**Houghton Lake**
Roscommon County
May 22, 2012

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## Environment

Houghton Lake is located in the central portion of the Lower Peninsula of Michigan in Roscommon County (Figure 1). The lake is part of the headwaters of the Muskegon River Watershed along with Higgins Lake and the Cut River that connects the two lakes. Houghton Lake is the largest inland Lake in Michigan with an area of 20,075 surface acres (Breck 2004). The maximum depth of Houghton Lake is 22 feet, and the majority of the lake is shallow with an average depth of 8.4 feet and an estimated total volume of 165,072 acre-feet.

Houghton Lake has several small tributary streams, including Backus, Denton, and Knappen creeks. The primary upstream flow comes from Backus Creek, which flows through a series of reservoirs about 6 miles upstream from Houghton Lake. Denton Creek also flows through a reservoir about 1 mile upstream. The Cut River, a tributary of Backus Creek, connects Houghton Lake with 238-acre Marl Lake and 9,600-acre Higgins Lake. The distance between Houghton and Higgins lakes is about 10 stream miles. Downstream from Houghton Lake, the Muskegon River initially flows to the northwest but eventually curves to the southwest and flows for 212 miles to Lake Michigan (O'Neal 1997).

Human development within the watershed of Houghton Lake has significantly altered fisheries habitat within and around the lake. Affects of development have been typical of those reported for other north temperate lakes (Christensen et al. 1996; Radomski and Geoman 2001; Rust et al. 2002; Bryan and Scarnecchia 1992; Schindler et al. 2000; and Jennings et al. 1999). The shoreline of Houghton Lake is surrounded by private homes, cottages, and businesses, including the three small towns of Houghton Heights, Houghton Lake, and Prudenville (Figure 3). There are numerous public and private boat launch sites on the lake, and Houghton Lake State Forest Campground is located on the north shore. A water-level control dam is located about ½ miles down the Muskegon River. The lake water level is defined by statute at 1138.1 ft elevation (Schrouder 1993). This is approximately 3.7 feet above natural levels of the lake (DNR Fisheries Division files). Partially in response to the higher water levels, hardened seawalls have been constructed around most of the lake. Also, upstream of Houghton Lake, the water level of Higgins Lake is regulated by a dam on the Cut River, which sometimes leads to unnaturally low water levels in this tributary.

Laarman (1976) reported results of limited water chemistry, benthos, and zooplankton sampling conducted in Houghton Lake. Briefly, August surface and bottom temperatures in 1972 were 74o and 71o F, respectively. The lake does not develop a thermocline. Surface alkalinity ranges from 63 to 129 ppm, and pH ranges from 7.5 to 8.7. Additional water quality information was reported by Pecor et al. (1973) and Schrouder (1993), and more recent data are available in files of MDNR and Michigan Department of Environmental Quality.

Large beds of emergent plants, including wild-rice (Zizania aquatica), were present historically in Houghton Lake. Now, wild-rice is nearly absent due to removal programs and maintenance of unnaturally high water levels (Ustipak 1995). Eurasian water-milfoil (Myriophyllum spicatum), a non-indigenous, submerged aquatic plant, has been widespread and abundant in the lake. Riparian property owners began a program to control water-milfoil, including treatment of the entire lake with the herbicide, SonarTM (Fluridone). Application of SonarTM occurred in summer 2002 (Heilman et al. 2003). Since that time, the Eurasian water-milfoil has primarily been controlled with 2, 4-D and a milfoil weevil stocking program.

The current fish community of Houghton Lake includes species typical of cool, eutrophic lakes of the region. Families of fishes present include bowfin, gar, pike, minnow, sucker, catfish, sunfish, and perch. Coldwater fishes, such as trout, are occasionally found in the lake, but are most likely immigrants from the colder Higgins Lake.

## History

Laarman (1976) and Schrouder (1993) summarized the early stocking history of fish in Houghton Lake. Few records were available from 1914 through 1932. Lake trout were stocked in 1904 and 1905; yellow perch in 1921, 1933-1938, and 1941; smallmouth bass in 1921 and 1922; largemouth bass in 1913 and 1925; bluegill in 1922; emerald shiners in 1934; and northern pike during 1969 through 1975 and 1977. Walleye fry were stocked during the period from 1908 through 1944 and fingerlings were stocked during the period from 1979 through 2011.

Significant changes in the fish community of Houghton Lake occurred during the 1920s and 1930s (Laarman 1976). The harvest of northern pike declined drastically in the mid-1930s while the harvest of bluegills increased proportionally. Research concluded that the cause for the decline in northern pike was due to loss of prime spawning habitat rather than spearing of large pike through the ice as many anglers suspected (Clark et al. 2004). The loss of spawning habitat resulted from the filling of tributaries and wetlands in the Houghton Lake system.

Clark et al. (2004) conducted an extensive fisheries and angler survey in 2001-2002. They found that walleye mortality and exploitation rates were average when compared to other Michigan lakes and elsewhere. Harvest per acre and population density of walleye was average to above average when compared to other Michigan Lakes and elsewhere. Harvest per hour of walleye was higher than in the 1950s and 1960s. Harvest per hour of northern pike was similar in 2001-2002 to that found in the 1950s and 1960s. Harvest per acre of northern pike was above average for Michigan lakes and elsewhere, but population density was below average. Total mortality and exploitation were average to above average compared to other Michigan lakes and elsewhere.

Angler-use and catch was estimated during summer and winter of 2001-02. A total of 386,287 fish were harvested and 6,371 fish were caught and released. The estimated harvest for each species was as follows: bluegill - 152,237; pumpkinseed - 105,129; yellow perch - 49,292; black crappie - 26,108; rock bass - 23,469; walleye - 18,265; northern pike - 9,291; smallmouth bass - 1,888; largemouth bass - 340; and white sucker - 268. Total angler hours expended during the summer and winter period was estimated at 499,048 or 199,056 trips. Based on an average $27 per angler day (2001 National Survey of Fishing, Hunting, and Wildlife Associated Resources) the annual value of this fishery to the local

economy was approximately $5.4 million for the one year period. Hanchin (2011) summarized the angler-use of seventeen large lakes in Michigan with similar fisheries surveyed from 2001 through 2007. Houghton Lake had the greatest number of angler-hours and fish harvested. Houghton Lake ranked fourth in angler-hours fished per acre, third in fish harvested per acre, and third in fish harvested per hour.

## Current Status

Two fisheries surveys were conducted in Houghton Lake during 2011, including a June trap net survey and an October electrofishing survey.

June Trap Net Surveys

The purpose of the June trap net survey was to evaluate the fish community using index sites sampled during June since 1972. Information from these surveys was compared to other surveys conducted since 1922. Information on fish growth, catch rates, and age composition were compiled from Fisheries Division surveys and reports.

Growth rates of various fish species in Houghton Lake have been relatively constant since 1922 (Table 1). Walleye, northern pike, and yellow perch have consistently had growth rates below state average. Smallmouth bass, largemouth bass, bluegill, pumpkinseed, rock bass, and black crappie have all exhibited relatively consistent growth rates near or above state average, with the exception of black crappie in 2011.

The length distributions of walleyes in June trap net surveys were similar between 1972 and 2007, although larger fish were collected in greater numbers in 1972 and 1983 (Table 2). The length distribution of walleyes shifted to smaller sizes in the June 2011 trap net survey although the number of walleye 15 inches and larger was similar to previous (1972-2007) June trap net collections. This indicates the abundance of walleye 15 inches and larger has not decreased, but the number of smaller fish has increased. The spring surveys conducted in 2001 and 2007 had much greater sample sizes, with modal lengths of 16 in or 17 in, and more typical length distributions (Figure 2). Good numbers of legal-sized (≥ 15 in) fish were present in all of the collections. The spring size distribution in 2001 was similar for both net (trap and fyke) and electrofishing samples (Table 2). Ages ranged from 2 to 15 with a mode at age 6 for both 2001 and 2007 spring collections (Figure 3). The spring 2001 age distribution was similar for both net (trap and fyke) and electrofishing samples. Walleye appear to be fully recruited to trap nets and electrofishing gear at 16 - 17 inches and age 6. Younger ages were present in the catch in both 2001 and 2007 (Figure 3). Walleye catch rates in June net collections were relatively constant between 1972 and 2007, with a moderately higher catch rate in 2011 (Figure 4).

Most of the walleye catch in 2011 was composed of age-2 to age-5 walleye (Table 3). These fish represent the 2006 through 2009 year-classes when walleye were not stocked into Houghton Lake. Most walleye had reached the legal harvestable size of 15 inches in length by age 4.

The length distributions of northern pike in June trap net samples were similar between 1972 and 2011 with a low percentage of fish legal size (≥ 24 in; Table 4). Sample sizes of northern pike in the 2001 spring trap net collections were much larger with a greater size range. Approximately 27% of the

northern pike collected in 2001 were legal size. The catch of larger fish in the 2001 spring trap nets may indicate greater vulnerability of larger fish in the spring, but the greater effort expended may also have been a factor. Age distributions of northern pike from trap net collections in June 2007 and spring 2001 were similar (Figure 5). Northern pike appear to be fully vulnerable to trap and fyke nets at 20 inches and age 3. June trap net catch rates of northern pike in 2007 were threefold greater than in any previous surveys, but decreased to the lowest level recorded in 2011 (Figure 4).

