Ecology, Management, and Status of Walleye, Sauger, and Yellow Perch in Michigan

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and
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Sauger  *Sander canadensis*

Yellow Perch  *Perca flavescens*
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Ecology, Management, and Status of Walleye, Sauger, and Yellow Perch in Michigan

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Introduction

Walleye Sander vitreus, sauger Sander canadensis, and yellow perch Perca flavescens are related species in the fish family Percidae. Walleyes are common throughout most of Michigan and the Upper Midwest. They attain the largest size of all the species in this family and are highly valued for their food, recreation, and trophy qualities. Saugers, which are similar to but smaller than walleyes, are also potentially valuable, but they have a very limited presence in Michigan and are officially listed as “threatened” by the state. The yellow perch is a ubiquitous and very important panfish and forage fish that likewise commands a high price at fish markets when available. Also belonging to the percid family are many species of darters, small fishes that grow to only a few inches in length. The darters have no sport or commercial value and are not endangered in Michigan; they will not be discussed further in this report.

A survey of Michigan anglers in 1983 (Latta 1990), found walleyes and yellow perch were among the top three species of fish sought (47% and 65%, respectively), and were the most preferred species for eating (26% each). In 2001, an estimated $838,558,000 and 19,320,000 angler-days were spent fishing for all species in Michigan (USFWS and USBOC 2002). An estimated 8,114,000 angler-days were spent fishing for panfish (this includes yellow perch) in Michigan with an economic value of approximately $349 million. There were an estimated 3,383,000 angler-days spent fishing for walleyes, with an economic value of approximately $145 million.

Ecology

The ecology of walleye, sauger, and yellow perch has been described by Colby et al. (1979), Trautman (1981), Carlander (1997), and Scott and Crossman (1998). Here, we summarize the general information from these references and emphasize the most important aspects of their ecology in Michigan.

Walleye, sauger, and yellow perch are classified as coolwater fish, which means they thrive in waters with intermediate temperatures and grow best at 70° to 82° F. Typical waters for walleyes and saugers are larger lakes and rivers of medium to low transparency. Transparency is a factor because their eyes are adapted for low light conditions and they avoid bright light. Yellow perch are a very adaptable species and can be found in nearly every pond, bog, lake, and sluggish river in Michigan. Walleyes are not likely to be found in waters of pH less than 6 and dissolved oxygen content of less than 2 ppm. Yellow perch can tolerate a pH as low as 4.2 and a dissolved oxygen content of less than
2 ppm. Consequently, yellow perch persist in acidic and winterkill (low dissolved oxygen) waters not tolerated by most fishes. Adult walleyes and saugers are primarily fish-eating predators, and suitable habitat must contain forage fish such as yellow perch, cisco *Coregonus artedi*, or various minnows. The diet of yellow perch is more flexible and adults can thrive on either fish or invertebrates. All three species require a progression of food types from zooplankton to benthic invertebrates as they develop from larval sizes through juvenile stages.

**Walleye**

Distinguishing characteristics of walleyes include cloudy eyes and white tips on anal and caudal fins (Figure 1). They have canine teeth and two dorsal fins – the anterior one has spiny rays and the posterior one has soft rays.

The key feature of walleye biology in Michigan is their narrowly defined spawning habitat requirements. They can spawn in large streams connected to lakes or within a lake on clean substrates of rock, cobble, or gravel from 1 to 4 feet deep. Such habitat provides the best chances for survival of eggs and fry but is absent, of poor quality, or in limited supply in much of Michigan. Thus, the abundance and distribution of naturally reproducing walleye populations in Michigan are primarily limited by the quantity and quality of this type of spawning habitat.

However, fingerling and adult walleyes can survive and grow in a wide variety of waters and fish communities. For this reason, and because of their popularity, walleyes are widely stocked in Michigan and throughout the Midwest. Many populations were created by stocking and are maintained by stocking.

Walleyes spawn once a year, beginning when spring water temperatures reach the upper 40s °F. Females lay many small eggs (27,000 per pound of female) over a life span of many years. No parental care is given, so eggs and fry tend to have low average survival rates. For self-sustaining populations the high abundance of eggs offsets their low survival. For populations unable to sustain themselves by natural reproduction, survival of eggs and fry is so low that insufficient numbers of fingerlings and adults are produced over the long term. Typically, the Great Lakes and larger inland lakes have the largest and best walleye populations, and support the best fisheries. These waters are more likely to have a wind-swept shoal or a tributary suitable for walleye spawning, plus forage fishes of favorable types and abundance.

Walleye eggs require about 3 weeks to hatch. During that time, they are vulnerable to displacement by wave action and smothering by silt. Both eggs and fry are vulnerable to weather changes and to predation, especially where white suckers *Catostomus commersonii* and panfish such as bluegills *Lepomis macrochirus* are abundant. A supply of zooplankton of the right size and type must be available for fry within a few days of hatching because fry contain only a small amount of nutritious yolk.

For spawning, adult walleyes concentrate on specific shoals of lakes or migrate many miles up tributary rivers to specific areas, often aggregating below migration barriers like dams. Males, which on average are smaller than females, reach the spawning grounds first and may remain there for up to 3 weeks. Both males and females mate with multiple partners. The sex ratio of fish on the spawning area is skewed towards males because they remain in the area longer and mature at an earlier age (typically, age 3 and 14 inches in length) than females (typically, age 4 or older and 17 inches in length). Comparisons between walleye populations over large regions have shown that the age of first sexual maturity is inversely related to growth rate (Beverton 1987; Quist et al. 2004). That is, populations with slower average growth rates tend to mature at a later age, and visa versa. The abundance of mature females and their eggs, rather than the abundance of males and sperm, is the first population-level constraint on reproductive success. Environmental factors (above) then act to
determine the survival of eggs and fry and ultimate recruitment to older ages. Food supply for fry is often weather related.

Even within a good self-sustaining walleye population, variations in weather during the reproductive stage can cause very large annual variations in spawning success, year class strength, and recruitment rate of juvenile fish to adulthood. The more age groups present in the adult population, the less these annual fluctuations in juvenile production affect the overall population abundance, but some level of annual fluctuations in adult walleye abundance and fisheries are the norm. Healthy walleye populations contain 10 or more age groups. The presence of a high proportion of older adults and the opportunity for a female to spawn more than once per lifetime are biological safety factors that help buffer a population from environmental instability and help insure perpetuity of the population.

Growth of walleyes can vary considerably across lakes, and even within a population over time, due to the abundance of food and the number of walleyes and other species competing for it. For a sample of all Michigan waters, an average length of 15 inches (the current statewide minimum size limit) is observed during the summer of age 3 (Schneider et al. 2000). Everywhere, average growth of females is faster than males, especially after sexual maturity is reached. Few males ever reach a length of 20 inches, whereas some females will grow to over 30 inches. Consequently, the largest walleyes in a population, and in a spawning run, are usually females.

Total mortality of adult walleyes is usually low compared to other sport fish. Natural mortality (all sources of mortality except fishing) tends to be low and sport-fishing mortality tends to be moderate. Walleyes are relatively difficult to catch by anglers because of their nocturnal feeding preference. Low adult mortality results in populations with many age groups, and as pointed out above, this buffers the population from irregular annual recruitment. An adult natural mortality rate of 20% per year is believed to be typical for Michigan populations (Schneider 1978). Sport fishing takes an additional 10–30% per year in most inland waters and somewhat less in Great Lakes waters. The mode of exploitation rates for North American walleye lakes is 21% (Table 1 and Baccante and Colby 1996). Thus, total adult mortality is about 30–50% per year. The most recent estimates of these vital statistics for inland lakes in Michigan are for Houghton Lake and Michigamme Reservoir: total mortality of adult walleyes was 46% and 37% and angler exploitation was 27% and 22%, respectively (Clark et al. 2004; Hanchin et al. 2005). It is likely that even waters with low accessibility are at least moderately exploited due to the high mobility of modern anglers.

Estimates of walleye population abundance have been made for 26 Michigan lakes (as used in this report, lakes include reservoirs) and 1 river by the mark-and-recapture technique using tagged or fin-clipped fish. In addition, estimates were made at two rivers using the rotenone method to collect all fish from small sections (Table 2). The estimates, for adults exceeding 13–15 inches in length, range from 0.0 to 9.2 walleyes per acre, and average 2.2 walleyes per acre. Nate et al. (2000) reported the same average of 2.2 walleyes per acre for 131 Wisconsin lakes having natural reproduction.

Fishery harvest statistics provide another measure of adult walleye population abundance. Statistics for Midwest and North American fisheries have been compiled in Table 1. However, it should be noted that these data are not directly comparable to Michigan data until the definition of “adult walleyes” is standardized. We defined “adults” as walleyes 15-inches and larger, because Michigan has a 15-inch minimum size limit (MSL) and most Michigan data are for adult fish of that size. We made adjustments to the data from outside Michigan to approximate 15-inch equivalents. We adjusted harvest by a multiple of 0.35 based on a Wisconsin estimate that 35% of the sport harvest was fish over 15 inches. After these rough conversions, typical angler yields for available out-of-state fisheries are approximately 0.6 walleyes per acre, 0.6 lb per acre, and 0.010 walleyes per hour (Table 1). By comparison, about 70% of the Michigan waters with fishery data exceeded one of those fishery
statistics (see tables in Status sections). For 32 inland Michigan lakes and reservoirs, the fishery harvest averages were 1.1 walleyes per acre and 0.055 walleyes per hour. Great Lakes and connecting waters averaged 0.07 walleyes per hour (Rakoczy 2000). Note that for the Michigan fishery data, effort includes time spent angling for all species of fish, not just walleye. Also, note that many winter fisheries were not sampled, which causes an underestimate of walleye yield per acre per year. For four lakes with both winter and summer data, the winter catch was 5–40% of the yearly total.

Based on a review of North American walleye literature, we offer the following criteria to help define a “good” walleye lake and fishery. First, “good” walleye lakes have population densities of greater than three adult walleyes per acre. Of 27 Michigan lakes with walleye population estimates (Table 2), 22% achieve that level. Second, “good” walleye fisheries sustain yields of greater than 1.0 walleyes per acre with a harvest rate of greater than 0.100 walleyes per hour. Of 59 inland and Great Lakes waters for which these harvest statistics are available, 32% are in the “good” range based on at least one of these fishery statistics. Of 32 inland lakes and reservoirs with harvest statistics, 25% yielded “good” walleye harvest per acre and 16% had “good” walleye harvest per hour. Only 6% of the fisheries would be considered “good” based on both criteria (see tables in Status sections for statistics on individual lakes).

Some large rivers support “good” densities of resident walleyes (Table 2). In addition, some sections of rivers host dense concentrations of spawning migrants from the Great Lakes or other downstream waters. These spawning concentrations are generally protected from fishing activity by a seasonal closure. In river and impoundment systems, many walleyes move downstream through dams and may end up in the Great Lakes. There, they may roam hundreds of miles.

Walleyes can strongly affect fish communities and the population characteristics of other species through predation. Adults feed primarily on yellow perch and soft-rayed fishes such as minnows, gizzard shad Dorosoma cepedianum, rainbow smelt Osmerus mordax, and alewife Alosa pseudoharengus. The dependence of walleyes on yellow perch as prey is especially strong in inland lakes, and on soft-rayed fish in the Great Lakes. Walleye predation can be used as a tool (e.g., by stocking) to reduce overabundance of small (stunted) perch or bluegill in lakes where this is a problem (Schneider and Lockwood 1997). However, stocking too many walleyes should be avoided because an overabundance of walleyes can exert excessive predation on some species, drive them to very low levels, and harm their fisheries. The size of prey a walleye can eat is a function of its mouth size (Schneider and Breck 1993), and because few walleyes are extremely large, prey fish become immune to walleye predation when they grow large. Large walleyes are cannibals of smaller ones, and this cannibalism can become more severe when alternative prey fishes are not available to feed adults. It can become a self-regulating mechanism limiting walleye population size by reducing recruitment of small walleyes.

**Sauger**

Saugers look very much like walleyes, but are smaller. Distinguishing characteristics include cloudy eyes and dark blotches along their sides (Figure 1). Like walleyes, they have canine teeth and two dorsal fins, one spiny-rayed and one soft-rayed. They can be distinguished from walleyes by the large dark spots on the spiny dorsal fin. They rarely attain lengths of greater than 16 inches and most are mature by 12 inches. Saugers compete with walleyes in places where they coexist. Walleyes generally out-compete saugers, but sauger eyes are better adapted to feeding in very turbid waters, which give them an advantage where turbidity is high. Saugers spawn about 1 week after walleyes, over the same type of coarse substrate, but sauger spawning is more likely on shoals of lakes than in rivers. Little is known about sauger biology and populations in Michigan.

The sauger is listed as a threatened species in Michigan because it is rare and has a limited distribution. It was never abundant in Michigan, and was largely limited to the Great Lakes. During
the 1900s, saugers were most abundant in the most shallow and turbid waters of Lake Erie, Lake St. Clair, Saginaw Bay, and Bay de Noc. Very small numbers of saugers probably remain in those areas. In Lake Erie, saugers declined 40–50 years ago due increased water clarity and inbreeding with walleye.

The only significant inland population of saugers occurred in the connecting waters of Torch and Portage lakes (Keweenaw and Houghton counties). No saugers have been taken there since 1985, and apparently, that population has been inadvertently extirpated. The loss was most likely due to pollution control efforts that increased water clarity and enabled walleyes to out-compete saugers.

**Yellow Perch**

Distinguishing characteristics of yellow perch are its yellowish sides with seven blackish bars (Figure 1). Like walleyes, they have two dorsal fins, one spiny-rayed and one soft-rayed. They have no canine teeth.

The key feature of yellow perch biology is their ability to adapt to a wide variety of conditions. Unlike walleye, yellow perch have such broad spawning habitat requirements that perch abundance and distribution in Michigan are not limited by the availability of spawning habitat. Predation by other species is often the most constraining factor on yellow perch populations.

Yellow perch spawn once a year, beginning when spring water temperatures reach the 50s °F. They have a much higher reproductive capacity than walleyes. Fecundity is higher for yellow perch (approximately 41,000 eggs per pound of female) than walleyes, and survival of yellow perch eggs and fry is usually better. This gives yellow perch populations a much higher intrinsic rate of population growth than walleyes, and enables yellow perch populations to expand rapidly whenever habitat conditions permit, such as for colonizing adjacent waters and repopulating waters disrupted by fish kills. Overpopulation and stunting of yellow perch populations commonly occur when predation does not sufficiently reduce the abundance of young (Schneider 1972, 1983).

Ideal spawning substrates for yellow perch are vegetation or submerged brush, but a wide range of substrates is used successfully. The eggs are suspended off the bottom and protected from predators and weather by a gelatinous matrix. Hatching time is relatively short, about 10 days. Adults leave after spawning and do not care for their young. The most critical stage for survival of young is within a few days of hatching, when an abundance of zooplankton of the right size and type must be available for first food. Food supply is often weather related.

For spawning in inland waters, adult yellow perch usually concentrate on relatively sheltered, weedy areas of lakes, but some may migrate a few miles up tributary rivers to find preferred spawning habitat. In the Great Lakes, they spawn on rock outcroppings and on almost any other type of structure available, as well as sand. They also move into inland river mouths and lakes to spawn in their associated wetlands. Males, which on average are smaller than females, reach the spawning grounds first and may remain there for up to 3 weeks. Males and females may mate with multiple partners. The sex ratio on the spawning area is skewed towards males because they remain in the area longer and mature at a smaller size. Males typically mature by age 1 or 3–5 inches in length (Schneider 1984). Females typically mature by age 4 or 6–7 inches in length, but a few mature at only 4 inches. The probability of being mature is a function of growth and age (Schneider 1984). For perch of a given age, the larger, faster-growing fish are most likely to be mature.

The abundance of mature females and their eggs, rather than the abundance of males and sperm, is the first population-level constraint on potential reproductive success. Variations in weather during fry stages and predation during juvenile stages often cause large (factor of 100 times of more) annual variations in year class strength and recruitment rate of juvenile fish. As with walleyes, the more age groups present in the adult population the less these annual fluctuations in juvenile production affect
the overall population abundance, but some level of annual fluctuations in adult yellow perch abundance and fisheries are typical.

Healthy yellow perch populations contain seven or more age groups. The presence of a high proportion of older fish and the opportunity for a female to spawn more than once per lifetime are biological characteristics that help buffer a population from environmental instability and serve to insure the perpetuity of each population. However, yellow perch populations show remarkable resiliency due to their high reproductive capacity and may persist under high stress. In a small experimental lake, as few as 1.5 mature females per acre were able to maintain adequate recruitment in the face of intensive mortality from anglers and walleye predation (Schneider 1997).

Growth of yellow perch varies considerably from lake to lake, and year to year, due to variations in the abundance of food and the number of yellow perch and other panfish species competing for it. For a sample of all Michigan waters, an average length of 7 inches is reached during the summer of age 4 (Schneider et al. 2000). Everywhere, average growth of females is faster than males, especially after sexual maturity is reached. Few males ever reach a length of 9 inches, whereas some females grow to over 11 inches. Consequently, the largest yellow perch in a population, and in a spawning run, are usually females.

Total mortality of juvenile yellow perch tends to be high (upwards of 70%) due primarily to predation, but mortality of adults is often modest, on a par with other sport fish. As pointed out above, this buffers the population from irregular reproductive success. An adult total mortality rate of about 50% per year is typical for Michigan waters unless exposed to high fishing pressure or predation by many large northern pike *Esox lucius*. Sport fishing mortality in inland waters is typically from 20–50% per year. Yellow perch are relatively easy to catch by angling and high exploitation rates are possible in small lakes. In one 13-acre lake, average total mortality increased from 22% to 87% due to angling (Schneider 1997). In a 136-acre lake, an estimated 61% of the yellow perch greater than 7.0 inches were caught in 3 days of summer fishing (Schneider 1973). In another 20-acre lake, 15–30% of the larger perch were caught by just two ice anglers in 2 days (Schneider 1993).

However, adult yellow perch populations may experience high mortality even when little or no angling occurs. The estimated total mortality rates in four lightly fished lakes were: 91% at Dead Lake (age 4 and older), 72% at Mill Lake (age 3 and older), 50% at Blueberry Pond (age 4 and older), and 22% for Jewett Lake (age 2 and older) (Schneider 1971, 1993, 1997). The high rates for the first two lakes may be attributed especially to predation by northern pike. Other predators were present also; largemouth bass *Micropterus salmoides* were abundant in the first three lakes and walleyes were abundant in the fourth lake.

The best populations of large yellow perch tend to occur in lakes with the most favorable combinations of food, temperature, and mortality factors. Such lakes tend to be either very large, to provide abundant food and cool well-oxygenated habitat in mid-summer, or to be lightly fished. Since yellow perch are usually easy to catch, it is likely that all waters accessible to anglers are exploited to a considerable degree.

Mark-and-recapture population estimates of yellow perch were available for 14 Michigan lakes (Table 3). Estimates of abundance of yellow perch greater than 7 inches long were as high as 62.8 per acre in Manistee Lake (Kalkaska County), but few lakes exceeded 20.0 per acre. Annual variation in abundance of some populations has been extreme, as high as 30-fold, due to uneven recruitment.

Fishery harvests also fluctuate considerably. The average harvest rate was 4.4 perch per acre and 0.170 perch per hour for 43 inland lakes in Michigan (see tables in Status sections for statistics on individual lakes) and 0.18 perch per hour in 26 areas in the Great Lakes and connecting waters (Rakoczy 2000). Note that for the harvest data, fishing effort includes time spent angling for all species of fish. Also, many winter fisheries were not sampled, which causes an underestimate of yellow perch yield per acre per year because yellow perch are readily caught by ice anglers. For five lakes with both winter and summer data, the winter catch was 1–68% (average 32%) of the yearly total.
Adult yellow perch are significant predators on fish and can affect the composition of fish communities and the population characteristics of other species. Adults also feed on a mix of benthic invertebrates, and sometimes on large zooplankton. Predation by yellow perch is restricted to smaller fishes because the size of prey they can eat is a function of mouth size and even large adult yellow perch are relatively small. In lakes containing both bluegills and yellow perch, predation by yellow perch on age-0 bluegills during winter is ecologically important and of value to the management of bluegill fisheries (Schneider and Breck 1993). It is a mechanism that tempers bluegill recruitment and may prevent bluegill overpopulation and stunting in some lakes. Predation (cannibalism) by yearlings and adult perch on their young also occurs and can be a self-regulating mechanism that limits perch population size by suppressing recruitment. However, overpopulation and stunting usually occur in waters containing only yellow perch (Schneider 1972).

