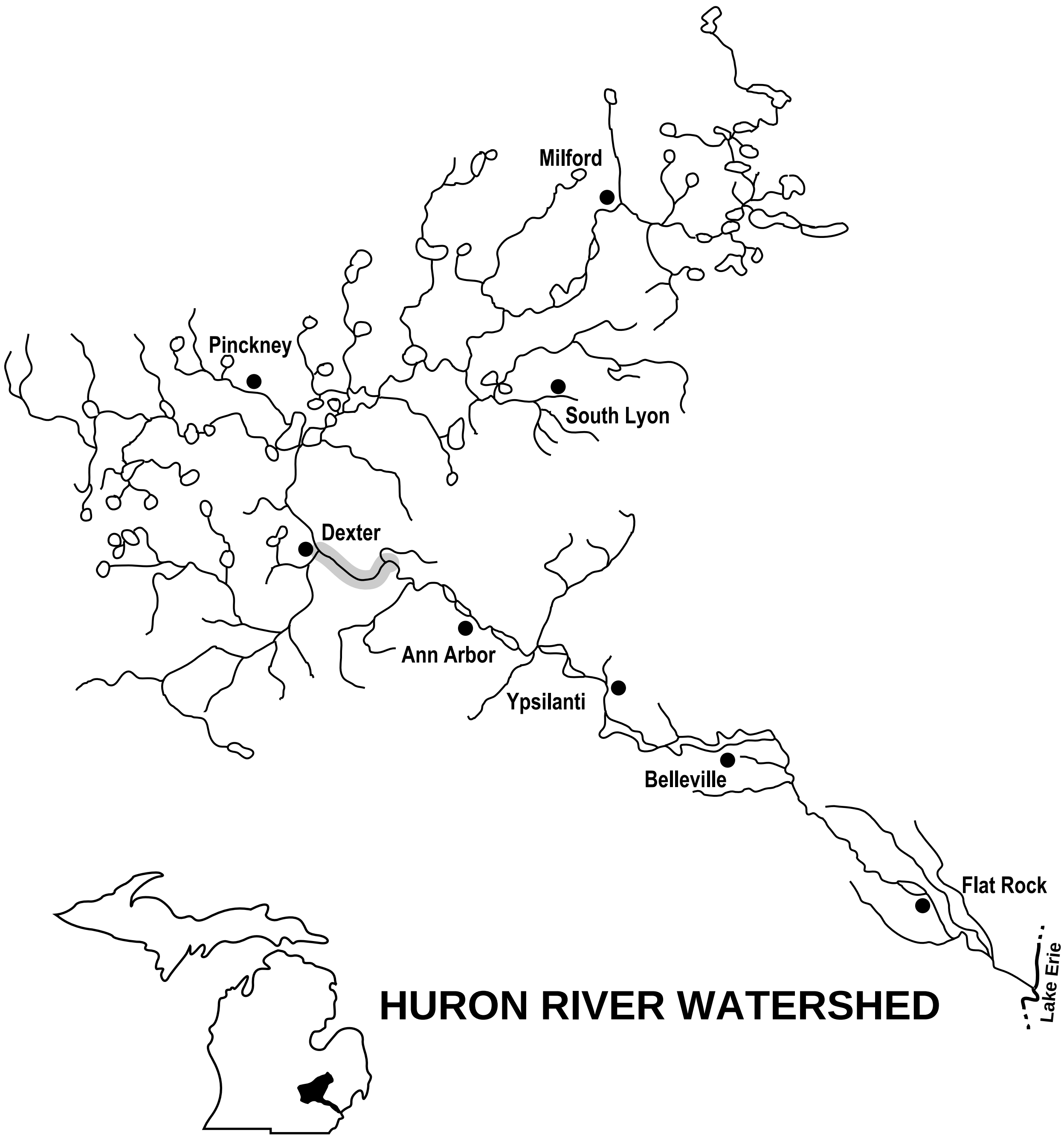
spawning
- large stones and pebbles present
- often below a riffle in shallow water
- gravel substrate



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

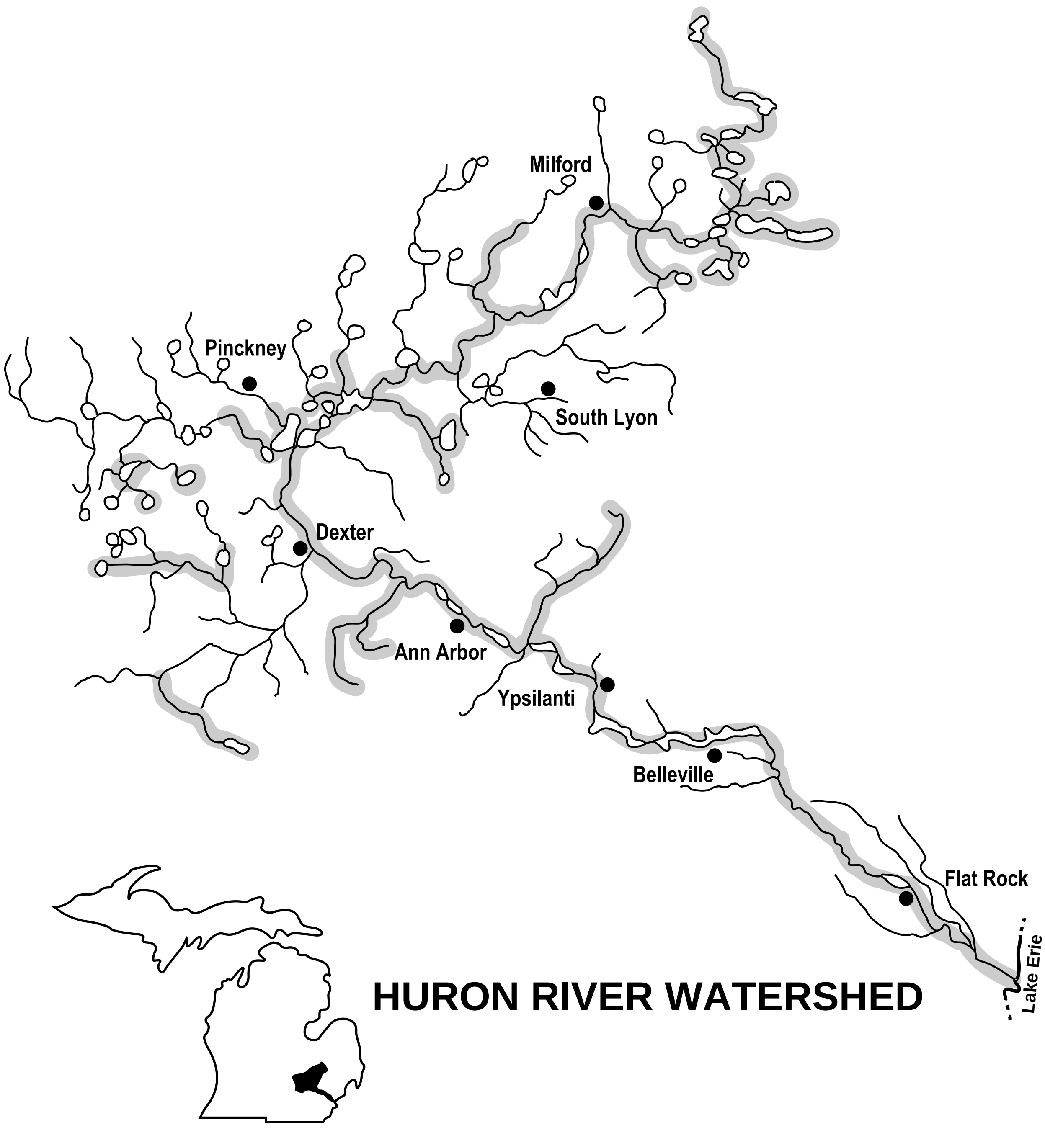


Golden shiner (*Notemigonus crysoleucas*)

Habitat:

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

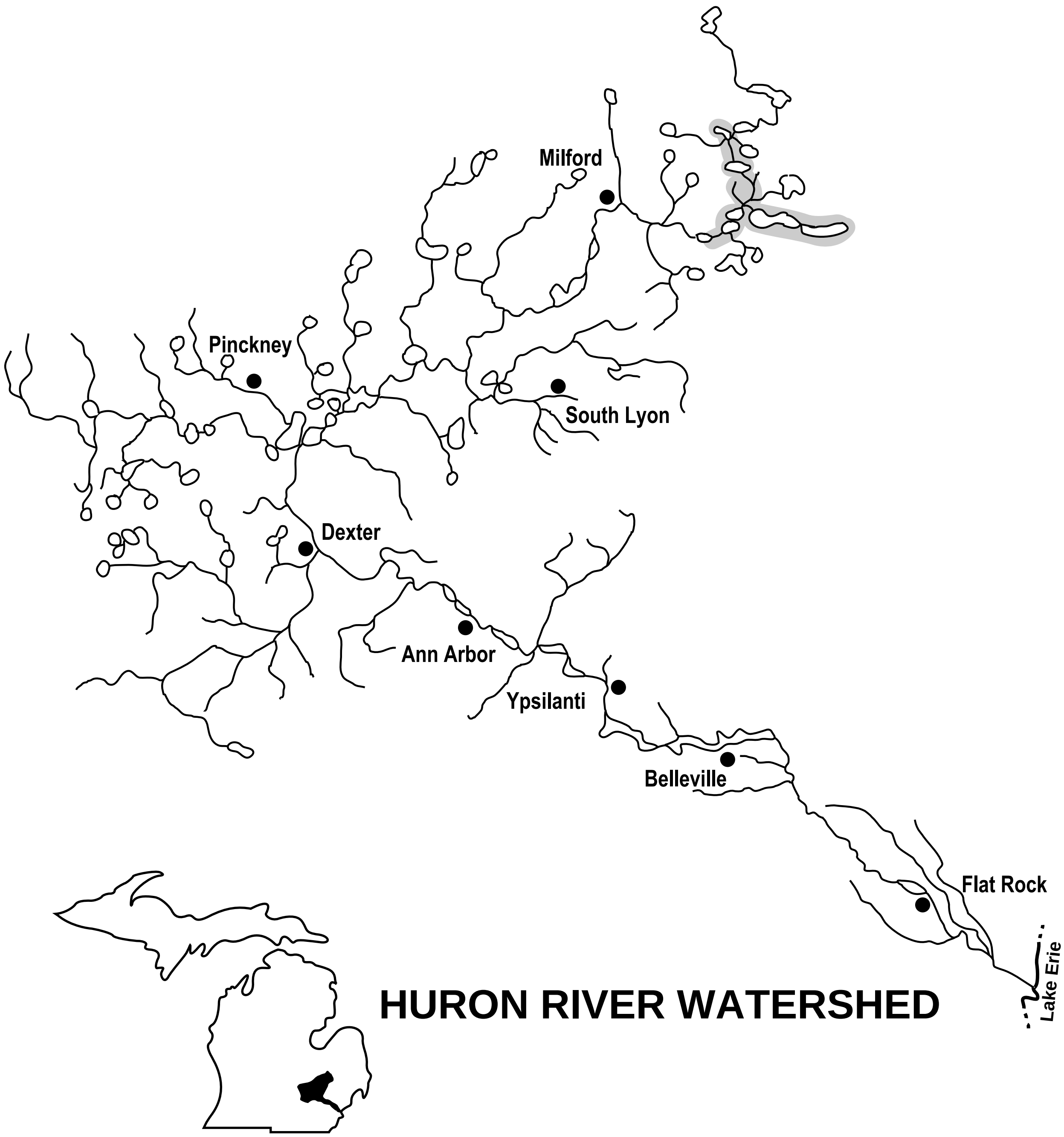
spawning - vegetation



Pugnose shiner (*Notropis anogenus*) - rare

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

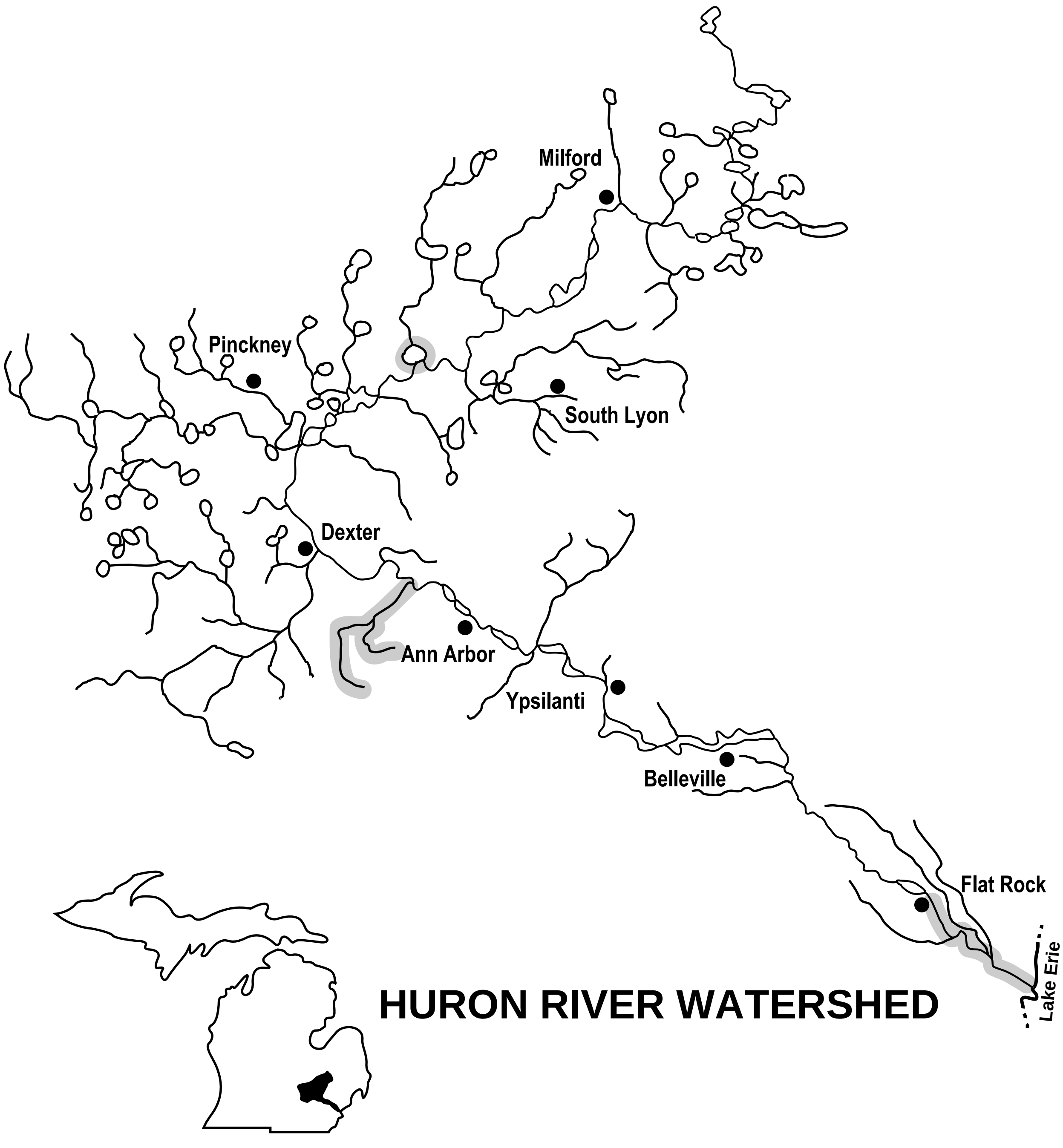


Emerald shiner (*Notropis atherinoides*)

Habitat:

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

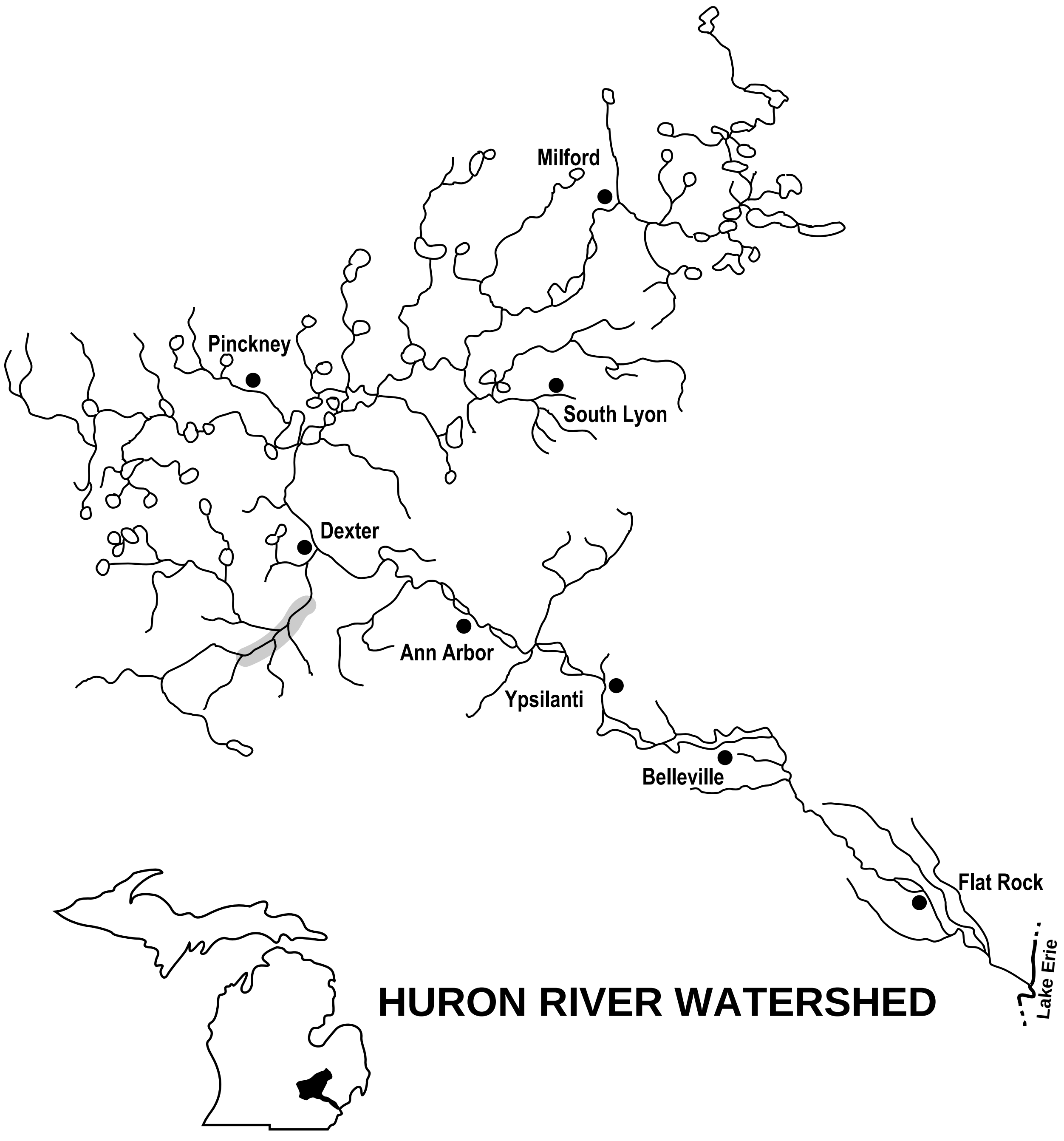
spawning - sand or firm mud substrate or gravel shoals



Silverjaw minnow (*Notropis buccatus*) - rare

Habitat:

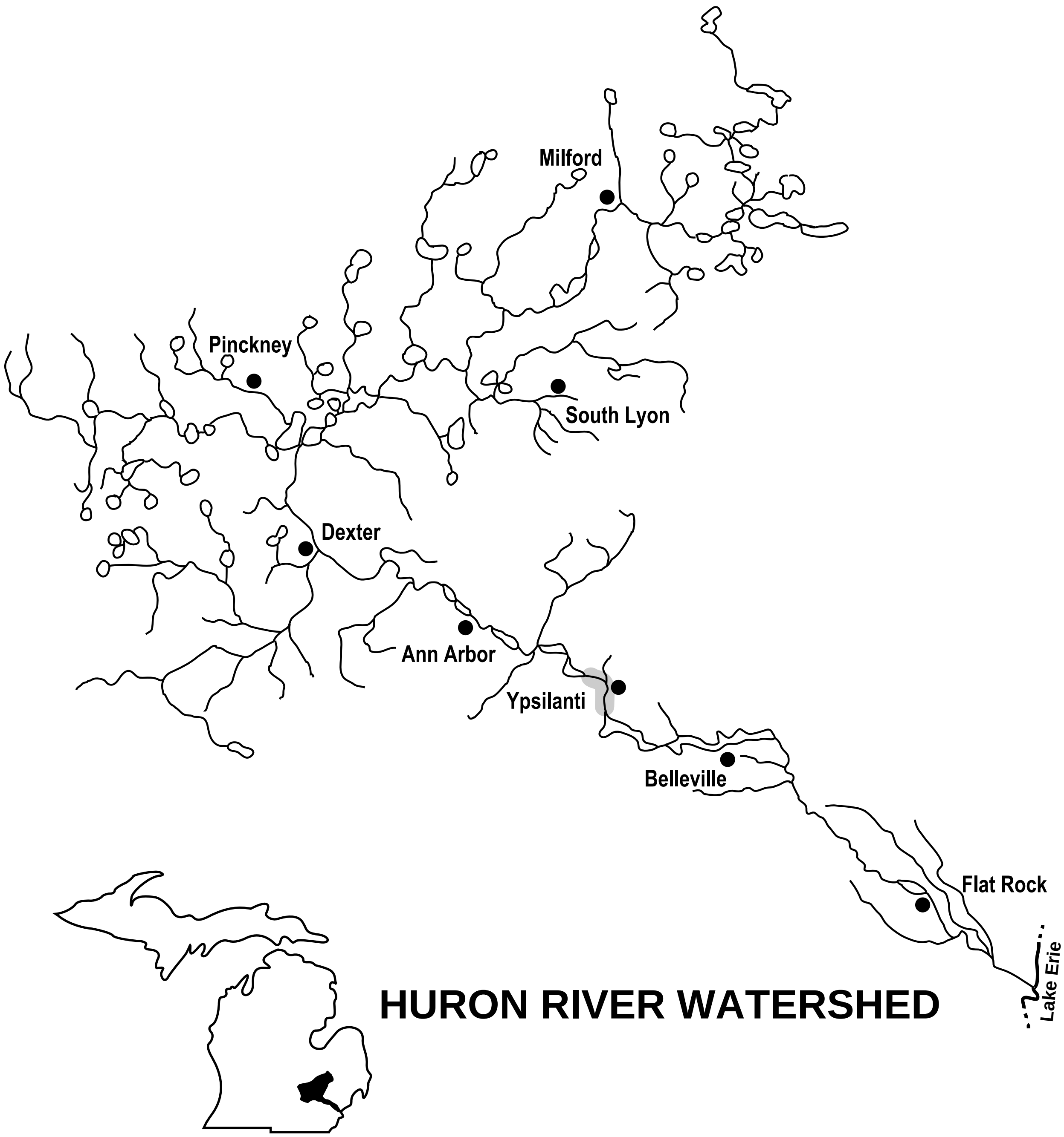
feeding
- small, clear, shallow streams
- sand substrate
- moderate gradient
- high tolerance to turbidity and domestic and industrial pollutants



Bigmouth shiner (*Notropis dorsalis*) - rare

Habitat:

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

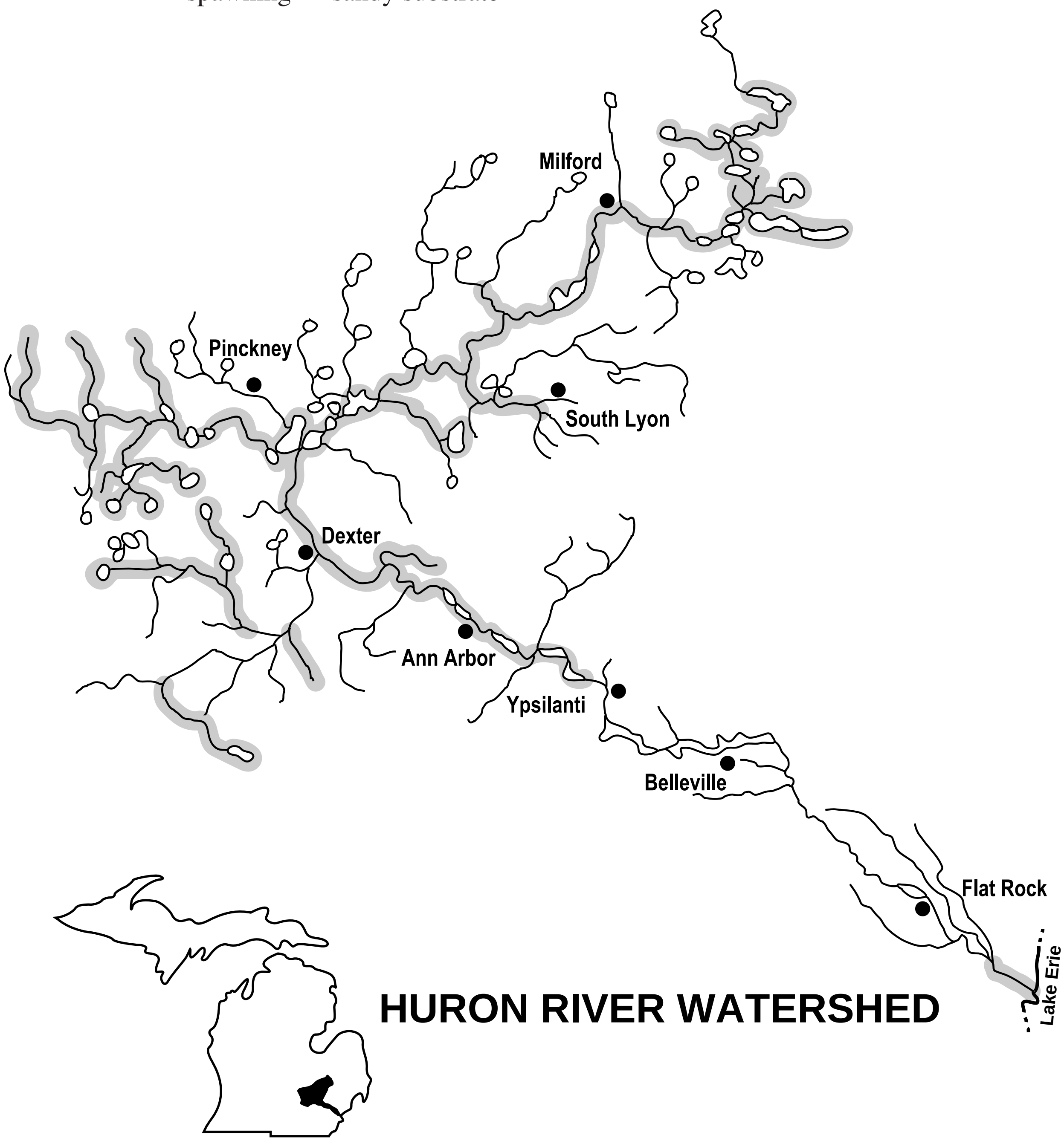


Blacknose shiner (*Notropis heterolepis*)

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

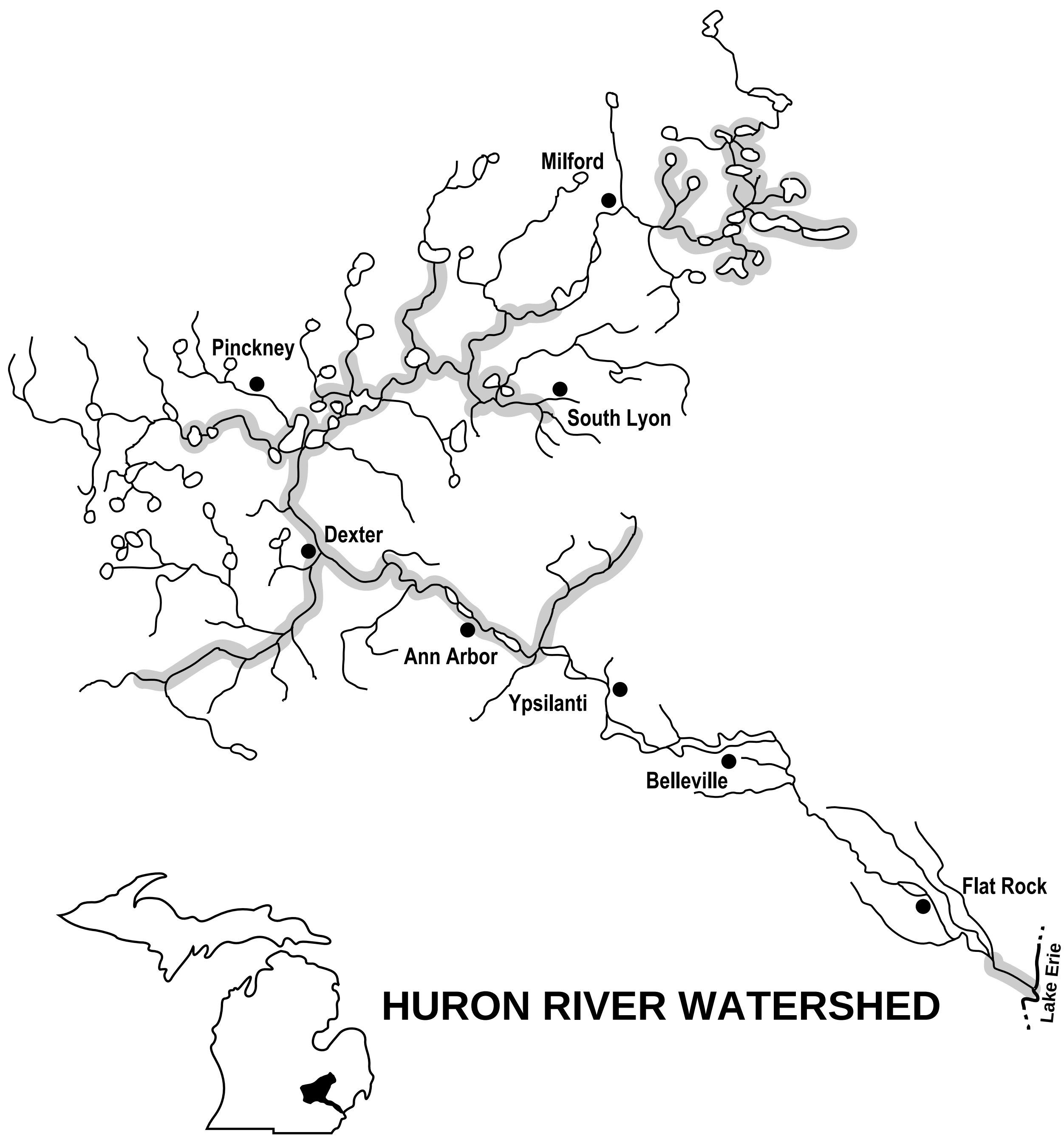
spawning
- sandy substrate



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

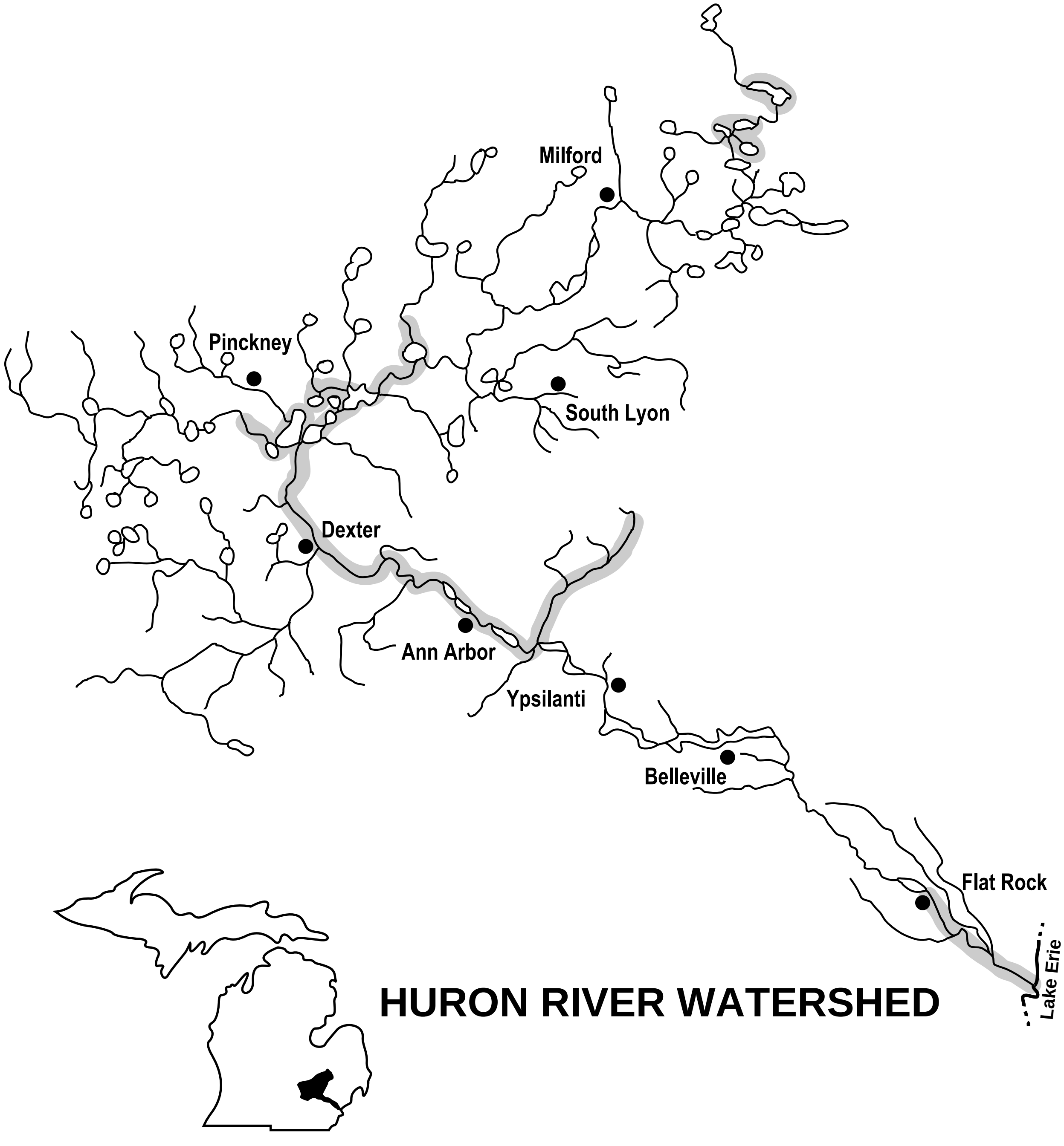


Spottail shiner (*Notropis hudsonius*)

Habitat:

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

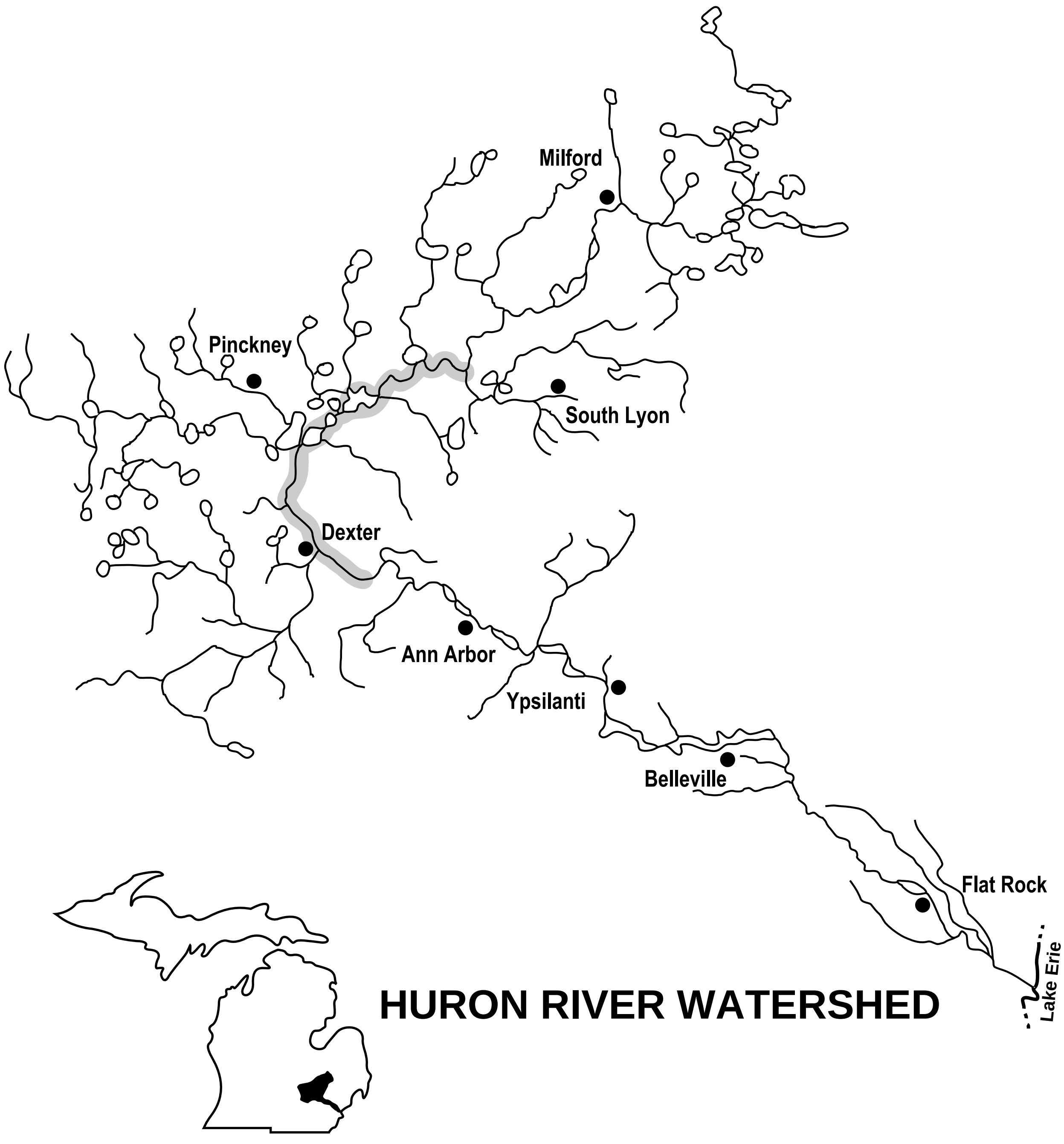
spawning
- over sandy shoals or gravelly riffles
- near the mouths of small streams



