

Witch Lake

Marquette County, T45N R30W Section 24
Michigamme Watershed, 2013

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Environment

Witch Lake is located approximately 9 miles south of Republic in southern Marquette County and within the Michigamme River watershed. It has a surface area of 210 acres and is adjacent to State Highway M-95. Homes, resorts, and seasonal camps are scattered around the perimeter of the lake (Figure 1). Witch Lake has an unnamed spring fed inlet and an outlet that flows to the Michigamme River. The surrounding area includes rolling hills of stone, gravel, and rock vegetated by northern hardwoods such as yellow birch, sugar maple, hemlock, white pine, and white birch.

The morphology of the lake is unique in that the west and east basins are very different in nature. The west basin is warmer, shallower, has a gradual slope to deeper water (25 ft), and consists of a silty bottom whereas the eastern basin is colder, has very few shallow areas, has a steep drop off around the entire perimeter with rocky shorelines, and has a depth of approximately 95 feet (Figure 1). Cover for fish includes submersed trees in a majority of the littoral zone and variable areas of aquatic vegetation. Public use of Witch Lake is primarily recreational in nature.

In general, Witch Lake can be described as a two-story lake, medium size, and has oligotrophic characteristics. Limnological parameters measured in August 2013 included temperature and oxygen. Temperature ranged from 75°F at the surface to 40°F at 90 feet. Thermocline was between 10-15 feet. Oxygen levels were 9.6 ppm at the surface, and dropping to nearly 0 at 95 feet. A substantial drop in oxygen concentration was observed between 30-40 feet (7.8 to 2.0 ppm, respectively). Alkalinity measured at 120 ppm indicating Witch Lake is moderately buffered. Water transparency, as measured by Secchi disk, was recorded at 19.5 feet. Additional samples were taken for Chlorophyll a (2.21 ppb) and total Phosphorus (5 ppb). These limnological parameters are consistent with other oligotrophic water bodies in northern Michigan.

History

Historical records indicate fisheries management of Witch Lake occurred in 1894 when 15,000 Lake Trout fry were stocked. Stocking of Lake Trout fry continued in 1905 (n=15,000), 1909 (n=15,000), and 1910 (n=21,000). Warmwater species management occurred throughout the 1930s. Bluegill (n=2,000-10,000, 4-5 months old), Largemouth Bass (n=150-300, 3-4 months old), Smallmouth Bass (n=200-300, 4 months old), Yellow Perch (n=240,000, swim-up fry), and Walleye (n=150,000-700,000, swim-up fry) were all stocked into Witch Lake during this time period. Conversely, Brook Trout, a coldwater species, was also stocked during this time period (n=1,000-3,200, adults and 7-10 months old). Management goals were not explicitly stated however, managers were most likely trying to utilize the two types of habitat that Witch Lake provides (both warmwater and coldwater).

Stocking efforts in the 1940s-1970s shifted to coldwater species, including Lake Trout, Rainbow Trout, Brook Trout and Brown Trout. However, the 30 years of efforts did not produce a viable trout fishery. Over this time period, the warmwater fisheries were relatively unmanaged and supported themselves through natural reproduction. Largemouth and Smallmouth Bass, Northern Pike, Yellow Perch, sunfish, Bluegills, Black Crappie, White Sucker, and assorted minnow species were reported in fisheries surveys that were conducted during this time. It was reported that anglers during this time period were rather quiet about their catches and fishing pressure was rather light. Walleyes were rumored to be present in low numbers but were not confirmed in Witch Lake until the 1970s.

The 1972 fisheries survey confirmed the presence of Walleye with the capture of three year classes of young fish. Another survey in 1975 demonstrated the presence of many older Walleye (likely the same Walleye taken in 1972) but no direct evidence of natural reproduction despite the availability of suitable habitat. Either natural reproduction was indeed happening or an unknown party stocked Walleyes here in the late 1960s. In 1978 and 1979, Walleye fingerlings were planted with the goal of increasing natural recruitment (Table 1). An evaluation survey in 1981 indicated good survival of both plants and a developing Walleye sport fishery was evident. The evaluation survey also indicated that Yellow Perch were abundant; however, only 17% of those captured were considered to be an acceptable size (8 inches or greater). The typical acceptable length for Yellow Perch is 7 inches; it is unclear why managers used 8 inches at the time.

