Long Lake

Alpena/Presque Isle counties
Lake Huron watershed, last surveyed 2004

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Environment

Long Lake lies along the Alpena and Presque Isle county line in the northeastern part of Michigan's Lower Peninsula. It is 5,342 acres in size and is situated about 7 miles north of the town of Alpena. Long Lake is fed by a variety of small creeks (Figure 1). The largest tributary is Shuberts Creek, which enters the lake on the northwest shore. Other tributaries, such as Clinton and Mindack creeks, enter the northwest arm of the lake, while Fitzgerald and Long Lake Park creeks enter the lake in the middle reaches. Most of these tributaries are used by game fish seasonally for spawning. In fact, springtime fishing closures are in place on Shuberts and Clinton creeks. The outlet (Long Lake Creek) can be found on the south shore which flows towards Lake Huron. There are two dams in the outlet; one at the head of the stream stabilizes the level of the lake, while the lower dam at one time formed a fish rearing pond. The main Long Lake dam was built in 1936, and the legal lake level (650.89 ft) was established by court order in 1948. A public access site exists along the western shore of the lake. It consists of a hard-surfaced ramp with sufficient water depth to accommodate large watercraft, has 10 parking spaces, a public toilet, and is handicap accessible. A county-owned ramp exists on the southeast shore which provides ample parking for anglers. Three smaller unimproved access sites are scattered along the lakeshore, including one in East Bay. Launching of watercraft can be difficult at some of these sites when the lake level is low.

The shoreline of Long Lake is largely developed with private residences, thus there is little public riparian land. There were 228 riparian residences in 1939, and there are approximately 750 at present (counted from Google Earth satellite image). The bathymetry of Long Lake was mapped between 1935 and 1936, and the maximum depth was recorded as 25 feet. The bathymetry is rather uniform, with most of the lake between 10 to 20 feet deep (Hanchin and Cwalinski 2011) (Figure 2). The relatively shallow depth of Long Lake, together with regular exposure to strong winds, allows for repeated mixing of its water. Thus, thermal stratification does not occur often, except during periods of extreme summer heat. The substrate of Long Lake consists of mainly sand, gravel, and cobble in the near-shore areas while marl and muck can be found in deeper water. Water clarity of Long Lake is typically high, although the shallow nature of the lake often leads to reduced clarity through wave action. When surveyed in the 1930's, various species of aquatic vegetation were common, particularly of the genus Chara (muskgrass), while near-shore vegetation was rare. Currently, aquatic vegetation is sparse in Long Lake. Emergent beds of rushes can be found in various protected areas near shore. The Long Lake Association installed 364 brush shelters in Long Lake from 1942 through 1952 to provide fish cover and improve angling.

Alkalinity in the late 1930s ranged from 110 to 141 parts per million of calcium carbonate. Temperature and dissolved oxygen profiles in June of 1939 demonstrated no thermal stratification and consistent (8ppm or more) oxygen levels throughout the water column. More recently, Long Lake limnological parameters were surveyed on various occasions: from 1973 to 1979, in 1989, 1993, 1994, and 2004. Detailed results for most of these samples can be found in TMI Environmental Services

(1994). Earliest surveys in the 1970s indicated elevated levels of surface phosphorus and average levels at the bottom. Summer dissolved oxygen and temperature values were typical for a well-mixed shallow lake system (Moreau and Mears 1973). The water had low salt content and was moderately hard. High nutrient concentrations were observed and were suggested to be from excessive watershed inputs. Aquatic invertebrates such as mayflies, alderflies, and midges were all common as were a variety of zooplankton species. The zooplankton community was said to reflect that of a nutrient rich environment in a mesotrophic state (Moreau and Mears 1973). The final conclusion from the 1973 survey indicated that Long Lake was severely enriched from overland nutrients and from other in-lake natural sources.

Alpena Community College conducted water quality monitoring of Long Lake in early June of 1989. Results indicated that Long Lake reached a quality level that had been fairly steady over the last decade. Again, no thermocline was established in Long Lake although dissolved oxygen levels declined near the bottom. Alkalinity was measured at 165 parts per million. Results suggested that Long Lake was maintaining its mesotrophic status and was not approaching eutrophy as suggested by the 1979 survey.

Results of the early to mid 1990s limnology surveys again indicated thorough mixing of the lake, and the lack of a thermocline (TMI Environmental Services 1994). Oxygen and temperature levels remained highly suitable for fish survival. Lake waters were alkaline in nature. Phosphorus levels were lowest in the spring and highest during the summer. Lead levels in the water and fish were considered negligible. Results from planktonic algae sampling indicated that Long Lake was still at mesotrophic status.

Another detailed limnological survey of Long Lake was made by Fusilier and Fusilier (2001) in 2001. Tests performed on the samples included total phosphorus, total nitrate nitrogen, total alkalinity, pH, conductivity, chlorophyll-a, water clarity, temperature, and dissolved oxygen. Late summer sampling found uniform oxygen and temperature throughout the water column. Total alkalinity was 95 to 108 parts per million in spring, and 122 to 124 parts per million in the summer. These values classify Long Lake as a moderately hard water lake. Nitrate nitrogen concentrations were found to be low, indicating that nitrate, rather than phosphorus, was the limiting nutrient during both the spring and summer (Fusilier and Fusilier 2001). The level of chlorophyll-a was found to be low in Long Lake, which suggested low algal densities. Secchi-disk readings measured in Long Lake from 1992 and 2001 ranged from 13 to 19 feet, and indicated a general decline in algae and increase in water clarity over the time period.

Various water parameters were measured by the MDNR Fisheries Division on Long Lake in mid-June 2004. A dissolved oxygen and temperature profile showed suitable dissolved oxygen levels for fish throughout the water column, and nearly uniform water temperature (72 F). Total alkalinity was 120 parts per million, well within the typical range for this type of lake. Chlorophyll-a measurement was 1.4 parts per billion. Secchi-disk reading was over 8 feet indicating fair water clarity. Although this indicates lower water clarity than observed from 1992 to 2001, Long Lake experiences occasional mixing during high wind events, which results in higher turbidity.

To summarize, Long Lake is a large wind-swept inland lake that rarely demonstrates a thermocline. Alkalinity values are not considered high in Long Lake indicating marginal productivity. Water clarity

can be high at times, and very low at other times (such as after a storm). Water temperatures and dissolved oxygen levels are suitable for most northern Michigan fish species.

History

Fishery management practices have varied through the last century in Long Lake. This is reflected in the amount and type of fish stocking efforts that have occurred in this time frame. Many of the initial stocking efforts focused on warm water species. Early lake managers viewed it as a shallow water lake with more potential to produce fish such as bass and perch. It was common for the Michigan Department of Conservation (MDOC) to stock such warm- and coolwater species throughout Michigan lakes in the first half of the twentieth century, without having quality presence and absence data for fish populations.

Fish stocking in Long Lake has involved a variety of species, ages, and sizes dating back to 1905 (Table 1). Lake trout fry stocking was attempted in 1910, and largemouth bass, bluegill, rock bass, black crappie, and pumpkinseed were stocked in varying numbers and sizes from 1905 through the middle of the twentieth century. Yellow perch were also stocked on occasion during this period. Smallmouth bass were stocked by the State of Michigan from 1933 through 1945 and included multiple occasions when adult fish from Lake Huron were transferred to various inland lakes, including Long Lake (Shetter 1942).

Northern pike fingerlings were released directly into Long Lake in 1964 and annually from 1976 to 1985 (Table 1). A pike spawning and rearing marsh, established in 1963 at the mouth of Fitzgerald Creek, was maintained by the MDNR and the local lake association. The MDNR released northern pike fry directly into the marsh in most years, until 1985 when adult pike were allowed to naturally enter the marsh for spawning. Use of this marsh was discontinued after 1985 due to concerns over flooded timber on adjacent private land. Other suitable pike spawning marshes on tributaries were investigated by the MDNR and lake association through the 1960s and 1970s, but these efforts failed due to the inability to acquire flowage rights on private land.

The earliest walleye stocking efforts using fry and fingerlings were made from 1910 to 1914, followed by fry and fingerling introductions in the 1930s (Table 1). Stocking of this species did not resume until 2004, after which a combination of fry, spring fingerlings, and fall fingerlings have been stocked on various occasions through 2011. Fry were approximately 0.5 inches long, spring fingerlings were approximately 1.7 inches long, and fall fingerlings were 6-7 inches long. All walleyes stocked in Long Lake by the MDNR during this period were marked with oxytetracycline in order to determine the contribution of stocked fish to the overall population. The Long Lake Association has also stocked more than 30,000 fall fingerling walleyes in Long Lake from 2004 through 2011. These stocking efforts were in response to perceived and measured low-density walleye abundance in the recent decade.