Silver shiner (*Notropis photogenis*) - threatened

Habitat:

feeding
- moderate to large sized streams
- clear water with moderate to high gradients
- gravel and boulder substrate
- riffles and swifter eddies and currents of pools
- does not like silt substrate or rooted aquatic vegetation

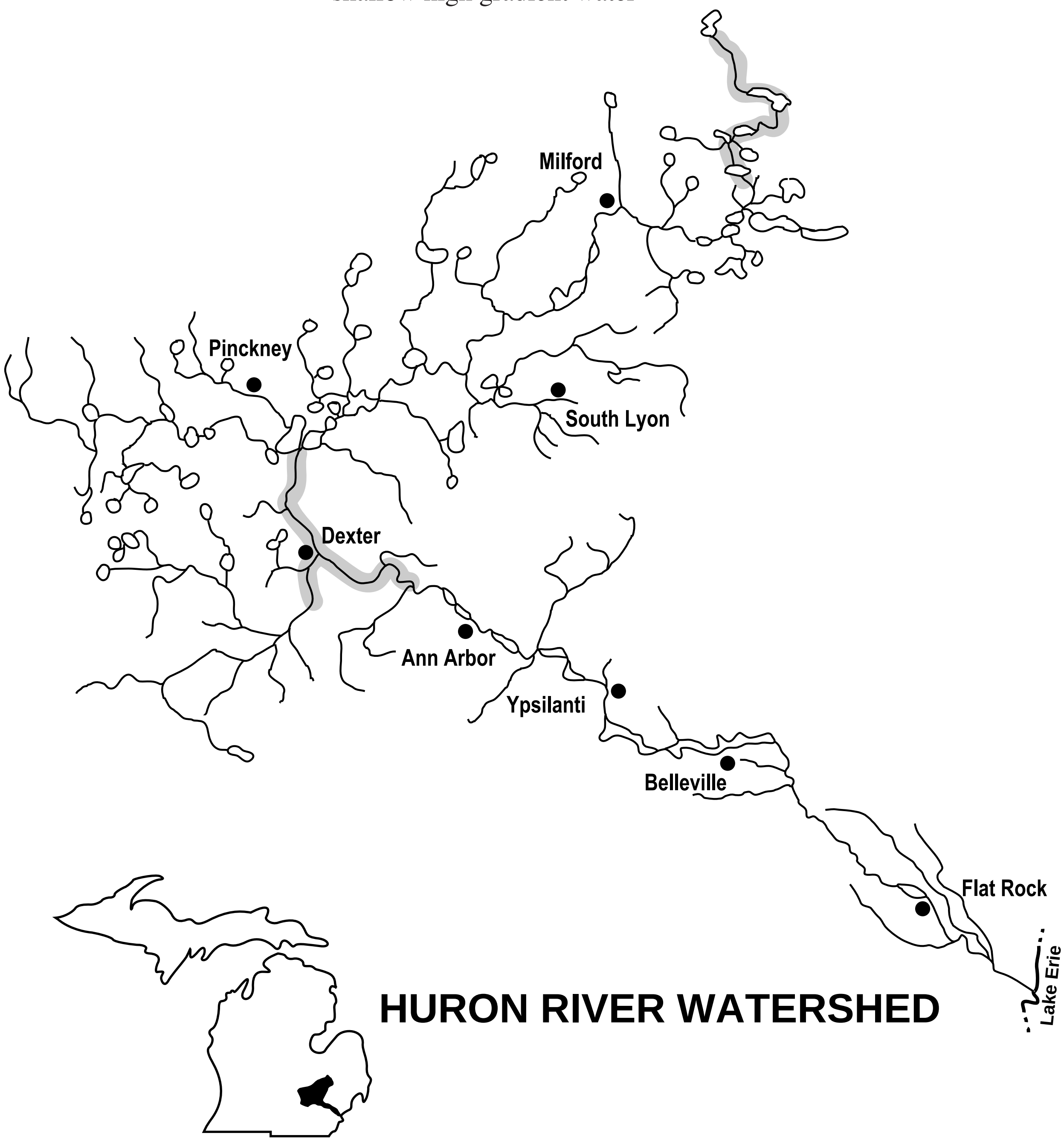


Rosyface shiner (*Notropis rubellus*)

Habitat:

feeding
- moderate sized streams
- moderate to high gradient
- gravel or sand substrate; intolerant of silt substrate
- clear water; intolerant of turbidity

spawning
- on nests of horneyhead chub, chesnut lamprey, and redhorses
- sandy-gravel, gravel or bedrock substrate
- shallow high gradient water

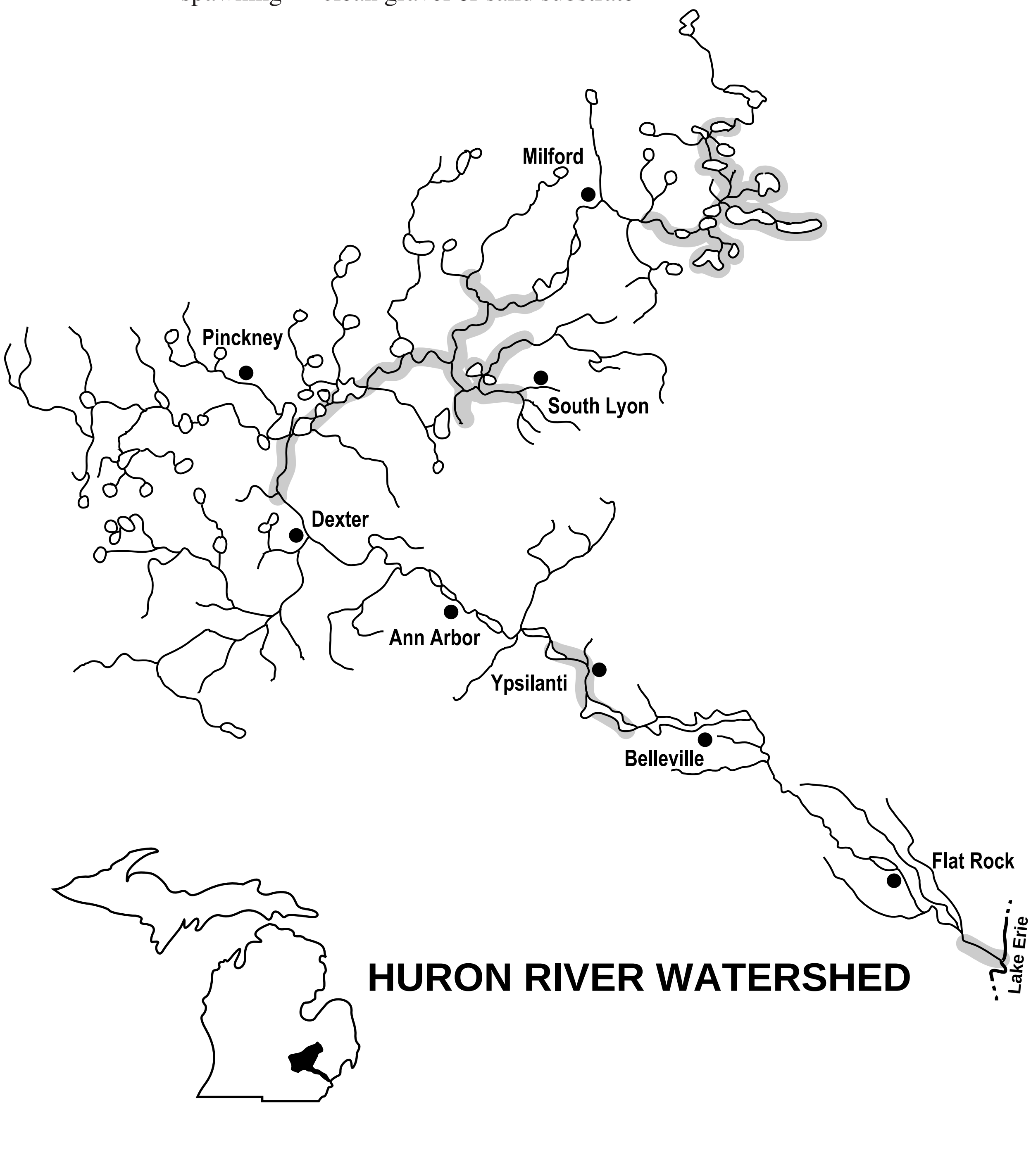


Sand shiner (*Notropis stramineus*)

Habitat:

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

spawning
- clean gravel or sand substrate

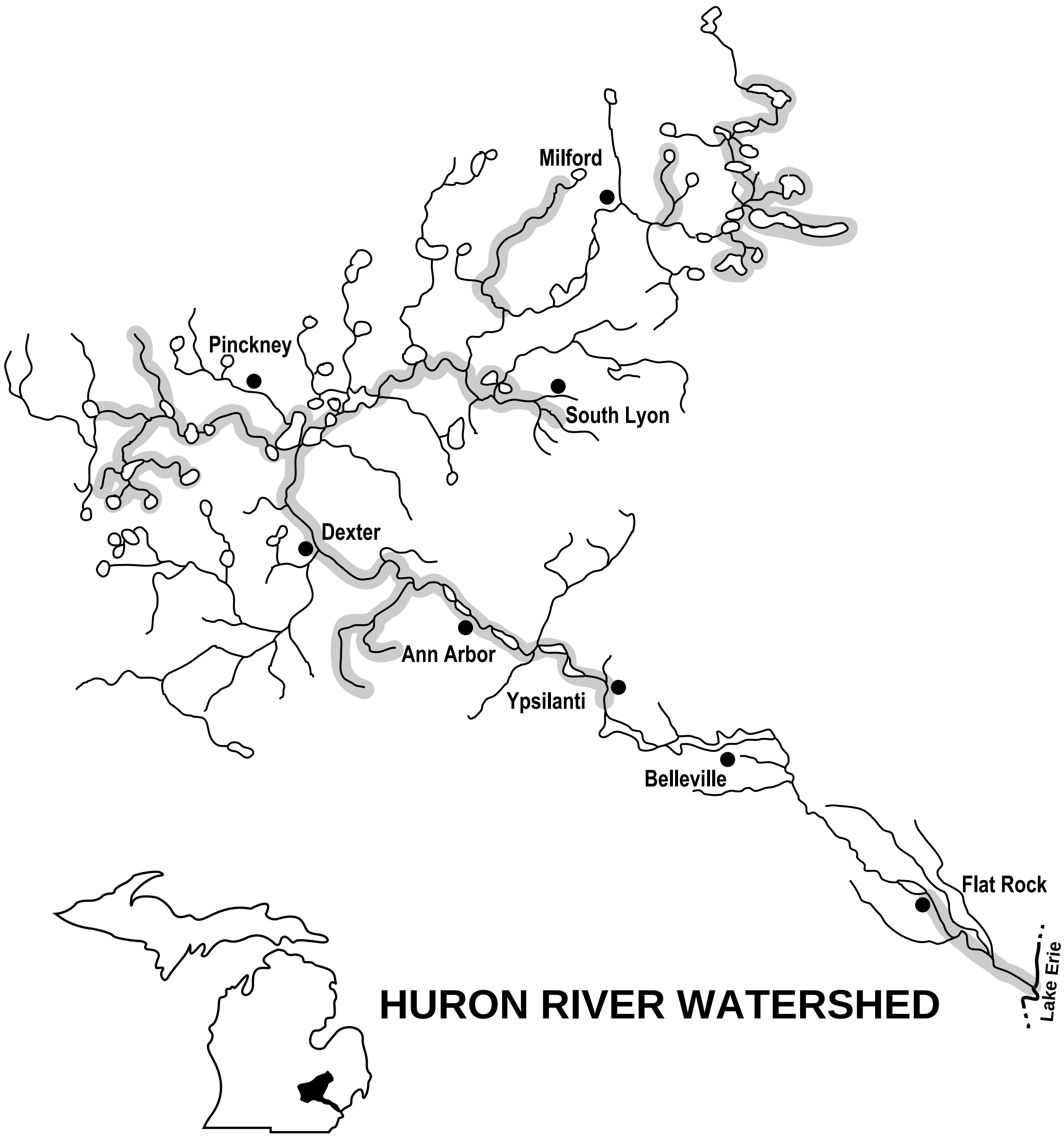


Mimic shiner (*Notropis volucellus*)

Habitat:

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

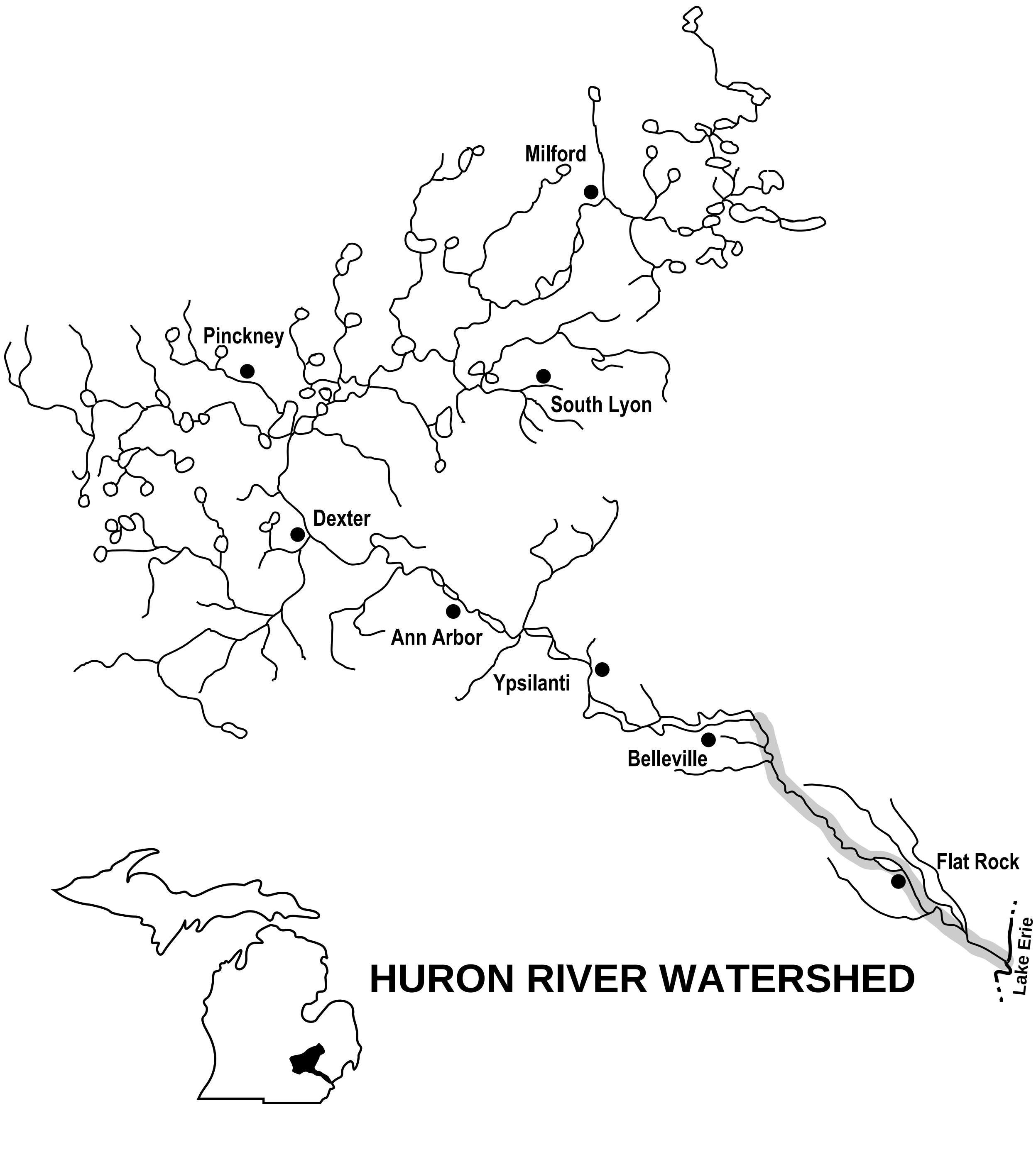
spawning - aquatic vegetation necessary



Pugnose minnow (*Opsopoeodus emiliae*) - rare

Habitat:

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

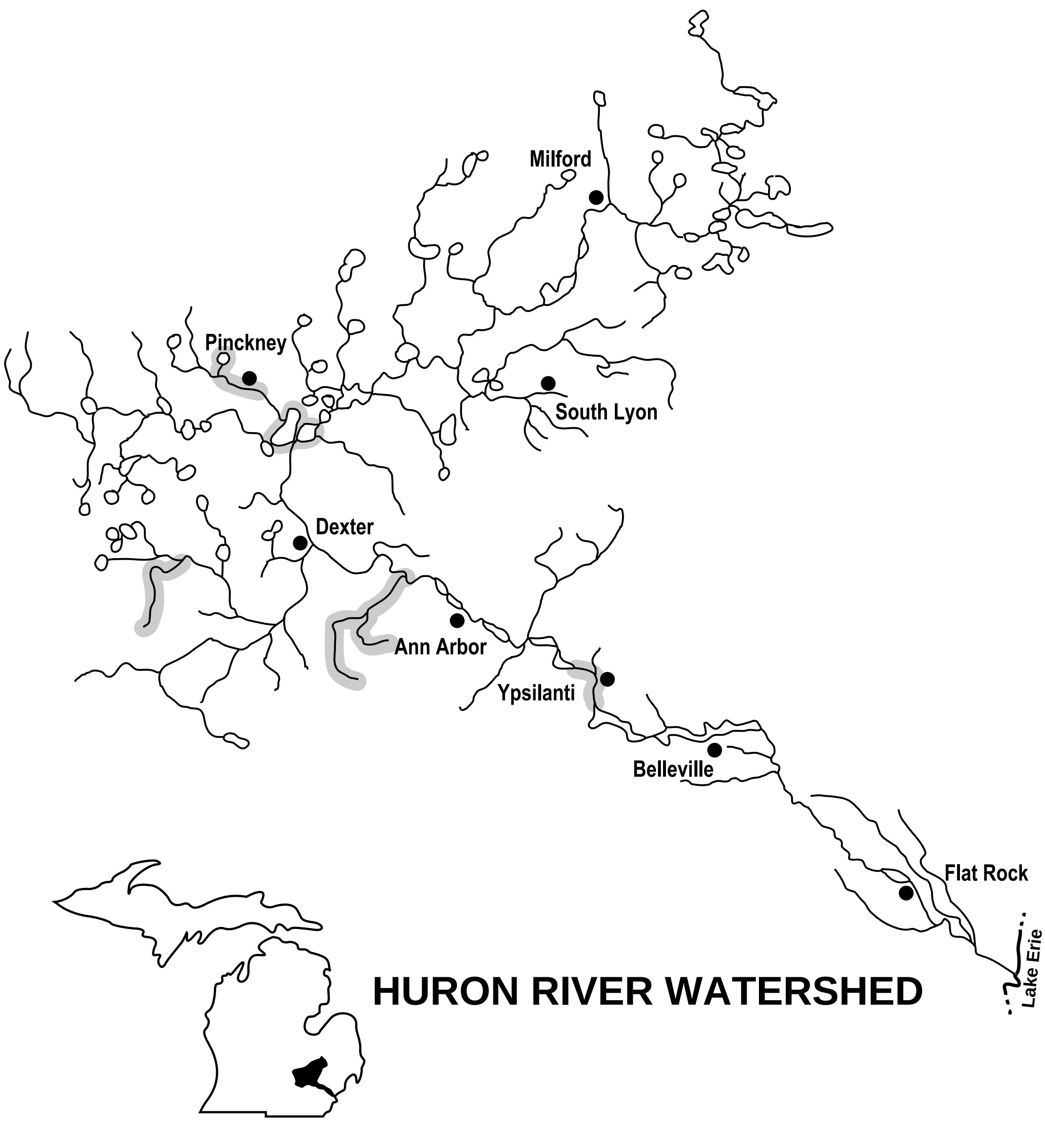


Northern redbelly dace (*Phoxinus eos*) - rare

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

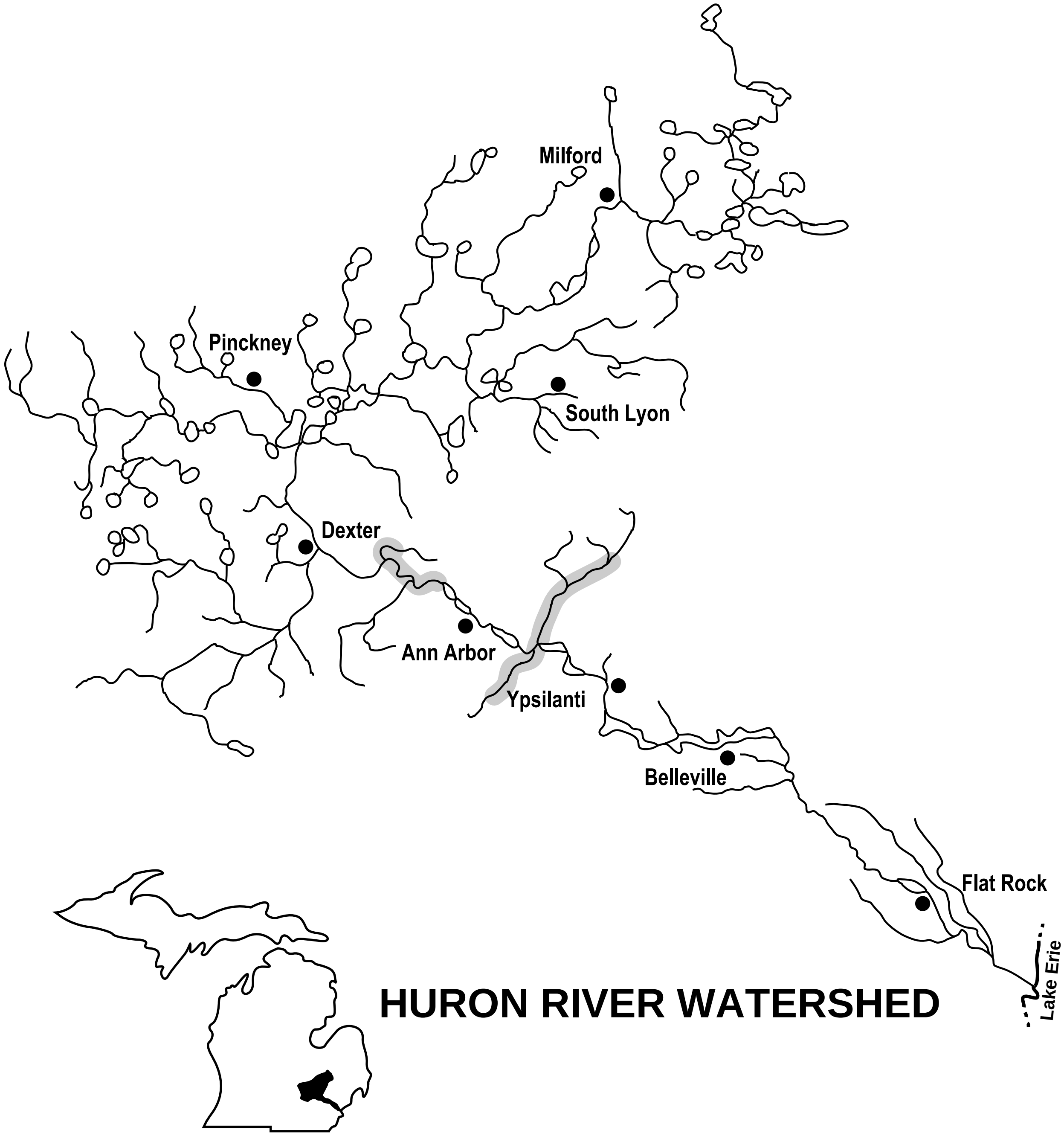


Southern redbelly dace (*Phoxinus erythrogaster*) - threatened

Habitat:

feeding
- cool, clear, silt-free small to medium streams
- gravel substrate
- cut banks overhung by vegetation
- instream aquatic vegetation rare or absent

spawning
- gravelly riffles
- eggs scattered in crevices and in other species nests

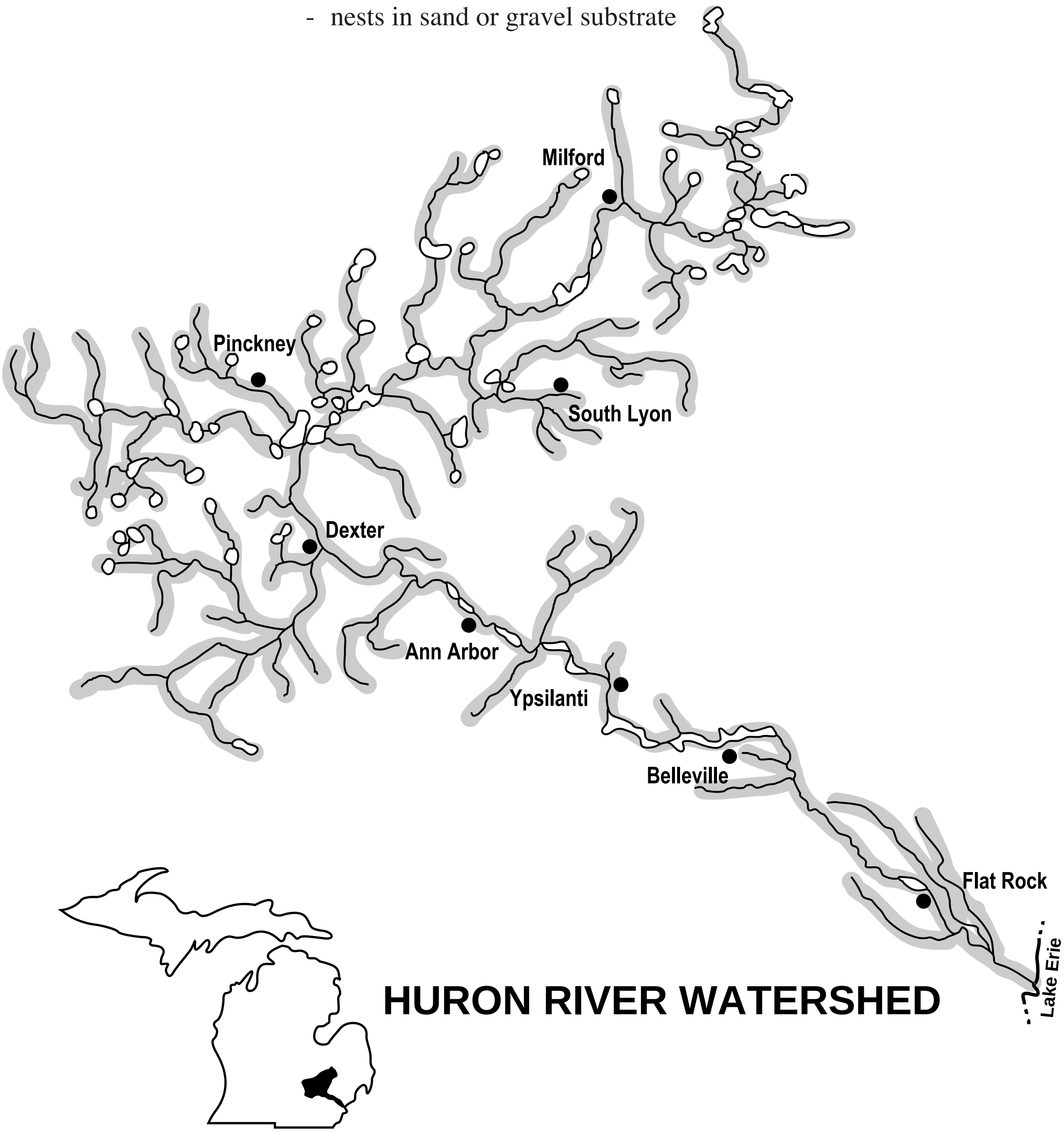


Bluntnose minnow (*Pimephales notatus*)

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

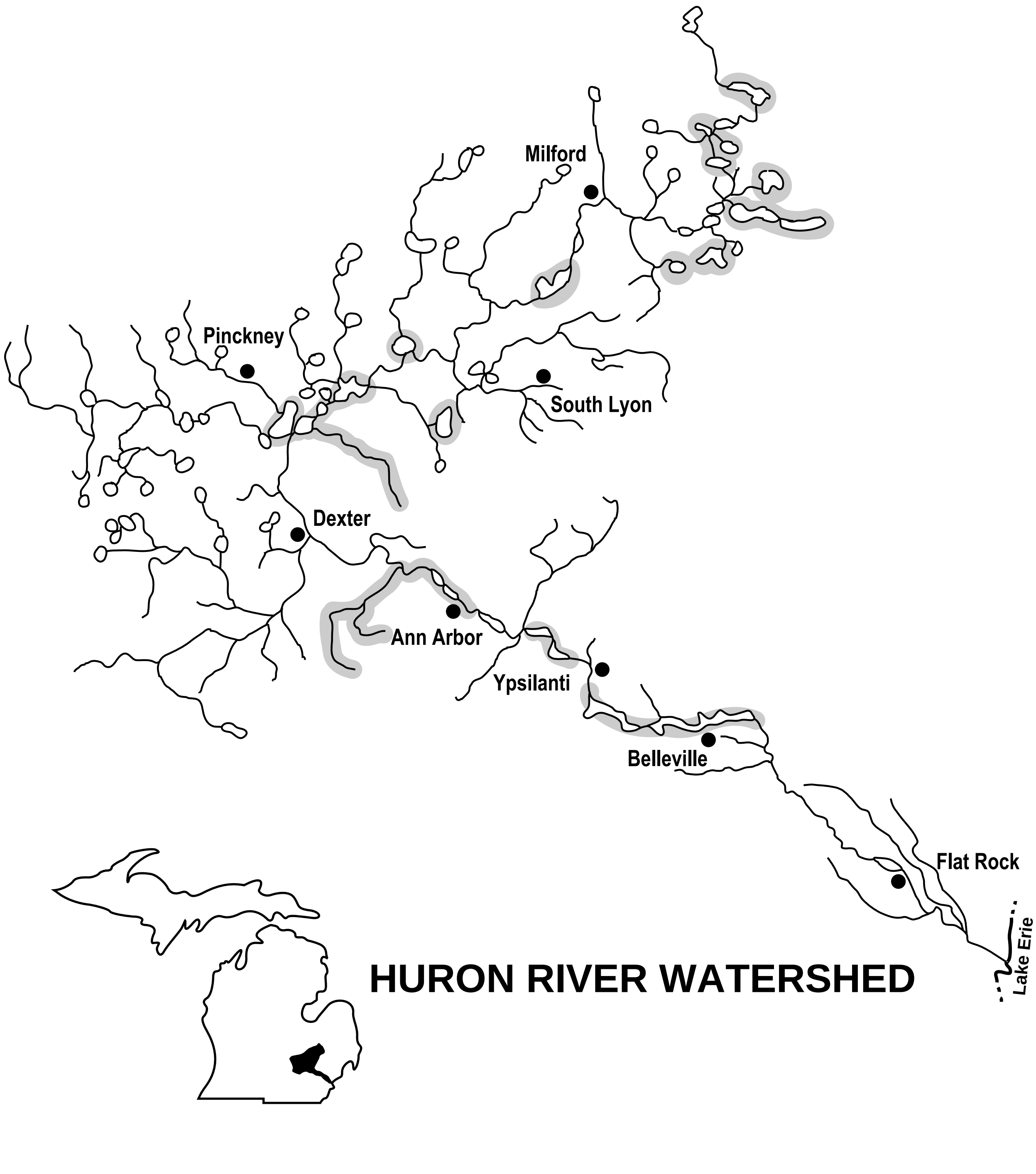


Fathead minnow (*Pimephales promelas*)

Habitat:

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

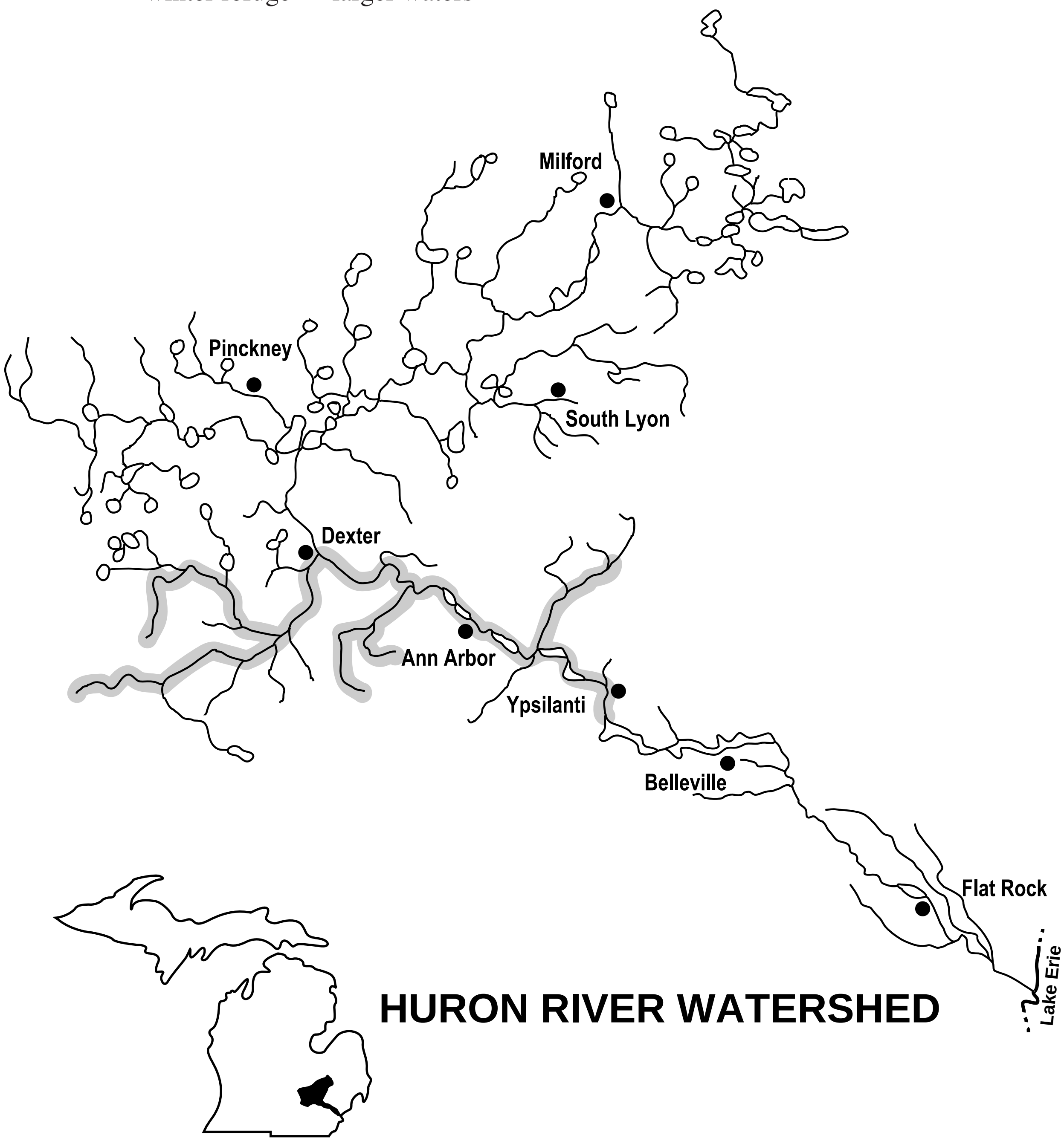
spawning - on underside of objects in water 2 to 3 feet deep
- prefer sand, marl, or gravel substrate



Blacknose dace (*Rhinichthys atratulus*)

Habitat:

