**Pickerel Lake**
Newaygo County, 12N 13W Sec. 1, 12
Muskegon River Watershed, last surveyed 2017

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## Environment

Pickerel Lake is a 318-acre natural lake in southern Newaygo County, approximately 2 miles north of Newaygo, Michigan. Pickerel Lake is irregularly shaped, with five different basins. Each of the basins are at least 37 feet deep, and the deepest is approximately 73 feet deep. Pickerel Lake has approximately 5.5 miles of shoreline and averages 28.2 feet in depth (Jones 2017). The lake substrate is mostly sand, with silty sand and detritus in the weedy shoreline areas. The shoreline is highly developed with many homes surrounding the lake, with only a few areas of undeveloped shoreline. The geography in the immediate vicinity of Pickerel Lake is hilly and forested, with predominantly sandy soils. To the west however, the landscape is heavily managed for agriculture.

Pickerel Lake lies in the Penoyer Creek subwatershed of the Muskegon River watershed. The subwatershed begins with the outflows of several small natural lakes including Peck Lake, Ford Lake, and Harmson Lake, which all have outlets that flow into Ryerson Lake. The outflow from Ryerson Lake (locally known as "Sandbar Creek") flows into Kimball Lake, which then flows directly into Pickerel Lake. The outflow from Pickerel Lake joins the outflow from Sylvan and Emerald Lakes just downstream of the Pickerel Lake outlet to form Penoyer Creek. The land in the upper portion of the watershed is primarily agriculture, with some of the streams having very little in the way of buffer strips. The immediate Kimball/Pickerel Lakes watershed is approximately 9,100 acres in size (Jones 2017). In addition to the Kimball Lake outflow, there is one other small unnamed stream that flows into the north shore of Pickerel Lake.

Public access to Pickerel Lake is available at an MDNR boat launch on the southern shore of the lake. The site has parking for 8 vehicles and trailers. Emerald (83 acres), Kimball (153 acres), and Sylvan (113 acres) Lakes do not have public launches on them; however, all have navigable channels that connect them to Pickerel Lake. The lakes drain into Penoyer Creek through a channel at the southeast end of Emerald Lake. A dam on Penoyer Creek has regulated lake levels in this system since at least the early 1950s. The dam is approximately 4.5 ft in height and the Newaygo County Drain Commissioner presently regulates water levels between the elevations of 760.0 ft during summer and 759.5 ft during winter (O'Neal 2009 and 2010). A sewer system was installed in 2002 which provides service to most of the residences on Sylvan, Emerald, Pickerel, and Kimball lakes (O'Neal 2009 and 2010).

Riparian ownership on Pickerel Lake is mostly private, except for the MDNR public boat launch site. Camp Newaygo, a summer camp for children, comprises 104 acres with significant frontage on the eastern shore of the lake. Little Switzerland Resort and Campground, which offers camping and rental cottages, is located on the southern shore of the lake.

Penoyer Creek is a Designated Trout Stream with a self-sustaining population of Brook Trout. It flows into the Muskegon River through an old abandoned industrial facility, and its outlet is "perched" by

approximately 10 feet. This prevents migratory fish such as Chinook Salmon or Steelhead from accessing Penoyer Creek. In addition to the structure that controls the levels of the Pickerel Lake chain, there are several other dams on Penoyer Creek. Penoyer Creek is unique in that the only salmonid species it hosts is Brook Trout. Most other area trout streams also have Brown Trout, which tend to be dominant over Brook Trout.

Because it has extensive shallow areas, Pickerel Lake has an abundance of aquatic vegetation. In the past, there have been problems with Eurasian milfoil and other nuisance aquatic vegetation. Pickerel Lake has also had issues with extensive mats of filamentous algae throughout the lake. Excessive Eurasian milfoil in inland lakes can lead to several fisheries problems including poor growth and stunting for a number of important species, in addition to interfering with other popular activities including boating, waterskiing, and swimming. Both the aquatic vegetation and the filamentous algae is likely due at least in part to the agricultural nature of the watershed upstream of Kimball and Pickerel Lakes. According to Jones (2017), "Both Pickerel and Kimball Lakes exhibit signs of internal loading of phosphorous". It is highly likely that the excess phosphorous is coming off agricultural fields located further upstream in the subwatershed. Also, in the summer both lakes experience oxygen depletion at depths greater than 13 feet (Jones 2017).

The first permit issued by the Michigan Department of Environmental Quality (MDEQ) for aquatic nuisance treatment on Pickerel Lake was issued to a single resident in 1994. In 1997, the first permit for lake-wide chemical treatment (primarily for Eurasian milfoil) was issued by MDEQ (Ryan Crouch, MDEQ, personal communication). The 1997 treatment was highly controversial, with some riparian landowners being strongly opposed to the chemical treatment, which was conducted over their objection. Since that first effort in 1997, chemical treatments have been conducted each year since. The most recent permit from MDEQ for chemical treatment of aquatic nuisance macrophytes (issued in April 2019) allows for the treatment of up to 99 acres of the lake but does not specify the chemicals to be used or the species to be targeted.

The primary citizen group for Pickerel Lake is the P-K Lakes Association (PKLA), referring to Kimball and Pickerel lakes. Although the date of its creation is unknown, the PKLA has been advocating for the lakes since at least the 1950s (Bill Alsover, PKLA, personal communication). There is also a Pickerel Lake Improvement Board (PLIB) that oversees the fund created by taxes on lakefront landowners. The funds are used primarily for chemical control of aquatic nuisance plants and algae. The PLIB was formed in 2011 (Bill Alsover, PKLA, personal communication).