Many of these stocking efforts followed a period of fish and aquatic community surveys of various intensities. The first recorded survey by MDOC of Long Lake came in 1925 and 1926 when personnel used seining and other netting (unspecified) to examine the basic fish community. They found the following to be present: yellow perch, walleye, rock bass, smallmouth bass, white suckers and various species of darters, shiners, minnows, and killifish. These were species fairly common to other inland

lakes in northern Michigan. A decade later, Long Lake contours were mapped by MDOC and produced the maps that are often still used today.

A fish community evaluation was made in 1939 on Long Lake and summarized by Brown and Moffett (1940). Effort consisted of shoreline seining and over 3,000 feet of gill net. The smallmouth bass stocking and transfer efforts were ongoing for this period as well as yellow perch stocking by the State of Michigan (Table 1). The dominant predators were smallmouth bass, northern pike and walleye. Yellow perch were found to be common with large perch present. Other species such as bluegill, pumpkinseed and lake whitefish were found in relatively small numbers while minnows, shiners, and darters were all present. Brown and Moffett (1940) considered Long Lake as an ideal pike and perch lake, but thought that walleye would only be sustainable in lower numbers and would occasionally require supplementation by stocking. The pike were thought to be in higher abundance at that time due to higher water levels which may have flooded quality spawning habitat that is lacking today due to development.

As mentioned previously, adult smallmouth bass were transferred in many years from Lake Huron to Long Lake (and other area lakes). This was done in cooperation with the commercial fishery on Lake Huron. Long Lake received 400-1,000 adult smallmouth bass in many years. Shetter (1942) reported that just over a 1,000 adult bass were transferred to Long Lake in 1940 and a sub-sample of 200 fish were jaw tagged. Jaw tag returns from anglers demonstrated that 25% of those tagged were recaptured by anglers within one year of their transfer. Most transplanted fish stayed within a small radius of the stocking site, yet approximately 1% of the fish returned to Lake Huron. This is important to consider even today that some small percentage of the Long Lake fish community naturally migrate downstream from Long Lake to Lake Huron.

Two less extensive fish community surveys were made at Long Lake in the 1940s. MDOC used a 25-foot bag seine (14 hauls) and 6 experimental gill-net lifts (870 total feet) in 1946 to capture mainly yellow perch, rock bass, northern pike, white suckers and various minnow species. In 1948, MDOC used trap nets for the first time in Long Lake. Twenty trap-net lifts captured the same typical game fish. Predator fish were again dominated by smallmouth bass, northern pike, and walleye (Laarman 1976).

Stocking efforts for most species had tapered off in Long Lake by the 1950s except for northern pike. A pike stocking program for Long Lake was initiated by the State of Michigan in 1964 and it continued for many years. Gill nets (1,050 total feet) were used by MDOC in August 1957 to examine the fish community. Yellow perch, rock bass, and smallmouth bass dominated the catch, and pike and walleye were caught to a lesser degree.

By the 1960s there was interest in creating a northern pike spawning marsh on one of the tributaries of Long Lake. Records are unclear, but it is believed that the lake association and Fisheries Division created a pike spawning marsh in 1963 on Fitzgerald Creek. The creek was temporarily dammed to create a flooding suitable for northern pike spawning or for the direct transfer of fingerlings or fry (which occurred starting in the next decade). Angler reports in the early 1960s indicated that fishing was excellent in Long Lake, especially for walleye 14-18 inches in length and for perch 7-11 inches. According to notes, angler pressure was high during this period and 186 ice fishing shanties were counted on the lake on a date in February 1965.

The next fish community survey was done by the Michigan Department of Natural Resources (MDNR) in June of 1966. Effort consisted of seven hours of night electrofishing and 34 experimental gill-net lifts. No thermocline was established at the time of the survey and dissolved oxygen was suitable for fish throughout the water column. Fishing, according to some residents, was considered "better in the past". Results of the survey showed that yellow perch were very abundant and growth was considered good (Table 2). Species such as rock bass, walleye and smallmouth bass were common while northern pike were still rare, despite recent developments with the pike marsh.

General fish community surveys were scarce for Long Lake through the 1970s. Concern arose from residents and anglers during this period that the illegal and legal harvest of walleye and northern pike in three key spawning tributaries was excessive. These included Shuberts, Clinton, and Mindack creeks (Figure 1). A report by a local conservation officer in the mid 1970s estimated a spring spawning run of 4,000-8,000 walleye in Shuberts Creek with most fish 15 inches in length. Concerns continued to rise over potential large numbers of congregated and vulnerable fish especially after 40 arrests were made for illegal spearing alone in these creeks in 1974. The walleye opening date at this time was May 1 but this would soon change. Shuberts and Clinton creeks were eventually closed to fishing during the entire month of May. Today, these streams are closed to fishing from April 1 through May 14 to allow for protection of spawning walleye and the less common northern pike. In addition, attempts were made at this time to create another northern pike spawning marsh on Fitzgerald Creek. This was never accomplished since flowage rights were impeded by adjacent landowners.

There have been a variety of angler surveys conducted on Long Lake from 1936 through 1975. The oldest harvest and effort estimates for Long Lake were reported by Laarman (1976). A special creel survey was conducted in 1936, a general creel survey (designed to measure the success of anglers who were actually interviewed) was conducted from 1938 to 1964, and mail surveys were used to assess the fishery in the early 1970s (Hanchin and Cwalinski 2011). Most of the fish caught in 1936 were yellow perch, which comprised 86% of the winter catch, and 69% of the summer catch. Walleye made up 4% of the winter catch and 3% of the summer catch, while northern pike comprised 10% of the winter catch and 9% of the summer catch in 1936. Other species observed in low abundance in the harvest back then were rock bass, pumpkinseed, bluegill, smallmouth bass, and largemouth bass.

Hanchin and Cwalinski (2011) summarized data from the general creel survey period (1938-64). During this time, yellow perch made up 69% of the total harvest in Long Lake, followed by northern pike (8%), smallmouth bass (7%), and walleye (6%). Many of the other species already mentioned comprised the remainder of the harvest along with a few cisco (lake herring) and whitefish. These cold water species indicated that either a cold water niche was available in Long Lake, or they were fish that entered Long Lake from Lake Huron. Smallmouth bass had become a much more prominent species in the angler catch as the decades proceeded, continuing into the 1970s. The estimated angler catch during 1970 was over 72,000 yellow perch, over 14,000 walleye, and more than 10,000 smallmouth bass, with bass comprising 11% of the total catch (harvest and release; Hanchin and Cwalinski 2011). Based on the mail surveys, angler effort at Long Lake was slightly more than 33,000 days in 1970, and nearly 27,000 days in 1973. These were translated to 100,000 angler hours in 1970 and 80,000 angler hours in 1973 based on estimates by Hanchin and Cwalinski (2011).

Fish community surveys continued at Long Lake with an intensive survey completed by MDNR in late-May and early-June of 1982. This effort was in response to the Long Lake Association's concerns that more bass and panfish were needed in Long Lake and that carp and sucker numbers were increasing. Other concerns raised at this time were that aquatic vegetation was declining in Long Lake, and that increased pleasure boats and waterskiing courses were interfering with angler activities. The 1982 fish survey effort consisted of 33 experimental gill net lifts and an unknown number of large-mesh trap-net lifts. A list of the species and numbers collected can be found in Table 3. Small mesh gear was not used in the survey, thus it can be assumed that small panfish, minnows, and shiners were not accurately represented in the survey.

Smallmouth bass were caught in large numbers in the 1982 survey. This species was represented by many year classes and demonstrated slightly slow growth. Few legal-sized bass were present but many in the 8-13 inch range could be found. Walleye were the second most common large predator and demonstrated average growth rates. Walleye had not been stocked in Long Lake for many decades, thus all these were naturally reproduced fish. Good numbers of legal-sized walleye were caught, and most walleye were 14-18 inches in length (Table 4). Nine year classes could be found with good distribution across all ages. Northern pike were present in the survey catch, but were not considered abundant. Northern pike growth was considered average and seven year classes were noted. A fair proportion (39%) of northern pike collected were larger than 24 inches (Table 4) which is the legal size for this species today.

