Characteristics of Waterbody and Biological Communities.
A status report and management plan for Houghton Lake was written in 1993 (Fish Collection System Survey Report 6/1-10/1993). The reader should consult this document for descriptions of the physical and biological communities, along with historical reviews. Refer to the site descriptions for specific information collected in this survey.

Purpose and Results of Survey.
This survey was conducted to continue evaluations of juvenile walleye recruitment in Houghton Lake. These evaluations were recommended in the 1993 management plan. Also provided is a summary of walleye stocking since 1908, catch rates of juveniles since 1990 and growth indices of juveniles and adults from electrofishing and netting surveys since 1922.

Fall electrofishing was conducted to evaluate walleye recruitment at four sites in 2008. Eight miles of shoreline were sampled at the four sites combined (Figure 1). Total walleye juveniles sampled included 82 (10.2/mi) age-0 and 18 (2.2/mi) age-1 fish. Walleye growth was 0.4 inches below state average for age-0 fish. Growth of age-1 walleye was 1.1 inches above state average. Age-2 and Age-5 fish averaged 1.0 inches below state average.

Nearly four hours of sampling was completed over eight miles of shoreline in 2008. This effort was sufficient to provide estimates of walleye abundance using electrofishing index procedures (Serns 1982; Serns 1983). Estimates of age-0 (2008 year-class) and age-1 (2007 year-class) walleye densities were 2.4/acre and 0.4/acre. Walleye were not stocked into Houghton Lake in 2007 or 2008.

Conclusions and Recommendations
Walleye stocking in Houghton Lake has been conducted since at least 1908 (Table 1). Some fry stocking was conducted in early years, followed by a long period without stocking. Stocking between 1979 and 2008 was predominantly spring fingerlings, with fewer numbers of fall fingerlings.

Juvenile walleye sampling was conducted in all but two years from 1990-2008 (Table 2). No relationship was evident between the number of fish stocked and catch rates for either age-0 or age-1 walleye (Figures 2 & 3). However, it appears that very low numbers of juveniles do not occur during years when fish are stocked. This indicates stocking may be stabilizing recruitment at low densities. Catch rates of age-1 walleye were not related to catch rates of age-0 walleye from the previous year (Figure 4). 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 1922-2008 were summarized in Table 2. Overall walleye growth in this lake was well below state average in most years. Slow walleye growth was evident during 1955, 1962, 1971, and 2006-2008, 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. 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 5). Growth rates of age-1 walleye were above state average during most years (Figure 6). The reason for the

difference in growth of the two age groups is uncertain at this time, but may be related to biological conditions in the lake or to the estimated state average growth rates for juveniles. There was no strong relationship between juvenile growth rates and juvenile densities (Figures 5 & 6). Variability was high and more information will be needed to determine if a relationship exits.

Young-of-the-year and yearling walleye population numbers were estimated (Serns 1983) for 13 years from 1991-2008 (Figure 7). Estimated age-0 and age-1 walleye densities generally were low in all years sampled. In Michigan, year-class strength is considered poor if juvenile densities are lower than 11 age-0 fish/acre (Ziegler and Schneider 2000). The four strongest year-classes observed occurred in 1991, 1994, 1995 and 2007. The 1995 and 2007 year-classes resulted from natural reproduction. The 1991 and 1994 year-classes may have been partially composed of stocked fish. The number of stocked fish was less than 50% of fall abundance, and generally only a small percentage of stocked fish survive. A good example of this occurred in 2001 when large numbers of marked fish were stocked. A relatively small year-class was produced and only 50% of those were stocked fish. Fall abundance of age-0 fish was estimated at 28,105 fish. Estimated survival of stocked fish was about 4.4% which is typical for Michigan lakes. It is also evident that strong age-0 year-classes do not always produce strong age-1 year-classes, as occurred in 1994 and 2007.

Houghton Lake is the largest inland Lake in Michigan and the large size of this lake allows substantial angler-use. During the past 50 years, total winter and summer angler effort has ranged from 500,000 to 1,000,000 hours (Clark et al. 2004). Predominant fish species taken in the creel were bluegill, rock bass, pumpkinseed, yellow perch, northern pike, and walleye. Historically, northern pike were a larger component of the fishery than today. They declined due to the filling of wetlands throughout the lake. Angler-use, and angler catch and harvest rates on this lake were about average when compared to other Michigan lakes. Similarly, walleye catch and harvest rates were moderate compared to other Michigan inland lakes. Fishing effort by anglers was significantly lower in 2001 and 2002 than from 1957-1961. However, the harvest rate of walleye was twice as high, suggesting abundance has not decreased.

