Long Lake

Grand Traverse County, T27N/R12W
Platte River Watershed, Last surveyed 2017

Heather L. Hettinger, Fisheries Biologist

Environment

Long Lake is a 2,860-acre lake located in the northwestern portion of Michigan's Lower Peninsula in Grand Traverse County (Figure 1). The lake is approximately seven miles southwest of Traverse City, the largest city in the northern Lower Peninsula. Long Lake is primarily located in Long Lake Township, with the southernmost portion of the lake located in Green Lake Township. The Long Lake watershed is approximately 14,435 acres (Benzie Conservation District 2005), and the main soil types within the watershed are Kalkaska Loamy Sands, Lupton Muck, and Rubicon Sand (Soil Survey Staff 2011). The surrounding countryside varies from level ground and gently rolling hills to moderately steep hills (Hay 1997), forested with conifers and northern hardwoods. The shoreline of Long Lake is heavily developed with homes and cottages. Other than the islands, little undeveloped shoreline remains on Long Lake.

Traverse City, the closest major city, has a population of 15,738 according to 2019 census information (United States Census Bureau 2021). From 1971 to 2000 mean monthly air temperatures ranged from 20.7° Fahrenheit (F) in January to 69.4° F in July. The extreme low for air temperatures in this time period was -37° F in 1979 and the extreme high was 101° F in 1982. Mean annual precipitation was 33.4 inches and the mean annual snowfall was 95.1 inches (Michigan State University Department of Geography 2009).

The Long Lake watershed is part of the Platte River watershed (Figure 2). The Platte River watershed contains approximately 100 miles of streams and more than 50 lakes that provide over 8,500 acres of both cold and warm water fisheries and bountiful recreational opportunities (MDEQ 2011). Long Lake has small seeps that feed the lake, however there are no major inlet streams and only one outlet, Sucker Creek. The outlet from Long Lake flows downstream into Lake Dubonnet, and then into Lake Ann and several smaller lakes, including Bronson Lake. From there, the Platte River flows for approximately 15 miles before flowing into Platte Lake. About one mile downstream of Platte Lake, the Platte River flows into Loon Lake. From Loon Lake, the Platte River flows for about two miles before entering Platte Bay of Lake Michigan (Tonello 2011). Forested, open lands and wetlands make up 82% of the watershed's land coverage followed by 12% agricultural and 7% urban use. Approximately 76% of the watershed is publicly owned as National Park Service land, a State of Michigan holding (Benzie Conservation District 2005). Long Lake is also connected to 59-acre Mickey Lake via a shallow channel that allows boats and fish to migrate back and forth. Long Lake is separated from 43-acre Ruth Lake by a sand bar, although at times in the past a channel was open between Ruth and Long that allowed movement of fish between the lakes (DNR file information).

Long Lake has five islands (Figure 3): 29.3-acre Long Island, 13.8-acre South Island, 10-acre Fox Island, 2.1-acre Picnic Island, and 1.1-acre Brush Island. Four of the islands (Long, Picnic, Fox, and South) are dedicated to the public for use as parks and are open to the public with reasonable use restrictions. (Long Lake Association 2011). South Island and Fox Island form a natural preserve which is open to the public and maintained by the Grand Traverse Regional Land Conservancy (GTRLC). Long Island and Picnic

Island are owned by the Oleson Foundation, which graciously allows for the use of both islands by the public. Brush Island is privately owned and not open for public access.

Long Lake has a maximum depth of 90 feet and a mean depth of 24.7 feet (Fusilier 1999). The lake bottom in the shoal areas is mostly sand with some gravel and in deeper water the bottom is mostly muck and organics (Hay 1997). In a 2000 summer survey conducted by the Great Lakes Environmental Center (GLEC), aquatic macrophytes appeared in approximately 1.6 percent of the total lake area. This increased to 1.7 percent in 2005. The total Eurasian milfoil area was not calculated in the 2000 survey, but the lake had a total of 7.1 acres in 2005 (equitable to approximately 14 percent of the total macrophyte area) and only 0.2 percent of total lake area. Macrophyte growth areas are primarily limited to depths of 20 feet or less. The vegetation observed during this survey was noted as being indicative of a well-balanced plant community with low overall abundance of plant growth, which is common in oligotrophic lakes. Eurasian milfoil control efforts are also reducing these numbers (GLEC 2009).

Long Lake has a history of water quality sampling that indicates the lake has high water quality, Specifically, during the 1990s a water quality index that ranges from 1 to 100, with 100 indicating excellent water quality, was used to rate Long Lake. The sampling was designed to look at water quality in spring and late summer, the two times of the year that are considered periods of poor water quality. The water quality sampling tested for dissolved oxygen, temperature, Secchi disk transparency, total phosphorus, conductivity, alkalinity, total nitrate, chlorophyll-a, and pH. Since the summer of 1993, every time Long Lake was sampled the Lake Water Quality Indices were in the 90s. In the spring of 1994 two samples scored 100, which were the highest water quality indices found for any of the lakes studied as part of a larger water quality study (Fusilier 1999).

The Long Lake Association has also monitored water quality of the lake at three different locations from 1997 to 2000, 2005 and 2008. These three locations were in deeper areas of the lake and samples were collected in early summer (June/July) and fall (October). Although the data collected demonstrated that Long Lake is considered a high quality, oligotrophic waterbody, there were a number of warning signs which indicated that Long Lake water quality could be vulnerable to degradation if long-term nutrient input is not limited (GLEC 2009).

Dissolved oxygen and temperature are two of the most important indicators of water quality for an inland lake. As water becomes warm, less oxygen can be dissolved in the water; when dissolved oxygen becomes too low it can create fatal conditions for fish and other aquatic organisms. From 1995 to 1998 fall temperatures were recorded and ranged from 75° F at the surface to 54° F at the bottom (75 to 90 feet). The temperature and oxygen profile of Long Lake demonstrated a thermocline at various depths in all years and showed oxygen depletion near the bottom. In 1995 the lake ran out of dissolved oxygen at 46 feet, 43 feet in 1996, 63 feet in 1997 when the thermocline was deeper, and 45 feet in 1998. Oxygen depletion below the thermocline has been found to be common in southern Michigan lakes in the summer, less common in northern Michigan lakes. Also, limnologists have noted that fish were still marked with their sounding electronics below these the depths of oxygen depletion (Fusilier 1999). From 1998-2005 oxygen concentrations were also found to be near zero in deeper portions of the lake (GLEC 2009).