Management in Michigan

General Goals and Practices

Michigan Department of Natural Resources (MDNR), Fisheries Division has expressed general goals for fisheries management in various administrative documents. The general goals for the management of all fishes include: (1) protect and maintain healthy populations and habitats, and rehabilitation of those now degraded; (2) provide diverse public fishing opportunities to maximize value of recreational fishing; and (3) permit and encourage efficient and stable commercial fisheries which accommodate tribal fishing rights and do not conflict with recreational fisheries (Fisheries Division 1997).

In addition, Fisheries Division was party to the development and adoption of goals and fish community objectives that are more specific for Great Lakes waters (e.g., Eshenroder et al. 1995) and inland watersheds (e.g., O’Neal 1997). Some fisheries management objectives have also been expressed for some inland lakes in Fisheries Division Status of the Fishery Reports (e.g., Tonello 2000) and for some fisheries rehabilitation efforts (Hay-Chmielewski and Whelan 1997; Fielder and Baker 2004), but specific management goals and objectives for inland fish communities, species, or populations have not been formally expressed or adopted. Habitat protection and restoration guidelines have been developed for lakes (O’Neal and Soulliere 2006) and streams (Alexander et al. 1995) in Michigan. In practice, local fisheries managers use expert judgment to attempt to maintain populations within the broader goals expressed above.

Management Objectives

Herein, we will suggest specific objectives that could be used under the broader goals to manage walleye, sauger, and yellow perch populations in Michigan. Our proposed objectives could be applied to large regions or individual water bodies. Some are overlapping and some are conflicting, so not all are applicable everywhere. Also, many of these objectives are already being used informally or implicitly by managers across the state.

More specific management objectives applicable to almost any fishery have been suggested by Colby et al. (1994). They include prevention of five types of overfishing:

1) **Prevent recruitment overfishing.** That is, prevent collapse of a population, due to excessive harvest, to the point where adequate broodstock, reproduction, and recruitment cannot be maintained. A decreasing trend in population numbers and a series of abnormally weak year classes are the usual indicators of a problem. In extreme circumstances, a population becomes extinct. The minimum sustainable size for a fish broodstock is difficult to predict because
recruitment is lake dependent, highly variable, and may change in response to water quality or invading exotic fishes. Minimum sustainable broodstock size for walleyes have been estimated for inland lakes in Indian treaty territories of Michigan and Wisconsin (treaties of 1837 and 1842). There, the minimum sustainable broodstock size is considered to be 65% of the estimated population size of adults; that is, a maximum of 35% exploitation is permitted on any one stock. Population estimates cannot be conducted in every lake every year, so additional safety factors are applied to older population estimates to account for annual population fluctuations and uncertainty (Hansen 1989). Minimum sustainable broodstock size has been directly estimated for western Lake Erie and the Bay of Quinte in Lake Ontario, but only because their walleye populations nearly collapsed while being intensively monitored. Baccante and Colby (1996) cite four other populations that collapsed under exploitation rates of 22–56%. These were relatively vulnerable because they were in relatively unproductive and cold areas of Canada (<1,400 growing degree days). By comparison, the growing degree days in Michigan range from about 1,800 to 2,600.

2) Prevent growth overfishing. That is, prevent the fishing exploitation rate from exceeding a level where yield declines because losses from mortality exceed gains from growth. For fast-growing, long-lived species such as walleyes, exploitation rates causing growth overfishing can be lower than those causing recruitment overfishing. However, for many species recruitment and growth overfishing occur at similar exploitation rates. Much depends on a population’s age (size) of initial harvest, age (size) of first maturity, and natural mortality rate. Mathematical models can be used to calculate what exploitation rate will cause growth overfishing for different minimum size limits and natural mortality rates. For walleye, growth overfishing typically occurs for exploitation rates exceeding 30% when minimum size of harvest is 13–16 inches. Growth overfishing is not a concern for yellow perch because at typical exploitation rates growth overfishing would not occur unless the minimum size of harvest was 4–5 inches, which is below what most anglers would want to harvest.

3) Prevent quality overfishing. That is, prevent excessive harvests of large fish from each population that cause significant declines in population abundance, size structure, age composition, and fishery characteristics. The latter includes, for sport fisheries, diminishing catch per hour and harvest rates, declines in numbers of large fish caught per hour, and the disappearance of trophy sizes (i.e., the loss of fishing quality and societal satisfaction). Some examples for Canadian walleye fisheries are cited by Post et al. (2002). All commercial and sport fisheries cause quality declines to some degree. Such changes occur gradually as fishing harvest rate increases, so it is difficult to define when a “significant” decline in quality has occurred. However, Baccante and Colby (1996) suggested that very few walleye populations can sustain quality fisheries at exploitation rates beyond 30%. They cautioned that this ill-defined threshold could be as low as 10% for fisheries in very cold and unproductive waters.

4) Prevent economic overfishing. That is, prevent loss of overall economic value to society in general and commercial and sport fisheries in particular. Usually, economic benefits are maximized by maintaining healthy and stable populations and favoring sport over commercial fisheries.

5) Prevent community overfishing. That is, prevent unfavorable changes in fish community composition that cannot be easily reversed. An example would be the depletion of predacious walleyes by fishing that may allow yellow perch or bluegill (or some exotic species such as round goby Neogobius melanostomus) to increase to undesirable levels, restructure community food webs, and cause walleye recruitment problems. Similarly, as mentioned above, depletion of yellow perch may contribute to bluegill stunting.

Walleye

Specific objectives for walleye management could include:

1) protect and restore essential habitat;
2) maintain abundance of adult walleyes so that optimal natural reproduction is likely to be assured in virtually all self-sustaining walleye waters in all years;
3) conservatively regulate fishing and harvest rates to avoid recruitment, growth, and quality overfishing, yet maximize opportunities for participation and distribute the harvest equitably;
4) restore depleted populations; and
5) create or maintain new walleye fishing opportunities with stocking by striking a balance among public demand and constraints imposed by environments, resources, and economics.

Objectives that are even more specific could be formulated using the following characteristics that indicate healthy, adequately-buffered, self-sustaining walleye populations:

1) stable recruitment with few missing or extremely weak year classes;
2) stable value for mean age at first maturity;
3) average total adult mortality of less than 50% per year.
4) presence of some walleyes over age 8 and 21 inches in length;
5) average total fishing mortality on all adults of less than 35% per year;
6) stable population of adults in terms of number of fish;
7) stable population in terms of growth, natural mortality, and size and age distributions;
8) stable fishery yield;
9) average catch rate when exploited within 50 to 100% of the value observed under a catch-and-release fishery;
10) mean age of catch more than 1.5 times mean age of population.

The relative importance of these specific objectives and population characteristics could be somewhat different for populations supported solely by stocking, depending on the purpose. For example, if the purpose were to restore indigenous populations, supplement natural populations, or establish new, reproducing populations, then all these objectives and characteristics would be just as important for stocked populations as for naturally reproducing ones. However, if the purpose for stocking were to create a better predator-prey balance or to produce a put-grow-take walleye fishery, then some of the objectives and characteristics listed above would be less important. One of the more important objectives for all put-grow-take fisheries is to produce a reasonable benefit-cost ratio, which means stocked fish should have reasonably good survival and the fishery should be managed to avoid growth overfishing. Other economic considerations, such as the amount of angler effort produced, could also be very important.

**Sauger**

The sauger, because of its threatened status, is protected in Michigan. Therefore, management objectives for sauger should be designed to minimize harvest and habitat destruction. Currently, sauger may not be harvested in Michigan unless specifically allowed by MDNR Fisheries Orders (administrative rules). One difficulty is that saugers look like walleyes and few anglers can tell them apart. Consequently, a few saugers are probably harvested by anglers as bycatch of various walleye fisheries. This is not likely a problem for the sauger because the 15-inch MSL in effect for walleyes serves to protect all but the largest saugers. No fisheries should be established anywhere in Michigan that deliberately target saugers, especially spawning aggregations.

**Yellow Perch**

Specific management objectives suggested for yellow perch would be the same as those listed in (1) through (4) above for walleyes, except that there would rarely be a need to create or maintain populations of yellow perch through stocking as in (5) above. Yellow perch are already widely distributed and have high reproductive potential.
Objectives that are even more specific could be formulated using the following characteristics that indicate healthy, adequately buffered, self-sustaining yellow perch populations:

1) stable recruitment with few missing or extremely weak year classes;
2) stable value for mean age at first maturity;
3) average total adult mortality less than 60% per year;
4) presence of some yellow perch over age 7 and 9 inches in length;
5) average total fishing mortality on all adults of less than 35% per year;
6) stable population of adults in terms of number of fish;
7) stable population in terms of growth, natural mortality, and size and age distributions;
8) stable fishery yield;
9) average catch rate when exploited within 50% to 100% of the value observed under a catch-and-release fishery.

Fishing Regulations

The primary tools for achieving percid management goals are regulations that limit harvest by sport and commercial fishing. The regulations may also attempt to protect spawning fish, distribute the catch fairly, and promote sportsmanship. These regulations have evolved considerably over the last 150 years in response to increases in fishing effort, real or perceived depletion of fish stocks, gains in science-based information, and a shift in societal and economic values away from harvesting toward recreation.

The majority of Michigan percid populations are managed by consistent, statewide regulations, although some exceptions do exist as described in next paragraph. In recent years, statewide regulations have been developed by consensus of MDNR fisheries biologists and citizens representing various special interests. Present statewide regulations are sufficiently conservative to protect percid stocks from recruitment overfishing. The compromises involved with quality, economic, and community overfishing were considered in their development (Schneider 1978; Fisheries Division 1996). The management goals and objectives listed above helped guide the discussion on degree of regulation required.

There have been situations in which percid fishing regulations in Michigan waters of the Great Lakes have been specifically adjusted to help solve special problems. In Lake Erie, walleye sport harvest in Michigan waters was exceeding guidelines established by the Great Lakes Fishery Commission (GLFC) Lake Committee, so minimum size and bag limits were made more restrictive to reduce harvest. In northern Lake Huron and southern Lake Michigan, yellow perch populations have declined and recruitment has been low (Schneeberger and Scott 1997; Clapp and Dettmers 2004). As a precaution, regulations in these two areas have been adjusted to provide greater protection while efforts are underway to determine the causes.

Walleye

Regulations are the primary tool for meeting many of the management objectives suggested for walleye fisheries. The degree of regulatory control needed in any fishery relates to the amount of fishing effort and the efficiency of the gears used. Sport fishing rod-and-reel gears are relatively inefficient compared commercial nets. Therefore, relatively simple sport fishing regulations based on seasonal closures, daily bag limits, and MSLs are enacted statewide, or regionally, and these are believed to be sufficiently conservative to protect virtually all walleye stocks and fisheries yet allow a safe harvest by fishers. The characteristics listed above and the amount of fishing effort expected in an area help guide the degree of regulation required. There are relatively few case histories of Michigan walleye populations that have clearly required intervention to correct recruitment
overfishing. Determining the exact reason for the collapse of a fishery is often complicated by the presence of multiple stress factors, of which fishing is only one. The best examples are walleye populations in various parts of the Great Lakes, such as western Lake Erie, Saginaw Bay of Lake Huron, or Bays De Noc of Lake Michigan (Schneider and Leach 1979). Some of these fisheries came close to total collapse in the 1960s due to overfishing from commercial and sport fisheries, competition or predation from invasive exotic species, and deterioration of habitat from pollution. Restoration efforts, including regulations to restrict fishing and restocking, are either ongoing or have been successful in many of these fisheries (Schneeberger 2000; Thomas and Haas 2000; Fielder 2002).

Michigan has a long history of progressively more restrictive regulations on walleyes and other species (Borgeson 1974). Legal restrictions on fishing methods included prohibiting the obstruction of fish passage in streams (1820); banning commercial netting in certain southern (1859) and northern inland waters (1872); prohibiting the use of explosives, toxins, seines and traps (1889); and banning netting (except dip nets for suckers and common carp Cyprinus carpio) on all inland waters (1911). The sport fishing bag limit on walleyes was reduced from no limit to 25 per day (1903, in combination with other species), to 10 per day (1917), and to 5 per day (1929). The bag limit remains at 5 walleyes per day (in combination with largemouth bass, smallmouth bass Micropterus dolomieu, and northern pike). Walleye MSLs were increased from no MSL to 10 inches (1915), increased to 14 inches (1929), reduced to 13 inches (1955), and increased to 15 inches (1976), where it is today. A closed spawning season for walleyes was not enforced until 1917.

Current sport fishing regulations: (1) allow sufficient walleyes to spawn and prevent harvest of small walleyes (15-inch MSL); (2) somewhat restrict and distribute the catch (possession limit of five walleyes per angler per day); and (3) decrease the efficiency, or promote the ethics, of sport fishing (legal gear restricted to two lines and no fishing allowed during spawning concentrations). The 15-inch MSL, established statewide in 1976, is the most powerful protector from recruitment, growth, and quality overfishing. It is a compromise most suitable for the characteristics of an average walleye population (Schneider 1978; Fisheries Division 1996). Ideally, regulations should be tailored to each population, with higher MSLs most appropriate for populations with faster growth, lower natural mortality and higher fishing mortality, and vice versa. The 15-inch MSL does not assure that all females will have the chance to spawn at least once because some females do not mature until larger. However, sufficient females are protected, and populations as a whole will likely produce more than enough eggs to assure successful recruitment of young. A slightly higher MSL would slightly improve the yield from average-growing females (they grow larger than males) and fast-growing walleye populations in general, but at the cost of lost potential fishery yield from slow-growing males and females.

Great Lakes commercial walleye fisheries were initially pursued with trap nets, gill nets, seines, spears, and hooks-and-lines, but were gradually restricted to trap nets. All commercial harvest of walleyes was eventually prohibited by the state. However, commercial walleye fishing has continued at relatively low levels in some Michigan waters of the Great Lakes by Indian tribes under treaty agreements (e.g., Enslen 2000). There are gear, season, depth, size, and area restrictions on tribal commercial fishing. The tribes also pursue subsistence walleye fisheries in the state by spearing on the spawning grounds in inland lakes of the 1842 treaty territory and netting in Great Lakes waters of the 1836 treaty territory. These fisheries are controlled by a permit and quota system.

Yellow Perch

Regulations have tended to be liberal for this widespread, relatively abundant, and prolific panfish. Yellow perch, like walleye and other species, were eventually protected from the destructive methods, such as explosives and toxins. Daily possession limits were changed from unlimited to 25 (1903, in combination with many other species), retained at 25 (1915, in combination with panfish), increased to no limit (1962), then changed (1979) to the current limit of 50 per day. The MSL was increased from none to 5 inches (1903), to 6 inches (1915), to 7 inches (1929), and then back to no
MSL (1949). There have been no statewide MSLs since 1949. Research has established that yellow perch, like other panfish, require very little protection to prevent recruitment overfishing. However, for some waters there are concerns about the potential for quality overfishing and the beneficial community role yellow perch serve as predators on small bluegills.

Habitat Protection

Other important tools for percid management are habitat protection and restoration practices that benefit entire biological communities (O’Neal and Soulliere, 2006). Important habitat factors include water quality parameters related to water temperature, dissolved oxygen, turbidity, sediment, and pollution. Important parameters in lakes include protection of spawning habitat, natural submerged vegetation, and emergent vegetation along shorelines. Important physical factors in streams include maintaining natural hydrology (flow patterns), natural substrate (especially gravel-cobble), and in-stream cover (wood cover) (Alexander et al. 1995). Since walleyes have limited spawning success in Michigan waters, protecting known or potential spawning areas is a very high priority. Spawning habitat is not a limiting factor for yellow perch, except perhaps in certain Great Lakes waters.

Activities associated with habitat protection include providing recommendations on Department of Environmental Quality permit applications under PA 451 (1994) Michigan Natural Resources and Environmental Code. This occurs on a continuing basis. Other activities include watershed assessment and planning, implementation of habitat projects, and providing assistance to other agencies and the public.

Habitat enhancement has also been attempted. Rock shoals have been placed in some lakes at considerable cost to provide better substrate for walleye spawning and eliminate or reduce the need for periodic stocking. The two primary examples that have received some study are Brevoort Lake and Six Mile Lake, in the Upper Peninsula. Both artificial reefs produced some larval walleyes, but the fisheries remained modest and it was not clear that benefits exceeded costs (Wagner 1990). In Nichols Lake, Newaygo County, an artificial reef produced no benefits to walleye reproduction (MDNR, unpublished survey reports).

Habitats continue to be modified by exotic species, especially in the Great Lakes and connecting waters. A succession of invaders, including sea lamprey Petromyzon marinus, alewife Alosa pseudoharengus, white perch Morone americana, ruffe Gymnocephalus cernuus, zebra mussel Dreissena polymorpha, and gobies Neogobius melanostomus and Proterorhinus marmoratus, have had negative effects on walleye, yellow perch, and other species in certain areas. In addition, aquatic habitats are being modified by exotic plant species, including Eurasian water-milfoil Myriophyllum spicatum, curly-leaf pondweed Potamogeton cripus, and purple loosestrife Lythrum hyssopifolia. All waters are at risk, are of concern, and should be protected to the extent possible.

Stocking

Dexter and O’Neal (2004) present MDNR guidelines and procedures for stocking fish in Michigan waters. Stocking is an important management practice for walleyes. Occasionally, yellow perch may be stocked for special purposes (such as restoration of populations following fish kills) by transferring adults, juveniles, or eggs from other populations. MDNR presently stocks from 6 to 8 million walleye fingerlings annually at a cost of approximately $0.5 million (1994 dollars, O’Neal 1998). According to MDNR records for 1995 to 1999, walleye stocking occurred in 304 lakes and reservoirs, 34 Great Lakes sites, and 63 river sites (some for river fisheries, others for Great Lakes fisheries). Stocking locations may vary from year to year. Principal purposes for stocking include restoring indigenous populations, supplementing natural populations, establishing new populations
for fishing, and improving slow-growing (stunted) panfish populations. Guidelines for stocking include evaluation of costs, benefits, effects on aquatic community, genetic effects on existing fish populations, biological soundness, community support, geographical need, existing regulations, and availability of fish (Dexter and O’Neal 2004). All stocking is experimental in the sense that it may be discontinued if deemed not worthwhile and other waters may be added. During the long history of walleye stocking in Michigan, nearly every potentially suitable body of water has been informally tested and many of them have been discontinued.

Genetics

Conserving the genetic integrity of fish populations is an important management objective for indigenous populations. This objective is incorporated into Michigan’s fish stocking guidelines (Dexter and O’Neal 2004). The long-term health and adaptability of fish populations in Michigan is dependant on preserving genetic diversity. Fish genetics in Michigan has been influenced on a broad geographic range by glaciations and colonization, and by localized environmental influences. The greatest amount of genetic diversity within Michigan can be retained by preserving the genetic traits of individual stocks. Preserving and managing self-sustaining populations is the most economical and best way to protect genetic diversity in fish populations. Management of wild populations with stocked fish must consider the effects on genetic diversity.

Genetic principals are an integral part of Great Lakes fishery management (GLFC 2001). Fish community objectives for the Great Lakes insure management programs incorporate the genetic stock concept, along with preservation of native species and species diversity. Both walleye and yellow perch were historically widely stocked throughout Michigan, but recent studies indicate Great Lakes populations are genetically structured (Clapp and Dettmers 2004) and managers should attempt to preserve that structure.

Status in Michigan

Fisheries management by MDNR is organized by watersheds. The state is divided into four Great Lakes watersheds (or basins), and then further subdivided into management units (MUs). There are eight MUs in the state (Figure 2).

In addition, some regions of the state are managed with consideration for the harvest needs of Indian tribes who retained fishing rights from 19th century treaties. Most of the Upper Peninsula west of Marquette (Figure 3) is part of the territory ceded by Indians in the Treaty of La Pointe in 1842. The Indians retained fishing rights under the treaty, including rights to issue and enforce fishing regulations pertaining to members of their tribes. Two Indian communities, Lac Vieux Desert and Keweenaw Bay, currently pursue a variety of commercial, subsistence, and sport fisheries in the 1842 territory under agreements with the states of Wisconsin and Michigan.