Walleye are indigenous to the Muskegon River system as which includes Houghton Lake. The walleye population in this lake was sustained with no stocking for a 33 year period from 1945-1978. Based on growth indices and catch rates, there appears to be sufficient natural reproduction in this lake to support the walleye population.

There was fairly consistent natural production of juvenile walleye in this lake, but year-class strength varied between years. Fingerling stocking in recent years has not increased recruitment substantially. 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). Walleye growth has been below state average since the earliest evaluations were made in 1922. Stocking additional fish into a system with limited forage is not recommended for management of healthy fish populations.

Evaluation and determination of the need for stocking Houghton Lake was listed as a primary goal in the 1993 management plan. There is a great deal of public support for walleye stocking in this lake, as in all lakes. However, scientific information should form an important basis shaping decisions on fish stocking, along with following guidelines for fish stocking in Michigan.

The value of the supplemental walleye stocking program in Houghton Lake should be evaluated based on criteria established in the Michigan Fish Stocking Guidelines. Criteria for fish stocking include 1) natural reproduction and survival are inadequate to maintain the fishery, 2) there is reasonable biological

expectation that the quality of the fishery or fish community will not be diminished, and 3) the fishery produced justifies the cost of the program.

An evaluation program has been designed that includes marking of all walleye stocked into the lake and annual estimates of juvenile population abundance and contributions of hatchery fish. Past and present flow regulation of the Cut River by the Higgins Lake dam needs to be evaluated for potential affects on walleye reproduction in Houghton Lake.

References

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Table 1. 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	400000	0	1971	0	0
1933	1800100	0	1972	0	0
1934	2100000	0	1973	0	0
1935	1800000	0	1974	0	0
1936	2000000	0	1975	0	0
1937	2000000	0	1976	0	0
1938	2000000	0	1977	0	0
1939	2200000	0	1978	0	0
1940	4000000	0	1979	0	68936
1941	0	0	1980	0	106717
1942	4000000	0	1981	0	178757
1943	4160000	0	1982	0	26699
1944	4000000	0	1983	0	39403
1945	0	0	1984	0	24739
1946	0	0	1985	0	70663
1947	0	0	1986	0	107950
1948	0	0	1987	0	17000
1949	0	0	1988	0	75200
1950	0	0	1989	0	67150
1951	0	0	1990	0	125469
1952	0	0	1991	0	101050
1953	0	0	1992	0	0
1954	0	0	1993	0	158282
1955	0	0	1994	0	10000
1956	0	0	1995	0	0
1957	0	0	1996	0	0
1958	0	0	1997	0	0
1959	0	0	1998	0	0
1960	0	0	1999	0	152346
1961	0	0	2000	0	0
1962	0	0	2001	0	319130 otc
1963	0	0	2002	0	0
1964	0	0	2003	0	0
1965	0	0	2004	0	50000
1966	0	0	2005	0	212568
1967	0	0	2006	0	0
1968	0	0	2007	0	0
1969	0	0	2008	0	0
1970	0	0			

Table 2. 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.

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	67150									
1990	125469	36.9	2.3	-0.8	0.7					
1991	101050	46.5	2.4	-0.4	0.2					
1992	0	17.6	29.6	-1	-0.5	-0.9	0			
1993	158282									-1.1
1994	10000	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	152346	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	319130	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	50000	29.7	1.0	-1.6	0.4					-0.7
2005	212568									
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