Much like temperature and oxygen, a lake's chlorophyll-a concentration can tell a lot about the water quality. Chlorophyll- a can be used as a measure of algae biomass and photosynthetic activity, essentially

a measure of productivity for the lake. The chlorophyll-a concentrations were found to be low in 1997 and 1998, ranging from 0.4 to 1.3 micrograms per liter. These findings were consistent with the Secchi disk readings. The 1995 to 1998 Secchi disk readings ranged from 50 to 60 feet in the spring. The 63-foot reading from 1998 was the deepest the limnologists had recorded for a Michigan inland lake; water clarity generally drops to 20 feet when water starts to warm. However, it was mentioned in the report that in 1970 the average water clarity for Long Lake was 20 feet, which would indicate the lake was getting clearer (Fusilier 1999). The introduction of invasive Zebra Mussels to the lake within this window of time may be partially responsible for the increase in clarity. From 1998 to 2005 chlorophyll- a concentrations averaged from 1.46 to 1.6 micrograms per liter in the summer and 2.01 to 2.7 micrograms per liter in the fall. The Secchi depth readings averaged 27 to 28.5 feet in the summer and 18.5 feet in the fall (GLEC 2009). This is an increase in chlorophyll-a and a decrease in Secchi disk depth readings from the previous years.

From 1993 to 1998 water samples found that the phosphorous concentration was generally low for a Michigan inland lake, and data from 1997 indicated that phosphorus was not being released from bottom sediments. Surface samples were generally 10 micrograms per liter or less, but at least one sample in 1994 was 19 micrograms per liter (Fusilier 1999). For the three sites sampled from 1998-2005 surface levels averaged 7.4 to 10.4 micrograms per liter and 9.1 to 15.9 micrograms per liter for bottom measurements. A measurement of sediment concentrations was two to three times higher than 10 other area lakes that have monitoring programs (GLEC 2009). The amount of nitrate nitrogen in Long Lake, from 1993 to 1998, dropped dramatically between spring and summer. Both spring and summer concentrations were found to be low compared to other Michigan inland lakes (Fusilier 1999).

When measuring alkalinity, the cutoff between a soft water lake and a hard-water lake is 75 milligrams per liter. The alkalinity data for Long Lake ranged from 65 to 89 milligrams per liter, thus classifying Long Lake as a soft-water to moderately hard-water lake. Long Lake pH values ranged from 7.6-8.8, which are within the normal ranges for a high-quality Michigan inland lake (Fusilier 1999).

The Long Lake watershed attracted industry (primarily logging in the mid to late 1800's) and agricultural use during the early settlement era. More recently, the watershed and lake have served as a focal point of outdoor recreation and residential development (GLEC 2009). Within the tree line surrounding the lake, the shoreline is developed and consists mostly of privately owned homes. Additionally, there are public parks, natural areas, and two boat launches around the lake. South Long Lake Forest Natural Area (managed by the GTRLC) can be accessed on South Long Lake Road or Bass Lake Road. Taylor Park, which has a public beach, and Haywood Park are both located off of North Long Lake Road. Gilbert Park, located on the north shore of the lake, has a public beach with a boat launch nearby and parking for anglers across the street from the launch. The other boat launch is the Crescent Shores Boat Launch at the end of Crescent Shores Road, off of West Long Lake Road (Long Lake Township 2011). These four parks and access sites are all managed by Long Lake Township.

History

Stocking

Throughout the years Long Lake has been stocked with several species of fish (Table 1). Stocking began with Walleye in 1894, became constant through the 1930s and 1940s, intermittently occurred in 1958, 1968. Walleye stocking became consistent again in the 1980s and 1990s. In the early 1960s it was proposed to chemically treat Long Lake prior to stocking walleye again. However, this idea was

abandoned because walleye from previous stocking events seemed to be doing well and a treatment on nearby Lime Lake, had caused a larger loss of fish than expected. Other early stockings included Largemouth Bass in 1905, and Lake Trout in 1909 and 1910. Species stocked throughout the 1930s and 1940s included Largemouth Bass, Smallmouth Bass, and Bluegill, with the addition of Yellow Perch and minnows in the 1930s. There was some public interest in stocking Rainbow Trout in the late 1940s, but this never came to fruition. The lake was evaluated in 1947 to determine if it would be suitable for stocking trout. The biologist at this time noted that Long Lake was deep and cold enough for trout, but the lake lacked sufficient oxygen to support Rainbow Trout, particularly during the summer months (Fisheries Division Files). Seven hundred adult Brown Trout were stocked in 1970, with little to no success. Northern Muskellunge were also stocked in Long Lake in 1976 and 1977 with the hopes of replenishing a very low natural population of fish. The idea of stocking Muskie again was brought up in 2006; while DNR Fisheries Division supported the idea, many members of the public did not. There were significant concerns from riparian users about the safety of pets and small children with Muskie in the lake, and the potential impacts to the Walleye fishery. Numerous conversations were held with the public and the lake association, and ultimately the idea was dropped.

Fish Surveys

The first recorded survey to evaluate fish populations of Long Lake was conducted in August 1950 by the Michigan Department of Conservation (MDOC, the precursor to today's Michigan Department of Natural Resources (MDNR)). Experimental gill nets and 30-foot bag seines were used. Fish caught during the thirty-two overnight gillnet sets included 150 Yellow Perch (5.5-11.4 inches), 72 Pumpkinseed Sunfish (3.5-7.3 inches), 77 Rock Bass (3.7-11.1 inches), 25 Smallmouth Bass (5.3-18.2 inches), 25 Northern Pike (15.1-34.5 inches), 18 White Suckers (10.3-19.1 inches), 18 Yellow Bullhead (8.3-12.8 inches), 12 Largemouth Bass (5.3-14.2 inches), eight Bluegill (3.8-9.4 inches), and three Bluegill-Pumpkinseed hybrids (4.8-4.9 inches). Seining along 400 feet of shoreline produced 56 Yellow Perch (1-4 inches), 62 Bluegills (2.7-5.5 inches), 17 Largemouth Bass (1-6.8 inches), 11 Rock Bass (2.2-5.4 inches), 11 White Sucker (1.9-2.3 inches), 10 Smallmouth Bass (1-5 inches), four Pumpkinseed Sunfish (5.3-5.8 inches), and one Mudpuppy. Other fish collected included Bluntnose Minnow, Spottail Shiners, Mimic Shiners, Sand Shiners, Blacknose Shiner, and Iowa Darter. DNR Fisheries Division files mention that scale samples from Smallmouth Bass, Largemouth Bass, Rock Bass, Yellow Perch, Bluegill, and Pumpkinseeds were collected and showed that Smallmouth Bass collectively were growing above state average, and all other species were growing at or near average. Walleye were not found in the survey despite previous stockings.

In July of 1967 Smallmouth Bass fishing was reported as being "good" and Walleye fishing as "fair" by local anglers. The MDOC conducted an electrofishing survey in Long Lake at this time and found many young of the year Yellow Perch, Smallmouth Bass, Bluegill, Pumpkinseed Sunfish, Rock Bass, and one Largemouth Bass.

