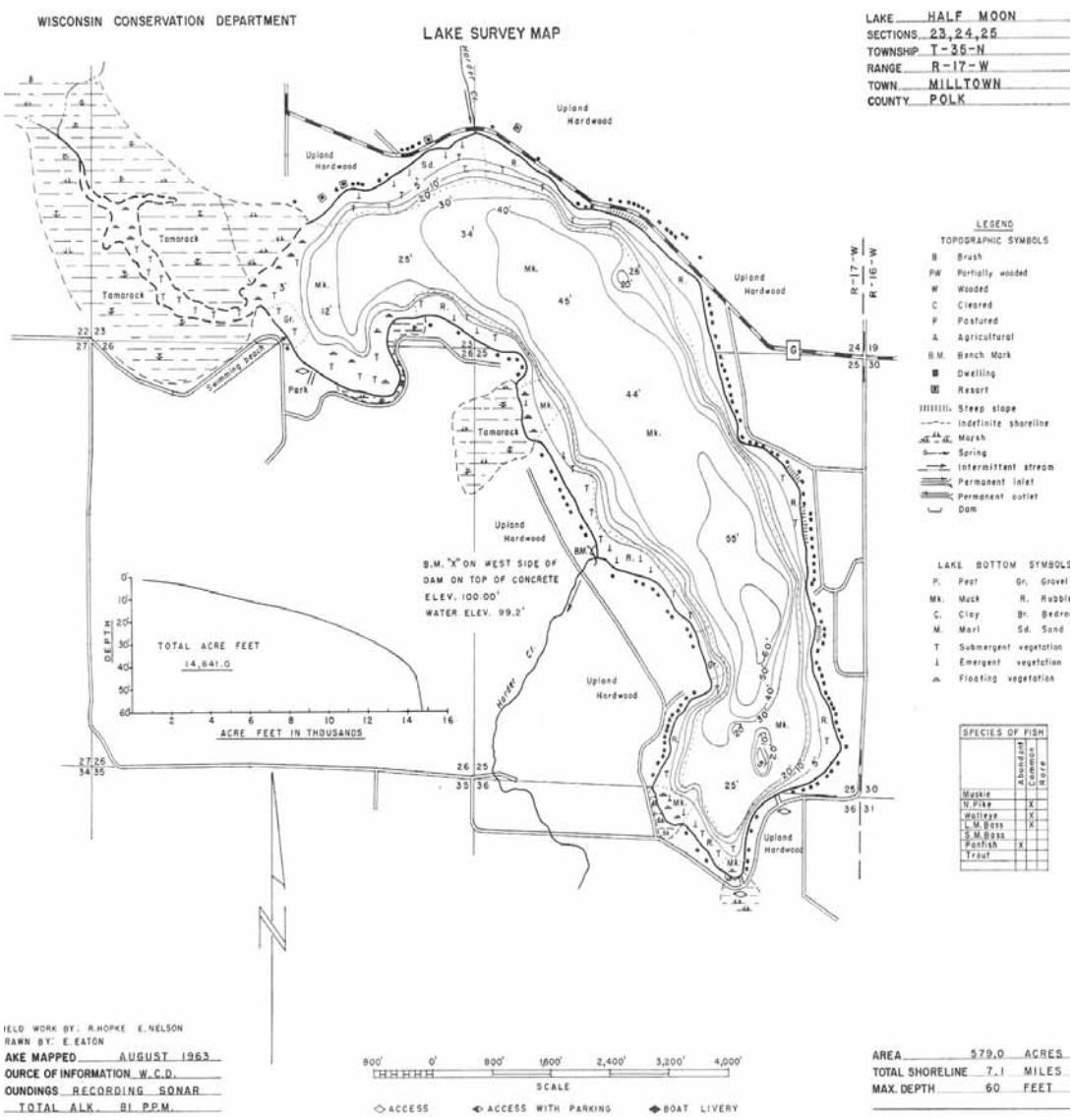
Half Moon Lake
Fisheries Assessment Survey
Polk County, Wisconsin
2001-2002
MWBIC (2621100)



