Lake Missaukee
Missaukee County
Muskegon River Watershed, last surveyed 2018

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Environment

Lake Missaukee is an 1,880-acre natural lake located in Lake Township in western Missaukee County, Michigan. Lake City sits on the eastern shore of Lake Missaukee. Lake Missaukee is the largest lake in Missaukee County and has a maximum depth of approximately 27 feet, although most of the lake is less than 15 feet. Substrates found in the lake are mostly sand, with silty sand and detritus in some of the deeper areas and in some weedy shoreline areas. Because it is a relatively shallow lake, Lake Missaukee has an abundance of aquatic vegetation.

The shoreline of Lake Missaukee is highly developed with many homes surrounding the lake, with only the northwestern shoreline being undeveloped. The north end of the lake features several shallow bays and several islands. The larger island is connected to the mainland by a bridge and is heavily developed, with over 40 homes on it. The landscape surrounding Lake Missaukee is diverse. Immediately east of the lake lies Lake City, but beyond that the landscape is primarily agricultural. To the south is much the same. To the north and west there are several lakes, of which Crooked and Sapphire are the largest. Wetlands are common to the north and west and upland areas are forested with conifers and northern hardwoods. Most of the lands surrounding the lake are in private ownership.

Lake Missaukee is part of the Muskegon River watershed. The lake sits at an elevation of 1,238 feet, relatively high for the lower peninsula of Michigan. Because of this, it has a very small watershed feeding it. According to Jaworski (1999), the size of the Lake Missaukee watershed is 1,775 acres, even less than the size of the lake. Therefore, the lake is primarily fed by ground water (springs) and rainfall. The lake has an intermittent drain/lake level control structure that flows into Mosquito Creek, a trout-stream tributary to the Clam River, which flows into the Muskegon River. Lake Missaukee is essentially the headwaters of Mosquito Creek. The court- mandated level of Lake Missaukee is 1238.5 feet.

Access to Lake Missaukee can be gained at several different locations. In downtown Lake City, there is a public dock where transient boats can dock for short periods of time. The dock reaches out to deeper water and provides good fishing opportunities for shore-bound anglers. Miltner Park, also in downtown Lake City, provides beach access. Missaukee Lake Park is located along the northeast shore of the lake and offers a campground, swimming beach, paved boat launch, and 80 boat slips available for rent. Another public access site is located at the end of Green Road on the south shore of the lake. This site includes restroom facilities, a paved boat ramp, and parking for 14 vehicles.

The primary citizen group for Lake Missaukee is the Missaukee Lake Association (MLA), which was created in 1997. According to their website (http://lakemissaukee.org/about_mla.html), "The purpose of the MLA is to promote and protect the environmental integrity of the lake through education, safety promotion, quality initiatives and public awareness. The focus of MLA is on the global issues impacting the lake: water quality, wetland protection, weed control, environmental protection and

safety". At the urging of MLA, the Lake Missaukee Improvement Board (LMIB) was established in 2004. The primary objective of the LMIB is to control the spread of invasive aquatic plants in Lake Missaukee. The LMIB is composed of a representative from each of the townships bordering Lake Missaukee, a representative of the county road commission, a representative of the county board of commissioners, and a Lake Missaukee property owner. The LMIB collects tax revenue from riparian landowners, which is used for the treatment of invasive Eurasian milfoil.

History

The shores of Lake Missaukee were first settled by European settlers in the late 1860's and early 1870s, although Native Americans had long inhabited the area, at least seasonally. Logging was prominent from then until the early 1900s. The lake was used for floating harvested logs to the many sawmills, shingle mills, and other wood-related factories that were present on the shores of the lake in the late 1800s and early 1900s. Wood debris from that time period can still occasionally be found in the lake. There is no longer any heavy industry remaining on the shores of Lake Missaukee.

The first recorded fish stocking of Lake Missaukee took place in 1905, when both Largemouth Bass and Walleye were stocked, likely by the Michigan Fishery Commission (Table 1). Smallmouth Bass were first stocked in 1909 and Yellow Perch in 1910. Further stockings were conducted by the Michigan Department of Conservation (MDOC; the precursor to the Michigan Department of Natural Resources or MDNR of today) between 1934 and 1941, with Walleye being the most commonly stocked species in that time period. Other species stocked then included Bluegill, Emerald Shiners (referred to as "Great Lakes Shiners"), Smallmouth Bass, and Yellow Perch (Table 1). After a 1942 MDOC report (Perry 1942) recommended halting all stocking in Lake Missaukee indefinitely, no stocking was conducted until 1970 when Walleye were again stocked. Walleye have been stocked regularly since then. Recently, Walleye have been stocked in most years since 2010, although the 2010 and 2016 stocking efforts consisted of less than 150 fall fingerlings each. The most recent stocking was 99,049 spring fingerlings in 2017.