Two surveys were conducted on Long Lake by MDOC during 1968 to evaluate the stocking of 500,000 Walleye fry from Thompson State Fish Hatchery, which were released on May 9, 1968. The first survey was on May 10, 1968 using small mesh seines to evaluate the survival of walleye stocked the day before. None of the newly stocked Walleye were found. In September, a lake survey was conducted using an electrofishing boat which shocked approximately three miles of shoreline. No Walleye were caught in this effort either. A total of 155 Yellow Perch were collected, along with 43 Smallmouth Bass,

30 Bluegill, 25 White Sucker, 16 Rock Bass, and three Largemouth Bass. Other species collected included shiners, minnows, and darters.

A comprehensive lake survey was conducted in June 1970 using three trap nets and two nights effort by electro-fishing. Good numbers of Smallmouth Bass, Panfish, and White Sucker were observed. Northern Pike and Walleye numbers were low, which led to the conclusion that the 1968 Walleye stocking effort was not successful.

However, a spring Walleye spawning evaluation conducted in late April 1971 indicated that some of the stocked fish did indeed survive. Nine Walleye from 20 to 23-inch, along with 36 White Suckers that ranged from 14 to 20 inches, were collected in an electrofishing effort which covered most of the north and northeastern shoreline.

In 1982 a general survey of Long Lake was conducted using Great Lakes gill nets and fyke nets. It was initially surveyed during the first two weeks of June and then again, the last week of July because of the poor catch in June. Aquatic vegetation was noted as being sparse and fish difficult to catch with fyke nets because of the very shallow, sandy shoals which drop off rapidly into deep water. It was also noted that fish may have been suspended since they were marked 20 to 40 feet down in 50 to 70 feet of water using a sonar device. Bluegill, Rock Bass, Yellow Perch, and Smallmouth Bass made up most of the catch by number. Growth rates for all age classes of Walleye were above the state average. Yellow Perch, Largemouth Bass, Bluegill, and Pumpkinseed Sunfish were found to be growing below the state average length at age, while Smallmouth Bass growth was average.

Netting surveys designed to evaluate Walleye growth and survival were conducted from 1982 to 1995. These surveys included the use of large mesh fyke nets, and either inland or Great Lakes gill nets. It was in this period that Long Lake really began to develop an abundant Walleye fishery, due mainly to increased stocking efforts as well as some natural reproduction that was beginning to occur. According to Hay (1997), "large numbers of Walleye were planted from 1988-90 and 1995 in an attempt to increase the number of adults. These adults would then produce enough young to create an attractive fishery. Survival of these plantings were better than anticipated. The result was an abundance of slow growing individuals. Plantings were subsequently suspended for several years to monitor growth". The 1982 and 1991 evaluations found Walleye growing above state average, but from 1992 to 1995 it ranged from -0.5 to -2.8 inches below state average (Table 2).

At least one Northern Muskellunge was observed in each of the Walleye surveys that took place in 1982, 1992, 1993, and 1994. These fish likely originated from the previous Muskellunge stocking efforts from 1976 and 1977, with the exception of the one individual found in the 1982 survey, which was likely a naturally reproduced fish based on its size (31 inches).

Another general fisheries survey was conducted by Fisheries Division during July 14 -18 of 1997 in order to document the existing fish community and evaluate the Walleye population. Gear used included large mesh fyke nets, small mesh fyke nets, and inland gill nets. Eleven different species were caught during the survey. Yellow Perch were most abundant followed by Bluegill, Rock Bass, Walleye, Common Shiner, Smallmouth Bass, Largemouth Bass, Brown Bullhead, Pumpkinseed Sunfish, White Sucker, and Northern Pike. The biologist at the time noted that the Yellow Perch population in Long Lake was one of the best of any lake in the area (Hay 1997). All species were found to be growing above

the state average except for Largemouth Bass and Walleye. Six different year classes of Walleye were represented in the catch but stocking only occurred during two of those years. This indicates that strong year classes of Walleye were being naturally produced in Long Lake. On July 14, the depth of the thermocline was 30-40 feet with a temperature range of 68° F to 56° F. Surface temperature was 75° F and 53° F at 75 feet. Oxygen concentration at the surface was 9.2 parts per million (ppm), in the thermocline it was 8.6 ppm and at 75 feet was 6.0 ppm (MDNR 1997).

Fisheries Division conducted a fall Serns Index (Serns 1982, Serns 1983) survey on September 20, 2004. This electrofishing effort covered a total of six miles of shoreline and resulted in a catch of 268 Walleye ranging in size from three to nineteen inches. Five age classes of Walleye were found; age 0, age I, age II, age III, and age V, and collectively growth rates were 0.1 inches above the State average (Table 2). Good numbers of young of the year Yellow Perch and various minnow species were also observed.

In 2007, Fisheries Division conducted a general netting survey from May 21-25. This survey followed Status & Trends protocols (Wehrly et al. 2009), and included six trap nets, four large mesh fyke nets, and four inland experimental gill nets. The crew returned to Long Lake on August 9 to conduct three 600-second long electrofishing runs and six beach seine hauls. A total of 1,373 fish representing 13 different species of fish and herptiles were collected (Table 3). Game fish observed included Walleye, Yellow Perch, Smallmouth Bass, Northern Pike, Largemouth Bass, Rock Bass, Pumpkinseed Sunfish, and Bluegill. Of the species aged, only Walleye were growing below the State average length at age (-0.6), while Bluegill (+0.4), Largemouth Bass (+0.3), Northern Pike (+2.1), Rock Bass (+1.3), Smallmouth Bass (+1.4), and Yellow Perch (+1.6) were all above average.

Management Efforts

In the fall of 1950, it was announced that the dam at Big Mud Lake (now known as Lake Dubonnet) would be restored to flood some additional acreage. The idea behind this project was that during the spring runoff period, Mud Lake and Long Lake would be consistently connected by the upper Platte River and higher water levels, thus giving Northern Pike an avenue between the two waterbodies and an enhanced ability to spawn. Mud Lake has much more suitable spawning areas for pike, and the hope was that Northern Pike would be more plentifully supplied to Long Lake from Mud Lake to supplement the fishery (Fisheries Division Files, Traverse City).

Historically, Long Lake has had a large natural White Sucker population. Starting in 1953 white suckers were removed from the lake. The first two years of harvests were completed by a local commercial fisherman, followed by a plethora of local groups organizing the effort until 1967. Some of the organizations who seined each spring for spawning White Suckers included the Long Lake Area Junior English Club, the Lions Club, the Long Lake Improvement Association, and the Grawn Fire Department. The harvested White Suckers were taken for personal use by individuals involved in the efforts, while others were sold to raise money for these organizations (Fisheries Division Files).

Creel Surveys

From 1928 to 1952, the MDOC conducted low effort angler creel surveys (Figure 4). In most of these surveys Northern Pike and Smallmouth Bass were caught occasionally, with panfish being the main catch by anglers. In 1953 while compiling the creel data, it was realized that the census had shown that only one Walleye had been caught during the duration of the survey efforts, and that was in 1944. It was also thought that this fish could have possibly been misidentified. This notion, along with no Walleye

being found during the 1950 fisheries survey, indicated that previous stocking efforts were not successful.