Panfish diversity was considered low based on survey results since only two species of panfish (rock bass and yellow perch) were collected (Table 3). Rock bass were extremely abundant and demonstrated average growth. Yellow perch were collected in lower numbers, but this may not have been indicative of true perch abundance since smaller mesh gear (fykes, seines) were not used to collect fish. Yellow perch growth was considered good and many perch larger than 8 inches were collected (Table 4).

Other species such as white suckers, carp, and channel catfish were not collected in high numbers and even one lake whitefish was caught (Table 3). Based on this survey, fisheries managers felt the lake had "excellent balance" among its fish community. It was recommended that the pike marsh continue to be operated when feasible. Managers also noted that some of the walleye and pike population would continue to be protected with the spawning closures in place on various tributaries.

Fisheries reports for Long Lake in the early 1990s were unclear, but evidence suggests that a white sucker removal was done in 1991 as a joint effort between MDNR and the Long Lake Association. Reports indicate that 900 white suckers were removed by lake association members, from nets owned by the DNR. It is presumed that suckers were removed to reduce competition with other species for food resources.

By the mid 1990s the focus at Long Lake (along with many northern Michigan lakes) turned to walleye. This species had become much more popular in northern Michigan by this time, and managers across the State of Michigan were assessing stocked and wild walleye populations by conducting fall shoreline electrofishing runs. These fall assessments were most useful for determining how strong various year classes of walleye were, and were especially useful in determining relative abundance of age-0 and age-1 juveniles. The first fall juvenile walleye assessment was made at Long

Lake in 1997, right about the time that invasive zebra mussels had become established in Long Lake. MDNR electrofished the shoreline for 1.6 hours in early September 1997 and sampled 65 total walleye (Table 5). This included a catch rate of over 27 age-0 walleye per hour, which is considered a good year class. Also collected was a good number (18) of age-1 walleye, or yearlings. Since Long Lake was not stocked, it appeared that natural production of walleye was considered good in 1996 and 1997. Survey notes also indicated abundant numbers of rock bass, yellow perch, shiners and log perch in the near-shore area.

By 1999, fishing reports from members of the Long Lake Association indicated an excellent spring and summer fishery that compared back to the "good old days". Angler reports indicated good numbers of walleye around 15 inches with many 9-10 inch perch and large smallmouth bass. There was public concern, however, on the possible deleterious effects associated with zebra mussels and another invader, the aquatic plant Eurasian water milfoil.

Following these angler reports came another fish community survey done by MDNR in early- to mid-May of 2000. Effort consisted of 13 experimental gill-net lifts, 17 trap-net lifts, and 6 fyke-net lifts. It is believed that most of the trap and fyke-nets had large mesh; thus smaller fish may not have been represented relative to their true abundance. A total of 1,022 fish were collected in the survey (Table 6). Notes from the survey indicate that Long Lake continued to produce fish populations exhibiting very good size distributions. The walleye population was represented by nine year classes (ages 2-7, 9-10, 12) with slightly lower than state average growth rates, which was not considered uncommon for this type of lake. Less walleye were collected in the 2000 survey, but the amount of sampling effort was believed to be much higher in the 1982 survey.

Despite the potential difference in effort, the catch of smallmouth bass in 2000 was nearly identical to the survey catch from 1982 (Table 4). This species was considered very healthy in Long Lake and had an acceptable size distribution (Table 4) with many legal-sized fish (14 inches and larger) available to anglers. Natural reproduction for smallmouth bass was excellent, with all age classes represented from age 1-11. Northern pike were caught in fewer numbers during the 2000 survey, possibly due to differences in survey effort. The pike marsh had not been operated in many years for reasons unknown.

Growth rates for yellow perch were slightly above state average. Reproduction of perch was considered consistent with every year class represented from age 2-8. A lower proportion of perch larger than 10 inches were caught in the 2000 survey compared to 1982 (Table 4). This could indicate that harvest was trimming off excessive numbers of larger fish since growth rates were still considered good. Rock bass continued to be an abundant member of the Long Lake fish community based on numbers and quality sizes (Table 4).

No carp or channel catfish were collected during the 2000 survey (Table 6). Given that these species thrive in turbid waterbodies, their reduced abundance may have resulted from the increased water clarity that resulted after zebra mussels were established. Seven lake whitefish were collected, indicating some small or seasonal niche for cold water species, despite the shallow nature of Long Lake. Managers after this survey considered the lake to have a healthy fish population.

Current Status

I will consider that fish surveys made on Long Lake since 2003 will fall under this section of "Current Status" since they retain a general theme revolving around walleye densities and production.

A walleye recruitment evaluation was made for Long Lake in the fall of 2003. This involved two hours of night electrofishing in August. Water temperature was considered slightly high (72F) for such a survey. No juvenile (age-0 and age-1) walleye were collected in the short survey span and only three adult walleyes were collected. Based on this limited sampling effort, it appeared that the 2002 and 2003 year classes of wild walleye in Long Lake were weak. There was growing discontent among anglers with the fish population of Long Lake at this time, especially for the walleye population. This survey may have been an early indicator of low walleye numbers.

The next evaluation of fish for Long Lake was extensive, and included predator population estimates and open water and ice-cover angler surveys. This effort is documented in detail by Hanchin and Cwalinski (2011) but will be summarized here. Primary objectives were to: 1) produce consistent indices of abundance and estimates of annual harvest and fishing effort for various fishes with emphasis on walleye, northern pike, and smallmouth bass, 2) to produce reliable growth and mortality statistics to evaluate the impacts of fishing on species, and 3) to produce such information for a variety of large inland lakes in Michigan and compare results among lakes.

Long Lake was netted by MDNR immediately following ice out in the spring of 2004. Effort included 261 trap-net lifts, 228 fyke-net lifts, and one night electrofishing run (Hanchin and Cwalinski 2011). A total of 7,669 fish of 14 species were collected. Smallmouth bass made up the largest portion of the total catch of predators, followed by walleye and northern pike (Table 7). Other fish species collected in order of abundance of total catch were: rock bass, white sucker, yellow perch, brown bullhead, pumpkinseed, black bullhead, bluegill, common carp, rainbow trout, black crappie, and largemouth bass. Rock bass comprised over 29% of the catch by number, and mean length of this species was 7.1 inches (Hanchin and Cwalinski 2011). White suckers and yellow perch comprised 24% and nearly 11% of the catch by number, respectively. Mean length of yellow perch was 8.1 inches and growth of this species was considered near or slightly above average. Species such as black crappie and largemouth bass are present in Long Lake, yet are rather uncommon based on the survey.

The percentages of walleyes, northern pike, and smallmouth bass that were legal sized was 86, 35, and 66, respectively (Table 8; Hanchin and Cwalinski 2011). The population of spawning walleyes was dominated by 15-21 inch walleyes, with none greater than 27 inches. Northern pike from 11-40 inches were collected, with more than half between 20 and 30 inches. Larger pike (30 inches and larger) made up 7% of the pike catch. Smallmouth bass were predominantly 12-17 inches, though fish over 20 inches were collected (Table 8).

Male walleyes were more numerous in the spring survey than females, which is consistent with most spring walleye estimates. Of all walleyes captured, 62% were male, 24% were female, and 14% were of unknown sex (Hanchin and Cwalinski 2011). The sex ratio for northern pike was more balanced than it was for walleye. The sex of smallmouth bass was not determined during the spring survey.

Abundance estimates were made for walleye, northern pike, and smallmouth bass in the spring of 2004. The population estimate was based on the single-census method where fish are marked in the spring, and the recapture phase is done with an angler survey during the following fishing year. The

ratio of marked to unmarked walleye, pike, and smallmouth bass caught by anglers is observed. Hanchin and Cwalinski (2011) reported that a total of 643 legal-sized walleye were tagged in Long Lake in April of 2004 while 106 sub-legal walleyes were clipped. A total of 47 tagged walleye were observed by the creel clerk. The estimate for legal-sized walleye by the single census method was 3,649 fish. This translates to 0.7 legal-sized walleye per acre which is considered low for what would be a good walleye lake. The estimated number of adult walleye was only slightly higher at 3,695 fish which demonstrates the lack of young walleye in the system at the time of the survey. Different methods were used by Hanchin and Cwalinski (2011) to determine exploitation rates, or rate of harvest of walleye by anglers. These rates ranged from 7-11% approximately which is considered normal for walleye populations in large Michigan inland lakes. Total annual mortality rate of 57% was calculated for Long Lake walleye. Again, this was considered normal.