Water levels have long been an issue on Lake Missaukee. A note written in 1939 by Hugo Kilpela of the MDOC (MDNR files, Cadillac office) mentions that "for about five or six years, according to Mr. Morrison, a year-round resident near Missaukee State Park, the water level of the lake has been going down with the subsequent destruction of marsh areas and pike spawning waters". Mr. Kilpela also mentions that the lake level had dropped by more than 4 feet in the last 10-15 years, and that Lake Missaukee had previously had connections to Crooked Lake, Little Goose Lake, and other waters. He reported that some residents believed the drop to have been caused by Lake City using the lake for drinking water. Perry (1942) also discusses the water level issue at length. He mentions that Lake Missaukee has no outlet but does have an artificial outlet that only flows at infrequent periods of exceptionally high water. He discusses the "receding water level" and how Lake Missaukee used to be connected to Goose and Crooked Lakes.

Although Walleye were not stocked between 1940 and 1970, they remained a species of interest. There is file correspondence (MDNR office, Cadillac) from Stan Lievense, the District Fisheries Supervisor, in 1958 that mentions that Walleye are continuing to be caught from the lake, and therefore must be naturally reproducing. There is also considerable correspondence in the Lake Missaukee file (MDNR office, Cadillac) from the late 1950s and throughout the 1960s regarding the potential construction of a spawning marsh adjacent to the lake for Northern Pike spawning. However, none was ever

constructed. While Northern Pike spawning marshes were constructed on many lakes in the lower peninsula during that time period, fisheries managers eventually learned that in most Michigan lakes, Northern Pike can sustain themselves naturally without the aid of artificial spawning marshes.

There is also substantial discussion in the Lake Missaukee file (MDNR office, Cadillac) from the early 1960s regarding extensive wetland filling and degradation along the north shore of the lake for development purposes. Unofficially called the "Redman's Island project", it involved dredging and filling riparian wetlands to make the area suitable for building homes. At that time, there were few environmental laws to protect critical habitat such as riparian wetlands. Although the MDOC Fisheries Biologists at that time had concerns over the effects of such a project, there was little they could do to prevent it.

In 1990, MDNR Fisheries Biologists changed the regulation on Northern Pike to "no minimum size limit". At that time, the statewide minimum size limit was 20 inches (although that was changed to 24 inches in 1993). There is no correspondence for this issue in the file (Cadillac MDNR office), but it was likely because Northern Pike from Lake Missaukee were growing very slowly. An MDNR fisheries survey in 1987 had documented the slow growth, as had scale samples from angler-caught Northern Pike. It is also likely that anglers were requesting such a regulation. The "no minimum size limit" regulation for Northern Pike remains in effect at present. The regulation includes a five fish per day catch limit, with no more than one over 24 inches.

Lake Missaukee anglers and riparian landowners have long been involved in the management of the lake, even prior to the formation of the MLA in 1997. There have been several times over the years where anglers have provided scale samples from sport-caught fish for aging purposes. In particular, the anglers have been vocal in their desire for the lake to be managed for Walleye. In 1993, the Lake City Chamber of Commerce and a group called Missaukee County Fishermen in Self Help ("MCFISH") entered into agreement with MDNR to assist in rearing Walleye to stock into Lake Missaukee and other area lakes. For several years after, MCFISH volunteers assisted with the operation of MDNR's Merritt Walleye Pond. In recent years, the Merritt Pond has not been in operation due to maintenance issues, so Walleye stocked into Lake Missaukee have come from other sources.

In the late 1990s/early 2000s there was a proposed condominium development on the west side of the lake. Due to the abundant nearshore wetlands and shallow, mucky nature of that part of the lake, the development would have required an extensive dredge and fill operation to make the site buildable. This raised concern with many Lake City residents, and an environmental assessment report for Lake Missaukee (Jaworski 1999; prepared at the behest of the MLA) cautioned that the proposed project could have grave impacts to the lake. The Missaukee Lakes Association officially opposed the project, as did MDNR Fisheries Biologist Rich O'Neal. Eventually the developer's permit application was denied by MDEQ.

In 2004, another major dredging project was proposed for the Tom's Bay area (on the northern shore of the lake, near where the Redman's Island project was conducted). This proposal was also opposed by the MLA and by MDNR Fisheries Division. The dredging permit application was initially denied by MDEQ, but the applicant filed an appeal. After the contested case proceedings, the permit was eventually granted, and the project completed.

Several invasive species are present in Lake Missaukee. Eurasian milfoil was first found in Lake Missaukee in the early 2000s. Excessive Eurasian milfoil can lead to several fisheries problems including slow growth and stunting for numerous important fish species. Chemical treatments for Eurasian milfoil began in the mid-2000s and have continued since then. In 2018, three different treatments were conducted; one each in June, July, and September. The June treatment was the largest, with approximately 52 acres of the lake treated for Eurasian milfoil. The primary chemical used was 2,4-D, which is a systemic herbicide. The July and September 2018 treatments were both on a much smaller scale. Zebra mussels are also present in Lake Missaukee, having first been documented in 2010. At present, there are no known control methods for zebra mussels on inland lakes as large as Lake Missaukee.