## History

The first recorded fish stocking of Pickerel Lake took place in 1874, when Lake Whitefish were stocked by the Michigan Fishery Commission (MFC; Table 1). The next recorded stockings were in 1896 and 1897 when Smallmouth Bass and Lake Trout were stocked. However, an 1892 report by the MFC (MDNR files, Cadillac) mentions that "Wall Eyed Pike has been planted there but failed to catch any". Therefore, it is likely that further stockings were conducted between 1874 and 1892, but the records no longer exist. The first "official" record of Walleye being stocked into Pickerel Lake was in 1905. Unfortunately, stocking records between 1910 and 1934 were lost in a fire. From 1934 through the mid-1940s, species stocked included warmwater/coolwater gamefish and panfish like Bluegill, Largemouth Bass, Smallmouth Bass, Yellow Perch, and Walleye (Table 1). Between 1934 (likely prior to that as well) and 1950, the stocked Walleye were adults that were captured from the spring

spawning run in the Muskegon River below Croton Dam (Eschmeyer 1947). From 1954 to 1956, Rainbow Trout were stocked. Brook trout were stocked once in 1965, and Brown Trout once in 1971.Walleye had been stocked on a somewhat regular basis from 1905-1954 but then were not stocked again until 1987. Since then, Walleye have been stocked into Pickerel Lake on a regular basis (Table 1). From 1987- 2017, all stocked Walleye were spring fingerlings. Fall fingerlings were stocked for the first time in 2018.

In the first half of the 20th century, Pickerel Lake was regularly stocked with adult Walleye taken from the Muskegon River below Croton Dam. Several other Newaygo County lakes also received adult Walleye stockings from the Muskegon River. According to Eschmeyer (1947), Pickerel Lake provided the best returns of all the lakes stocked. A tagging study conducted by Eschmeyer documented that Walleye "apparently move freely about among the north lakes (Pickerel, Kimball, Emerald, and Sylvan)".

There is little discussion in the file (Cadillac Office) regarding the trout stockings that occurred in the mid- 1900s (Table 1). One file correspondence from MDOC Fisheries Biologist Bill Bullen mentions that "trout plantings in the past have been unsuccessful and from lakefront owners the opinion is that they migrated out of the lake towards the Muskegon River". It is also likely that Northern Pike preyed heavily on the stocked trout. In any case, no trout have been stocked into Pickerel Lake since 1971.

Starting in 1969, there is considerable discussion in the file about stunted Bluegill and a distinct lack of predators in the lake. MDOC Biologists proposed to conduct a Bluegill "thinning" treatment with Antimycin (a fish toxicant), but the treatment was never conducted.

Cisco (also known as Lake Herring) are listed as a State-threatened species in Michigan. They were historically found in Pickerel Lake and were caught in MDNR/MDOC fisheries surveys through 1984 (Table 2). However, in the fall of 1986, there was a very large rain event in the area that caused significant mortality of Cisco in Pickerel Lake. After the rain event, residents noted large numbers of dead Cisco washing up on the shores of Pickerel Lake. It is likely that the massive rainfall washed excess nutrients off upstream agricultural fields and into the lake, creating an oxygen depletion issue which resulted in the Cisco fish kill. Cisco have not been reported by anglers or caught in any MDNR fisheries surveys since then.

In 2016, due to angler complaints regarding overabundant small Northern Pike and poor growth rates, managers removed the minimum size limit on Northern Pike and changed the bag limit to five per day. In addition to Pickerel Lake, the other lakes in the chain (Emerald, Kimball, and Sylvan) were also included in this regulation change.

Since 1994, a total of 58 exceptional fish caught from Pickerel Lake have been entered in the MDNR Fisheries Division Master Angler program. Master Angler species caught from Pickerel Lake have included Bluegill, Yellow Bullhead, Rock Bass, Black Crappie, Largemouth Bass, Pumpkinseed Sunfish, Black Bullhead, Brown Bullhead, and Smallmouth Bass (Table 3). Bluegill was the most numerous species entered, with 24 entries.

Historical Fisheries Surveys

The first fisheries survey of Pickerel Lake was conducted by the Michigan Fish Commission in 1892 (MDNR files, Cadillac). Gill nets were used in the survey. Species recorded as caught included Bluegill, Yellow Perch, Rock Bass, "Black Bass" (likely Largemouth Bass), and "Pickerel" (likely Northern Pike). The author recommended the stocking of Walleye and Smallmouth Bass.

In response to angler complaints regarding a supposed declining fishery in Pickerel Lake, a seine survey was conducted in 1945 (Cooper 1945). The survey consisted of a number of seine hauls, resulting in large catches of Largemouth Bass and panfish. Cooper concluded that the fish populations of Pickerel Lake were adequate, and that stocking of native species like Largemouth Bass or panfish was not warranted.

In 1947, another fisheries survey of Pickerel Lake was conducted by MDOC. This survey consisted of seine efforts, gill nets, and creel census (Eschmeyer 1947). The seine/gill net portions of the survey caught Bluegill, Yellow Perch, Northern Pike, Rock Bass, Black Crappie, Pumpkinseed Sunfish, Largemouth Bass, and Yellow Bullheads (Table 2). The creel census portion of the survey was primarily aimed at recovering tagged Walleye that had been stocked into Pickerel Lake. Anglers from Ohio, Florida, Indiana, and Illinois were reported in the creel census, as well as anglers from Michigan.