In 1983, Yellow Perch were targeted for manual removal, in an attempt to reduce the overabundance and improve size structure. The effort failed to remove any Yellow Perch, but managers did remove 3,415 pounds of White Sucker. Zero Yellow Perch were caught in the nets, which was attributed to an increase in predation by recently stocked Walleye. In 1987, another removal was attempted, but only 70 pounds of White Suckers were removed, and again, no Yellow Perch were caught. By 1989, it was reported that the Yellow Perch population had rebounded (N=30, 6-13.5 inches, 83% acceptable size). The increase in Yellow Perch size structure and abundance was attributed to the large removal of White Suckers. White Suckers can compete with Yellow Perch for food, such as highly nutritious benthic invertebrates. With the White Sucker population reduced, so was the competition for food resources.

From 1983-2003, spring Walleye fingerlings were stocked every other year ranging from 10,200-36,034 and averaging a rate of 94/acre. These rates were much higher than what is typically used in the rest of the management unit (25-50/acre). In 2004, stocking ceased due to concerns over low abundance of forage and it was thought that natural reproduction was sufficient to support the Walleye population (56% of the Walleye captured were from non-stocked years).

In 2000, adult and fingerling Lake Trout and Splake were stocked. The goal of stocking Lake Trout was to provide additional angler opportunity. There are no available prescriptions or documents that mention why Splake were stocked in Witch Lake.

General hook-and-line fishing regulations are in effect for all game species except Northern Pike. A no minimum size limit has been in place for Northern Pike since 2009. The regulation was amended in 2013 with the additional regulation of allowing only 1 Northern Pike greater than 24 inches in the daily possession limit (5).

Beginning in 2008, concerned citizens reported to Fisheries Division decreased Walleye catch and reported poor catches again in 2011. Fisheries Division recognized Witch Lake's importance for recreational opportunities and scheduled a comprehensive survey to be completed in 2013.

Current Status

A Status and Trends survey was completed by staff from the Northern Lake Michigan Management Unit (NLMMU) on Witch Lake during June 17-27 (netting and electrofishing), August 27th (limnology) and on October 8 (habitat survey), 2013 to gather information on the status of the fish community. Surface water temperatures ranged from 66-69.5°F on June 17th-20th to 75.8°F on August 27th. During the survey, three-10 minute electrofishing transects were completed, four (4) seine hauls were conducted, two (2) experimental gillnets were set for 5 net nights (NN), four (4) large mesh fyke nets were set for 12 NN, and two (2) small mesh fyke nets were set for 4 NN. In addition to the collection of the biological data, staff also surveyed habitat features including the numbers of dwellings, docks, submerged logs, and distance of armored shoreline (i.e. riprap, seawall etc.).

A total of 2,616 fish were captured during the June survey efforts. Species captured included: Black Crappie, Bluegill, Bluntnose Minnow, Common Shiner, Johnny Darter, Largemouth Bass, Northern Pike, Northern Redbelly Dace, Pumpkinseed, Rock Bass, Smallmouth Bass, Walleye, White Sucker, and Yellow Perch. In terms of the number captured during the survey, Bluegill were the most abundant (comprising 55.6% of the total catch), Bluntnose Minnow were second at 26.5% and Rock Bass at 7.4% (Table 2). In terms of biomass captured during the survey, Northern Pike comprised 26.6% of the survey catch, Bluegill were second at 25.7% and Rock Bass were third at 15.6% (Table 2).

Bluegill (N=1,454) were the most abundant species captured during the survey. Bluegill averaged 3 inches and ranged from 1-9 inches in length (Table 3) with 9% of the catch meeting or exceeding an acceptable size for harvest of 6 inches (Table 2). Age analysis indicated ages 1-9 present in the population and the mean growth index was considered to be average at +0.4 inches. (satisfactory growth, Table 4).

Bluntnose Minnow (N=692) were also abundant and averaged 2.5 inches and ranged from 2-3 inches in length.

Northern Pike (N=40) averaged 19.6 inches and ranged from 10-27 inches in length (Table 3). Age analysis indicated ages 1-6 present in the population and the mean growth index was -0.8 inches (slow but fair growth, Table 4).

Pumpkinseed (N=128) averaged 5.8 inches and ranged from 2-8 inches in length (Table 3) with 55% of the catch meeting or exceeding an acceptable size for harvest of 6 inches (Table 2). Age analysis indicated ages 1-8 present in the population and the mean growth index was considered to be average at +0.1 inches. (good growth, Table 4).