In the spring of 2016, the Lake Township Board embarked on a campaign to improve habitat in Lake Missaukee (along with Crooked and Sapphire Lakes, which also fall within Lake Township). A Lake Enhancement Committee was formed, with members coming from the Lake Township Board and each individual lake association. As a result, several dozen fish habitat structures were strategically placed in Lake Missaukee. The structures consisted of several whole trees tied together and weighted with stones or cinder blocks. The idea was that the structures will attract fish and provide locations for anglers to target them.

Historical Fisheries Surveys

The first MDOC investigation of Lake Missaukee took place in 1927. Fisheries Biologist Jan Metzelaar conducted several seine efforts, and noted the presence of Mimic Shiners, White Suckers, Bluntnose Minnows, Smallmouth Bass, Yellow Perch, Iowa Darters, Brown Bullhead, and Johnny Darters (Table 2). Although he did not collect any Walleye, he noted that they were likely present, and that they had been recently stocked (although no records exist for that time period). His recommendation was to stock Walleye into Lake Missaukee.

More extensive fisheries surveys of Lake Missaukee were conducted by MDOC personnel in 1939 and 1941 (Perry 1942; Table 2). The 1939 survey consisted of seining and one fyke net, while the 1941 survey included gill nets. Centrarchids like Smallmouth Bass, Bluegill, Pumpkinseed Sunfish and Rock Bass dominated the catch in both surveys. Walleye, Northern Pike, and Largemouth Bass were also reported, along with minnow species including Banded Killifish and Bluntnose Minnow. Perry's report (1942) mentions 21 species of fish as present in Lake Missaukee, although only 17 had been caught in the fisheries surveys (Table 2). The other four species included Brown Bullhead, Common Carp, "Great Lakes Shiners", and "Straw Colored Shiners". No species with name of Straw Colored Shiner is known today, and it is unknown what species Perry might have been actually referring to. While Brown Bullhead are common in lake Missaukee, Common Carp (which had been reported by locals) have never been documented in Lake Missaukee. Although "Great Lakes Shiners" (Emerald Shiners) were stocked several times in the years prior to the surveys, they were not documented in either 1939 or 1941, or in any other survey since then. Perry (1942) also documented 21 different species of aquatic plants in Lake Missaukee.

The next MDOC survey of Lake Missaukee was conducted in April of 1965 (Table 2). It was a two-day survey with trap nets, fyke nets, and inland gill nets. The catch was relatively low. Northern Pike and Bullheads dominated the catch numerically. The Northern Pike were mostly between 14 and 20 inches. District Fisheries Biologist Buddy Jacob noted slow growth among most of the game and

panfish species. He also noted that "people are able to consistently catch Walleyes" from Lake Missaukee.

A series of netting surveys were conducted in 1975, 1976, and 1977. All three surveys were conducted in June. These surveys consisted of gill nets and trap nets and the purpose was to assess the Walleye stocking program, which had begun in earnest in 1974 (Table 1). The surveys documented good survival of Walleye from the stocked 1974-year class, and somewhat lower survival of the 1975-year class. Older Walleye were also caught, and those were attributed to natural reproduction from previous years.

A series of creel census surveys were conducted between 1975 and 1979. The primary purpose of the surveys was to document if anglers were catching Walleye. While final reports for these surveys are missing from the Cadillac office files, enough correspondence exists to verify that anglers were indeed targeting and catching Walleye regularly. The 1978 creel census survey showed 46,772 hours of angler effort generated between May and November of that year. Electrofishing surveys targeting juvenile Walleye were also conducted in 1978 and 1980. Both surveys documented modest survival of the 1977-year class in addition to some older year classes as well.

Despite the documented survival of several of the year classes of Walleye stocked in the 1970s, and the consistent presence of Walleye in the creel surveys, fisheries managers stopped stocking Walleye in Lake Missaukee and very few were stocked between 1981 and 1990. Although not well documented, this was likely due the inability to rear enough Walleye fingerlings to stock all prescribed waters. Also, it is possible that unrealistic expectations were placed on the fishery. Despite the temporary halt, Walleye stocking was resumed in 1990 and Walleye have been stocked on a regular basis since then.

Another netting survey was conducted in the April of 1987. The effort was primarily conducted as a "rough fish removal" based on research conducted by Hayes (1990). In the Hayes study, populations and growth rates of other more desirable fish species improved in Douglas Lake in Otsego County when the White Sucker population was manually reduced. While the Hayes study showed that White Suckers competed with Yellow Perch for limited invertebrate food resources, other species like Bluegill and juvenile Walleye may also be impacted. Although White Sucker were the species studied by Hayes, some Fisheries Biologists believe an overabundance of Bullhead may create the same impacts on more desirable species. Although the 1987 effort was not overly successful in removing the targeted species, further efforts targeting the removal of White Sucker and Bullhead were conducted in 1990, 1991, 1993, and 1999, and those were more successful. Whether or not these removals had any impact on the fishery of Lake Missaukee is unclear. O'Neal (2012) stated that "manual removals of White Sucker and Bullhead in this lake do not appear to have affected other species in Lake Missaukee". He recommended that these removal efforts be discontinued.