Most of the Upper Peninsula east of Marquette and the Lower Peninsula from the Mackinaw Bridge to Grand Haven (Figure 3) is part of the territory ceded by Indians in the Treaty of Washington in 1836. The Courts have affirmed that the tribes still have fishing rights under this treaty, but only in Great Lakes waters. The continued existence of tribal fishing rights in inland areas is still in dispute. Five Indian communities, Bay Mills, Sault Ste. Marie, Little Traverse Bay, Grand Traverse Bay, and Little River, currently pursue a variety of commercial, subsistence, and sport fisheries in the Great Lakes waters of the 1836 territory under an agreement with the state of Michigan (Enslen 2000).

Walleyes have a more limited natural distribution and abundance than most other coolwater or warmwater sport fish. Bailey et al. (2004) presented the distribution of walleyes in Michigan based on
voucher specimens from the University of Michigan, Museum of Zoology and several other field survey databases from collaborating agencies, including the Michigan Department of Natural Resources (MDNR). While these records are reliable, they include only waters that were surveyed and only surveys that collected walleyes. However, walleyes are more actively managed than most species, with waters constantly added to, or subtracted from, stocking lists. We attempted to compile a nearly complete list of waters likely to contain walleyes based on MDNR stocking records from 1995 through 1999, automated MDNR biological survey records since 1980 or later, and a questionnaire sent to each MDNR fisheries MU in February 2002. The questionnaire responses (Appendices 1–4) likely contain the most important walleye lakes. Possibly excluded from these three sources of information are some small wild populations in rivers, some public or private waters that have not been surveyed recently or at all, and stockings in private lakes (lakes without public access or connecting waters are not required to obtain a stocking permit). On the other hand, some listed lakes may no longer contain walleyes if stocking was discontinued.

The questionnaire also asked the MU biologists to make judgments regarding walleye recruitment (e.g., consistent natural reproduction, recruitment from stocking only, etc.), population origin (whether or not walleyes were native to the water body), access to Great Lakes (whether or not fish migrate to Great Lakes), and fishery rank (subjective assessment of level of fishing effort).

Identifying the source and level of recruitment is one of the more helpful ways to classify walleye waters for management purposes. We classified waters according to the source and level of recruitment in their walleye populations. That is, whether walleye populations are supported by:

1) natural reproduction exclusively, which is consistent enough to produce relatively even year classes of adults;
2) natural reproduction exclusively, but is inconsistent and periodically results in missing year classes;
3) natural reproduction primarily, but stocking also occurs;
4) both natural reproduction and stocking about equally;
5) stocking primarily, but some natural reproduction occurs;
6) stocking exclusively, which is consistent enough to produce relatively even year classes of adults;
7) stocking exclusively, but population is in decline and likely to disappear due to recent termination of stocking;
8) stocking exclusively, but harvestable population has not yet developed; or
9) unknown recruitment sources.

The origin of walleye populations was coded as: (1) probably native to water body; (2) due to stocking or introduction; or (3) unknown.

Walleye population access to the Great Lakes was coded as: (1) presently has access to and migrates to Great Lakes; (2) historically migrated to Great Lakes; (3) does not have access to Great Lakes; or (4) unknown.

Walleye fishery rank was coded as: (1) excellent, used extensively by anglers; (2) moderate, used at average level by anglers; (3) fair, used at low level by anglers; or (4) poor, used rarely by anglers.

In addition, we requested ranks for yellow perch fisheries in the same walleye lakes using the same codes. The list of yellow perch lakes in the appendices and tables is far from complete, but includes many of the most important waters. Finally, we also requested published and unpublished estimates of walleye and perch populations that had been stored in MU files.
Lake Superior Basin

Michigan’s part of the Lake Superior Basin (LSB) is about 160 miles north to south and 300 miles east to west. It extends south of Lake Superior to about the towns of Watersmeet on the west side and Rexton on the east side, but is very narrow in between. It only extends about 5 miles south of Lake Superior at Munising. The Basin is divided into two fisheries management units, the Western Lake Superior Management Unit (WLSMU) and the Eastern Lake Superior Management Unit (ELSMU) (Figure 2). Most of the Basin west of Marquette is part of the 1842 ceded territory, and most of the Basin east of Marquette is part of the 1836 ceded territory (Figure 3).

Walleye

*Distribution.*—For the LSB there were 86 sites containing walleyes based on recent stocking records, fish collections, and questionnaires (Appendix 1). The majority of sites were in the western management unit, especially in Gogebic County. Sixteen waters were classified as having adequate natural reproduction (recruitment code 1 or 2), 37 waters were classified as having a mixture of natural reproduction and stocking (coded 3, 4, or 5), and 16 waters were classified as maintained solely by stocking (coded 6, 7, or 8). Many additional waters listed in Appendix 1 have not yet been classified, but most depend on stocking.

The biological characteristics of walleyes in inland waters of the Upper Peninsula, including the LSB, may differ slightly, on average, from those described earlier for Michigan as a whole. This area of the state is more likely to have better walleye recruitment because rocky outcrops are more common and competing bluegills are less abundant. Consequently, these lakes are more likely to have regular natural recruitment and more numerous adult walleye populations. Many lakes in the western Upper Peninsula more closely resemble the classic walleye lakes in northern Wisconsin and northeastern Minnesota. It is likely that, on average, walleye growth is somewhat slower than the Michigan state average due to the lower nutrient content of waters and shorter growing season in the western Upper Peninsula. For example in Lake Gogebic (WLSMU, Ontonagon and Gogebic counties), a length of 15 inches is not attained until age 4 or 5 instead of age 3 (Miller 2000). In addition, natural mortality may tend to be lower than the statewide norm. Few inland lakes within the Lake Superior basin contain “good” walleye populations or fisheries based on available statistics. Two lakes, Gogebic and Six Mile (WLSMU, Houghton County), had populations of adult walleyes sometimes exceeding 3.0 per acre (Table 2). Two other lakes, Cisco and Thousand Island (both in WLSMU, Gogebic County), produced good yields of greater than 1.0 walleyes per acre per year (Table 4). Only Lake Gogebic had a good catch rate, greater than 0.100 walleyes per hour, in some years. Twelve other waters were ranked by MU biologists as receiving extensive walleye fishing (Appendix 1).

Lake Gogebic is the most renowned inland walleye lake in Michigan. Eschmeyer (1950) conducted an extensive study on walleye life history and several other studies of the fishery have been made since (e.g., Norcross 1986; Miller 2000). Angling yields in this large, low-productivity lake range from 0.2 to 0.7 walleyes per acre per year, and hourly catch rates vary from 0.100 to 0.153 walleyes per hour (Table 4). These statistics are on a par with other walleye fisheries in the Midwest (Table 2).

A Lake Gogebic walleye holds the state record for longevity. A male walleye tagged during Eschmeyer’s (1950) study achieved an estimated age of 26 years and a length of only 19.6 in at recapture (Schneider et al. 1977). Sport fishing exploitation and total mortality rates have increased since the 1940s (Miller 2000). Minimum angling exploitation rates based on tag returns were 4% in 1947, 6% in 1976, 7% in 1977, 20% in 1984, and 21% in 1994. Returns for the last 2 years were enhanced by rewards, so it is likely that the true exploitation rate is currently about 25%. Total mortality rates for those same years were estimated at 24%, 27%, 27%, 38%, and (for males) 37%, respectively. Natural mortality was about 18–22% per year. Estimates of number of adults (13 inches and larger) have ranged from 2.8 to 9.2 fish per acre, a three-fold variation (Table 3).
Mark-and-recapture estimates were also made at Six Mile Lake, a walleye population established in the 1970s by stocking, but partially maintained in the 1980s by reproduction on an artificial spawning reef (Wagner 1990). There, estimates averaged 1.5 walleyes per acre, with a four-fold variation (Table 2). Total mortality and exploitation were not estimated.

Lake Superior proper supports few walleyes because it is so deep and cold. However, their presence has been documented in at least 24 locations in Michigan waters (Hoff 1996), and we will mention the most significant of those here. The lower Tahquamenon River (ELSMU, Luce County) supports a small run of 2,379 wild and stocked, lake and river walleyes (MDNR 2001, unpublished data). A small population of large walleyes spawns in the Ontonagon River (WLSMU, Ontonagon County) and resides in the river and adjacent waters of Lake Superior. Sport anglers catch about 1,000 walleyes per year (Table 5). Smaller populations are associated with the Black River (WLSMU, Gogebic County), the Portage Lake waterway (WLSMU, Houghton County), and Huron Bay (shoal spawners – WLSMU, Keweenaw County). Biological data for the Lake Superior stocks is scant but most are now a mixture of stocked and naturally reproduced fish.

Special concerns.—Some common management concerns for fisheries everywhere include, but are not limited to: (1) controlling fishing effort and harvest; (2) protecting water quality and habitat from deterioration; (3) managing stocking activities; (4) protecting significant and unique spawning populations; (5) controlling spread of exotic species; and (6) dealing with toxic contaminants. The problems associated with each of these concerns vary in severity with species of fish and from one MU to another. Of those listed, the primary concerns for walleyes in LSB would be for controlling fishing, managing stocking, and dealing with contaminants. While the other problems listed are always present, they are currently of less concern than the others in LSB.

Walleye populations in LSB are generally in good condition. Overall habitat deterioration has been minimal, and there is no evidence that recruitment overfishing is occurring, with the possible exception of Parent Lake (WLSMU, Baraga County – V. Nurenburg, MDNR, personal communication). Biological surveys in Parent Lake indicated a serious decline in abundance of walleyes. As a precaution, the Keweenaw Bay Tribal Community imposed a moratorium on spearing the lake in 2002 and 2003. But overall, the present levels of fishing effort and harvest in the LSB are not of concern, except that walleye fishing effort and harvest are probably increasing. For example, sport fishing mortality rates for walleyes in Lake Gogebic increased from the 1970s to the 1990s (Miller 2000). Also, spring spearing harvest of walleyes for Lac Vieux Desert Tribal Community was 0 prior to 1989 and gradually increased to over 4,300 in 2002 (J. Krueger, Great Lakes Indian Fish and Wildlife Commission, personal communication, 2003). Much of this tribal harvest was from lakes in the 1842 ceded territory of the WLSMU. These increasing trends are a concern for LSB, and they should continue to be monitored. Further increases in either sport or subsistence harvest, or both, might require more restrictive regulations in the future.

With regard to managing stocking, walleye fry or fingerlings were stocked in 36 lakes and reservoirs, 3 Great Lakes sites, and 3 river sites in the LSB from 1995 through 1999 (Appendix 1). These fish were used to establish or maintain fisheries where walleyes were not native and to supplement native populations. Significant walleye sport fisheries have developed in some of the waters (Appendix 1). However, walleye stocking should be managed carefully (Dexter and O’Neal 2004). Even though there often is more demand for stocking than fish available, individual lakes probably still exist where too many are being stocked. It has been shown that overstocking can cause undesirable, density-dependent problems, such as reduced growth and recruitment of walleyes (Clark et al. 2004) and excessive predation on prey fish populations (see special concerns for walleyes in the Lake Erie Basin for examples). In addition, the benefit-cost ratio for stocking should be evaluated periodically to make sure it is within acceptable guidelines.

Another special concern in LSB is the presence of toxic contaminants in walleyes. It has been necessary to issue fish consumption advisories for walleyes in parts of the LSB (MDCH 2004). This
includes a general advisory for mercury for all fish species from inland lakes. It states that no one should eat more than one meal of walleyes a week and women of childbearing age and children under age 15 should not eat more than one meal of walleyes a month. In addition, specific waters in LSB have more strict advisories (see list in MDCH 2004). While these advisories are of great concern from the standpoint of utilizing walleyes as food, there is no evidence that the current levels of contamination are affecting the ability of walleye populations to sustain themselves.

Yellow Perch

_Distribution._—Yellow perch are distributed throughout the LSB and are likely to occur in all waters that meet their general requirements for pH and dissolved oxygen. Yellow perch are the prevalent panfish in this area, and most lakes contain important and fishable populations.

It is likely that all inland waters accessible to anglers and that contain significant populations of yellow perch are exploited to some degree. No estimates of perch exploitation rates have been made within the LSB and perch abundance has been estimated only for Cub Lake (WLSMU, Gogebic County) in the Sylvania Tract (Clady 1970). There, the number of 7-inch and larger adults varied from 1.1 to 33.1 per acre over 3 years (Table 3). Cub Lake was unexploited, but total mortality of adults was 57% and few perch lived to age 4. No commercial, but some Indian subsistence, fishing occurs for yellow perch in the LSB.

Yellow perch angling harvest rates are available for nine lakes (Table 6). They range up to 25 fish per acre and 0.711 fish per hour, but only two lakes exceeded the Michigan average of 4.4 fish per acre. Cisco, Thousand Island, and Gogebic lakes (all in WLSMU, Gogebic County), had the best perch fisheries. Sport fisheries for yellow perch in many walleye lakes were ranked by fisheries managers in Appendix 1.

Most of Lake Superior is too deep and cold for yellow perch. A modest population of them occurs in Keweenaw Bay (WLSMU, Keweenaw County) that sustains a sport harvest varying from 15 to 120,000 yellow perch per year.

_Special concerns._—Yellow perch populations in the LSB are generally in good condition. Of the general fisheries problems listed earlier for walleyes, the only one that is a special concern for yellow perch in the LSB is contaminants.

There is no evidence that recruitment overfishing is occurring for yellow perch in the LSB. The general trend of increasing fishing effort and harvest mentioned earlier for walleyes is not as much of a concern for yellow perch from the standpoint of recruitment overfishing. Yellow perch populations have very high reproductive capacities. However, the potential for quality overfishing exists statewide because yellow perch are relatively easy to catch by angling at times, and the mobility of anglers and the popularity of yellow perch assure that virtually all waters will be at least moderately exploited. Regulation of yellow perch exploitation rate is made difficult by large annual fluctuations in recruitment of young and subsequent abundance of adults. This causes “boom or bust” fisheries in some lakes.

Habitat deterioration has been minimal in LSB and current programs that conserve water quality and shorelines adequately protect yellow perch habitat. Yellow perch reproduce satisfactorily and stocking is not necessary except in waters deficient in forage fish or depleted by a total fish kill.

As with walleyes, fish consumption advisories for yellow perch have been issued in parts of the LSB (MDCH 2004). The general, statewide advisory for mercury is a special concern for yellow perch. However, there is no evidence that current levels of contamination are affecting the ability of yellow perch populations to sustain themselves.
Lake Michigan Basin

The Michigan part of the Lake Michigan Basin (LMB) is about 300 miles north to south and about 200 miles east to west. It is divided into three fisheries management units, Northern Lake Michigan (NLMMU), Central Lake Michigan (CLMMU), and Southern Lake Michigan (SLMMU) (Figure 2). Most of NLMMU is part of the 1842 ceded territory. Most of CLMMU and some of SLMMU are part of the 1836 ceded territory (Figure 3).

Walleye

Distribution.—For the LMB there are 325 sites containing walleyes based on recent stocking records, fish collections, and questionnaires (Appendix 2). Of those, 24 waters were classified as adequately sustained by natural reproduction (recruitment code 1 or 2), 60 had a mixture of natural reproduction and stocking (coded 3, 4, or 5), and 104 were maintained solely by stocking (coded 6, 7, or 8). Many additional waters listed in Appendix 2 have not yet been classified, but most are dependent on stocking. About 38% of the listed sites in the LMB were stocked at least once in 1995–99.

The waters of the LMB include the complete range of types found within Michigan. The basin contains the largest (Houghton – CLMMU, Roscommon County) and the deepest (Torch – CLMMU, Antrim County) inland lakes in the state and has lakes with a wide natural range in water quality. For example, some lakes in the western Upper Peninsula are relatively acidic (low pH) whereas some marl lakes in the Lower Peninsula have a relatively high pH. Climate ranges from the coldest part of the state (Baraga County) to the warmest part (Berrien County). The lakes support the full variety of coldwater, coolwater, and warmwater fish communities. Rivers and impoundments are equally diverse. All of the waters coded with the best walleye reproduction (recruitment code 1 or 2) were in either NLMMU or CLMMU. South of the Muskegon River Watershed, the boundary between CLMMU and SLMMU, some reproduction occurs in rivers and impoundments, but walleye lake fisheries are heavily dependent on stocking.

The biological characteristics of walleyes in inland waters of NLMMU (most of southern half of the Upper Peninsula) are more similar to those in the LSB than to other waters in the LMB. Lakes in the western portion are more likely to have better walleye spawning habitat because rocky outcrops are more common. Consequently, these lakes are more likely to have regular natural recruitment and more numerous adult walleye populations. However, the large, wind-swept Manistique lakes in the eastern portion of NLMMU (Luce and Mackinac counties) also sustain good reproduction. Some lakes in the NLMMU resemble classic walleye lakes in northern Wisconsin and northeastern Minnesota. Walleye growth in the NLMMU is somewhat slower than the Michigan-wide average (Hanchin et al. 2005), probably due to fewer nutrients and a shorter growing season. Natural mortality may also tend to be lower than the statewide norm.

Population estimates of adult walleyes (13 or 15 inches) are available for 16 lakes and 3 rivers in the LMB (Table 2). Estimates in lakes ranged from 0.4 to 5.4 walleyes per acre. Estimates for rivers, based on section sampling with rotenone, range from 0.0 to 6.0 walleyes per acre. Estimates for populations created primarily by stocking sometimes exceeded those composed predominately of naturally-reproduced fish, at least in the short term. The most recent estimates for large walleye lakes with good reproduction are 1.5 walleyes per acre for Lake Michigamme (NLMMU, Iron County) and 2.9 walleyes per acre for Houghton Lake (CLMMU, Roscommon County) (Clark et al. 2004; Hanchin et al. 2005).

Mid-1970s data for Manistee Lake (CLMMU, Kalkaska County) indicated a fishing harvest rate of about 17% per year and a total mortality rate of 42% for age-2 and older walleyes (Laarman and Schneider 1986). Very recent estimates for Houghton Lake and Lake Michigamme Reservoir were 46% and 37% for total mortality, and 27% and 22% for angler exploitation, respectively (Clark et al. 2004; Hanchin et al. 2005). These exploitation estimates were based on rewards for some tags. Other
recent estimates of minimum angling exploitation rates, based on voluntary tag returns, are 26% for Maple Lake (SLMMU, Van Buren County), and 7% for Sessions Lake (SLMMU, Ionia County) (J. Dexter and A. Herrington, MDNR, personal communications). None of these rates are excessive because they apply to fish larger than 15 inches. Also, Indian subsistence fisheries for walleyes operate on certain lakes in of the 1842 treaty territory in NLMMU.

Data accumulated since 1976 on walleye sport fishing catch and total effort at 15 sites are summarized in Table 7. Harvest rates ranged up to 13.7 walleyes per acre (Sessions Lake, a new and productive stocked impoundment) and 0.230 per hour (South Manistique, a lake with natural reproduction). Seven populations at least partially met the criteria defined earlier for “good” walleye fisheries. Based on rankings by MU biologists (Appendix 2), 13 inland lakes, 4 drowned river-mouth lakes, and 3 rivers have extensive walleye sport fisheries.

A number of populations in LMB migrate freely between inland and Great Lakes waters but have strong tendencies to return to inland waters for spawning. Lake Michigan tributaries that have migratory populations include the Muskegon, St. Joseph, Kalamazoo, Grand, White, Pentwater, Pere Marquette, and Manistee rivers. Most of these rivers contain lakes near their confluence with Lake Michigan (known as drowned-river-mouth lakes) that support the bulk of the walleye populations and fisheries and some of their walleyes are caught from Lake Michigan proper. Drowned-river-mouth lakes are unique systems that in the State of Michigan occur only in the LMB. Walleyes also occur in northern Green Bay, but those fish use various tributaries and reefs for spawning, and then move to the bay where they support very large sport fisheries.