Another seine/gill net survey was conducted in 1952 by MDOC personnel. This survey had more effort than the 1947 survey, resulting in the documentation of 19 different fish species (Table 2). Although no report was ever completed, notes from the survey indicate that Pickerel Lake riparian landowners were upset at non-resident ice anglers, perceiving that they were harvesting too many Bluegill. Unfortunately, the gear used in the 1952 survey was not particularly conducive to catching adult Bluegill, so the survey was not able to confirm or deny the concerns of the landowners.

A series of surveys of Pickerel Lake were conducted MDOC personnel in 1967, 1968, and 1970. The 1967 survey was an electrofishing effort of 1.5 hours. The 1968 survey utilized fyke nets, and the 1970 survey utilized gill nets. Very few larger Bluegill were seen in these surveys. As a result, there was subsequent discussion about a possible chemical treatment to thin the panfish population, which would theoretically lead to better growth and population structure. However, no chemical treatment was never conducted on Pickerel Lake.

Another fisheries survey of Pickerel Lake was conducted by MDNR in 1984. The survey consisted of trap nets and inland gill nets. The survey documented an "excellent panfish population", according to Fisheries Biologist David Smith. He also mentioned that "Walleye are highly desired but rarely caught". Growth rates for panfish species in the 1984 survey were all right around the State average. The 1984 survey also marked the last time that Cisco were ever caught in a fisheries survey of Pickerel Lake.

The next fisheries surveys of Pickerel Lake were conducted in 1994 and 1995. The 1994 effort consisted of four trap nets and two inland gill nets but was conducted in October. This is odd, as most netting surveys are conducted in the spring. No report was produced from the survey, and the catch was relatively sparse. The 1995 survey consisted of two different efforts aimed at estimating the Walleye population of Pickerel Lake. The first effort took place in April and consisted of 28 trap net lifts. During this effort, all Walleye caught were marked with a fin clip and released. The second effort was in June and consisted of ten trap net lifts. All fish were counted in both efforts. The survey

resulted in a population estimate of 2.6 Walleye per acre. According to Hanchin (2017), the average Walleye population for large Michigan lakes was approximately 3.0 Walleye per acre, so the Pickerel Lake population estimate was comparable (although the surveys described by Hanchin had considerably more effort than the 1995 Pickerel Lake survey). The 1995 Pickerel Lake survey also documented survival from multiple stocked Walleye year classes, and even some Walleye from non-stocked year classes. The survey also showed robust populations of adult Largemouth Bass and Northern Pike.

## Current Status

The most recent comprehensive fisheries surveys of Pickerel Lake were conducted in 2017. This survey consisted of netting, electrofishing, and habitat evaluation and was conducted in the spring/summer of 2017. In this survey, fish were sampled 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 May 15 through May 19, and the electrofishing and seining portion was completed on June 19. Surface water temperatures ranged from 63.5F to 67.1F during the netting portion of the survey and was 77.5F during the electrofishing portion of the survey. Habitat evaluation and water chemistry data was collected on August 24, 2017. Further sampling with gill nets was conducted from November 28 through December 1, 2017. This effort specifically targeted cisco, although other species caught were also recorded.

In the May netting portion of the 2017 survey, a total of 539 fish were caught, representing 13 different species (Table 4). Rock Bass were the most frequently collected species in the survey, with 163 caught ranging in size from 2 to 12 inches. Other panfish species caught included Black Crappie (30 individuals ranging from 7 to 12 inches), Bluegill (82 caught from 1 to 10 inches), Pumpkinseed Sunfish (15 caught ranging from 2 to 8 inches), and Yellow Perch (8 caught ranging from 3 to 13 inches). Northern Pike were the most numerous predator species caught in the survey, with 58 individuals ranging from 11 to 28 inches in size. Largemouth Bass ranged from 8 to 19 inches in length, with 17 individuals caught. Thirteen adult Walleye were also caught, ranging from 15 to 25 inches in length. Yellow Bullhead were also very abundant in the 2017 survey, with 116 individuals caught.

All species (except for Northern Pike) captured during the netting portion of the 2017 survey (Table 5) were growing substantially better than the state average length at age. In particular, Black Crappie, Bluegill, Rock Bass, and Walleye were all growing well. Although Northern Pike were growing more slowly than the other species, they were only 0.7 inches below the State average length at age. There were not enough Yellow Perch collected during the 2017 survey to make inferences regarding growth rates.

Another 729 fish representing 18 species were caught in the June 19 electrofishing/seining effort (Table 6). Bluegill and Yellow Perch were the most numerous species represented in this portion of the survey. Largemouth Bass were also better represented in this portion of the survey, with 67 individuals caught from 1 to 18 inches in length. Growth rates for individuals caught from these efforts were slightly slower than fish sampled in May (Table 7).

The final component of the 2017 Pickerel Lake fisheries survey was a fall 2017 inland gill net effort (Table 8). This part of the survey targeted Cisco, although other species caught were also recorded. A

total of 114 fish representing 9 species were caught in the gill nets. Northern Pike were by far the most numerous species, with 73 caught from 14 to 27 inches in length. No Cisco were caught.