Fall electrofishing surveys targeting juvenile Walleye were conducted in 1993 and 1994. Both surveys documented the presence of age-0 Walleye, although the 1994 survey found a larger number. However, 1993 was not a stocking year, leading Fisheries Biologist Tom Rozich to the conclusion that the age-0 Walleye found in 1993 were naturally reproduced. To further examine Walleye in Lake Missaukee, a mark and recapture netting survey was conducted in the spring of 1994 to establish a population estimate of Walleye in the lake. However, the survey analysis was never completed, and no

population estimate was made. It is likely that not enough marked fish were recaptured during the study to produce a population estimate.

Another fall electrofishing effort targeting juvenile Walleye was conducted on September 20, 2000 (Phillips 2001). The survey was only moderately successful due to heavy winds, rain, and turbid water that made it difficult to see stunned fish while shocking. Only three age-0 Walleye were caught, although 13 age-2 Walleye were caught along with some older Walleye.

A comprehensive survey of Lake Missaukee was conducted in 2004 (O'Neal 2012). The 2004 survey documented good populations of panfish including Bluegill, Pumpkinseed Sunfish, and Black Crappie. Good numbers of Largemouth Bass were also caught. Walleye, Northern Pike, and Smallmouth Bass were also found in acceptable numbers; however, Yellow Perch were less abundant and were mostly small. Growth rates were good for the panfish species and Walleye. Largemouth and Smallmouth Bass were growing more slowly, but the population structure was good with multiple year classes present and plenty of legal fish (> 14 inches) available for anglers. O'Neal's management recommendations included continuing to stock Walleye at a rate of 50/acre every other year. He also recommended continuation of the "no minimum size limit" regulation for Northern Pike.

Since 1994, a total of 18 exceptional fish caught by anglers from Lake Missaukee have been entered in the MDNR Fisheries Division Master Angler program. Master Angler species caught from Lake Missaukee have included Bluegill, Largemouth Bass, Pumpkinseed Sunfish, Brown Bullhead, Northern Pike, and Smallmouth Bass (Table 3). Bluegill was the most numerous species entered, with 9 entries.

Current Status

The most recent fisheries surveys of Lake Missaukee were conducted in 2017 and 2018. On November 8, 2017, an electrofishing effort was conducted targeting juvenile Walleye. This effort was similar to the previous fall Walleye surveys conducted in 1993, 1994, and 2000 (Phillips 2001) and was conducted using methods established by Ziegler and Schneider (2000). In this survey, a total of 46 Walleye were caught. Of those, 45 were between 6 and 8 inches and belonged to the 2017-year class (Table 4). This resulted in catch rates of 11.1 age-0 Walleye per mile of shoreline and 22.5 Walleye per hour of electrofishing. Only one other Walleye was caught, a 13-inch fish that belonged to the 2015-year class.

The most recent comprehensive fisheries survey of Lake Missaukee was conducted in May and June of 2018. Fish sampling was conducted with trap nets, large-mesh fyke nets, small-mesh fyke nets, inland gill nets, minnow seines, and electrofishing gear. The netting portion of the survey occurred from June 14 through June 18, and the electrofishing and seining portion was completed on June 20.

A total of 2,566 fish representing 18 different species were caught in the netting portion of the 2018 survey (Table 5). Cold water temperatures prior to the survey resulted in lower catches than expected for some species, panfish in particular. Both numerically and by weight, the catch was dominated by Brown and Yellow Bullheads. When combined, the bullhead species comprised 65.5% of the catch numerically and 62.4% by weight.

Black Crappie were the most abundant panfish in the survey, with 222 from 5 to 12 inches caught. Other panfish species caught included Bluegill (147 individuals ranging from 1 to 9 inches), Pumpkinseed Sunfish (102 caught ranging from 1 to 9 inches in length), and Rock Bass (76 caught ranging from 2 to 9 inches). Largemouth Bass were the most numerous predator species caught in the survey, with 59 individuals ranging from 2 to 18 inches in size. Smallmouth Bass were represented by 32 individuals ranging from 9 to 18 inches in length. Northern Pike ranged from 15-30 inches in length, with 17 individuals caught. A total of 43 Walleye were also caught, ranging from 13 to 28 inches in length.

Growth for most species caught in the netting portion of the 2018 survey was satisfactory (Table 6). Although Bluegill, Largemouth Bass, and Northern Pike were growing slightly slower than the State of Michigan average, that is not uncommon for northern Lower Peninsula lakes. Walleye, Pumpkinseed Sunfish, Rock Bass, and Smallmouth Bass were all growing faster than the State average. Walleye from the 2016- and 2013- year classes were well-represented in the survey, and those year classes were growing 2.4 inches faster than the State average.