Northern Green Bay (NLMMU, Menominee and Delta counties), including the bays de Noc, supports one of the major Great Lakes walleye populations in Michigan. This walleye population is still in the process of rehabilitation following a near-total collapse in the 1960s (Schneider et al. 1991). Fingerling walleye stocking has enhanced spawning runs in the north end of Little Bay de Noc and in tributary rivers – especially the Cedar and Menominee rivers. Natural reproduction is substantial in some years but stocking continues. The population of legal-sized walleyes is roughly 484,000 fish (Schneeberger 2000). Based on tagging data, these fast growing and large walleyes experience total mortality rates of 40% per year in Little Bay de Noc, 5% in Big Bay de Noc, 13% near Cedar River, and 59% near Menominee. Tag return rates are 5% for Little Bay de Noc and 2–6% for other areas. If it is assumed that under-reporting of unrewarded tags occurred by a factor of 2.5, then the true exploitation rate is about 12% per year. The sport fishery in 1985–96 took an average of 34,000 walleyes per year from Little Bay de Noc (with a 6-fold annual variation), 3,000 from Big Bay de Noc (16-fold variation), 250 from Cedar River area, and 12,400 from the Menominee area. Data for the year 2000 are in Table 4.

The Muskegon river-lake system (CLMMU, Muskegon County) supports a very good sport fishery (Appendix 2) and sustains the principal walleye population in CLMMU. It is one of the principal broodstock rivers used for the MDNR walleye rearing-stocking program. Marking programs have shown that Muskegon River walleyes migrate along the coast south to Indiana and north to southern Green Bay. They also move into other inland rivers within these boundaries. Spawning population levels have been estimated as follows: 1953 – 114,000; 1954 – 139,000; 1975 – 2,000; 1986 – 43,000; and 1998 – 46,479. Population levels in the 1950s were likely near the maximum for the system because walleyes exhibited substantially slower growth rates than now. Significant declines occurred in the 1960s and 1970s associated with the dramatic changes in Lake Michigan fish communities (Schneider and Leach 1979; Eshenroder et al. 1995). A restoration program was started in 1979 by stocking pond-reared fingerling walleyes derived as eggs from the Muskegon River spawning run (Schneider et al. 1991). Population levels appear to have stabilized as indicated by the 1986 and 1998 estimates. Growth rates increased when population levels dropped, but decreased in recent years as the population was restored to moderate levels. The number of walleyes in the 1998 spawning run exceeding 15 inches in length was estimated at 45,806. Total mortality was estimated at 35%, corresponding to an instantaneous total mortality (Z) of 0.43. Poor recruitment was likely the
cause of the population decline during the 1960s and 1970s (Schneider and Leach 1979), and it continues to be a problem today. Marking studies (1997–2001) have shown that fewer than 5% of juveniles in this system are from natural reproduction and the rest are stocked fish. A significant number of the walleyes in the spawning run, about two adults per acre (Table 3), reside in the Muskegon River year around. For the river section between Croton Dam and Muskegon Lake, the estimated harvest of walleyes by anglers was 731 in 1999 and 1,061 in 2000 (Table 8). The average catch rate for all types of anglers (including effort directed at trout) was 0.002 walleyes per hour for both years. In 2002-03, a year-round angler survey was conducted on Muskegon Lake. Results indicated that anglers fished 177,833 hours and caught 2006 walleyes. Studies on walleye recruitment are currently underway.

White Lake (CLMMU, Muskegon County) has a very good sport fishery for walleyes (Appendix 2) and there is a substantial spawning run of adult walleyes in the White River each year. Marking studies indicate this system is also supported by stocking. In 1999 and 2000, all juveniles collected from the lake were of stocked origin; in 2001, 75% of the young-of-the-year were of stocked origin.

Mona Lake and Black Creek (CLMMU, Muskegon County) have a fair walleye fishery, as reported by anglers. It is believed that fish from the Muskegon River supported this fishery until recently because the system was not stocked until 2001 and the creek is probably too cold for walleye reproduction.

The Pentwater (CLMMU, Oceana County) and Pere Marquette (CLMMU, Mason County) rivers generally do not support substantial spawning runs of walleyes because they are too cold. However, Pentwater and Pere Marquette lakes support fair walleye fisheries. Walleyes in Pentwater Lake may originate from stocking upstream in Hart Lake Impoundment.

The Manistee lake-river system (CLMMU, Manistee County) has small walleye fisheries. For Manistee Lake, angling catch estimates are less than 100 walleyes per year (Table 8). For the Manistee River downstream of Tippy Dam, estimated catches are 120–260 walleyes per year.

In waters of SLMMU, the Grand River has a migratory walleye population below the dam in the City of Grand Rapids. Estimates of walleye population levels and fishery statistics are not available for this system but the fishery is extensive (Appendix 2). During the 1990s, standard survey work in the Grand Rapids area during the spawning season found many adult walleyes. Sportfishing tournaments for walleyes are frequent during the open water season in the lower Grand River near Grand Haven. This system is presently stocked and natural recruitment has not been evaluated.

Lake Macatawa and the Macatawa River (SLMMU, Ottawa County) are stocked with walleyes and contain some migrants. Angler use, population levels, and natural recruitment information for this system are not available at this time. There is at least a moderate sport fishery in Lake Macatawa based on angler reports and observations (Appendix 2).

The Kalamazoo River (SLMMU, Allegan County) has a substantial population of walleyes, especially downstream of the first dam (Caulkins Dam, 26 miles from Lake Michigan). This river is stocked with walleyes and there is a limited amount of natural recruitment in the upper portions of the river based on survey data. The Black River (at South Haven) and the Galien River have very small walleye fisheries supported by stocking.

The St. Joseph River (SLMMU) supports walleyes throughout its length, but the primary fisheries are in Michigan waters of St. Joseph and Berrien counties. The St. Joseph River is a shared resource with the State of Indiana and is cooperatively managed. A fish ladder-lamprey barrier at Berrien Springs Dam prevents substantial movement of migratory walleyes into upstream areas. Based on video counting, very few walleyes move upstream during periods of the year when the fish ladder-lamprey barrier is not operational. There is some downstream movement of walleyes over the dams and through the fish ladders. Walleyes are stocked throughout this system. Survey information collected during 1990, and creel surveys in following years, indicated a limited amount of natural
reproduction was occurring downstream of Berrien Springs. In 1998 and 1999, harvest estimates averaged about 4,500 walleyes per year and catch rates averaged about 0.016 walleyes per hr (Table 8).

**Special concerns.**–As mentioned earlier, some of the common management concerns for fisheries everywhere include: (1) controlling fishing effort and harvest; (2) protecting water quality and habitat from deterioration; (3) managing stocking activities; (4) protecting significant and unique spawning populations; (5) controlling spread of exotic species; and (6) dealing with toxic contaminants. All six of these are special concerns for walleyes in LMB.

Habitat deterioration and overfishing have harmed some walleye fisheries in LMB, such as in the Muskegon River, but recent management programs, including stocking and more restrictive fishing regulations, have been fairly successful in restoring them. These same programs have also created many walleye fisheries where none previously existed. Thus, walleye populations in the LMB are more numerous than ever and are generally in good condition.

As far as is known, recruitment overfishing is not occurring anywhere in the LMB, although there is probably a general trend of increasing sport fishing effort and harvest. There is also an increasing trend in subsistence harvest in the 1842 territory of NLMMU, as mentioned earlier. These trends should be monitored and continued increases might require more restrictive regulations in the future. Depending on how it is defined, quality overfishing might be occurring in some places in the LMB. The potential for quality overfishing always exists because it is defined differently by different people and walleyes are highly sought after by people with diverse and often conflicting interests.

The threat of water quality and habitat deterioration is directly proportional to human population size. CLMMU and SLMMU are much more heavily populated than NLMMU, and so would be of greatest concern. The aquatic resources are continuously threatened from general human land and water use, ill-advised construction projects, and pollution. The MDNR and MDEQ must try to ensure these threats are minimized or mitigated. One of the primary concerns for walleyes would be deterioration of spawning habitat, which is usually in short supply and often limits the abundance of native populations.

With regard to managing stocking, walleye fry or fingerlings were stocked in 166 lakes and reservoirs, 25 Great Lakes sites, and 35 river sites in the Lake Michigan basin from 1995 through 1999 (Appendix 2). Stocking established new fisheries in some areas where walleyes were not native and supplemented fisheries on some small native populations. In some of the waters, such as Chicagon (NLMMU, Iron County), Silver (CLMMU, Oceana County), and Sessions (SLMMU, Ionia County) lakes, the St. Joseph (SLMMU, Berrien County) and Muskegon (CLMMU, Muskegon County) rivers, and northern Green Bay waters (NLMMU, Menominee and Delta counties), significant walleye sport fisheries have developed (Tables 7 and 8). Also, stocked walleyes reproduce to a limited extent in some waters. In spite of this overall success, there is a continuous need to monitor results and refine walleye stocking. Even though there is more overall demand for stocking than fish available, individual lakes probably still exist where too many are being stocked. It has been shown that overstocking can cause undesirable, density-dependent problems, such as reduced growth and recruitment of walleyes (Clark et al. 2004) and excessive predation on prey fish populations (see special concerns for walleyes in the Lake Erie Basin for examples).

With regard to protecting significant and unique spawning populations, probably the three most important walleye populations in LMB are in Big and Little bays de Noc and the Muskegon River. These populations are in the process of restoration by heavy stocking. Exploitation should be kept minimal to buildup the broodstock and improve chances for natural reproduction. The total mortality rate for walleyes in the Menominee area, 59%, is of concern because it exceeds the upper threshold level we proposed of 50%. However, the 59% figure may not be representative (Schneeberger 2000). Some improvement has become evident in Little Bay de Noc.
Many undesirable species have been introduced to the LMB including: (1) vertebrates such as alewives, sea lamprey, and gobies; (2) invertebrates such as zebra mussels, spiny waterfleas Bythotrephes cederstromi, and rusty crayfish Orconectes rusticus; and (3) plants such as Eurasian watermilfoil Myriophyllum spicatum, curly-leaf pondweed Potamogeton crispus, and purple loosestrife Lythrum salicaria. Both vertebrate and invertebrate invaders can affect walleyes through predation (especially on eggs and young) and competition for food and other resources, and plant invaders can adversely affect the aquatic habitat. Alewives, in particular, have a negative effect on walleye fry in Lake Michigan (Schneider et al. 1991). Controls need to be put in place to slow or halt the spread of existing exotic species and to prevent any new ones from being introduced.

As in the LSB, fish consumption advisories for walleyes have been issued for the LMB (MDCH 2004). The general, statewide advisory for mercury is a concern for walleye fisheries. Also, walleyes are contaminated with PCBs in some lakes and rivers in the LMB (see list in MDCH 2004). However, there is no evidence that current levels of contamination are affecting the ability of walleye populations to sustain themselves.

Yellow Perch

Distribution.—Yellow perch are distributed throughout the Lake Michigan basin and are likely to occur in all significant waters meeting their general requirements for pH and dissolved oxygen. In many of the large northern lakes, yellow perch are the dominant panfish, and the lakes contain important and fishable populations of yellow perch. In more southern lakes, bluegills usually outnumber yellow perch.

It is likely that all inland waters of LMB that are accessible to anglers and contain significant populations of yellow perch are exploited to some degree. No commercial fishing and little Indian subsistence fishing occurs for yellow perch.

Within the LMB, estimates of yellow perch population size have been made for six lakes (Table 3). Estimates of adults (>7 inches) range from 1.3 to 62.8 perch per acre. The best data are for Manistee Lake (CLMMU, Kalkaska County) (Laarman and Schneider 1986). For 9 years of data, 1974–84, the average population of yellow perch 7.0 inches and longer was 27.2 perch per acre. The variation was extreme: from 0.6 to 62.8 per acre, reflecting weak and strong year classes. The average total mortality of adult perch was a modest 45% per year, indicating overexploitation was not occurring. There have been no direct measurements of yellow perch exploitation rates in inland waters of the LMB.

Yellow perch fishery data have been compiled for 25 lakes (Table 9). Estimates ranged up to 29.3 fish per acre and 0.933 fish per hour, but only eight lakes exceeded the state average of 4.4 fish per acre. Annual variations of 12-fold have been observed at Manistee Lake. Extensive yellow perch fisheries reportedly exist in four of the lakes ranked by fisheries managers (Appendix 2).

The largest yellow perch population is located in Michigan waters of Green Bay (NLMMU, Delta County). From 1985 to 1996, anglers annually harvested 226,000 yellow perch from Little Bay de Noc and 72,000 from Big Bay de Noc (Schneeberger 2000). Estimates for 2000 are in Table 10. Tribal commercial and subsistence fisheries currently take small numbers of yellow perch. Population statistics for Little Bay de Noc yellow perch are a population size of approximately 657,000 fish over 7 inches in length, a total mortality of 58%, and an adjusted exploitation rate of 10% (Schneeberger 2000). Comparable statistics have not been estimated for Big Bay de Noc yellow perch.

The other major yellow perch concentration in LMB is from Muskegon to Grand Haven (CLMMU, Muskegon and Ottawa counties) and from South Haven to St. Joseph (SLMMU, Van Buren and Berrien counties). Sport harvest from those ports totaled 183,000 yellow perch in 2000 (Table 10). This fishery has been at a reduced level for a decade, but is in better shape than yellow perch populations to the south and west. Some of these yellow perch migrate into the rivers and lakes with connecting channels to Lake Michigan. These movements can be substantial during some years,
especially in the drowned-river-mouth lakes that have short, deep connecting channels to Lake Michigan. Important connecting lakes in CLMMU are Mona, Muskegon, Duck, and White (all in Muskegon County); Pentwater (Oceana County); Pere Marquette, Manistee, Portage, and Arcadia (all in Manistee County); Betsie (Benzie County); Elk (Grand Traverse County); and Charlevoix (Charlevoix County). Some juvenile perch produced in these inland waters move into Lake Michigan.

**Special concerns.**—Yellow perch populations in the LMB are generally in good condition. Of the general fisheries problems listed earlier for walleyes, the two that are of most concern for yellow perch are controlling exotic species and dealing with contaminants. There is no evidence that recruitment overfishing is occurring in Michigan waters. However, recruitment overfishing is a suspected problem in Indiana, Illinois, and Wisconsin waters of Lake Michigan (Clapp and Dettmers 2004). Also, the potential for quality overfishing always exists.

Habitat deterioration has been minimal for yellow perch in LMB and current programs that conserve water quality and shorelines adequately protect yellow perch habitat. Yellow perch reproduce satisfactorily and stocking is not necessary except in waters deficient in forage fish or depleted by a total fish kill.

Managers should be aware of the role of yellow perch play as a predator on small bluegills in the inland lakes where stunted bluegill populations are often a problem. This would be more of an issue in SLMMU than anywhere else in the LMB. Managers should try to maintain adequate numbers of larger, older yellow perch in such lakes, but this is difficult to achieve in practice.

Exotic species are a major concern for yellow perch in LMB, especially in the Great Lakes and connecting waters. These include the same species as mentioned earlier for walleyes. And as with walleyes, these invaders can affect yellow perch through predation, competition, and habitat alterations.

For Lake Michigan waters, the continued low abundance of yellow perch in the southern half is a concern that merits more study. The bag limit has been reduced to 35 perch per day to conserve brood stock. Possible effects of exotic species such as alewife and zebra mussels on yellow perch fry are suspected as contributing factors (Clapp and Dettmers 2004).

Fish consumption advisories for yellow perch have been issued for the LMB (MDCH 2004). The general, statewide advisory for mercury is the primary concern. However, there is no evidence that current levels of contamination are affecting the ability of yellow perch populations to sustain themselves.

**Lake Huron Basin**

The Michigan portion of the Lake Huron Basin (LHB) is about 280 miles long (north to south) and about 150 miles wide (east to west). It is divided into two fisheries management units, Northern Lake Huron (NLHMU) and Southern Lake Huron (SLHMU) (Figure 2). Much of NLHMU and a small part of SLHMU are part of the 1836 ceded territory (Figure 3).

**Walleye**

**Distribution.**—Over 129 waters in the Lake Huron basin contain walleyes based on recent stocking records, fish collections, and questionnaires completed by fisheries managers (Appendix 3). Twelve waters were classified as adequately sustained by natural reproduction (recruitment code 1 or 2), 32 had a mixture of natural reproduction and stocking (coded 3, 4, or 5), and 21 were maintained solely by stocking (coded 6, 7, or 8). Many additional waters listed in Appendix 3 have not yet been classified, but most are dependent on stocking.

Estimates of walleye population density have been made for only four inland lakes in the Lake Huron basin (Table 2). Densities for the three more typical lakes range from 0.7 to 1.5 adults per acre.
The highest figure, 8.4 adults per acre, is the average for an experimental fish community in Jewett Lake (SLHMU, Ogemaw County). Jewett Lake is unusual because walleyes spawned successfully there on sand and, despite the lake’s small size (13 acres), anglers were able to harvest only 1.2 walleyes per acre (Schneider 1997).

The primary walleye waters are those included in the Inland Waterway, Mullett, Burt, Pickerel, and Crooked lakes (all in NLHMU, Emmet and Cheboygan counties). Walleyes migrate extensively within that system. Burt Lake is widely considered to be among the best native walleye waters in the area, yielding a walleye harvest up to 4.8 walleyes per acre (Table 11, summer data only). For Mullett Lake, 10.8% of the spawning walleyes tagged in 1998 were reportedly caught in the next 12 months (D. Borgeson, MDNR, personal communication). This is a minimal rate of exploitation based on voluntary tag returns. However, returns were enhanced by offering rewards for some tags and the presence of a census clerk on the lake. Still, it may underestimate the true angling exploitation rate by a factor of two. Voluntary tag returns from Burt Lake walleyes in the 1950s and 1970s were 7% and 18%, respectively (Schneider 1978).

The St. Marys River system (NLMMU, Chippewa County), a connecting waterway between lakes Superior and Huron, has long been known for its varied habitat and diverse fish community, including many walleyes. The St. Mary’s River has a substantial migratory walleye spawning run and a year-around fishery. Spawning occurs primarily in Munuscong Bay and the Munuscong River, but also in other small tributaries in the U.S. and Canada.

Ontario and Michigan share jurisdiction over these boundary waters. The river also lies within the 1836 treaty territory and was specifically addressed in the 2000 Consent Decree (Enslen 2000). That court order closed the river to tribal commercial harvest, but permitted tribal subsistence harvest with nets and sport gears. Operating on the Ontario side, and certainly over the same populations of fish, are First Nation (Canadian Indians) and Ontario provincial commercial fisheries.

The sport fishery in Ontario plus Michigan waters of Lake Huron is very large in most years (Table 12; Fielder et al., in press). In 1999, the combined angling pressure was estimated at 556,000 hours, which was about one-third of the total sport fishing effort spent on all waters of Lake Huron. The corresponding combined angling and subsistence harvest for 1999 was 11,145 walleyes. Of those, subsistence anglers took about 2% and anglers took about 98%. The Ontario commercial fishery harvested 2,557 kg from Potagannissing Bay, or about another 5,000 walleyes. First Nation extractions in Ontario waters are unknown. The grand total harvest for 1999 was estimated to be at least 16,300 walleyes.

The total annual mortality of walleyes in the St. Marys River was high in 1995, 51% (Fielder and Waybrant 1998). Their growth rate is slow relative to other notable Great Lakes walleye populations and females do not reach sexual maturity until age 4 or 5. Walleyes older than age 5 constituted only 7.5% of the population in 1995. There are no recent estimates of walleye exploitation rate. The St. Marys River Fisheries Task Group, formed in 1997 by the Great Lakes Fishery Commission, has devised a multi-agency assessment plan and is working to provide coordination on the collection and interpretation of survey data to facilitate joint management of these fisheries (Gebhardt et al., in press).

Small walleye populations and fisheries occur in NLHMU near the mouths of the Au Sable (Oscoda County) and Thunder Bay (Alpena County) rivers. These consist of mixtures of local fish and migrants from Saginaw Bay. In the Au Sable area, some spawning occurs below the first dam and additional recruits probably originate from native populations in upstream impoundments. In the Thunder Bay area, the population includes hatchery fish stocked every other year and wild fish produced by spawning below the first dam. The dam blocks access to better spawning grounds upstream. Anglers in each area harvest about 1,000 walleyes, many very large, but the estimates may be low because a sizeable night fishery was not sampled at either site (Table 12).