A total of 119 northern pike were tagged while 22 tagged northern pike were observed in the angler survey. The estimate of legal-sized pike (24 inches and larger) yielded 600 fish. The estimate of adult northern pike was two times higher (Hanchin and Cwalinski 2011). In summary, these estimates are very low for a northern Michigan lake, indicating limited spawning habitat is available in Long Lake for northern pike. Harvest rates for pike ranged from 14-18% while annual mortality rates were nearly 50% (Hanchin and Cwalinski 2011).

Hanchin and Cwalinski (2011) reported tagging 673 legal-sized smallmouth bass in Long Lake in April 2004. An additional 358 sub-legal smallmouth bass were fin clipped. The creel clerk that following year observed 133 harvested smallmouth bass of which 8 were tagged. This provided a population estimate of smallmouth bass of approximately 10,000 legal fish, or roughly 2 legal smallmouth bass per acre. This was considered an estimate of a healthy population and was coupled with a low harvest rate of 7-14% annually.

Age and growth for each of these three species was calculated using spines as the aging structure. Walleye ages 1-13 were collected (Table 9). Walleye typically reach legal size (15 inches and larger) in Long Lake around age 3 to 4 but this varies by gender, with females growing faster. According to Hanchin and Cwalinski (2011), the majority of the walleye sampled were ages 6-8, representing the 1996-1998 wild year classes. Few walleye age 10 and older were found. Overall walleye growth was considered near or slightly below (-0.5 inches) statewide average for this species.

Northern pike ages 1-10 were collected in the survey. A male pike in Long Lake reaches legal size (24 inches) around age 5 while a female pike attains this size around age 3 or 4. Age-2 to age-4 northern pike were the most abundant in the lake. Significantly fewer pike age 5 and older were collected, possibly indicating higher harvest of legal-sized northern pike. Despite this, pike growth was fast (+1.8 inches) compared to the statewide average for this species.

Smallmouth bass demonstrated a much wider age range from 3-14 (Table 10). Legal size (14 inches) is attained by Long Lake smallmouth bass roughly by age 5. There were a large number of year classes represented in the sample, with a wide distribution across ages. This indicates relatively consistent year to year production of smallmouth bass. Smallmouth bass growth was near the statewide average.

In addition to the fish survey, an angler survey was also conducted on Long Lake by MDNR from spring 2004 through winter 2005 (Table 11). Total catch of fish was highest in Long Lake from July

through September (primarily July) while fishing pressure was highest in July and August. Total angler hours for the estimated period was nearly 35,000 hours with an estimated 20,673 fishing trips. Total fish harvest for the period was over 7,000 fish which was comprised of yellow perch (68%), smallmouth bass (24%), and walleye (4%). A total of 18,356 fish were also caught and released and were comprised mostly of yellow perch (61%), smallmouth bass (32%), and northern pike (4%). Not many walleyes were caught and released, simply because there may not have been a large number of sub-legal fish available in the population. A variety of other species were harvested or caught and released, though in smaller numbers. Panfish such as bluegill and pumpkinseed were not a large component of the total catch (Table 11), and may never have been at Long Lake. Hanchin and Cwalinski (2011) report that most of the angler hours were during the open-water period as compared to the ice-cover period.

A series of fall juvenile walleye evaluations was made at Long Lake in the seasons following the 2004 spring survey. The first juvenile walleye survey was done by the MDNR on September 1 and involved 4.08 hours of shoreline electrofishing. A total of 67 age-0 walleye were collected for a catch rate of 16.4/hour (Table 5). This was considered a good catch rate, considering the fact that there was a general lack of juvenile walleye in Long Lake immediately prior to 2004. No yearling (age-1) walleye and very few adult walleye were observed during the survey. Despite this decent catch rate of age-0 walleye, fall fingerling walleyes were stocked in the fall of 2004 by both MDNR and the Long Lake Association. These were stocked with the goal of supplementing the natural population. A total of 16,250 fall fingerlings were stocked (Table 1).

Walleye stocking continued in the spring and fall of 2005. MDNR stocked 57,000 spring fingerlings that were marked with the chemical oxytetracycline (OTC) in June while the lake association stocked more than 2,000 fall fingerlings later in the year (Table 1). This continued as a joint effort to supplement the relatively low walleye density in Long Lake. MDNR again conducted a fall juvenile walleye evaluation (prior to the fall 2005 stocking event). This was done in mid-September and again consisted of just over 4 hours of night shoreline electrofishing (Table 5). The catch rate of age-0 walleye was 14.5/hour, indicating good year class strength. A total of 31 of the age-0 walleye were sacrificed in order to determine if they were stocked or naturally produced. Results showed that nearly 75% of the sampled fish were from stocked origin, indicating a smaller wild year class. Eleven yearlings were collected which indicated that the 2004 year class had shown some survival over the last winter. Few adults were collected.

Age-0 walleye were again stocked in Long Lake in 2006 by both the MDNR and the Long Lake Association (Table 1). MDNR stocked more than 1.5 million fry (0.4") in the spring, while the lake association stocked nearly 2,800 fall fingerlings (5-7") in the fall. As in past years, MDNR continued to monitor the stocking efforts with night electrofishing in the fall. This survey was also done in mid-September with effort consisting of four hours of surveying. The catch of age-0 walleyes was poorer (Table 5) with a catch rate of only 3/hour surveyed. Of these age-0 fish, it was determined that 20% were from stocked origin (MDNR stocked OTC marked spring fry). Results from the fall survey and OTC evaluation indicated a poor 2006 year class, regardless of stocking or natural reproduction. The good news was that the catch of yearlings (age-1) in 2006 was higher, indicating a stronger 2005 year class. The adult catch during the shoreline survey also appeared to increase (Table 5).

Fish stocking efforts in 2007 consisted only of fall fingerling walleyes (Table 1) by a private source. MDNR evaluated the wild year class in the fall prior to the fall stocking event and determined that a fair wild year class had been established (catch rate = 7/hr). The catch of yearlings was again good, indicating that age-0 walleyes from 2006 had survived better than first suspected from the previous year of sampling. The catch of adult walleye had increased significantly as well.

Thus, in summary, both private and state sponsored walleye stocking had occurred in Long Lake from 2004 through 2007. MDNR evaluations of these stocking programs as well as examination of wild production demonstrated that juvenile walleye numbers (age-0 and age-1 fish) increased during this time period, as had the numbers of adult walleye observed through fall evaluations. Stocking was probably a significant factor in these increases, however, wild walleye production was also significant at times, and contributed to one of the bigger year classes (2004). Fall juvenile walleye assessments have not occurred at Long Lake since 2007. Stocking has occurred on two more occasions since, including fall fingerling stocking events by the Long Lake Association in 2009 and 2011.

Cormorant hazing and limited lethal control has occurred at Long Lake on a limited basis from 2005 through 2011. This effort is organized by the Long Lake Association and overseen by the U.S. Department of Agriculture. This occurs each year following ice-out when these predatory birds are attracted to Long Lake along their northward migration. Efforts are thought to reduce the heavy predation associated with their presence on such a lake.

Analysis and Discussion

The current fish community of Long Lake can be generally characterized as having the following: 1) a low-diversity panfish community dominated by yellow perch and rock bass, 2) a moderate-diversity predator population dominated by smallmouth bass and walleye, 3) a variable wild walleye population that is supplemented with occasional state or private stocking efforts, 4) a low-density northern pike population with good growth, 5) a limited number of cold water species such as lake whitefish which probably migrate from Lake Huron, 6) a typical non-game fish community comprised of white suckers and bullheads, and 7) a component of invasive aquatic species including zebra mussels, rusty crayfish, and round gobies. Management of Long Lake has primarily been with the use of statewide standard regulations, maintenance of most species through natural reproduction, and providing low-level walleye stocking when necessary.

The Long Lake panfish community is low in diversity and fair in quality. Species available to anglers include predominantly yellow perch and rock bass and incidental catches of bluegill, pumpkinseed, and black crappie. Yellow perch and rock bass tend to thrive in the lake and have done so for years. Perch growth has remained stable through the decades and is a major component of the harvest. Quality size (8 inches and larger) yellow perch are available to anglers, and it takes approximately four years to attain eight inches in length. Species such as bluegill and pumpkinseed are scarce and found in local pockets on the lake, often linked to aquatic vegetation. Submergent plant growth is limited in the lake, which may help explain historically low densities of fish such as bluegill. However, increased water clarity due to zebra mussels may be favorable for plant growth.