By

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Executive Summary

Half Moon Lake is a 579-acre drainage lake located in central Polk County near Milltown, Wisconsin. Half Moon Lake was surveyed in 2001-2002 following the Wisconsin Department of Natural Resources Treaty Assessment protocol. Projected angler effort for all species of fish in Half Moon Lake was 35 hours/acre. Largemouth bass were the most common gamefish caught by anglers followed by northern pike and walleye. The largemouth bass population estimate was 9.8 fish/acre ($\geq$ 8.0 in). The 2001 total walleye population estimate of 1.2 fish/acre was lower compared to past surveys of 3.2 fish/acre and 3.4 fish/acre in 1991 and 1988, respectively. The adult walleye population of 1.2 fish/acre in 2001 was also lower than 1988 (1.8 fish/acre) and 1991 (1.7 fish/acre). The average length of walleye harvested has increased from 1991 to 2001. Length of harvested northern pike was greater compared to the average for 55 northern Wisconsin lakes. Angler catch rates for largemouth bass were higher during the open water season in 2001, when compared to 1991. Growth of walleye, northern pike, and bluegill was good, but largemouth bass growth was slow and may be related to high largemouth bass densities. Future stocking changes are recommended to enhance the current walleye fishery. Largemouth bass density, growth and size structure should be closely monitored overtime to prevent a sub-optimal bass fishery from developing.

Introduction

Half Moon Lake is a 579-acre drainage lake located east of Milltown, Wisconsin in central Polk County. There is one intermittent inlet, and one permanent outlet, Harder Creek, which flows into nearby Balsam Lake. A two-foot high dam is present on the outlet of Half Moon Lake.

Half Moon Lake has 7.1 miles of shoreline and a maximum and mean depth of 60 and 25 feet, respectively. Two public boat landings are present on Half Moon Lake. Most of the shoreline has been developed into residential and recreational housing. Half Moon Lake has a diverse fishery consisting of walleye Sander vitreus, northern pike Esox lucius, largemouth bass Micropterus salmoides as well as bluegill Lepomis macrochirus, black crappie Pomoxis nigromaculatus, pumpkinseed Lepomis gibbosus, green sunfish Lepomis cyanellus, yellow perch Perca flavescens, rock bass Ambloplites rupestris, and warmouth Lepomis gulosus.

Walleye stocking in Half Moon Lake was initiated in 1970 (Table 1). Walleye stocking from 1970-1982 consisted of sporadic fry or small fingerling (< 3 in) stockings. Regular stocking of small fingerling walleye (50 fish/acre) began in 1990 due to decreasing walleye densities from the 1970s and 1980s (Cornelius 1989). In 1999 and 2001, the quota was increased to over 100 fish/acre. No other fish stocking occurs. Fisheries management goals for Half Moon Lake were to provide a walleye fishery with an adult walleye population of 3 adult fish/acre (Cornelius 1992). In addition, largemouth bass electrofishing catch per unit of effort (CPUE) values should range between 40 to 50 fish/hour, and northern pike electrofishing CPUE should range between 4 to 6 fish/hour. The objectives of this study were to assess the status of the walleye population as part of the treaty assessment sampling rotation of lakes for the Ceded Territory of Wisconsin. Secondary objectives included assessing the status of other important fish species such as largemouth bass, northern pike, and panfish.

Methods

Half Moon Lake was sampled during 2001-2002 following the Wisconsin Department of Natural Resources treaty assessment protocol (Hennessy 2002). This sampling included spring fyke netting and electroshocking to estimate walleye and largemouth bass abundance, fall electroshocking to estimate year class strength of walleye young-of-the-year (YOY), and a creel survey (both open water and ice). Walleye abundance was determined for the total population and separately for adult fish. Adult walleye were defined as being $\geq$ 15 in or sexable and adult largemouth bass were considered to be $\geq$ 8 in (Hennessy

2002). Survey data was also collected to estimate abundance and angler catch information on other species such as northern pike, and panfish. Size distribution of largemouth bass was summarized using relative stock density (RSD) values (Anderson and Neumann 1996). Northern pike harvest statistics were also compared with 55 northern Wisconsin lakes (Margenau et al. 2003)

Creel census data were collected in 2001-2002 beginning the first Saturday in May and continuing through 1 March of the following year (the open season for game fish angling in Wisconsin). No creel survey data was collected during November because thin ice created dangerous fishing conditions. Creel survey methods followed a stratified random design as described by Rasmussen et al. (1998). The minimum length limit for walleye in Half Moon Lake was 15 in with a daily bag that fluctuates on an annual basis dependent on annual safe harvest estimates. The minimum length limit for bass was 14 in with a daily bag of 5 in total. No minimum length limits are in effect for northern pike or panfish and the bag limits were 5 and 25, respectively.