A total of 644 fish were caught in the seining/electrofishing portion of the 2018 survey (Table 7). The majority of those were Mimic Shiners, Sand Shiners, and Bluntnose Minnows caught by seining. Yellow Perch, which were not caught in the netting portion of the survey, but were caught in both the electrofishing and seining efforts. Lower numbers of panfish and gamefish species were collected in this portion of the survey, although smaller individuals from younger year classes were caught. These younger, smaller fish are typically not caught in trap, large mesh fyke, or inland gill nets. For example, six Walleye from 7 to 8 inches were caught by electrofishing. Of the fish caught by seining, only enough Bluegill, Walleye, and Yellow Perch were caught to analyze age and growth (Table 8). Age-3 Bluegill were growing 1.2 inches slower than the State average, while age-1 and age-2 Yellow Perch were growing 0.7 inches slower. Age-1 Walleye were growing near the State average.

Shoreline data were collected on August 3, 2018 (Table 9). Lake Missaukee had 21.7 docks/km, 26.8 dwellings/km, 41.3% shoreline armoring, and 0.3 submerged trees/km. Lake Missaukee is heavily-developed with cottages and residences along most of its shoreline. Compared to other shallow, medium-sized lakes in Michigan, Lake Missaukee is far above-average for its number of docks and dwellings and is far below average for its number of submerged trees (Wehrly et al. 2015).

Analysis and Discussion

The 2018 fisheries survey showed that the panfish populations of Lake Missaukee remain strong. Although overall catch numbers were somewhat low, that was likely due to colder than average temperatures in the days before the survey. Angler reports remain good and growth rates on the three primary panfish species (Black Crappie, Bluegill, and Pumpkinseed Sunfish) fell well within acceptable ranges. It is interesting to note that the 2012-year class was strongly represented in most of the Lake Missaukee centrarchid species, including Black Crappie, Bluegill, Largemouth Bass, Pumpkinseed Sunfish, and Rock Bass (Table 6). Late winter and spring of 2012 were abnormally warm, and the summer of 2012 was also relatively warm.

The Walleye population of Lake Missaukee is currently robust and exhibiting good growth rates (Table 6). There was a stocking gap from 2005-2010 due to concerns over the potential spread of Viral Hemorrhagic Septicemia from stocking. Eventually those concerns were alleviated, and stocking

resumed in 2011. In the late 2000s and early 2010s we received calls from concerned anglers regarding poor Walleye fishing. However, stocking throughout the 2010s seems to have bolstered the population and restored the fishery. While some natural reproduction has been documented in the past, stronger year classes have typically been linked with stocking. The fall 2017 and spring 2018 surveys documented good numbers of Walleye from the 2017 (stocked), 2016 (natural reproduction), and 2013 (stocked) year classes. In addition to providing a popular fishery, the Walleye likely play a role in maintaining good growth and population structure for the Bluegill fishery in Lake Missaukee. Schneider (1997) showed that adult Walleye can heavily influence Bluegill populations and keep them from stunting.

The Largemouth Bass and Smallmouth populations of Lake Missaukee remain strong and are a major draw for anglers. The 2018 survey showed consistent recruitment of these species, with individuals present from many different year classes. Although Largemouth Bass were growing a bit slow, large individuals approaching the 20-inch class were present. Lake Missaukee is an extremely popular lake for bass tournaments, with nine different bass tournaments registered on Lake Missaukee in 2018 (MDNR unpublished data).

Although the Northern Pike catch in the 2018 survey was somewhat low numerically, they were growing well and more than half of those caught exceeded 24 inches in length. Northern Pike recruitment appears to be consistent, with six different year classes represented. Angler reports for Northern Pike remain positive, with the occasional very large (> 40 inches) fish taken. Ice fishing for Northern Pike is very popular among anglers that spear fish and by those fishing with tip-ups.

The 2018 survey (combining the netting, seining, and electro-fishing portions) detected the most species on record (Table 2). Only Blacknose Shiner, Bowfin, and Johnny Darter had been detected in previous surveys and were not detected in the 2018 survey, and each of those had only been detected once previously. New species encountered in 2018 that had not been previously documented in Lake Missaukee included Fathead Minnow and Golden Shiner.

Management Direction

The Walleye fishery of Lake Missaukee is extremely popular with anglers, and the stocked Walleye are likely helping to keep the Bluegill population in good condition. While some fish from unstocked years were present in the 2018 survey catch, the bulk of the catch came from stocked years. If stocking was halted, Walleye would likely persist at a low level through natural reproduction but would not provide the fishery desired by anglers or the benefits realized in other species. Therefore, Walleye fingerlings should continue to be stocked into Lake Missaukee to maintain the Walleye fishery. The stocking rate should be 53/acre, or 100,000 spring fingerlings on an every-other-year basis. Lake Missaukee was most recently stocked in 2017, so the next stocking event should occur in 2019.

Since 1990, Lake Missaukee has had a "no minimum size limit" regulation (five fish per day harvest limit, with no more than one over 24 inches) for Northern Pike. Since then, the Northern Pike population has been relatively stable, and anglers have shown no desire to change the regulation. Previous fisheries surveys (O'Neal 2012) have shown some variation in growth rates depending on the size of a particular year class. Despite this, Lake Missaukee continues to provide excellent Northern Pike fishing, with some trophy potential. Therefore, the "no minimum size limit" regulation should remain in place for the foreseeable future.