Rock Bass (N=194) averaged 6.4 inches and ranged from 1-10 inches in length (Table 3) with 66% of the catch meeting or exceeding an acceptable size for harvest of 6 inches (Table 2). Age analysis indicated ages 1-11 present in the population and the mean growth index was considered to be average at -0.4 inches. (slow but good growth, Table 4).

Smallmouth Bass (N=27) averaged 6.8 inches and ranged from 2-10 inches in length (Table 3) with 14% of the catch meeting or exceeding the legal size for harvest of 14 inches (Table 2). Age analysis indicated ages 1-7 present in the population and the mean growth index was under state average at -2.6 inches (slow and poor growth, Table 4).

Largemouth Bass (N=7) averaged 11.1 inches and ranged from 4-15 inches in length (Table 3) with 14% of the catch meeting or exceeding the legal size for harvest of 14 inches (Table 2). There weren't enough scale samples taken to make an accurate assessment of the age structure.

Walleye (N=21) averaged 14.2 inches, and the catch included fish that were 1 inch (N=1), 11-15 inches (N=16), 19-20 inches (N=3) and 23 inches (N=1, Table 3) with 23% of the catch meeting or exceeding the legal size for harvest (≥ 15 in, Table 2). Age analysis indicated ages 3-9 present in the population and the mean growth index was under the state average at -2.1 inches. (slow and poor to fair growth, Table 4).

Yellow Perch (N=23) averaged 6.5 inches and ranged from 3-11 inches (Table 3) with 39% of the catch meeting or exceeding an acceptable size for harvest of 7 inches (Table 2). Age analysis indicated ages 1-5 present in the population and the mean growth index was considered to be average at +0.4 inches (good growth, Table 4).

Witch Lake was found to have 7 dwellings/mile, 5 docks/mile, and 139 submerged logs/mile.

Analysis and Discussion

The fish community of Witch Lake can be described as follows: 1) a panfish community consisting of Bluegill, Pumpkinseed, Yellow Perch, and Rock Bass with good growth, reproduction and recruitment that enables fishing opportunities for anglers, 2) Walleye and Northern Pike populations that appear to have variable recruitment and slow growth rates, 3) a White Sucker population of relatively low abundance and consisting mainly of a few larger-bodied fish, and 4) shiner and darter populations that are abundant and serve as diverse forage sources for predators.

Bluegill can play a key role in community structure and overall sport fishing quality in Michigan waters (Schneider 1981). Schneider (1990) suggests indices of Bluegill characteristics can be used to classify populations. The "Schneider Index" uses size scores of length frequency and growth data and relates them to an adjective ranking systems ranging from "very poor" to "superior". Using the Schneider Index for classifying Bluegill populations, Witch Lake scored 5 for a "good" ranking.

Rock Bass have never been recorded in Witch Lake until the 2013 survey and never reported as catch by anglers. Interestingly, they have good growth, exhibit 10 age classes, and were the third most abundant fish species (15.5% by weight). Rock Bass are often overlooked as a sportfish but their popularity has increased in recent years, as they can provide anglers with another fishing opportunity. Inter- and intraspecific competition is possible since they eat aquatic insects, crayfish, and small fish, including their own young, Yellow Perch, and minnows. However, the lack of data prior to 2013 makes analysis difficult.

The 2004 stocking evaluation of Witch Lake indicated natural reproduction was occurring for Walleye (fish were captured from non-stocked years); however growth rates were determined to be under state

average. Additionally, it was determined that forage abundance (minnows and other small bait fish) was low which may have also been a contributing variable for slow Walleye growth. As a result of natural reproduction and low available forage, no further Walleye stocking was conducted.

The current Status and Trends survey indicates a continued naturally reproducing Walleye population. The survey did not capture any Walleye age two or younger. However, this survey was conducted in June and could have easily missed any younger year classes during this time. A spring survey would likely result in higher numbers since they are typically concentrated near shore earlier in the year. Six age classes, ranging from 3 to 9 years old, were observed. All Walleye captured were naturally produced since no stocking has occurred since 2003. The oldest Walleye aged would have hatched in 2004.

In 2008 and again in 2011, anglers of Witch Lake expressed concern over a reportedly declining abundance of Walleye and concurrently few catches of fish that were of legal size. After the 2013 survey, it appears that the Walleye population is still small- both in size and in numbers. However, the forage/prey that is available is 59% of the total biomass, so it is currently unclear as to why the Walleyes are on average smaller and in lower abundance. It's possible there is high competition for forage by predators. A good amount of habitat for spawning (rocky shoals) is reported to be available. There is also an abundant amount of submerged trees for forage species. Perhaps the nutrient limited oligotrophic conditions of Witch Lake prohibit the production of large and numerous Walleye. Lastly, Witch Lake is 210 acres in size, however, half of the lake a steep drop off to 95 feet. Depths between 30-40 feet were considered anoxic and unable to support fish life. This dramatically decreases the available habitat for all fish species, including Walleye.