Limnological and shoreline data were collected on August 24, 2017 (Tables 9 and 10). The limnological profile showed steady temperature and dissolved oxygen readings from the surface down to 15 feet. Below that, oxygen readings dropped abruptly, going from 8.29 ppm at 15 feet to 3.63 ppm at 18 feet and then 0 ppm at 21 feet (Table 9). The temperature also dropped below 15 feet, although the decline was not as abrupt as the dissolved oxygen. Pickerel Lake had 28.5 docks/km, 20.0 dwellings/km, 48.8% shoreline armoring, and 9.2 submerged trees/km. Pickerel Lake is heavily developed with cottages and residences along most of its shoreline. Compared to other deep, medium-sized lakes in Michigan and in the Central Lake Michigan Management Unit (CLMMU; basically, the northwestern portion of the Lower Peninsula), Pickerel Lake has an above-average number of docks and dwellings, and a high percentage of armored shoreline (Wehrly et al. 2015; Table 10).

During the 2017 fisheries survey, the DNR crew noted an extremely high abundance of filamentous algae, more than they had ever seen in a May fisheries survey. The field notes contain the following descriptions: "huge filamentous algae bloom"; "algae bloom is horrendous". When the survey nets were pulled from the lake after the survey was complete, they were loaded with algae and required extensive power washing to remove the algae. The survey field notes also contain the following quote: "Numerous people complaining about weed treatments".

In the summer of 2018, Environmental DNA (eDNA) sampling was conducted on Pickerel and Kimball Lakes. This was an additional effort to determine if Cisco remained in the lakes or if they were extirpated. No Cisco DNA was detected in any of the eDNA samples taken from either lake (Dr. Kim Scribner, Molecular Ecology Lab, Michigan State University, personal communication).

## Analysis and Discussion

In general, the 2017 MDNR fisheries survey of Pickerel Lake found healthy fish populations. Despite having issues with stunting in the past, the panfish populations of Pickerel Lake currently exhibit good size-structure. 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) were well within the acceptable range. Native predator species like Largemouth Bass and Northern Pike were well-represented in the catch and showed satisfactory growth rates. While not overly numerous, Walleye from seven different year classes were present in the catch. Most were stocked year classes, although several individuals were from non-stocked years. It is possible that low-level natural reproduction is occurring in some years.

Pickerel Lake remains an excellent destination for sport anglers. The panfish, Northern Pike, and Largemouth Bass populations remain strong and are a major draw for anglers. Angler reports for those species remain positive. Northern Pike are pursued in the winter through the ice by spear fishers and anglers fishing with tip ups. While perhaps not a "destination fishery" for Walleye, there are enough legal Walleye in Pickerel Lake that anglers should catch them if they target them. The panfish populations of Pickerel Lake also remain strong. This is likely due to the abundance of adult Walleye. Research (Schneider and Lockwood 1997) has shown that even a low population of adult Walleye can

have positive effects on Bluegill growth rates and population structure. In addition to providing such ecosystem benefits, Walleye are also popular with anglers and riparian landowners.

Although no Smallmouth Bass have ever been caught in any fisheries surveys of Pickerel Lake (including the 2017 survey), a Master Angler record from 2012 exists. Smallmouth Bass were stocked into Pickerel Lake in the early 1900s but have not been stocked since. It is possible or even likely that Smallmouth Bass are present within the watershed at least at a low level, and they occasionally wind up in Pickerel Lake. The Master Angler program is a voluntary program and catches are not necessarily verified, so it is possible that the entry was not accurate. Another curiosity of Pickerel Lake is the lack of White Sucker. White Suckers are very common in most northern Lower Peninsula lakes but have only occasionally been found in Pickerel Lake. None were caught in the 2017 survey.

One disappointment of the 2017 fisheries survey was the lack of Cisco in the catch. This was compounded by the lack of Cisco DNA in the 2018 eDNA sampling effort. It is highly likely that Cisco have been extirpated from Pickerel Lake. They were most likely extirpated in the fall 1986 rain event, as none have been caught in any fisheries surveys or reported by anglers since. A similar phenomenon was recorded for Lower Herring Lake in Manistee County. A Cisco die-off was noted by riparian landowners after a large rain event in 1955 (Tonello 2015; MDNR files, Cadillac office), and no Cisco have been captured in fisheries surveys or reported by anglers since. Latta (1995) commented that "the most common cause of extirpation in inland lakes is eutrophication with loss of the Cisco layer". Both the Pickerel and Lower Herring Lake watersheds have major agricultural influences in their headwaters. It is possible that the heavy rain events washed excessive nutrients into the watersheds (and therefore the lakes themselves), creating a heavy Biological Oxygen Demand (BOD) that reduced oxygen levels in the "Cisco layer" referred to by Latta (1995), resulting in a single-event extinction of the Cisco in each lake.

Aquatic nuisance weed treatments remain controversial on Pickerel Lake, based on comments received from the public during the 2017 survey. Also, the amount of filamentous algae in the lake during the survey was astounding. The presence of so much algae is likely due to an excess of nutrients in the lake, and possibly also due to weed treatments conducted in previous years. There needs to be a balance between the nutrients in the lake and the amount of aquatic plants in the lake. Without enough aquatic plants to utilize the existing nutrients in the lake, filamentous algae will continue to thrive in Pickerel Lake.