The predator base of Long Lake is dominated by smallmouth bass and walleye. Northern pike also inhabit its waters, albeit in relatively low numbers. Smallmouth bass are important as a keystone predator which helps keep many other species in balance. In addition, they are an important predator

on the invasive rusty crayfish, which can alter species communities through removal of aquatic vegetation. Smallmouth bass provide for a quality fishing experience in Long Lake. Walleye have been able to sustain themselves primarily through natural reproduction. However, populations have naturally fluctuated for reasons that are not totally understood. Other northern inland lakes in Michigan have seen depressed levels of walleye reproduction following mussel invasion. Supplemental stocking of spring and fall fingerlings was completed in various years in the last decade and may have helped boost the adult walleye population. These stocking efforts were driven by the local lake association with some additional stocking done by MDNR. Some natural reproduction has occurred during this supplemental stocking period. Walleye densities in Long Lake today are better than they were a decade ago. The lake has ample amounts of spawning substrate and reproduction should continue into the future. This habitat should be protected. Again, other variables will always affect successful walleye reproduction, including spring weather conditions and invasive species. Growth rates of walleye are average in Long Lake. Northern pike are limited in abundance in Long Lake. Given the shoreline development and loss of riparian wetlands, northern pike spawning areas are limited in Long Lake. Northern pike populations are dependent on flooded shoreline vegetation and having ample amounts of submergent aquatic vegetation. Northern pike will continue to be an incidental part of the fishery since spawning habitat is limited. They can grow to quality size in Long Lake, but supplemental stocking would be necessary to supplement the population if increased density was desired. Such efforts would have to be done by a private sector since MDNR Fisheries Division no longer has a northern pike stocking program.

There is no coldwater niche in Long Lake since it is a relatively shallow and windswept lake. A thermocline is rarely established (if ever). Despite this, some species have migrated into Long Lake from Lake Huron, most likely surpassing the control structure during high water levels. Species such as lake whitefish, salmon, steelhead, and gobies (invasive) have occasionally entered Long Lake via this route, but some speculate that some of these species (e.g. lake whitefish) live in the lake all year and have acclimated to its conditions and possible underwater springs at warm times of the year. Very little is known about the minnow and shiner populations of the lake, but they are believed to be stable. Records indicate that commercial bait harvest is minimal at Long Lake. For example, from 2008 through 2010, a total of 270 gallons of emerald shiners were reported harvested from the lake by a single license holder (Tom Goniea, DNR Fisheries, personal communication). This is not considered a large harvest. The remaining non-game species such as white suckers, carp and bullheads are typical for such a large waterbody, but are not considered overly abundant.

Management Direction

1) The Long Lake aquatic community is complex and should be monitored on a fairly consistent basis. Each species plays a vital role not only in the fishery, but also for overall ecosystem balance. A complete fish community survey documenting changes should be accomplished no later than 2020 at Long Lake. Angler reports should continue to be gathered to provide information on the fish community and fishery to supplement survey data. Evaluations of the walleye population should be made more frequently. These surveys will provide managers with essential information on walleye year-class strength and growth. A juvenile walleye assessment is scheduled in the fall of 2013 at Long Lake and will involve shoreline electrofishing. Periodic evaluations of the adult walleye population should also be made.

2) Continue to rely predominantly on natural reproduction of walleye in Long Lake, while retaining flexibility for supplemental stocking. Private stocking efforts may continue periodically into the future, and future survey data will help guide stocking efforts. Walleye should be stocked in the event that multiple year-class failures occur in the wild population and the adult population shows signs of weakness. This can be evident if four or more successive year classes are weak or absent. If spring fingerlings are stocked, managers should attempt to stock fish that are OTC marked.

3) Northern pike are native to Long Lake but are found in limited numbers, possibly as a result of habitat loss and the general lack of aquatic vegetation. Efforts should be made to keep these tributaries (e.g. Mindack, Fitzgerald, Shuberts, Clinton) free of obstructions and to allow for unrestricted passage to spawning areas. Spawning closures currently exist on all or parts of Clinton and Shuberts creeks, and these should be retained.

4) Smallmouth bass are vitally important to the Long Lake ecosystem. This species preys on rusty crayfish and can help reduce, or control, the population of this invasive species. In doing so, limited aquatic vegetation which is important to the ecosystem can be preserved, or at least maintained. Size and season limits are appropriate for bass.

5) Continue to work with members of the Long Lake Association on issues such as supplemental stocking, fishing enhancement, and cormorant control.

6) Current Standard State of Michigan fishing regulations are appropriate for Long Lake.

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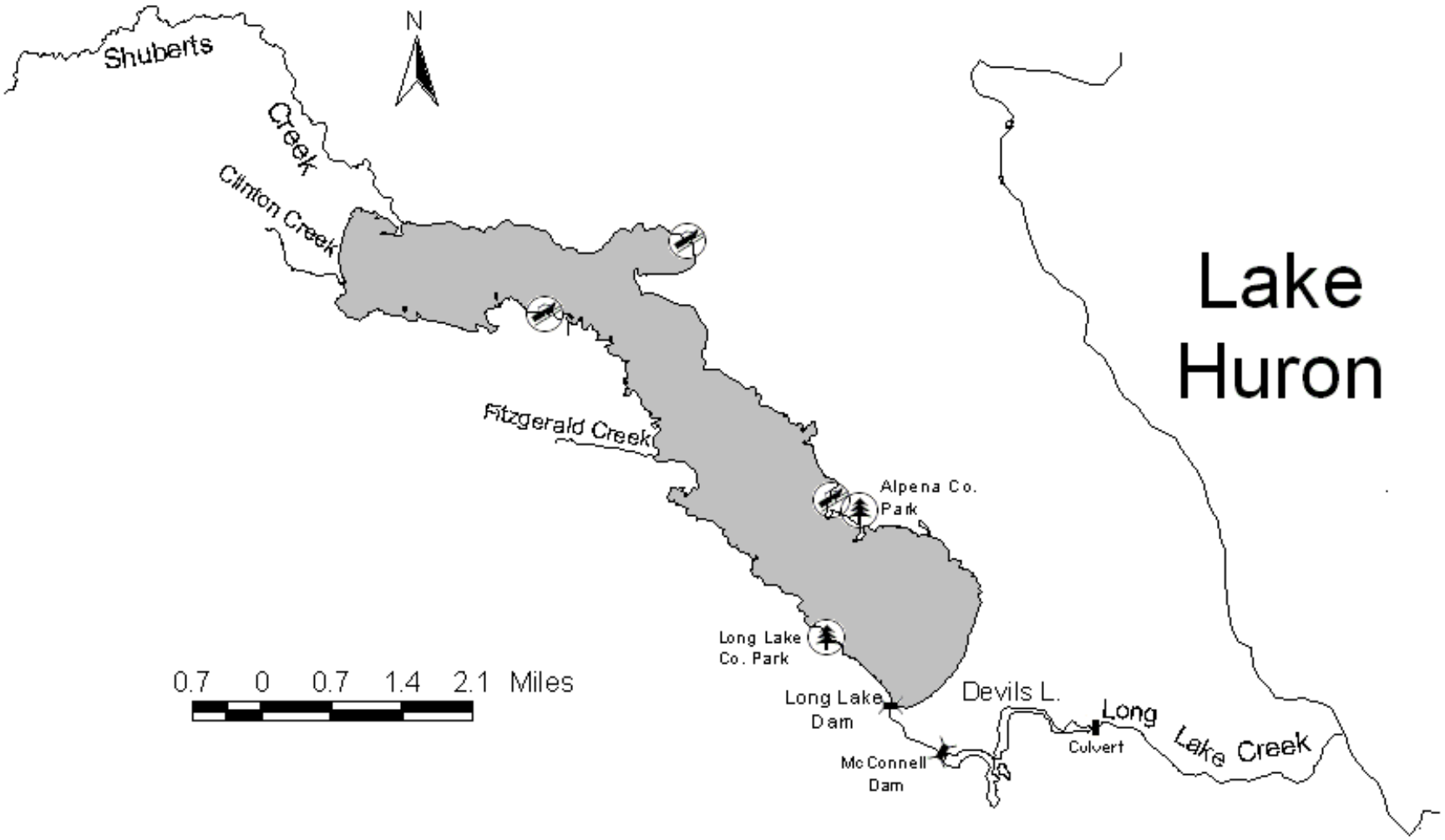

Figure 1. - Long Lake, Presque Isle and Alpena Co., Michigan. Reproduced with permission from Hanchin and Cwalinski (2011).