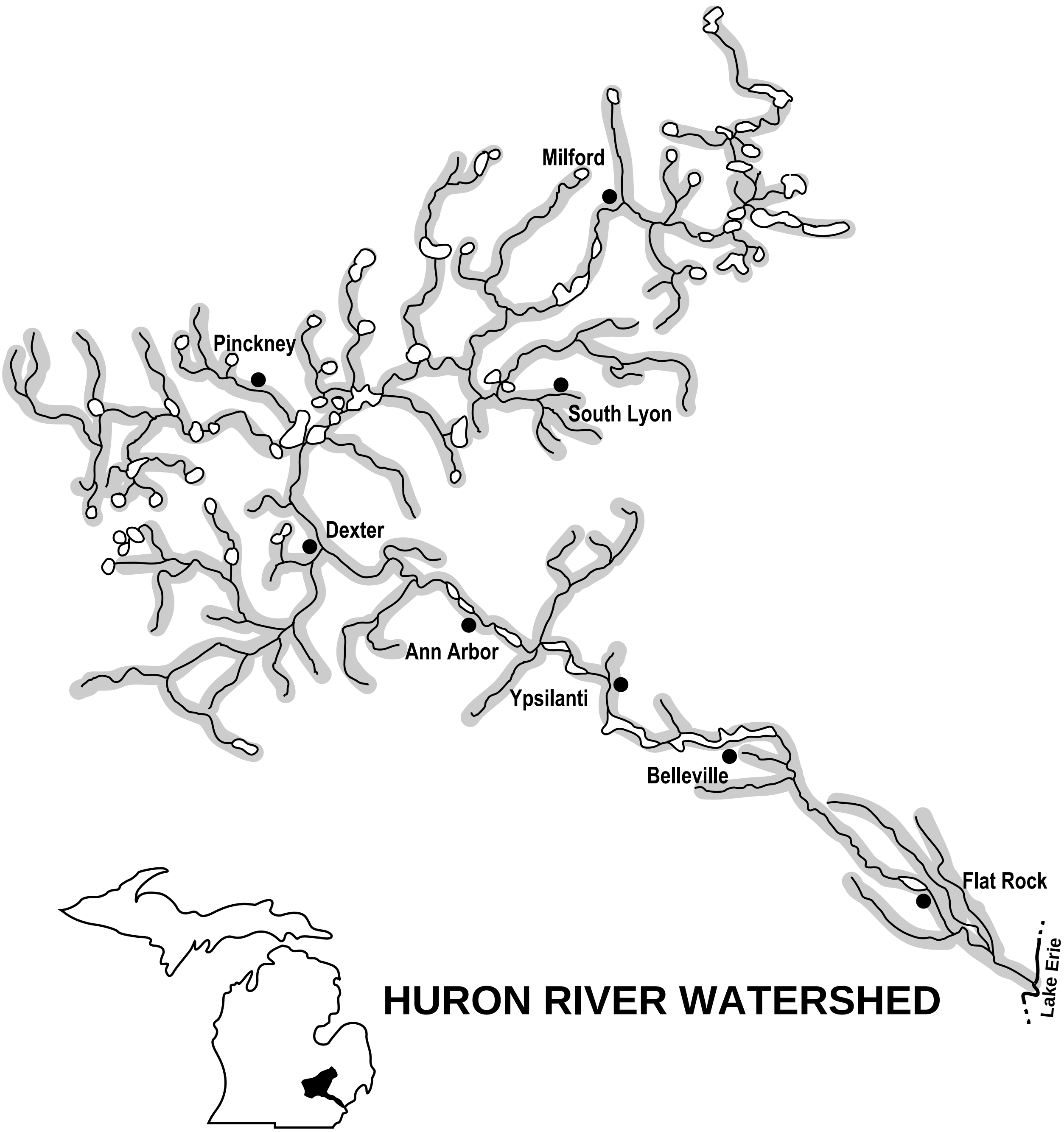
feeding	-	moderate to high gradient streams
	-	sand and gravel substrate
	-	clear cool water in pools with deep holes and undercut banks
	-	does not tolerate turbidity and silt well
spawning	-	riffles with gravel substrate and fast current
winter refuge	-	larger waters



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

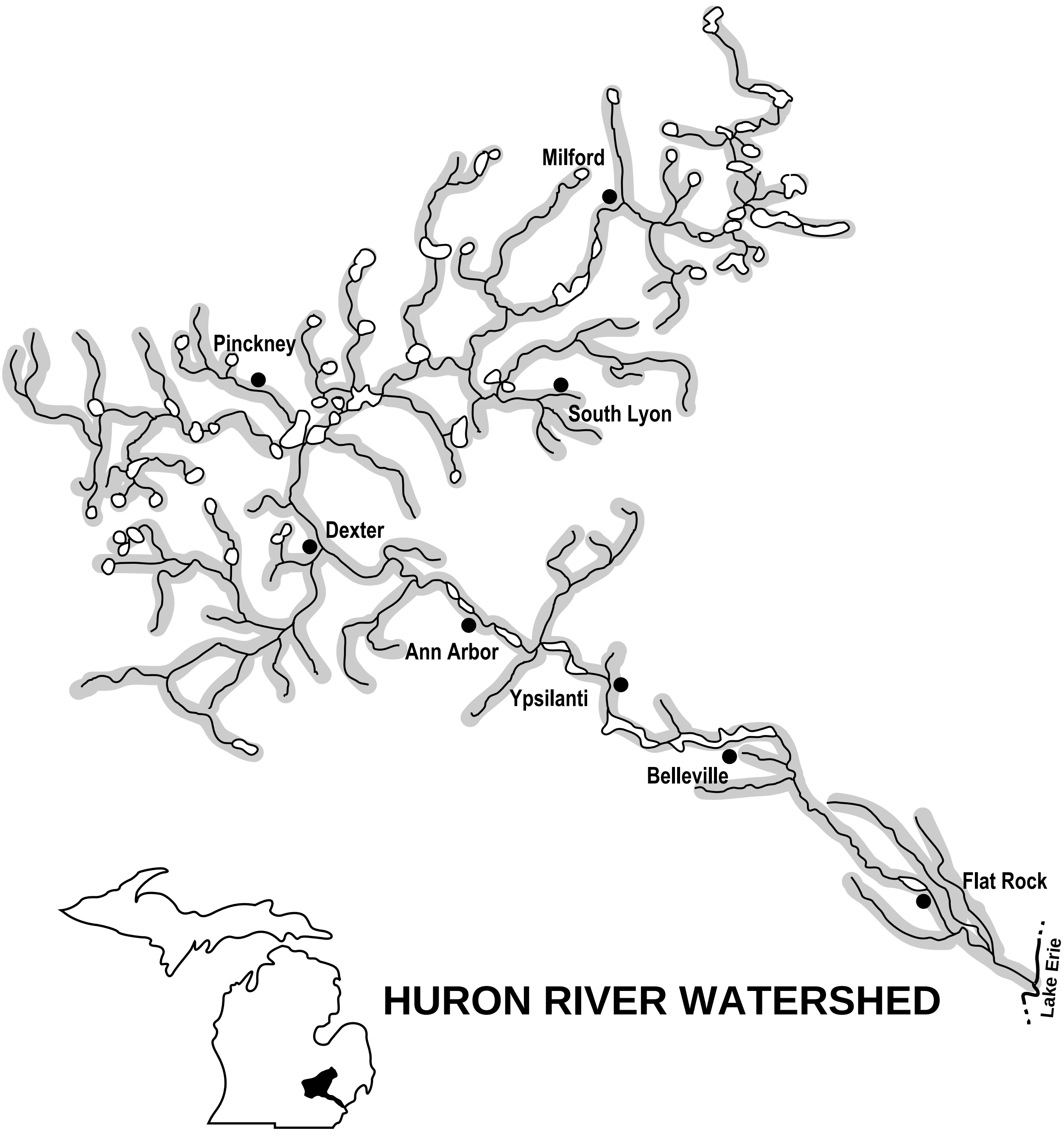


White sucker (*Catostomus commersoni*)

Habitat:

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

spawning - quiet gravelly shallow areas of streams

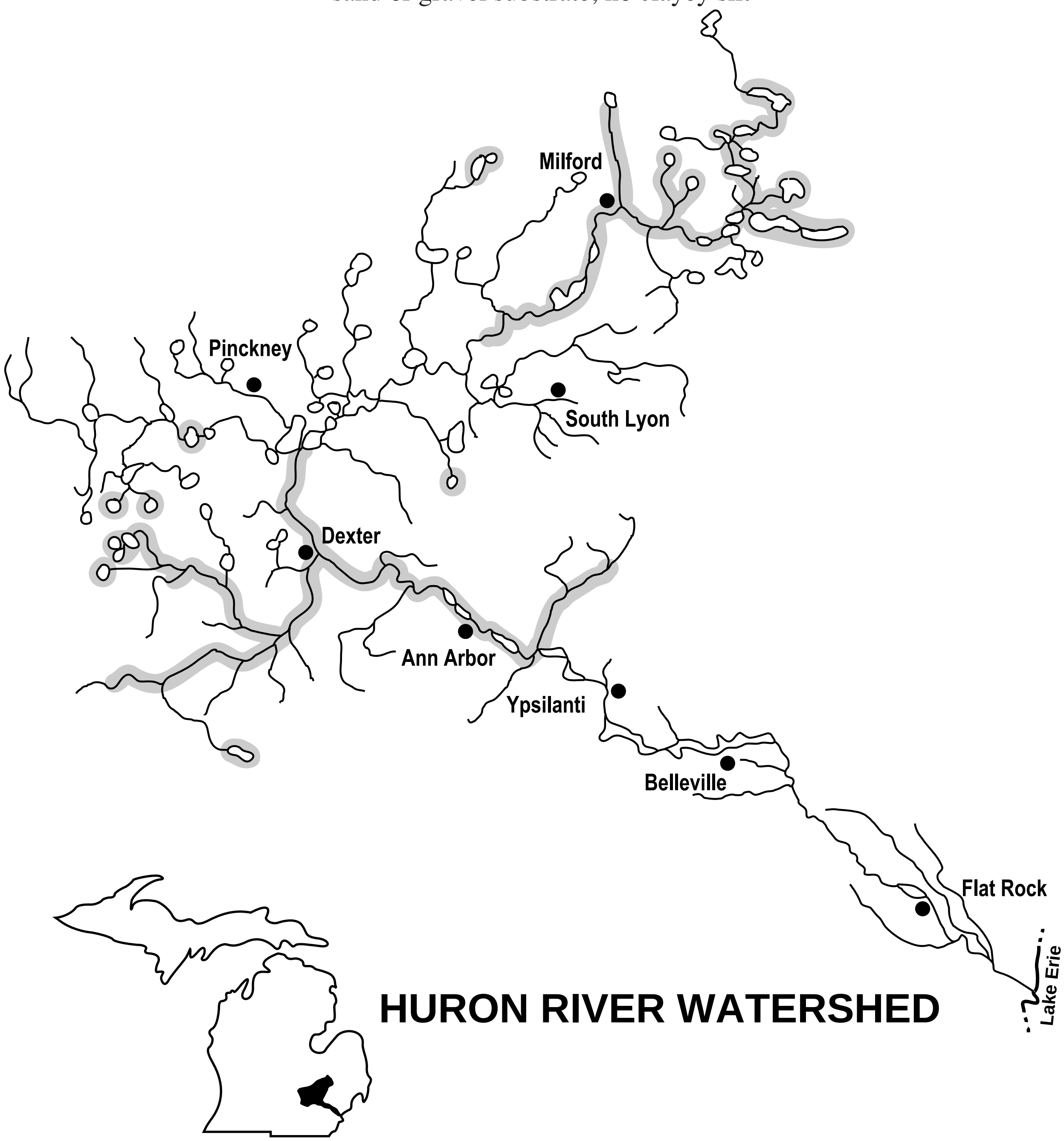


Lake chubsucker (*Erimyzon sucetta*)

Habitat:

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

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



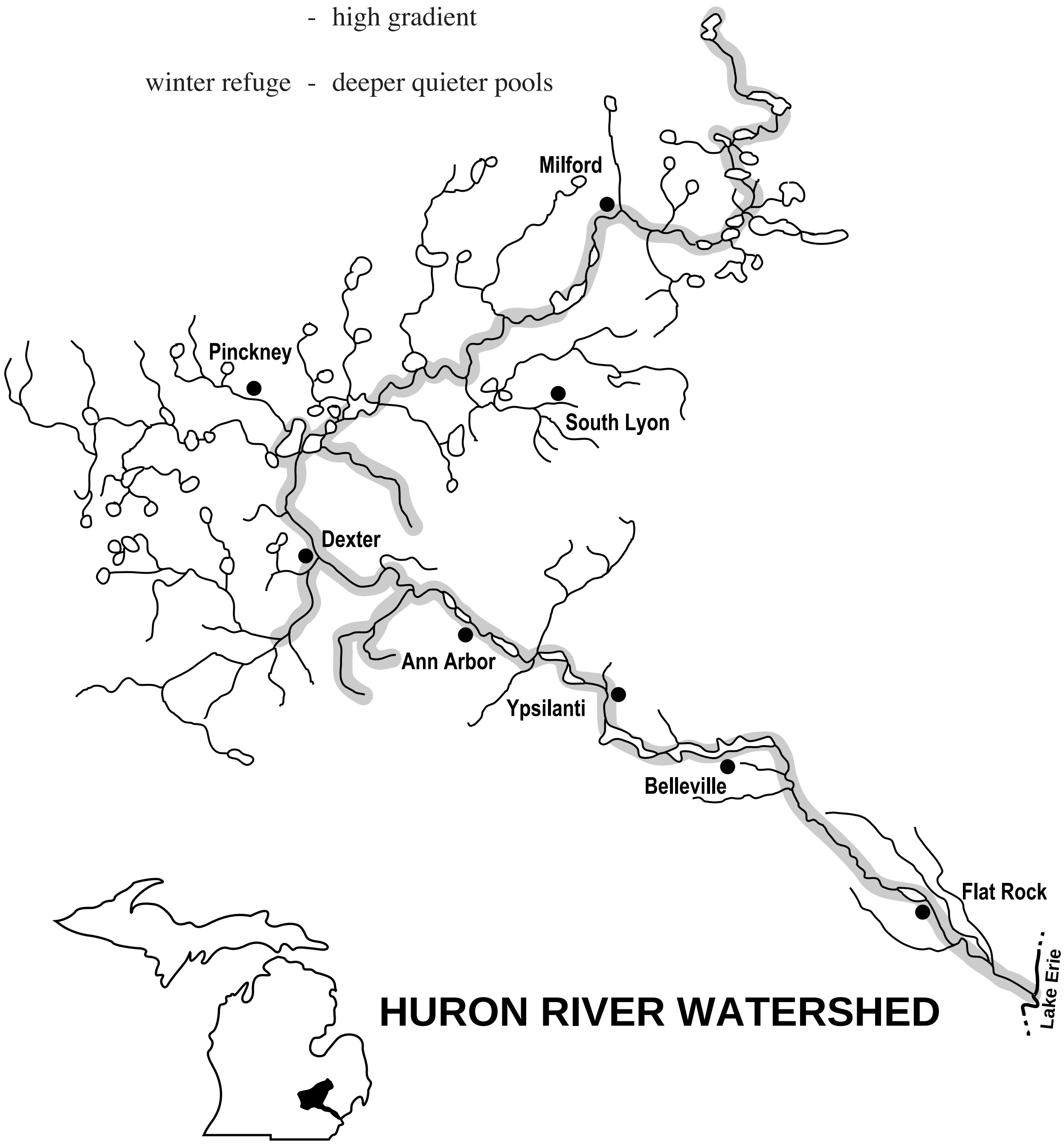
Northern hog sucker (*Hypentelium nigricans*)

Habitat:

feeding - gravel or rubble substrate
- riffles and adjacent pools of warm shallow streams
- clear water
- doesn't like turbidity or siltation
- avoids profuse amounts of aquatic vegetation

spawning - riffles
- shallow gravel substrate
- high gradient

winter refuge - deeper quieter pools

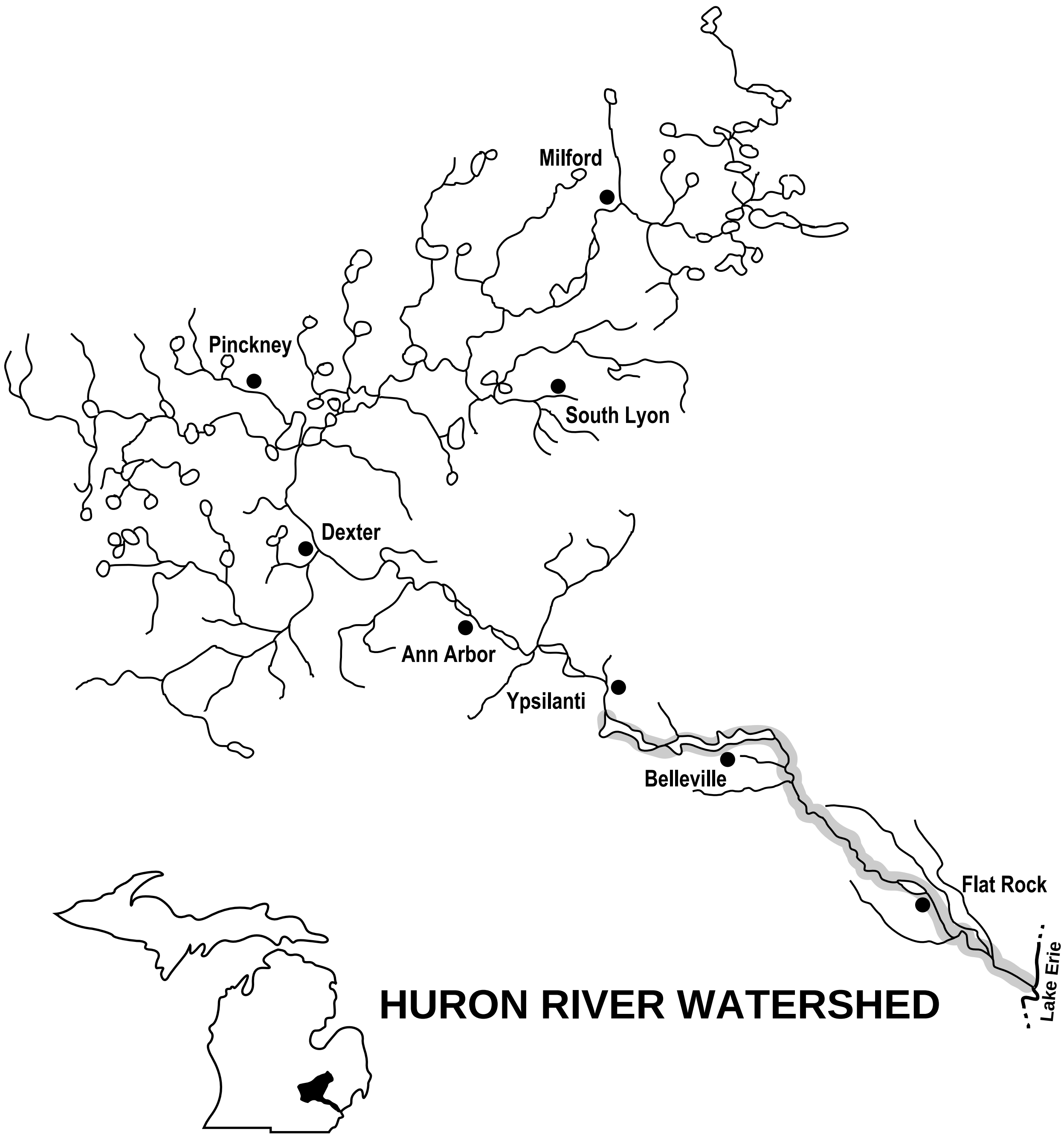


Spotted sucker (*Minytrema melanops*)

Habitat:

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

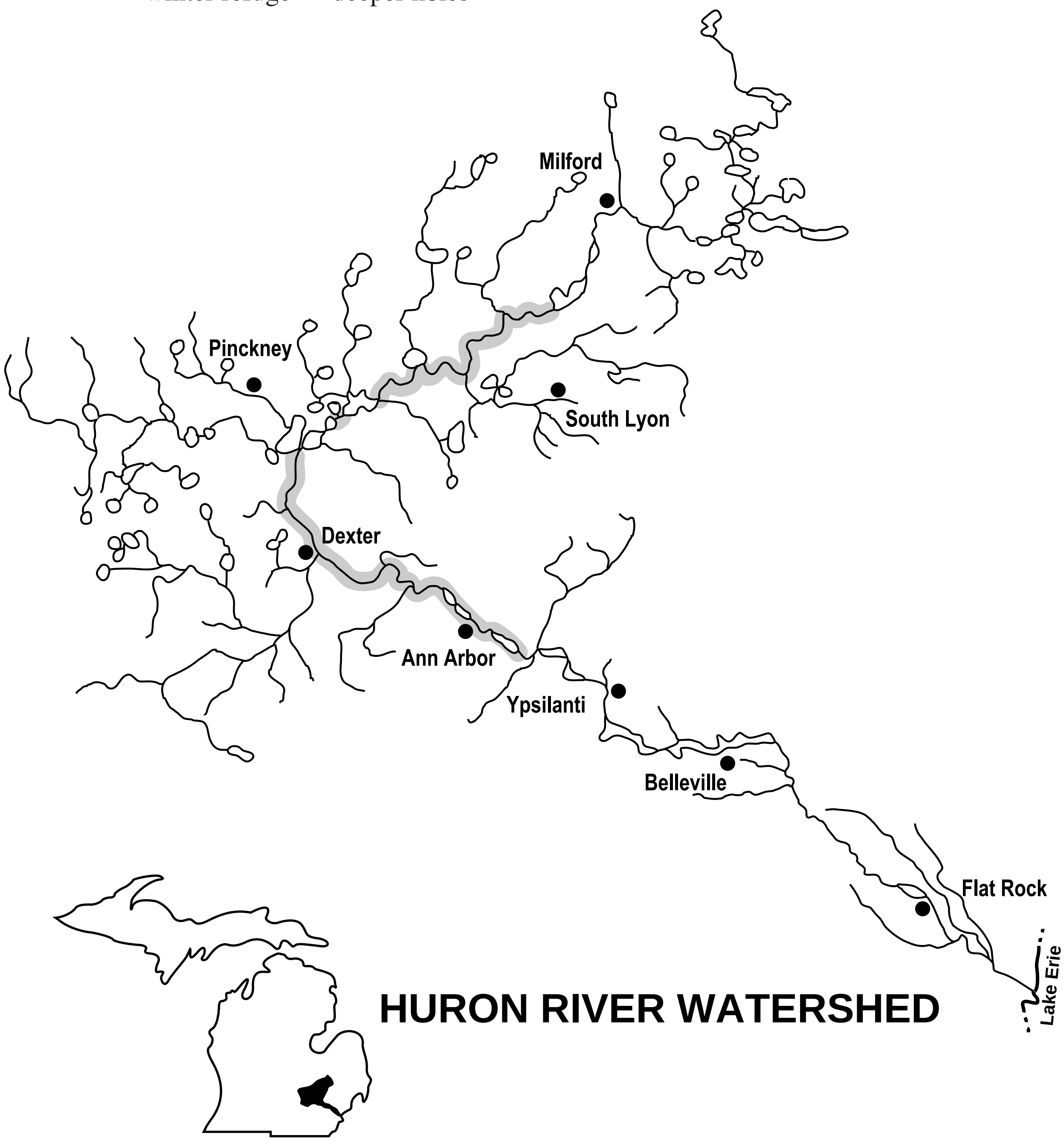
spawning
- riffles



Black redhorse (*Moxostoma duquesnei*) - declining

Habitat:

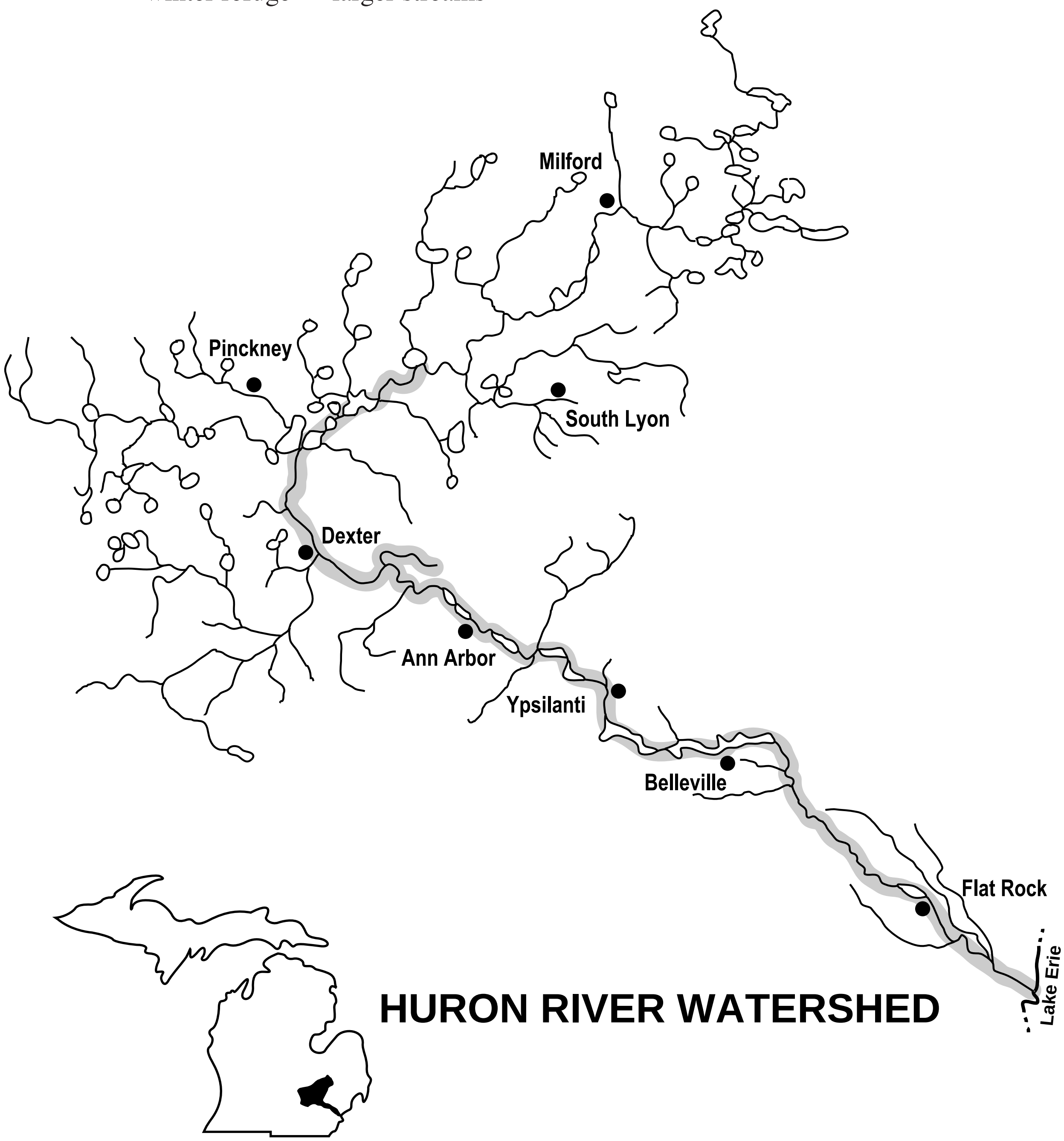
feeding	-	gravel substrate
	-	clear water, intolerant of siltation, turbidity, and low gradients
	-	medium size streams
	-	cooler swifter streams and short rocky pools with current
spawning	-	gravelly riffles
winter refuge	-	deeper holes



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

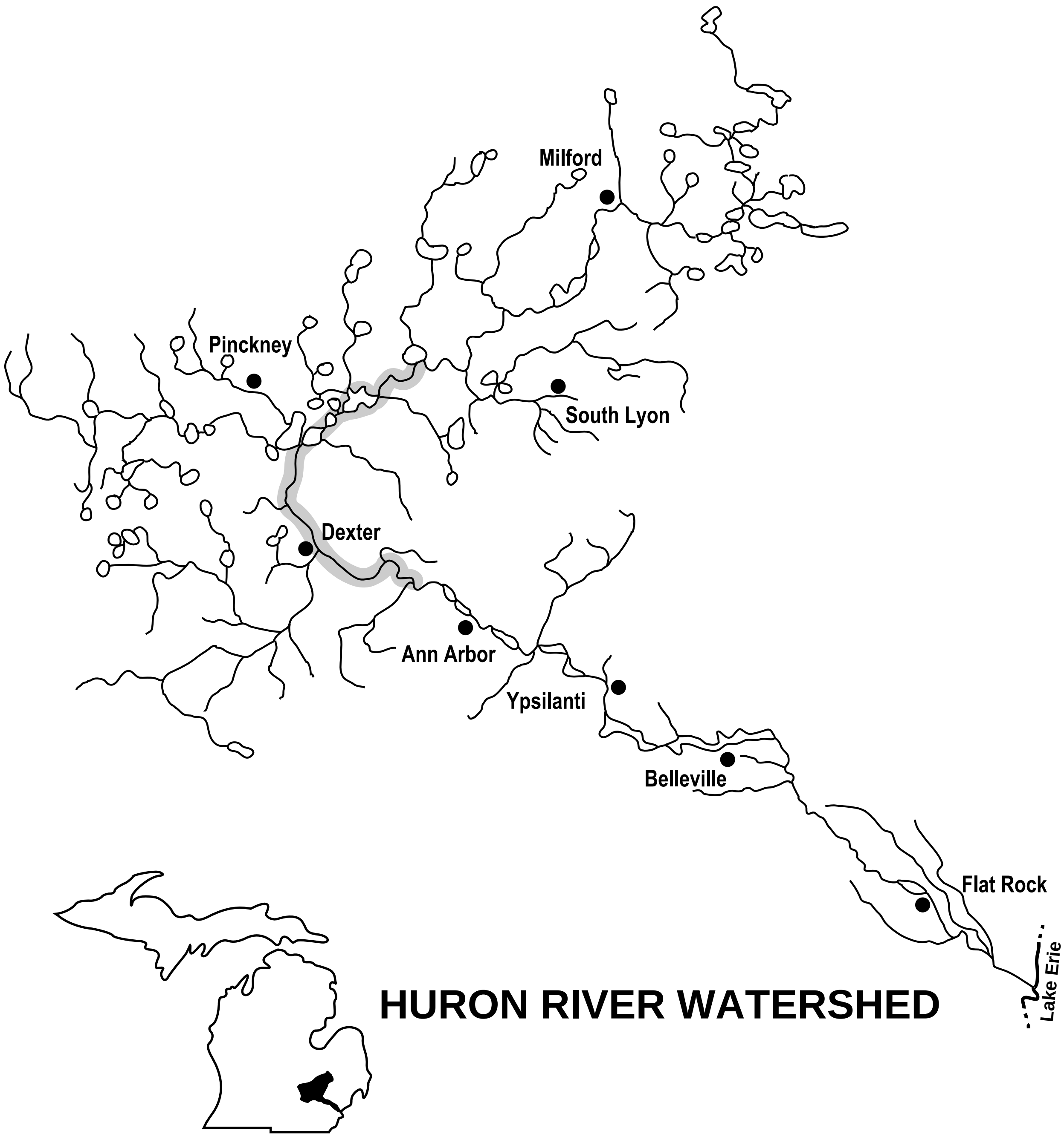


Shorthead redhorse (*Moxostoma macrolepidotum*)

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

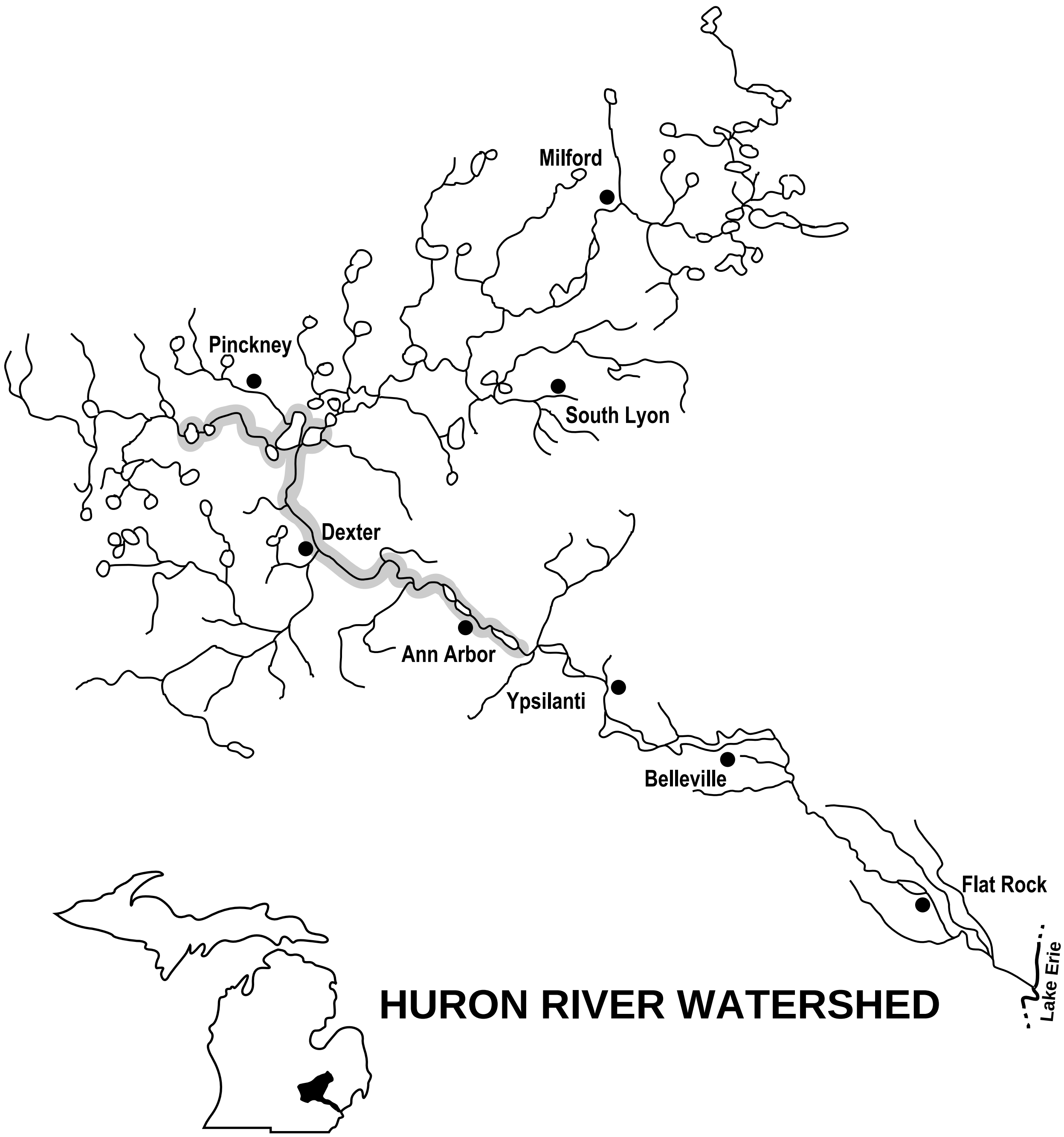


Greater redhorse (*Moxostoma valenciennesi*) - rare

Habitat:

feeding - large clear streams
- clean sand, gravel, or boulder substrate
- intolerant of excessive turbidity and chemical pollutants

spawning - moderately rapid current

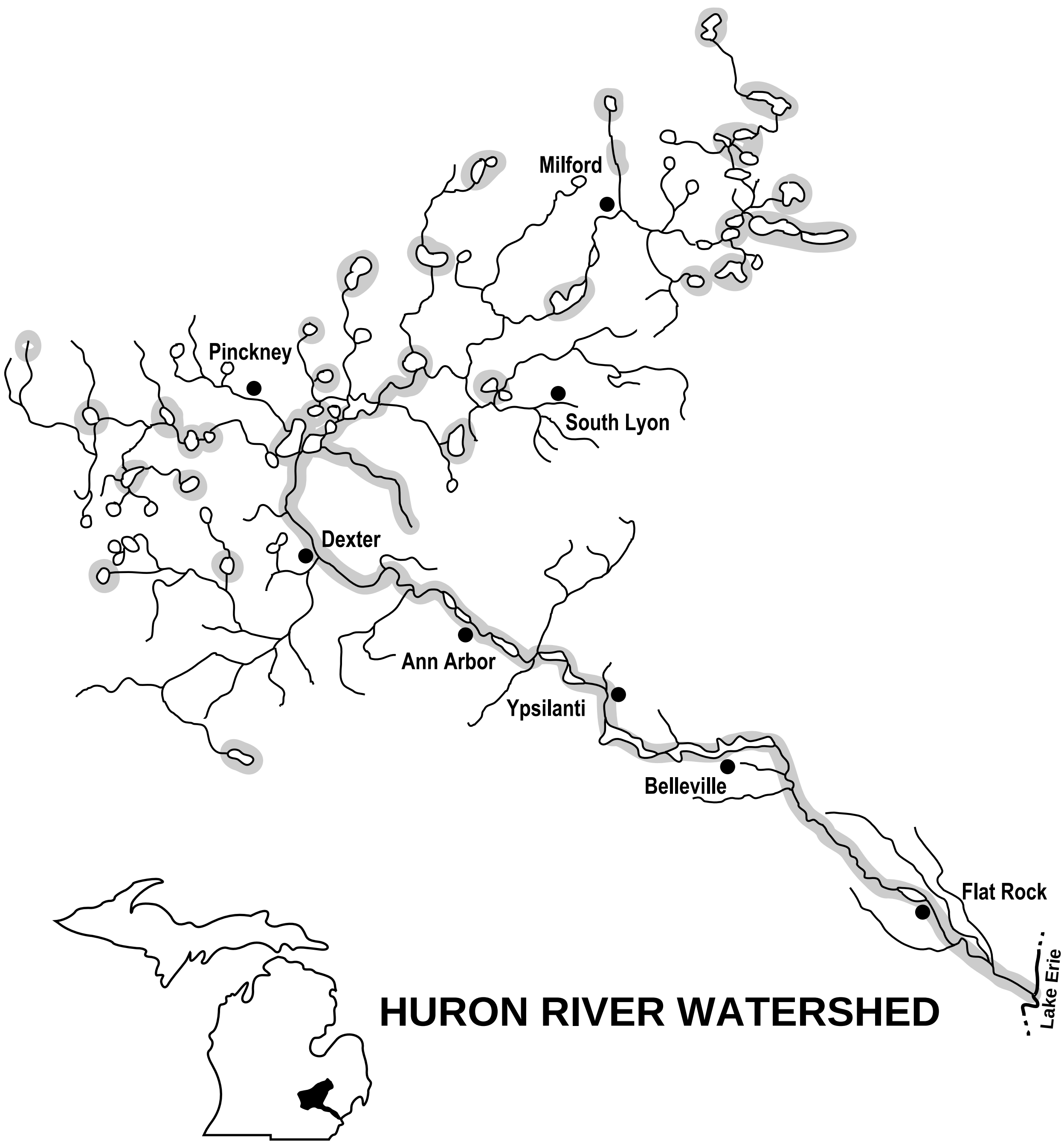


Black bullhead (*Ameiurus melas*)