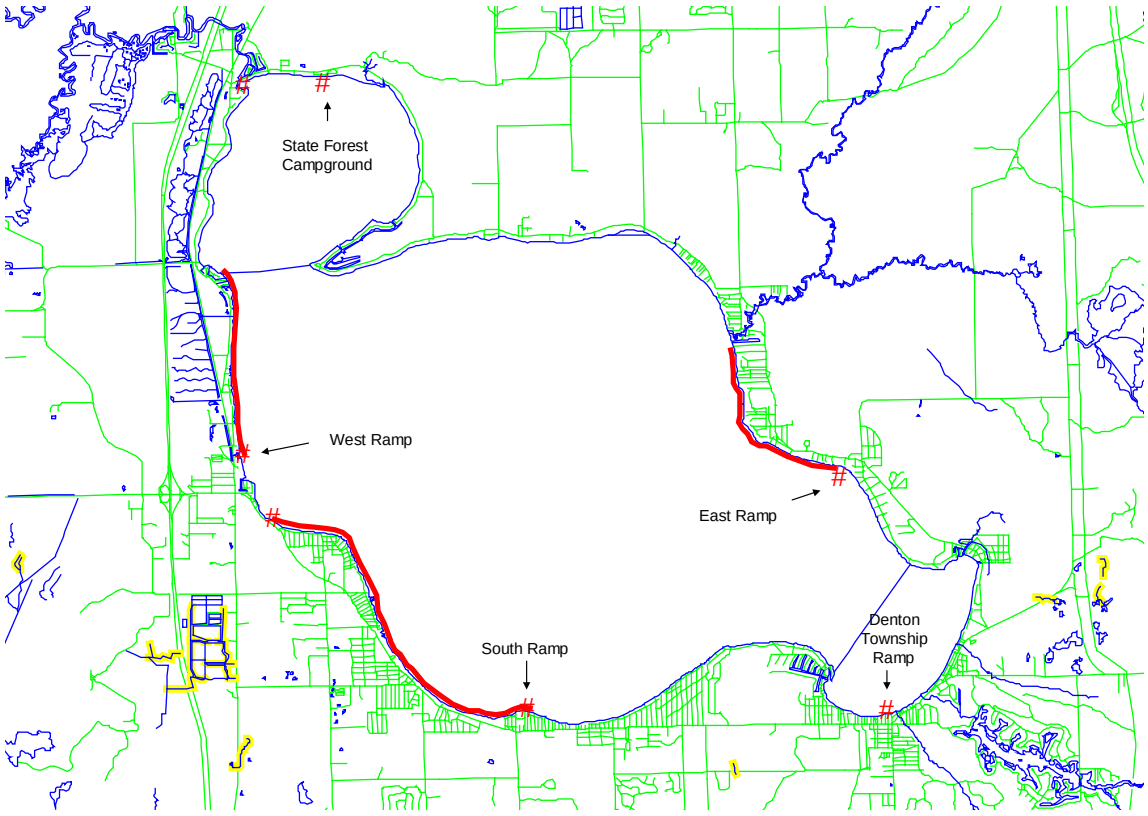

Figure 1. Shoreline sample sites used on Houghton Lake during fall 2008 electrofishing surveys for juvenile walleye.