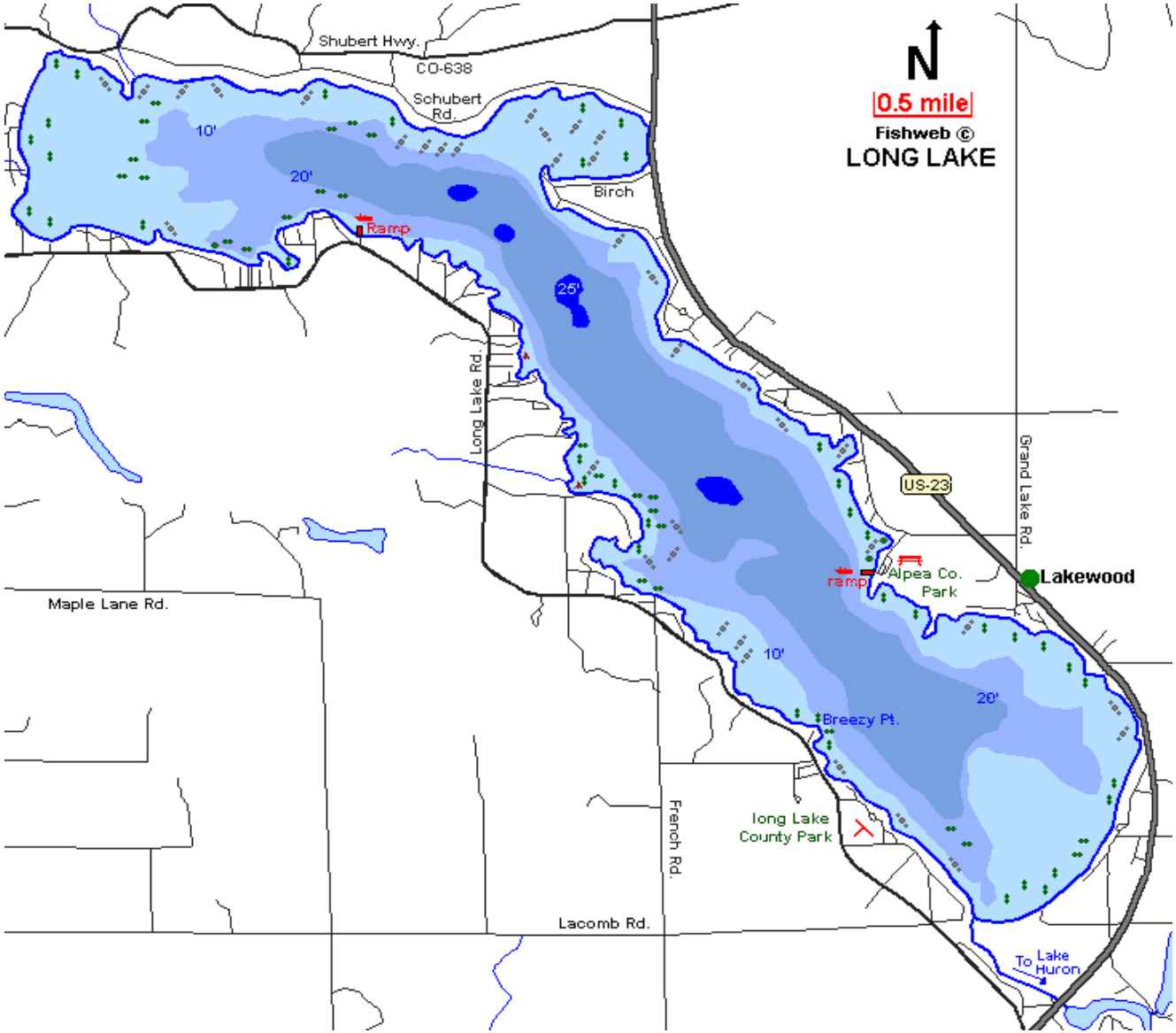

Figure 2. - Bathymetric map of Long Lake. Reproduced with permission from Hanchin and Cwalinski (2011).

Table 1.-Number and size of fish stocked in Long Lake from 1905 through 2011.

Species	Dates	Size	Number	Source
Lake trout	1910	Fry	24,000	State
Largemouth bass	1905-14	Fry and fingerling	102,575	State
	1938-44	Fingerling	25,250	State
	1980	Fingerling	2,500	Private
Bluegill	1934-43	Fingerling	358,500	State
	1980	Fingerling	2,500	Private
Smallmouth bass	1933-45	Fingerling and adult	28,510	State
Black crappie	1938	Yearling	180	State
Rock bass	1938	Yearling	200	State
Pumpkinseed	1938	Yearling	220	State
Yellow perch	1921	Fingerling	17,650	State
	1933-43	Fingerling and adult	442,856	State
	1953	Adult	2,000	State
Northern pike	1964	Fingerling	2,000	State
	1976	Fingerling	4,800	State
	1977	Fingerling	15,000	State
	1978	Fingerling	20,000	State
	1979	Fingerling	31,800	State
	1980	Fingerling	300	State
	1981	Fingerling	20,000	State
	1982	Fingerling	200	State
	1983	Fingerling	25,000	State
	1984	Fingerling	20,000	State
	1985	Fingerling	15,000	State
Walleyes*	1910-14	Fry	1,200,000	State
	1933-40	Fry and fingerling	3,429,050	State
	2004	Fall fingerling	3,900	State
	2004	Fall fingerling	12,350	Private
	2005	Spring fingerling	57,000	State
	2005	Fall fingerling	2,070	Private
	2006	Fry	1,550,000	State
	2006	Fall fingerling	2,781	Private
	2007	Fall fingerling	2,140	Private
	2009	Fall fingerling	3,967	Private
	2011	Fall fingerling	3,300	Private

* Private fall fingerlings stocking efforts after 2004 were walleye from the St. Marys River or Bay De Noc strain. Fry and small fingerling MDNR stocking efforts were Bay De Noc or Tittabawassee River strain.

Table 2.-Comparison of mean length (inches) at age for various game fishes of Long Lake from 1966 to 2004. Number in parentheses represents number aged. Growth comparison in last column was across all ages for 2004. Dorsal spines, in addition to scales, were used to age some of the walleye, northern pike, and smallmouth bass in 2004. Statewide growth comparisons are based on ages with scales.

Species	Age group	June 1966	May 1982	May 2000	April 2004
Yellow perch	I	--	--	--	--
	II	5.3 (2)	5.7 (9)	5.6 (3)	--
	III	7.2 (2)	6.4 (12)	6.5 (13)	7.2 (17)
	IV	8.2 (2)	8.0 (18)	7.5 (12)	8.1 (9)
	V	8.9 (1)	10.0 (8)	8.9 (13)	9.1 (10)
	VI	13.2 (1)	10.8 (8)	10.0 (9)	10.3 (16)
	VII	--	11.6 (7)	11.2 (2)	11.2 (8)
	VIII	12.2 (1)	12.7 (16)	11.8 (1)	11.7 (4)
	IX	--	13.2 (8)	--	--
	X	--	14.0 (1)	--	--
Walleye	I	8.8 (2)	7.7 (2)	--	8.1 (22)
	II	10.7 (3)	12.1 (2)	11.1 (3)	12.9 (47)
	III	14.0 (2)	14.3 (10)	14.5(13)	14.7 (12)
	IV	--	16.1 (17)	15.7 (9)	16.3 (24)
	V	17.0 (1)	17.2 (16)	17.2 (3)	17.3 (17)
	VI	19.2 (1)	18.3 (20)	19.4 (2)	18.0 (42)
	VII	--	20.5 (10)	21.1 (1)	18.5 (41)
	VIII	19.8 (1)	21.7 (6)	--	19.1 (39)
	IX	--	23.9 (2)	22.0 (2)	19.1 (10)
	X	--	--	23.4 (2)	21.3 (2)
	XI	--	--	--	20.7 (1)
	XII	--	--	26.3	21.9 (2)
	XIII	--	--	--	27.1 (1)