The largest Lake Huron walleye population is located in Saginaw Bay (SLHMU, Bay and other counties). It is still in the process of rehabilitation following a near-total collapse in the 1940s,
primarily due to water quality problems (Schneider and Leach 1979; Fielder and Baker 2004). A major spawning run has been restored in the Saginaw River system by pollution control efforts and fingerling walleye stocking (Mrozinski et al. 1991; Fielder et al. 2000). Large numbers of spawning walleyes now concentrate below the lower dams, especially in the Tittabawassee and Flint rivers. However, formerly important offshore spawning reefs are still too degraded to attract spawners or produce fry (Fielder and Baker 2004). Presently, the resident population consists of approximately 20% naturally reproduced and 80% hatchery fish. In addition, there are seasonal migrants from the Lake Erie-Lake St. Clair corridor that spend time in Saginaw Bay. The population of adults over 15 inches in length averaged 999,691 fish between 1996 and 2000 (D. G. Fielder, MDNR, personal communication). While substantial, this population is probably still short of historic levels, because the very rapid growth of walleyes indicates their numbers are well below the carrying capacity of the bay. The MDNR is actively engaged in further recovery efforts (Fielder and Baker 2004). These extremely fast growing and large walleyes experience a total mortality of approximately 35% per year, of which exploitation is estimated at 9% per year (based on voluntary tag returns corrected for non-reporting). The sport fishery, pursued in the bay and seasonally in the river, takes about 88,700 walleyes per year (Table 12).

A few thousand walleyes are also caught from southern Lake Huron along the east side of the thumb (SLHMU, ports of Harbor Beach, Port Sanilac, and Lexington; Table 12). These fish probably originate from Saginaw Bay and the St. Clair-Lake Erie corridor.

Special concerns.–All six of the general concerns listed earlier for walleyes in the LMB are also valid for the LHB. Our general discussion of these concerns would be the same, so we will not repeat it here. Two more specific concerns in the LHB would be for walleyes in Saginaw Bay and the St. Marys River system.

In Saginaw Bay and connecting waters, walleyes are being stocked to restore populations experiencing poor natural reproduction and to provide fisheries. It is anticipated that adequate natural reproduction will resume if on-going efforts to improve water quality are successful, exploitation can be kept low, sufficiently large populations of spawning adults can be reestablished, and the fish community can be restructured by walleye predation.

In the St. Marys River system, mortality of walleyes is marginally high at 51% and few fish are reaching old age. Reduction of fishing effort could be required in the future.

With regard to managing stocking, over 93 sites in the Lake Huron basin were stocked at least once in 1995–99. Of the stocking sites, 67 were on inland lakes and reservoirs, 18 sites were on the Great Lakes, and 8 were on rivers (Appendix 3).

Yellow Perch

Distribution.–Yellow perch are distributed throughout the Lake Huron basin and likely occur in all significant waters meeting the general requirements for pH and dissolved oxygen. In many of the large lakes of NLHMU, yellow perch are the dominant panfish, and the lakes contain important and fishable populations of yellow perch. In lakes of SLHMU, bluegills usually outnumber yellow perch.

Population estimates of yellow perch greater than 7 inches have been made for three small inland lakes (Table 3). The estimates range from 3.6 to 17.5 perch per acre, with the highest population in a winterkill situation at Grebe Lake (SLHMU, Ogemaw County). No estimates of typical exploitation rates have been made, but total mortality in one experimental 13-acre lake (Jewett Lake, SLHMU, Ogemaw County) increased from 22% to 87% due to angling.

Yellow perch fishery data collected since 1976 have been compiled for five inland lakes (Table 13). Harvest rates ranged up to 22.9 perch per acre and 1.690 perch per hour. However, only two lakes yielded more than the Michigan averages of 4.4 and 0.170, respectively, and two of the largest lakes in the LHB, Burt and Mullett (both in NLHMU, Cheboygan County), yielded fewer than 1.0
perch per acre. None of the yellow perch sport fisheries in LHB walleye lakes were given the highest rank by fisheries managers (Appendix 3).

Major yellow perch fisheries occur in four areas of Lake Huron: the St. Marys river-lake system (NLHMY, Chippewa County); the Les Cheneaux Islands area (NLHMY, Mackinac County); Saginaw Bay (SLHMY); and the southwest shore (SLHMY, Huron, Sanilac, and St. Clair counties).

The St. Marys River-lake system, a connecting waterway between Lakes Superior and Huron, contains many yellow perch. Ontario and Michigan share jurisdiction over these boundary waters. As with walleyes, sport and subsistence fishing occur for yellow perch on the Michigan side, and sport, subsistence, and commercial fishing occur on the Ontario side.

The combined angling fishery in Ontario and Michigan waters of the St. Marys is very large in most years (Table 14). In 1999, the combined angling pressure was estimated at 556,000 angler hours and the combined harvest by sport and subsistence anglers was estimated at 75,200 yellow perch. First Nation extractions from Ontario waters are unknown

Yellow perch total annual mortality is highest in the lower reaches of the St. Marys River and Potagannissing Bay (60%) and lowest in the upper reaches (25%), a pattern consistent with the uneven distribution of sport fishing effort (Fielder and Waybrant 1998). Yellow perch were found to grow at the state average rate in 1995. There is no up-to-date estimate of exploitation rate for yellow perch in the system.

The Les Cheneaux area, on the southeastern shore of the Upper Peninsula, once supported an extensive yellow perch fishery and resort industry. The fishery slowly declined despite intensive study and management efforts. In 1986, the estimated annual sport harvest was 439,000 yellow perch (Diana et al. 1987); by the summer of 2000, only 693 yellow perch were taken (Table 14). An Indian commercial and subsistence fishery once operated in the area, but has been reduced since 2000. Causes for the yellow perch decline are not clear, but could include relatively high angler exploitation during the 1980s (Lucchesi 1988), a dramatic increase in fish-eating cormorants in the 1990s (Ludwig and Summer 1997; Maruca 1997), and possible declines in recruitment. Total annual mortality rate for yellow perch was estimated to be 49% in 1993–95 (Schneeberger and Scott 1997). Despite some restrictions on the fisheries, total annual mortality was higher in 2001, (estimated at 67%, D. G. Fielder, MDNR, personal communication) and the fishery continues to spiral downward. The most recent estimate of exploitation rate for the sport fishery was only 2.5% (D. G. Fielder, MDNR, personal communication).

Another major yellow perch population is located in Saginaw Bay. In 1997–2001, the annual harvest was 1,076,227 yellow perch by anglers, plus another 224,000 (94,336 lbs) by commercial fishers (D. G. Fielder, MDNR, personal communication). The total annual mortality of yellow perch averaged 48% between 1997 and 2001. Population abundance and exploitation rates have not been estimated for Saginaw Bay, but the total yellow perch fishery yield remains close to the long-term average.

The southwestern shore of Lake Huron produces a fishery varying from 11,000 to 48,000 yellow perch per year (Table 14). Little is known about the biology of these perch, and they may originate from a variety of distant spawning grounds, such as Saginaw Bay or Lake St. Clair.

Special concerns.—Yellow perch populations in the LHB are generally in good condition, with the important exception of those in the Les Cheneaux Island area. The general concerns for yellow perch in the LHB are the same as those listed earlier for the LMB. In Lake Huron, the status of the yellow perch population in the Les Cheneaux area has become grave and further remedial action is needed soon. The fisheries have already been greatly curtailed, and unless other causes for weak recruitment can be quickly identified and corrected, control of cormorant predation should be considered. In Saginaw Bay, yellow perch growth and condition improved during the 1990s and is no longer of concern (Fielder et al. 2000).
Lake Erie Basin

The Michigan portion of the Lake Erie Basin (LEB) is about 130 miles (north to south) by about 80 miles (east to west). It contains one fisheries management unit, the Lake Erie Management Unit (LEMU) (Figure 2). The LEB is not part of either the 1836 or 1842 ceded territories (Figure 3).

Walleye

Distribution.—For the Lake Erie watershed there are 52 sites containing walleyes based on recent stocking records, fish collections, and questionnaires (Appendix 4). Eleven waters were classified as adequately sustained by natural reproduction (recruitment code 1 or 2), 7 had a mixture of natural reproduction and stocking (coded 3, 4, or 5), and 20 were maintained solely by stocking (coded 6, 7, or 8). Many additional waters listed in Appendix 4 have not yet been classified, but most are dependent on stocking. About 69% of the listed sites were stocked at least once in 1995–99.

The growing season is relatively long and inland waters tend to be more fertile in southeastern Michigan, both of which can aid walleye growth. Generally, few large and cool lakes are present and rocky shoals are rare. In addition, these lakes are more likely to have large bluegill populations that may further reduce walleye recruitment success. Consequently, these lakes are more likely to have irregular recruitment and sparser adult walleye populations. Successful spawning, when it occurs, is more likely to be in tributary rivers than on lake shoals. Self-sustaining walleye populations are limited to river-reservoir systems in LEB. Stocking is widespread.

Walleye population data for four inland waters in the Lake Erie basin are summarized in Table 2. Estimates range from 0.4 to 2.1 walleyes per acre. Two large and productive impoundments, Kent Lake (Oakland County) and Stoney Creek Reservoir (Macomb County), have stocked populations estimated at 1.1 to 2.1 adult walleyes per acre. In both, there is concern that walleyes have become too abundant, are not sufficiently exploited, and may have depleted once-abundant bluegill populations and eliminated important fisheries.

Walleye fishery data for eight inland waters in the Lake Erie basin are summarized in Table 15. All those waters were stocked, but Belleville Lake and other impoundments on the Huron River (Washtenaw and Wayne counties) also contained many wild walleyes. Estimated harvest rates ranged up to 1.3 walleyes per acre and 0.008 walleyes per hour. A relatively good fishery at Belleville Lake was initiated by an extensive rotenone reclamation and restocking project on the productive Huron River impoundments in the mid-1970s. Some walleyes slip downstream through the dams in the system. One walleye tagged in Belleville Lake was recaptured from the St. Clair River, 80 miles away. Minimum estimates of angling exploitation rates based on voluntary tag returns are 6.7% for Belleville Lake (Schneider and Spitler 1987) and 4.6% for Kent Lake (J. Braunscheidel, MDNR, personal communication).

The largest and most important walleye stock in Michigan resides in western Lake Erie, the Detroit River, Lake St Clair, the St Clair River, and southern Lake Huron (Thomas and Haas 2000). These walleyes migrate extensively, with some wandering as far as Saginaw Bay. Since these are boundary waters, management is shared by Michigan, Ohio, and Ontario. The fish are overwhelmingly of natural origin. Primary spawning areas are on certain offshore reefs in Ohio waters; and in the Maumee and Sandusky rivers in Ohio, the Thames River in Ontario, and probably the Detroit River in both Michigan and Ontario (Regier et al. 1969). Small spawning runs occur in Michigan’s Huron River (Monroe County) and Clinton River (Macomb County). In 1992–94, the spawning run below the first dam on the lower Huron River was estimated at 3,400 to 7,800 walleyes (Leonardi and Thomas 2000).

The population in Lake Erie nearly collapsed in the 1960s, but recovered nicely when commercial harvest was greatly restricted and pollution controls were implemented. This walleye stock is intensively managed, with quotas reestablished each year to allocate harvest among sport fisheries in
Ohio, Michigan, and Ontario, and commercial fisheries in Ontario. The MSL has varied from 13 to 15 inches and the bag limit from five to six walleyes per day. First Nation tribal fishers take small numbers of walleyes from the Thames River (Ontario). The general management goal is to maintain the spawning stock well above the low level experienced during the 1960s while optimizing yield.

Annual sport harvest of walleyes from Michigan waters is 167,000 for Lake Erie (in 1998–2001) and 458,000 for the rest of the system (in 1983–84), for a total of 0.6 million walleyes (Table 16). The following estimates of walleye statistics were supplied by R. Haas (MDNR). Estimates of walleye total mortality were 35% for Lake Erie (in 2000) and 46% for Lake St Clair (in 1975–84). Estimates of exploitation were 13% for Lake Erie and approximately 10% for Lake St Clair (actual voluntary tag returns were 5.4% in 1975–84). The population of walleyes in western Lake Erie alone is approximately 35 million adults.

Special concerns.—Habitat deterioration and overfishing have harmed some walleye fisheries in LEB, such as in Lake Erie, but recent management programs, including pollution controls and more restrictive fishing regulations, have been very successful in restoring them. These same programs also created many walleye fisheries where none previously existed. Thus, walleye populations in the LEB are more numerous than ever and generally in good condition. However, all six of the concerns listed earlier for walleyes in other basins are also valid for the LEB. We covered the basics of these concerns earlier, so we will not repeat them here.

One more specific concern for LEB is that walleye recruitment has been low and brood stocks have been declining in Lake Erie and the Detroit River. There, as a precaution, the walleye season has been shortened, the bag limit has been reduced to 5 walleyes per day (from 10 per day), and the MSL has been increased from 13 to 15 inches. These adjustments are expected to be temporary.

The LEB is heavily urbanized and is by far the most densely populated area of the state. Therefore, the potential for degradation of water quality and habitat deserve special mention. One of the primary concerns for walleyes would be deterioration of spawning habitat, which is usually in short supply and often limits the abundance of native populations.

From 1995 through 1999, walleye fry or fingerlings were stocked in 32 lakes and reservoirs and 2 river sites in the LEB. These were used to establish new fisheries where walleyes were not native and to supplement small native populations. Significant walleye sport fisheries developed in some of the reservoirs (Table 15). In spite of this overall success, there is a continuous need to monitor results and refine walleye stocking. One concern is for stocking too many walleyes. In the LEB, stocked walleyes are suspected of excessively depleting once-abundant bluegill populations in Kent Lake and Stoney Creek Reservoir through predation. Also, excessive stocking of walleyes can cause undesirable, density-dependent problems within the walleye population itself, such as reduced growth or recruitment (Clark et al. 2004).

Another concern with stocking in the LEB (and elsewhere) is the possibility that stocked fish could alter gene pools of native populations (Dexter and O’Neal 2004). Of particular concern in the LEB is the preservation of important native spawning populations in lakes Erie and St. Clair and connecting rivers. These native populations should be surveyed regularly to monitor status and carefully protected from habitat degradation and overfishing. In inland waters of LEB, walleyes are native only to large rivers and impoundments and all those populations have probably already been altered genetically to some degree by widespread stocking in the past. None-the-less, in future management plans consideration should be given to the genetic strains of walleyes stocked and their potential impacts on existing native populations.

Yellow Perch

Distribution.—Yellow perch are widely distributed throughout the LEB and occur in nearly all significant waters. Yellow perch fisheries are relatively minor in most lakes because LEB lakes tend
to be small to medium-sized, and bluegill rather than yellow perch are the dominant panfish. Sport fisheries for yellow perch in many LEB lakes were ranked by fisheries managers (Appendix 4).

Population estimates of larger yellow perch have been made at four relatively small (<136 acres) inland lakes in the LEB (Table 3). The estimates range from 4.0 to 53.0 fish per acre. All but Cassidy Lake (Washtenaw County) were very lightly fished lakes. At Blueberry Pond (Livingston County), annual variations of five-fold have been documented for adults and eight-fold for young.

Sport fishery statistics have been collected from eight inland lakes in the LEB since 1980 (Table 17). Harvest rates were as high as 5.18 perch per acre and 0.067 perch per hour despite the dominance of bluegill in these lakes. No very large yellow perch fisheries were reported in the questionnaire for inland waters (Appendix 4).

Very large yellow perch sport fisheries do exist in LEB in Michigan waters of western Lake Erie (harvest over 400,000 perch per year), Lake St Clair (over 800,000 perch per year), and connecting waters (150,000 perch per year). The population in western Lake Erie is intensively managed, with quotas reestablished each year to allocate harvest among sport fisheries in Ohio, Michigan, and Ontario, and commercial fisheries in Ontario. Recent estimates of vital statistics indicated a population size of 48.9 million adult yellow perch with a total mortality rate for age-3 and older of 61%, of which exploitation rate is 20% (Yellow Perch Task Group 2001).

Special concerns.—Yellow perch populations in the LEB are generally in good condition. However, the common concerns listed earlier for yellow perch in other basins are also valid for the LEB. These include concerns about our ability to: (1) control future increases in fishing effort and harvest; (2) protect water quality and habitat; (3) protect significant and unique spawning populations; (4) control invasions of exotic species; and (5) deal with toxic contaminants.

For inland and Great Lakes waters of LEB, there is no specific evidence for recruitment overfishing or that characteristics of any yellow perch population are routinely unhealthy. However, depending on how it is defined, quality overfishing might be occurring in some places in the LEB. The potential for quality overfishing always exists because it is defined differently by different people and yellow perch are highly sought after by people with diverse and often conflicting interests.

Managers should be aware of the role of yellow perch as a predator on small bluegills in the inland lakes of LEB where stunted bluegill populations are often a problem. They should try to maintain adequate numbers of larger, older yellow perch in such lakes, but this is difficult to achieve in practice.

Of continued concern are the possible effects of zebra mussel, gobies, and other exotic species on yellow perch and other fish in LEB.
Figure 1.—Characteristics of walleye, sauger, and yellow perch as depicted by Joseph R. Tomelleri.
Figure 2.—Map of Michigan showing the approximate boundaries of state fisheries management units.
Figure 3.—Map of Michigan showing the approximate boundaries of the 1836 and 1842 treaty territories.
Table 1.—Synopsis of walleye sport fishery and population characteristics, primarily from Wisconsin, Minnesota, and Ontario sources, and adjustments to approximate levels for the 15-inch minimum size limit (MSL) used in Michigan.

<table>
<thead>
<tr>
<th>Location</th>
<th>Description</th>
<th>Harvested per hr (number)</th>
<th>Walleye per acre (number)</th>
<th>Per acre (lbs)</th>
<th>Exploitation rate (%)</th>
<th>Fishing effort (hrs per acre)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wisconsin</td>
<td>Statewide mean</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5.2</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>Ceded lakes mean</td>
<td>0.04^c</td>
<td>1.92</td>
<td></td>
<td></td>
<td>50</td>
<td>3.7</td>
</tr>
<tr>
<td>Minnesota</td>
<td>Large walleye lakes</td>
<td>0.17–0.35</td>
<td></td>
<td></td>
<td></td>
<td>50</td>
<td>–</td>
</tr>
<tr>
<td>Minnesota</td>
<td>Ceded territory lakes</td>
<td></td>
<td>1.63</td>
<td></td>
<td></td>
<td></td>
<td>–</td>
</tr>
<tr>
<td>North America</td>
<td>Mode of 46-168 lakes and (range)</td>
<td>–</td>
<td>1.50^d</td>
<td>1.10</td>
<td>21</td>
<td>6.0</td>
<td>(&lt;0.1–68.0)</td>
</tr>
<tr>
<td>Summary</td>
<td>Range adjusted to 15” MSL  e</td>
<td>0.01–0.12</td>
<td>0.53–0.67</td>
<td>&lt;0.01–15.4</td>
<td>3–56</td>
<td>50</td>
<td>&lt;0.1–54.4 f</td>
</tr>
</tbody>
</table>

^a No MSL for nearly all of these sport fisheries. This was non-targeted fishing effort.

^b Described as “adults” – sexually mature or larger than legal size (12 inches in Wisconsin).

^c Number of walleye harvested by anglers targeting walleye was 0.10 per hr.

^d An approximation based on modal yield of 1.1 pounds per acre times modal weight of 1.4 pounds per walleye harvested.

^e An approximate adjustment based on a Wisconsin figure that 35% of the sport catch is greater than 15 inches in length when no minimum size limit exists (e.g., 1.92*0.35=0.67).

^f A rough approximation based on the assumption that 20% of the “adults” above are less than 15 inches.
Table 2.—Estimates of inland walleye population density in Michigan. For lakes, the mark-and-recapture method was used. For rivers, sample sections were blocked with nets, the toxicant rotenone was applied, and all larger fish were collected.