Common Carp, which were mentioned as possibly present by Perry (1942; although he did not actually catch any), have never been officially documented in Lake Missaukee. There have been several recent reports of sightings of Common Carp, but none have ever been caught in MDOC/MDNR fisheries surveys of the lake, including the 2018 survey. Common Carp are an invasive species that could have negative effects on native fish populations, should they become established in Lake Missaukee. If any are caught by anglers, they should be removed and disposed of.

Another comprehensive fisheries survey should be conducted within the next ten years to monitor the fish populations of Lake Missaukee. In particular, the Walleye population should be targeted to assess the effectiveness of the Walleye stocking program. In addition, fall electrofishing surveys following the protocols outline by Ziegler and Schneider (2000) should be conducted in years when Walleye are stocked into Lake Missaukee. Other goals of future fisheries surveys should include further assessment of panfish, Largemouth Bass, and Northern Pike populations. Creel census should also be conducted on Lake Missaukee. Creel census data would help to estimate the economic value of the Lake Missaukee fishery to the local economy.

Eurasian milfoil will likely continue to require treatment, at least in some years. We recommend continued small-scale spot chemical treatments for dealing with the Eurasian milfoil, but only when absolutely necessary. We also recommend that native plants not be treated. A healthy aquatic plant community is critical to healthy fish communities. Many of the desired fish species in Lake Missaukee, including Walleye, Northern Pike, Largemouth Bass, Bluegill, Black Crappie, Pumpkinseed Sunfish, and Yellow Perch, require healthy native aquatic plant communities.

The remaining riparian wetlands adjacent to Lake Missaukee should be protected and considered critical to the continued health of the lake's aquatic community. The Lake Missaukee shoreline is already more developed than most other lakes in Michigan. Future unwise riparian development and wetland loss may result in further deterioration of the water quality and aquatic habitat. Healthy biological communities in inland lakes require suitable natural habitat. Human development within the lake watershed and along the shoreline has a tendency to change and diminish natural habitat. Guidelines for protecting fisheries habitat in inland lakes can be found in Fisheries Division Special Report 38 (O'Neal and Soulliere 2006). The 2016 installation of woody structure in the lake was a positive step toward improving fish habitat, but more can be done. In particular, the shoreline of Lake Missaukee should be improved through softening and restoring native plant communities. The Michigan Natural Shoreline Partnership (http://www.mishorelinepartnership.org/) is an excellent resource for restoring critical shoreline habitat.

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Table 1. Fish stocked in Lake Missaukee, Missaukee County, 1905-2018.

Year	Species	Number	Size	Strain
1905	Largemouth Bass	2,000	adv. Fingerlings	
	Walleye	150,000	fry	
1909	Largemouth Bass	3,000	fingerlings	
	Smallmouth Bass	3,000	fingerlings	
1910	Walleye	80,000	fry	
	Yellow Perch	800	fingerlings	
1934	Walleye	400	adult	
1935	Great Lakes Shiners	500,000		
	Walleye	337	adult	
	Walleye	240,000	fry	
1936	Great Lakes Shiners	10,000		
	Walleye	200	adult	
	Walleye	330,000	fry	
1937	Walleye	525,000	fry	
	Yellow Perch	10,000	7 months	
1938	Bluegill	20,000	5 months	
	Walleye	460,000	fry	
	Yellow Perch	20,000	7 months	
1939	Yellow Perch	60,000	7 months	
1940	Bluegill	400	yearlings	
	Smallmouth Bass	1,500	7 months	
	Walleye	160,000	fry	
1941	Bluegill	15,000	4 months	
	Yellow Perch	7,500	7 months	
1970	Walleye	100	fingerlings	
1971	Walleye	20,000	fry	
1972	Walleye	3,700	spring fingerlings	
1974	Walleye	188,000	spring fingerlings	
1975	Walleye	102,700	spring fingerlings	
1977	Walleye	52,913	spring fingerlings	
1980	Walleye	100,735	spring fingerlings	
1985	Walleye	5,750	spring fingerlings	
1988	Walleye	60	spring fingerlings	
1989	Walleye	43,366	spring fingerlings	
1990	Walleye	122,988	spring fingerlings	
1991	Walleye	112,986	spring fingerlings	
1992	Walleye	3,000	spring fingerlings	
1994	Walleye	75,028	spring fingerlings	Muskegon
1996	Walleye	67,157	spring fingerlings	Muskegon
1998	Walleye	60,098	spring fingerlings	Muskegon
2000	Walleye	79,734	spring fingerlings	Muskegon
2001	Walleye	61,992	spring fingerlings	Muskegon
2003	Walleye	50,900	spring fingerlings	Muskegon
2004	Walleye	58,293	spring fingerlings	Muskegon
2010	Walleye	132	fall fingerlings	Muskegon
2011	Walleye	100,918	spring fingerlings	Muskegon
2013	Walleye	148,586	spring fingerlings	Muskegon

Table 1, continued

2015	Walleye	99,039	spring fingerlings	Muskegon	
2016	Walleye	117	fall fingerlings	Muskegon	
2017	Walleye	99,049	spring fingerlings	Muskegon	

Table 2. Presence/absence of fish species in historical fisheries surveys of Lake Missaukee, Missaukee County.