Table 2.-continued

Species	Age group	June 1966	May 1982	May 2000	April 2004
Rock bass	I	3.9 (1)	--	--	--
	II	4.5 (2)	2.8 (1)	--	3.7 (2)
	III	5.1 (2)	3.9 (10)	4.2 (11)	5.2 (13)
	IV	5.4 (1)	5.1 (9)	5.0 (12)	6.0 (12)
	V	10.0 (1)	5.8 (7)	5.9 (7)	6.9 (11)
	VI	--	6.8 (14)	6.8 (11)	7.5 (7)
	VII	--	8.3 (12)	7.6 (5)	8.6 (11)
	VIII	--	8.9 (12)	8.4 (10)	8.7 (9)
	IX	--	9.9 (5)	9.3 (5)	--
	X	--	--	9.7 (8)	10.5 (1)
	XI	--	--	10.6 (3)	--
S. bass	I	5.5 (1)	5.0 (2)	5.1 (2)	
	II	7.0 (1)	7.4 (18)	6.6 (25)	
	III	9.6 (3)	8.8 (11)	9.1 (28)	11.5 (14)
	IV	11.1 (1)	10.5 (19)	10.6 (7)	12.7 (32)
	V	12.5 (1)	12.1 (28)	12.3 (7)	14.1 (27)
	VI	15.3 (2)	14.2 (9)	14.1 (30)	15.2 (14)
	VII	--	15.2 (5)	15.7 (10)	16.2 (20)
	VIII	--	16.2 (12)	16.7 (12)	16.9 (6)
	IX	--	17.6 (13)	17.8 (8)	16.8 (8)
	X	--	17.4 (2)	18.5 (7)	17.9 (13)
	XI	--	--	18.8 (1)	18.4 (10)
	XII	--	--	--	--
	XIII	--	--	--	18.6 (5)
	XIV	--	--	--	18.4 (4)
N. pike	I	--	--	--	12.4 (19)
	II	--	17.6 (9)	21.2 (6)	17.8 (85)
	III	20.0 (2)	20.9 (17)	22.9 (1)	22.8 (114)
	IV	--	24.5 (8)	24.1 (5)	25.0 (49)
	V	--	26.6 (6)	26.1 (1)	27.4 (12)
	VI	--	28.0 (6)	--	29.1 (20)
	VII	--	28.8 (1)	--	33.6 (8)
	VIII	--	33.0 (2)	--	33.9 (2)
	IX	--	--	--	30.6 (2)
	X	--	--	--	39.0 (1)

Table 3.-Species and relative abundance of fishes collected with survey gear at Long Lake, May 20 – June 4, 1982. Only large mesh traps and experimental gill nets were used to catch fish.

Common Name	**Number**	**Average Size** *(inches)*	**Growth***
Smallmouth bass	1,493	11.1	Below average
Rock bass	1,402	7.6	Average
Yellow perch	322	10.1	Above average
Walleye	187	16.1	Average
White sucker	83	15.6	--
Brown bullhead	55	11.5	--
Northern pike	49	22.5	Average
Carp	16	24.1	--
Channel catfish	3	23.3	--
Lake whitefish	1	14.0	--
TOTAL	**3,611**		

Table 4.-Length-frequency distribution (some subsamples) of certain game fishes collected during the 1982 and 2000 fish community surveys at Long Lake. Some distributions are a sub-sample of the overall catch.

Length (in)	N. pike 82	N. pike 00	S. bass 82	S. bass 00	Walleye 82	Walleye 00
1						
2						
3			1			
4			1			
5			2	8		
6			3	15	1	
7			13	8	1	
8			40	28		
9			72	30	1	
10			41	41	4	
11			74	28	1	3
12			67	41	6	1
13			56	28	4	1
14			40	16	25	5
15			21	19	33	8
16	4		4	18	31	3
17	1		7	11	26	2
18	4			8	21	1
19	6		1	2	10	2
20	4	2			7	
21	3				11	2
22	6	2			2	1
23	2	1			1	2
24	1	1			1	
25	3					
26	6	1				1
27	3					
28	4					
29						
30						
31						
32	1					
33	1					
34						
35						
36						
37						
38						
39						
40						
41						
42						
43						

Table 4.-continued

Length (in)	Y. perch 82	Y. perch 00	Rock bass 82	Rock bass 00
1				
2				
3			2	3
4			13	24
5	19	5	19	63
6	20	8	29	93
7	23	20	81	97
8	19	10	101	88
9	29	12	56	40
10	31	4	3	5
11	72	3		
12	81			
13	24			
14	4			
15				
16				
17				
18				
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Table 5.-Results of fall walleye indexes at Long Lake using nighttime boomshocking data. Data collected by MDNR. Adult walleye were considered age 2 and older.

Year	***Date***	***Hours***	***Miles Shocked***	***Age-0 walleye***	***No. age-0 per hour***	***Yearling walleye collected***	***Adults***	***% Age-0 Stocked (sample no.)***
1997	9/9	1.6	--	44	27.5	18	3	0 (0)
2003	8/27	2.0	--	0	0.0	0	3	--
2004	9/1	4.08	--	67	16.4	0	2	0
2005	9/13	4.07	7.61	59	14.5	11	2	74 (31)
2006	9/14	4.00	7.55	12	3.0	21	5	20 (10)
2007	9/17	4.00	7.34	29	7.3	11	19	0 (0)

Table 6.-Species and relative abundance of fishes collected with survey gear at Long Lake, May 8 – May 18, 2000. Survey effort included small mesh fyke nets, large mesh trap nets, and inland gill nets.

Common Name	**Number**	**Average Size** *(inches)*	**Growth***
Rock bass	413	7.2	Below average
Smallmouth bass	301	11.9	Below average
White sucker	119	17.2	--
Brown bullhead	71	13.0	--
Yellow perch	62	8.1	Average
Walleye	36	16.8	Average
Northern pike	13	22.9	Above average
Lake whitefish	7	17.6	--
TOTAL	**1,022**		

Table 7. Fish collected from Long Lake using a total sampling effort of 261 trap-net lifts, 228 fyke-net lifts, and one elctrofishing run from April 7 to April 22, 2004. Table provided with permission from Hanchin and Cwalinski (2011).

Species	Total catch[a]	Percent by number	Mean trap-net CPUE[a,b]	Mean fyke-net CPUE[a,b]	Length range (in)	Average length (in)[c]
Rock bass	2,243	29.2	4.9	3.2	3.6–10.5	7.1
White sucker	1,840	24.0	2.2	4.9	8.7–21.8	16.9
Smallmouth bass	1,076	14.0	2.3	1.5	8.1–20.5	15.1
Walleyes	837	10.9	1.9	1.0	7.3–27.1	17.1
Yellow perch	831	10.8	2.3	0.8	3.2–13.8	8.1
Northern pike	397	5.2	0.8	0.7	9.9–40.5	22.1
Brown bullhead	238	3.1	0.3	0.7	6.7–15.9	12.4
Pumpkinseed	80	1.0	0.1	0.2	3.3–8.4	6.4
Black bullhead	57	0.7	<0.1	0.2	6.7–15.1	10.7
Bluegill	57	0.7	0.1	0.1	3.8–8.9	6.0
Common carp	10	0.1	<0.1	<0.1	28.2–33.9	30.5
Rainbow trout	1	<0.1	<0.1	0.0	23.2–23.2	23.2
Black crappie	1	<0.1	<0.1	0.0	11.8–11.8	11.8
Largemouth bass	1	<0.1	<0.1	0.0	17.3–17.3	17.3

[a] Includes recaptures
[b] Number per trap-net or fyke-net night
[c] Does not include recaptures for walleyes, northern pike, or smallmouth bass.

Table 8.-Number of fish per inch group caught and measured in spring netting on Long Lake, April 7 to 22, 2004. Table provided with permission from Hanchin and Cwalinski (2011).