Bluegill collections in June trap net surveys contained many large fish in all years between 1972 and 2011 (Table 5). Modal lengths have been 6 inches (1998), 7 inches (1972, 1983, 2007, and 2011) and 9 inches (1993) and average lengths have ranged from 6.5 in to 8.8 inches. Annual ranking of bluegill sizes have ranged from Good to Superior and growth rates have ranged from Satisfactory to Superior based on Schneider's (1990) classification methods (Table 6). Catch rates of bluegill in June trap nets have increased each year since 1983, with similar levels found in 2007 and 2011 (Figure 4).

Length ranges and average lengths for smallmouth bass, largemouth bass, pumpkinseed, black crappie, and rock bass indicated good size structure and continued natural reproduction for these species (Table 7). The percentage of fish of legal, harvestable size, captured in the 2007 trap net samples, was very high for all species but declined for smallmouth and largemouth bass in 2011. Other species of fish present in the catch included yellow perch, channel catfish, brown bullhead, bowfin, common carp, longnose gar, and white sucker.

Fall Electrofishing Surveys

The purpose of the fall electrofishing surveys was to evaluate the relative abundance of juvenile walleye in Houghton Lake. These surveys were primarily conducted to capture age-0 and age-1 walleye but older walleye were also collected. Juvenile walleye move into shallow, sandy shoreline areas of the lake as water temperatures cool during the late summer and fall. Collections were made using an electro-fishing boat sampling standard index sites along the shoreline of the lake after sunset.

Walleye fry were stocked into Houghton Lake during the period from 1908 through 1944 (Table 8). Fingerling walleyes were stocked during the period from 1979 through 2011. Walleyes were not stocked from 2006 through 2010 because of a moratorium on inland stocking related to prevention of spreading disease (Viral Hemorrhagic Septicemia) from wild Great Lakes brood-stocks to inland waters. Walleye stocking in inland waters was resumed in 2011. Stocked walleye fingerlings were marked with oxytetracycline (OTC) in 2001 and 2011 to help evaluate the contribution of stocked fish to the Houghton Lake walleye population.

Juvenile walleye sampling was conducted in all but two years from 1990-2011 (Table 9). No relationship was evident between the number of fish stocked and catch rates for either age-0 or age-1 walleye (Figures 6 & 7). Catch rates of age-1 walleye did not appear to be strongly related to catch rates of age-0 walleye from the previous year (Figure 8). This indicates that survival during the first winter and second summer of life was highly variable. More information is needed to better understand the relationship between age-0 and age-1 survival.

Growth indices for age-0 through age-5 fish collected in fall electrofishing surveys and for netting surveys (mean growth indices of combined ages) from 1922-2010 were summarized in Table 9.

Overall walleye growth in this lake was well below state average in most years. Slow walleye growth was evident during 1955, 1962, 1971, and 2006-2010, when walleye stocking was not conducted. Slow growth of walleye in Houghton Lake appears to be a natural condition, and likely is limited by available forage or habitat conditions, including the lack cool water refuge during summer resulting in high metabolic rates. Similar conclusions were made regarding growth of both walleye and yellow perch for Houghton Lake by W. C. Latta (Appendix A in Christensen 1957).

Growth rates of age-0 walleye were below state average during all years except one (Figure 9). Growth rates of age-1 walleye were above state average during most years, although they were below state average in 1992, 2010 and 2011 (Figure 10). The reason for the difference in growth patterns of the two age groups is uncertain at this time, but may be related to biological conditions in the lake including density dependent competition the first year of life. There was no strong relationship between juvenile growth rates and juvenile densities (Figures 9 & 10).

## Analysis and Discussion

During the 1920's and 1930's northern pike and walleye were the predominant species in the Houghton Lake fishery (Laarman 1976). During the mid-1930s, the catch of northern pike declined dramatically and panfish catch increased proportionally. This shift in dominance of northern pike to panfish resulted from the filling of wetlands and shoreline development of Houghton Lake, with the consequential loss of spawning habitat for northern pike. Survey data through 1972 generally indicated that growth rates of yellow perch, northern pike, and walleye were below state average, while growth rates of other game species were near or above state average (Laarman 1976). Similar growth characteristics in the fish populations continued through 2011, with the exception of slower growth of black crappie in 2011.

Bluegill sizes and growth rates ranged from a rating of `satisfactory' to `superior' (Schneider 1990) in all years between 1972 and 2011. Catch rates in trap nets have increased steadily from 1983 through 2007 and remained similar in 2011. The pumpkinseed, black crappie and rock bass populations also appear to have good size structure and large mean sizes. The panfish populations appear in good condition with no substantial changes since 1972. The number of legal-size smallmouth bass and largemouth bass declined in 2011 when compared to 2007, but adequate numbers of young fish were present in the catch.

The length and age distributions of northern pike do not appear to have changed substantially between 1972 and 2011. Mean sizes appear to have increased after 1993 following the state-wide increase in minimum harvestable size to 24 inches (Table 4). The June trap net catch rate was very high in 2007 but declined in 2011 to levels similar to the period from 1972 through 1998. The lower catch rate in 2011 was consistent with angler reports of catching lower numbers of sublegal fish in recent years. Clark et al. (2004) found harvest per acre of northern pike was above average for Houghton Lake in 2001, but population density was below average (0.3 - 1.6 /acre of $\geq$ age-2 fish). Total mortality and exploitation were average to above average compared to other Michigan lakes. Harvest of northern pike was much greater in winter than in summer.

The effectiveness of sampling northern pike with trap nets in June should be evaluated. Although catch-per-unit-effort can be high in June samples, larger fish may be more vulnerable during spring, or greater effort may be needed to capture a representative sample of larger fish during June.

The walleye samples collected during spring in 2001 an 2007 were much larger than any of the June trap net samples and provide a better representation of length and age distributions in Houghton Lake. Modal lengths in the catch were 16 - 17 inches and good numbers of fish larger than 15 inches were present. Clark et al. (2004) estimated adult walleye abundance in Houghton Lake during 2001 at approximately 58,000-60,000 (3/acre). They found that walleye abundance and harvest per acre were average or above compared to other Michigan lakes, and total mortality and exploitation were average.

Evaluation and determination of the need for stocking walleye onto Houghton Lake was listed as a primary goal in the 1993 management plan. Six June trap net surveys, twenty fall electrofishing surveys, two years of marked juvenile walleye evaluations and an intensive evaluation of the fish community (Large Lake survey) and angler survey have been conducted on Houghton Lake during the forty year period from 1972 through 2011. These surveys provide substantial information to evaluate the walleye population and effectiveness of the walleye stocking program in Houghton Lake. Based on June trap net catches, the walleye population appears to have been relatively stable between 1972 and 2007, with moderately higher catch rates in 2011. Walleye length distributions were similar from 1972 through 2007, but shifted to smaller sizes in 2011. The number of walleye 15 inches and larger collected during 2011 did not decrease, indicating the shift in the length distribution resulted from greater numbers of smaller fish present in the catch. The greater numbers of small fish in the catch also resulted in the moderately higher catch rates in 2011. Anglers reported higher catches of smaller walleye during recent years, consistent with survey information in 2011. Walleye were not stocked into Houghton Lake from 2006 through 2010, yet the catch in 2011 trap net samples was comprised of primarily of fish from the 2006 through 2009 year-classes. The 2011 fall electro-fishing survey also found relatively large numbers of walleye from the 2008 through 2011 year-classes. There was very strong natural recruitment of walleye during the period from 2006 through 2011. For example, an evaluation of fingerling walleye during fall 2011 found that only 7% of age-0 fish collected had been stocked (Figure 2). Stocked fish accounted for 50% of the age-0 walleye collections made during 2001, but catch rates were relatively low indicating poor survival of age-0 walleye that year. As indicated earlier, there is no evident relationship between the number of walleye stocked into Houghton Lake and catch rates of age-0 fish. This information, along with the long historical record (33 years) of no walleye stocking prior to 1979, indicates walleye stocking is not necessary in Houghton Lake. The poor growth rates of predators, including walleye, in this lake also indicates that stocking additional predators into this lake is biologically unsound. Fisheries Division does not recommend stocking fish into self-sustaining populations and stocking walleye in Houghton Lake does not meet Michigan Fish Stocking Guidelines criteria (Dexter and O'Neal 2004).

There is a great deal of public support for walleye stocking in this lake, as in many lakes. However, scientific information should form an important basis shaping decisions on fish stocking, along with following guidelines for fish stocking in Michigan. Li (1996) concluded that stocking most likely increases walleye abundance in lakes where natural reproduction is limited but food is not. Laarman (1978) showed that walleye stocking was successful for only 5% of supplemental stockings (lakes with natural reproduction).

Another factor that deserves further evaluation in regard to natural reproduction of walleye in Houghton Lake is alteration of water flow in the Cut River by the lake-level control dam on Higgins Lake. The Cut River flows from Higgins Lake to Houghton Lake. Walleye move from Houghton Lake into the Cut River during spring to spawn. Spring water flows in the Cut River have been altered by the Higgins Lake dam to increase lake levels in Higgins Lake for many years. During some years flows have been severely depleted in the Cut River during the walleye spawning and rearing period. In 2007, a permanent opening was installed in the lake-level dam as part of a renovation project. This opening was designed to allow a continuous flow of water into the Cut River at the 95% exceedence level (base flow). Age-0 walleye catch has been very stable in Houghton Lake since 2007 when compared to earlier years (Table 2). If possible, age-0 walleye catch rates should be compared to historical flows in the Cut River. It is unclear at this time if historical flows can be determined from available data.