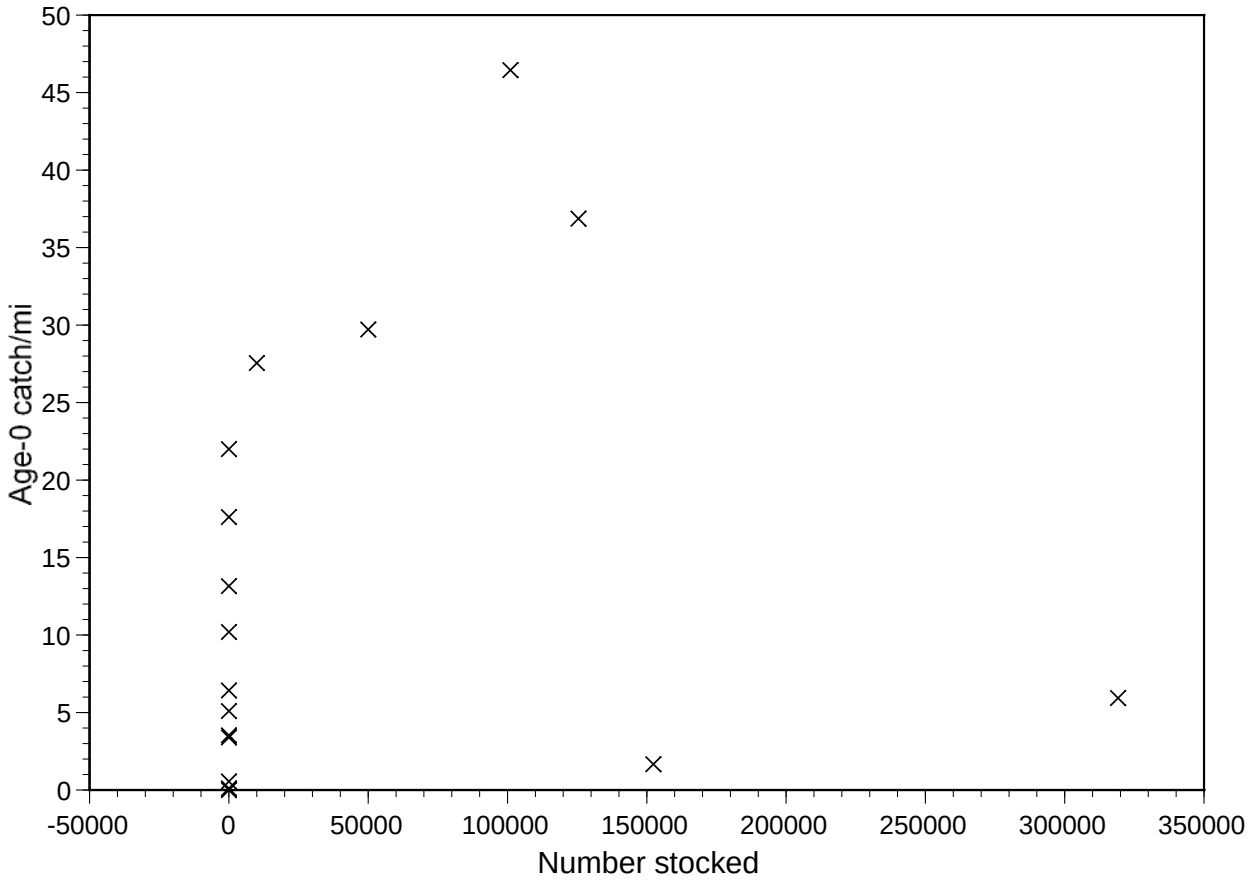

Figure 2. Catch rates of age-0 walleye from fall electrofishing surveys in Houghton Lake, 1990-2008 year-classes.