<table>
<thead>
<tr>
<th>Water body</th>
<th>County</th>
<th>Management unit</th>
<th>Wild or stocked</th>
<th>Year(s)</th>
<th>Number per acre</th>
<th>Minimum fish length (in)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monacle Lake</td>
<td>Chippewa</td>
<td>ELSMU</td>
<td></td>
<td>S 2000</td>
<td>1.7</td>
<td>15</td>
<td>MDNR files</td>
</tr>
<tr>
<td>Lake Gogebic</td>
<td>Gogebic</td>
<td>WLSMU</td>
<td></td>
<td>W 1976, 77, 84, 94</td>
<td>2.8–9.2</td>
<td>13</td>
<td>Miller (2001)</td>
</tr>
<tr>
<td>Six Mile Lake</td>
<td>Houghton</td>
<td>WLSMU</td>
<td></td>
<td>W c 1980–87</td>
<td>1.5</td>
<td>13 (0.7–3.0)</td>
<td>Wagner (1990)</td>
</tr>
</tbody>
</table>

**Lake Superior Basin**

<table>
<thead>
<tr>
<th>Water body</th>
<th>County</th>
<th>Management unit</th>
<th>Wild or stocked</th>
<th>Year(s)</th>
<th>Number per acre</th>
<th>Minimum fish length (in)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brevoort Lake</td>
<td>Mackinac</td>
<td>NLMMU</td>
<td>S 2001</td>
<td>0.5</td>
<td>15 MDNR files</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brule Lake</td>
<td>Iron</td>
<td>NLMMU</td>
<td>W 1991</td>
<td>2.1</td>
<td>15 MDNR files</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chicagon Lake</td>
<td>Iron</td>
<td>NLMMU</td>
<td>S 1992</td>
<td>2.9</td>
<td>15 MDNR files</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hagerman Lake</td>
<td>Iron</td>
<td>NLMMU</td>
<td>W 1991</td>
<td>0.8</td>
<td>15 MDNR files</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indian Lake</td>
<td>Iron</td>
<td>NLMMU</td>
<td>S 1992</td>
<td>3.4</td>
<td>15 MDNR files</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Michigamme Reservoir</td>
<td>Iron</td>
<td>NLMMU</td>
<td>W 2001</td>
<td>1.5</td>
<td>15 MDNR files</td>
<td></td>
<td>Hanchin et al. (2005)</td>
</tr>
<tr>
<td>Stanley Lake</td>
<td>Iron</td>
<td>NLMMU</td>
<td>W 1991</td>
<td>1.5</td>
<td>15 MDNR files</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steuben Lake</td>
<td>Schoolcraft</td>
<td>NLMMU</td>
<td>S 1999</td>
<td>1.2</td>
<td>14.5 MDNR files</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thunder Lake</td>
<td>Schoolcraft</td>
<td>NLMMU</td>
<td>S 1997</td>
<td>5.4</td>
<td>15 MDNR files</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fife Lake</td>
<td>Kalkaska</td>
<td>CLMMU</td>
<td>S 1964, 65, 74</td>
<td>1.7–2.2</td>
<td>13 Schneider and Lockwood (1979)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manistee Lake</td>
<td>Kalkaska</td>
<td>CLMMU</td>
<td>S 1973–84</td>
<td>0.5–3.6</td>
<td>15 or 15 Laarman and Schneider (1986)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Houghton Lake</td>
<td>Roscommon</td>
<td>CLMMU</td>
<td>W 2001</td>
<td>2.9</td>
<td>15 MDNR files</td>
<td></td>
<td>Clark et al. (2004)</td>
</tr>
<tr>
<td>Muskegon River</td>
<td>Newaygo</td>
<td>CLMMU</td>
<td>S 1990–93</td>
<td>0.0–2.2</td>
<td>15 O’Neal (1997)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pickerel Lake</td>
<td>Newaygo</td>
<td>CLMMU</td>
<td>S 1995</td>
<td>1.0</td>
<td>15 MDNR files</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silver Lake</td>
<td>Oceana</td>
<td>CLMMU</td>
<td>S 1997</td>
<td>2.3</td>
<td>15 MDNR files</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bills Lake</td>
<td>Newaygo</td>
<td>SLMMU</td>
<td>S 1995</td>
<td>1.1</td>
<td>15 MDNR files</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maple Lake</td>
<td>Van Buren</td>
<td>SLMMU</td>
<td>S 1993</td>
<td>0.4</td>
<td>15 MDNR files</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kalamazoo River</td>
<td>Kalamazoo</td>
<td>SLMMU</td>
<td>S 1982</td>
<td>0.0–6.0</td>
<td>15 Towns (1984)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paw Paw River</td>
<td>Van Buren</td>
<td>SLMMU</td>
<td>S 1989</td>
<td>0.0–3.0</td>
<td>15 Dexter (1991)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water body</td>
<td>County</td>
<td>Management unit(^a)</td>
<td>Wild or stocked(^b)</td>
<td>Year(s)</td>
<td>Number per acre</td>
<td>Minimum fish length (in)</td>
<td>Reference</td>
</tr>
<tr>
<td>-------------------</td>
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</tr>
<tr>
<td>Mullett Lake</td>
<td>Cheboygan</td>
<td>NLHMU</td>
<td>W</td>
<td>1998</td>
<td>0.8</td>
<td>15</td>
<td>MDNR files</td>
</tr>
<tr>
<td>Jewett Lake</td>
<td>Ogemaw</td>
<td>SLHMU</td>
<td>W(^d)</td>
<td>1987–93</td>
<td>8.4</td>
<td>14</td>
<td>Schneider (1997)</td>
</tr>
<tr>
<td>Holloway Reservoir</td>
<td>Genesee</td>
<td>SLHMU</td>
<td>S</td>
<td>1995</td>
<td>1.5</td>
<td>15</td>
<td>MDNR files</td>
</tr>
<tr>
<td>Lake Nepessing</td>
<td>Lapeer</td>
<td>SLHMU</td>
<td>S</td>
<td>1993</td>
<td>0.7</td>
<td>Adult</td>
<td>MDNR files</td>
</tr>
<tr>
<td>Cass Lake</td>
<td>Oakland</td>
<td>LEMU</td>
<td>S</td>
<td>1992, 96</td>
<td>0.4, 1.0</td>
<td>15</td>
<td>MDNR files</td>
</tr>
<tr>
<td>Kent Lake</td>
<td>Oakland</td>
<td>LEMU</td>
<td>S</td>
<td>1994–95</td>
<td>2.1</td>
<td>15</td>
<td>MDNR files</td>
</tr>
<tr>
<td>Pontiac Lake</td>
<td>Oakland</td>
<td>LEMU</td>
<td>S</td>
<td>1999</td>
<td>1.3</td>
<td>15</td>
<td>MDNR files</td>
</tr>
<tr>
<td>Stoney Creek Reservoir</td>
<td>Oakland</td>
<td>LEMU</td>
<td>S</td>
<td>1991</td>
<td>1.1</td>
<td>13</td>
<td>MDNR files</td>
</tr>
</tbody>
</table>

\(^a\) MDNR fisheries management unit: WLPMU = Western Lake Superior; ELMU = Eastern Lake Superior; NLMMU = Northern Lake Michigan; CLMMU = Central Lake Michigan; SLMMU = Southern Lake Michigan; NLHMU = Northern Lake Huron; SLHMU = Southern Lake Huron; and LEMU = Lake Erie.

\(^b\) W= mostly wild walleyes; S=mostly or entirely stocked walleyes.

\(^c\) Mostly fish produced on an artificial reef by walleye stocked prior to 1978. Estimates are for age 3 and older, approximately equivalent to 13 inches and larger.

\(^d\) Shown is the average estimate for years when Jewett Lake contained an experimental community of walleye, bluegill, and yellow perch.
Table 3.–Mark-and-recapture population estimates for large yellow perch in Michigan.

<table>
<thead>
<tr>
<th>Lake</th>
<th>County</th>
<th>Management unit</th>
<th>Year(s)</th>
<th>Number per acre (range)</th>
<th>Minimum fish length (in)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cub</td>
<td>Gogebic</td>
<td>WLSMU</td>
<td>1967–69</td>
<td>1.1, 1.1, 33.1</td>
<td>7</td>
<td>Clady (1970)</td>
</tr>
<tr>
<td>Lake Superior Basin</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anderson</td>
<td>Marquette</td>
<td>NLMMU</td>
<td>1985</td>
<td>1.3</td>
<td>7</td>
<td>Wagner (1988)</td>
</tr>
<tr>
<td>Big Shag</td>
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<td>NLMMU</td>
<td>1985</td>
<td>26.9</td>
<td>7</td>
<td>Wagner (1988)</td>
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<tr>
<td>East</td>
<td>Schoolcraft</td>
<td>NLMMU</td>
<td>1984</td>
<td>3.5</td>
<td>7</td>
<td>Wagner (1988)</td>
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<tr>
<td>Stager</td>
<td>Iron</td>
<td>NLMMU</td>
<td>1983</td>
<td>15.5</td>
<td>7</td>
<td>Wagner (1988)</td>
</tr>
<tr>
<td>Manistee</td>
<td>Kalkaska</td>
<td>CLMMU</td>
<td>1974–84</td>
<td>27.2</td>
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<td>Laarman and</td>
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<td></td>
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<td></td>
<td>(0.6–62.8)</td>
<td></td>
<td>Schneider (1986)</td>
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<td>Lake Michigan Basin</td>
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<tr>
<td>Grebe</td>
<td>Ogemaw</td>
<td>SLHMU</td>
<td>1960s</td>
<td>Up to 17.5</td>
<td>7</td>
<td>Schneider (1971)</td>
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<td>Jewett</td>
<td>Ogemaw</td>
<td>SLHMU</td>
<td>1987–91</td>
<td>7.2</td>
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<td>Schneider (1997)</td>
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<td>3.6, 11.3</td>
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<td>Schneider (1971)</td>
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<td>Scaup</td>
<td>Ogemaw</td>
<td>SLHMU</td>
<td>1960s</td>
<td>5.1</td>
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<td>Schneider (1971)</td>
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<td>Lake Erie Basin</td>
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<td>Blueberry</td>
<td>Washtenaw</td>
<td>LEMU</td>
<td>1984–89</td>
<td>30.0</td>
<td>8</td>
<td>Schneider (1993)</td>
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<td>Cassidy</td>
<td>Washtenaw</td>
<td>LEMU</td>
<td>1964, 87</td>
<td>4.0, 15.9</td>
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<td>Schneeberger (1988)</td>
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<td>Dead</td>
<td>Washtenaw</td>
<td>LEMU</td>
<td>1984–85</td>
<td>4.0</td>
<td>7</td>
<td>Schneider (1993)</td>
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<tr>
<td>Mill</td>
<td>Washtenaw</td>
<td>LEMU</td>
<td>1965–68</td>
<td>6.5</td>
<td>7</td>
<td>Schneider (1971)</td>
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<td></td>
<td></td>
<td>(1.7–11.8)</td>
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</table>

a MDNR fisheries management unit: WLSMU = Western Lake Superior; ELSMU = Eastern Lake Superior; NLMMU = Northern Lake Michigan; CLMMU = Central Lake Michigan; SLMMU = Southern Lake Michigan; NLHMU = Northern Lake Huron; SLHMU = Southern Lake Huron; and LEMU = Lake Erie.
<table>
<thead>
<tr>
<th>Lake</th>
<th>County</th>
<th>Area (acres)</th>
<th>Management unit</th>
<th>Wild or stocked</th>
<th>Months and year</th>
<th>Number harvested</th>
<th>Fishing effort (hrs)</th>
<th>Harvest per hr</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beaver</td>
<td>Alger</td>
<td>765</td>
<td>ELSMU</td>
<td>S</td>
<td>May–Sep 1998</td>
<td>621</td>
<td>6,496</td>
<td>0.096</td>
<td>Lockwood (2000)</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>May–Oct 1977</td>
<td>372</td>
<td>27,085</td>
<td>0.014</td>
<td>Ryckman and Lockwood (1985)</td>
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<tr>
<td>Duck</td>
<td>Gogebic</td>
<td>622</td>
<td>WLSMU</td>
<td>S</td>
<td>May–Sep 1994</td>
<td>163</td>
<td>11,932</td>
<td>0.014</td>
<td>Lockwood (2000)</td>
</tr>
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<td></td>
<td></td>
<td>May–Sep 1993</td>
<td>107</td>
<td>8,426</td>
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<td>Lockwood (2000)</td>
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<td></td>
<td></td>
<td></td>
<td>May–Sep 1999</td>
<td>8,878</td>
<td>90,086</td>
<td>0.099</td>
<td>Lockwood (2000)</td>
</tr>
<tr>
<td>Pomeroy</td>
<td>Gogebic</td>
<td>317</td>
<td>WLSMU</td>
<td>W</td>
<td>May–Sep 1993</td>
<td>253</td>
<td>8,129</td>
<td>0.031</td>
<td>Lockwood (2000)</td>
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<tr>
<td>Tamarack</td>
<td>Gogebic</td>
<td>326</td>
<td>WLSMU</td>
<td>S</td>
<td>May–Sep 1993</td>
<td>62</td>
<td>2,386</td>
<td>0.026</td>
<td>Lockwood (2000)</td>
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<tr>
<td>Thousand Island</td>
<td>Gogebic</td>
<td>1,020</td>
<td>WLSMU</td>
<td>W</td>
<td>May–Aug 1978</td>
<td>1,228</td>
<td>37,599</td>
<td>0.033</td>
<td>Lockwood (2000)</td>
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<td></td>
<td></td>
<td>May–Oct 1977</td>
<td>497</td>
<td>35,301</td>
<td>0.014</td>
<td>Lockwood (2000)</td>
</tr>
</tbody>
</table>

* MDNR fisheries management unit: WLSMU = Western Lake Superior; ELSMU = Eastern Lake Superior; NLMMU = Northern Lake Michigan; CLMMU = Central Lake Michigan; SLMMU = Southern Lake Michigan; NLHMGU = Northern Lake Huron; SLHMGU = Southern Lake Huron; and LEMU = Lake Erie.

* W = mostly wild walleye; S = mostly or entirely stocked walleye

* Non-targeted effort directed at all species of fish.
Table 5.—Estimated walleye sport fishery statistics for Michigan waters of Lake Superior.

<table>
<thead>
<tr>
<th>Location</th>
<th>Management unit</th>
<th>Wild or stocked</th>
<th>Years</th>
<th>Total number harvested</th>
<th>Fishing effort (hrs)</th>
<th>Harvest per hr</th>
<th>Reference</th>
</tr>
</thead>
</table>

\[a\] MDNR fisheries management unit: WLSMU = Western Lake Superior; ELSMU = Eastern Lake Superior; NLMMU = Northern Lake Michigan; CLMMU = Central Lake Michigan; SLMMU = Southern Lake Michigan; NLHMU = Northern Lake Huron; SLHMU = Southern Lake Huron; and LEMU = Lake Erie.

\[b\] W = mostly wild walleye; S = mostly or entirely stocked walleye

\[c\] Non-targeted effort directed at all species of fish.
Table 6.–Estimated yellow perch sport fishery statistics for inland waters of the Lake Superior Basin.

<table>
<thead>
<tr>
<th>Lake</th>
<th>County</th>
<th>Area (acres)</th>
<th>Management unit&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Months and year</th>
<th>Number harvested (Total per acre)</th>
<th>Fishing effort&lt;sup&gt;c&lt;/sup&gt; (hrs)</th>
<th>Harvest per hr&lt;sup&gt;c&lt;/sup&gt;</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beaver</td>
<td>Alger</td>
<td>765</td>
<td>ELSMU</td>
<td>May–Sep 1998</td>
<td>640 (0.84)</td>
<td>6,496</td>
<td>0.099</td>
<td>Lockwood (2000)</td>
</tr>
<tr>
<td>Grand Sable</td>
<td>Alger</td>
<td>657</td>
<td>ELSMU</td>
<td>May–Sep 1998</td>
<td>154 (0.23)</td>
<td>5,136</td>
<td>0.030</td>
<td>Lockwood (2000)</td>
</tr>
<tr>
<td>Bond Falls Flowage</td>
<td>Ontonagon</td>
<td>2,118</td>
<td>WLSMU</td>
<td>May–Sep 1994</td>
<td>275 (0.13)</td>
<td>7,812</td>
<td>0.035</td>
<td>Lockwood (2000)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>May–Oct 1977</td>
<td>12,641 (24.98)</td>
<td>27,085</td>
<td>0.467</td>
<td>Ryckman and Lockwood (1985)</td>
</tr>
<tr>
<td>Duck</td>
<td>Gogebic</td>
<td>622</td>
<td>WLSMU</td>
<td>May–Sep 1994</td>
<td>455 (0.73)</td>
<td>11,932</td>
<td>0.038</td>
<td>Lockwood (2000)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>May–Sep 1993</td>
<td>243 (0.39)</td>
<td>8,426</td>
<td>0.029</td>
<td>Lockwood (2000)</td>
</tr>
<tr>
<td>Gogebic</td>
<td>Ontonagon and Gogebic</td>
<td>12,898</td>
<td>WLSMU</td>
<td>Jan–Apr 1999</td>
<td>10,208 (0.79)</td>
<td>31,439</td>
<td>0.324</td>
<td>Lockwood (2000)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>May–Sep 1999</td>
<td>4,741 (0.37)</td>
<td>90,086</td>
<td>0.053</td>
<td>Lockwood (2000)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dec–Mar 1993–94</td>
<td>968 (3.04)</td>
<td>1,361</td>
<td>0.711</td>
<td>Lockwood (2000)</td>
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<tr>
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<td></td>
<td></td>
<td></td>
<td>May–Oct 1977</td>
<td>5,419 (0.42)</td>
<td>31,062</td>
<td>0.174</td>
<td>Ryckman and Lockwood (1985)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>May–Aug 1976</td>
<td>2,059 (0.16)</td>
<td>15,679</td>
<td>0.131</td>
<td>Ryckman and Lockwood (1985)</td>
</tr>
<tr>
<td>Tamarack</td>
<td>Gogebic</td>
<td>326</td>
<td>WLSMU</td>
<td>May–Sep 1993</td>
<td>25 (0.07)</td>
<td>2,386</td>
<td>0.011</td>
<td>Lockwood (2000)</td>
</tr>
<tr>
<td>Tepee</td>
<td>Iron</td>
<td>121</td>
<td>WLSMU</td>
<td>May–Sep 1983</td>
<td>225 (1.86)</td>
<td>1,571</td>
<td>0.143</td>
<td>Wagner (1988)</td>
</tr>
<tr>
<td>Thousand Island</td>
<td>Gogebic</td>
<td>1,020</td>
<td>WLSMU</td>
<td>May–Aug 1978</td>
<td>7,668 (7.52)</td>
<td>37,599</td>
<td>0.204</td>
<td>Ryckman and Lockwood (1985)</td>
</tr>
</tbody>
</table>

<sup>a</sup> MDNR fisheries management unit: WLSMU = Western Lake Superior; ELSMU = Eastern Lake Superior; NLMMU = Northern Lake Michigan; CLMMU = Central Lake Michigan; SLMMU = Southern Lake Michigan; NLHUM = Northern Lake Huron; SLHUM = Southern Lake Huron; and LEMU = Lake Erie.

<sup>b</sup> Non-targeted effort directed at all species of fish.
Table 7.—Estimated walleye sport fishery statistics for inland waters of the Lake Michigan Basin.