In 2007 a creel survey was conducted on both Long and Mickey Lakes from April 27 to September 30 using a roving-access (roving counts and access point interviews) design (MDNR 2007). A total of 8,333 trips comprising 33,255 angler hours were estimated to be spent on Long Lake and resulted in a total catch of 29,499 fish. Of these 18,435 were estimated to be released, and Walleye and Yellow Perch were the fish most frequently encountered by anglers. An estimated 4,466 Walleye were harvested and 7,481 were released, while an estimated 5,649 Yellow Perch were harvest and 6,045 were released.

Current Status

In 2017 a discretionary survey aimed at evaluating Walleye recruitment was completed on Long Lake. The survey was comprised of two portions; the first portion took place from May 22 to May 25 and included the use of experimental gill nets, large mesh fyke nets, small mesh fyke nets, and traps nets, with all nets checked daily. The second portion of the survey took place on June 27 and included seining (six sites) and electrofishing (seven transects).

A limnology component including a shoreline survey and temperature and oxygen profiles, was completed on August 24 and 25. The maximum depth observed was 80 feet of water, the thermocline was found at 42 feet, and the Secchi disk depth was reported as 9.5 feet. Air temperature at 10:24 am was 57° F. Water temperature was taken at 3-foot intervals starting at the surface and showed a gradual decrease throughout the water column (Table 4).

Gamefish species including Bluegill, Pumpkinseed, Walleye, Yellow Perch, Largemouth Bass, Smallmouth Bass, and Northern Pike were measured to the nearest 0.1 inches (Schneider et al. 2000). Aging structures (10 per inch group) were collected from each gamefish species for age analysis. Scales were collected from panfish species less than 6.0-inches and bass less than 10.0-inches. Anal fin spines were collected from panfish greater than 6.0-inches, bass greater than 10.0-inches, and all Northern Pike. Dorsal spines were collected from all Walleye captured.

A total of 2, 298 fish were collected representing 19 species (Table 5). These fish combined weighed in at 1,380 pounds, with gamefish species such as Walleye, Yellow Perch, Bluegill, Smallmouth Bass, Largemouth Bass, and Northern Pike comprising 65.2% of the total biomass. Bluegill comprised the majority of the fish by number with 673 individuals, followed by Sand Shiner at 464 individuals, Rock Bass at 259 individuals, and Yellow Perch at 251 individuals. Largemouth Bass represented the heaviest weight by species with 312.0 pounds, followed by White Sucker with 213.5 pounds, and Walleye with 184.9 pounds of fish.

Of the eight species which had ageing structures collected, only Pumpkinseed did not have enough individuals to calculate a Mean Growth Index, which requires a minimum of five fish per age group in order to be statistically conclusive (Table 6).

Analysis and Discussion

The 2017 Fisheries Division survey collected residential development information such as the total number of dwellings around the lake, as well as the number of docks present. A total of 599 dwellings

were counted, equating to 22.3 dwellings per kilometer of shoreline. According to Wehrly et al. 2015, this classifies Long Lake as having a "high dwelling density" in comparison to other lakes across the state. A note in the Fisheries Division files from 1950 when the lake was mapped indicated that there were approximately 250 or 300 cottages on the lake at that time. The total number of docks counted was 609, equating to 22.6 docks per kilometer of shoreline. This many docks puts Long Lake in the "high dock density" category (Wehrly et al. 2015).

The limnological profile from 2017 documented total oxygen depletion at 39 feet, which was just above the thermocline at 42 feet. While the thermocline is comparable to what has been documented in the past, this was the shallowest depth that oxygen depletion has been documented. Secchi disk depth was also very poor compared to historical depths, with a reading at 9.5 feet; this is roughly half as deep as has been documented in the past. Poor weather conditions including a significant rainfall event in the week prior to data collection may have contributed to these abnormal readings.

There were significant differences in the fish community from the 2007 survey to the 2017 survey. This may be partially attributed to minor differences in the gear types used for each survey, however it is important to note that both surveys followed Status and Trends protocols and the 2017 survey included more electrofishing effort. Early on the crew noticed that far more Largemouth Bass were in the netting gear than in previous efforts (64 in 2007 versus 170 in 2017), and that the numbers of Bluegill had exploded (98 in 2007 versus 673 in 2017). The number of Northern Pike tripled from 12 caught in 2007 to 25 caught in 2017, but even more impressive was the range of sizes; pike expanded from a 21-29-inch range in 2007 to a much broader 11-43-inch range representing more year classes in 2017. Both Rock Bass and Yellow Perch saw large increases in the number of fish caught, however size distribution stayed the same. Relative abundance and size structure of some species remained constant between the survey years, with Pumpkinseed, Smallmouth Bass, and Walleye all having similar numbers of individuals caught and similar size ranges. Forage species appear to be abundant, though the species composition changed dramatically with far more shiner species present in 2017, whereas the dominant species in 2007 were minnows. Overall, more fish were collected, and more species were represented (13 in 2007 versus 19 in 2017). Despite the differences in sampling gear from 2007 to 2017, the changes documented do align with anecdotal comments received from anglers and riparian's during the decade between surveys.

Growth rates were acceptable to good for all species collected from Long Lake (Table 6). Smallmouth Bass exhibited the best growth, at 3.1 inches above the State average length at age. Rock Bass followed with 2.8 inches above average, and Northern Pike, Bluegill, and Largemouth Bass all showed growth over an inch above average. Only Yellow Perch and Walleye were slow growing at 0.2 and 0.6 inches below average, respectively. The decline in Yellow Perch growth rates may have some correlation with the increase in abundance of Bluegill; Schneider (1997) found that when Bluegill were introduced to a lake already dominated by Walleye and Yellow Perch, the growth rates of Yellow Perch tended to decline due to competitive interactions with Bluegill at early life stages, thus suppressing growth. Walleye growth, though below average, has followed the trends often seen in lakes where a Walleye program has been established over time. Looking back at the growth rates through time (Table 2), we see that in the first few years following Walleye introductions that very high growth rates are exhibited when the number of year classes was low, followed by some fluctuations in the 1990's as more age classes began to appear in the population, and then in more recent surveys where ten or more-year classes are represented we see more stable growth rates. Walleye tend to grow very quickly during their first

three to four years of life, although males tend to slow down once they reach maturity; this often results in the below average growth documented in Michigan lakes with natural reproduction.

Management Direction

Long Lake is a very popular lake for a multitude of species but is best known as a destination for its Walleye, Smallmouth Bass, and Yellow Perch fisheries.

Fisheries Division should conduct a spring population estimate survey targeting Walleye and Northern Pike. This type of survey will provide information needed to better understand and manage the population of naturally reproducing Northern Pike and Walleye. This should be conducted in conjunction with an inland creel survey to better understand angler effort, harvest, and demographics. Walleye are heavily targeted in Long Lake and a better understanding of the population level, recruitment, and exploitation will greatly assist in managing the lake.