## Management Direction

The Walleye fishery in Pickerel Lake is extremely popular with riparian landowners and local anglers. In addition, the stocked Walleye are likely helping to keep the Bluegill population in good condition for anglers. While a few fish from unstocked years were present in the 2017 survey catch, the bulk of the catch came from stocked years. Therefore, Walleye fingerlings should continue to be stocked into Pickerel Lake to maintain the Walleye fishery. The stocking rate should be 50/acre, or 15,900 spring fingerlings on an every-other-year basis. Also, if fall fingerling Walleye become available, up to 3,200 (10/acre) can also be stocked on an every-other year basis, as an alternate to spring fingerlings. Survival from fall fingerlings is typically much higher than that of spring fingerlings; however, fall fingerlings are more difficult to rear. Pickerel Lake was most recently stocked with spring fingerlings in 2017, although it was supplemented with fall fingerlings in 2018 (Table 1). Therefore, the next stocking event (with spring fingerlings) should occur in 2019.

Another comprehensive fisheries survey should be conducted within the next ten years to monitor the fish populations of Pickerel Lake. In particular, the Walleye population should be targeted to assess the continued effectiveness of the Walleye stocking program. Other goals of future fisheries surveys should include continued monitoring of the panfish, Largemouth Bass, and Northern Pike populations.

The nutrient budget of Pickerel Lake should be closely examined. Possible sources of excess nutrients in the lake could include poor management practices like riparian lawn fertilization, mowed lawns right to the lakeshore, removal of lakefront vegetation, and blowing leaves into the lake. Also, it is likely that much of the nutrient load entering Pickerel Lake is coming from upstream agricultural sources. Poor agricultural practices such as spreading manure or agricultural digestate onto frozen or snow-covered fields or spreading right before predicted large rain events will continue to allow excess nutrients to enter the Pickerel Lake watershed, to the detriment of Pickerel Lake residents and the public who recreate on Pickerel Lake.

Eurasian milfoil will likely continue to require treatment, at least in some years. We recommend small-scale treatments of 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 Pickerel Lake, including Walleye, Northern Pike, Largemouth Bass, Bluegill, Black Crappie, Pumpkinseed Sunfish, and Yellow Perch require healthy native aquatic plant communities. In addition, a healthy, robust aquatic plant community will sequester nutrients in Pickerel Lake and help reduce filamentous algae blooms.

The remaining riparian wetlands adjacent to Pickerel Lake should be protected and considered critical to the continued health of the lake's aquatic community. The Pickerel Lake shoreline is already more developed than most other lakes in Michigan of comparable size. 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, along the shoreline, and in the lake basin tends to change and diminish natural habitat.

Appropriate watershed management is necessary to sustain healthy biological communities, including fish, invertebrates, amphibians, reptiles, birds and aquatic mammals. Generally, for inland lakes this includes maintenance of good water quality, especially for nutrients; preservation of natural shorelines, especially shore contours and vegetation; and preservation of bottom contours, vegetation, and wood structure within a lake. Guidelines for protecting fisheries habitat in inland lakes can be found in Fisheries Division Special Report 38 (O'Neal and Soulliere 2006). Also, the Michigan Natural Shoreline Partnership, an organization dedicated to promoting natural shoreline landscaping to protect Michigan's inland lakes (http://www.mishorelinepartnership.org/), can provide guidance and training on how best to manage the land/water interface for the benefit of Pickerel Lake.

Within the past ten years there have been quantum leaps in Cisco aquaculture, and it is currently possible to rear and stock Cisco. Although current Cisco rearing programs being conducted by Native American tribes and the US Fish and Wildlife Service have targeted the Great Lakes, Cisco could certainly be stocked in inland lakes as well. The current broodstock sources have been developed from the Great Lakes, however it would be possible to develop an inland broodstock source for inland lakes. Pickerel Lake would not be a good candidate for Cisco reintroduction unless the nutrient issues are

solved. Cisco survival is unlikely with the water quality and nutrient issues that currently plague Pickerel Lake.

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Table 1. Fish stocked in Pickerel Lake, Newaygo County, 1874-2018.

| Year | Species | Number | Size | Strain |
|---|---|---|---|---|
| 1874 | Lake Whitefish | 5,000 | fry | Detroit River |
| 1896 | Smallmouth Bass | 2,000 | unknown | |
| 1897 | Lake Trout | 25,000 | unknown | |
| 1905 | Walleye | 125,000 | fry | |
| 1909 | Largemouth Bass | 6,000 | fry | |
| | Walleye | 125,000 | fry | |
| 1910 | Walleye | 75,000 | fry | |
| 1934 | Bluegill | 6,000 | 4 months | |
| | Largemouth Bass | 1,000 | 4 months | |
| | Walleye | 875 | adult | |
| 1935 | Bluegill | 10,000 | 3 months | |
| | Walleye | 581 | adult | |
| | Yellow Perch | 5,000 | 7 months | |
| 1936 | Largemouth Bass | 1,260 | 4 months | |
| | Yellow Perch | 10,000 | 8 months | |
| 1937 | Bluegill | 6,000 | 5 months | |
| | Walleye | 70 | adult | |
| 1938 | Bluegill | 8,000 | 3 months | |
| | Largemouth Bass | 1,000 | 5 months | |
| | Walleye | 278 | adult | |
| | Yellow Perch | 4,000 | 6 months | |
| 1939 | Bluegill | 5,000 | 4 months | |
| | Northern Pike | 1 | adult | |
| | Walleye | 273 | adult | |
| 1940 | Bluegill | 3,000 | 5 months | |
| | Northern Pike | 1 | adult | |
| | Smallmouth Bass | 801 | 5 months, adult | |
| | Walleye | 110 | adult | |
| | Yellow Perch | 4 | adult | |
| 1941 | Smallmouth Bass | 3,000 | 1 month | |
| 1942 | Smallmouth Bass | 500 | 5 months | |
| | Walleye | 200,000 | fry | |
| 1943 | Smallmouth Bass | 3,960 | 2 months | |
| | Walleye | 326 | adult | |
| 1944 | Walleye | 1,000 | 4 months | |
| 1945 | Walleye | 45 | adult | |
| 1946 | Walleye | 67 | adult | |
| 1947 | Walleye | 176 | adult | |
| 1950 | Walleye | 117 | adult | |
| 1954 | Rainbow Trout | 2,000 | fall fingerlings | |
| | Walleye | 7,000 | spring fingerlings | |
| 1955 | Rainbow Trout | 2,000 | sublegal | |
| 1956 | Rainbow Trout | 2,000 | sublegal | |
| 1965 | Brook Trout | 12,000 | sublegal | |
| 1971 | Brown Trout | 4,000 | yearling | |
| 1987 | Walleye | 12,000 | spring fingerlings | Muskegon |
| 1988 | Walleye | 1,760 | fall fingerlings | Muskegon |
| 1989 | Walleye | 15,900 | spring fingerlings | Muskegon |