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

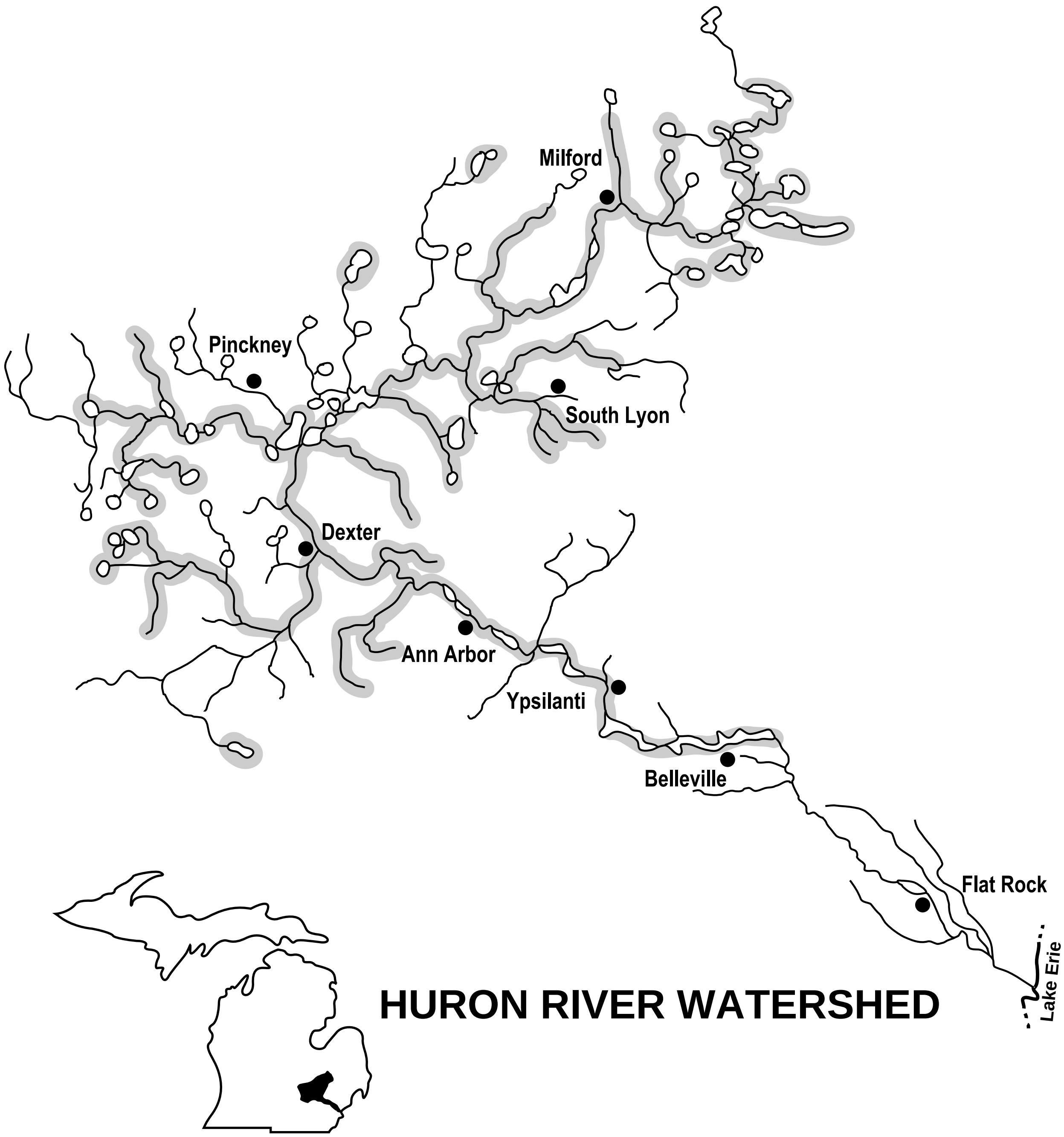


Yellow bullhead (*Ameiurus natalis*)

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



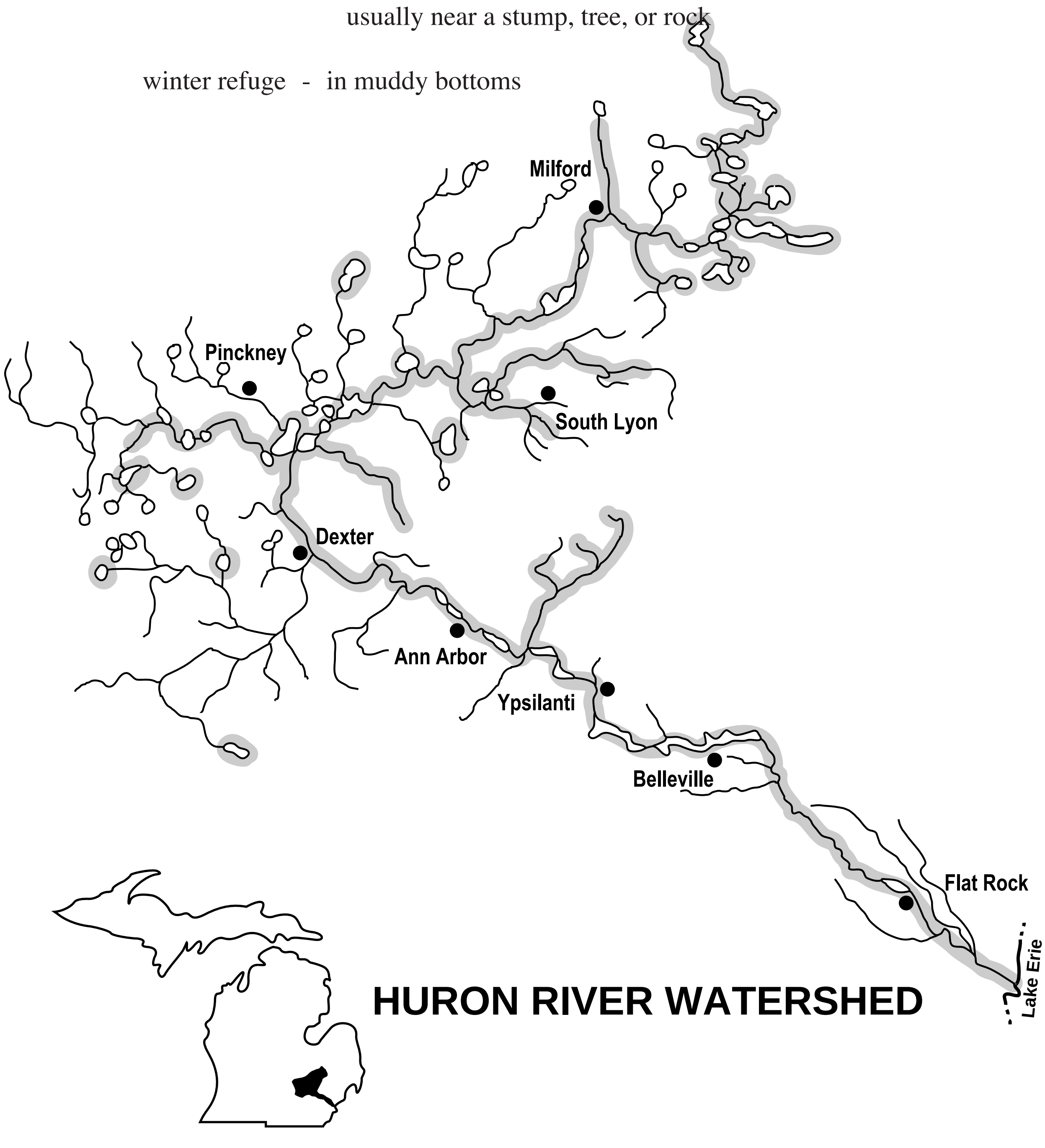
Brown bullhead (*Ameiurus nebulosus*)

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

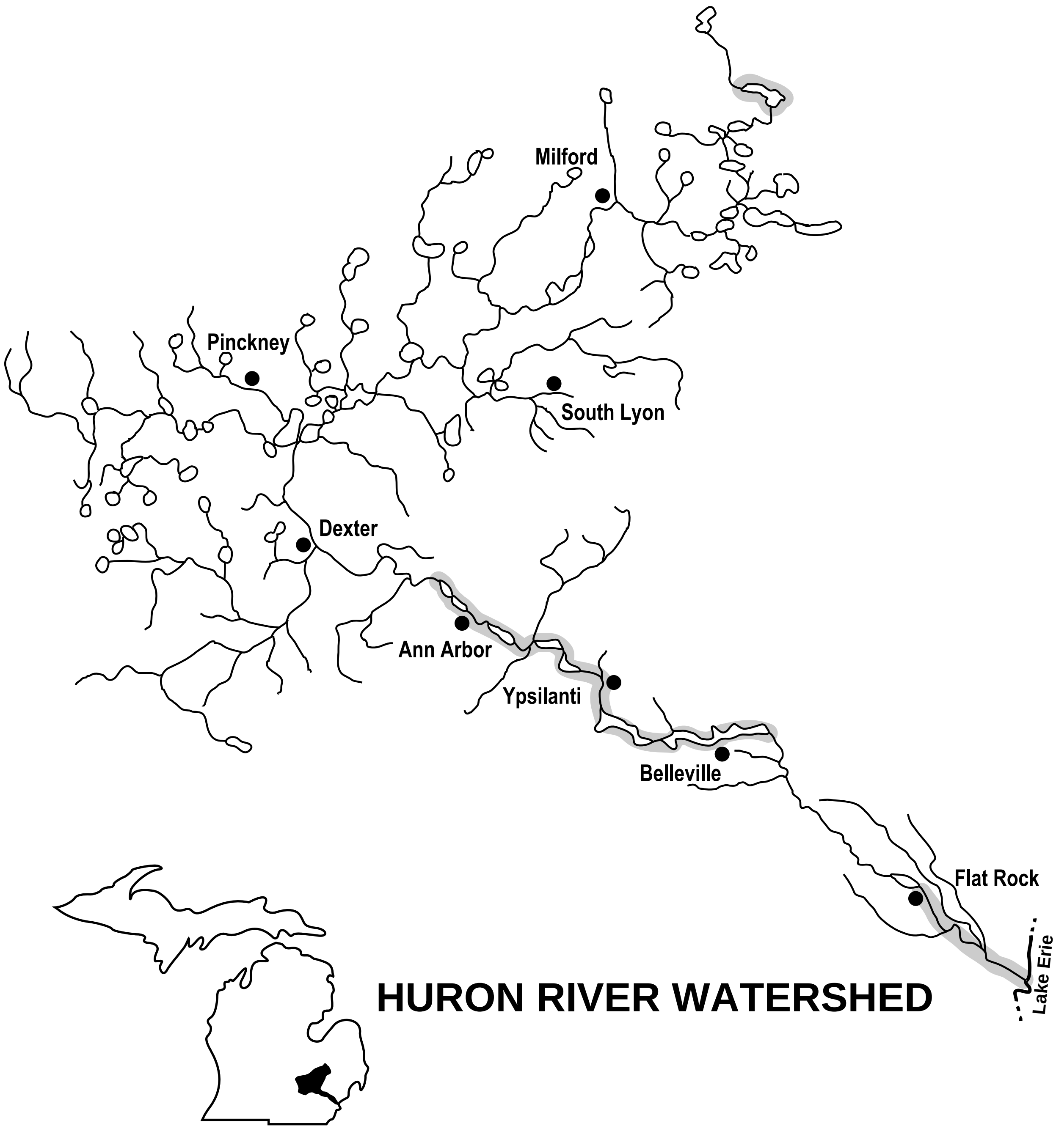


Channel catfish (*Ictalurus punctatus*)

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

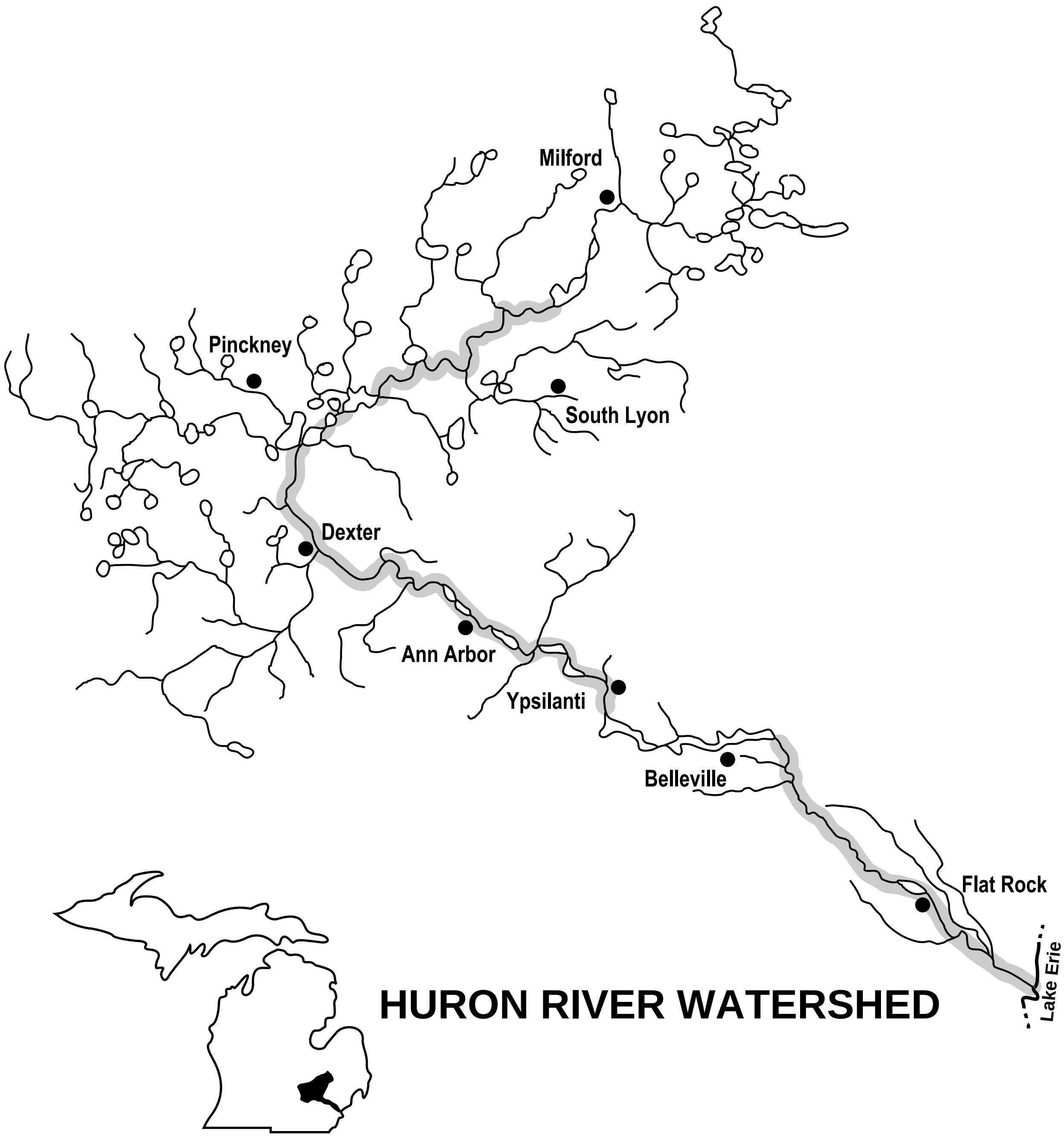


Stonecat (*Noturus flavus*)

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

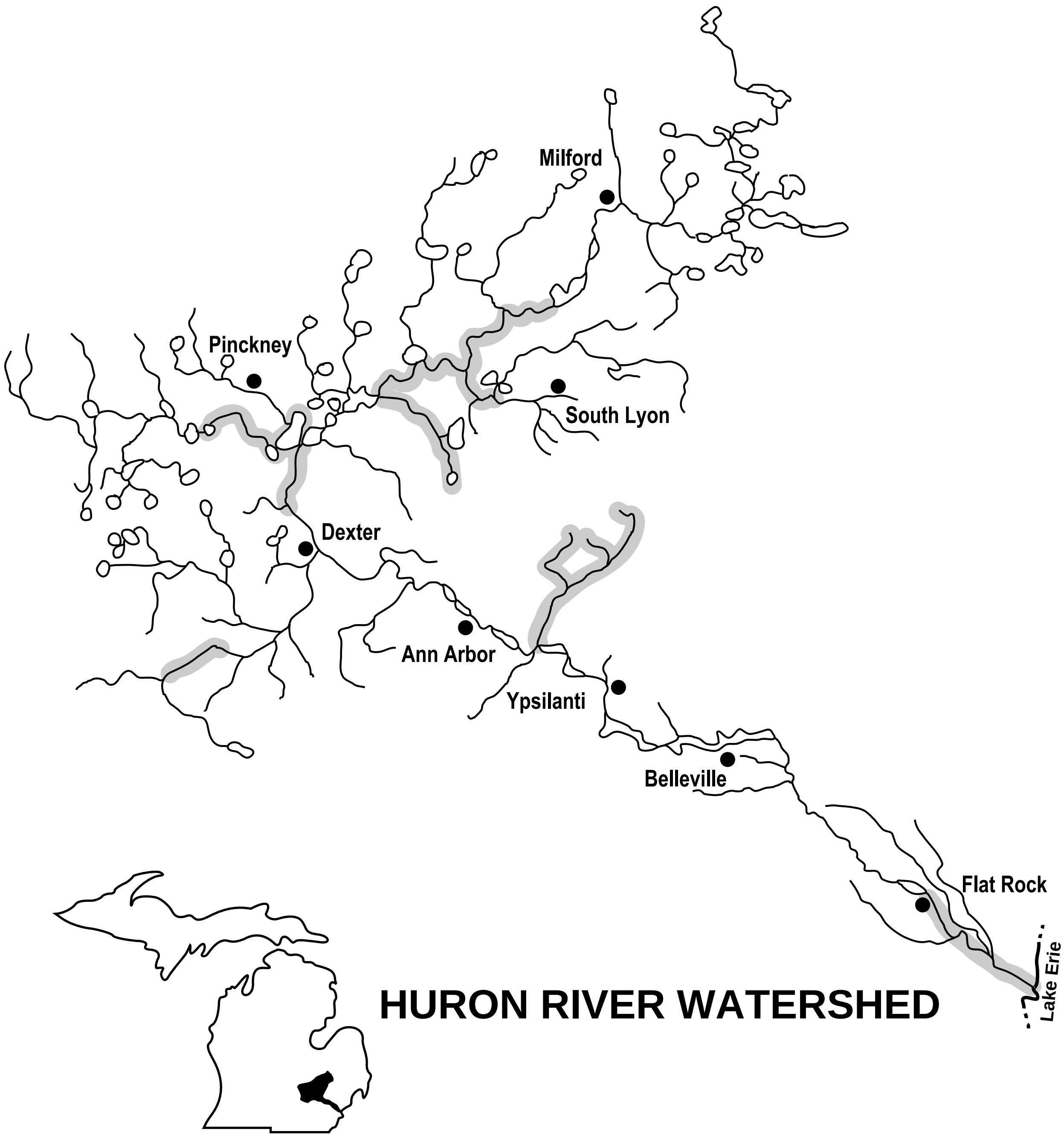


Tadpole madtom (*Noturus gyrinus*)

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)

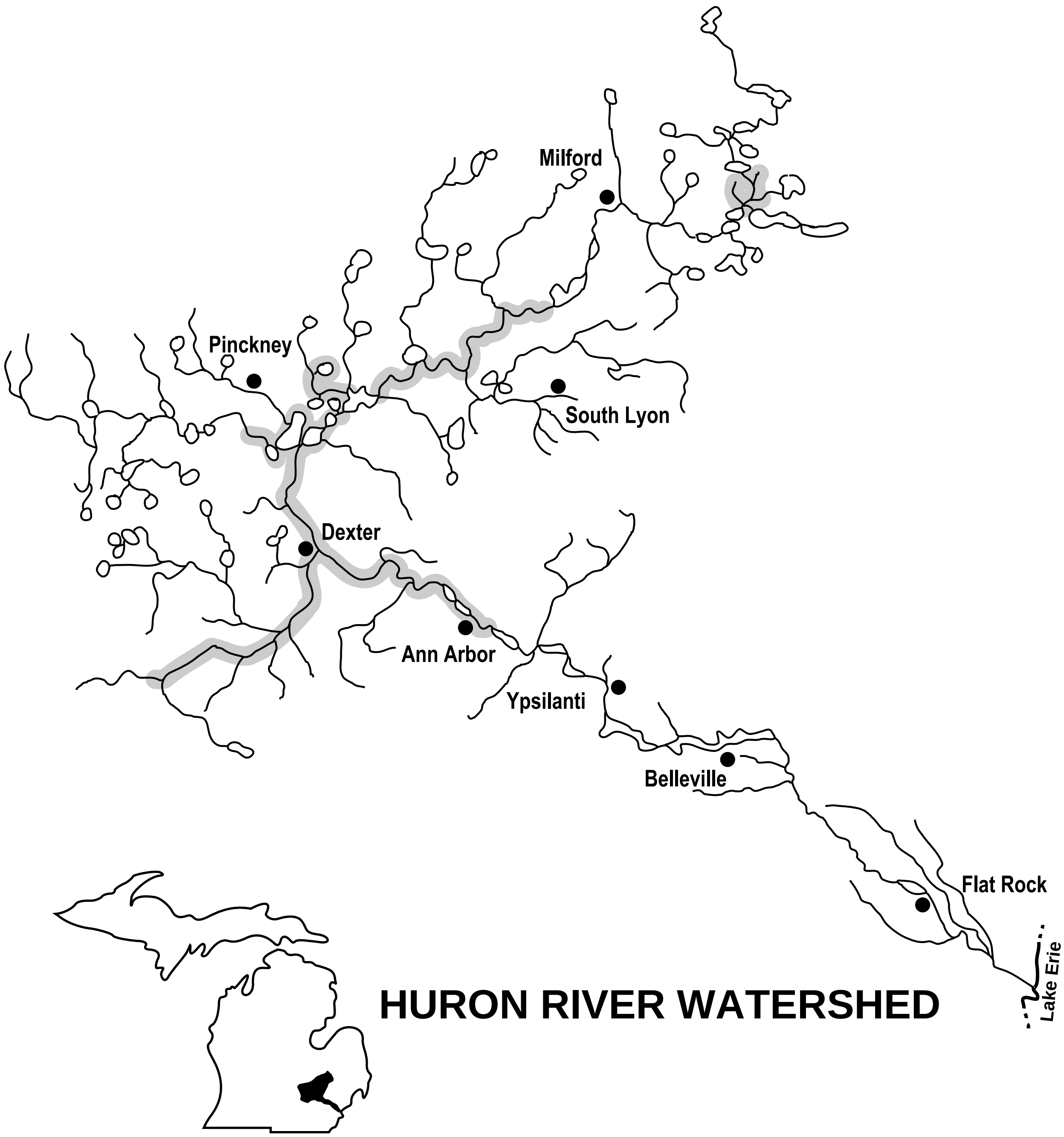


Brindled madtom (*Noturus miurus*) - declining

Habitat:

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

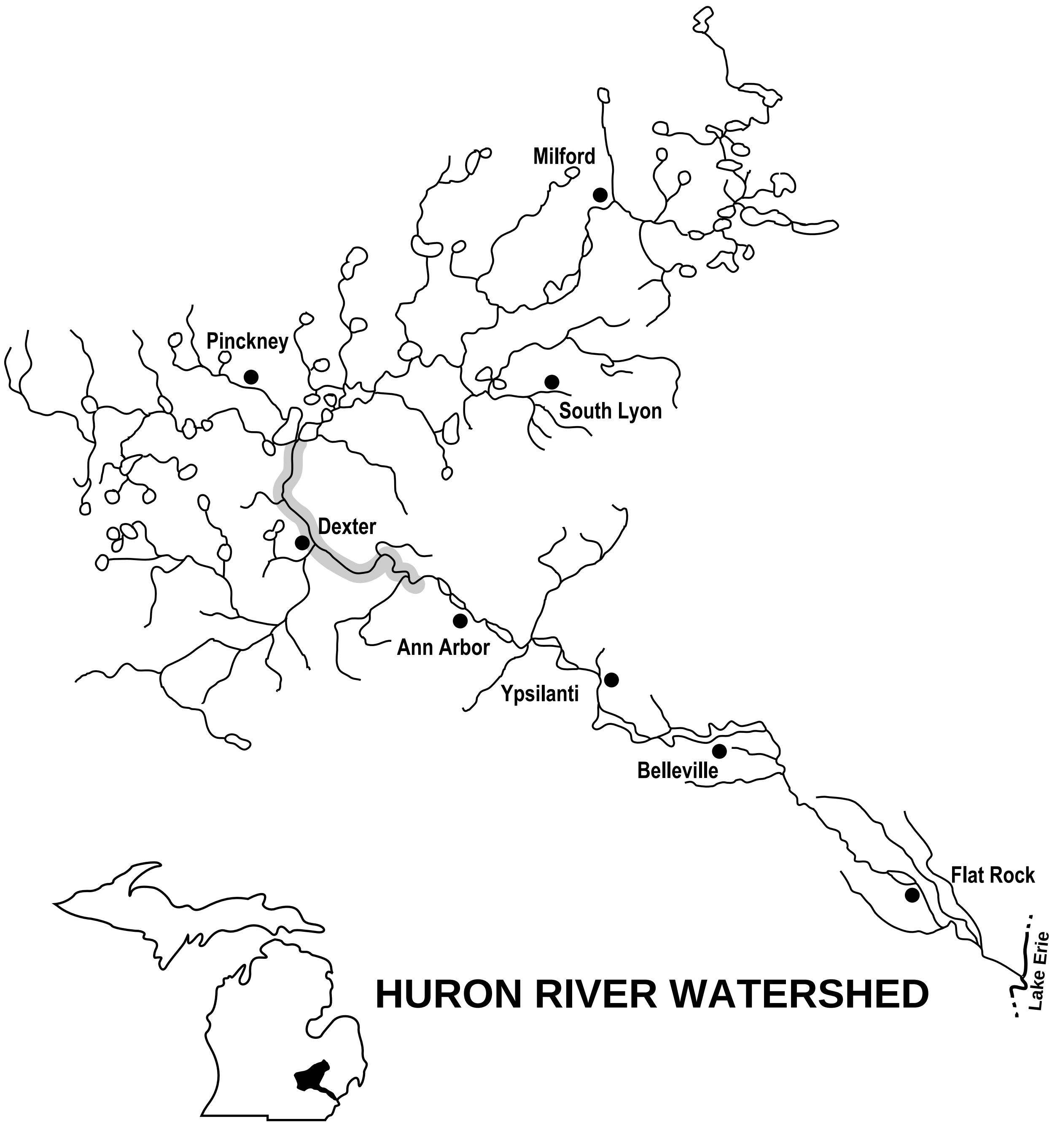
spawning
- silt or mud substrate
- emergent vegetation



Northern madtom (*Noturus stigmosus*) - endangered

Habitat:

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

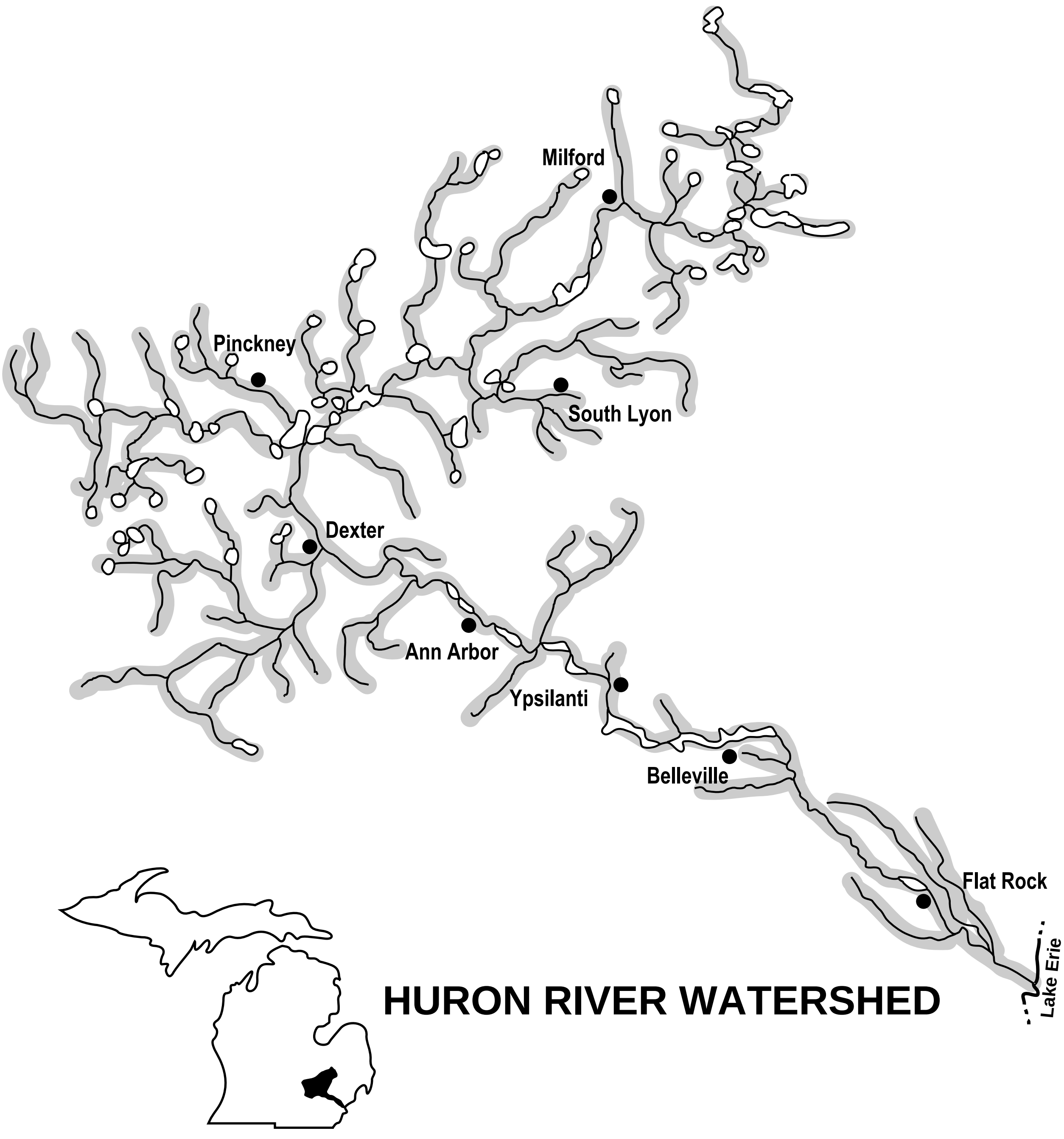


Grass pickerel (*Esox americanus vermiculatus*)

Habitat:

feeding
- juveniles: along shore
- adults: in deeper portions of streams, rivers, lakes, and impoundments
- clear water, little current, dense vegetation
- tolerates low oxygen concentrations

spawning
- broadcast spawner over submerged vegetation

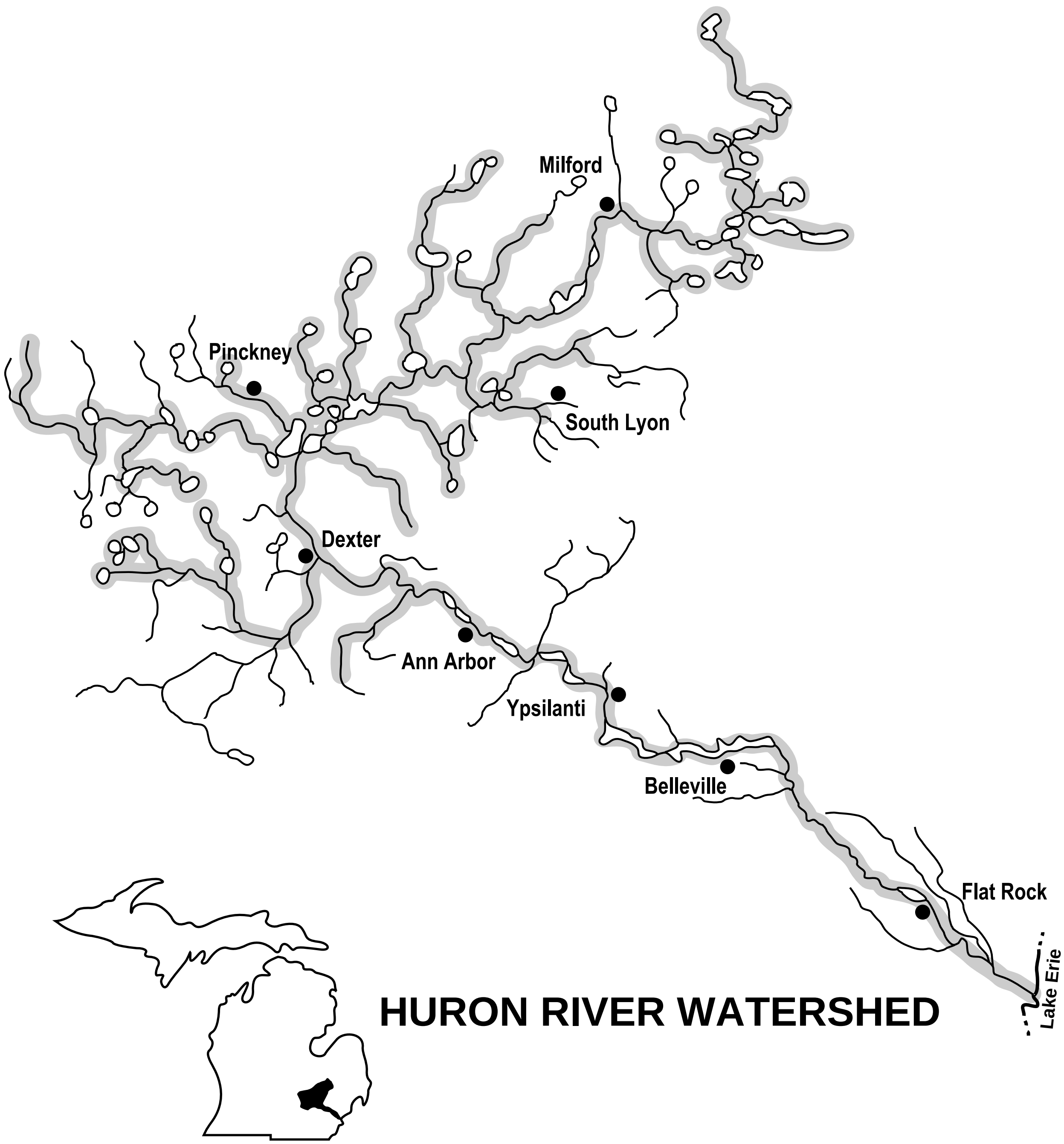


Northern pike (*Esox lucius*)

Habitat:

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

spawning - submerged vegetation with slow current in shallow water

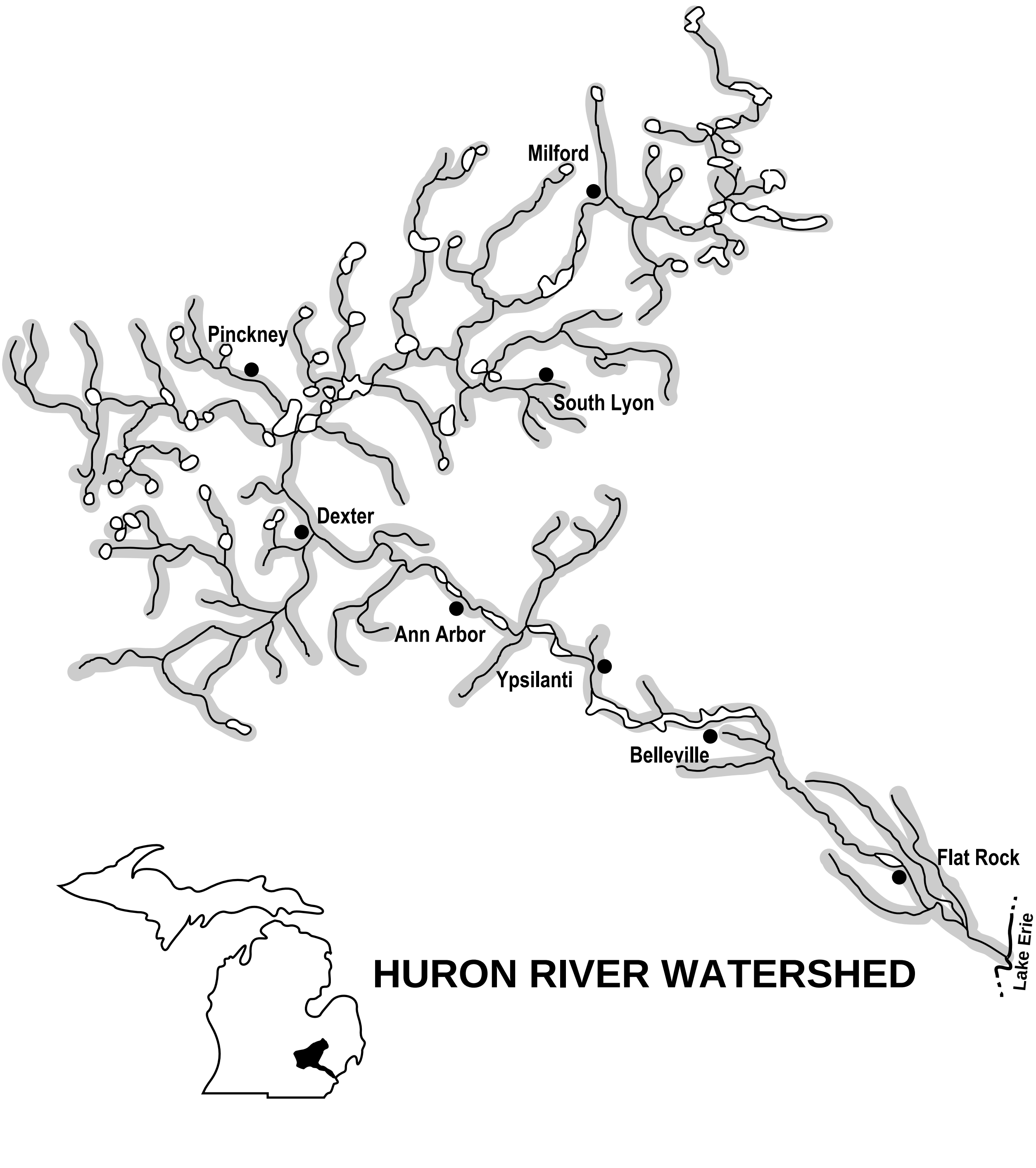


Central mudminnow (*Umbra limi*)