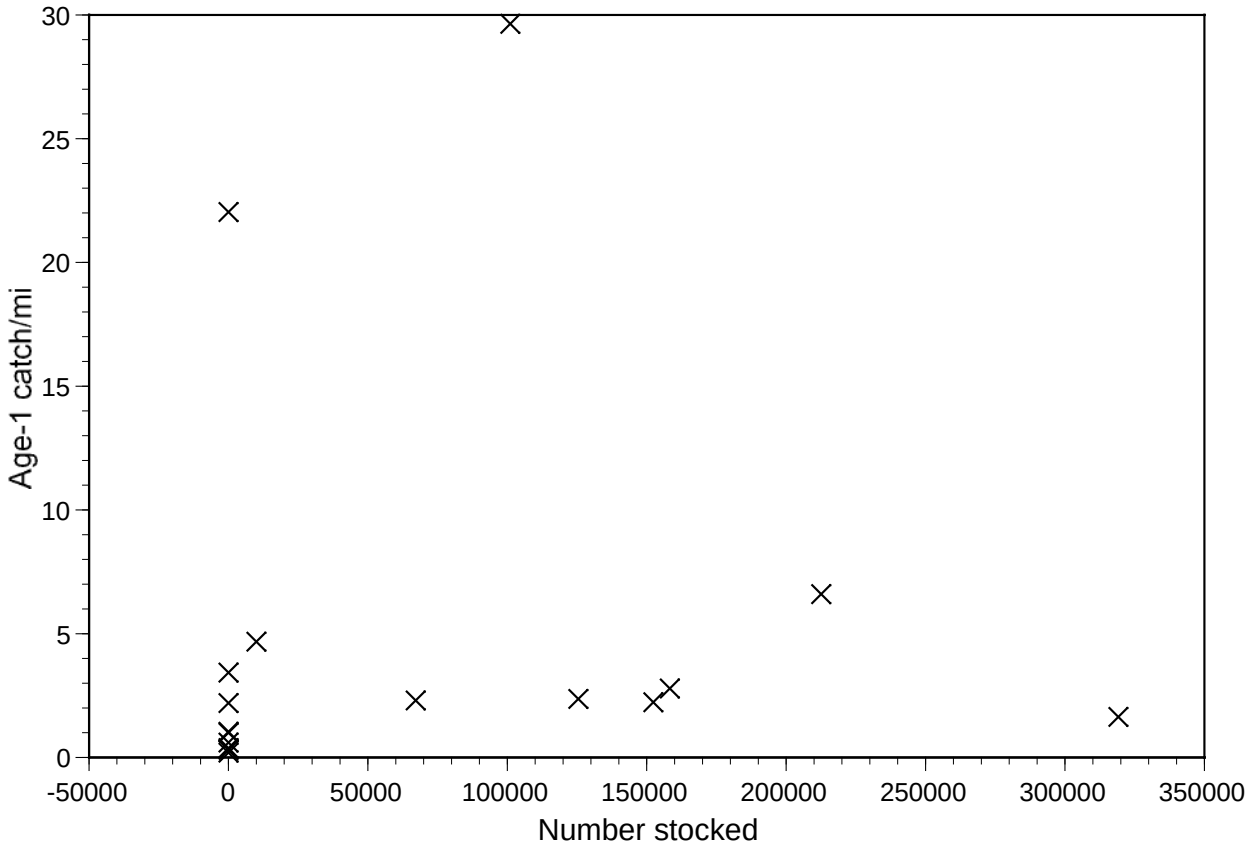

Figure 3. Catch rates of age-1 walleye from fall electrofishing surveys in Houghton Lake, 1989-2008 year-classes.