Table 1, continued

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|---|---|---|---|---|
| 1990 | Walleye | 25,000 | spring fingerlings | Muskegon |
| 1992 | Walleye | 45,473 | spring fingerlings | Muskegon |
| 1996 | Walleye | 32,013 | spring fingerlings | Muskegon |
| 1997 | Walleye | 33,936 | spring fingerlings | Muskegon |
| 1999 | Walleye | 19,633 | spring fingerlings | Muskegon |
| 2001 | Walleye | 26,663 | spring fingerlings | Muskegon |
| 2003 | Walleye | 13,037 | spring fingerlings | Muskegon |
| 2005 | Walleye | 16,163 | spring fingerlings | Muskegon |
| 2009 | Walleye | 15,900 | spring fingerlings | Muskegon |
| 2011 | Walleye | 15,900 | spring fingerlings | Muskegon |
| 2013 | Walleye | 17,865 | spring fingerlings | Muskegon |
| 2015 | Walleye | 16,289 | spring fingerlings | Muskegon |
| 2017 | Walleye | 15,604 | spring fingerlings | Muskegon |
| 2018 | Walleye | 1,777 | fall fingerlings | Muskegon |

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

| Species | 1945 | 1947 | 1952 | 1967 | 1968 | 1970 | 1984 | 1994 | 1995 | 2017 |
|---|---|---|---|---|---|---|---|---|---|---|
| Banded Killifish | x | | x | | | | | | | |
| Black Bullhead | | | x | | | | | | | |
| Black Crappie | | x | x | x | x | x | x | x | x | x |
| Blackchin Shiner | x | | x | | | | | | | x |
| Bluegill | x | x | x | x | x | | x | x | x | x |
| Bluntnose Minnow | x | | x | | | | | | | x |
| Brown Bullhead | | | x | x | x | x | x | | x | x |
| Central mudminnow | x | | | | | | | | | |
| Cisco | | | x | | | x | x | | | |
| Common Carp | | | | | | | | | x | x |
| Golden Shiner | x | | x | | x | x | x | x | | x |
| Green Sunfish | x | | x | x | | | | | | x |
| Hybrid Sunfish | | | | | | | | | | x |
| Johnny Darter | x | | x | | | | | | | x |
| Iowa Darter | x | | x | | | | | | | x |
| Lake Chubsucker | | | | | | | | | x | x |
| Largemouth Bass | x | x | x | x | x | x | x | x | x | x |
| Mimic Shiner | | | x | | | | | | | |
| Mud Pickerel* | x | | | | | | | | | |
| Northern Pike | x | x | | x | x | x | x | x | x | x |
| Pumpkinseed | x | x | x | x | x | | x | x | | x |
| Rock Bass | x | x | x | x | x | x | x | x | x | x |
| Walleye | | | x | | | | | x | x | x |
| White Sucker | | | x | | | x | | | x | |
| Yellow Bullhead | x | | | | | | x | x | x | x |
| Yellow Perch | x | x | x | x | x | x | x | x | x | x |

* There is no fish by this name in Michigan. It is unknown what species the researchers were referring to.

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

| Species | Number of Master Angler awards issued |
|---|---|
| Bluegill | 24 |
| Yellow Bullhead | 10 |
| Rock Bass | 6 |
| Black Crappie | 5 |
| Largemouth Bass | 5 |
| Pumpkinseed Sunfish | 3 |
| Black Bullhead | 2 |
| Brown Bullhead | 2 |
| Smallmouth Bass | 1 |
| Total: | 58 |

Table 4. Number, weight, and length of fish collected from Pickerel Lake, Newaygo County, with trap nets, large mesh fyke nets, small mesh fyke nets, and inland gillnets, May 15-19, 2017.