Habitat:

feeding - undisturbed clear, low-gradient streams or rivers and lakes and impoundments
- organic debris, muck, or peat substrates
- aquatic vegetation

spawning - floodplain areas, on vegetation

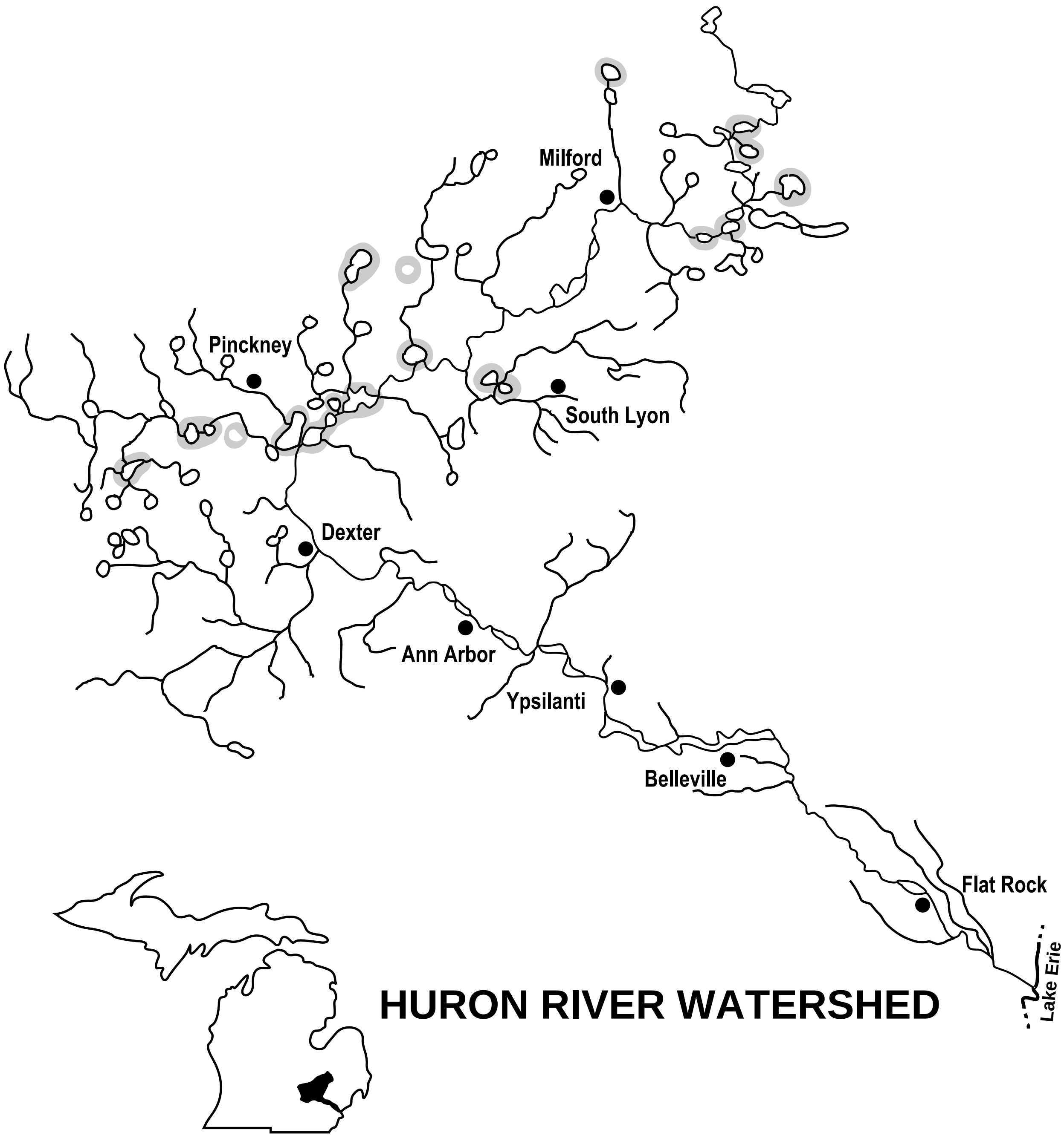


Cisco {Lake herring} (*Coregonus artedi*)

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

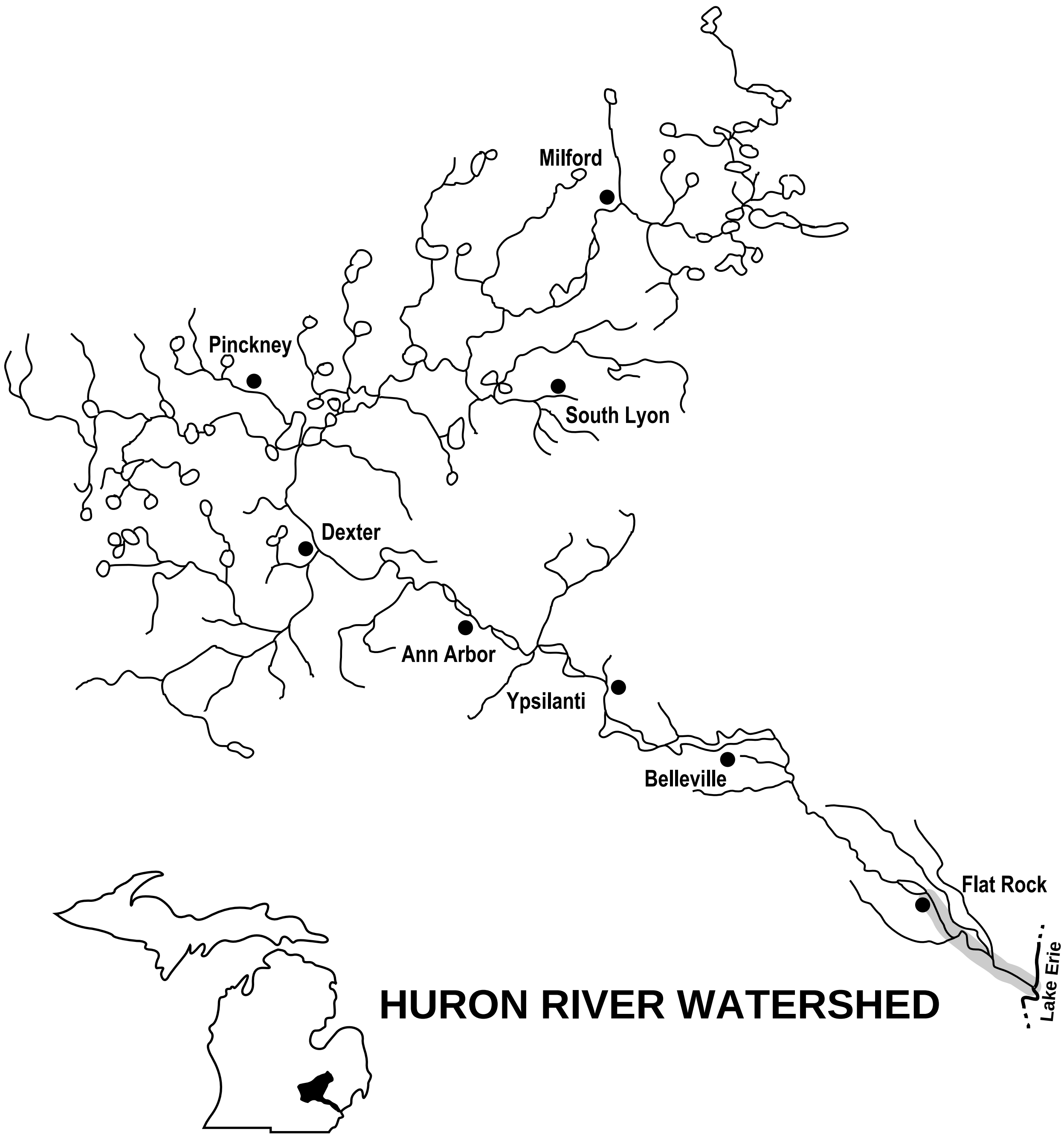


Coho salmon (*Oncorhynchus kisutch*)

Habitat:

feeding - adults: Lake Erie
- young: shallow gravel substrate in cold streams, later into pools

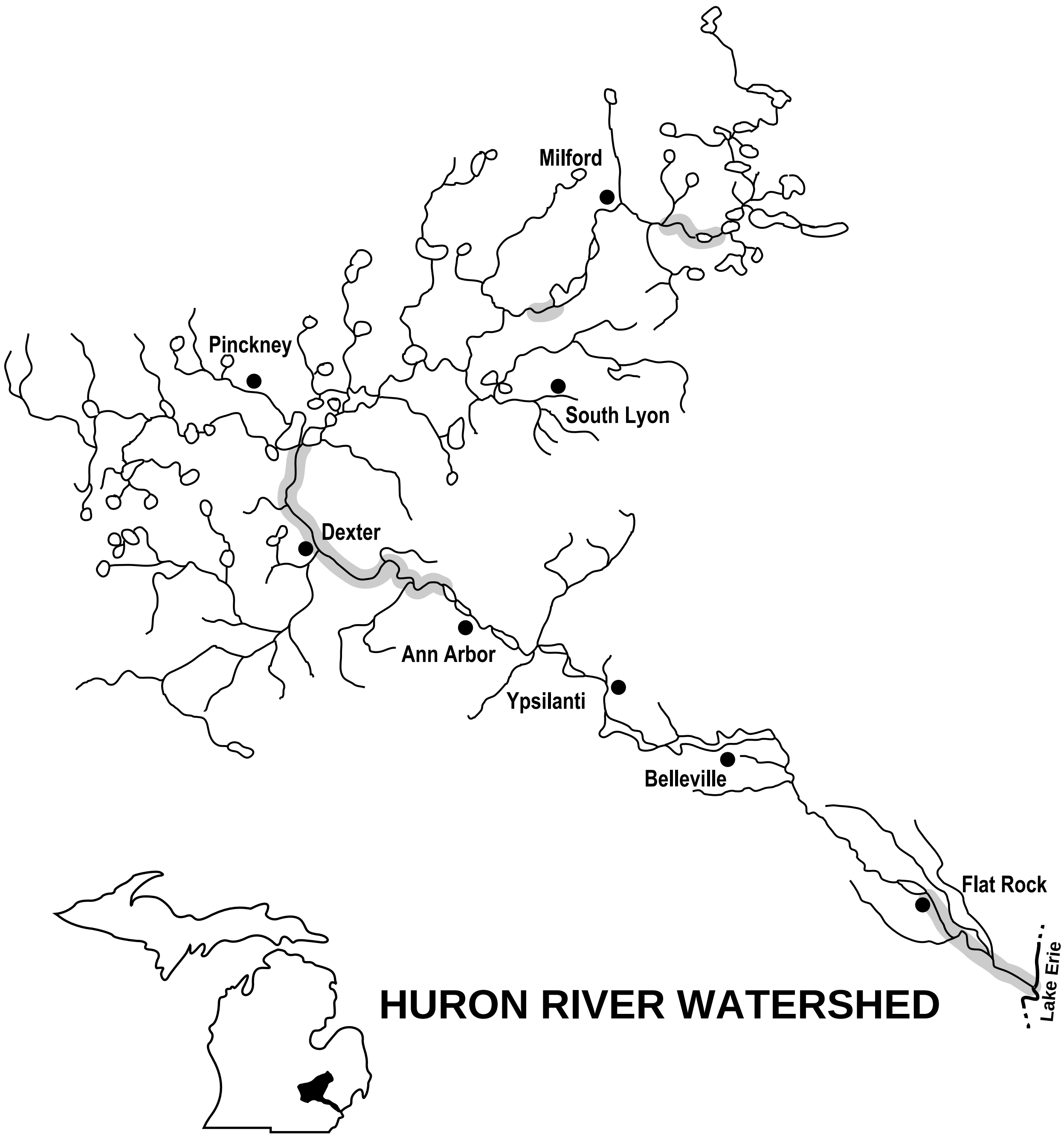
spawning - cold streams and rivers
- swifter water of shallow gravelly substrate



Rainbow trout (*Oncorhynchus mykiss*)

Habitat:

feeding	- cold clear water of rivers and Lake Erie
	- moderate current
spawning	- gravelly riffles above a pool
	- smaller tributaries

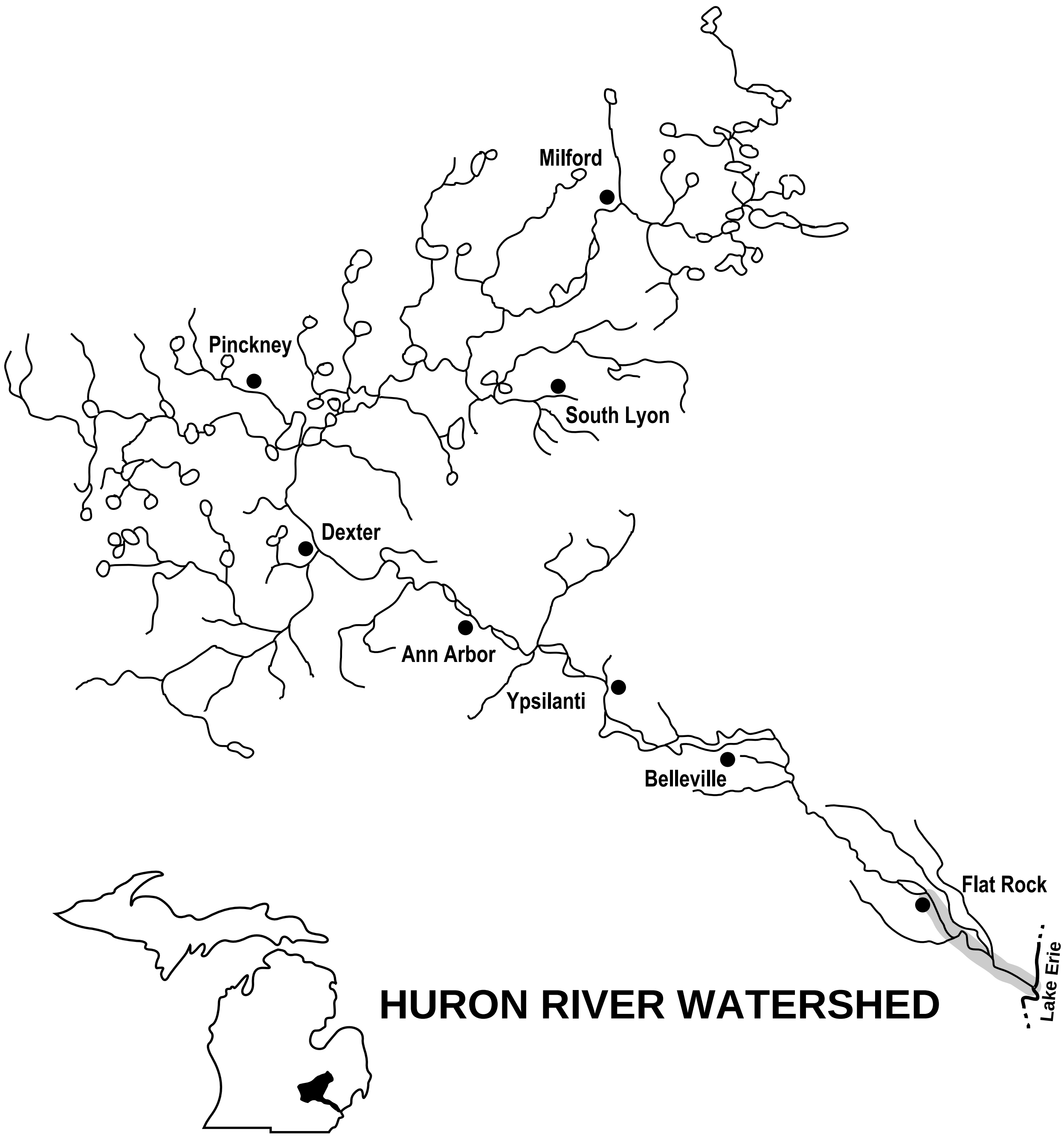


Chinook salmon (*Oncorhynchus tshawyscha*)

Habitat:

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

spawning - gravelly substrate in cool streams

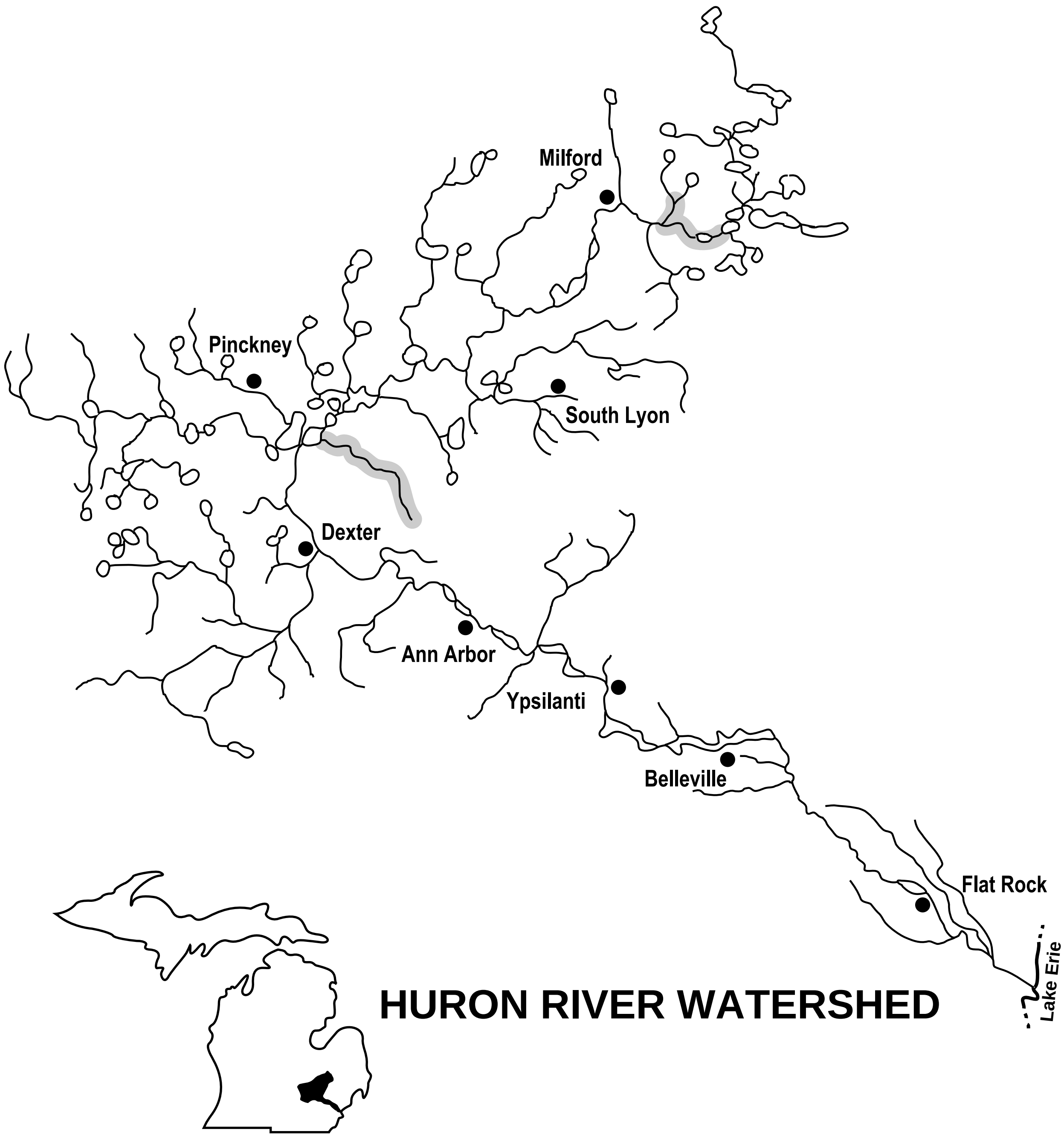


Brown trout (*Salmo trutta*)

Habitat:

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

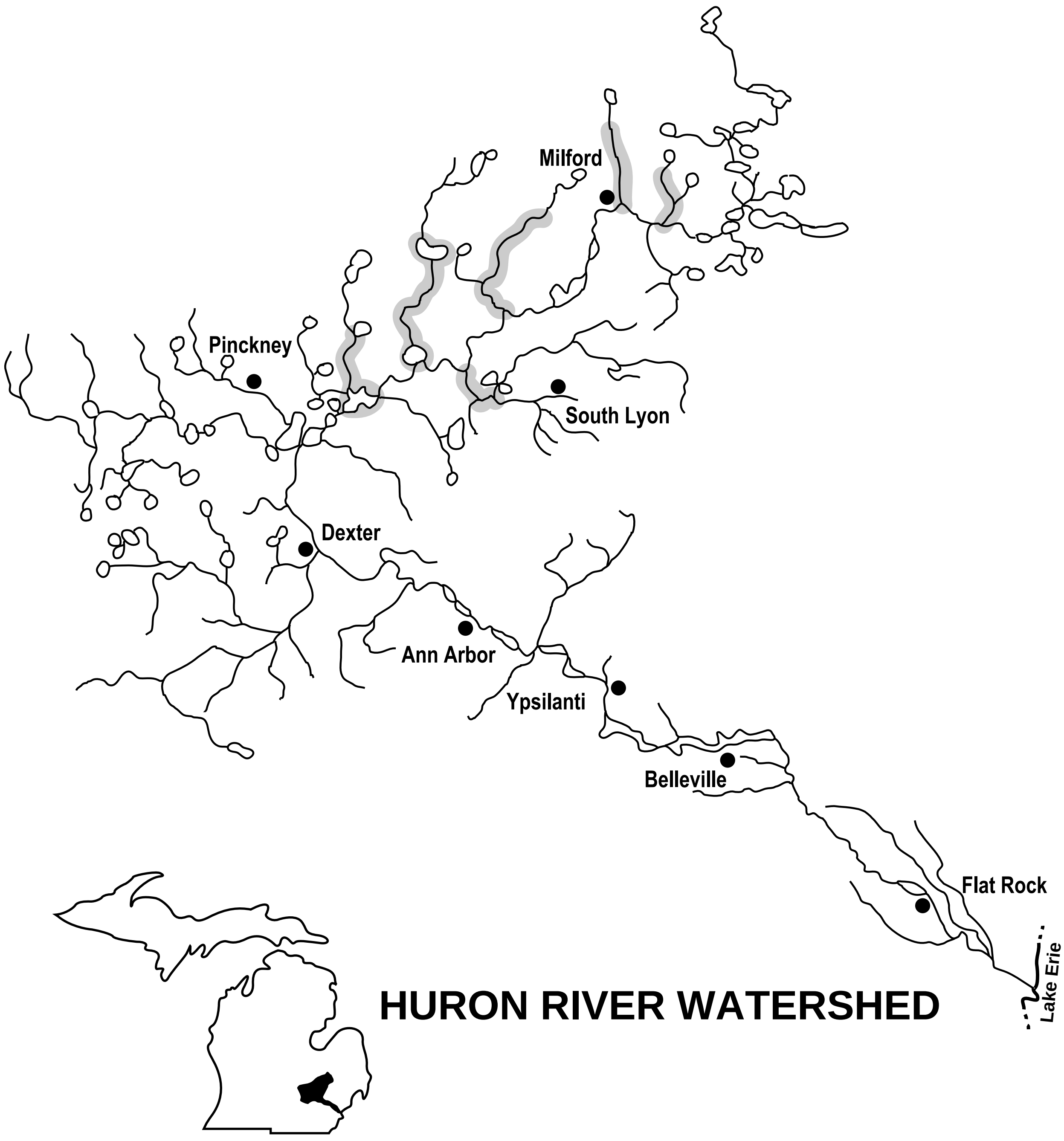
spawning - gravelly riffles; shallow headwater areas



Brook trout (*Salvelinus fontinalis*)

Habitat:

feeding	-	cold, clear streams, rivers, and lakes (not >65˚F)
	-	low current
	-	well oxygenated water
spawning	-	gravelly riffles; shallow or headwater streams

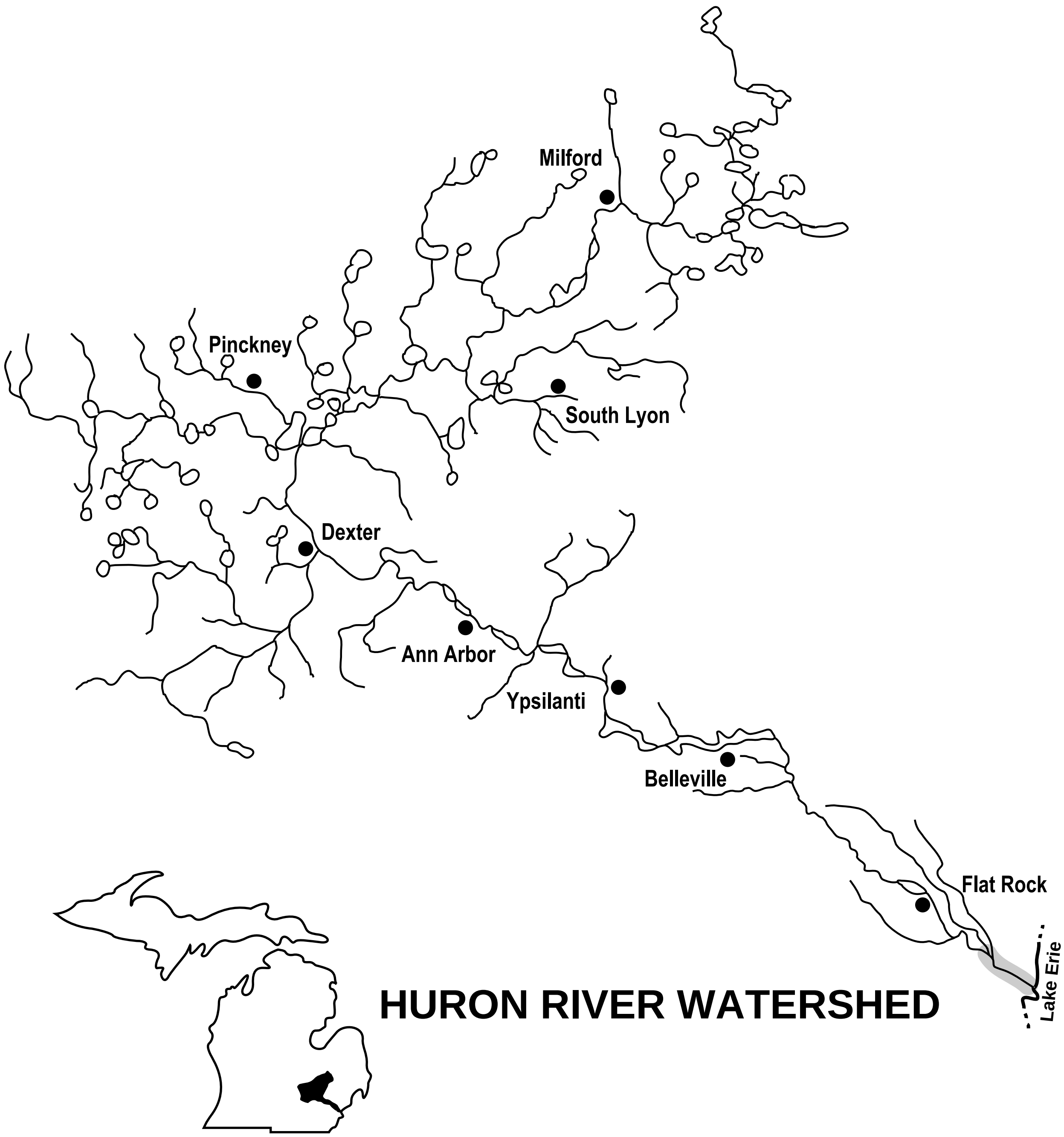


Trout-perch (*Percopsis omiscomaycus*)

Habitat:

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

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

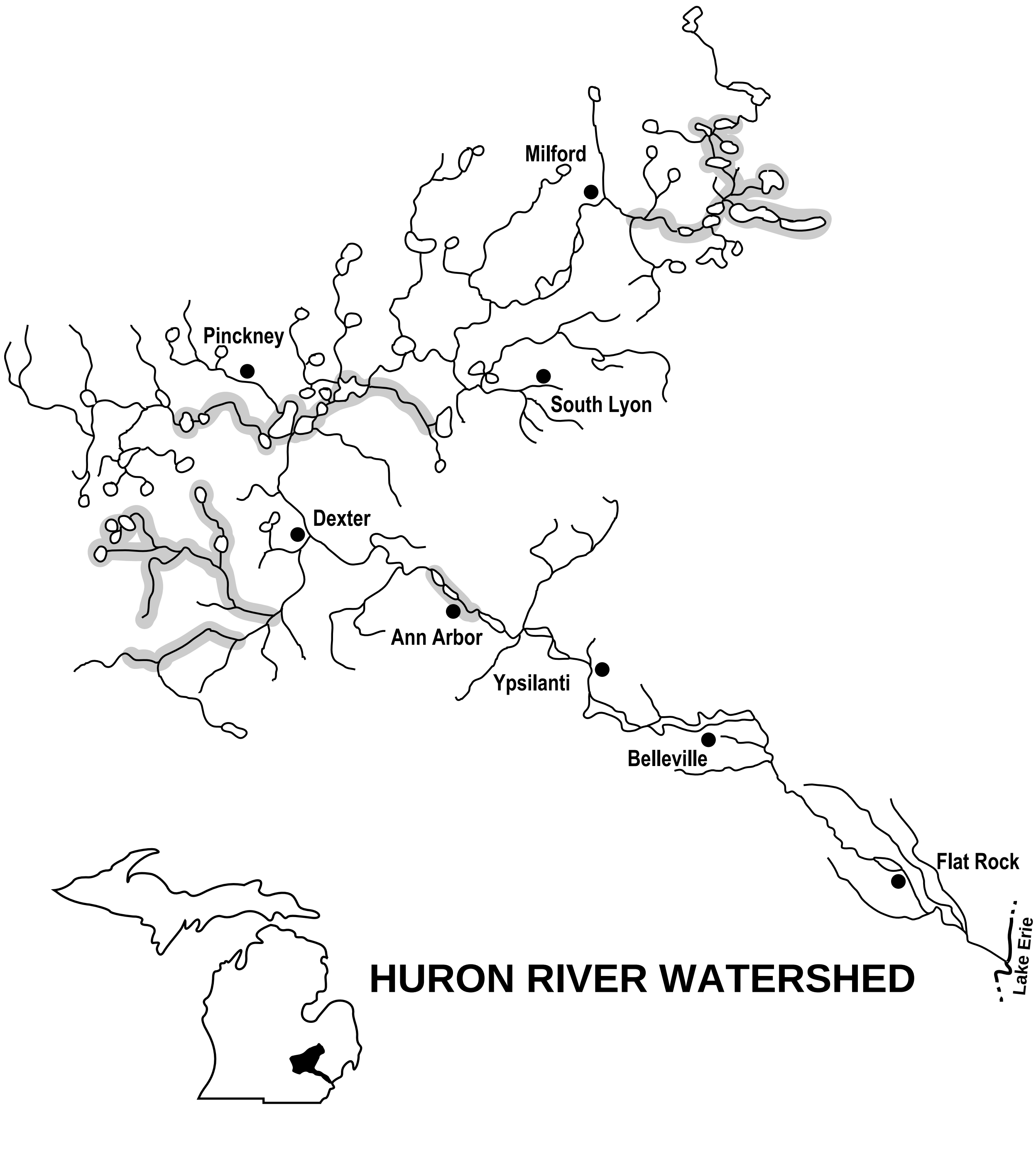


Banded killifish (*Fundulus diaphanus*)

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



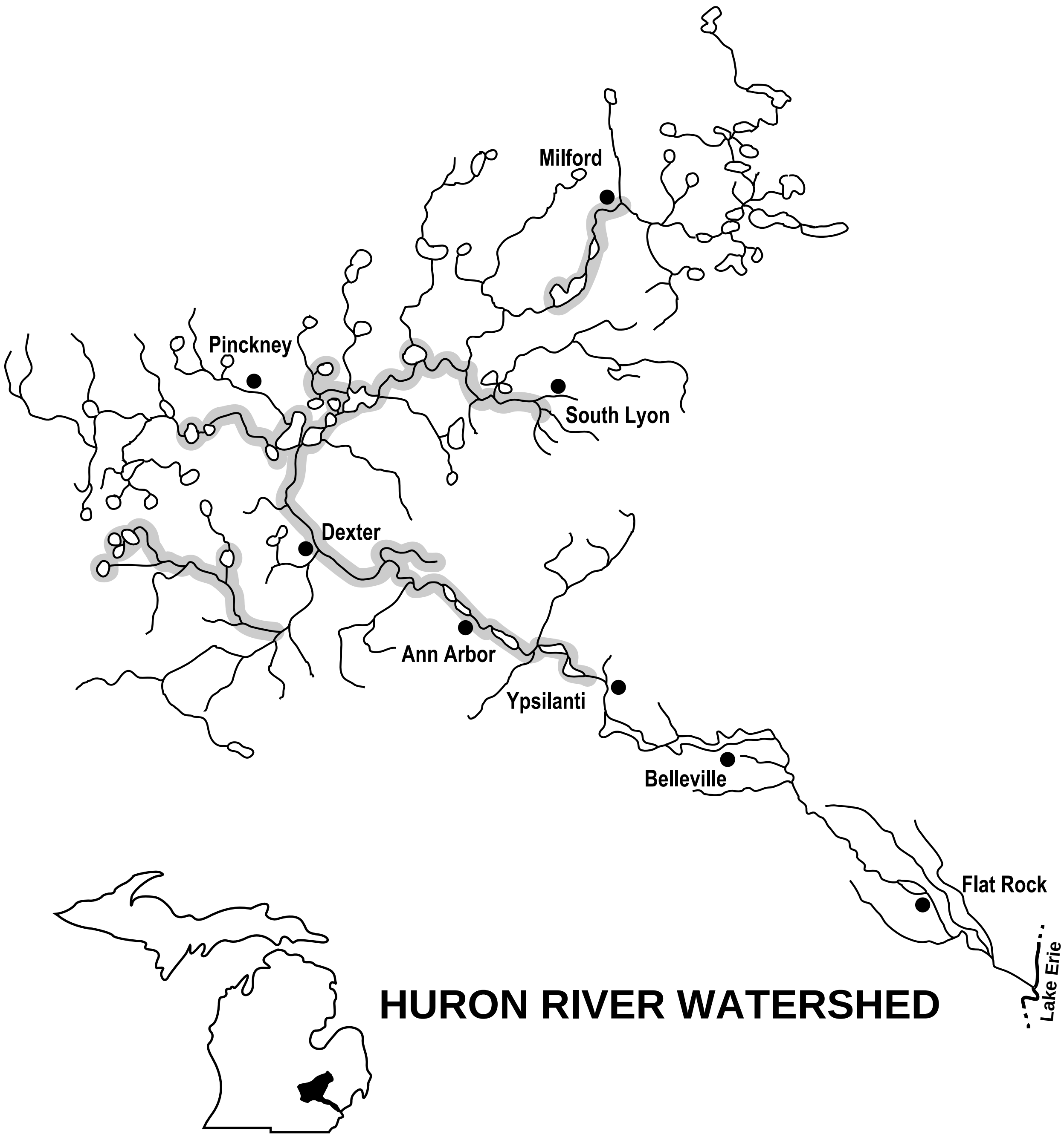
Blackstripe topminnow (*Fundulus notatus*)

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

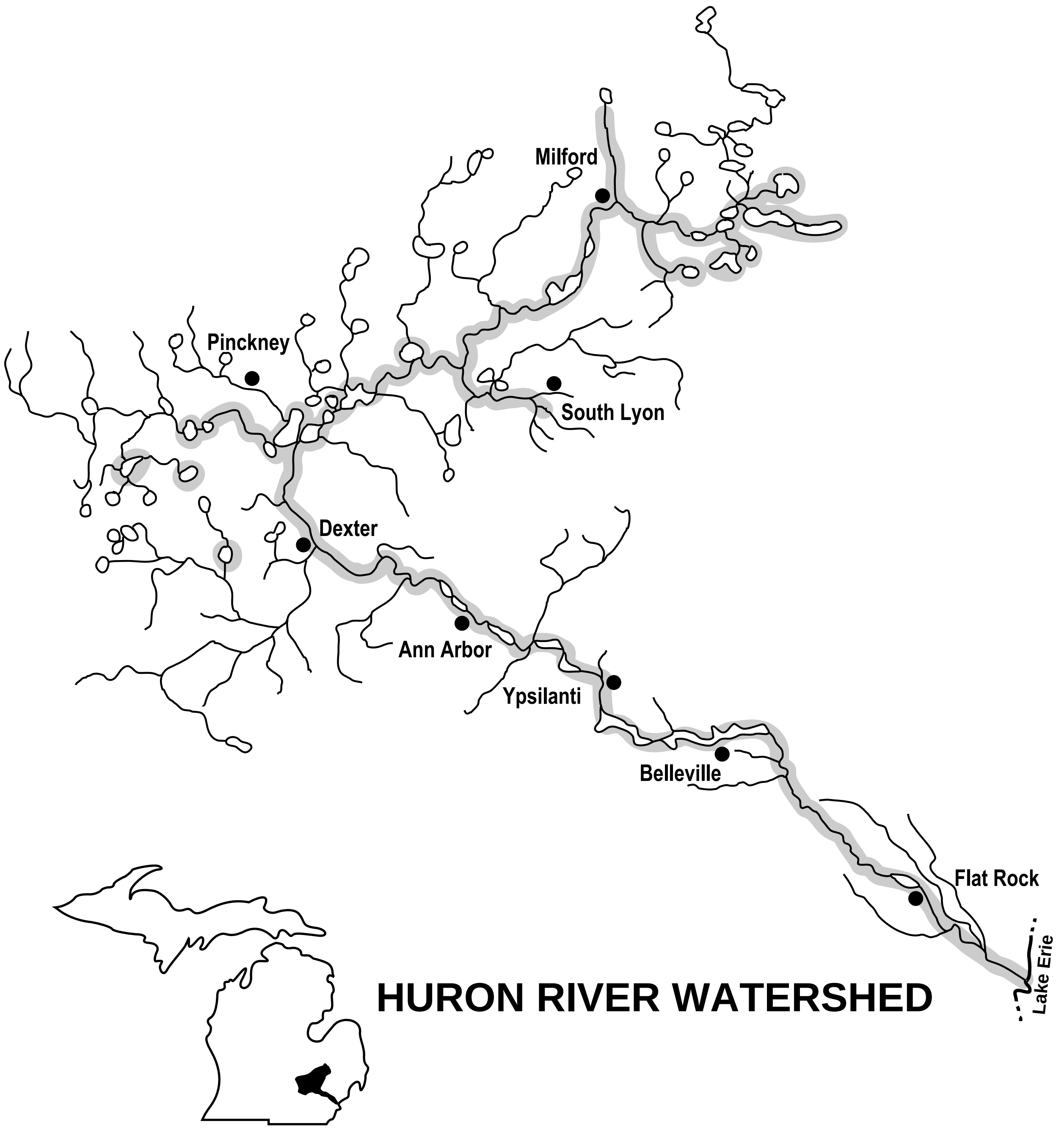


Brook silverside (*Labidesthes sicculus*)