Houghton Lake is the largest inland Lake in Michigan and its large size allows for substantial angler-use. The economic benefit of this fishery to the local economy during summer and winter (2001-02) was over $5 million. Clark et al. (2004) found that total fish harvest from Houghton Lake during summer 2001 and winter 2002 was 386,287 fish. Panfish (bluegill, pumpkinseed, yellow perch, black crappie, and rock bass) accounted for 92.2% of the harvest, with 152,237 bluegill harvested. Predator species accounted for 7.7% of the harvest including walleye (18,265), and northern pike (9,291), smallmouth bass (1,888), and largemouth bass (340). A small number of white suckers were also harvested.

Overall, the fisheries of Houghton Lake are dominated by panfish, walleye, and northern pike. When compared to earlier surveys, the 2011 survey indicated bluegill abundance was relatively high and walleye abundance was moderately higher in Houghton Lake. Northern pike abundance appears to have returned to more normal levels following the high levels recorded in 2007.

## Management Direction

Management Objective 1: Discontinue walleye stocking in Houghton Lake.
This objective is based on the following information:

1) There is sufficient natural recruitment of walleye to support the population and the fishery. The Houghton Lake walleye fishery was sustained by natural recruitment for a 33-year period prior to recent fingerling stockings. Stocked walleye contribute little to the population as indicated by surveys conducted over the past twenty years.
2) Stocking walleye into Houghton Lake is not biologically sound. There is sufficient predator abundance in Houghton Lake to provide a balanced fish population as indicated by the excellent panfish fishery. Predator growth rates are slow, indicating too many predators are present for available forage.
3) Stocking walleye into Houghton Lake does not meet Michigan Fish Stocking Guidelines. The guidelines state that stocking can occur if: natural reproduction and survival are inadequate to maintain the fishery, there is reasonable biological expectation the quality of the existing fishery or fish community will not be diminished, and the fishery produced justifies the cost of the program. Walleye stocking in Houghton Lake does not meet any of these guidelines.

Management Objective 2: Apply appropriate fishing regulations to better manage the northern pike population.

Growth of northern pike is relatively slow in Houghton Lake. The spring net collections in 2001 indicated about 27% of the northern pike population was greater than 24 inches in length. Recent netting data indicated the abundance of northern pike is variable in this lake and that substantial numbers of small fish were present in the period surrounding 2007. A new suite of northern pike regulations is currently under development for Michigan. A regulation other than the current 24 inch minimum size limit may be more appropriate for northern pike management in Houghton Lake. Spring net collections should be used to evaluate northern pike age and size structure if more data is required to select new regulations.

Management Objective 3: Restoration of fisheries habitat is a long term goal in Houghton Lake.

Fisheries habitat in Houghton Lake has been altered significantly by human development. The lake-level control structure raises water levels substantially causing widespread shoreline erosion and subsequent construction of hardened shoreline around almost the entire lake. Wild rice beds and other emergent vegetation have been significantly degraded as a result of the high water levels. Eurasian water-milfoil was widespread throughout the lake resulting in a whole lake treatment with Fluridone in 2002. Since then, extensive treatments of milfoil have been made every year with 2, 4-D and a milfoil weevil program was also started. It is uncertain what effects these vegetation removal programs are having on the aquatic vegetation or food base in the lake. There is likely little wood cover left in Houghton Lake. Habitat evaluations and restoration programs should be conducted in this lake following the Conservation Guidelines for Michigan Lakes and Associated Resources (O'Neal and Soulliere 2006).

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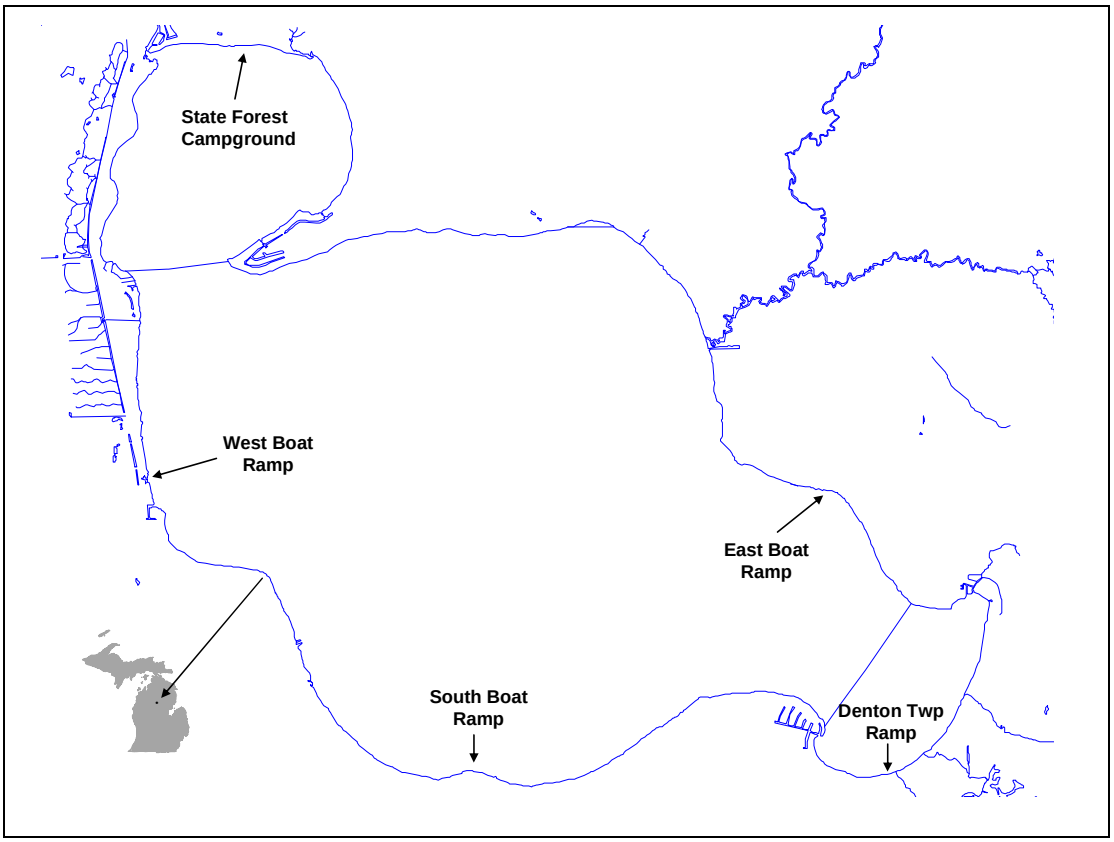

Figure 1. Location of Houghton Lake and boat access ramps.

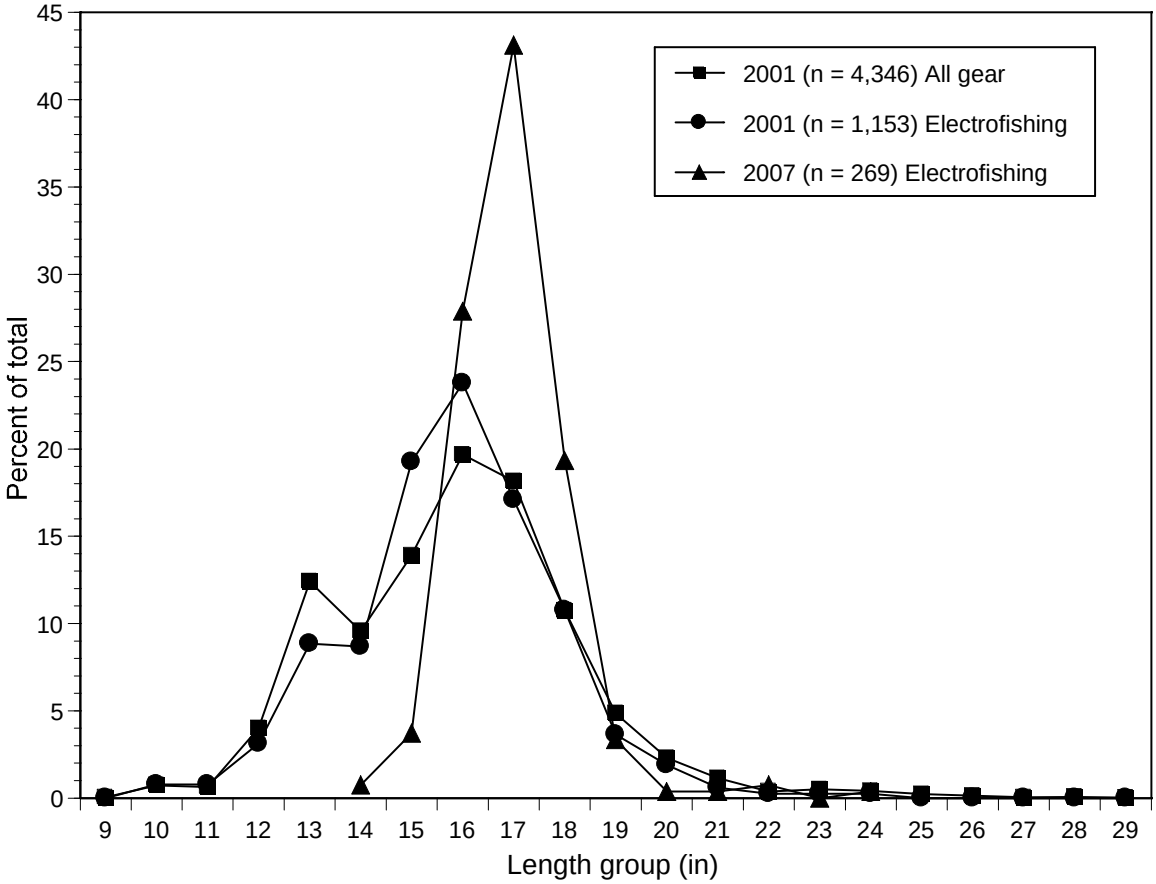


Figure 2. Length distribution of walleyes in Houghton Lake, from spring collections in 2001 and 2007.