Prior to 1983, Northern Pike populations were reported as above average for health and condition. Anglers also reported catching large Northern Pike prior to the sucker removal. Beginning in 1984 and continuing through the current survey, the populations are reported as small and slow growing. Ages 1 and 2 are indicating slower than state average growth indicating possible competition for forage. However, when older Northern Pike are caught they exhibit average growth. Similar to the Walleye population, it is unclear as to why the Northern Pike population is small in size. It has been documented Northern Pike growth is negatively related to density, water transparency, and abundance of small Bluegills (Margenau et al 1998). One of these factors, along with competition for forage, could be limiting growth of Northern Pike in Witch Lake.

Management Direction

- 1) The long term goal is to maintain the areas of undeveloped shoreline. Natural shorelines often contribute to large woody debris on the water's edge thus providing cover that helps protect fish during critical life stages (i.e. predation while young). Conversely woody debris can provide cover for ambush predators such as Northern Pike. A potential obstacle in obtaining this goal would be lake property owners who wish to have manicured lawns to the water's edge. The riparian owner's education to the benefits of a natural shoreline is critical in reaching this goal.
- 2) Conduct a Walleye population evaluation in the spring to determine Walleye recruitment. These results will help inform future management decisions (i.e. reevaluating Walleye stocking or review of fishing regulations).

- 3) Future plans should be to continue to monitor the forage base as part of periodic fish community surveys. It appears the available forage is increasing but Walleye and Northern Pike growth rates are not following suite.
- 4) Maintain current Northern Pike regulations.
- 5) Anglers are encouraged to report sport catches of all species to the NLMMU. Reports are useful to track population trends and aid further management of the fishery for current and future managers.

References

Margenau, T.L., P.W. Rasmussen, and J.M. Kampa. 1998. Factors affecting growth of northern pike in small northern Wisconsin lakes. *North American Journal of Fisheries Management* 18:625-639.

Schneider, J.C. 1981. Fish communities in warmwater lakes. Michigan Department of Natural Resources, Fisheries Research Report 1890, Ann Arbor.

Schneider, J.C. 1990. Classifying bluegill populations from lake survey data. Michigan Department of Natural Resources, Fisheries Technical Report 90-10, Ann Arbor.



Figure 1: Map of Witch Lake showing depth contours and bottom substrates.

Table 1: Known Walleye stocked into Witch Lake, Marquette County.
 Data from DNR, Fisheries Division records.

Year	Number	Rate (#/acre)	Size (inches)
1934	15,000	71	fry
1936	210,000	1000	fry
1937	300,000	1429	fry
1978	15,812	75	fingerlings
1979	17523	83	2
1983	36,034	172	n/a
1985	14,773	70	1.64
1985	10,451	50	2.52
1987	20,500	98	2.12
1989	19,784	94	1.8
1991	21,029	100	1.84
1993	12,500	60	2.12
1993	8,940	43	1.92
1995	17,900	85	2.24
1997	18,338	87	2.56
1999	10,200	50	1.96
2001	20,800	99	1.52
2003	24,336	116	1.72

Table 2: Number, length, and percentages of fishes collected from Witch Lake, Marquette County, in June 2013. Data from DNR, Fisheries Division records.