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

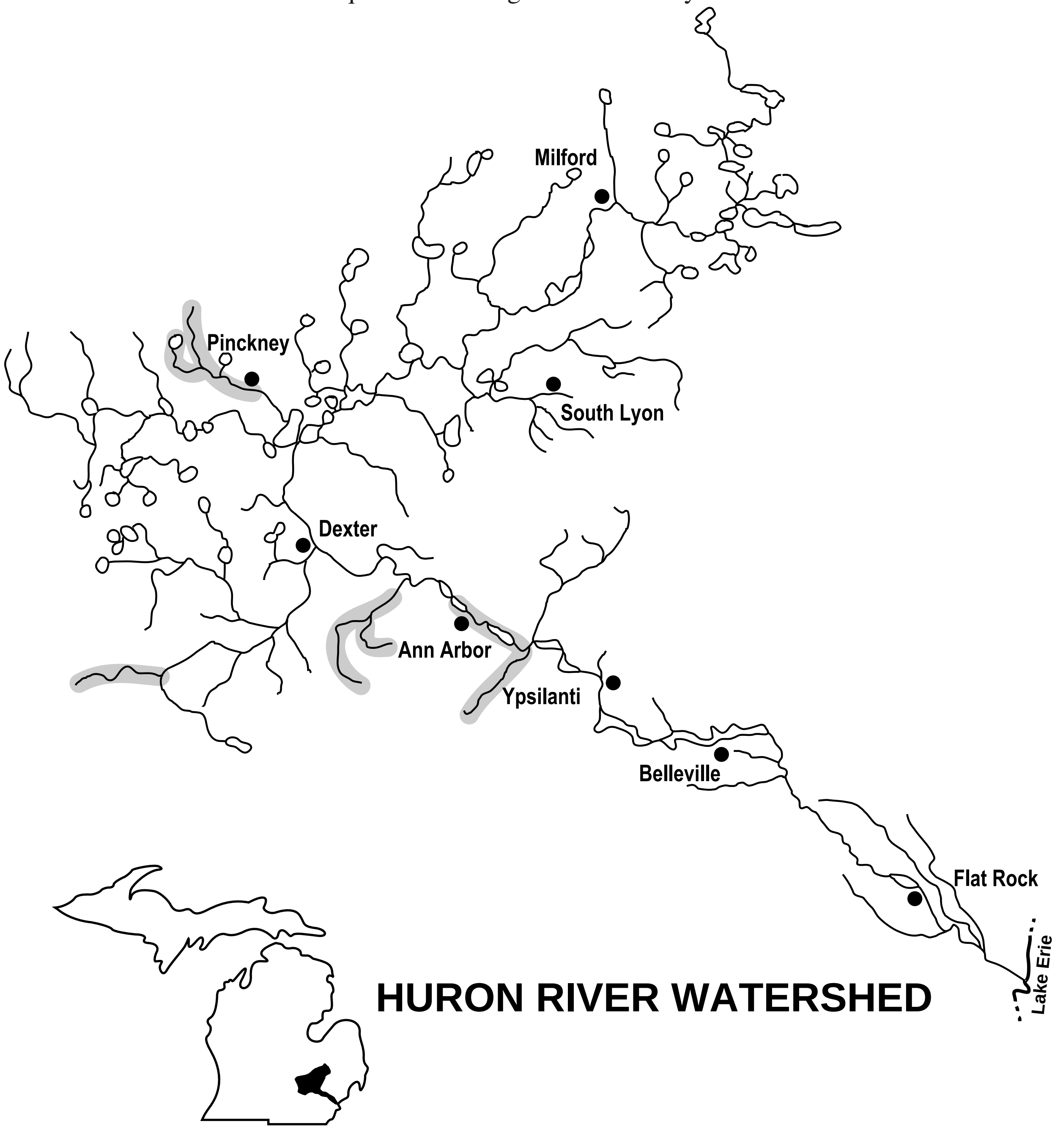


Brook stickleback (*Cluaea inconstans*)

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

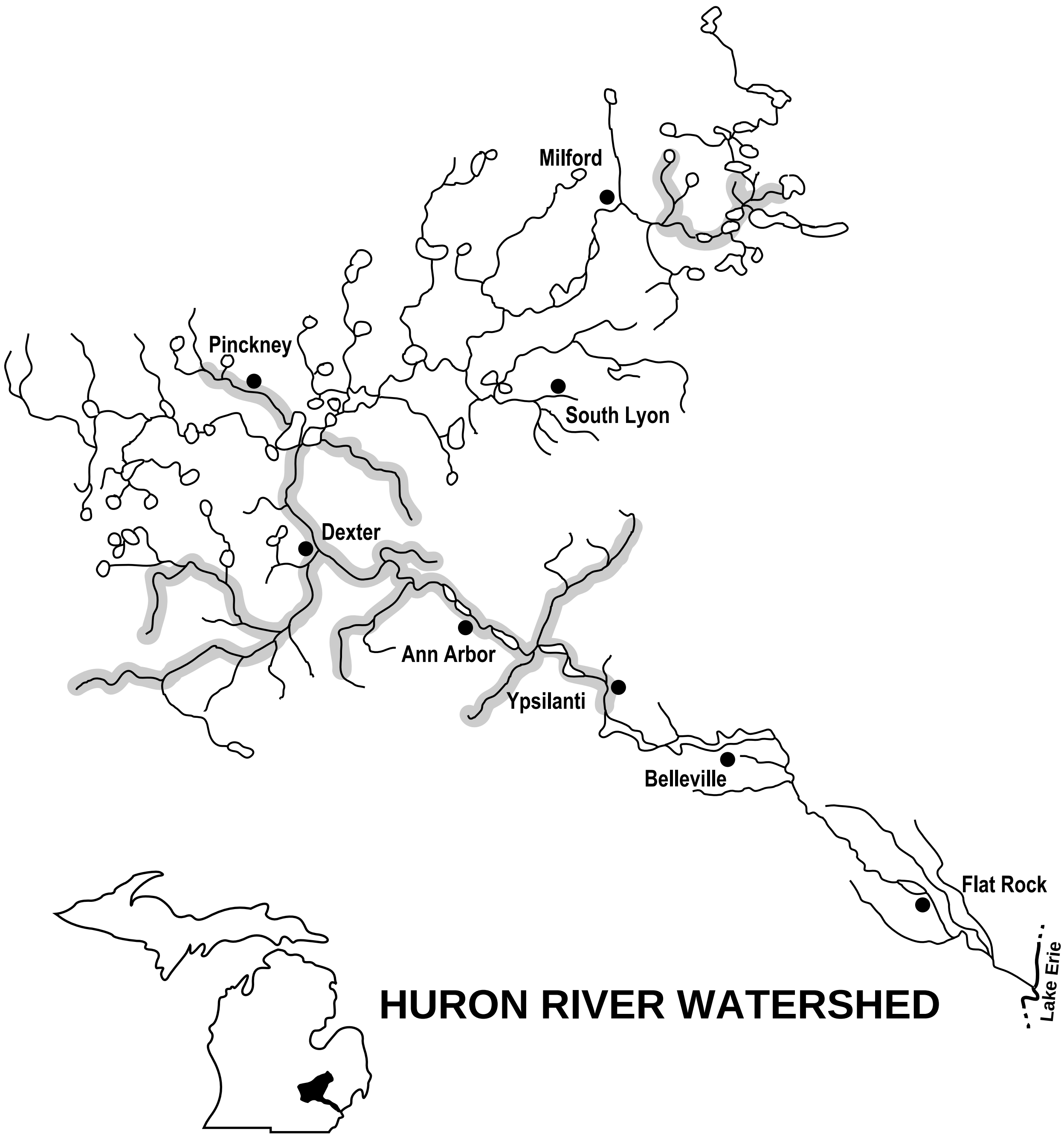


Mottled sculpin (*Cottus bairdi*)

Habitat:

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

spawning - nests under logs or rock

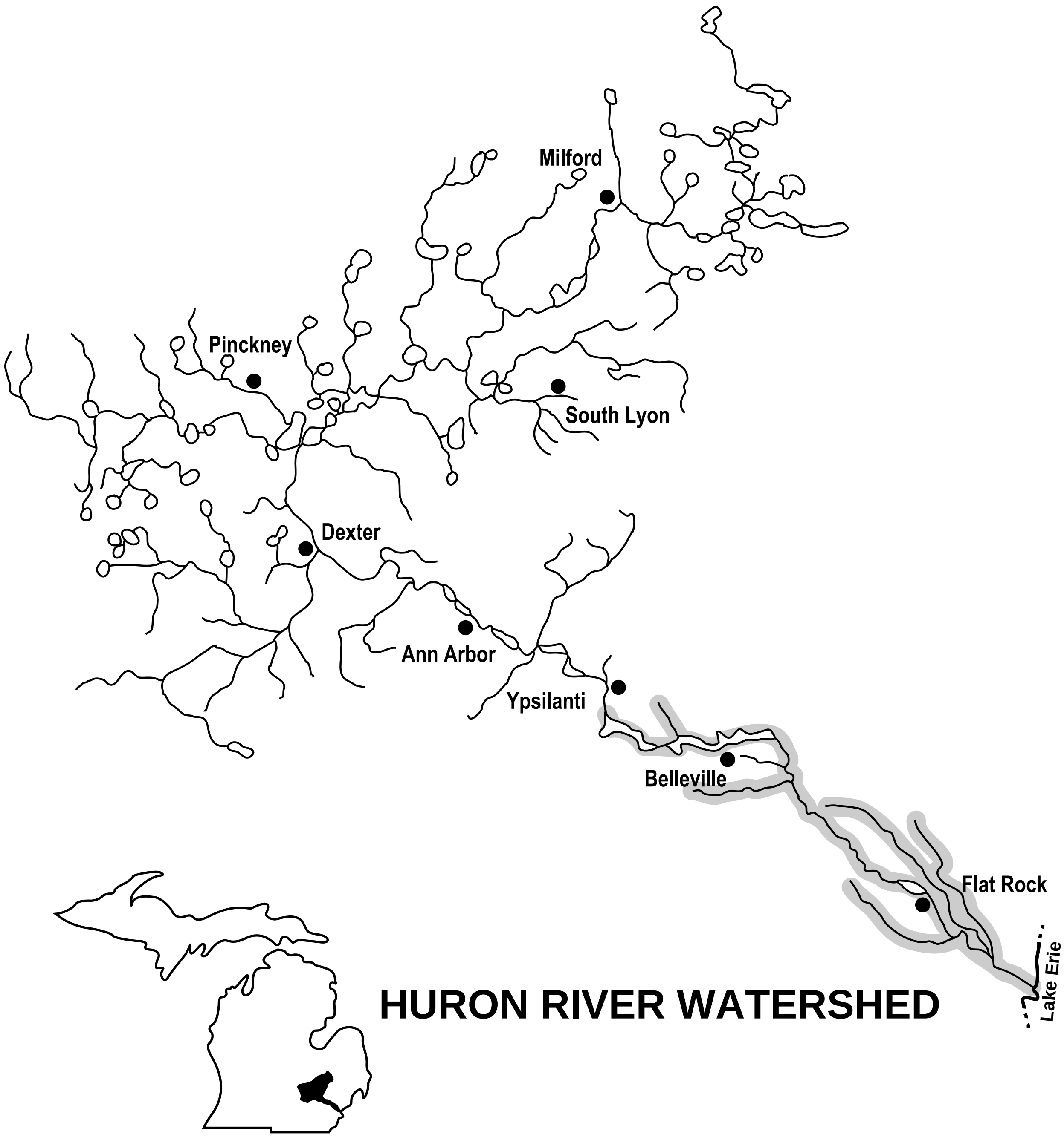


White perch (*Morone americana*)

Habitat:

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

spawning - shallow water over firm substrate

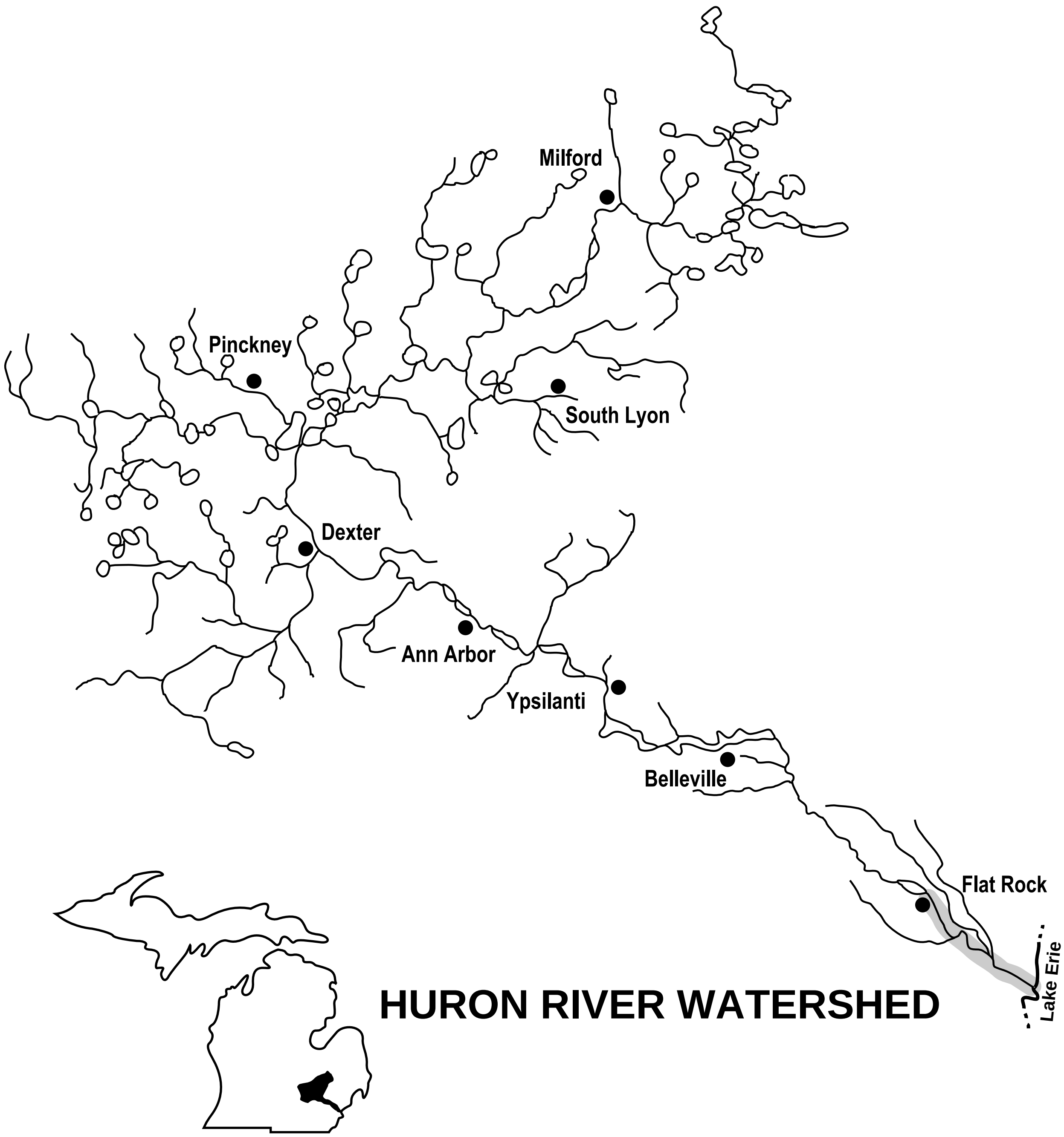


White bass (*Morone chrysops*)

Habitat:

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

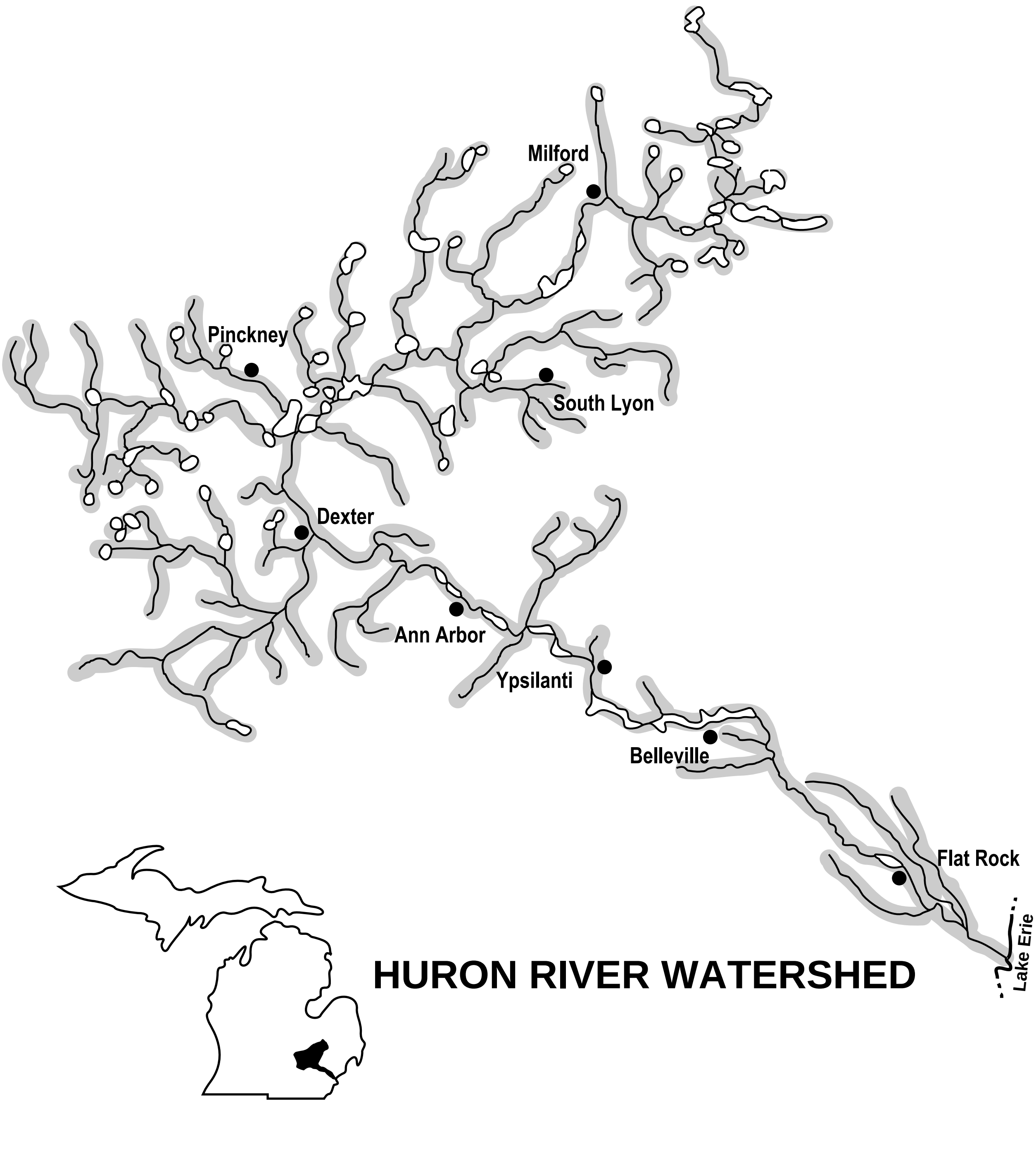
spawning - tributary streams or shallow water of lakes
- over firm substrate



Rock bass (*Ambloplites rupestris*)

Habitat:

feeding	-	clear, cool streams, rivers, and lakes
	-	rocky to sand substrate
	-	woody or vegetative cover
spawning	-	sand or gravel nests
	-	shallow water
winter refuge	-	deep water

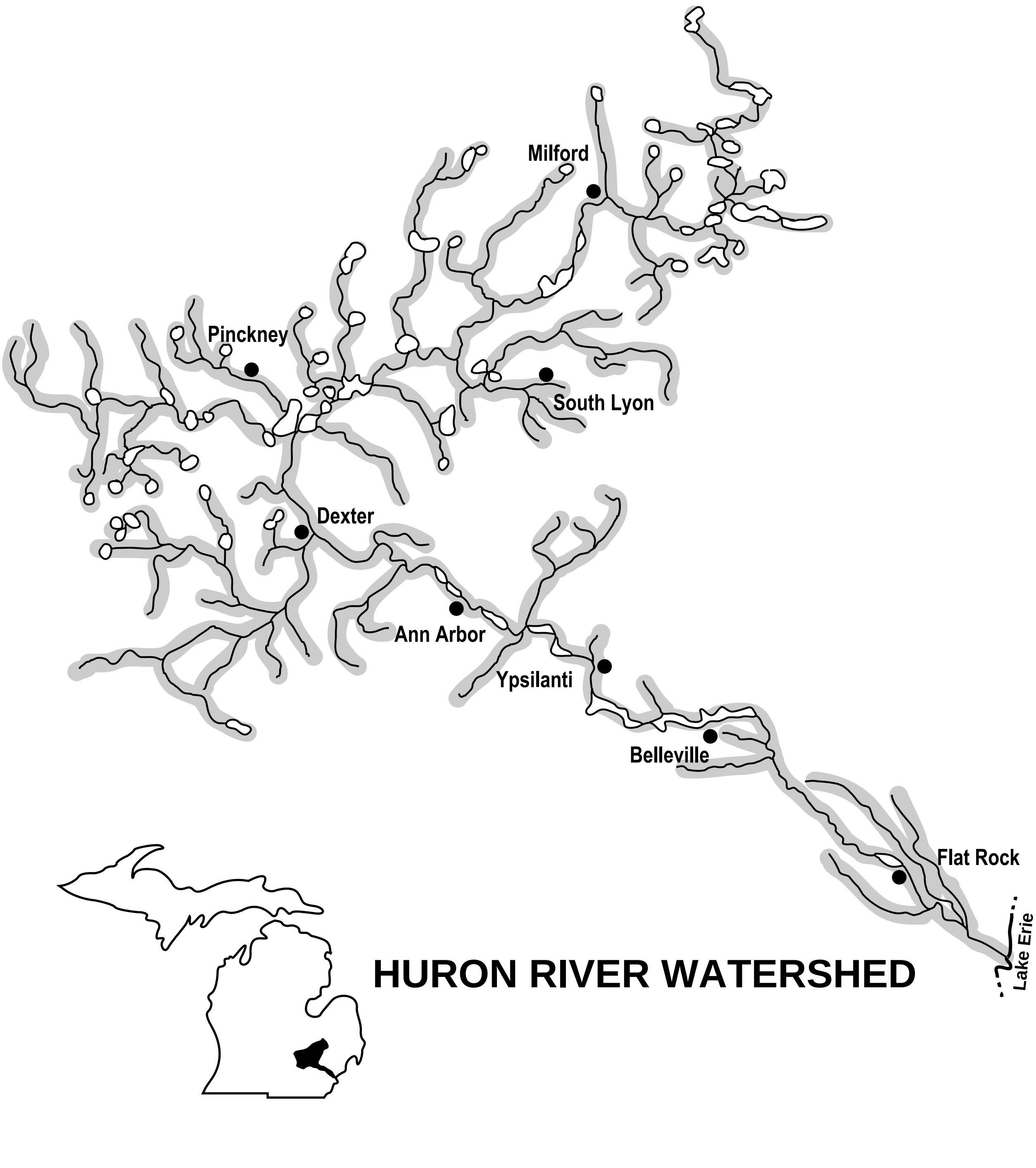


Green sunfish (*Lepomis cyanellus*)

Habitat:

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

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

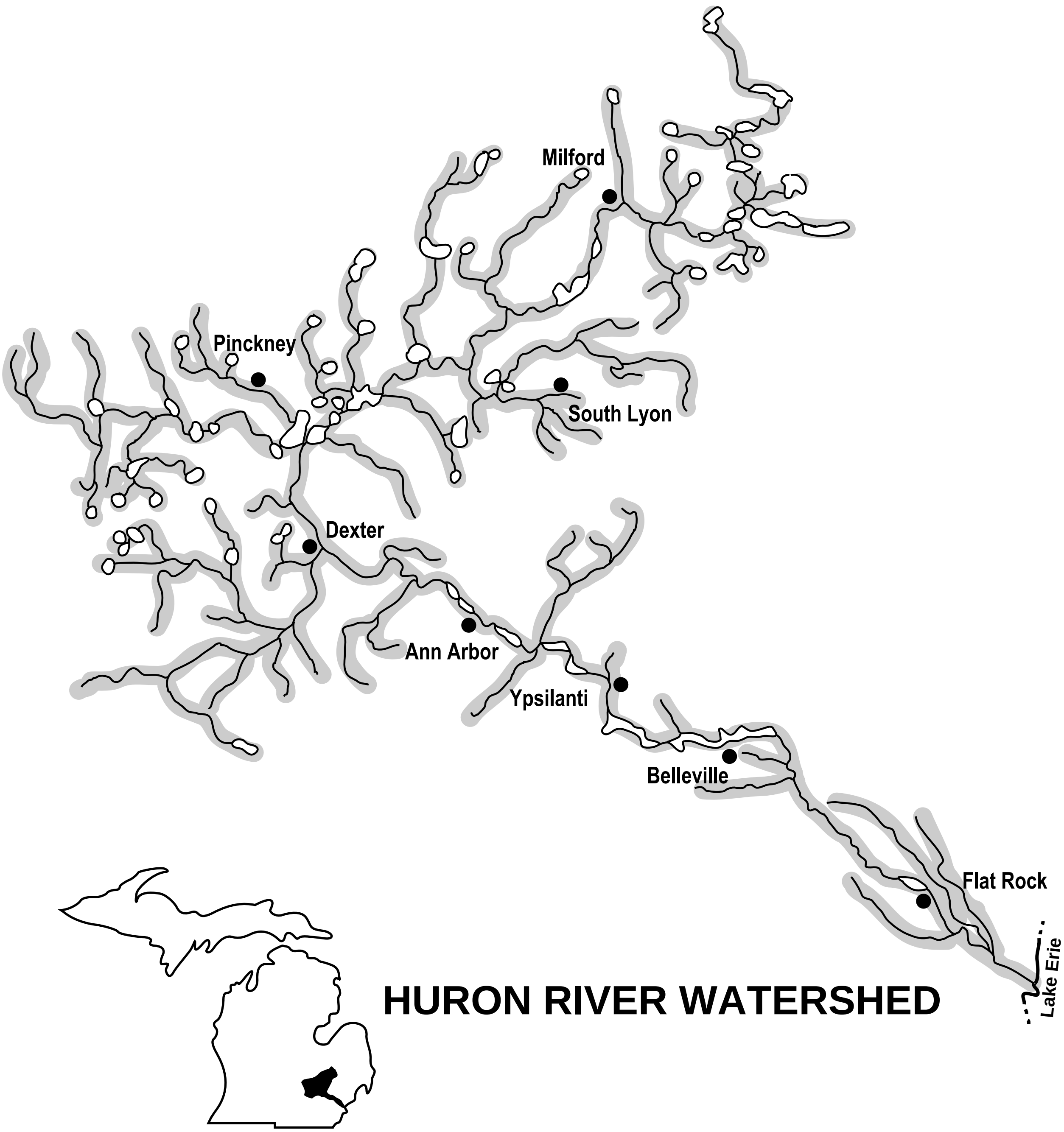


Pumpkinseed sunfish (*Lepomis gibbosus*)

Habitat:

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

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

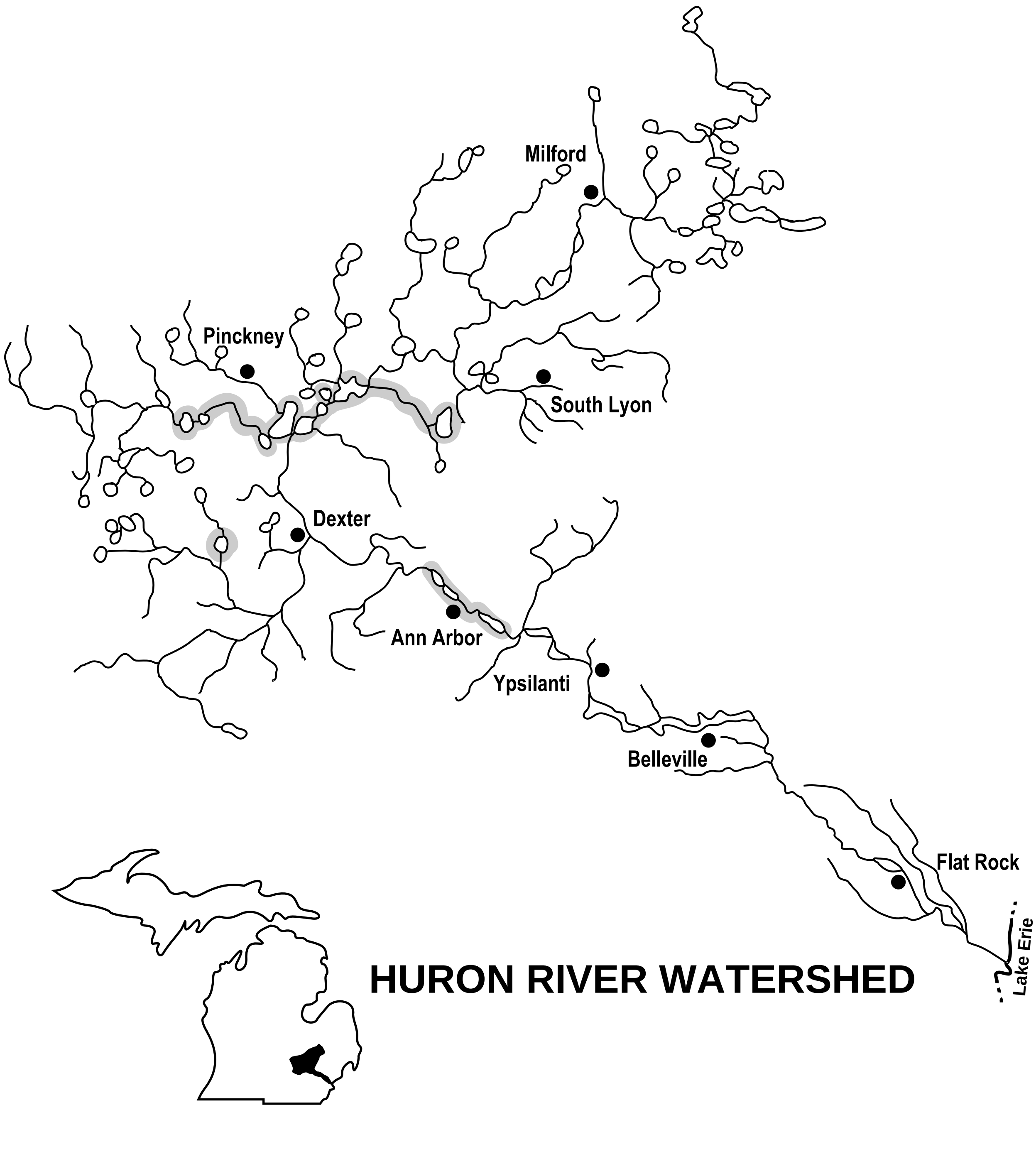


Warmouth (*Lepomis gulosus*)

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



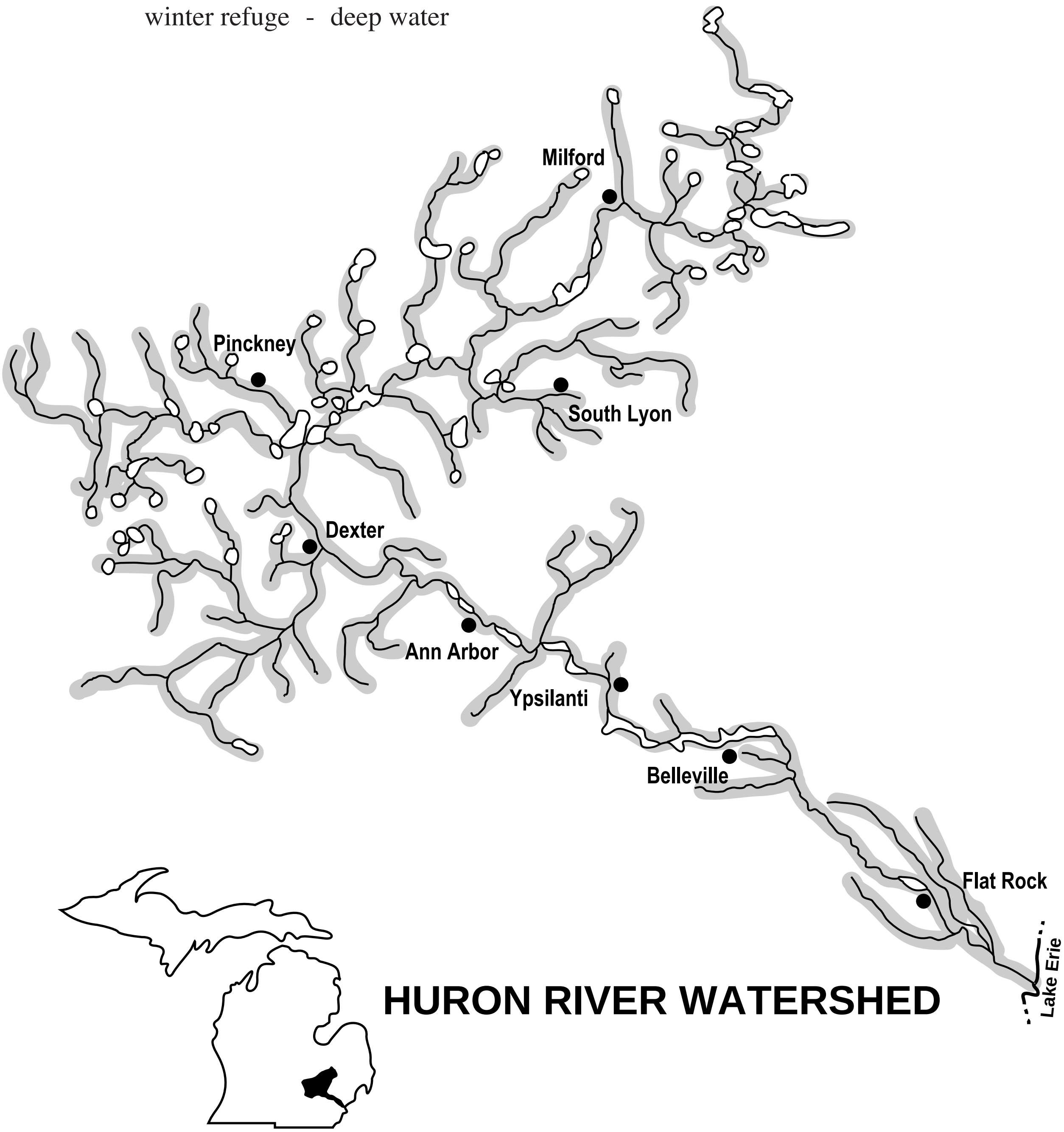
Bluegill (*Lepomis macochrius*)