The shoreline survey conducted of Long Lake clearly indicates that the lake is heavily developed, and the nearshore littoral zone habitat is somewhat compromised due to human activity. Improving nearshore habitat would be beneficial to the nearshore ecology of Long Lake and could also assist in improving the size structure of panfish. Fisheries Division should continue to work with the Department of Environment, Great Lakes, and Energy (EGLE) to review permit applications and work with riparian property owners to choose softer engineering approaches in conjunction with native plantings instead of seawalls and sheet piling when shoreline stabilization is required or desired. Fisheries Division and EGLE should also encourage riparian landowners to reduce nutrient loading in the form of lawn fertilizer and chemical treatments, to discontinue the practice of clearing all nearshore plant growth from their beach areas, and instead allow trees and woody debris the opportunity to fall into the nearshore area and be recruited into the lake as habitat. These practices may be contributing to some of the issues documented with dissolved oxygen depletion and increased temperatures within the lake.

Limnological profiles should be completed in more frequent intervals. While the abnormalities in oxygen depletion and secchi disk readings in 2017 compared to historical data may have been tied to a singular weather event, it may not be, and additional sampling would provide added clarity on the recent water quality findings that indicated concerns of low dissolved oxygen. Increasing changes in climate is expected to result in warmer water temperatures and other abiotic conditions that are important for Walleye. In fact, changing inland lake habitats because of climate change has already been highlighted as a mechanism for several decreasing Walleye populations in Wisconsin (Hansen et al. 2015).

Fisheries Division should replicate this discretionary survey as time allows between 2027 and 2032, so that comparisons of the fish community and habitat characteristics can be determined among the years. Additionally, it is recommended that a fall Serns Index survey be completed to assess the continued presence of Walleye natural recruitment. These surveys would provide the information necessary to evaluate the desired fish community goals and when necessary would inform whether adaptive manage efforts are warranted to address concerning trends.

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Table 1. Historic Long Lake fish stocking, 1894-1995.

Year	Species	No. of Fish Stocked
1894	Walleye	400,000
1895	Walleye	400,000
1905	Largemouth Bass	1,500
1909	Lake Trout	20,000
1910	Lake Trout	15,000
1933	Largemouth Bass	2,000
	Bluegill	12,000
	Walleye	200,000
1935	Bluegill	10,000
	Walleye	240,000
1936	Bluegill	700
	Black Bass	21,350
	Minnows	227,000
	Walleye	450,000
	Yellow Perch	3,250
1937	Bluegill	30,000
	Black Bass	17,400
	Walleye	420,000
1938	Bluegill	30,000
	Black Bass	7,000
	Walleye	300,000
1939	Bluegill	25,000
	Black Bass	4,667
	Walleye	300,000
	Yellow Perch	10,000
1940	Black Bass	4,534
	Walleye	180,000
1941	Bluegill	20,000
	Black Bass	3,552
1942	Black Bass	2,560
	Walleye	200,000
1944	Bluegill	1,000
	Black Bass	2,400
1958	Walleye	20,000
1968	Walleye	500,000
1970	Brown Trout	700
1976	Muskellunge	6,114
1977	Muskellunge	5,694
1986	Walleye	6,720
1988	Walleye	7,450,000
1989	Walleye	22,554
1990	Walleye	6,000,000

1995	Walleye	40,630

Table 2. Walleye and Muskellunge growth rates in Long Lake, Grand Traverse County, 1982-2017.

Survey Year	Species	Age Groups Observed	Total Number of Fish Aged	Mean Growth Index*
1982	Walleye	I, II, III, IV, V, VI, VII	45	+2.8"
	Northern strain Muskellunge	VI	1	NA
1991	Walleye	II, III, IV,V	65	+ 5.5"
1992	Walleye	II, III, IV	94	- 1.1"
	Northern Muskie	V, VIII, X	3	NA
1993	Walleye	III, IV, V, VI	60	-0.5"
	Northern Muskie	XII	1	NA
1994	Walleye	I, III, IV, V, VI	54	-2.8"
	Northern Muskie	VIII	1	NA
1995	Walleye	I, II, III, IV, V, VI	36	-1.5"
1997	Walleye	I, II, III, IV, VI, VII	61	-1.4"
2004	Walleye	0, I, II, III, V	99	+0.1"
2007	Walleye	0, I, II, III, V, VI, VII, IX, X, XII	139	-0.6
2017	Walleye	I, II, III, IV, V,VI, VII, VIII, IX, X, XI, XII	107	-0.6"

Table 3. Number, weight, and length of fish collected from Long Lake with large mesh fyke nets, seines, trap nets, inland gillnets, and electrofishing in May and August of 2007.

Species	Number	Percent by number	Weight (Pounds)	Percent by weight	Length range (inches)[1]
Bluegill	98	7.1%	24.5	2.9%	3-9
Bluntnose Minnow	520	37.9%	2.9	0.3%	1-3
Brown Bullhead	16	1.2%	16.0	1.9%	8-15
White Sucker	41	3.0%	147.7	17.5%	17-23
Largemouth Bass	64	4.7%	84.9	10.1%	2-19
Northern Pike	12	0.9%	36.2	4.3%	21-29
Pumpkinseed	4	0.3%	1.0	0.1%	6-7
Map Turtle	3	0.2%	0.0	0.0%	5-7
Rock Bass	198	14.4%	99.8	11.8%	3-12
Smallmouth Bass	111	8.1%	243.8	28.9%	2-20
Walleye	154	11.2%	165.1	19.5%	3-26
Mudpuppy	1	0.1%	0.0	0.0%	13
Yellow Perch	151	11.0%	22.8	2.7%	1-13
Total	1,373	100.0%	844.7	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.

Table 4. Limnological profile for Long Lake, Grand Traverse County, August 25, 2017.

Water Depth (feet)	Temperature (ºF)	Oxygen (ppm)	pH
0	71.6.	8.28	8.43
3	71.5	8.38	8.45
6	71.4	8.38	8.44
9	71.3	8.39	8.45
12	71.3	8.33	8.45
15	71.3	8.21	8.45
18	71.2	8.24	8.44
21	71.2	8.17	8.4
24	71.1	8.14	8.41
27	71.1	8.02	8.4
30	71.1	7.94	8.39
33	70.9	7.96	8.35
36	70.8	1.71	8.32
39	70.8	0	8.34
42	66.6		7.38
45	61.6		7.15
48	59.8		7.1
51	58.8		7.09
54	58.4		7.09
57	58		7.08
60	57.9		7.09
63	57.6		7.1
66	57.4		7.11
69	57.4		7.1
72	57.2		7.16
75	57		7.14
78	56.9		7.16

Table 5. Number, weight, and length of fish collected from Long Lake with large mesh fyke nets, seines, trap nets, inland gillnets, and electrofishing in May and August of 2017.