| Species | Number | Percent by number | Weight (pounds) | Percent by weight | Length range (inches)[1] | Average length | Percent legal size[2] |
|---|---|---|---|---|---|---|---|
| Black Crappie | 30 | 5.6 | 20.5 | 3.6 | 7-12 | 10.5 | 100 (7") |
| Bluegill | 82 | 15.2 | 35.2 | 6.3 | 1-10 | 8.1 | 96 (6") |
| Bluntnose Minnow | 5 | 0.9 | 0.0 | 0.0 | 2-2 | 2.5 | |
| Brown Bullhead | 21 | 3.9 | 24.7 | 4.4 | 11-14 | 13.6 | 100 (7") |
| Common Carp | 11 | 2.0 | 117.6 | 20.9 | 19-36 | 28.3 | |
| Green Sunfish | 1 | 0.2 | 0.0 | 0.0 | 3-3 | 3.5 | |
| Largemouth Bass | 17 | 3.2 | 28.7 | 5.1 | 8-19 | 14.4 | 71 (14") |
| Northern Pike | 58 | 10.8 | 103.5 | 18.4 | 11-28 | 19.5 | 7 (24") |
| Pumpkinseed Sunfish | 15 | 2.8 | 1.7 | 0.3 | 2-8 | 5.8 | 40 (6") |
| Rock Bass | 163 | 30.2 | 88.9 | 15.8 | 2-12 | 8.7 | 96 (6") |
| Walleye | 13 | 2.4 | 47.1 | 8.4 | 15-25 | 22.0 | 100 (15") |
| Yellow Perch | 7 | 1.3 | 2.7 | 0.5 | 3-13 | 8.5 | 57 (7") |
| Yellow Bullhead | 116 | 21.5 | 92.6 | 16.4 | 2-14 | 11.8 | 99 (7") |
| Total | 539 | 100 | 563.2 | 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 5. Average total weighted length (inches) at age, and growth relative to the state average, for fish sampled from Pickerel Lake, Newaygo County, with trap nets, large mesh fyke nets, small mesh fyke nets, and inland gill nets, May 15-19, 2017. 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 | | 6.7 (2) | 9.2 (10) | 10.6 (8) | 11.6 (9) | 12.4 (1) | 12.2 (1) | | | | | | +2.0 |
| Bluegill | 2.0 (1) | | 6.7 (9) | 7.6 (14) | 9.1 (12) | 9.7 (5) | | | | | | | +2.1 |
| Largemouth Bass | | 8.1 (1) | 10.1 (1) | 12.8 (2) | 14.4 (7) | | 15.9 (5) | 19.6 (1) | | | | | +0.4 |
| Northern Pike | 13.1 (12) | 17.5 (11) | 20.5 (11) | 22.0 (10) | 22.6 (9) | 27.1 (3) | 25.9 (1) | | | | | | -0.7 |
| Pumpkinseed Sunfish | | | 4.9 (8) | 6.5 (4) | 8.0 (2) | 8.1 (1) | | | | | | | 0.0 |
| Rock Bass | 2.4 (3) | 3.9 (3) | 6.1 (16) | 7.9 (14) | 8.8 (12) | 10.0 (10) | 10.4 (5) | 11.2 (2) | 11.2 (1) | | | | +1.7 |
| Walleye | | | 15.8 (1) | 19.3 (1) | | 19.8 (1) | 21.3 (2) | 23.6 (6) | | | | 25.1 (2) | +2.0 |
| Yellow Perch | 3.2 (1) | | 6.6 (3) | | 11.0 (1) | 10.9 (1) | 13.1 (1) | | | | | | -- |

Table 6. Number, weight, and length of fish collected from Pickerel Lake, Newaygo County, with seining and electrofishing, June 19, 2017.

| Species | Number | Percent by number | Weight (pounds) | Percent by weight | Length range (inches)1 | Average length | Percent legal size2 |
|---|---|---|---|---|---|---|---|
| Black Crappie | 4 | 0.5 | 0.2 | 0.2 | 3-4 | 4.0 | 0 (7") |
| Blackchin Shiner | 10 | 1.4 | 0.0 | 0.0 | 1-2 | 2.3 | |
| Bluegill | 267 | 36.6 | 22.8 | 24.4 | 1-8 | 4.3 | 19 (6") |
| Bluntnose Minnow | 71 | 9.7 | 0.4 | 0.4 | 1-3 | 2.5 | |
| Brown Bullhead | 3 | 0.4 | 2.4 | 2.6 | 10-13 | 11.8 | 100 (7") |
| Common Carp | 1 | 0.1 | 10.4 | 11.1 | 28-28 | 28.5 | |
| Golden Shiner | 20 | 2.7 | 0.6 | 0.6 | 3-6 | 4.5 | |
| Hybrid Sunfish | 2 | 0.3 | 0.4 | 0.4 | 6-6 | 6.5 | 100 (6") |
| Iowa Darter | 6 | 0.8 | 0.0 | 0.0 | 2-2 | 2.5 | |
| Johnny Darter | 1 | 0.1 | 0.0 | 0.0 | 1-1 | 1.5 | |
| Lake Chubsucker | 9 | 1.2 | 1.6 | 1.7 | 4-9 | 6.4 | |
| Largemouth Bass | 67 | 9.2 | 26.6 | 28.4 | 1-18 | 6.7 | 12 (14") |
| Northern Pike | 5 | 0.7 | 5.4 | 5.8 | 3-21 | 13.5 | 0 (24") |
| Pumpkinseed Sunfish | 46 | 6.3 | 5.3 | 5.7 | 2-8 | 4.6 | 20 (6") |
| Rock Bass | 24 | 3.3 | 5.8 | 6.2 | 2-10 | 6.3 | 63 (7") |
| Walleye | 1 | 0.1 | 0.1 | 0.1 | 7-7 | 7.5 | 0 (15") |
| Yellow Perch | 181 | 24.8 | 4.8 | 5.1 | 1-7 | 3.8 | 0 (7") |
| Yellow Bullhead | 11 | 1.5 | 6.8 | 7.3 | 9-13 | 10.8 | 100 (7") |
| Total | 729 | 100 | 93.6 | 100 | | | |

1Note 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.