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

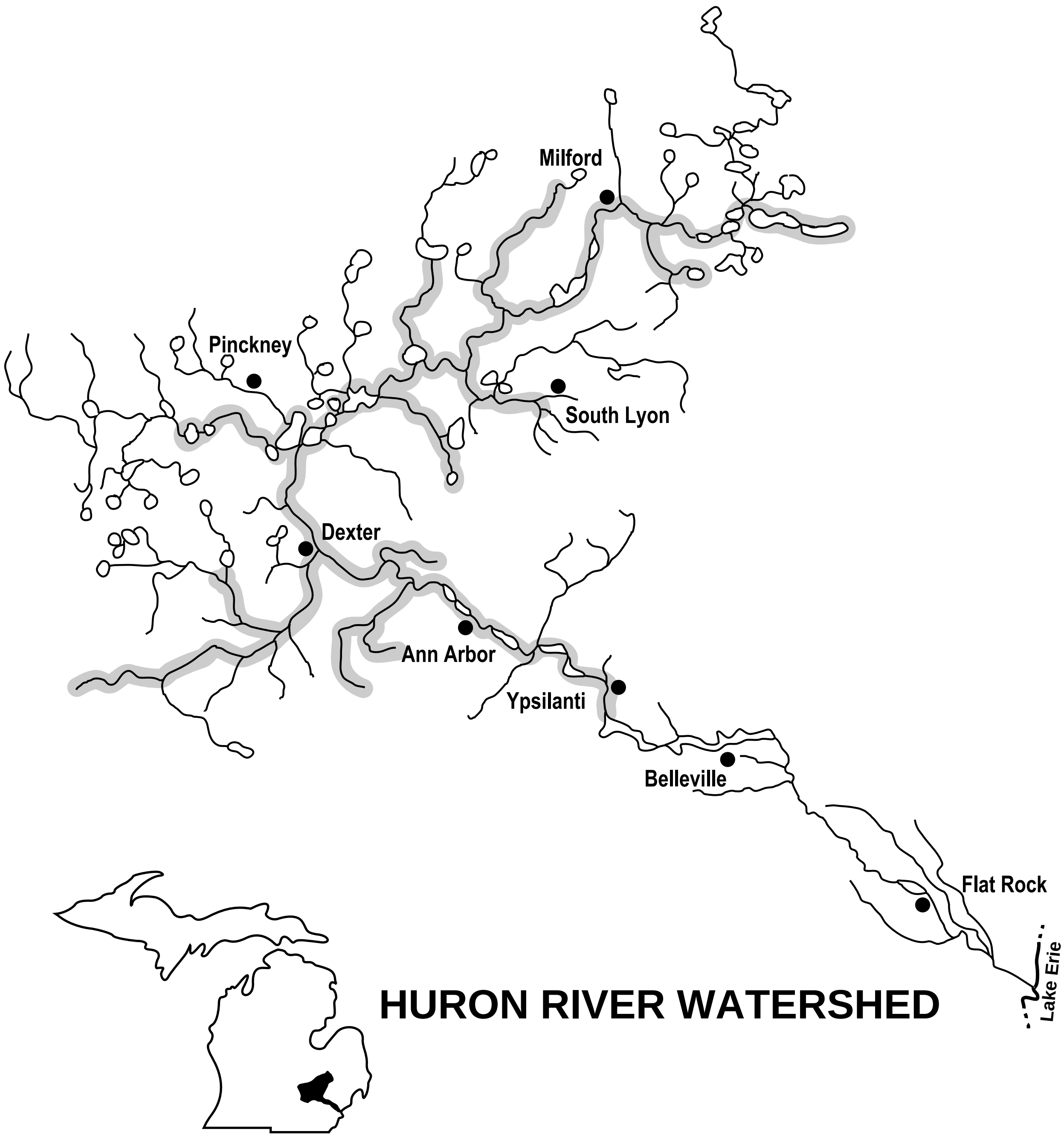


Longear sunfish (*Lepomis megalotis*)

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

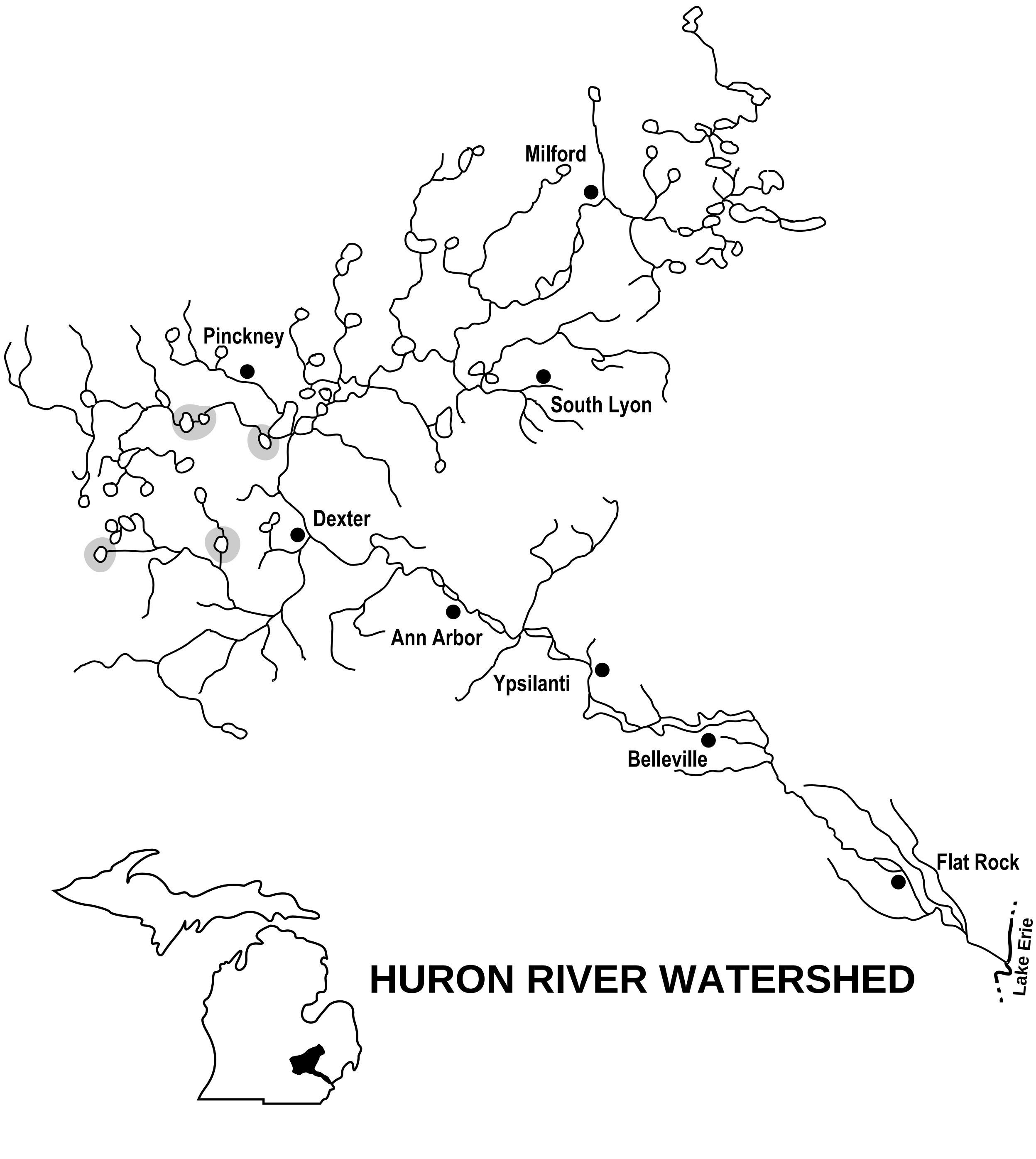


Redear sunfish (*Lepomis microlophus*)

Habitat:

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

spawning - nest in silt or gravel substrate



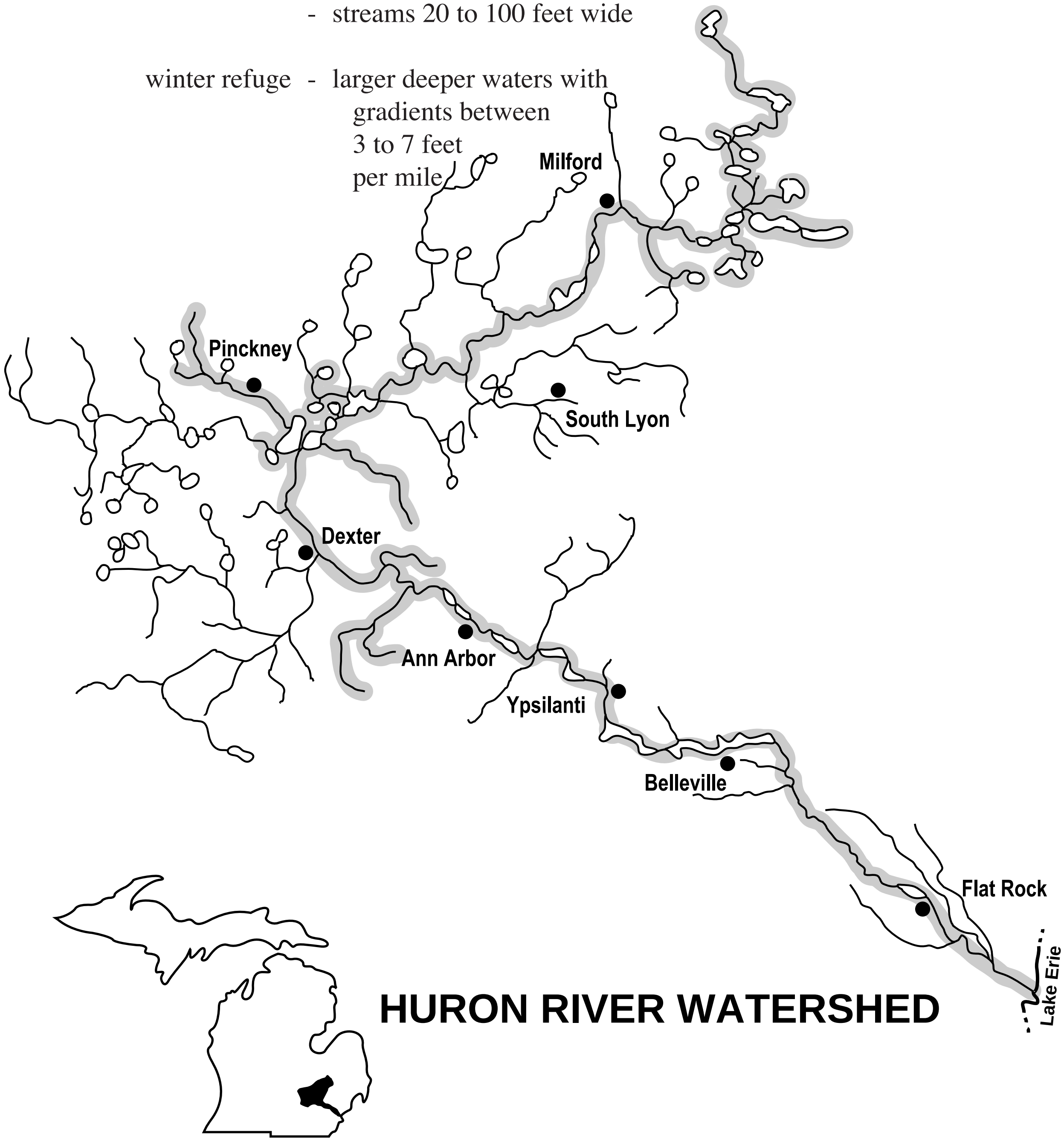
Smallmouth bass (*Micropterus dolomieu*)

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

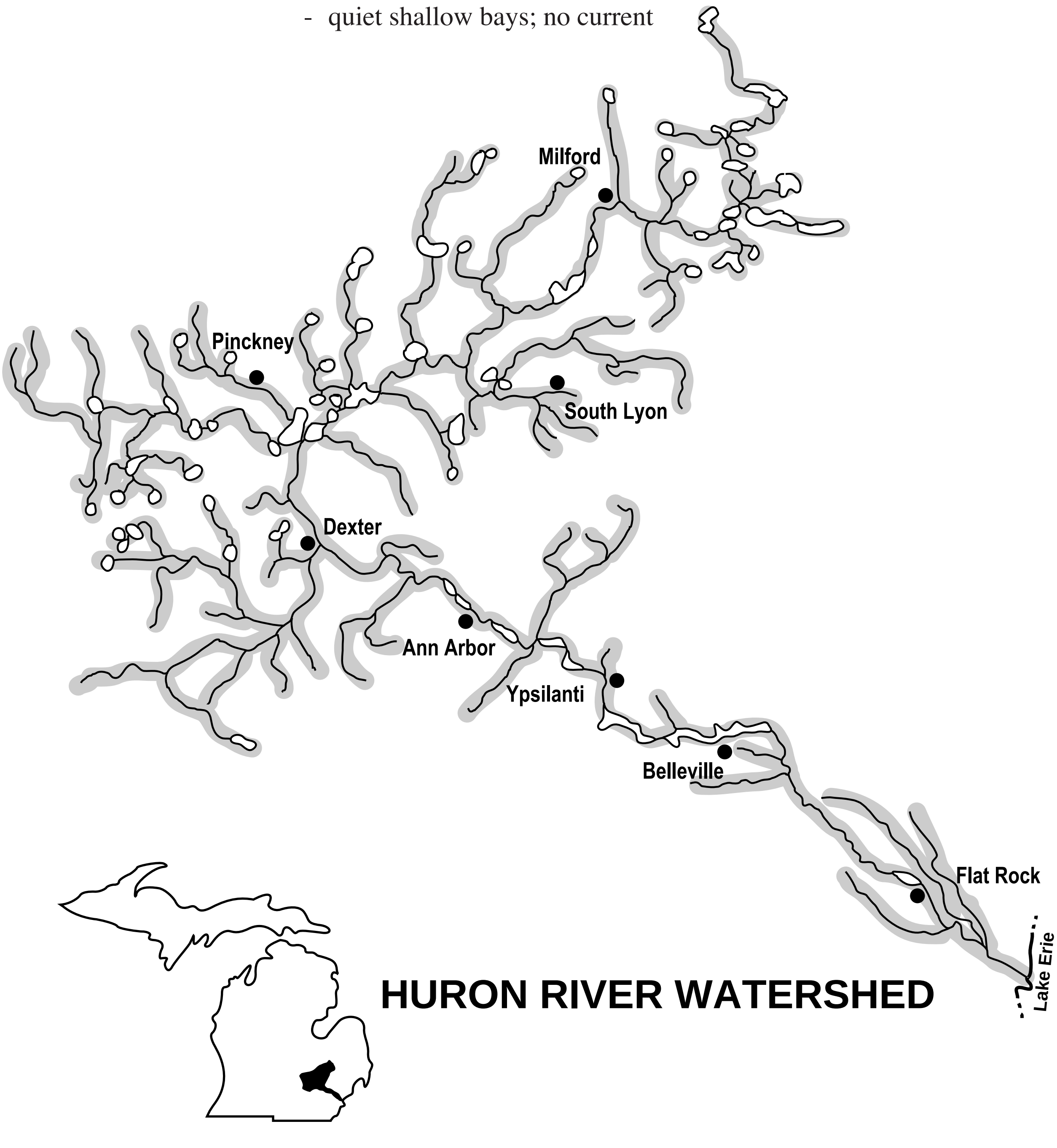


Largemouth bass (*Micropterus salmoides*)

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

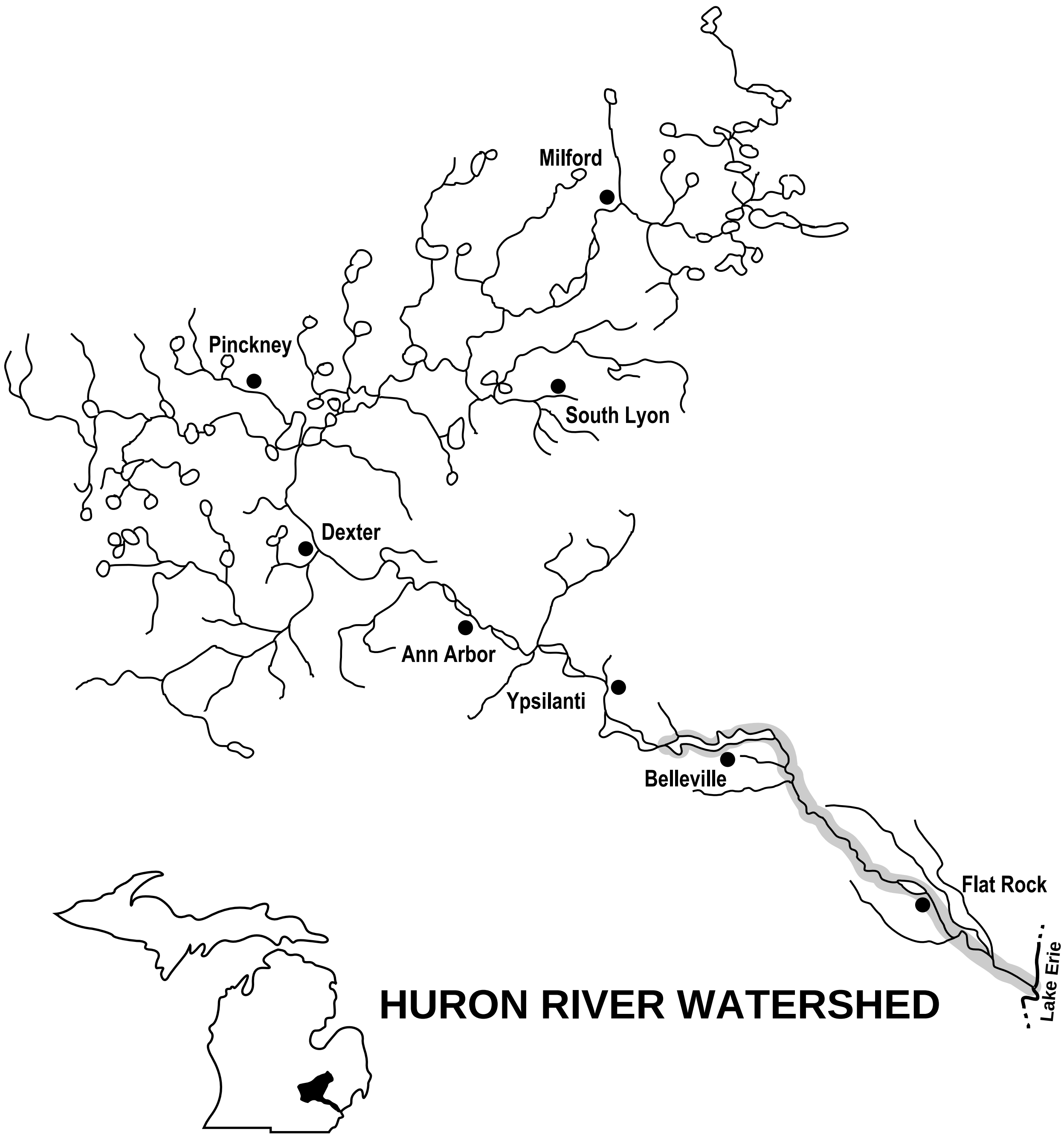


White crappie (*Pomoxis annularis*)

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

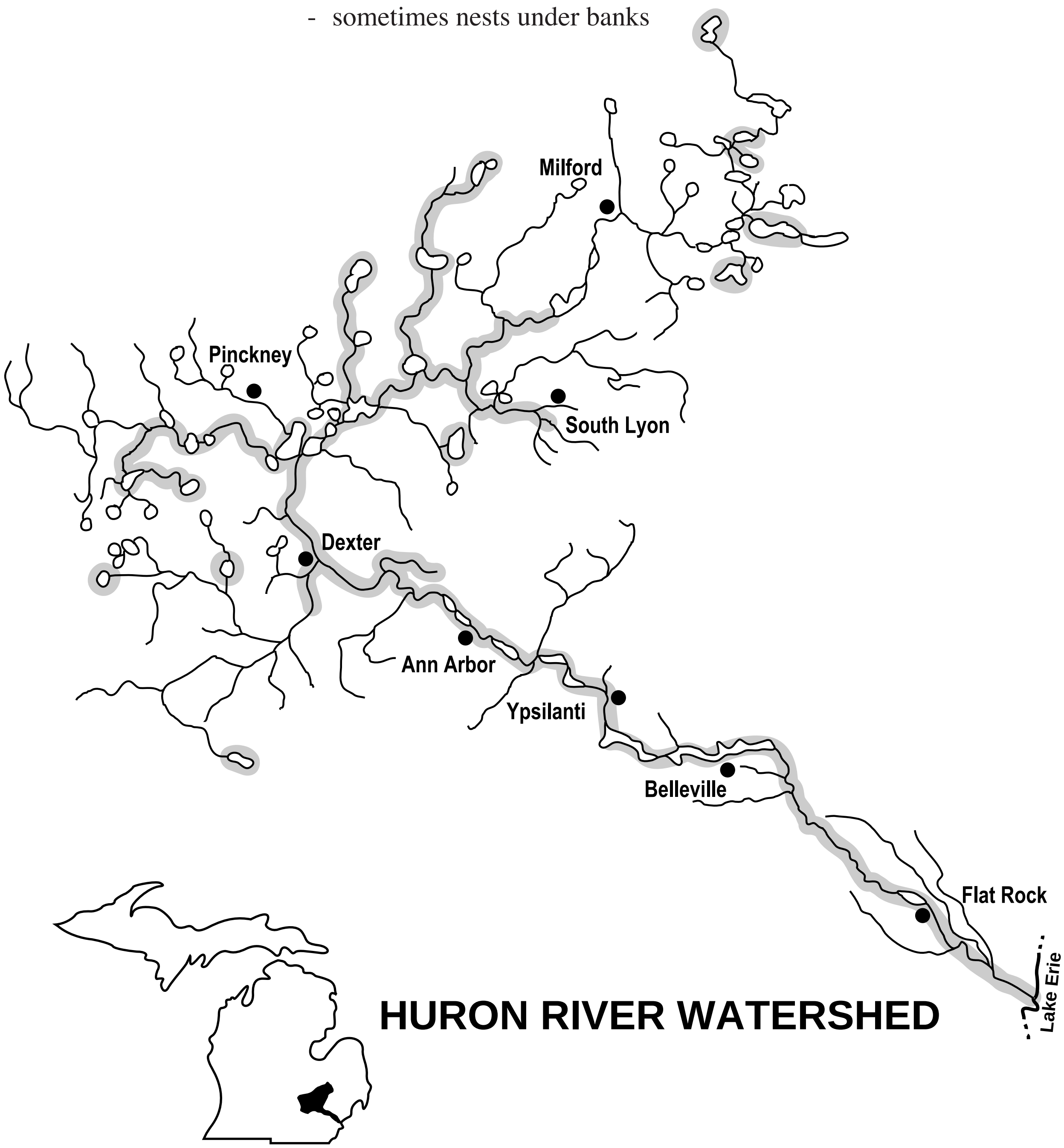


Black crappie (*Pomoxis nigromaculatus*)

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

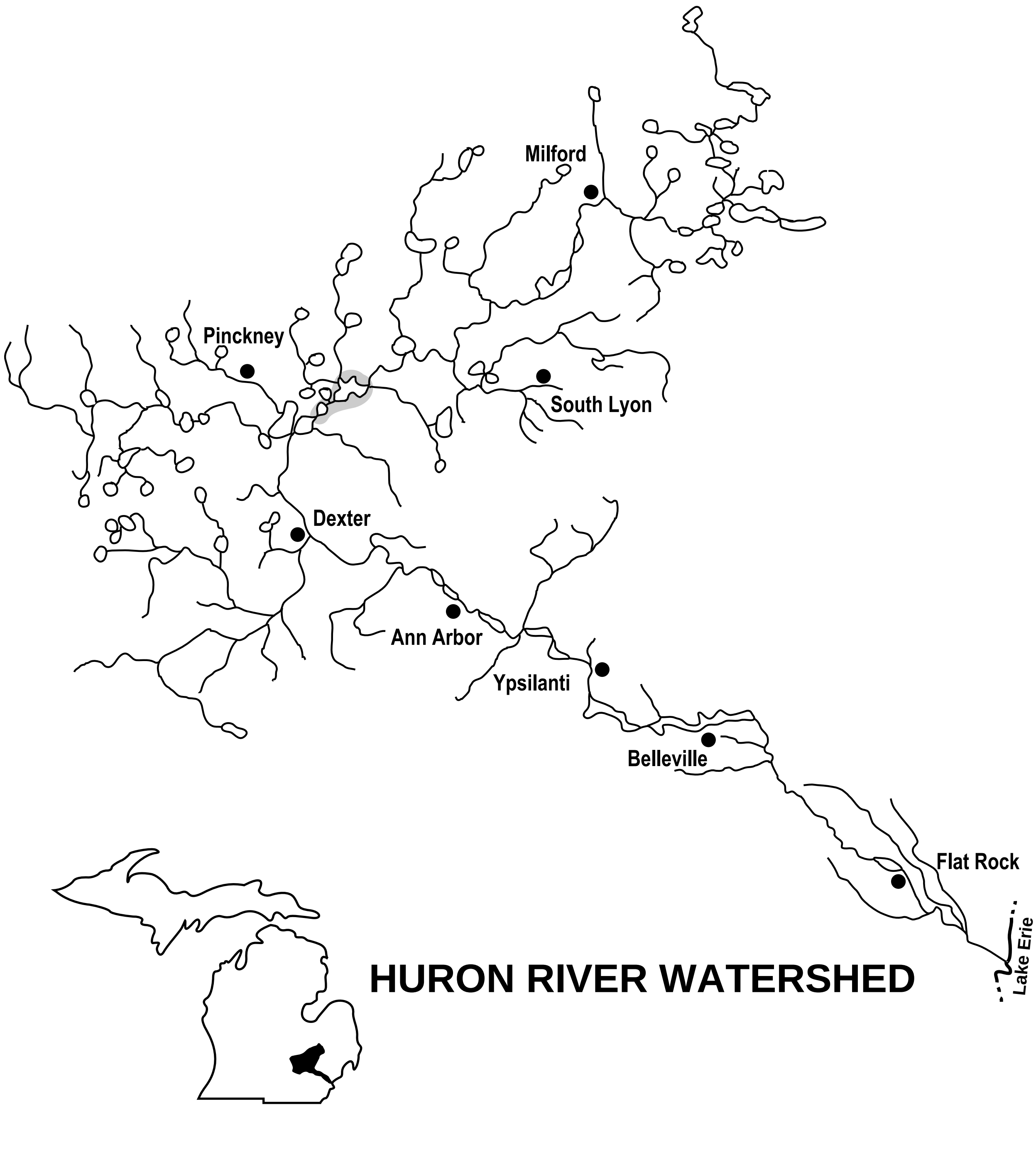


Eastern sand darter (*Ammocrypta pellucida*) - threatened

Habitat:

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

spawning - sandy substrate

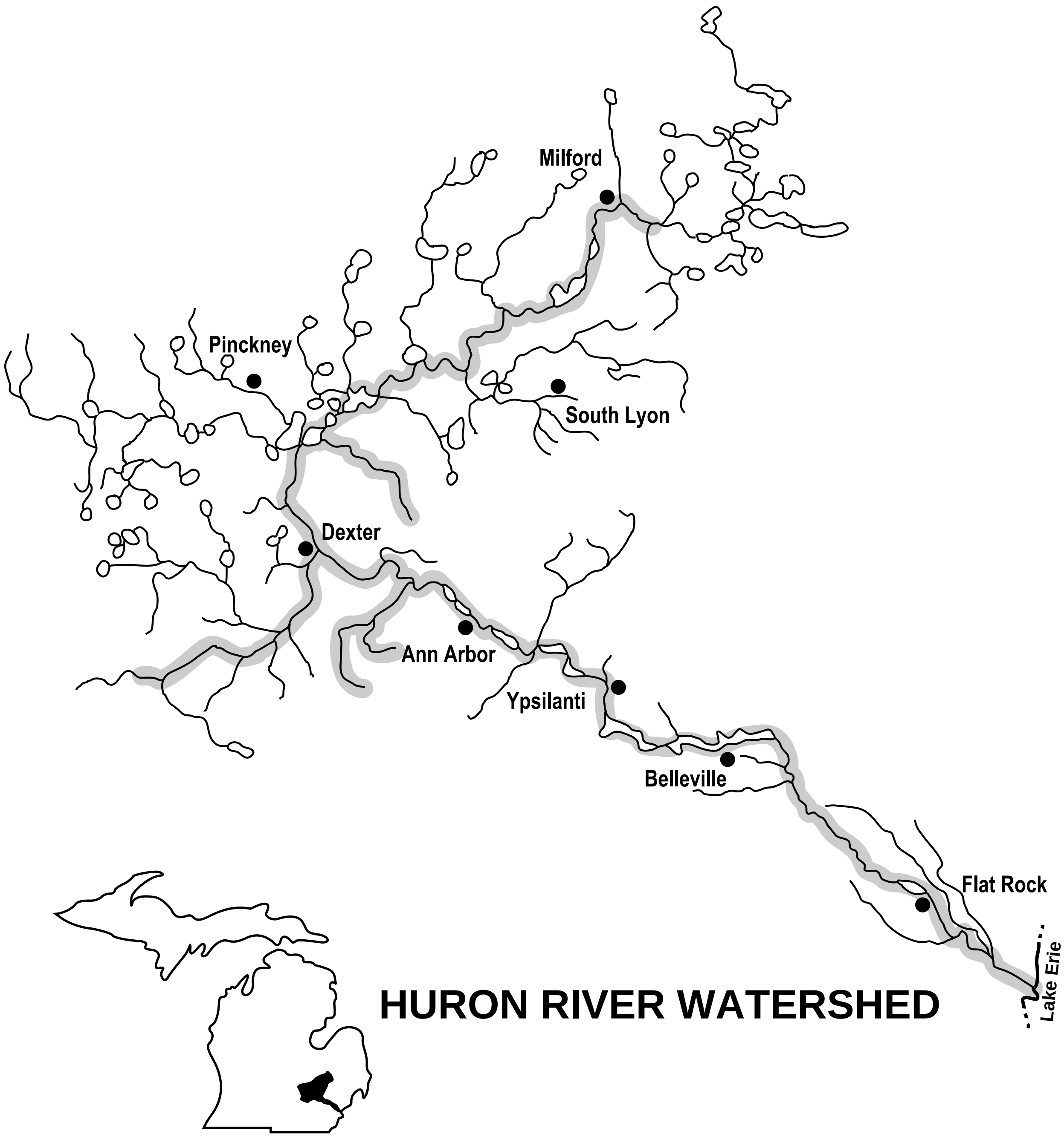


Greenside darter (*Etheostoma blennioides*)

Habitat:

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

spawning - filamentous algae necessary for egg deposition

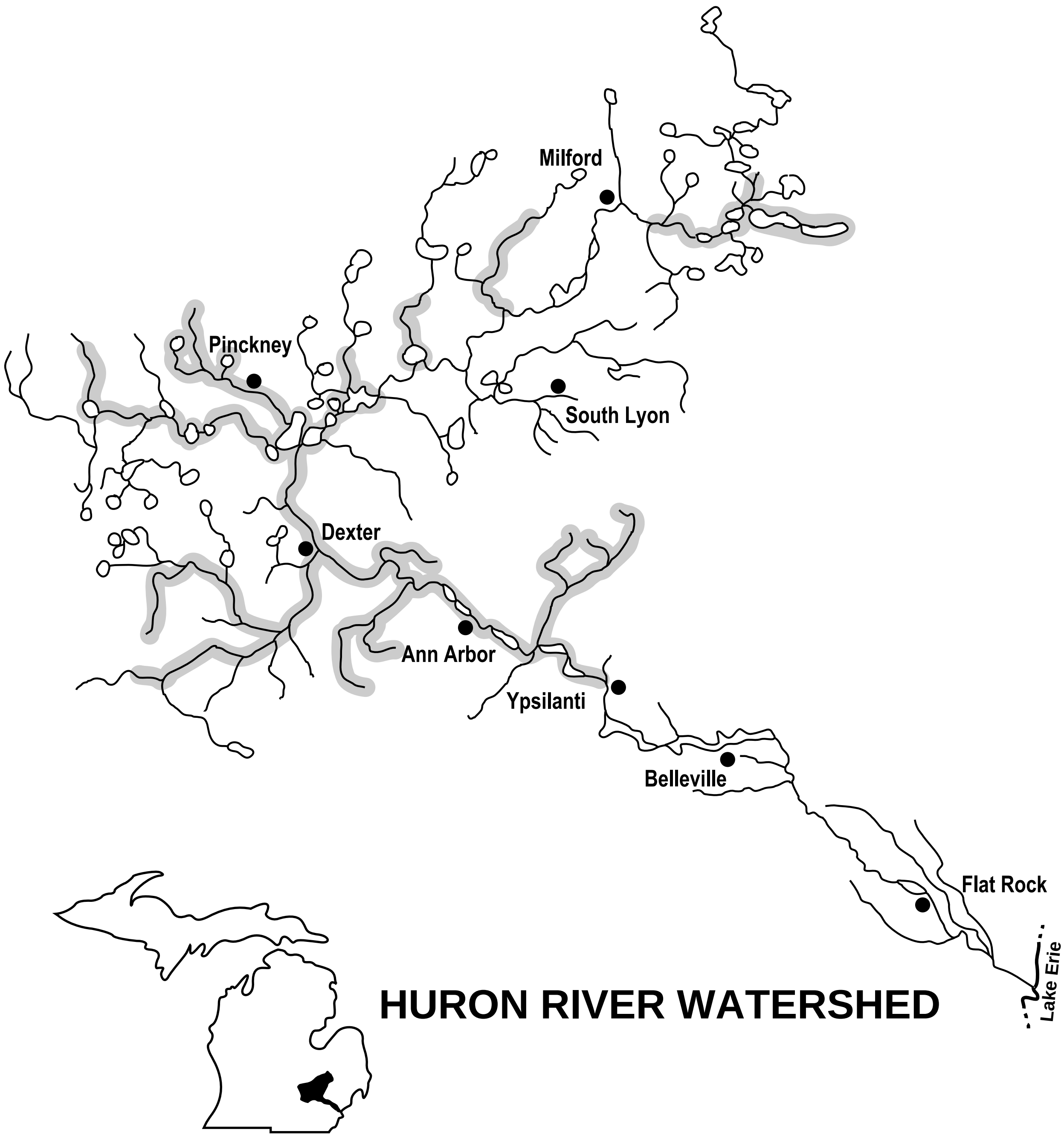


Rainbow darter (*Etheostoma caeruleum*)

Habitat:

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

spawning - gravel or rubble riffles

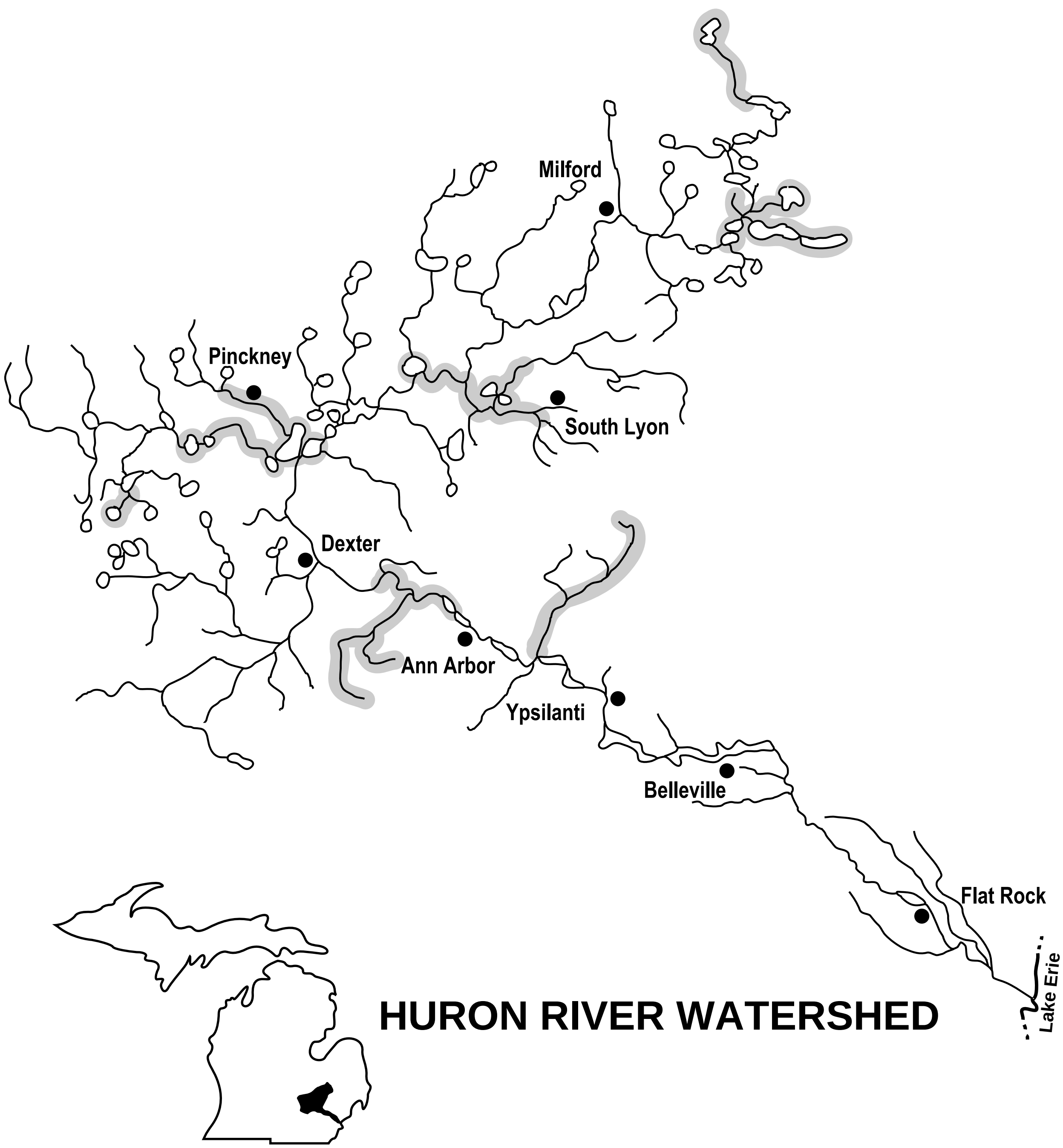


Iowa darter (*Etheostoma exile*)

Habitat:

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

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



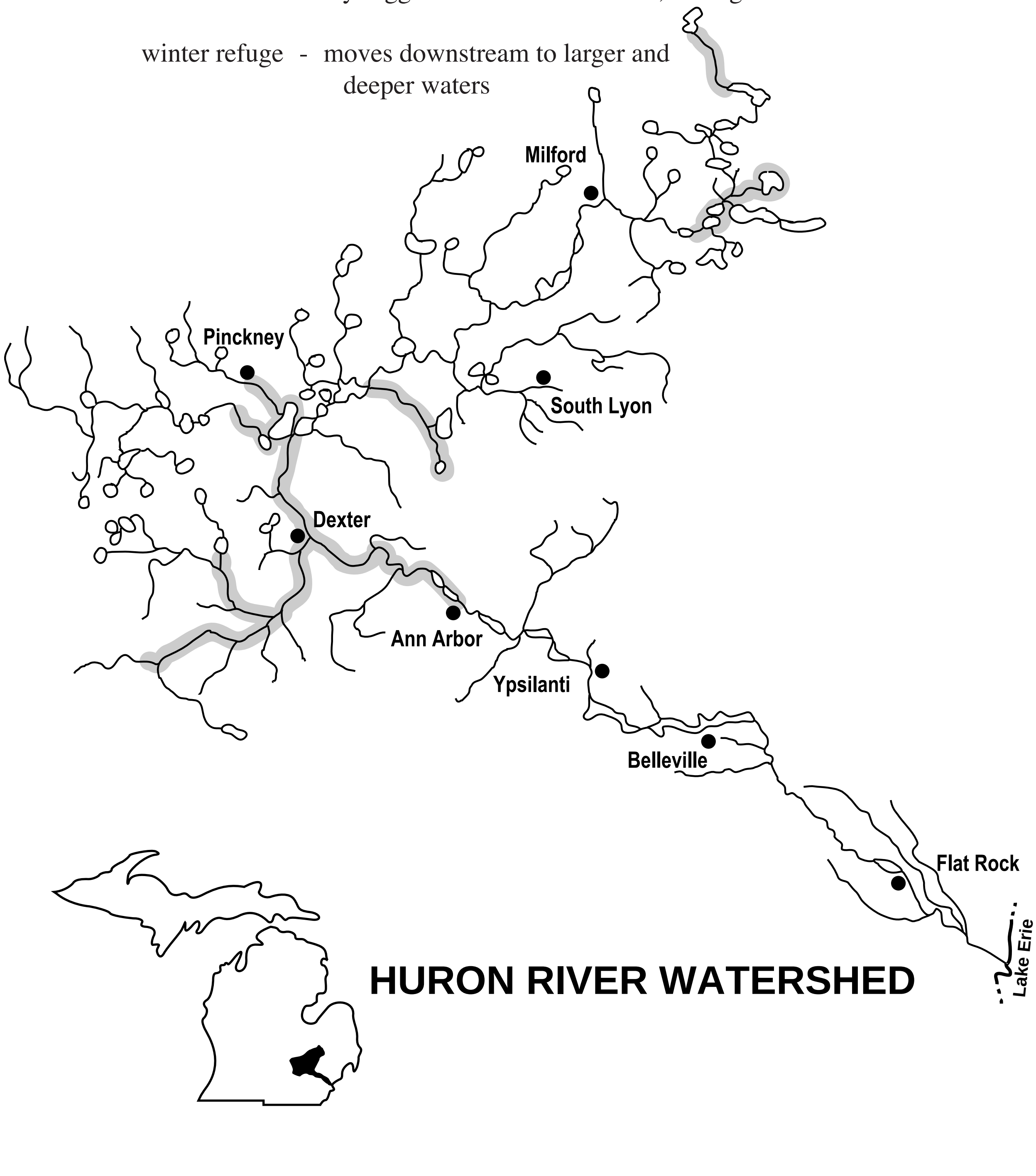
Fantail darter (*Etheostoma flabellare*)

Habitat:

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

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

winter refuge
- moves downstream to larger and deeper waters

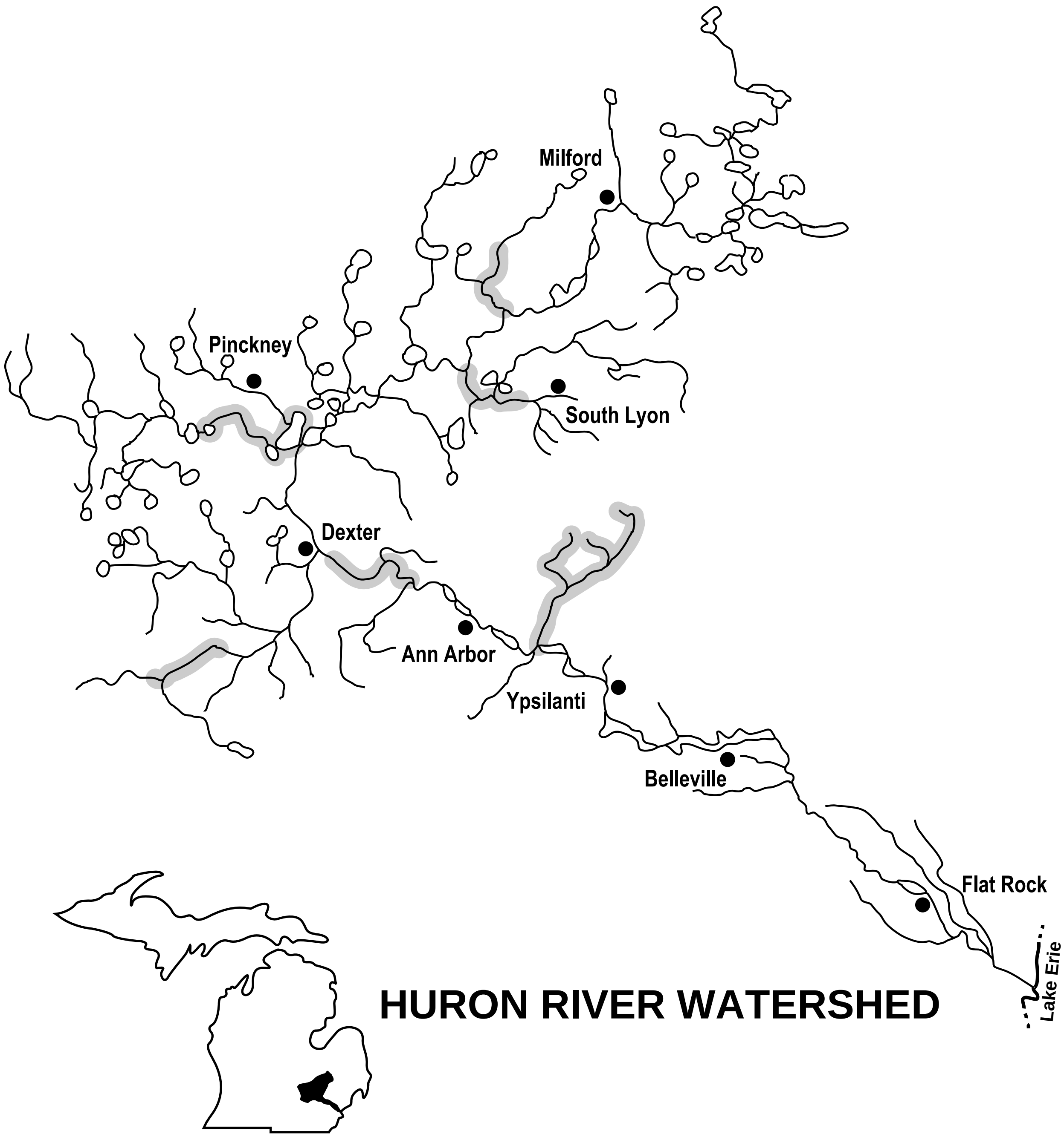


Least darter (*Etheostoma microperca*)

Habitat:

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

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

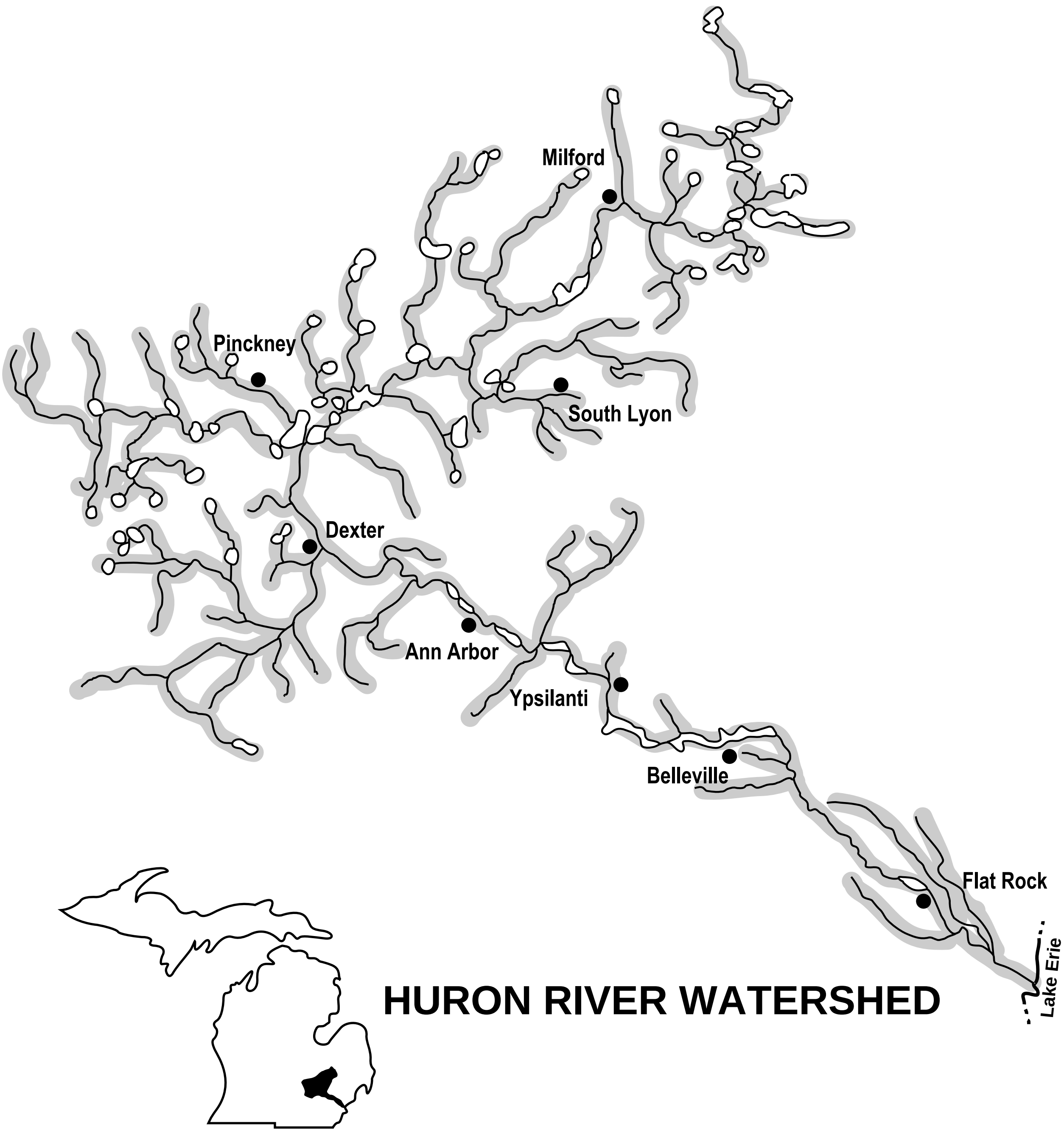


Johnny darter (*Etheostoma nigrum*)

Habitat:

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

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

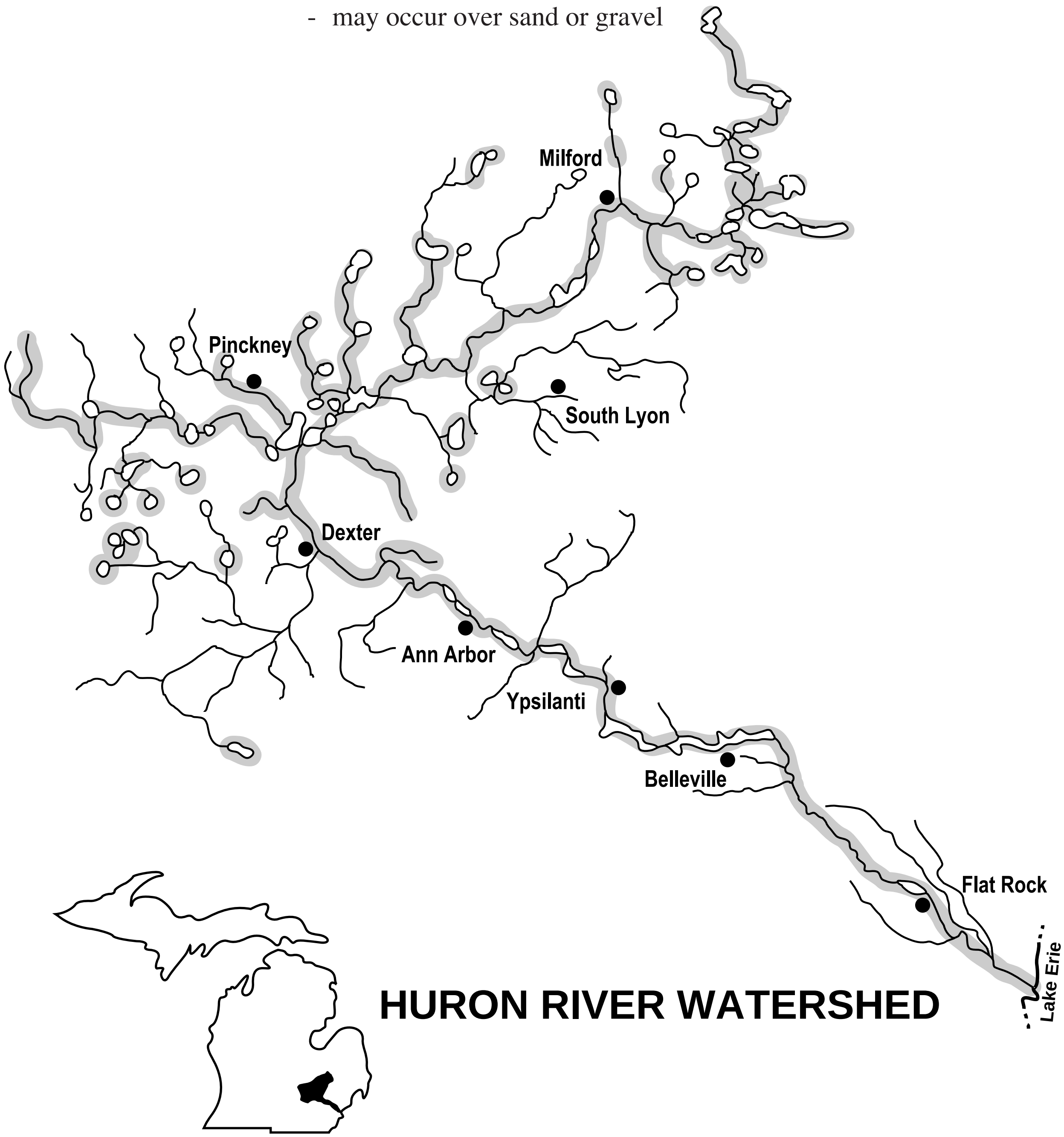


Yellow perch (*Perca flavescens*)

Habitat:

feeding
- clear lakes and impoundments; also Lake Erie
- 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

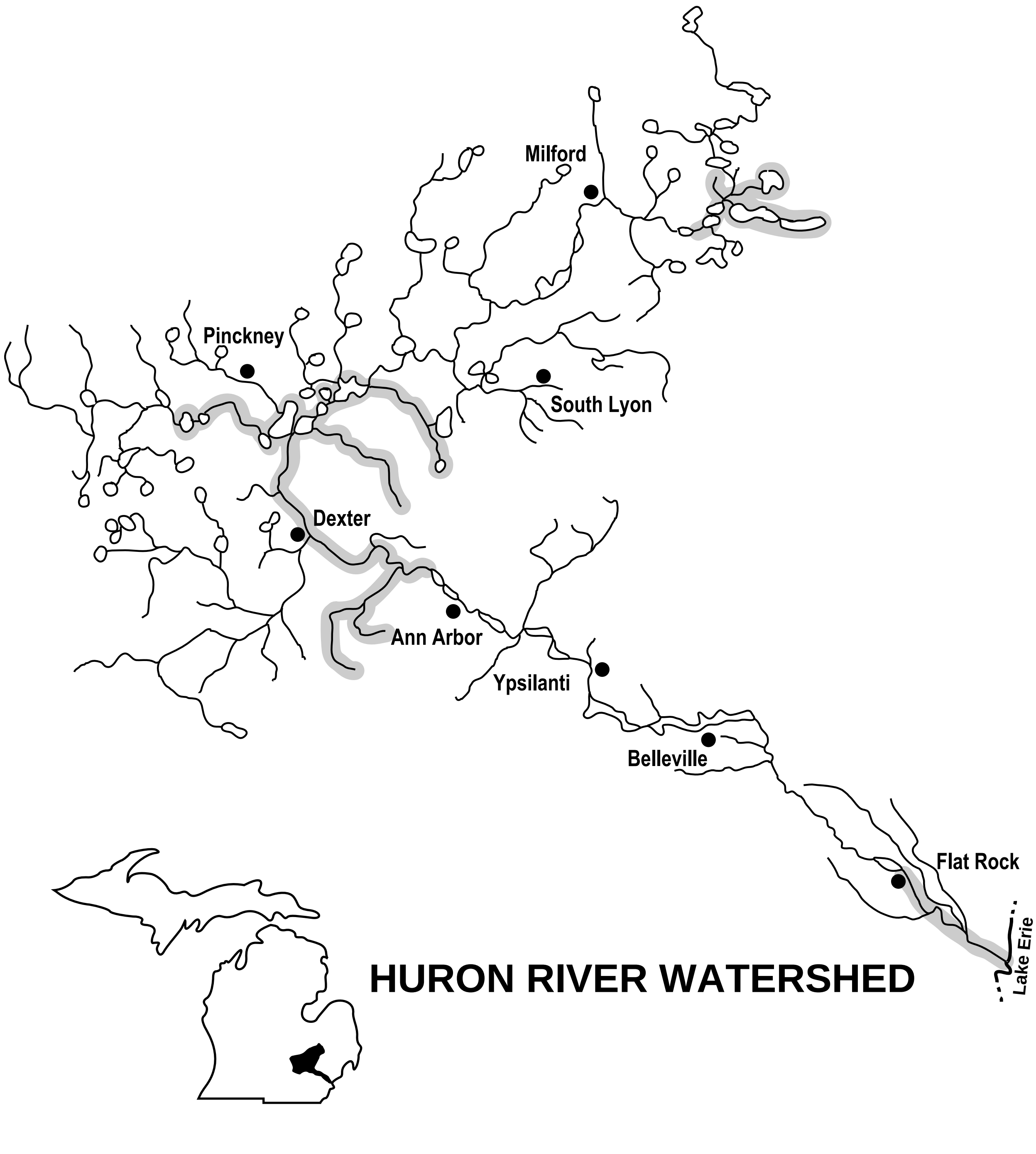


Logperch (*Percina caprodes*)

Habitat:

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

spawning - riffles or sandy in-shore shallows

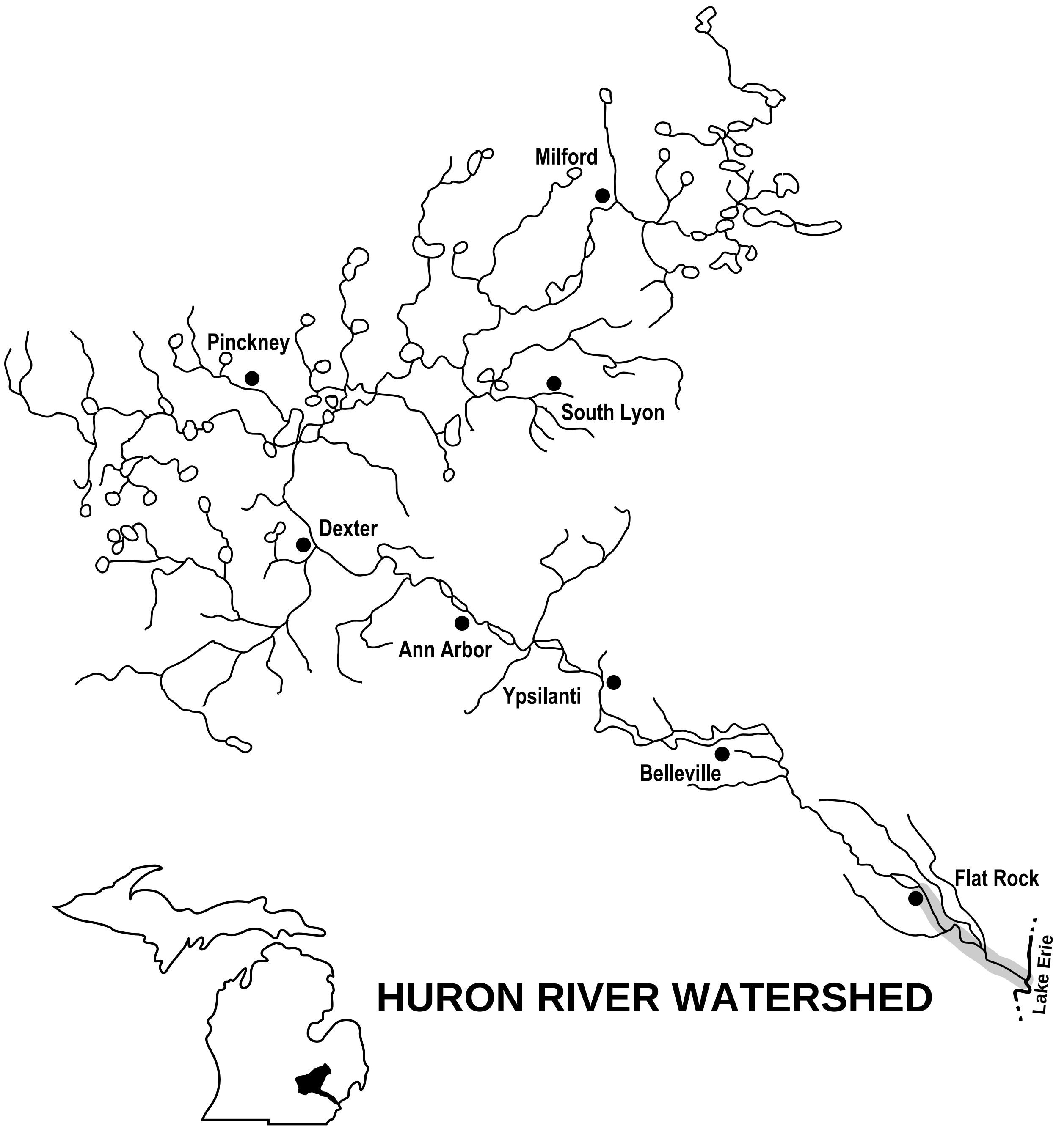


Channel darter (*Percina copelandi*) - locally extirpated

Habitat:

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

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

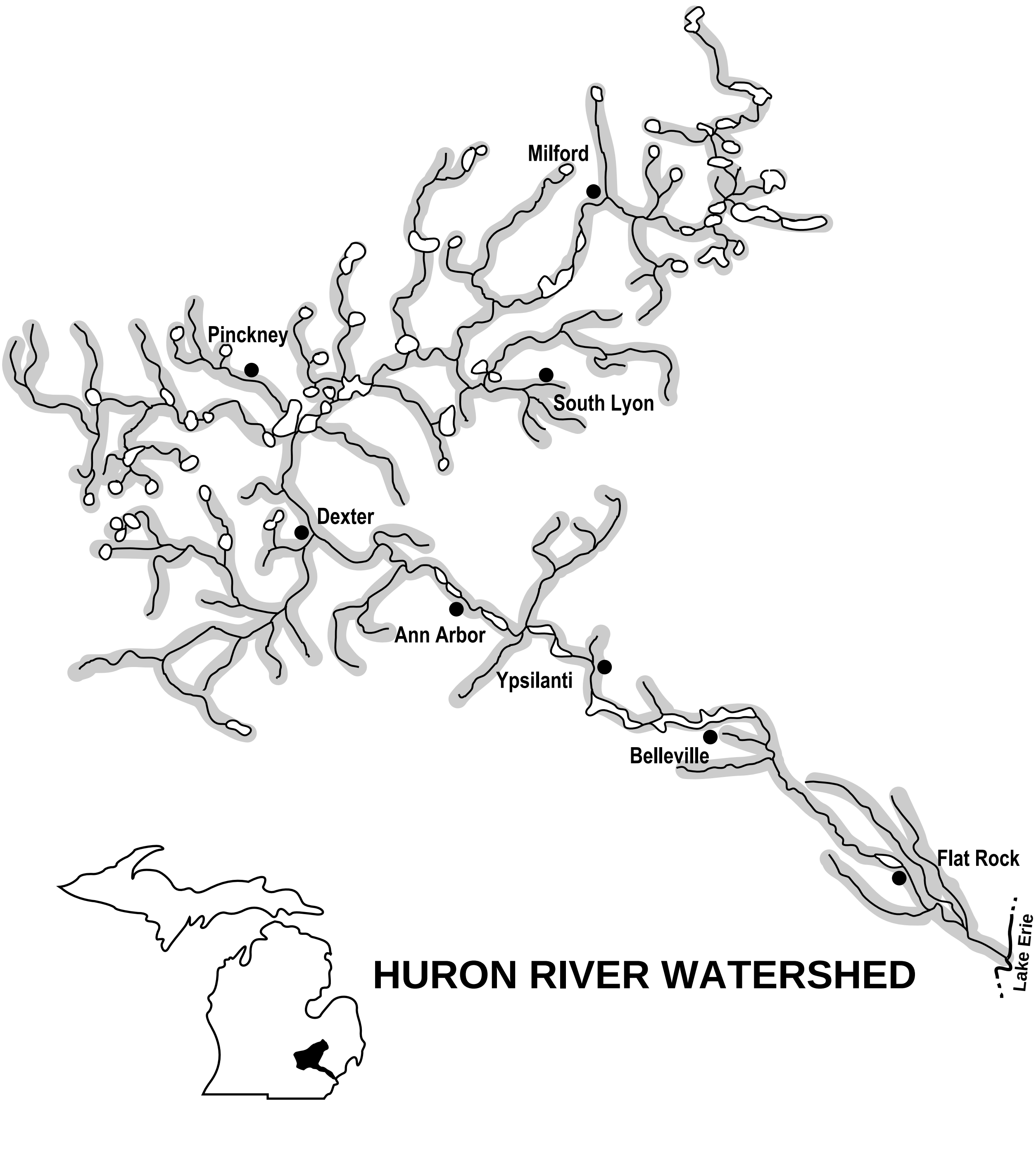


Blackside darter (*Percina maculata*)

Habitat:

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

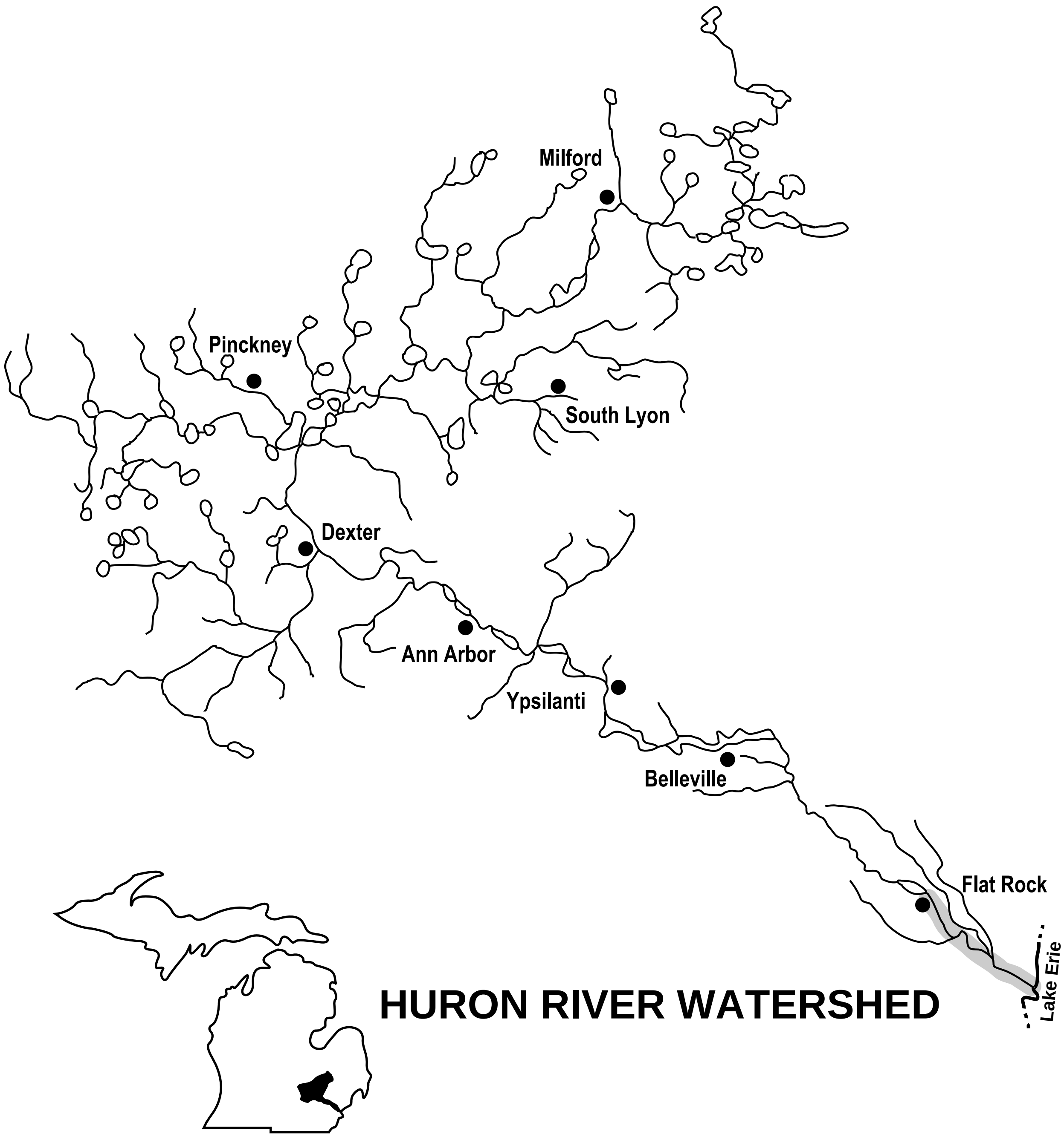
spawning
- gravel and sand substrate



River darter (*Percina schumardi*) - believed locally extirpated

Habitat:

feeding - medium to large rivers
- moderate to swift current
- coarse rock rubble or boulder-strewn substrate
- can tolerate turbidity

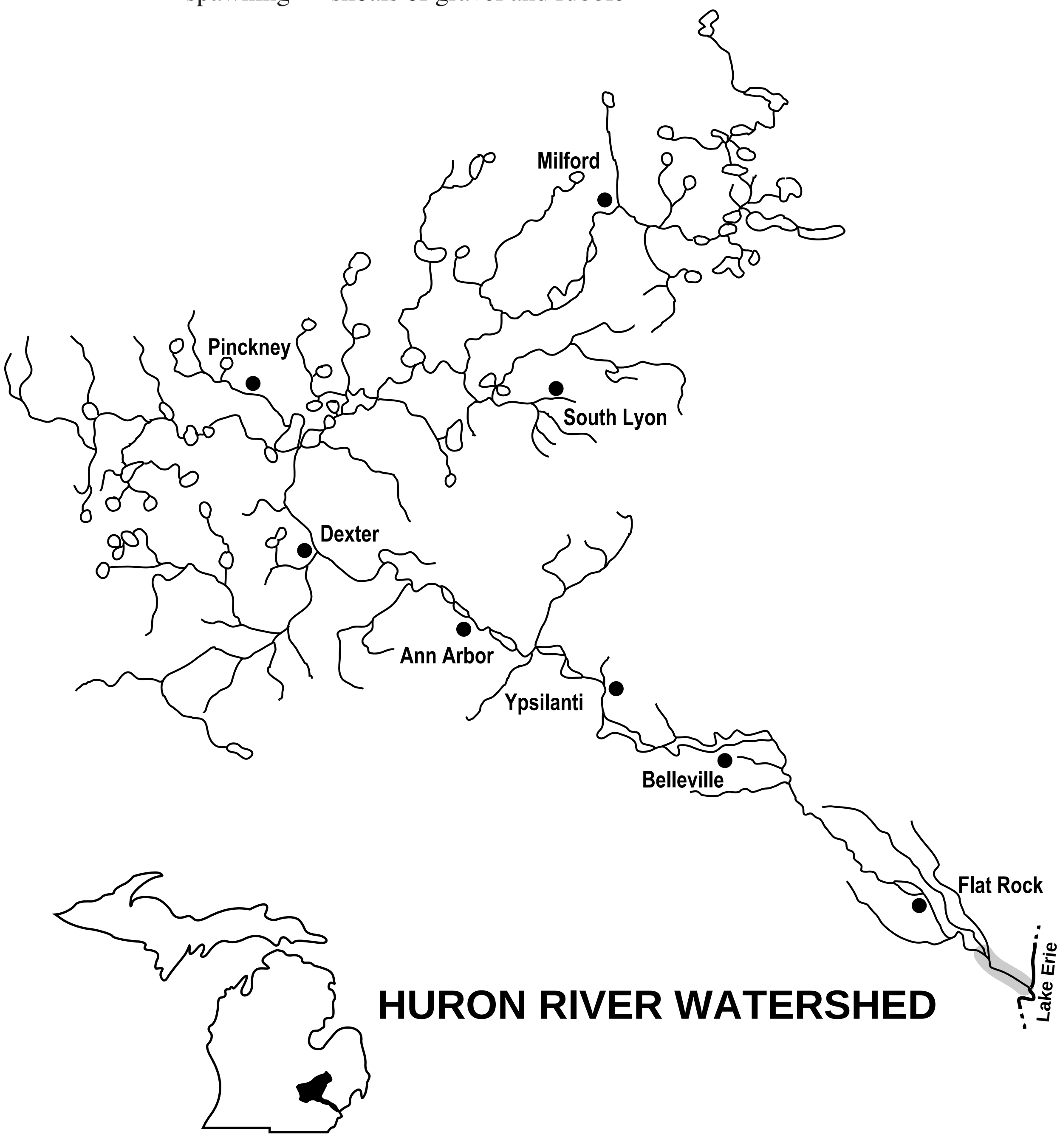


Sauger (*Stizostedion canadense*) - threatened

Habitat:

feeding - larger, deeper, low gradient rivers; turbid lakes and impoundments; also Lake Erie
- not tolerant of high gradient
- tolerant of silted substrate
- more tolerant of turbid water than walleye
- young may be in shallows or flats

spawning - shoals of gravel and rubble



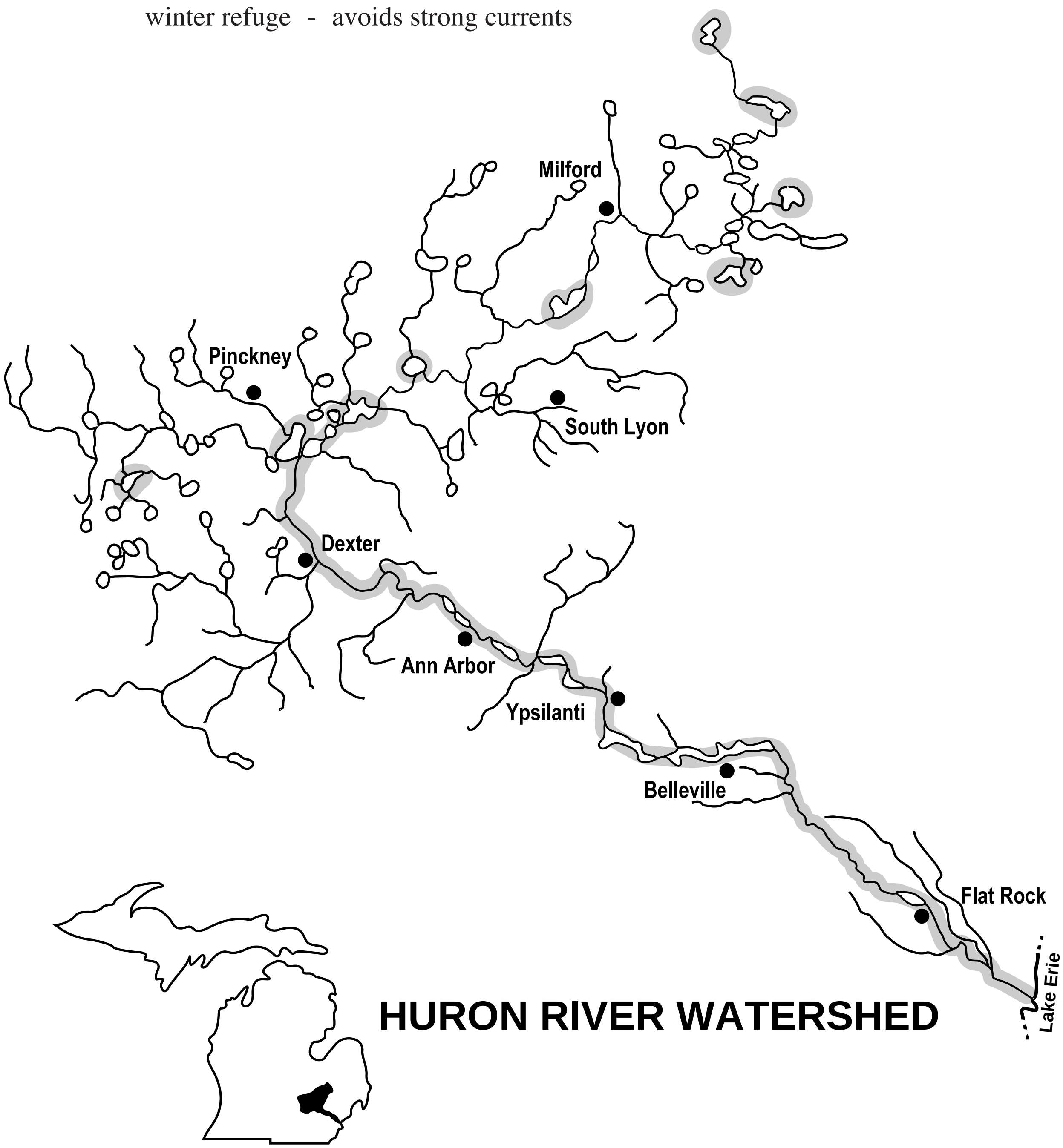
Walleye (*Stizostedion vitreum*)

Habitat:

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