<table>
<thead>
<tr>
<th>Lake</th>
<th>County</th>
<th>Area (acres)</th>
<th>Management unit</th>
<th>Wild or stocked</th>
<th>Months and year</th>
<th>Number harvested</th>
<th>Fishing effort (hrs) per hr</th>
<th>Harvest per hr</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Big Manistique</td>
<td>Mackinac</td>
<td>10,130</td>
<td>NLMMU</td>
<td>W</td>
<td>May–Feb 1978–79</td>
<td>6,367</td>
<td>0.63</td>
<td>64,691</td>
<td>0.098 Ryckman and Lockwood (1985)</td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>May–Feb 1979–80</td>
<td>5,335</td>
<td>0.53</td>
<td>46,068</td>
<td>0.116 Ryckman and Lockwood (1985)</td>
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<td>Brevoort</td>
<td>Mackinac</td>
<td>4,001</td>
<td>NLMMU</td>
<td>W</td>
<td>May–Aug 1996</td>
<td>383</td>
<td>0.10</td>
<td>26,329</td>
<td>0.015 Lockwood (2000)</td>
</tr>
<tr>
<td>Chicagon</td>
<td>Iron</td>
<td>1,083</td>
<td>NLMMU</td>
<td>S</td>
<td>May–Oct 1994</td>
<td>1,461</td>
<td>1.35</td>
<td>36,341</td>
<td>0.040 Lockwood (2000)</td>
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<tr>
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<td></td>
<td>Dec–Mar 1994</td>
<td>357</td>
<td>0.33</td>
<td>8,168</td>
<td>0.044 Lockwood (2000)</td>
</tr>
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<td></td>
<td>May–Nov 1993</td>
<td>2,583</td>
<td>2.39</td>
<td>27,825</td>
<td>0.093 Lockwood (2000)</td>
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<td>Dec–Mar 1993–94</td>
<td>50</td>
<td>0.09</td>
<td>382</td>
<td>0.131 Lockwood (2000)</td>
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<tr>
<td>Michigamme Reservoir</td>
<td>Iron</td>
<td>6,400</td>
<td>NLMMU</td>
<td>W</td>
<td>May–Oct 2001</td>
<td>2,102</td>
<td>0.33</td>
<td>34,383</td>
<td>0.061 Hanchin et al. (2005)</td>
</tr>
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<td></td>
<td>Dec–Feb 2002</td>
<td>1,013</td>
<td>0.16</td>
<td>18,303</td>
<td>0.055 Hanchin et al. (2005)</td>
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<tr>
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<td></td>
<td>May–Feb 2001–02</td>
<td>3,115</td>
<td>0.48</td>
<td>52,686</td>
<td>0.059 Hanchin et al. (2005)</td>
</tr>
<tr>
<td>Petes</td>
<td>Schoolcraft</td>
<td>194</td>
<td>NLMMU</td>
<td>S</td>
<td>May–Sep 1993</td>
<td>217</td>
<td>1.12</td>
<td>3,090</td>
<td>0.072 Lockwood (2000)</td>
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<td>South Manistique</td>
<td>Mackinac</td>
<td>4,001</td>
<td>NLMMU</td>
<td>W</td>
<td>May–Sep 1978</td>
<td>14,137</td>
<td>3.53</td>
<td>61,472</td>
<td>0.230 Ryckman and Lockwood (1985)</td>
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<td>Dec–Mar 1993–94</td>
<td>29</td>
<td>0.09</td>
<td>1,361</td>
<td>0.021 Lockwood (2000)</td>
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<tr>
<td>Wedge</td>
<td>Schoolcraft</td>
<td>27</td>
<td>NLMMU</td>
<td>W</td>
<td>May–Sep 1993</td>
<td>3</td>
<td>0.12</td>
<td>744</td>
<td>0.004 Lockwood (2000)</td>
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<tr>
<td>Houghton</td>
<td>Roscommon</td>
<td>20,075</td>
<td>CLMMU</td>
<td>W</td>
<td>Jan–Mar 2001</td>
<td>3,584</td>
<td>0.18</td>
<td>78,908</td>
<td>0.045 Clark et al. (2004)</td>
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<tr>
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<td></td>
<td></td>
<td>Apr–Sep 2001</td>
<td>13,486</td>
<td>0.67</td>
<td>278,214</td>
<td>0.048 Clark et al. (2004)</td>
</tr>
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<td></td>
<td>Jan–Mar 2002</td>
<td>4,779</td>
<td>0.24</td>
<td>220,834</td>
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<td>Apr–Mar 2001–02</td>
<td>18,265</td>
<td>0.91</td>
<td>499,048</td>
<td>0.037 Clark et al. (2004)</td>
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<td>Manistee</td>
<td>Kalkaska</td>
<td>860</td>
<td>CLMMU</td>
<td>S</td>
<td>Dec–Nov 1975–76</td>
<td>62</td>
<td>0.07</td>
<td>12,214</td>
<td>0.005 Laarman (1980)</td>
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<td>Dec–Nov 1976–77</td>
<td>16</td>
<td>0.02</td>
<td>5,614</td>
<td>0.003 Laarman (1980)</td>
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<td>Dec–Nov 1977–78</td>
<td>713</td>
<td>0.83</td>
<td>20,884</td>
<td>0.034 Laarman (1980)</td>
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<td>Missaukee</td>
<td>Missaukee</td>
<td>1,707</td>
<td>CLMMU</td>
<td>S</td>
<td>May–Nov 1978</td>
<td>130</td>
<td>0.08</td>
<td>46,772</td>
<td>0.003 Ryckman and Lockwood (1985)</td>
</tr>
<tr>
<td>Silver</td>
<td>Oceana</td>
<td>690</td>
<td>CLMMU</td>
<td>S</td>
<td>Apr–Aug 1997</td>
<td>3,016</td>
<td>4.37</td>
<td>14,772</td>
<td>0.204 Lockwood (2000)</td>
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<td>Apr–Sep 1996</td>
<td>1,847</td>
<td>13.68</td>
<td>37,801</td>
<td>0.049 Lockwood (2000)</td>
</tr>
</tbody>
</table>

a MDNR fisheries management unit: WLSMU = Western Lake Superior; ELSMU = Eastern Lake Superior; NLMMU = Northern Lake Michigan; CLMMU = Central Lake Michigan; SLMMU = Southern Lake Michigan; NLHMU = Northern Lake Huron; SLHMU = Southern Lake Huron; and LEMU = Lake Erie.

b W = mostly wild walleye; S = mostly or entirely stocked walleye

c Non-targeted effort directed at all species of fish.

d At Moore’s Park, Lansing.
Table 8.–Estimated walleye sport fishery statistics for Michigan waters of Lake Michigan and select tributaries.

<table>
<thead>
<tr>
<th>Location</th>
<th>Management unit</th>
<th>Wild or stockeda</th>
<th>Year</th>
<th>Total number harvested</th>
<th>Fishing effort b (hrs)</th>
<th>Harvest per hr c</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Little Bay de Noc</td>
<td>NLMMU</td>
<td>W</td>
<td>2000</td>
<td>31,920</td>
<td>544,072</td>
<td>0.0587</td>
<td>Rakoczy (2000)</td>
</tr>
<tr>
<td>Big Bay de Noc</td>
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<td>S</td>
<td>2000</td>
<td>902</td>
<td>18,548</td>
<td>0.0486</td>
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</tr>
<tr>
<td>Cedar River</td>
<td>NLMMU</td>
<td>S</td>
<td>2000</td>
<td>953</td>
<td>16,974</td>
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<tr>
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<td>W</td>
<td>2000</td>
<td>2,374</td>
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<td>10</td>
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<td>1999</td>
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<td>Muskegon River (below Croton Dam)</td>
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<td>St Joseph River (below Berrien Springs)</td>
<td>CLMMU</td>
<td>S</td>
<td>1998d</td>
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<td>St Joseph River (below Berrien Springs)</td>
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<td>St Joseph River (below Berrien Springs)</td>
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<td>21,505</td>
<td>0.0221</td>
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</table>

a MDNR fisheries management unit: WLSMU = Western Lake Superior; ELSMU = Eastern Lake Superior; NLMMU = Northern Lake Michigan; CLMMU = Central Lake Michigan; SLMMU = Southern Lake Michigan; NLHUM = Northern Lake Huron; SLHUM = Southern Lake Huron; and LEMU = Lake Erie.

b W = mostly wild walleye; S = mostly or entirely stocked walleye

c Non-targeted effort directed at all species of fish.

d Charter boat fishery only.
<table>
<thead>
<tr>
<th>Lake</th>
<th>County</th>
<th>Area (acres)</th>
<th>Management unit</th>
<th>Months and year</th>
<th>Number harvested total per acre</th>
<th>Fishing effort (hrs)</th>
<th>Harvest per hr</th>
<th>Reference</th>
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<tr>
<td>Anderson</td>
<td>Marquette</td>
<td>49</td>
<td>NLMMU</td>
<td>May–Sep 1985</td>
<td>15</td>
<td>0.31</td>
<td>2,752</td>
<td>0.009 Wagner (1988)</td>
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<tr>
<td>Big Shag</td>
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<td>185</td>
<td>NLMMU</td>
<td>May–Sep 1985</td>
<td>1,086</td>
<td>5.87</td>
<td>10,726</td>
<td>0.101 Wagner (1988)</td>
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<td>10,130</td>
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<td>16,975</td>
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<td>May–Feb 1978–79</td>
<td>18,271</td>
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<td>0.282 Ryckman and Lockwood (1985)</td>
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<td>Mackinac</td>
<td>4,001</td>
<td>NLMMU</td>
<td>May–Aug 1996</td>
<td>7,106</td>
<td>1.78</td>
<td>26,329</td>
<td>0.270 Lockwood (2000)</td>
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<td>Dec–Mar 1994</td>
<td>5,926</td>
<td>5.47</td>
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<td>0.726 Lockwood (2000)</td>
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<td>May–Nov 1993</td>
<td>7,996</td>
<td>7.38</td>
<td>27,835</td>
<td>0.287 Lockwood (2000)</td>
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<td>Hagerman</td>
<td>Iron</td>
<td>566</td>
<td>NLMMU</td>
<td>May–Dec 1993</td>
<td>307</td>
<td>0.54</td>
<td>11,314</td>
<td>0.027 Lockwood (2000)</td>
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<td>Dec–Mar 1993–94</td>
<td>1</td>
<td>0.00</td>
<td>382</td>
<td>0.003 Lockwood (2000)</td>
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<td>Iron</td>
<td>6,400</td>
<td>NLMMU</td>
<td>May–Oct 2001</td>
<td>3,127</td>
<td>0.49</td>
<td>34,383</td>
<td>0.091 Hanchin et al. (2005)</td>
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<td>Dec–Feb 2002</td>
<td>317</td>
<td>0.05</td>
<td>18,303</td>
<td>0.017 Hanchin et al. (2005)</td>
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<td>May–Feb 2001–02</td>
<td>3,444</td>
<td>0.54</td>
<td>52,686</td>
<td>0.065 Hanchin et al. (2005)</td>
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<tr>
<td>Petes</td>
<td>Schoolcraft</td>
<td>194</td>
<td>NLMMU</td>
<td>May–Sep 1993</td>
<td>15</td>
<td>0.08</td>
<td>3,009</td>
<td>0.005 Lockwood (2000)</td>
</tr>
<tr>
<td>South Manistique</td>
<td>Mackinac</td>
<td>4,001</td>
<td>NLMMU</td>
<td>May–Sep 1978</td>
<td>9,293</td>
<td>2.32</td>
<td>61,472</td>
<td>0.151 Ryckman and Lockwood (1985)</td>
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<td>Thunder</td>
<td>Schoolcraft</td>
<td>349</td>
<td>NLMMU</td>
<td>May–Sep 1995</td>
<td>4,289</td>
<td>12.29</td>
<td>6,000</td>
<td>0.715 Lockwood (2000)</td>
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<td>Elk</td>
<td>Antrim</td>
<td>8,088</td>
<td>CLMMU</td>
<td>Aug 1996</td>
<td>2,799</td>
<td>0.35</td>
<td>11,384</td>
<td>0.246 Lockwood (2000)</td>
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<td>Houghton</td>
<td>Roscommon</td>
<td>20,044</td>
<td>CLMMU</td>
<td>Jan–Mar 2001</td>
<td>15,070</td>
<td>0.75</td>
<td>78,908</td>
<td>0.191 Clark et al. (2004)</td>
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<td>Apr–Sep 2001</td>
<td>29,338</td>
<td>1.46</td>
<td>278,214</td>
<td>0.105 Clark et al. (2004)</td>
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<td>Jan–Mar 2002</td>
<td>19,954</td>
<td>1.00</td>
<td>220,834</td>
<td>0.090 Clark et al. (2004)</td>
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<td>Apr–Mar 2001–02</td>
<td>49,292</td>
<td>2.46</td>
<td>499,048</td>
<td>0.099 Clark et al. (2004)</td>
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<tr>
<td>Missaukee</td>
<td>Missaukee</td>
<td>1,707</td>
<td>CLMMU</td>
<td>May–Nov 1978</td>
<td>508</td>
<td>0.30</td>
<td>46,772</td>
<td>0.011 Ryckman and Lockwood (1985)</td>
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Table 9.–Continued.

<table>
<thead>
<tr>
<th>Lake</th>
<th>County</th>
<th>Area (acres)</th>
<th>Management unit</th>
<th>Months and year</th>
<th>Number harvested per acre</th>
<th>Fishing effort (hrs)</th>
<th>Harvest per hr</th>
<th>Reference</th>
</tr>
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<tbody>
<tr>
<td></td>
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<td></td>
<td>Dec–Nov 1976–77</td>
<td>279 0.32 5,614 0.050</td>
<td>Laarman (1980)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dec–Nov 1977–78</td>
<td>2,182 2.54 20,884 0.104</td>
<td>Laarman (1980)</td>
<td></td>
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<tr>
<td>Silver</td>
<td>Oceana</td>
<td>690</td>
<td>CLMMU</td>
<td>Apr–Aug 1997</td>
<td>375 0.54 14,772 0.025</td>
<td>Lockwood (2000)</td>
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<td></td>
<td>Apr–Sep 1996</td>
<td>652 0.94 21,537 0.030</td>
<td>Lockwood (2000)</td>
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<tr>
<td>Bankson</td>
<td>Van Buren</td>
<td>217</td>
<td>SLMMU</td>
<td>Jun–Aug 1986</td>
<td>1,824 8.41 13,323 0.137</td>
<td>Duffy (1991)</td>
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<td>Gull</td>
<td>Kalamazoo</td>
<td>2,022</td>
<td>SLMMU</td>
<td>Jan–Feb 1987</td>
<td>2,035 1.01 12,073 0.169</td>
<td>Dexter (1991b)</td>
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<td>Lansing</td>
<td>Ingham</td>
<td>453</td>
<td>SLMMU</td>
<td>Apr–Sep 1987</td>
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<td>Herman (1989)</td>
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<td>Dec–Nov 1975–76</td>
<td>2,256 7.60 20,897 0.108</td>
<td>Beyerle (1984)</td>
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<tr>
<td>Osterhout</td>
<td>Allegan</td>
<td>168</td>
<td>SLMMU</td>
<td>May–Aug 1979</td>
<td>200 1.19 7,211 0.028</td>
<td>Beyerle (1984)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Round</td>
<td>Van Buren</td>
<td>187</td>
<td>SLMMU</td>
<td>May–Sep 1977–78</td>
<td>0 0.0 14,400 0.000</td>
<td>Beyerle (1984)</td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
<td>May–Sep 1979</td>
<td>42 0.22 15,593 0.0030</td>
<td>Beyerle (1984)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>May–Sep 1980</td>
<td>902 4.82 13,470 0.067</td>
<td>Beyerle (1984)</td>
<td></td>
<td></td>
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<tr>
<td>Sessions</td>
<td>Ionia</td>
<td>135</td>
<td>SLMMU</td>
<td>Apr–Sep 1997</td>
<td>4,045 29.96 33,561 0.120</td>
<td>Lockwood (2000)</td>
<td></td>
<td></td>
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<td></td>
<td>Apr–Sep 1996</td>
<td>1,433 10.62 37,801 0.038</td>
<td>Lockwood (2000)</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Jun–Aug 1986</td>
<td>2,391 1.18 20,065 0.112</td>
<td>Dexter (1991a)</td>
<td></td>
<td></td>
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</tbody>
</table>

\(a\) MDNR fisheries management unit: WLSMU = Western Lake Superior; ELSMU = Eastern Lake Superior; NLMMU = Northern Lake Michigan; CLMMU = Central Lake Michigan; SLMMU = Southern Lake Michigan; NLHMU = Northern Lake Huron; SLHMU = Southern Lake Huron; and LEMU = Lake Erie.

\(b\) Non-targeted effort directed at all species of fish.
Table 10.—Estimated yellow perch sport fishery statistics for Michigan waters of Lake Michigan in 2000. All data were taken from Rakoczy (2000).

<table>
<thead>
<tr>
<th>Location</th>
<th>Management unit</th>
<th>Total number harvested</th>
<th>Fishing effort (hrs)</th>
<th>Harvest per hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Little Bay de Noc</td>
<td>NLMMU</td>
<td>142,873</td>
<td>544,072</td>
<td>0.263</td>
</tr>
<tr>
<td>Big Bay de Noc</td>
<td>NLMMU</td>
<td>153</td>
<td>18,548</td>
<td>0.008</td>
</tr>
<tr>
<td>Cedar River</td>
<td>NLMMU</td>
<td>223</td>
<td>16,974</td>
<td>0.013</td>
</tr>
<tr>
<td>Menominee</td>
<td>NLMMU</td>
<td>3,450</td>
<td>115,321</td>
<td>0.030</td>
</tr>
<tr>
<td>Onekama</td>
<td>CLMMU</td>
<td>1,220</td>
<td>37,780</td>
<td>0.032</td>
</tr>
<tr>
<td>Manistee</td>
<td>CLMMU</td>
<td>2,781</td>
<td>187,944</td>
<td>0.015</td>
</tr>
<tr>
<td>White Hall</td>
<td>CLMMU</td>
<td>5,914</td>
<td>65,931</td>
<td>0.090</td>
</tr>
<tr>
<td>Muskegon</td>
<td>CLMMU</td>
<td>57,619</td>
<td>171,032</td>
<td>0.337</td>
</tr>
<tr>
<td>Grand Haven</td>
<td>SLMMU</td>
<td>35,373</td>
<td>199,781</td>
<td>0.177</td>
</tr>
<tr>
<td>Port Sheldon</td>
<td>SLMMU</td>
<td>814</td>
<td>49,760</td>
<td>0.016</td>
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<td>Holland</td>
<td>SLMMU</td>
<td>7,153</td>
<td>119,901</td>
<td>0.060</td>
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<tr>
<td>South Haven</td>
<td>SLMMU</td>
<td>44,748</td>
<td>129,105</td>
<td>0.347</td>
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<tr>
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<td>23,082&lt;sup&gt;c&lt;/sup&gt;</td>
<td>35,323&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.653&lt;sup&gt;c&lt;/sup&gt;</td>
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<td>St. Joseph</td>
<td>SLMMU</td>
<td>22,000</td>
<td>224,000</td>
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<td>New Buffalo</td>
<td>SLMMU</td>
<td>7,413</td>
<td>38,518</td>
<td>0.193</td>
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</table>

<sup>a</sup> MDNR fisheries management unit: WLSMU = Western Lake Superior; ELSMU = Eastern Lake Superior; NLMMU = Northern Lake Michigan; CLMMU = Central Lake Michigan; SLMMU = Southern Lake Michigan; NLHMMU = Northern Lake Huron; SLHMMU = Southern Lake Huron; and LEMU = Lake Erie.

<sup>b</sup> Non-targeted effort directed at all species of fish.

<sup>c</sup> Charter boat fishery only.
Table 11.–Estimated walleye sport fishery statistics for inland waters of the Lake Huron Basin.

<table>
<thead>
<tr>
<th>Lake</th>
<th>County</th>
<th>Area (acres)</th>
<th>Management unit *</th>
<th>Wild or stocked b</th>
<th>Months and year</th>
<th>Number harvested</th>
<th>Fishing effort c (hrs)</th>
<th>Harvest per hr c</th>
<th>Reference</th>
</tr>
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<tr>
<td>Big Bear</td>
<td>Otsego</td>
<td>435</td>
<td>NLHMU</td>
<td>S</td>
<td>May–Sep 1982</td>
<td>368</td>
<td>17,002</td>
<td>0.022</td>
<td>Ryckman and Lockwood (1985)</td>
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<td>Burt</td>
<td>Cheboygan</td>
<td>17,120</td>
<td>NLHMU</td>
<td>W</td>
<td>Apr–Sep 1993</td>
<td>17,186</td>
<td>134,957</td>
<td>0.127</td>
<td>Lockwood (2000)</td>
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<td></td>
<td></td>
<td>May–Aug 1977</td>
<td>3,869</td>
<td>45,514</td>
<td>0.085</td>
<td>Ryckman and Lockwood (1985)</td>
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<td></td>
<td></td>
<td>Apr–Sep 1996</td>
<td>3,310</td>
<td>21,537</td>
<td>0.154</td>
<td>Lockwood (2000)</td>
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<td>Mullett</td>
<td>Cheboygan</td>
<td>17,360</td>
<td>NLHMU</td>
<td>W</td>
<td>May–Aug 1998</td>
<td>3,338</td>
<td>87,520</td>
<td>0.381</td>
<td>Lockwood (2000)</td>
</tr>
</tbody>
</table>

a MDNR fisheries management unit: WLSMU = Western Lake Superior; ELSMU = Eastern Lake Superior; NLMMU = Northern Lake Michigan; CLMMU = Central Lake Michigan; SLMMU = Southern Lake Michigan; NLHMU = Northern Lake Huron; SLHMU = Southern Lake Huron; and LEMU = Lake Erie.

b W = mostly wild walleye; S = mostly or entirely stocked walleye

c Non-targeted effort directed at all species of fish.
Table 12: Estimated walleye sport fishery statistics for Michigan waters of Lake Huron and the St. Marys River.