Species	Number	Percent by number	Weight (Pounds)	Percent by weight	Length range (inches)[1]
Bluegill	673	29.3%	80.1	5.8%	1-10
Bluntnose Minnow	30	1.3%	0.2	0.0%	1-3
Brown Bullhead	19	0.8%	24.0	1.7%	0-15
Common Shiner	1	0.0%	0.0	0.0%	2
White Sucker	77	3.4%	213.5	15.5%	1-24
Green Sunfish	2	0.1%	0.0	0.0%	2-3
Hybrid Sunfish	1	0.0%	0.5	0.0%	8
Iowa Darter	1	0.0%	0.0	0.0%	2
Largemouth Bass	170	7.4%	312.0	22.6%	1-19
Logperch	1	0.0%	0.0	0.0%	2
Mimic Shiner	78	3.4%	0.4	0.0%	1-3
Northern Pike	35	1.5%	141.7	10.3%	11-43
Pumpkinseed	4	0.2%	1.2	0.1%	6-8
Rock Bass	259	11.3%	161.2	11.7%	2-12
Sand Shiner	464	20.2%	2.2	0.2%	1-3
Smallmouth Bass	109	4.7%	181.1	13.1%	0-20
Walleye	113	4.9%	184.9	13.4%	6-24
Yellow Perch	251	10.9%	67.3	4.9%	1-14
Yellow Bullhead	10	0.4%	9.7	0.7%	8-15
Total	2,298	100.0%	1380.0	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.

Table 6. Average total weighted (inches) at age, and growth relative to the state average, for fish sampled from Long Lake in 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.

	Age												
Species	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Mean Growth Index
Bluegill	1.80	2.89	6.17	7.23	8.55	9.86	9.54						+1.2
	(12)	(22)	(19)	(29)	(7)	(6)	(3)						
Pumpkinseed			6.90	6.55	8.30								--
			(1)	(2)	(1)								
Smallmouth Bass	6.23	10.88	14.15	16.27	17.02	17.68	18.10	18.50	20.10	19.78			+3.1
	(4)	(42)	(12)	(6)	(9)	(12)	(2)	(4)	(1)	(4)			
Largemouth Bass	4.0	8.06	10.44	12.90	15.35	15.77	16.42	17.34	17.94	17.80	18.23	18.55	+1.1
	(1)	(9)	(22)	(10)	(23)	(18)	(10)	(4)	(3)	(1)	(5)	(2)	
Northern Pike	15.20	18.22	22.40	25.10	26.9	26.73	42.25						+1.3
	(1)	(6)	(10)	(5)	(9)	(4)	(2)						
Walleye	6.66	11.15	14.86	15.35	17.26	19.12	19.27	19.15	19.91	15.70	22.84	22.95	-0.6
	(7)	(17)	(13)	(13)	(12)	(9)	(14)	(10)	(7)	(1)	(2)	(2)	
Rock Bass	2.47	5.42	7.51	9.0	10.4	11.18	11.74	11.74	12.30				+2.8
	(3)	(13)	(33)	(18)	(11)	(5)	(9)	(4)	(1)				
Yellow Perch	3.70	4.39	6.30	7.10	8.72	9.41	9.98	10.63	11.68	13.55			-0.2
	(26)	(21)	(11)	(17)	(13)	(7)	(11)	(11)	(10)	(2)			
			(5)	(4)	(2)	(2)		(2)	(1)	(1)		(1)	

Figure 1. Bathymetric map of Long Lake, Grand Traverse County.

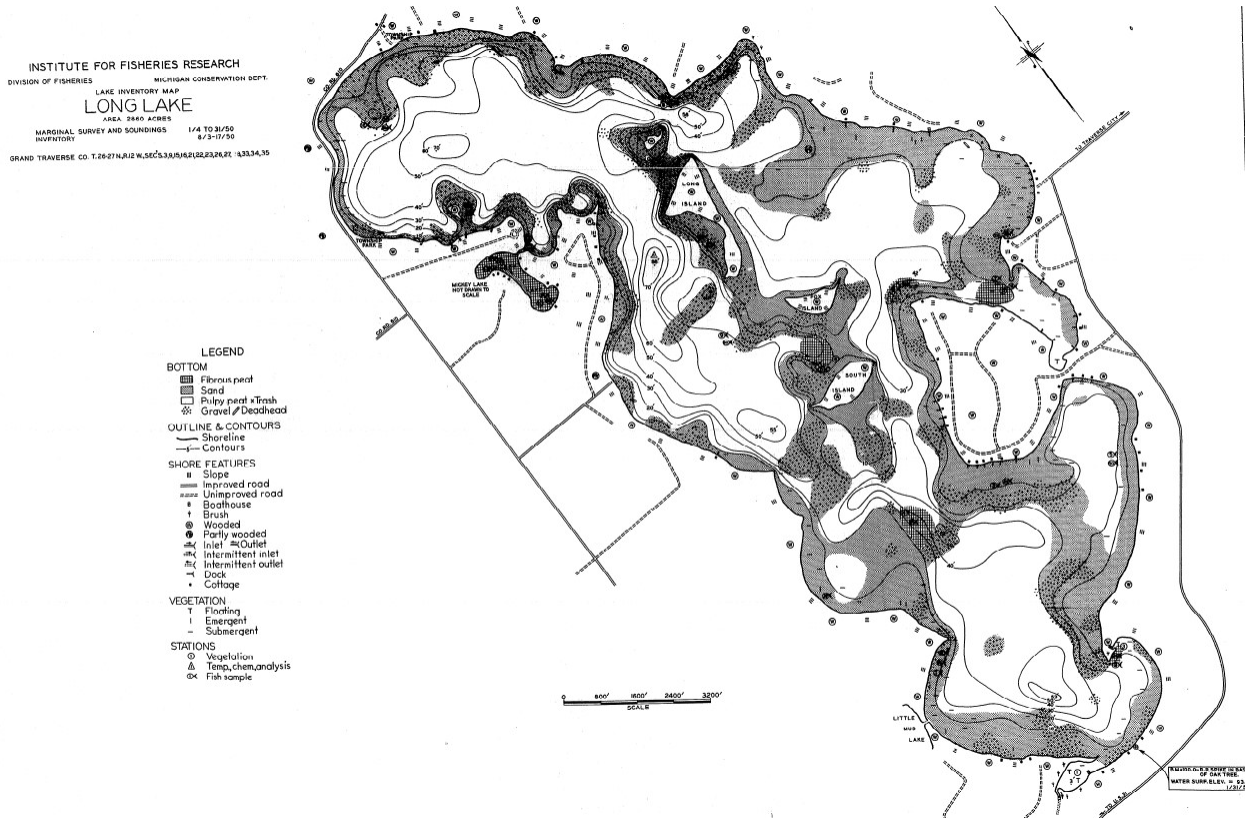


Figure 2. Long Lake, part of the Platte River Watershed, Benzie, and Grand Traverse Counties.