	Species													
Inch group	Rock bass	White sucker	Smallmouth bass	Walleyes	Yellow perch	Northern pike	Brown bullhead	Pumpkinseed	Black bullhead	Bluegill	Common carp	Rainbow trout	Black crappie	Largemouth bass
3	4	–	–	–	1	–	–	1	–	1	–	–	–	–
4	24	–	–	–	2	–	–	7	–	4	–	–	–	–
5	116	–	–	–	22	–	–	18	–	25	–	–	–	–
6	175	–	–	–	113	–	1	29	1	16	–	–	–	–
7	226	–	–	12	142	–	4	18	5	6	–	–	–	–
8	141	1	3	31	124	–	4	7	5	4	–	–	–	–
9	58	5	11	–	66	1	16	–	6	–	–	–	–	–
10	6	4	13	–	41	1	43	–	15	–	–	–	–	–
11	–	22	59	3	27	12	33	–	10	–	–	–	1	–
12	–	41	119	18	8	12	15	–	6	–	–	–	–	–
13	–	23	153	37	3	5	38	–	5	–	–	–	–	–
14	–	10	137	5	–	13	63	–	2	–	–	–	–	–
15	–	12	136	41	–	6	19	–	2	–	–	–	–	–
16	–	21	186	83	–	12	–	–	–	–	–	–	–	–
17	–	53	119	187	–	16	–	–	–	–	–	–	–	1
18	–	56	86	181	–	15	–	–	–	–	–	–	–	–
19	–	66	22	88	–	21	–	–	–	–	–	–	–	–
20	–	44	3	39	–	23	–	–	–	–	–	–	–	–
21	–	17	–	15	–	24	–	–	–	–	–	–	–	–
22	–	–	–	7	–	33	–	–	–	–	–	–	–	–
23	–	–	–	1	–	36	–	–	–	–	–	1	–	–
24	–	–	–	–	–	34	–	–	–	–	–	–	–	–
25	–	–	–	1	–	15	–	–	–	–	–	–	–	–
26	–	–	–	–	–	24	–	–	–	–	–	–	–	–
27	–	–	–	1	–	14	–	–	–	–	–	–	–	–
28	–	–	–	–	–	6	–	–	–	–	2	–	–	–
29	–	–	–	–	–	4	–	–	–	–	1	–	–	–
30	–	–	–	–	–	5	–	–	–	–	5	–	–	–
31	–	–	–	–	–	3	–	–	–	–	1	–	–	–
32	–	–	–	–	–	–	–	–	–	–	–	–	–	–
33	–	–	–	–	–	2	–	–	–	–	1	–	–	–
34	–	–	–	–	–	4	–	–	–	–	–	–	–	–
35	–	–	–	–	–	3	–	–	–	–	–	–	–	–
36	–	–	–	–	–	3	–	–	–	–	–	–	–	–
37	–	–	–	–	–	1	–	–	–	–	–	–	–	–
38	–	–	–	–	–	2	–	–	–	–	–	–	–	–
39	–	–	–	–	–	1	–	–	–	–	–	–	–	–
40	–	–	–	–	–	1	–	–	–	–	–	–	–	–
41	–	–	–	–	–	–	–	–	–	–	–	–	–	–
42	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Total	750	375	1,047	750	549	352	236	80	57	56	10	1	1	1

Table 9.-Weighted mean lengths by age and sex for walleyes collected from Long Lake, April 7 to 22, 2004. Standard deviation in parentheses. Table reproduced with permission from Hanchin and Cwalinski (2011).

Age	Mean length					
	Males		Females		All fish[a]	
1	—		—		8.1	(0.4)
2	13.8	(0.2)	—		12.9	(1.0)
3	15.3	(0.0)	—		14.6	(1.0)
4	16.1	(0.3)	17.1	(0.2)	16.4	(0.6)
5	16.5	(0.6)	18.0	(0.7)	17.3	(1.0)
6	17.7	(0.6)	19.2	(0.9)	18.0	(0.9)
7	18.0	(0.7)	19.3	(1.0)	18.5	(1.0)
8	18.3	(0.7)	20.4	(1.3)	19.1	(1.4)
9	18.8	(0.9)	19.7	(1.6)	19.1	(0.9)
10	20.6	(0.0)	22.2	(—)	21.1	(0.9)
11	20.7	(0.0)	—		20.7	(0.0)
12	20.0	(0.0)	25.2	(—)	21.7	(3.0)
13	—	(—)	27.1	(—)	27.1	(—)

[a] Mean length for ‘All fish’ includes males, females, and fish of unknown sex.

Table 10.–Weighted mean lengths and sample sizes for smallmouth bass collected from Long Lake, April 7 to 22, 2004. Standard deviation is in parentheses. Table reproduced with permission from Hanchin and Cwalinski (2011).

Age	Mean length		N
3	11.4	(1.1)	14
4	12.7	(1.0)	32
5	14.1	(0.8)	27
6	15.1	(0.9)	14
7	16.2	(1.0)	20
8	16.9	(0.6)	6
9	16.8	(0.7)	8
10	17.9	(0.7)	13
11	18.4	(0.6)	10
12	–		–
13	18.6	(0.5)	5
14	18.5	(1.0)	4

Table 11.–Angler survey estimates for summer and winter 2004–05 from Long Lake. Survey period was April 24 through October 13, 2004 and December 17, 2004 through March 26, 2005. Two standard errors are given in parentheses. Table reproduced with permission from Hanchin and Cwalinski (2011).

Species	C/H	Month									
		Apr-May	Jun	Jul	Aug	Sep-Oct	Dec	Jan	Feb	Mar	Season
		Number harvested									
Smallmouth bass	0.049	102	462	267	382	483	0	0	0	0	1,696
	(0.018)	(197)	(260)	(198)	(238)	(292)	(0)	(0)	(0)	(0)	(536)
Walleyes	0.009	0	29	94	51	82	0	26	23	0	305
	(0.005)	(0)	(43)	(96)	(58)	(81)	(0)	(41)	(28)	(0)	(153)
Yellow perch	0.137	0	0	650	1,380	1,500	119	935	178	25	4,787
	(0.051)	(0)	(0)	(498)	(943)	(871)	(174)	(576)	(135)	(42)	(1,509)
Northern pike	0.005	0	5	60	24	54	0	6	19	0	168
	(0.003)	(0)	(11)	(62)	(37)	(65)	(0)	(13)	(29)	(0)	(102)
Bluegill	0.001	0	0	0	0	20	0	0	0	0	20
	(0.001)	(0)	(0)	(0)	(0)	(40)	(0)	(0)	(0)	(0)	(40)
Largemouth bass	<0.001	0	0	5	0	0	0	0	0	0	5
	<(0.001)	(0)	(0)	(9)	(0)	(0)	(0)	(0)	(0)	(0)	(9)
Brown bullhead	0.001	0	0	0	0	22	0	0	0	0	22
	(0.001)	(0)	(0)	(0)	(0)	(45)	(0)	(0)	(0)	(0)	(45)
Total harvest	0.201	102	496	1,075	1,838	2,161	119	967	219	25	7,003
	(0.060)	(197)	(263)	(548)	(975)	(926)	(174)	(577)	(141)	(42)	(1,613)

Table 11.–continued.

Species	C/H	Month									
		Apr-May	Jun	Jul	Aug	Sep-Oct	Dec	Jan	Feb	Mar	Season
		Number released									
Bowfin	<0.001	0	10	0	0	0	0	0	0	0	10
	<(0.001)	(0)	(19)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(19)
Smallmouth bass	0.166	684	755	1,586	1,394	1,327	0	6	3	47	5,801
	(0.057)	(823)	(408)	(854)	(889)	(599)	(0)	(13)	(5)	(78)	(1,652)
Walleyes	0.004	67	0	37	0	36	0	4	0	0	144
	(0.004)	(133)	(0)	(44)	(0)	(43)	(0)	(8)	(0)	(0)	(147)
Northern pike	0.019	47	74	164	97	221	0	0	29	16	647
	(0.007)	(72)	(76)	(119)	(79)	(136)	(0)	(0)	(35)	(24)	(227)
Rock bass	0.004	0	0	25	92	22	0	0	0	0	139
	(0.005)	(0)	(0)	(50)	(143)	(45)	(0)	(0)	(0)	(0)	(158)
Brown bullhead	<0.001	0	0	12	0	0	0	0	0	0	12
	<(0.001)	(0)	(0)	(25)	(0)	(0)	(0)	(0)	(0)	(0)	(25)
Bluegill	0.009	0	0	6	96	200	0	0	0	0	302
	(0.008)	(0)	(0)	(12)	(113)	(254)	(0)	(0)	(0)	(0)	(278)
Pumpkinseed	0.002	0	0	34	20	10	0	0	0	0	65
	(0.002)	(0)	(0)	(53)	(41)	(20)	(0)	(0)	(0)	(0)	(70)
Yellow perch	0.322	0	14	3,386	3,514	2,115	0	1,736	461	0	11,226
	(0.120)	(0)	(29)	(2,487)	(2,044)	(1,103)	(0)	(1,067)	(319)	(0)	(3,581)
Total released	0.526	797	863	5,250	5,212	3,931	0	1,746	493	63	18,356
	(0.152)	(837)	(417)	(2,634)	(2,238)	(1,290)	(0)	(1,067)	(321)	(82)	(3,966)
Total (harvest + release)	0.727	899	1,359	6,325	7,050	6,093	119	2,714	712	87	25,360
	(0.186)	(859)	(493)	(2,690)	(2,442)	(1,588)	(174)	(1,213)	(350)	(92)	(4,282)
Angler hours		3,589	4,277	8,650	8,561	4,874	608	2,167	1,809	360	34,894
		(4,458)	(1,173)	(2,943)	(3,322)	(1,780)	(459)	(684)	(643)	(296)	(6,730)
Angler trips		2,278	2,321	4,902	5,034	2,889	402	1,428	1,183	237	20,673
		(2,965)	(617)	(1,583)	(2,133)	(1,124)	(305)	(453)	(421)	(195)	(4,243)