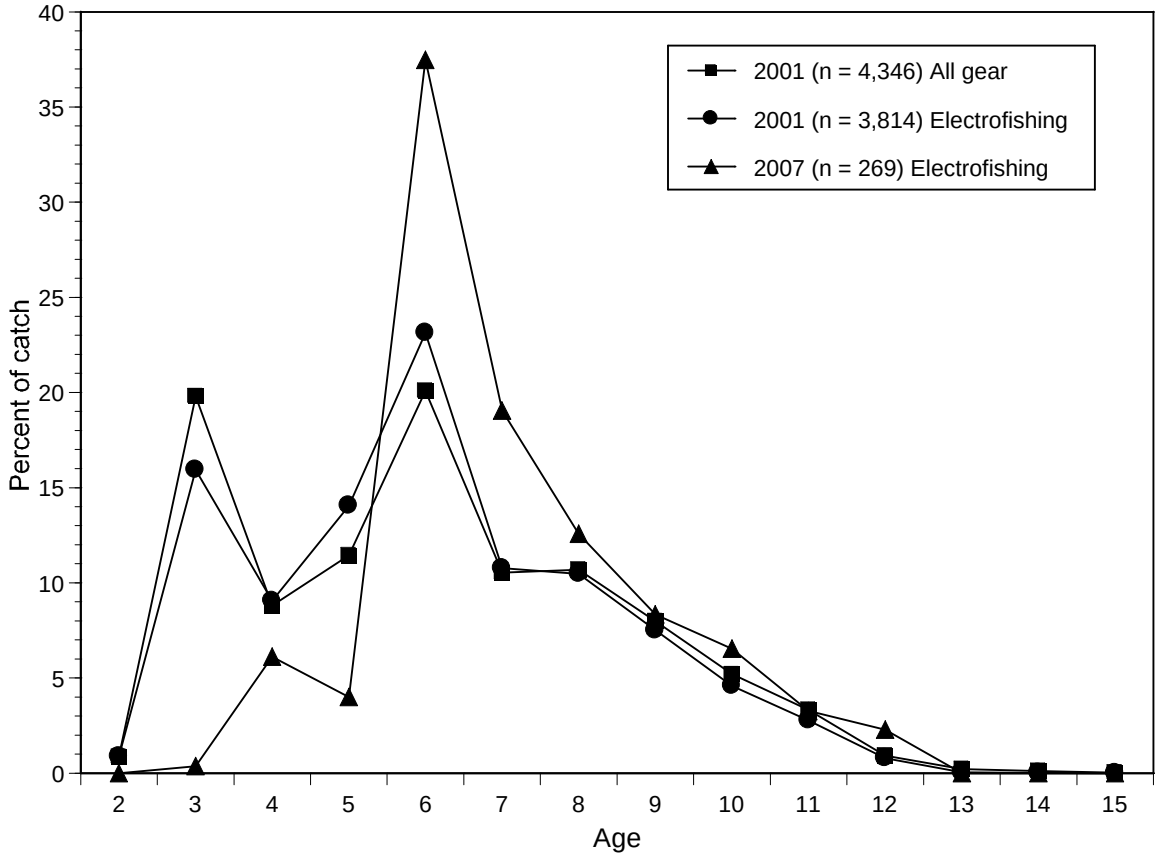

Figure 3. Age distribution (apportioned by length-age keys) of walleyes in Houghton Lake, from spring collections in 2001 and 2007.

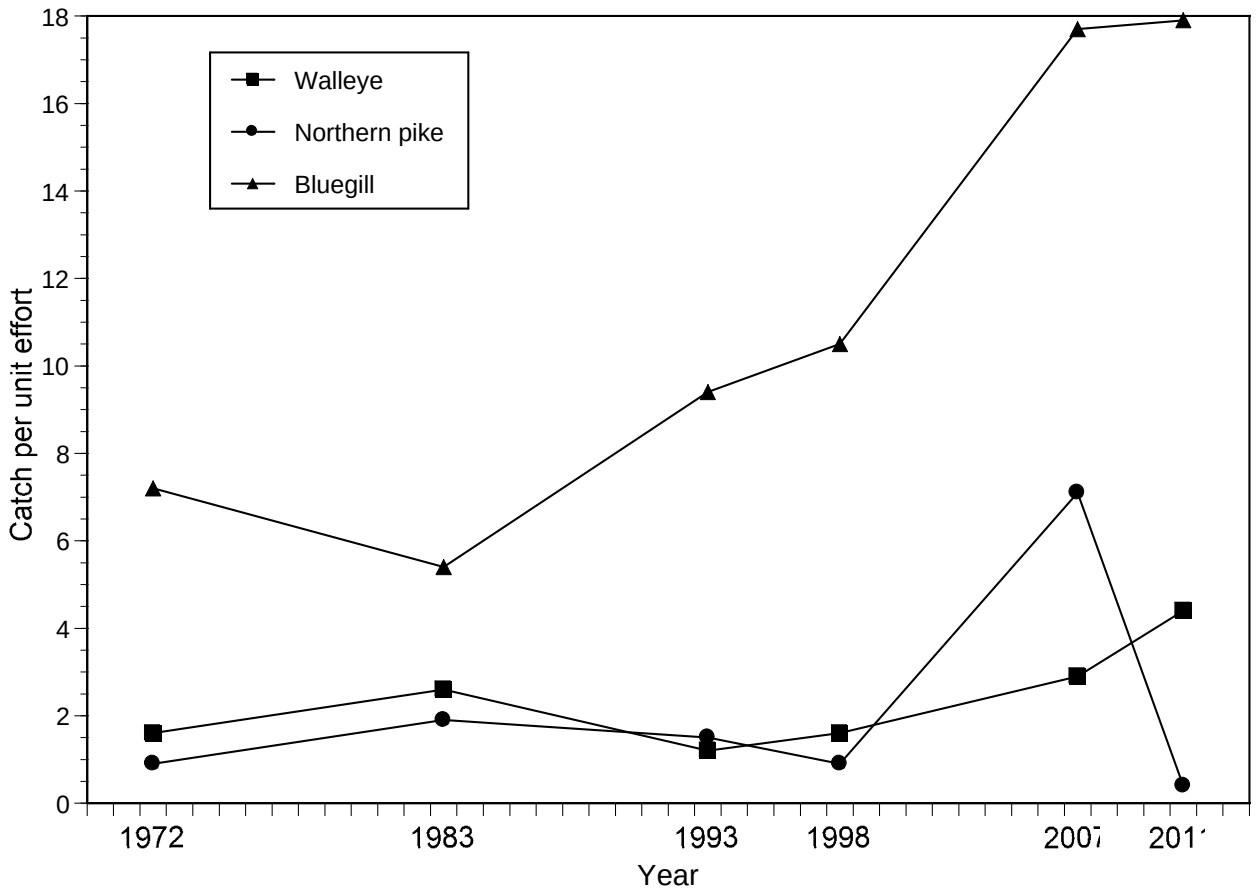

Figure 4. June trap net catch rates of walleye, northern pike, and bluegill in Houghton Lake, from 1972 through 2011.

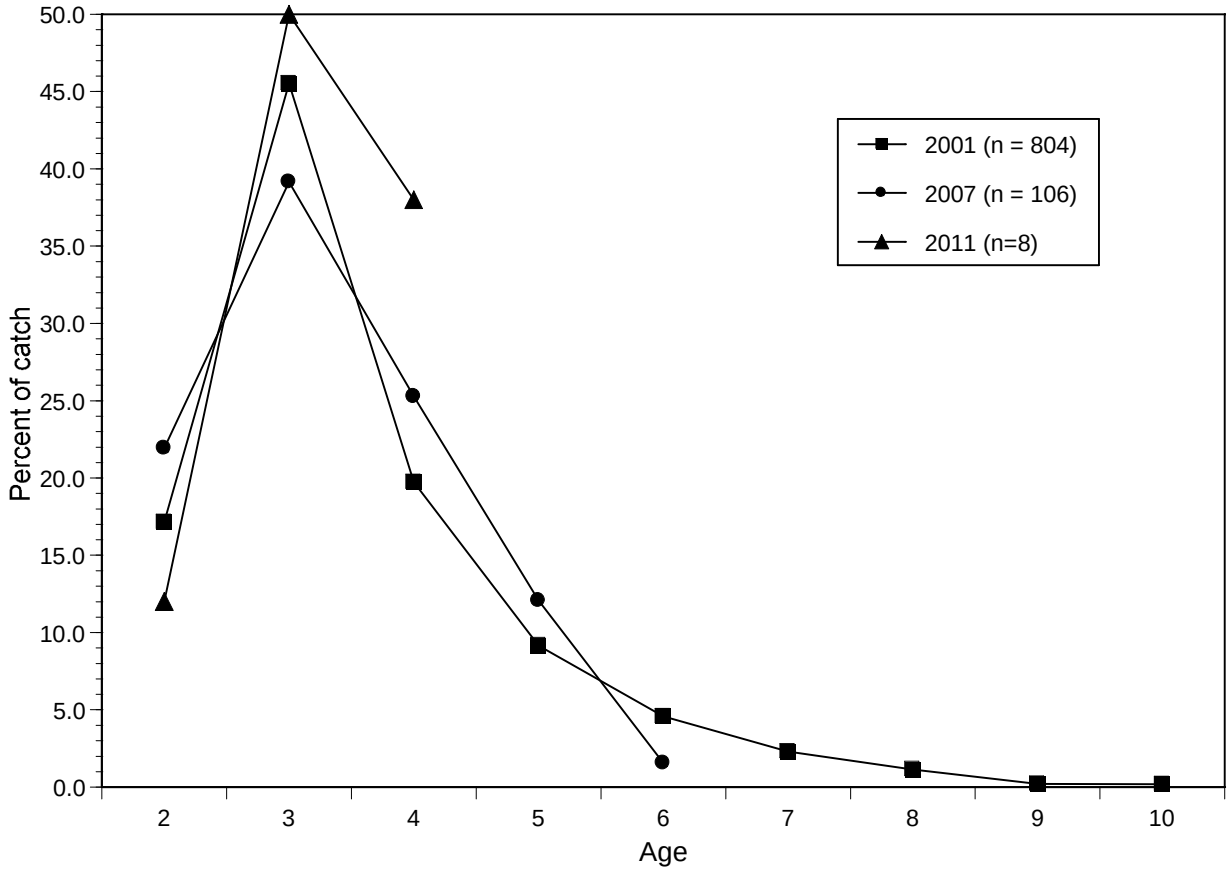


Figure 5. Age distribution (apportioned by length-age keys) of northern pike in Houghton Lake, from trap net collections in spring 2001, June 2007 and June 2011.