<table>
<thead>
<tr>
<th>Location</th>
<th>Management unit</th>
<th>Wild or stocked</th>
<th>Year(s)</th>
<th>Total number harvested</th>
<th>Fishing effort (hrs)</th>
<th>Harvest per hr</th>
<th>Reference</th>
</tr>
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<td>St. Marys system</td>
<td>NLHMU</td>
<td>W</td>
<td>1999</td>
<td>11,145</td>
<td>556,399</td>
<td>0.0207</td>
<td>Fielder et al. (in press)</td>
</tr>
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<td>Saginaw and Tittabawassee rivers</td>
<td>SLHMU</td>
<td>S</td>
<td>2000 winter</td>
<td>38,830</td>
<td>308,932</td>
<td>0.126</td>
<td>Rakoczy (2000)</td>
</tr>
<tr>
<td>Saginaw Bay</td>
<td>SLHMU</td>
<td>S</td>
<td>2000</td>
<td>56,598</td>
<td>927,925</td>
<td>0.0610</td>
<td>Rakoczy (2000)</td>
</tr>
</tbody>
</table>

- MDNR fisheries management unit: WLSMU = Western Lake Superior; ELSMU = Eastern Lake Superior; NLMMU = Northern Lake Michigan; CLMMU = Central Lake Michigan; SLMMU = Southern Lake Michigan; NLHMU = Northern Lake Huron; SLHMU = Southern Lake Huron; and LEMU = Lake Erie.
- W = mostly wild walleye; S = mostly or entirely stocked walleye
- Non-targeted effort directed at all species of fish.
Table 13.–Estimated yellow perch sport fishery statistics for inland waters of the Lake Huron Basin.

<table>
<thead>
<tr>
<th>Lake</th>
<th>County</th>
<th>Area (acres)</th>
<th>Management unit&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Months and year</th>
<th>Number harvested</th>
<th>Fishing effort&lt;sup&gt;b&lt;/sup&gt; (hrs)</th>
<th>Harvest per hr&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Big Bear</td>
<td>Otsego</td>
<td>435</td>
<td>NLHMU</td>
<td>May–Sep 1982</td>
<td>185</td>
<td>0.42</td>
<td>17,002</td>
<td>0.011</td>
</tr>
<tr>
<td>Burt</td>
<td>Cheboygan</td>
<td>17,120</td>
<td>NLHMU</td>
<td>Apr–Sep 1993</td>
<td>433</td>
<td>0.02</td>
<td>134,957</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>May–Aug 1977</td>
<td>230</td>
<td>0.01</td>
<td>45,514</td>
<td>0.005</td>
</tr>
<tr>
<td>Mullett</td>
<td>Cheboygan</td>
<td>17,360</td>
<td>NLHMU</td>
<td>May–Aug 1998</td>
<td>12,286</td>
<td>0.71</td>
<td>87,520</td>
<td>0.140</td>
</tr>
<tr>
<td>Jewett&lt;sup&gt;c&lt;/sup&gt;</td>
<td>Ogemaw</td>
<td>13</td>
<td>SLHMU</td>
<td>1987–91</td>
<td>81</td>
<td>6.23</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

<sup>a</sup> MDNR fisheries management unit: WLSMU = Western Lake Superior; ELSMU = Eastern Lake Superior; NLMMU = Northern Lake Michigan; CLMMU = Central Lake Michigan; SLMMU = Southern Lake Michigan; NLHMU = Northern Lake Huron; SLHMU = Southern Lake Huron; and LEMU = Lake Erie.

<sup>b</sup> Non-targeted effort directed at all species of fish.

<sup>c</sup> Average estimate for years when lake contained an experimental community of walleyes, bluegills, and yellow perch.
Table 14.—Estimated yellow perch sport fishery statistics for Michigan waters of Lake Huron and the St. Marys River.

<table>
<thead>
<tr>
<th>Location</th>
<th>Management unit</th>
<th>Year</th>
<th>Total number harvested</th>
<th>Fishing effort (hrs)</th>
<th>Harvest per hr</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>St. Mary system</td>
<td>NLH MU</td>
<td>1999–00</td>
<td>75,238</td>
<td>556,399</td>
<td>0.135</td>
<td>Fielder et al. (in press)</td>
</tr>
<tr>
<td>Les Cheneaux Islands</td>
<td>NLH MU</td>
<td>2000</td>
<td>693</td>
<td>22,792</td>
<td>0.030</td>
<td>Rakoczy (2000)</td>
</tr>
<tr>
<td>Saginaw Bay</td>
<td>SLH MU</td>
<td>2000</td>
<td>613,583</td>
<td>927,925</td>
<td>0.662</td>
<td>Rakoczy (2000)</td>
</tr>
</tbody>
</table>

a MDNR fisheries management unit: WLSMU = Western Lake Superior; ELSMU = Eastern Lake Superior; NLMMU = Northern Lake Michigan; CLMMU = Central Lake Michigan; SLMMU = Southern Lake Michigan; NLH MU = Northern Lake Huron; SLH MU = Southern Lake Huron; and LEMU = Lake Erie.

b Non-targeted effort directed at all species of fish.

c For combined sport fishery in Michigan and Ontario waters, May 1999–March 2000.
Table 15.–Estimated walleye sport fishery statistics for inland waters of the Lake Erie Basin and LEMU.

<table>
<thead>
<tr>
<th>Lake</th>
<th>County</th>
<th>Area (acres)</th>
<th>Wild or stocked&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Months and year</th>
<th>Number harvested</th>
<th>Fishing effort&lt;sup&gt;b&lt;/sup&gt; (hrs)</th>
<th>Harvest per hr&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belleville</td>
<td>Washtenaw</td>
<td>1,270</td>
<td>S</td>
<td>May–Oct 1976–79</td>
<td>1,700</td>
<td>261,804</td>
<td>0.006</td>
<td>Laarman (1979); Schneider (1987)</td>
</tr>
<tr>
<td>Cass</td>
<td>Oakland</td>
<td>1,280</td>
<td>S</td>
<td>Apr–Aug 1987</td>
<td>65</td>
<td>30,703</td>
<td>0.002</td>
<td>Schneider et al. (1989)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Jan–Nov 1986</td>
<td>241</td>
<td>39,205</td>
<td>0.006</td>
<td>Waybrant and Thomas (1988)</td>
</tr>
<tr>
<td>Devils</td>
<td>Lenawee</td>
<td>1,300</td>
<td>S</td>
<td>Apr–Sep 1987</td>
<td>68</td>
<td>42,428</td>
<td>0.002</td>
<td>Herman (1989)</td>
</tr>
<tr>
<td>Kent</td>
<td>Livingston</td>
<td>1,000</td>
<td>S</td>
<td>Jan–Oct 1986</td>
<td>386</td>
<td>231,000</td>
<td>0.002</td>
<td>Thomas (1990)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Apr–Aug 1987</td>
<td>763</td>
<td>92,075</td>
<td>0.008</td>
<td>Schneider et al. (1989)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>May–Oct 1980</td>
<td>81</td>
<td>191,134</td>
<td>0.000</td>
<td>Ryckman and Lockwood (1985)</td>
</tr>
<tr>
<td>Maceday-Lotus</td>
<td>Oakland</td>
<td>419</td>
<td>S</td>
<td>Jan–Nov 1986</td>
<td>12</td>
<td>37,010</td>
<td>0.000</td>
<td>Waybrant and Thomas (1988)</td>
</tr>
<tr>
<td>Orchard</td>
<td>Oakland</td>
<td>788</td>
<td>S</td>
<td>Jan–Nov 1986</td>
<td>0</td>
<td>24,422</td>
<td>0.000</td>
<td>Waybrant and Thomas (1988)</td>
</tr>
<tr>
<td>Vineyard</td>
<td>Jackson</td>
<td>505</td>
<td>S</td>
<td>Apr–Sep 1987</td>
<td>0</td>
<td>28,070</td>
<td>0.000</td>
<td>Herman (1989)</td>
</tr>
</tbody>
</table>

<sup>a</sup> W = mostly wild walleye; S = mostly or entirely stocked walleye

<sup>b</sup> Non-targeted effort directed at all species of fish.
Table 16.—Estimated walleye sport fishery statistics for Michigan waters of Lake St. Clair, Lake Erie, and connecting rivers.

<table>
<thead>
<tr>
<th>Location</th>
<th>Wild or stocked</th>
<th>Year</th>
<th>Total number harvested</th>
<th>Fishing effort (hrs)</th>
<th>Harvest per hr</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>St Clair River</td>
<td>W</td>
<td>1983–84</td>
<td>103,528</td>
<td>551,454</td>
<td>0.188</td>
<td>Haas et al. (1985)</td>
</tr>
<tr>
<td>Harsen’s Island channels</td>
<td>W</td>
<td>1983–84</td>
<td>58,045</td>
<td>258,407</td>
<td>0.225</td>
<td>Haas et al. (1985)</td>
</tr>
<tr>
<td>Lake St. Clair</td>
<td>W</td>
<td>1983–84</td>
<td>132,454</td>
<td>1,952,694</td>
<td>0.068</td>
<td>Haas et al. (1985)</td>
</tr>
<tr>
<td>Detroit River</td>
<td>W</td>
<td>1998–00</td>
<td>163,830</td>
<td>1,409,195</td>
<td>0.116</td>
<td>Haas et al. (1985)</td>
</tr>
<tr>
<td>Lake Erie</td>
<td>W</td>
<td></td>
<td>166,788</td>
<td>600,000</td>
<td>0.280</td>
<td>Walleye Task Group (2001)</td>
</tr>
</tbody>
</table>

a W = mostly wild walleye; S = mostly or entirely stocked walleye
b Non-targeted effort directed at all species of fish.
Table 17.–Estimated yellow perch sport fishery statistics for inland waters of the Lake Erie Basin and LEMU.

<table>
<thead>
<tr>
<th>Lake</th>
<th>County</th>
<th>Area (acres)</th>
<th>Months and year</th>
<th>Number harvested</th>
<th>Fishing effort (^a) (hrs)</th>
<th>Harvest per hr (^a)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cass</td>
<td>Oakland</td>
<td>1,280</td>
<td>Apr–Aug 1987</td>
<td>300</td>
<td>30,703</td>
<td>0.010</td>
<td>Schneider et al. (1989)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Jan–Nov 1986</td>
<td>106</td>
<td>39,205</td>
<td>0.003</td>
<td>Waybrant and Thomas (1988)</td>
</tr>
<tr>
<td>Devils</td>
<td>Lenawee</td>
<td>1,300</td>
<td>Apr–Sep 1987</td>
<td>1,593</td>
<td>42,428</td>
<td>0.038</td>
<td>Herman (1989)</td>
</tr>
<tr>
<td>Kent</td>
<td>Livingston</td>
<td>1,000</td>
<td>Apr–Aug 1988</td>
<td>3,018</td>
<td>92,075</td>
<td>0.033</td>
<td>Schneider et al. (1989)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Jan–Oct 1987</td>
<td>2,671</td>
<td>231,000</td>
<td>0.012</td>
<td>Thomas (1990)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>May–Oct 1980</td>
<td>5,176</td>
<td>191,134</td>
<td>0.027</td>
<td>Ryckman and Lockwood (1985)</td>
</tr>
<tr>
<td>Maceday-Lotus</td>
<td>Oakland</td>
<td>419</td>
<td>Jan–Nov 1986</td>
<td>2,121</td>
<td>37,010</td>
<td>0.057</td>
<td>Waybrant and Thomas (1988)</td>
</tr>
<tr>
<td>Orchard</td>
<td>Oakland</td>
<td>788</td>
<td>Jan–Nov 1986</td>
<td>191</td>
<td>24,422</td>
<td>0.008</td>
<td>Waybrant and Thomas (1988)</td>
</tr>
<tr>
<td>Vineyard</td>
<td>Jackson</td>
<td>505</td>
<td>Apr–Sep 1987</td>
<td>684</td>
<td>28,070</td>
<td>0.024</td>
<td>Herman (1989)</td>
</tr>
<tr>
<td>White</td>
<td>Oakland</td>
<td>540</td>
<td>Jan–Oct 1987</td>
<td>2,691</td>
<td>40,257</td>
<td>0.067</td>
<td>Thomas (1990)</td>
</tr>
<tr>
<td>Whitmore</td>
<td>Washtenaw</td>
<td>677</td>
<td>May–Oct 1980</td>
<td>2,545</td>
<td>64,526</td>
<td>0.039</td>
<td>Ryckman and Lockwood (1985)</td>
</tr>
</tbody>
</table>

\(^a\) Non-targeted effort directed at all species of fish.
Table 18.–Estimated walleye sport fishery statistics for Michigan waters of Lake St. Clair, Lake Erie, and connecting rivers.

<table>
<thead>
<tr>
<th>Location</th>
<th>Year</th>
<th>Total number harvested</th>
<th>Fishing effort b (hrs)</th>
<th>Harvest per hr b</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>St Clair River</td>
<td>1983–84</td>
<td>8,602</td>
<td>551,454</td>
<td>0.016</td>
<td>Haas et al. (1985)</td>
</tr>
<tr>
<td>Harsen’s Island channels</td>
<td>1983–84</td>
<td>8,290</td>
<td>258,407</td>
<td>0.032</td>
<td>Haas et al. (1985)</td>
</tr>
<tr>
<td>Lake St. Clair</td>
<td>1983–84</td>
<td>868,829</td>
<td>1,952,694</td>
<td>0.445</td>
<td>Haas et al. (1985)</td>
</tr>
<tr>
<td>Detroit River</td>
<td>1983–84</td>
<td>135,986</td>
<td>1,409,195</td>
<td>0.096</td>
<td>Haas et al. (1985)</td>
</tr>
<tr>
<td>Lake Erie</td>
<td>1997–01</td>
<td>411,289</td>
<td>600,000</td>
<td>0.670</td>
<td>Yellow Perch Task Group (2001)</td>
</tr>
</tbody>
</table>

a Non-targeted effort directed at all species of fish.
References


Hanson, M. J. 1989. A walleye population model for setting harvest quotas. Wisconsin Department of Natural Resources, Fish Management Report 143, Madison.


Appendix 1.—Lake Superior Basin walleye waters based on stocking records for 1995–99, fish collected since 1980, and questionnaires completed by management unit biologists. Questionnaires asked management biologists to rank each walleye population regarding its recruitment, origin, Great Lakes (GL) access, and fishery. They were also asked to rank yellow perch fisheries, if any existed in the water body. These ranks are defined in the text at the beginning of the Status of Percids of Michigan section.

<table>
<thead>
<tr>
<th>Management unit</th>
<th>Water body</th>
<th>Size</th>
<th>T</th>
<th>R</th>
<th>S</th>
<th>Data source</th>
<th>Recruitment</th>
<th>Origin</th>
<th>GL access</th>
<th>Fishery</th>
<th>Yellow perch fishery rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern Lake Superior</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alger</td>
<td>Au Train Lake</td>
<td>845</td>
<td>46N</td>
<td>20W</td>
<td>05</td>
<td>s, f</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Beaver Lake</td>
<td>783</td>
<td>48N</td>
<td>16W</td>
<td>08</td>
<td>s</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Cleveland Basin</td>
<td>1,489</td>
<td>45N</td>
<td>20W</td>
<td>06</td>
<td>s</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Deer Lake</td>
<td>266</td>
<td>47N</td>
<td>21W</td>
<td>18</td>
<td>s, f</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Kingston Lake</td>
<td>123</td>
<td>48N</td>
<td>15W</td>
<td>06</td>
<td>s, f</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Little Beaver Lake</td>
<td>40</td>
<td>48N</td>
<td>16W</td>
<td>18</td>
<td>f</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Nawakwa Lake</td>
<td>442</td>
<td>48N</td>
<td>13W</td>
<td>19</td>
<td>f</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Chippewa</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Lake Superior</td>
<td></td>
<td>47N</td>
<td>02W</td>
<td></td>
<td>35</td>
<td>s</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Lower Tahquamenon River</td>
<td></td>
<td>17</td>
<td>48N</td>
<td>06W</td>
<td></td>
<td>many</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Monocle Lake</td>
<td></td>
<td>172</td>
<td>47N</td>
<td>03W</td>
<td>14</td>
<td>f</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Tahquamenon River</td>
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<td>48N</td>
<td>07W</td>
<td></td>
<td>13</td>
<td>s</td>
<td>5</td>
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<td>3</td>
<td>2</td>
<td>3</td>
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<tr>
<td>Tahquamenon River</td>
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<td>48N</td>
<td>06W</td>
<td></td>
<td>15</td>
<td>s</td>
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<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Tahquamenon River</td>
<td></td>
<td>49N</td>
<td>07W</td>
<td></td>
<td>32</td>
<td>s</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Luce</td>
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<td></td>
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<tr>
<td>Bass Lake</td>
<td></td>
<td>144</td>
<td>47N</td>
<td>11W</td>
<td>17</td>
<td>s</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Beaverhouse Lake</td>
<td></td>
<td>33</td>
<td>49N</td>
<td>11W</td>
<td>33</td>
<td>s, f</td>
<td>6</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Belle Lake I</td>
<td></td>
<td>26</td>
<td>47N</td>
<td>12W</td>
<td>09</td>
<td>f</td>
<td>6</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Belle Lake II</td>
<td></td>
<td>107</td>
<td>47N</td>
<td>12W</td>
<td>09</td>
<td>s, f</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Bodi Lake</td>
<td></td>
<td>275</td>
<td>50N</td>
<td>08W</td>
<td>29</td>
<td>s, f</td>
<td>6</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Culhane Lake</td>
<td></td>
<td>100</td>
<td>50N</td>
<td>08W</td>
<td>30</td>
<td>s, f</td>
<td>6</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
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$^a$ Size is in surface acres for lakes and impoundments. Size is in length in miles for rivers.

$^b$ Data source is s = stocking records for 1995–99 or f = Fish Collection System of MDNR.
Appendix 2—Lake Michigan Basin walleye waters based on stocking records for 1995–99, fish collected since 1980, and questionnaires completed by management unit biologists. Questionnaires asked management biologists to rank each walleye population regarding its recruitment, origin, Great Lakes (GL) access, and fishery. They were also asked to rank yellow perch fisheries, if any existed in the water body. These ranks are defined in the text at the beginning of the Status of Percids of Michigan section.

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*a* Size is in surface acres for lakes and impoundments. Size is in length in miles for rivers.

*b* Data source is s = stocking records for 1995–99, f = Fish Collection System of MDNR, or c = creel survey.
Appendix 3.—Lake Huron Basin walleye waters based on stocking records for 1995–99, fish collected since 1980, and questionnaires completed by management unit biologists. Questionnaires asked management biologists to rank each walleye population regarding its recruitment, origin, Great Lakes (GL) access, and fishery. They were also asked to rank yellow perch fisheries, if any existed in the water body. These ranks are defined in the text at the beginning of the Status of Percids of Michigan section.

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*a Size is in surface acres for lakes and impoundments. Size is in length in miles for rivers.

*b Data source is s = stocking records for 1995–99, f = Fish Collection System of MDNR, or c = creel survey.
Appendix 4.—Lake Erie Basin (LEMU) walleye waters based on stocking records for 1995–99, fish collected since 1980, and questionnaires completed by management unit biologists. Questionnaires asked management biologists to rank each walleye population regarding its recruitment, origin, Great Lakes (GL) access, and fishery. They were also asked to rank yellow perch fisheries, if any existed in the water body. These ranks are defined in the text at the beginning of the Status of Percids of Michigan section.

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\(^a\) Size is in surface acres for lakes and impoundments. Size is in length in miles for rivers.

\(^b\) Data source is s = stocking records for 1995–99, f = Fish Collection System of MDNR, or c = creel survey.