Species	1927	1939	1941	1965	1975	1976	1977	1987	1994	1999	2004	2017	2018
Banded Killifish		x	x										x
Black Bullhead											x		x
Black Crappie				x	x	x	x		x		x		x
Blacknose Shiner			x										
Bluegill		x	x	x	x	x	x	x	x		x		x
Bluntnose Minnow	x	x	x								x		x
Bowfin										x			
Brown Bullhead					x						x		x
Bullhead spp.				x		x	x	x	x	x			
Common Shiner			x										x
Fathead Minnow													x
Golden Shiner													x
Hybrid Sunfish			x										x
Johnny Darter	x												
Iowa Darter	x												x
Largemouth Bass		x	x	x	x	x	x		x		x		x
Mimic Shiner	x	x	x								x		x
Northern Pike		x	x	x	x	x	x	x	x	x	x	x	x
Pumpkinseed			x	x	x	x	x		x		x	x	x
Rock Bass		x	x	x	x	x	x	x	x		x		x
Sand Shiner									x				x
Smallmouth Bass	x	x	x	x	x	x	x	x		x	x	x	x
Walleye		x		x	x	x	x	x	x	x	x	x	x
White Sucker	x		x	x	x	x	x	x	x	x	x	x	x
Yellow Bullhead					x						x		x
Yellow Perch	x	x	x	x	x	x	x		x		x	x	x

Table 3. Michigan DNR Master Angler awards issued for fish caught from Lake Missaukee, Missaukee County, Michigan, 1994-2018.

Species	Number of Master Angler awards issued
Bluegill	9
Pumpkinseed Sunfish	4
Largemouth Bass	2
Brown Bullhead	1
Northern Pike	1
Smallmouth Bass	1
Total:	18

Table 4. Results of a fall electrofishing effort targeting Walleye on Lake Missaukee on November 8, 2017, Missaukee County, Michigan.

Lake Missaukee acreage	1,880
Miles of shoreline sampled:	4.05
Hours of electrofishing:	2.0
Water temperature:	40.2°F

Year Class	Age	# Walleye captured	Catch Rate (# Walleye/mile of shoreline sampled)	Catch Rate (# Walleye/hour of electrofishing)
*2017	0	45	11.11	22.50
*2015	2	1	0.25	0.5

*stocked year class

Table 5. Number, weight, and length of fish collected from Lake Missaukee with trap nets, large mesh fyke nets, small mesh fyke nets, and inland gillnets, May 14-17, 2018.

Species	Number	Percent by number	Weight (pounds)	Percent by weight	Length range (inches)[1]	Average length	Percent legal size[2]
Banded Killifish	2	0.4	0.0	0.0	1-2	2	
Black Crappie	222	2.1	115.8	7.2	5-12	9.6	99 (7")
Bluegill	147	5.7	18.8	1.2	1-9	4.3	31 (6")
Bluntnose Minnow	128	5.0	1.3	0.1	1-3	2.9	
Brown Bullhead	173	6.7	183.5	11.4	11-14	13.2	100 (7")
Common Shiner	10	0.4	0.1	0.0	1-3	2.4	
Golden Shiner	1	0.0	0.1	0.0	5-5	5.5	
Hybrid Sunfish	1	0.0	0.7	0.0	9-9	9.5	100 (7")
Iowa Darter	7	0.3	0.0	0.0	1-2	2.2	
Largemouth Bass	59	2.3	77.0	4.8	2-18	13.2	34 (14")
Mimic Shiner	5	0.2	0.0	0.0	2-3	2.7	
Northern Pike	17	0.7	61.8	3.9	15-30	24.8	59 (24")
Pumpkinseed Sunfish	102	4.0	44.6	2.8	1-9	7.8	69 (6")
Rock Bass	76	3.0	29.8	1.9	2-9	7.9	96 (6")
Smallmouth Bass	32	1.2	52.7	3.3	9-18	14.4	59 (14")
Walleye	43	1.7	98.5	6.1	13-28	18.3	72 (15")
White Sucker	33	1.3	100.6	6.3	9-23	19.1	
Yellow Bullhead	1508	58.8	817.8	51.0	8-12	10.4	100 (7")
Total	2,566	94	1603.1	100			

[1]Note some fish were measured to 0.1 inch, others to inch group: e.g., "5"=5.0 to 5.9 inch, 12=12.0 to 12.9 inches; etc.

[2]Percent legal size or acceptable size for angling. Legal size or acceptable size for angling is given in parentheses.

Table 6. Average total weighted length (inches) at age, and growth relative to the state average, for fish sampled from Lake Missaukee with trap nets, large mesh fyke nets, small mesh fyke nets, and inland gill nets, May 14-18, 2018. Number of fish aged is given in parenthesis. A minimum of five fish per age group is statistically necessary for calculating a Mean Growth Index, which is a comparison to the State of Michigan average.