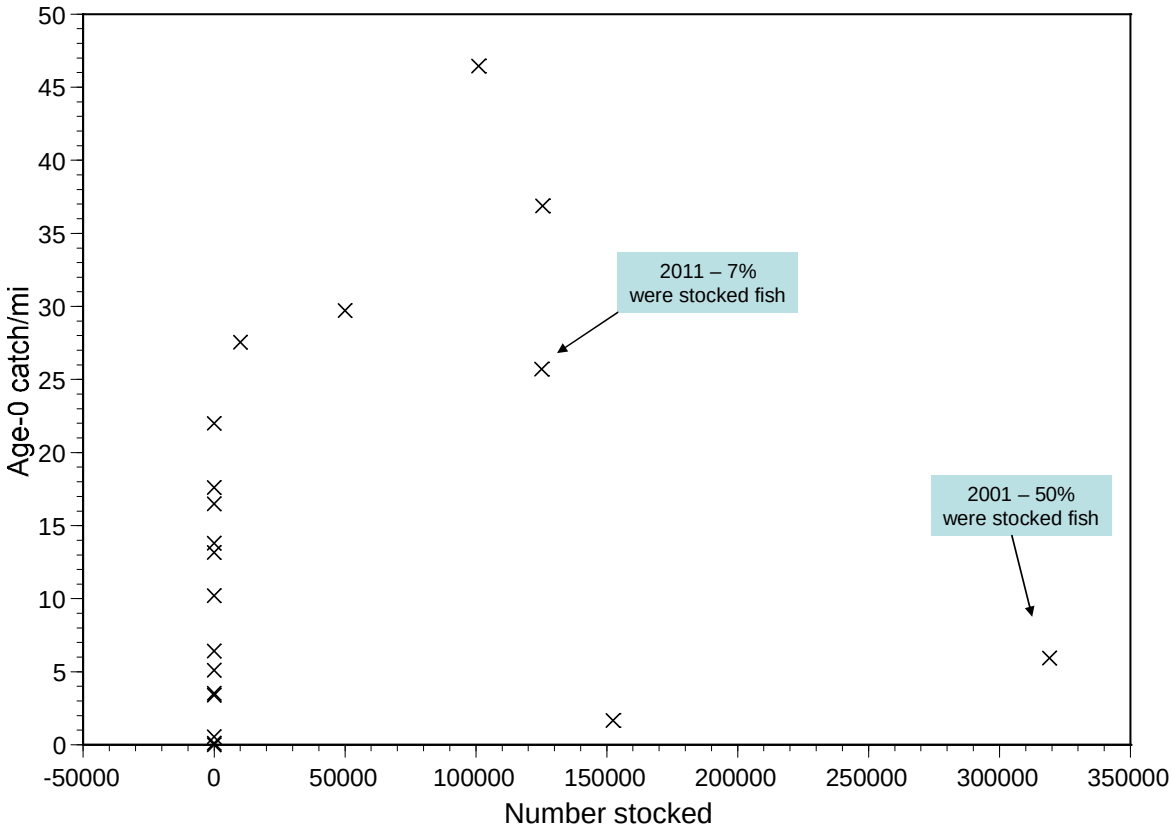


Figure 6. Catch rates of age-0 walleye from fall electrofishing surveys in Houghton Lake, 1990-2011 year-classes. In 2001, 50% of age-0 walleye were stocked (marked) fish and in 2011, 7% of age-0 walleye were stocked fish.

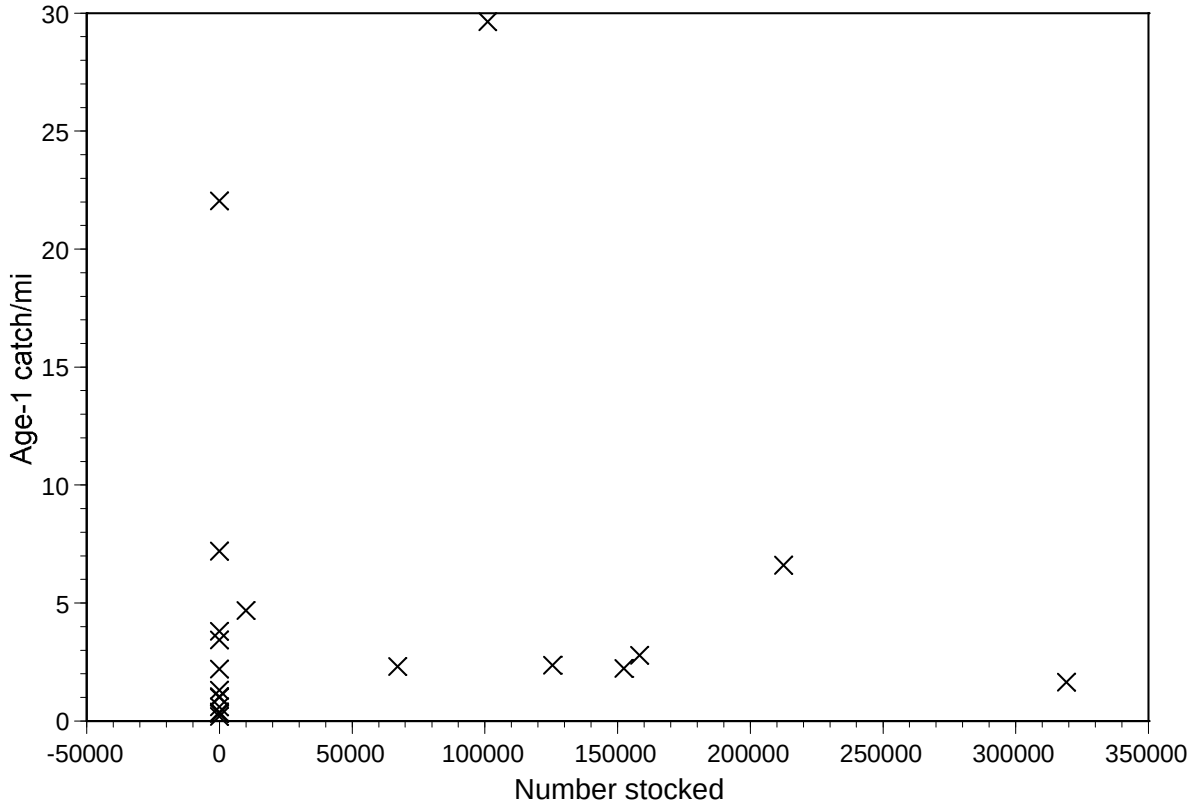


Figure 7. Catch rates of age-1 walleye from fall electrofishing surveys in Houghton Lake, 1989-2011 year-classes.