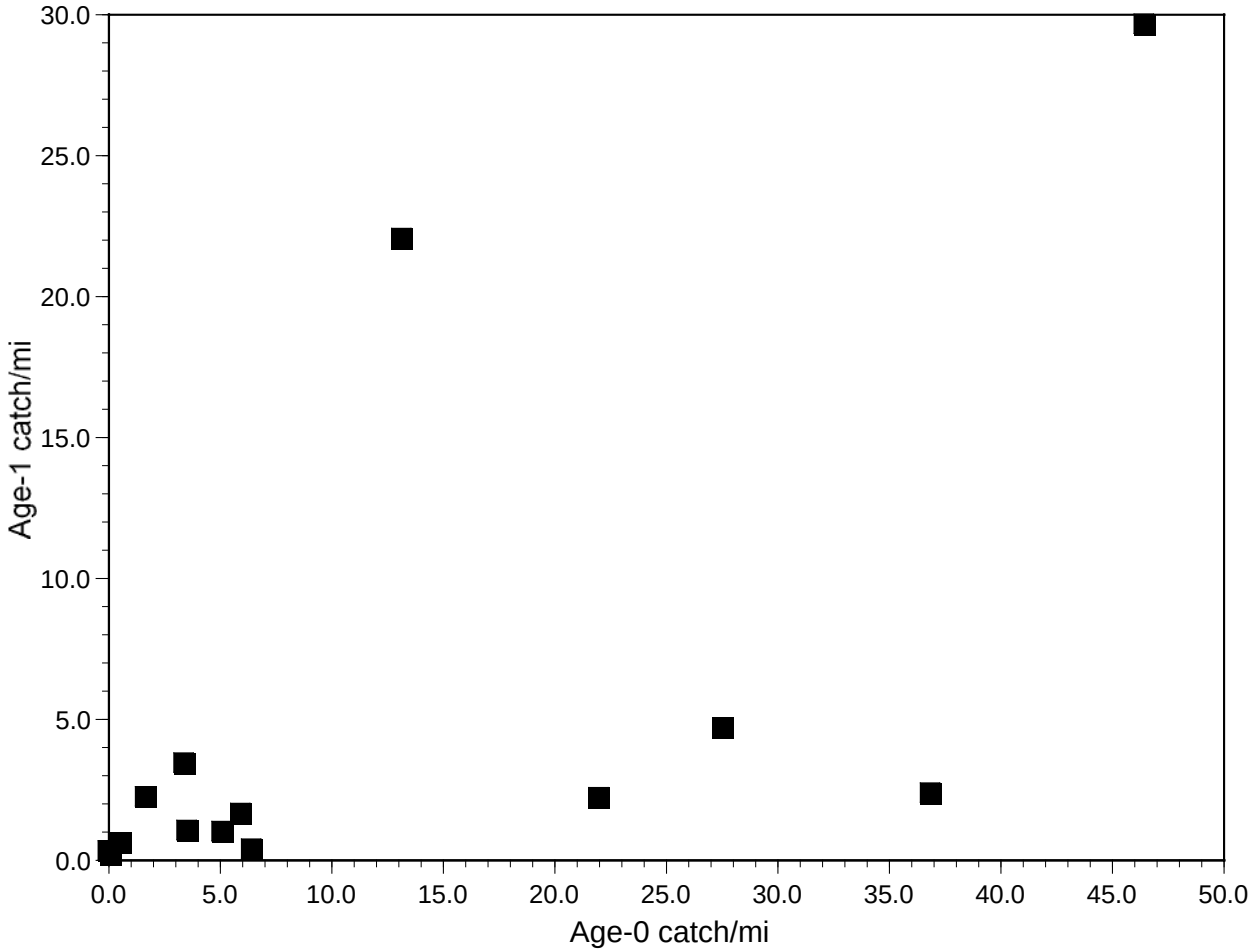

Figure 4. Catch of age-1 walleye compared to age-0 walleye catch the previous year in Houghton Lake, 1989-2008.