Common name	Scientific name	Number	Total weight (lbs.)	Average length (in)	Percent of catch by number	Percent of catch by weight	Percent legal or acceptable size
Black Crappie	<i>Pomoxis nigromaculatus</i>	2	1.3	10.5	<1	0.5	100 (≥6")
Bluegill	<i>Lepomis macrochirus</i>	1454	72.1	3.0	55.6	25.7	9.4 (≥6")
Bluntnose Minnow	<i>Pimephales notatus</i>	692	4.0	2.5	26.5	1.4	-
Common Shiner	<i>Luxilus cornutus</i>	13	<1	2.4	<1	<1	-
Johnny Darter	<i>Etheostoma nigrum</i>	7	<1	2.5	<1	<1	-
Largemouth Bass	<i>Micropterus salmoides</i>	7	6.0	11.1	<1	2.1	14.3 (≥14")
Northern Pike	<i>Esox lucius</i>	40	74.6	19.6	1.5	26.6	20.0 (≥24")*
Northern Redbelly Dace	<i>Chrosomus eos</i>	2	<1	2.5	<1	<1	-
Pumpkinseed	<i>Lepomis gibbosus</i>	128	26.6	5.8	4.9	9.5	54.7 (≥6")
Rock Bass	<i>Ambloplites rupestris</i>	194	43.7	6.4	7.4	15.6	66.5 (≥6")
Smallmouth Bass	<i>Micropterus dolomieu</i>	27	11.6	6.8	1.0	4.1	14.8 (≥14")
Walleye	<i>Sander vitreus</i>	21	24.4	14.2	<1	8.7	23.8 (≥15")
White Sucker	<i>Catostomus commersoni</i>	6	12.5	16.0	<1	4.5	-
Yellow Perch	<i>Perca flavescens</i>	23	4.0	6.5	<1	1.4	39.1 (≥7")

*No minimum size limit.

Table 3: Total catch by length range of select fishes collected from Witch Lake, Marquette County in June 2013. Data from DNR, Fisheries Division records.

Inch group	Black Crappie	Bluegill	Largemouth Bass	Northern Pike	Pumpkinseed	Rock Bass	Smallmouth Bass	Walleye	White Sucker	Yellow Perch
0	-	-	-	-	-	-	-	-	-	-
1	-	520	-	-	-	1	-	1	-	-
2	-	416	-	-	12	10	1	-	-	-
3	-	269	-	-	18	10	8	-	1	5
4	-	34	1	-	3	5	5	-	-	3
5	-	79	-	-	25	39	2	-	-	2
6	-	36	-	-	33	62	2	-	-	4
7	-	31	-	-	27	45	2	-	-	3
8	-	53	-	-	10	16	2	-	-	2
9	-	16	-	-	-	4	-	-	-	1
10	-	-	2	1	-	2	1	-	-	1
11	2	-	2	1	-	-	-	3	-	2
12	-	-	-	3	-	-	-	4	-	-
13	-	-	1	-	-	-	-	3	-	-
14	-	-	-	-	-	-	1	5	-	-
15	-	-	1	3	-	-	1	1	-	-
16	-	-	-	6	-	-	1	-	-	-
17	-	-	-	3	-	-	-	-	2	-
18	-	-	-	1	-	-	1	-	1	-
19	-	-	-	2	-	-	-	2	2	-
20	-	-	-	1	-	-	-	1	-	-
21	-	-	-	5	-	-	-	-	-	-
22	-	-	-	5	-	-	-	-	-	-
23	-	-	-	1	-	-	-	1	-	-
24	-	-	-	5	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-	-	-
26	-	-	-	2	-	-	-	-	-	-
27	-	-	-	1	-	-	-	-	-	-

Table 4: Weighted mean length (inches) at age and growth relative to the state average for select species of fish sampled from Witch Lake, Marquette County, in June 2013. Number of fish aged is in parentheses. Data from DNR, Fisheries Division records.

Species	Age Group												Mean growth index ¹	
	0	1	2	3	4	5	6	7	8	9	10	11		12
Bluegill		2.7 (16)	3.6 (15)	5.5 (20)	6.6 (5)	7.4 (8)	7.9 (7)	8.7 (8)	9.3 (5)	9.8 (2)				+0.4
Northern Pike		11.4 (4)	16.6 (13)	22.2 (15)	23.7 (6)	24.7 (1)	26.7 (1)							-0.8
Pumpkinseed		2.6 (6)	3.3 (12)	4.0 (2)	5.3 (6)	6.2 (16)	7.6 (11)	8.1 (5)	8.4 (1)					+0.1
Rock Bass		2.4 (6)	3.5 (9)	5.2 (13)	6.1 (7)	6.9 (11)	8.0 (12)	9.0 (4)	9.3 (1)		10.5 (1)	10.5 (1)		-0.4
Smallmouth Bass		3.4 (11)	5.6 (7)	8.6 (5)	11.8 (1)	15.7 (2)							18.7 (1)	-2.6
Walleye				12 (9)	14.4 (6)	14.7 (1)	19.8 (2)	19.6 (1)		23 (1)				-2.1
Yellow Perch		4.0 (9)	6.0 (2)	6.6 (4)	8.2 (5)	11.0 (3)								+0.4

¹Mean growth index is the average deviation from the state average length at age.