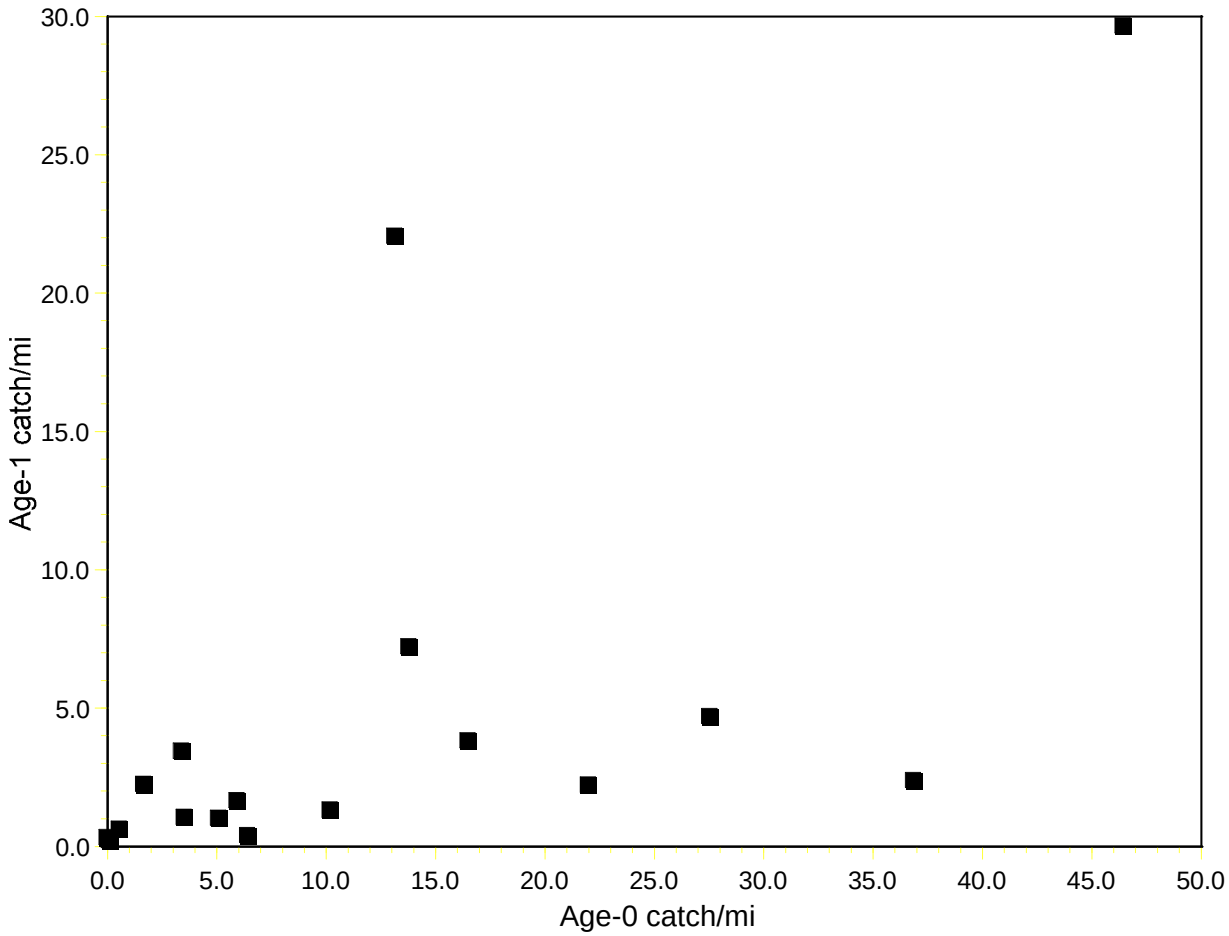


Figure 8. Catch of age-1 walleye compared to age-0 walleye catch the previous year in Houghton Lake, 1989-2010.

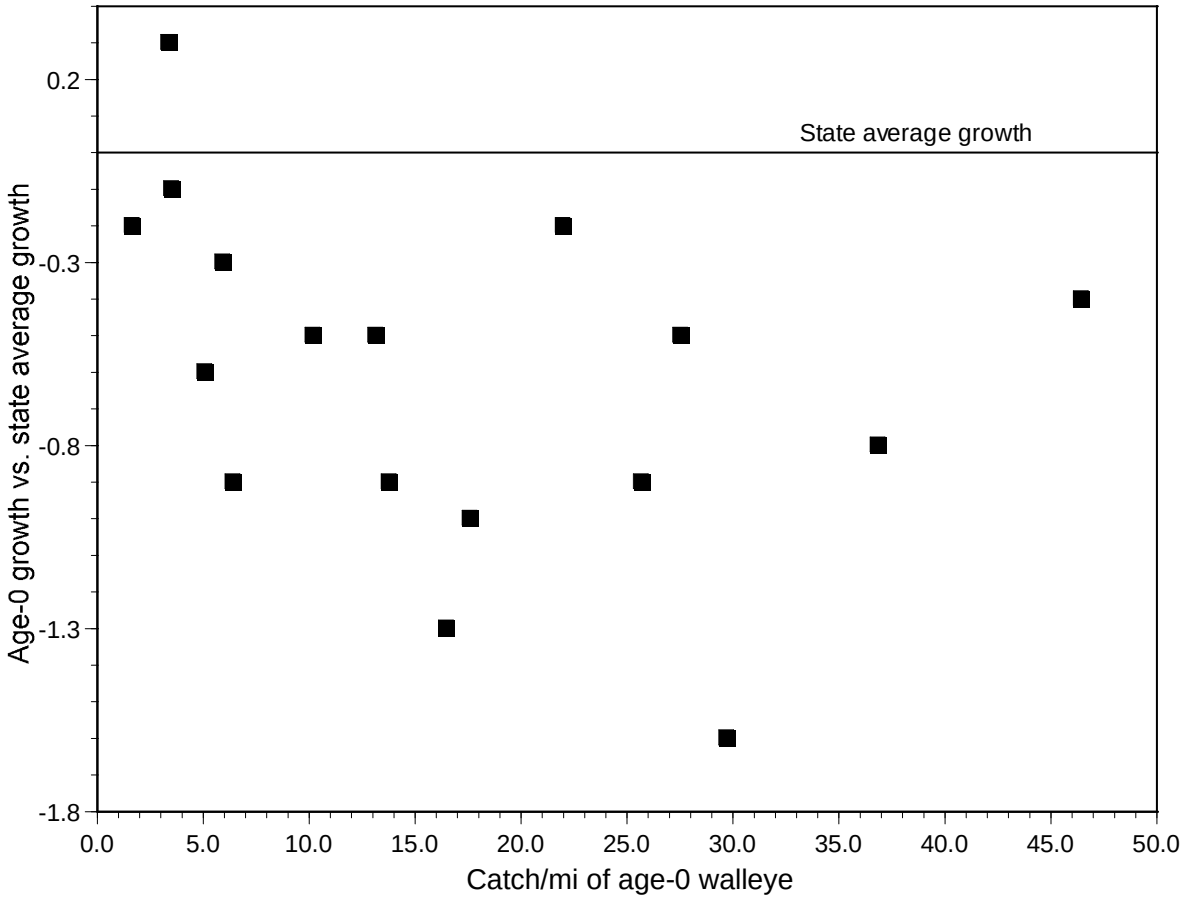


Figure 9. Age-0 walleye density compared to the state average walleye growth (deviation between mean length at age-0 and state average length), 1990-2011.

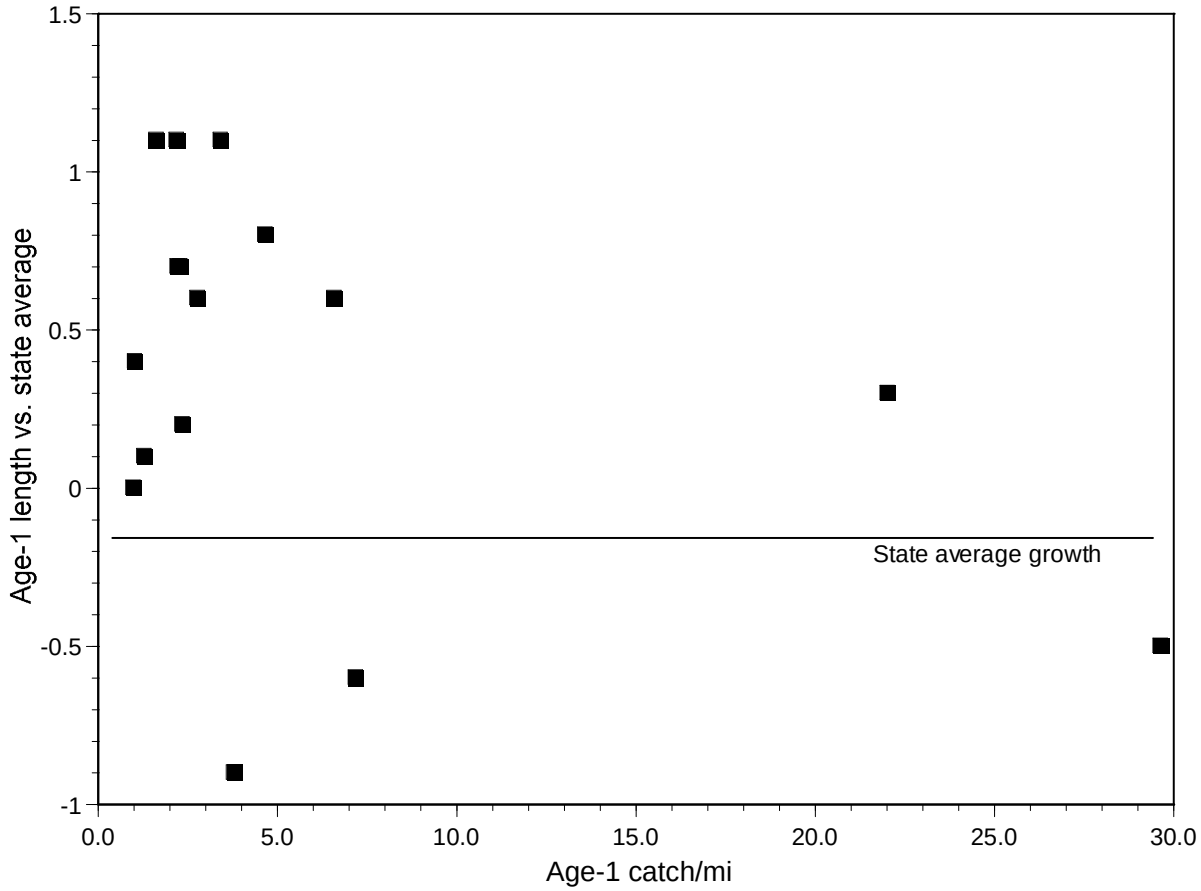


Figure 10. Age-1 walleye density compared to the state average walleye growth index (deviation between mean length at age-1 and state average length), 1990-2011.