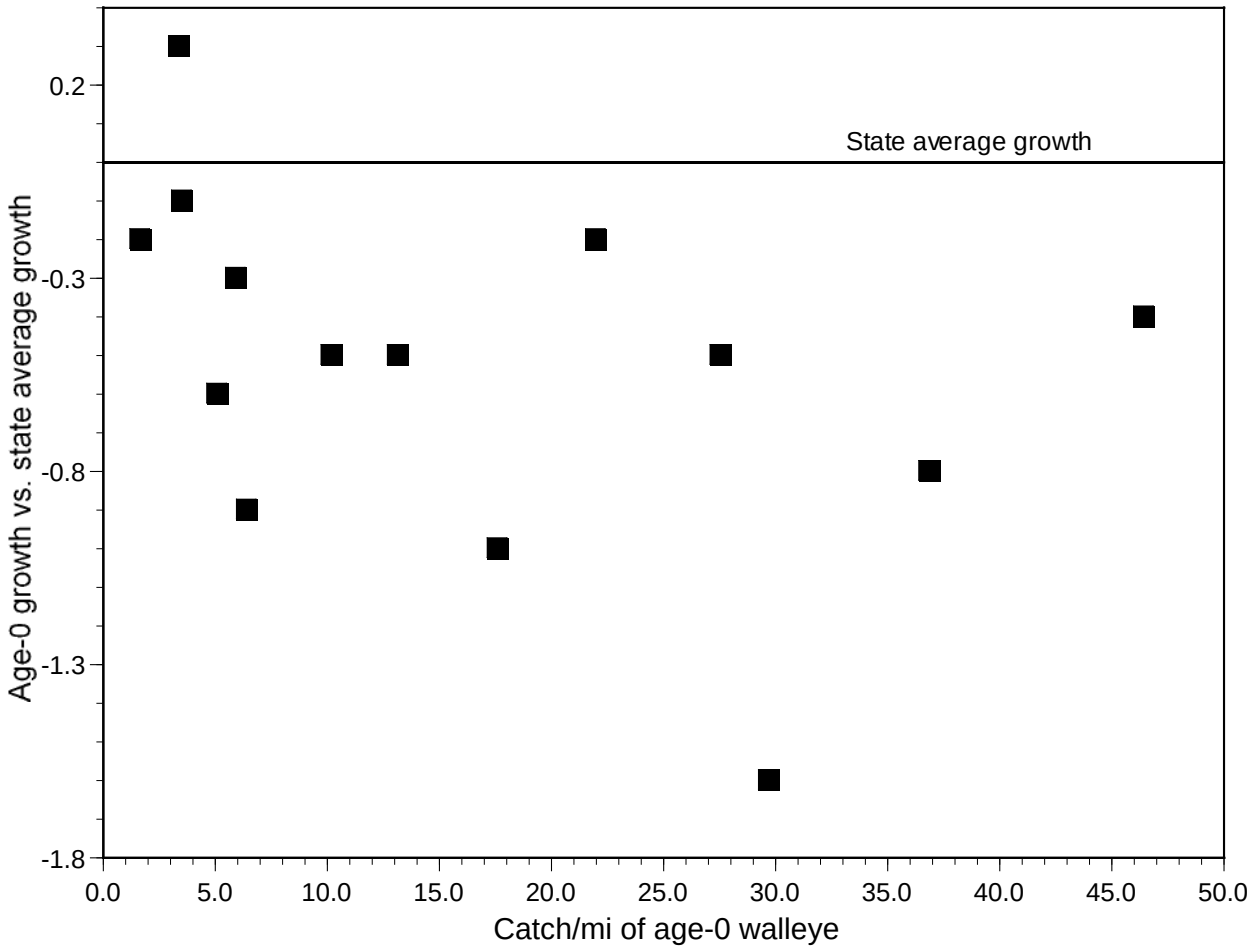

Figure 5. Age-0 walleye density compared to the state average walleye growth, 1990-2008.

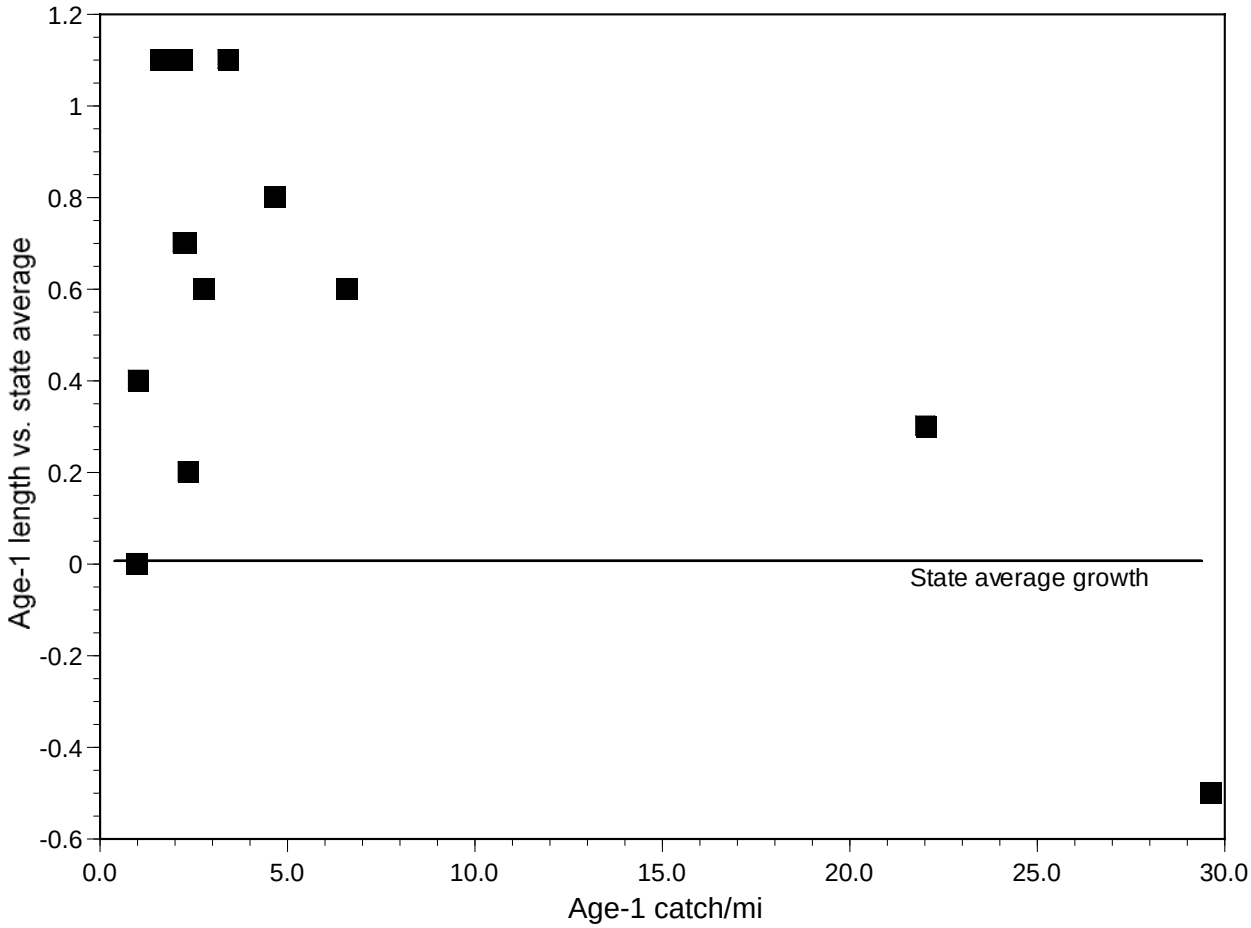

Figure 6. Age-1 walleye density compared to the state average walleye growth index, 1990-2008.