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

Table 7. Average total weighted length (inches) at age, and growth relative to the state average, for fish sampled from Pickerel Lake, Newaygo County, with electrofishing and seining, June 19, 2017. 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 | 4.1 (4) | | | | | | | | | | | | -- |
| Bluegill | 2.7 (19) | 5.3 (29) | 4.1 (2) | | | | | | | | | | +0.7 |
| Largemouth Bass | 3.5 (9) | 4.9 (4) | 8.5 (23) | 10.0 (2) | 14.9 (2) | 16.3 (6) | | | | | | | -0.9 |
| Northern Pike | | 20.2 (2) | | | | 20.9 (1) | | | | | | | -- |
| Pumpkinseed Sunfish | 2.6 (11) | 4.5 (13) | 5.6 (10) | 7.0 (3) | 7.0 (1) | | | | | | | | +0.3 |
| Rock Bass | 3.0 (4) | 4.6 (1) | | 5.9 (1) | | | | | | | | | -- |
| Yellow Perch | 3.6 (19) | 5.2 (9) | 6.2 (11) | 7.2 (2) | | | | | | | | | -0.5 |

Table 8. Number, weight, and length of fish collected from Pickerel Lake, Newaygo County, with experimental inland gill nets and straight-run gill nets, November 28 - December 1, 2017.

| Species | Number | Percent by number | Weight (pounds) | Percent by weight | Length range (inches)[1] | Average length | Percent legal size[2] |
|---|---|---|---|---|---|---|---|
| Black Crappie | 1 | 0.9 | 0.5 | 0.3 | 9-9 | 9.5 | 100 (7") |
| Bluegill | 3 | 2.6 | 0.7 | 0.4 | 6-7 | 6.8 | 100 (6") |
| Largemouth Bass | 7 | 6.1 | 5.7 | 3.4 | 6-17 | 10.6 | 14 (14") |
| Northern Pike | 73 | 64.0 | 124.2 | 73.8 | 14-27 | 19.6 | 7 (24") |
| Pumpkinseed Sunfish | 2 | 1.8 | 0.3 | 0.2 | 5-5 | 5.5 | 0 (6") |
| Rock Bass | 12 | 10.5 | 3.8 | 2.3 | 4-10 | 7.3 | 92 (7") |
| Walleye | 9 | 7.9 | 29.5 | 17.5 | 17-24 | 21.3 | 100 (15") |
| Yellow Perch | 4 | 3.5 | 1.6 | 1.0 | 9-10 | 9.8 | 100 (7") |
| Yellow Bullhead | 3 | 2.6 | 2.1 | 1.2 | 9-13 | 11.2 | 100 (7") |
| Total | 114 | 100 | 168.4 | 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 9. Temperature, dissolved oxygen, pH, and specific conductance profile for Pickerel Lake, Newaygo County, on 8/24/2017.

| Depth (feet) | Temperature (F) | O2 (ppm) | pH | Specific conductance (mS/cm) |
|---|---|---|---|---|
| 0 | 73.3 | 8.25 | 8.72 | 0.3235 |
| 3 | 73.4 | 8.23 | 8.61 | 0.3232 |
| 6 | 73.4 | 8.25 | 8.61 | 0.3234 |
| 9 | 73.4 | 8.23 | 8.63 | 0.3234 |
| 12 | 73.4 | 8.3 | 8.64 | 0.3233 |
| 15 | 73.4 | 8.29 | 8.65 | 0.3234 |
| 18 | 70.8 | 3.63 | 8.01 | 0.3309 |
| 21 | 63.6 | 0 | 7.75 | 0.3409 |
| 24 | 56 | 0 | 7.7 | 0.3409 |
| 27 | 52.4 | 0 | 7.64 | 0.3365 |
| 30 | 48.6 | 0 | 7.59 | 0.3366 |
| 33 | 47 | 0 | 7.57 | 0.3379 |
| 36 | 46.5 | 0 | 7.54 | 0.34 |
| 39 | 45.9 | 0 | 7.54 | 0.3402 |
| 42 | 45.8 | 0 | 7.55 | 0.3389 |
| 45 | 45.3 | 0 | 7.53 | 0.3411 |
| 48 | 45.2 | 0 | 7.55 | 0.3406 |
| 51 | 44.8 | 0 | 7.53 | 0.342 |
| 54 | 44.5 | 0 | 7.58 | 0.3434 |
| 57 | 44.1 | 0 | 7.6 | 0.3478 |
| 60 | 43.8 | 0 | 7.64 | 0.3503 |
| 63 | 43.5 | 0 | 7.66 | 0.3563 |
| 66 | 43.5 | 0 | 7.61 | 0.3615 |
| 68 | 43.4 | 0 | 7.54 | 0.3862 |

Table 10. Shoreline data for Pickerel Lake, Newaygo County, compared with that for other medium, deep lakes in the Central Lake Michigan Management Unit (CLMMU; essentially the northwestern Lower Peninsula) and statewide (from Wehrly et al. 2015). Sampling was conducted by MDNR Fisheries personnel on August 24, 2017.

| | Total docks per km | Dwellings per km | Percent shoreline armoring | Submerged trees per km |
|---|---|---|---|---|
| Pickerel Lake | 28.5 | 20.0 | 48.8 | 9.2 |
| Average for other medium-sized, deep inland lakes in the CLMMU | 10.5 | 16.3 | 19.2 | 4.9 |
| Michigan statewide average for medium-sized, deep inland lakes | 12.7 | 16.7 | 25.3 | 14.5 |