Table 1. Mean growth indices from 1922-2011 for Houghton Lake. Values in parentheses indicate number of fish aged. Mean growth index is a comparison to state average growth rates.

| | July-August 1922 | July 1948 | May-June 1955 | May 1962 | June-July 1967 | July 1971 | June 1972 | June 1983 | June 1993 | June 1998 | June 2007 | June 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Walleye | | | -2.9 | -1.1 | | -2.0 | | 0.0 | -1.1 | -1.1 | -0.8 | -1.0 |
| | | | (52) | (45) | | (15) | | (87) | (151) | (53) | (46) | (57) |
| Largemouth bass | | 2.2 | 0.0 | | 0.2 | | | | 0.1 | 0.3 | 0.8 | |
| | | (8) | (37) | | (8) | | | | (29) | (27) | (28) | |
| Smallmouth bass | | 0.2 | | | 1.6 | | | 0.6 | 0.4 | -0.1 | 1.6 | 0.5 |
| | | (5) | | | (5) | | | (53) | (32) | (51) | (26) | (13) |
| Northern pike | | | | -1.8 | -1.5 | | | -2.0 | -2.2 | -0.5 | -2.1 | |
| | | | | (29) | (53) | | | (50) | (58) | (20) | (93) | |
| Bluegill | 0.6 | 1.1 | 0.2 | 0.7 | 0.4 | | 0.6 | 0.2 | 1.0 | 0.9 | 0.5 | 0.5 |
| | (23) | (55) | (78) | (59) | (327) | | (108) | (99) | (97) | (85) | (101) | (77) |
| Pumpkinseed | -0.2 | 1.2 | 0.8 | 0.3 | 0.6 | | 0.6 | 0.7 | 0.8 | 1.0 | 1.4 | 0.6 |
| | (79) | (71) | (80) | (18) | (134) | | (104) | (32) | (39) | (35) | (44) | (5) |
| Rock bass | 0.4 | 0.8 | 0.6 | 0.6 | 1.6 | | 0.5 | 0.8 | 0.8 | 1.1 | 1.1 | 1.2 |
| | (115) | (28) | (72) | (50) | (131) | | (85) | (51) | (74) | (49) | (28) | (56) |
| Black crappie | | 0.1 | 0.7 | 0.6 | | | 0.5 | 0.4 | 0.2 | 0.2 | 0.5 | -1.2 |
| | | (5) | (40) | (5) | | | (13) | (39) | (89) | (36) | (34) | (22) |
| Yellow perch | | | | -0.7 | -1.5 | | -1.4 | -1.9 | -1.7 | -0.6 | -1.9 | |
| | | | | (14) | (43) | | (14) | (43) | (52) | (31) | (27) | |

Table 2. Walleye size distributions, catch per unit effort (CPUE) per net lift or per hour for electrofishing, and average lengths from net and electrofishing surveys in Houghton Lake.

| | June | | | | | | Spring | | Spring | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Trap nets | | | | | | Trap nets | Fyke nets | Electrofishing | |
| Length (in) | 1972 | 1983 | 1993 | 1998 | 2007 | 2011 | 2001 | 2001 | 2001 | 2007 |
| 9 | | | 1 | | | 3 | 2 | | | |
| 10 | | | | | 6 | 5 | 20 | 3 | 9 | |
| 11 | 1 | | | | 1 | 5 | 8 | 11 | 9 | |
| 12 | | 2 | 1 | 1 | 4 | 4 | 83 | 55 | 36 | |
| 13 | 6 | 8 | 5 | 5 | 3 | 13 | 258 | 179 | 102 | |
| 14 | | 5 | 9 | 6 | 2 | 26 | 199 | 117 | 100 | 2 |
| 15 | 3 | 9 | 6 | 5 | 2 | 14 | 238 | 144 | 222 | 10 |
| 16 | | 6 | 4 | 2 | 9 | 4 | 371 | 210 | 274 | 75 |
| 17 | 3 | 5 | 3 | 2 | 6 | 2 | 401 | 191 | 197 | 116 |
| 18 | | 2 | 4 | 5 | 2 | 2 | 220 | 123 | 124 | 52 |
| 19 | 7 | 9 | | 1 | 3 | 1 | 110 | 59 | 42 | 9 |
| 20 | | 2 | | | 4 | | 46 | 32 | 22 | 1 |
| 21 | 11 | | 2 | | | | 30 | 13 | 7 | 1 |
| 22 | | | 1 | 1 | 1 | | 10 | 4 | 3 | 2 |
| 23 | | | | | | | 13 | 6 | 3 | |
| 24 | | | | | | | 8 | 7 | 3 | 1 |
| 25 | | 1 | | | | | 5 | 5 | | |
| 26 | | 1 | | | | | 3 | 3 | | |
| 27 | | 1 | | | | | 1 | 1 | | |
| 28 | | | | | | | 2 | 1 | | |
| 29 | | | | | | | 1 | | | |
| Total | 31 | 51 | 36 | 28 | 43 | 79 | 2,028 | 1,164 | 1,153 | 269 |
| Effort | 20 | 20 | 29 | 18 | 15 | 18 | 336 | 215 | | 3.5 |
| CPUE | 1.6 | 2.6 | 1.2 | 1.6 | 2.9 | 4.4 | 6.0 | 5.4 | 23.4[a] | 76.9 |
| Average length | 18.2 | 17.0 | 15.9 | 16.0 | 15.8 | 14.1 | 16.5 | 16.3 | 16.3 | 17.5 |

a. CPUE determined from 2 efforts

Table 3. The age distribution, length ranges, and mean lengths for walleye from trap net collections on Houghton Lake during June 2011.

| Year-class | Age | Number collected | Percent of catch | Length Range (in) | Mean Length (in) |
|---|---|---|---|---|---|
| 2009 | 2 | 9 | 11 | 9.1-11.3 | 10.2 |
| 2008 | 3 | 47 | 59 | 11.2-15.0 | 13.5 |
| 2007 | 4 | 14 | 18 | 14.8-16.1 | 15.3 |
| 2006 | 5 | 6 | 8 | 15.9-17.9 | 16.9 |
| 2005 | 6 | 0 | 0 | | |
| 2004 | 7 | 1 | 1 | | |
| 2003 | 8 | 2 | 3 | | |
| Total | | 79 | 100 | | |

Table 4. Northern pike size distributions, catch per unit effort (CPUE) per net lift or per hour for electrofishing, and average lengths from net and electrofishing surveys in Houghton Lake.

| | June | | | | | | Spring | | Spring | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Trap net | | | | | | Trap net | Fyke net | Electrofishing | |
| Length (in) | 1972 | 1983 | 1993 | 1998 | 2007 | 2011 | 2001 | 2001 | 2001 | 2007 |
| 9 | | | | | | | 0 | 1 | | |
| 10 | | | | | | | 0 | | | |
| 11 | | | | | 1 | | 1 | | | |
| 12 | | | | | | | 0 | | | |
| 13 | | | | | | | 4 | 1 | 1 | |
| 14 | | | | | 1 | | 3 | 1 | | |
| 15 | | | | | | | 6 | 2 | | |
| 16 | | | 2 | | 5 | | 13 | 9 | | |
| 17 | 6 | 1 | 2 | | 8 | | 19 | 7 | 2 | |
| 18 | | 7 | 4 | | 12 | | 64 | 16 | 1 | |
| 19 | 8 | 13 | 9 | 2 | 17 | 2 | 85 | 22 | 5 | |
| 20 | | 7 | 17 | 6 | 15 | | 111 | 40 | 4 | |
| 21 | 3 | 3 | 5 | | 19 | 1 | 104 | 34 | 3 | 2 |
| 22 | | 3 | | 2 | 14 | 1 | 92 | 40 | 1 | |
| 23 | | 2 | 2 | 3 | 7 | 2 | 68 | 25 | 4 | |
| 24 | | | 1 | 1 | 4 | 1 | 73 | 14 | 1 | |
| 25 | | | 1 | 3 | 1 | 1 | 41 | 7 | 2 | |
| 26 | | 1 | | | 1 | | 25 | 7 | 1 | |
| 27 | | | | | 1 | | 25 | 6 | 1 | |
| 28 | | | | | | | 17 | 9 | | |
| 29 | | | | | | | 13 | 5 | | |
| 30 | | | | | | | 9 | 5 | | |
| 31 | | 1 | | | | | 4 | 2 | | |
| 32 | | | | | | | 4 | 1 | | |
| 33 | | | | | | | 4 | 1 | | |
| 34 | | | | | | | 6 | | | |
| 35 | | | | | | | 5 | | | |
| 36 | | | | | | | 1 | | | |
| 37 | | | | | | | 3 | 1 | | |
| 38 | | | | | | | 3 | | | |
| 39 | | | | | | | 1 | | | |
| 40 | | | | | | | 0 | | | |
| 41 | | | | | | | 1 | | | |
| Total | 17 | 38 | 43 | 17 | 106 | 8 | 805 | 256 | 26 | 2 |
| Effort | 20 | 20 | 29 | 18 | 15 | 18 | 336 | 215 | | 3.5 |
| CPUE | 0.9 | 1.9 | 1.5 | 0.9 | 7.1 | 0.4 | 2.4 | 1.2 | 0.4[a] | 0.6 |
| Average length | 19.1 | 20.6 | 20.2 | 22.3 | 20.5 | 22.5 | 22.6 | 22.3 | 21.8 | 21.5 |

a. CPUE determined from 2 efforts

Table 5. Bluegill size distributions, catch per unit effort (CPUE) per net lift, and average lengths from June trap net surveys in Houghton Lake.