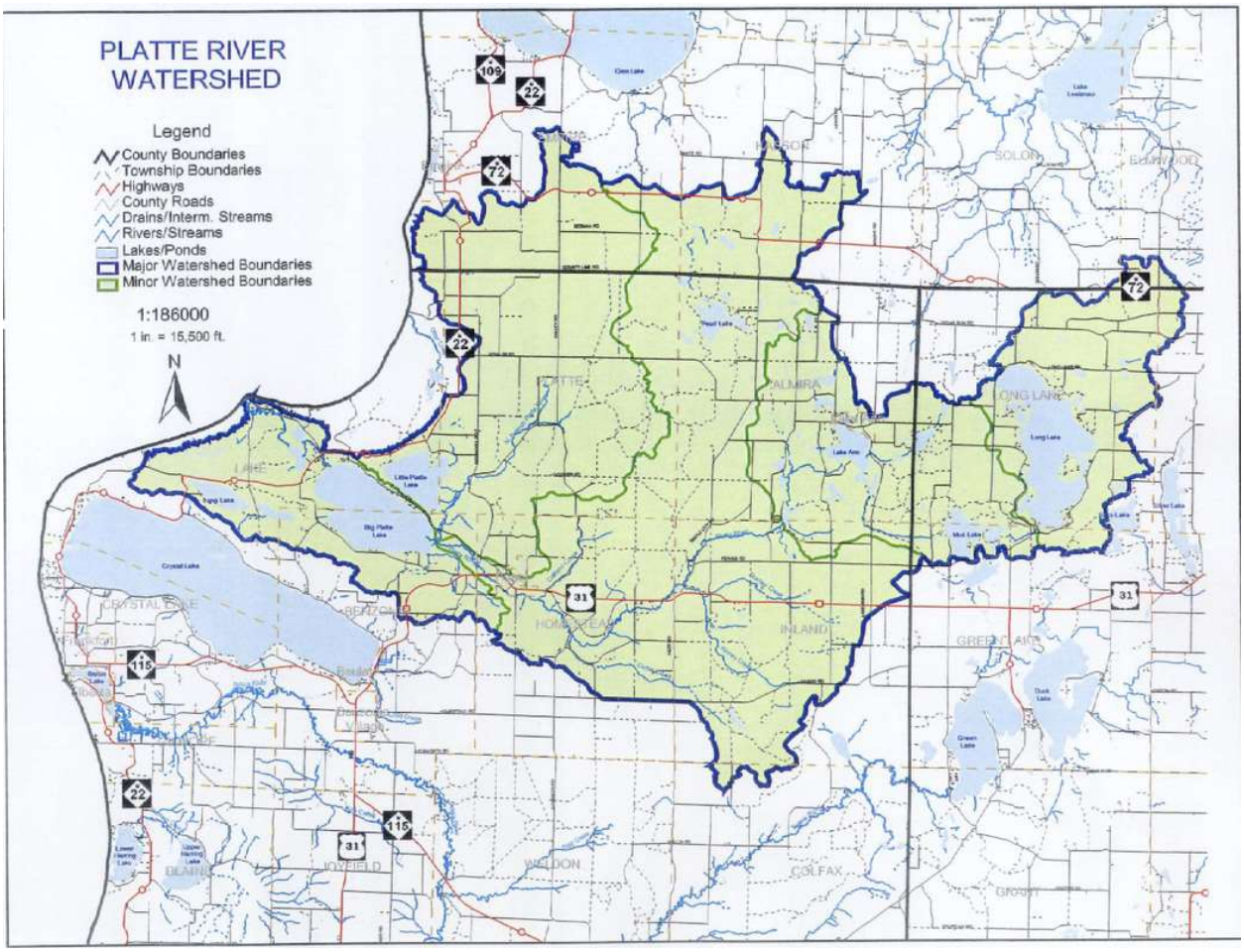


Figure 3. Islands of Long Lake, Grand Traverse County.