Data collected during the 2001-2002 survey were compared with previous treaty assessment surveys on Half Moon Lake in 1988 and 1991. In addition, northern pike catch and harvest statistics were compared with 55 northern Wisconsin lakes (Margenau et al. 2003). Growth data were compared with local (Barron and Polk County) and regional (18 county WDNR Northern Region) means utilizing the WDNR Fisheries and Habitat database. Age assessment for walleye was determined from both scale samples (< 12 in) and dorsal spine sections (≥ 12.0 in). Age assessment for all other species was done with scale samples. Juvenile walleye (YOY) electrofishing runs were conducted in 1991, 1992, 1993, 1997, 1999, 2000 and 2001. Cost analysis for stocked walleye utilized cost figures reported in WDNR (1999).

Results

Angling Effort**.** Angling pressure increased on Half Moon Lake between 1991-1992 and 2001-2002, especially during the open water period (Table 2). Projected angling pressure for all species in 2001-2002 was 34.7 hours/acre. Total directed effort for all species in 2001-2002 was 36,211 hours. In comparison, projected angling pressure for all species in 1991-1992 was 19.7 hours/acre. Total directed effort for all species in 1991-1992 was 21,547 hours (Table 2).

Walleye. The total walleye population in 2001 was 686 or 1.2 fish/acre (95% C.I. 547-825). Walleye abundance was 64% and 65% lower in 2001 when compared to previous surveys in 1991 and 1988,

respectively (Figure 1). The total walleye population in 1991 was 1,881 or 3.2 fish/acre (95% C.I. 1043-2719) and in 1988 was 1,962 or 3.4 fish/acre (95% C.I. 1169-2755).

The adult walleye population in 2001 was 717 or 1.2 fish/acre (95% C.I. 569-865). Adult walleye abundance was 26% and 31% lower in 2001 compared to previous surveys in 1991 and 1988, respectively. (Figure 2). The adult walleye population in 1991 was 963 or 1.7 fish/acre (95% C.I. 765-1161) and in 1988 was 1033 or 1.8/acre (95% C.I. 880-1165).

Walleye YOY were collected in only three years (1991, 1992, and 2001) of the seven years of fall electroshocking surveys (Table 1). Catch per mile during the 1991, 1992 and 2001 runs were 2.0, 0.1 and 7.7, respectively. All three years where YOY were collected, were years in which walleye were stocked.

Growth of walleye in Half Moon Lake was good. Growth rates for age 3 through 5 walleye in Half Moon Lake increased from previous surveys in 1988 and 1991 (Figure 3). Walleye mean length at age 3 of 14.8 in during 2001 was nearly 2 in greater than in previous surveys. This increase was maintained through age 5. In addition, walleye growth was faster than the local and regional means (Figure 4).

Angling effort for walleye made up 18% of the total directed effort (open water and ice combined) on Half Moon Lake in 2001-2002. This compares to 21% of the directed angling effort for walleye in 1991. However, both catch and harvest rates for walleye decreased over this period. Angler catch/hr during the open water season decreased from 0.06 fish/hr in 1991 to 0.04 fish/hr in 2001 (Table 3).

Anglers harvested larger walleye in 2001-2002 compared to 1991. Harvested walleye averaged 18.2 in (SD = 2.4 , N=14) during the open water season and 21.5 in (N=1) during the ice fishing season compared to 16.2 (SD = 1.8, N=17) and 17.4 (SD = 1.6, N=6) inches, respectively in 1991 (Table 3). Angler projected harvest in 2001-2002 was 83 walleye during the open water and ice fishing periods combined. Tribal spear fishers harvested 36 walleye in 2001. Combined tribal and angler exploitation was estimated at 11% of the adult population.

Largemouth Bass. Largemouth bass abundance ($\geq$ 8.0 in) in 2001 was 5,696 or 9.8 fish/acre (95% C.I. 2,972-8,668). No historic population estimates were available for largemouth bass on Half Moon Lake for comparison purposes. Growth rates of largemouth bass in 2001 were below average compared to local and regional means (Table 4). However the size structure of largemouth bass was good based on RSD_{14} values of 39%.