| Length (in) | 1972 | 1983 | 1993 | 1998 | 2007 | 2011 |
|---|---|---|---|---|---|---|
| 2 | | | | 2 | | |
| 3 | 3 | 1 | | | 5 | 1 |
| 4 | 3 | 5 | | 11 | 5 | 21 |
| 5 | 27 | 5 | 6 | 41 | 4 | 32 |
| 6 | 27 | 21 | 17 | 81 | 19 | 70 |
| 7 | 28 | 29 | 39 | 45 | 117 | 94 |
| 8 | 27 | 24 | 57 | 3 | 90 | 78 |
| 9 | 20 | 21 | 121 | 3 | 23 | 22 |
| 10 | 9 | 2 | 32 | 3 | 3 | 4 |
| Total | 144 | 108 | 272 | 189 | 266 | 322 |
| Effort | 20 | 20 | 29 | 18 | 15 | 18 |
| CPUE | 7.2 | 5.4 | 9.4 | 10.5 | 17.7 | 17.9 |
| Average length | 7.4 | 7.7 | 8.8 | 6.5 | 7.8 | 7.3 |

Table 6. Bluegill size structures, length frequency ranks, and growth ranks in Houghton Lake from June trap net catches. Size and growth ranks (very poor, poor, acceptable, satisfactory, good, excellent, superior) determined by methods described by Schneider (1990). Refer to Table 1 for growth indices.

| Date of sample | Sample size | Length Range (in) | Average size | % > 6" | % > 7" | % > 8" | Size rank | Growth rank |
|---|---|---|---|---|---|---|---|---|
| June 1972 | 144 | 3.5-10.5 | 7.4 | 77 | 58 | 39 | Excellent | Good |
| June 1983 | 108 | 3.5-10.5 | 7.7 | 90 | 70 | 43 | Excellent | Satisfactory |
| June 1993 | 272 | 5.5-10.5 | 8.8 | 98 | 91 | 77 | Superior | Excellent |
| June 1998 | 189 | 2.5-10.5 | 6.5 | 71 | 29 | 5 | Good | Good |
| June 2007 | 266 | 3.5-10.5 | 7.8 | 95 | 88 | 44 | Superior | Superior |
| June 2011 | 322 | 3.5-10.5 | 7.3 | 83 | 61 | 32 | Excellent | Good |

Table 7. Average lengths and length ranges for five fish species collected in trap nets during June 2007 and June 2011.

| Species | 2007 | | | 2011 | | |
|---|---|---|---|---|---|---|
| | Average length (in) | Length range (in) | Percent legal size | Average length (in) | Length range (in) | Percent legal size |
| Smallmouth bass | 15.0 | 10 - 18 | 76 | 9.7 | 5 - 18 | 10 |
| Largemouth bass | 14.0 | 10 - 16 | 78 | 11.9 | 6 – 16 | 38 |
| Pumpkinseed | 7.9 | 6 - 9 | 100 | 7.3 | 4 - 8 | 87 |
| Black crappie | 10.1 | 5 – 12 | 81 | 7.9 | 4 - 12 | 61 |
| Rock bass | 8.9 | 4 - 11 | 85 | 8.2 | 4 - 11 | 88 |

Table 8. Walleye stocking in Houghton Lake, Michigan (OTC indicates marked with oxytetracycline). Few stocking records were available from 1914-1932 (Laarman 1976).

| Year | Number stocked | | Year | Number stocked | |
|---|---|---|---|---|---|
| | Fry | Fingerlings | | Fry | Fingerlings |
| 1908 | 400,000 | 0 | 1972 | 0 | 0 |
| 1933 | 1,800,100 | 0 | 1973 | 0 | 0 |
| 1934 | 2,100,000 | 0 | 1974 | 0 | 0 |
| 1935 | 1,800,000 | 0 | 1975 | 0 | 0 |
| 1936 | 2,000,000 | 0 | 1976 | 0 | 0 |
| 1937 | 2,000,000 | 0 | 1977 | 0 | 0 |
| 1938 | 2,000,000 | 0 | 1978 | 0 | 0 |
| 1939 | 2,200,000 | 0 | 1979 | 0 | 68,936 |
| 1940 | 4,000,000 | 0 | 1980 | 0 | 106,717 |
| 1941 | 0 | 0 | 1981 | 0 | 178,757 |
| 1942 | 4,000,000 | 0 | 1982 | 0 | 26,699 |
| 1943 | 4,160,000 | 0 | 1983 | 0 | 39,403 |
| 1944 | 4,000,000 | 0 | 1984 | 0 | 24,739 |
| 1945 | 0 | 0 | 1985 | 0 | 70,663 |
| 1946 | 0 | 0 | 1986 | 0 | 107,950 |
| 1947 | 0 | 0 | 1987 | 0 | 17,000 |
| 1948 | 0 | 0 | 1988 | 0 | 75,200 |
| 1949 | 0 | 0 | 1989 | 0 | 67,150 |
| 1950 | 0 | 0 | 1990 | 0 | 125,469 |
| 1951 | 0 | 0 | 1991 | 0 | 101,050 |
| 1952 | 0 | 0 | 1992 | 0 | 0 |
| 1953 | 0 | 0 | 1993 | 0 | 158,282 |
| 1954 | 0 | 0 | 1994 | 0 | 10,000 |
| 1955 | 0 | 0 | 1995 | 0 | 0 |
| 1956 | 0 | 0 | 1996 | 0 | 0 |
| 1957 | 0 | 0 | 1997 | 0 | 0 |
| 1958 | 0 | 0 | 1998 | 0 | 0 |
| 1959 | 0 | 0 | 1999 | 0 | 152,346 |
| 1960 | 0 | 0 | 2000 | 0 | 0 |
| 1961 | 0 | 0 | 2001 | 0 | 319,130 otc |
| 1962 | 0 | 0 | 2002 | 0 | 0 |
| 1963 | 0 | 0 | 2003 | 0 | 0 |
| 1964 | 0 | 0 | 2004 | 0 | 50,000 |
| 1965 | 0 | 0 | 2005 | 0 | 212,568 |
| 1966 | 0 | 0 | 2006 | 0 | 0 |
| 1967 | 0 | 0 | 2007 | 0 | 0 |
| 1968 | 0 | 0 | 2008 | 0 | 0 |
| 1969 | 0 | 0 | 2009 | 0 | 0 |
| 1970 | 0 | 0 | 2010 | 0 | 0 |
| 1971 | 0 | 0 | 2011 | 0 | 125,097 otc |

Table 9. Juvenile catch rates (electrofishing) and growth indices of walleye in Houghton Lake. Growth indices indicate growth rates compared to state average growth rates for walleye. Mean growth indices determined from netting surveys using all ages. OTC indicates the fish were marked with oxytetracycline.

| Year | Number stocked | Catch/mile Age-0 | Catch/mile Age-1 | Growth index (electrofishing samples) | | | | | | Mean growth index |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Age-0 | Age-1 | Age-2 | Age-3 | Age-4 | Age-5 | |
| 1922 | ? | | | | | | | | | -2.9 |
| 1948 | 0 | | | | | | | | | -0.4 |
| 1955 | 0 | | | | | | | | | -1.9 |
| 1962 | 0 | | | | | | | | | -1.8 |
| 1971 | 0 | | | | | | | | | -2 |
| 1989 | 67,150 | | | | | | | | | |
| 1990 | 125,469 | 36.9 | 2.3 | -0.8 | 0.7 | | | | | |
| 1991 | 101,050 | 46.5 | 2.4 | -0.4 | 0.2 | | | | | |
| 1992 | 0 | 17.6 | 29.6 | -1 | -0.5 | -0.9 | 0 | | | |
| 1993 | 158,282 | | | | | | | | | -1.1 |
| 1994 | 10,000 | 27.6 | 2.8 | -0.4 | 0.3 | | | | | |
| 1995 | 0 | 13.2 | 4.7 | -0.7 | 0.9 | | | | | |
| 1996 | 0 | 0.6 | 22.0 | | 0.2 | -0.4 | | | | |
| 1997 | 0 | 6.4 | 0.6 | -0.8 | | -0.8 | -1.5 | | | |
| 1998 | 0 | 3.4 | 0.4 | 0.3 | | | | -2.1 | | -1.1 |
| 1999 | 152,346 | 1.7 | 3.4 | -0.2 | 1.1 | -1.6 | | -1 | | |
| 2000 | 0 | 0.0 | 2.2 | | 0.7 | -0.3 | -1.3 | | -1.2 | |
| 2001 | 319,130otc | 5.9 | 0.3 | -0.3 | | | | | | -2.2 |
| 2002 | 0 | 0.1 | 1.6 | | 1.1 | | | 0 | | |
| 2003 | 0 | 3.5 | 0.2 | -0.7 | | 0.5 | -0.8 | | | |
| 2004 | 50,000 | 29.7 | 1.0 | -1.6 | 0.4 | | | | | -0.7 |
| 2005 | 212,568 | | | | | | | | | |
| 2006 | 0 | 5.1 | 6.6 | -0.6 | 0.6 | -2.0 | | | | -0.7 |
| 2007 | 0 | 22.0 | 1.0 | -0.2 | 0.0 | -0.4 | 0.0 | -0.9 | -1.6 | -0.8 |
| 2008 | 0 | 10.2 | 2.2 | -0.5 | 1.1 | -0.9 | | -1.1 | | -1.0 |
| 2009 | 0 | 16.5 | 1.3 | -1.3 | 0.1 | 0.1 | -1.2 | | | -1.0 |
| 2010 | 0 | 13.8 | 3.8 | -0.9 | -0.9 | 0.0 | -0.2 | | | -0.5 |
| 2011 | 125,097otc | 25.7 | 7.2 | -0.9 | -0.6 | -2.6 | -1.7 | -2.2 | | -1.6 |