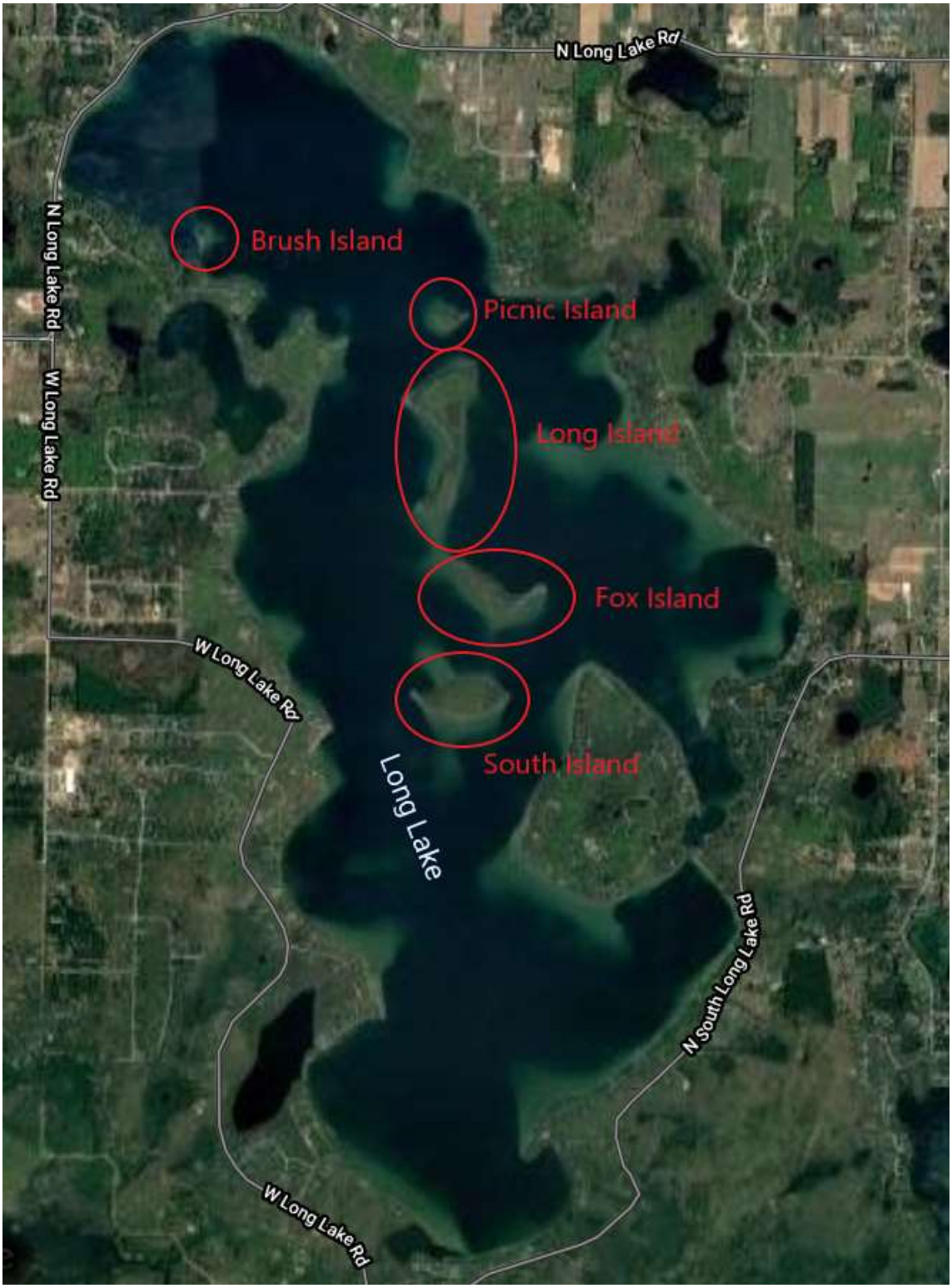
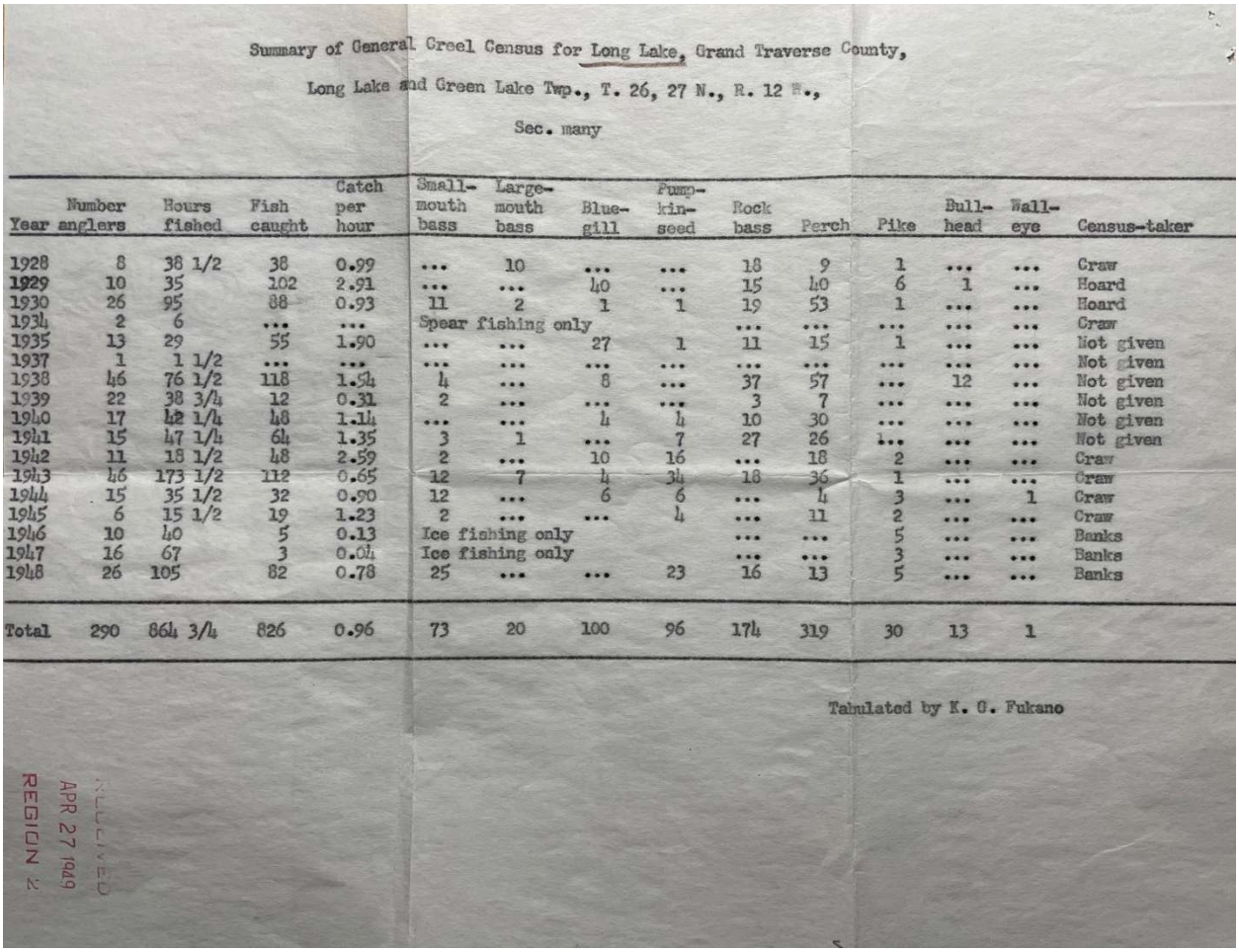


Figure 4. Historic creel surveys of Long Lake anglers, 1928-1948.



Summary of General Creel Census for Long Lake, Grand Traverse County,

Long Lake and Green Lake Twp., T. 26, 27 N., R. 12 W.,

Sec. many

Year	Number anglers	Hours fished	Fish caught	Catch per hour	Small-mouth bass	Large-mouth bass	Blue-gill	Pump-kin-seed	Rock bass	Perch	Pike	Bull-head	Wall-eye	Census-taker
1928	8	38 1/2	38	0.99	...	10	...	...	18	9	1	...	...	Craw
1929	10	35	102	2.91	...	...	40	...	15	40	6	1	...	Hoard
1930	26	95	88	0.93	11	2	1	1	19	53	1	...	...	Hoard
1934	2	6	...	...	Spear fishing only				...	...	...	...	...	Craw
1935	13	29	55	1.90	...	...	27	1	11	15	1	...	...	Not given
1937	1	1 1/2	...	...	...	...	...	...	...	...	...	...	...	Not given
1938	46	76 1/2	118	1.54	4	...	8	...	37	57	...	12	...	Not given
1939	22	38 3/4	12	0.31	2	...	...	...	3	7	...	...	...	Not given
1940	17	42 1/4	48	1.14	...	...	4	4	10	30	...	...	...	Not given
1941	15	47 1/4	64	1.35	3	1	...	7	27	26	...	...	...	Not given
1942	11	18 1/2	48	2.59	2	...	10	16	...	18	2	...	...	Craw
1943	46	173 1/2	112	0.65	12	7	4	34	18	36	1	...	...	Craw
1944	15	35 1/2	32	0.90	12	...	6	6	...	4	3	...	1	Craw
1945	6	15 1/2	19	1.23	2	...	...	4	...	11	2	...	...	Craw
1946	10	40	5	0.13	Ice fishing only				...	...	5	...	...	Banks
1947	16	67	3	0.04	Ice fishing only				...	...	3	...	...	Banks
1948	26	105	82	0.78	25	...	...	23	16	13	5	...	...	Banks
Total	290	864 3/4	826	0.96	73	20	100	96	174	319	30	13	1	

Tabulated by K. G. Fukano

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Randall M. Claramunt, Desktop Publisher and Approval