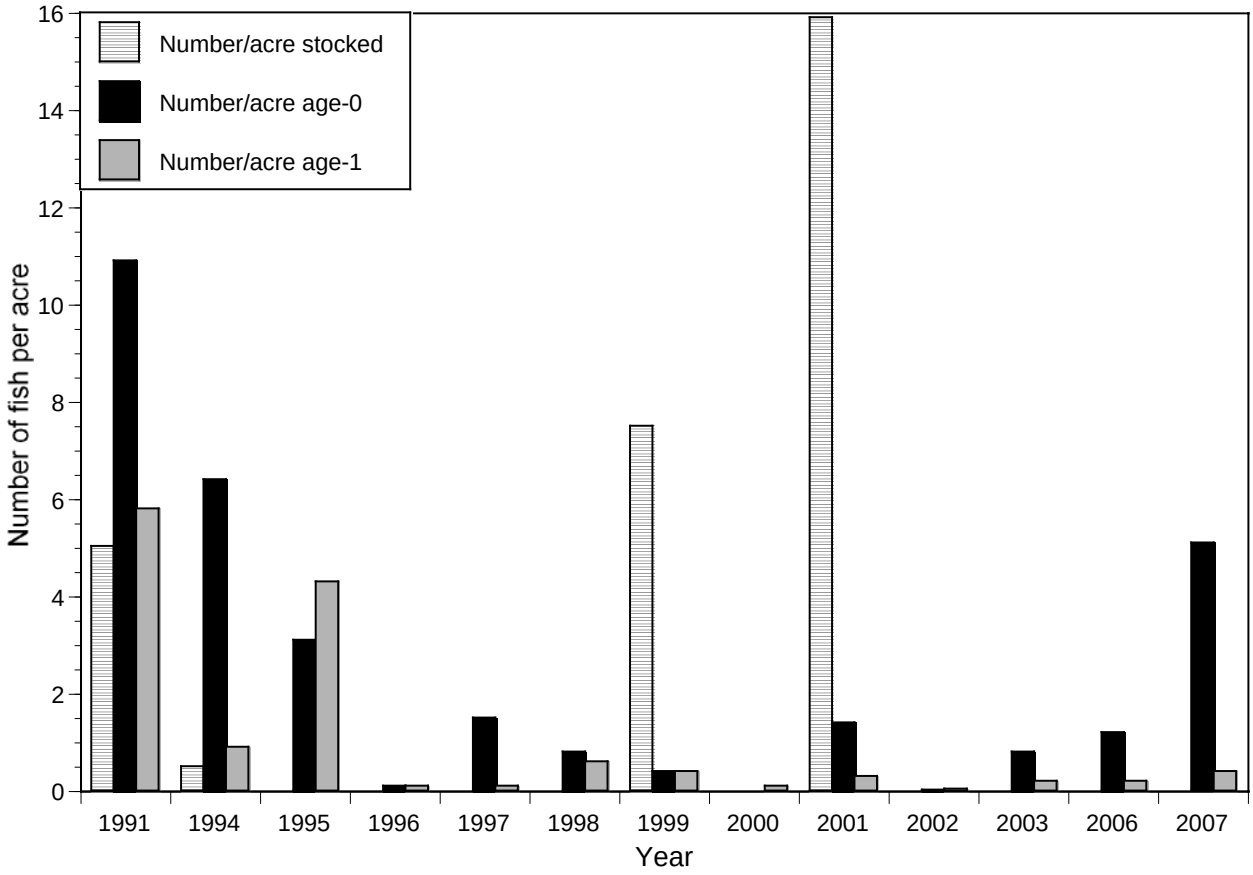

Figure 7. Number of walleye stocked compared to the estimated fall abundance of age-0 and age-1 walleye (by year-class) in Houghton Lake, 1991-2008.