Species	Age I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Mean Growth Index
Black Crappie		5.5 (2)	7.9 (17)	7.7 (7)	9.8 (4)	10.6 (18)	11.3 (3)						0
Bluegill	1.7 (10)	2.4 (10)	3.2 (10)	6.2 (2)	7.4 (12)	8.0 (10)	9.0 (2)	9.2 (2)					-0.4
Largemouth Bass	2.6 (2)		10.4 (3)	10.2 (3)	13.5 (6)	13.1 (13)	14.5 (7)	14.2 (4)	15.2 (2)	16.9 (2)		18.9 (1)	-1.0
Northern Pike		15.9 (1)	20.7 (2)	24.4 (2)	27.1 (6)	20.6 (1)	26.9 (5)						-0.4
Pumpkinseed Sunfish	1.5 (1)	2.7 (2)	3.6 (1)	4.5 (2)	7.5 (11)	8.1 (13)	8.6 (4)	9.0 (1)					+1.4
Rock Bass	2.5 (1)		4.8 (3)	6.7 (12)	7.3 (8)	8.7 (10)	8.8 (2)	9.4 (4)	8.6 (1)				+0.6
Smallmouth Bass		9.6 (1)	10.6 (3)	12.5 (7)	14.8 (5)	14.0 (3)	14.6 (4)	16.4 (1)	17.0 (3)	17.6 (3)	16.9 (1)		+0.2
Walleye		14.0 (12)	15.9 (4)		18.7 (15)	19.7 (1)	22.6 (2)	19.5 (1)			24.8 (2)		+2.4

Table 7. Number, weight, and length of fish collected from Lake Missaukee with seining and electrofishing, June 20, 2018.

Species	Number	Percent by number	Weight (pounds)	Percent by weight	Length range (inches)[1]	Average length	Percent legal size[2]
Banded Killifish	1	0.4	0.0	0.0	2-2	2.5	
Bluegill	46	7.1	1.5	3.2	2-7	4.0	13 (6")
Bluntnose Minnow	80	12.4	0.7	1.5	2-3	2.8	
Fathead Minnow	1	0.2	0.0	0.0	1-1	1.5	
Hybrid Sunfish	4	0.6	0.9	1.9	3-9	5.7	25 (7")
Largemouth Bass	17	2.6	18.2	39.1	3-19	11.9	18 (14")
Mimic Shiner	126	19.6	0.6	1.3	1-3	2.5	
Pumpkinseed Sunfish	9	1.4	2.2	4.7	4-8	6.3	44 (6")
Rock Bass	9	1.4	2.4	5.2	3-8	6.7	78 (6")
Sand Shiner	256	39.8	1.3	2.8	1-2	2.5	
Smallmouth Bass	11	1.7	8.1	17.4	3-19	9.4	18 (14")
Walleye	6	0.9	1.1	2.4	7-8	8.3	0 (15")
White Sucker	24	3.7	0.0	0.0	1-1	1.5	
Yellow Bullhead	18	2.8	8.6	18.5	8-10	10.0	100 (7")
Yellow Perch	36	5.6	1.0	2.1	1-6	3.8	0 (7”)
Total	644	100	46.6	100			

[1]Note some fish were measured to 0.1 inch, others to inch group: e.g., "5"=5.0 to 5.9 inch, 12=12.0 to 12.9 inches; etc.

[2]Percent legal size or acceptable size for angling. Legal size or acceptable size for angling is given in parentheses.

Table 8. Average total weighted length (inches) at age, and growth relative to the state average, for fish sampled from Lake Missaukee with electrofishing and seining, June 20, 2018. Number of fish aged is given in parenthesis. A minimum of five fish per age group is statistically necessary for calculating a Mean Growth Index, which is a comparison to the State of Michigan average.

Species	Age I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Mean Growth Index
Bluegill			4.1 (7)	4.4 (3)	6.1 (4)								-1.2
Largemouth Bass	3.3 (1)	7.2 (1)	9.9 (4)	10.4 (2)	12.9 (1)	14.7 (2)	11.1 (1)					19.6 (1)	--
Pumpkinseed Sunfish			4.5 (2)	5.2 (2)	6.1 (2)		7.2 (1)						--
Rock Bass		3.7 (2)											--
Smallmouth Bass	3.8 (2)	7.9 (4)	10.0 (3)	14.9 (1)							19.7 (1)		--
Walleye	8.3 (6)												+0.1
Yellow Perch	3.6 (10)	4.7 (10)		6.7 (1)									-0.7

Table 9. Shoreline data for Lake Missaukee, Missaukee County, compared with that for other large, shallow depth lakes in Michigan (from Wehrly et al. 2015). Sampling was conducted by MDNR Fisheries personnel in August, 2018.

	Total docks per km	Dwellings per km	Percent shoreline armoring	Submerged trees per km
Lake Missaukee	21.7	26.8	41.3	0.3
Michigan statewide average for large, shallow depth inland lakes	8.9	11.5	28.4	17.3