Anglers directed more effort toward largemouth bass in 2001 compared to the 1991 survey. Thirty-four percent of the directed angling effort (open water and ice combined) targeted largemouth bass in

2001compared to 14% of the directed angling effort in 1991. Angler catch rate also increased from 0.30 fish/hr to 1.31fish/hr during the open water season in 1991 and 2001, respectively (Table 3). Projected angler harvest for largemouth bass in 2001 was 1,328 during the open water and ice fishing periods combined, however 88% of the harvest occurred during the open water season. Projected angler harvest of largemouth bass in 1991 was 64. Mean length of largemouth bass harvested in 2001 was 15.1 in (SD = 1.0, N = 189) and 16.5 in (SD = 0.9, N = 14) during the open water and ice fishing season, respectively. In comparison, mean length of largemouth bass harvested in 1991 during the open water and ice fishing seasons was 14.6 in (SD = 1.1, N = 20) and 15.5 in (SD =0.84, N= 9) respectively

Northern Pike. Northern pike abundance was not estimated during the 2001 sampling event (netting, electroshocking). The creel survey estimated 16% of the directed angling effort was for northern pike in 2001-2002, compared to 12% in 1991. Open water angler catch rates increased from 0.09 fish/hr to 0.27 fish/hr and ice angler catch rates increased from 0.12 fish/hr to 0.20 fish/hr in 1991 and 2001, respectively. Projected angler harvest in 2001-2002 was 520 northern pike during the openwater and ice fishing seasons of which 51% was open water angler harvest and 49% was ice angler harvest. Mean length of northern pike harvested in 2001 was 22.6 in (SD = 4.4, N = 43) and 22.3 in (SD = 3.3, N = 24) during the open water season and ice fishing season, respectively. Harvest rates were 0.07 and 0.08 fish/hr during open water and ice fishing, respectively. Mean length of northern pike harvested in 1991 during the open water and ice fishing seasons was 22.8 in (SD = 4.0, N = 17) and 23.0 in (SD = 2.7, N = 93), respectively. Northern pike growth was average when compared to local and regional means (Table 4).

Panfish**.** Population abundance was not estimated for panfish during 2001 netting and electroshocking. Fifteen percent of the directed angling effort was for bluegill in 2001-2002, compared to 30% in 1991. Twelve percent of the directed angling effort was for black crappie in 2001 when compared to 17% in 1991. Combined, 47% of the directed angling effort in 1991 was for black crappie and bluegill compared to 27% of the total directed effort in 2001. The projected number of bluegill harvested in 2001 was 4,251 and the projected number of black crappie harvested in 2001 was 1,238. The average length of bluegill and black crappie harvested in 2001was 7.2 in (SD = 0.78, N = 466), and 9.8 in (SD = 1.1, N = 133), respectively. Bluegill growth was below average for age 3-5 fish and average for age 6-8 fish, compared to local and regional means (Table 4). The remaining panfish (rock bass, yellow perch, pumpkinseed and warmouth) only accounted for 5% of the directed angling effort combined.

Discussion

Walleye**.** Total and adult walleye abundance decreased from 1988-2001. This decrease is likely related to poor year class strength over the past decade (1991-2001). The higher number of walleye in 1988 was due to the presence of smaller walleye (≤ 12.0 in) compared to the 1991 and 2001 population estimates. Fall YOY walleye surveys collected over the past decade suggests that year class strength has been poor. Only 1991 and 2001 provided any measurable recruitment of YOY walleye into the fishery. Interestingly, year class determination from aging indicates additional year classes in 1998, 1996, 1994, and 1992. While these were all years walleye were stocked in Half Moon Lake, these year classes were not documented during fall YOY walleye surveys. This information indicates that either walleye year classes were produced during those years even though they were not documented during our fall YOY runs, or there were errors in year class determination from age interpretations. Hence, it is not possible to determine whether the few walleye that are recruiting into the fishery are a product of natural reproduction or from stocking efforts.

Walleye abundance in 2001 remained below the management goal of 3.0 fish/acre even with the additional stocking of small fingerling walleye since 1990. The likely reason that the walleye fishery has not increased may be due to two reasons. First, walleye natural reproduction is probably very limited or non-existent in Half Moon Lake. Second, small fingerling walleye stocking seems marginally successful and has only produced very modest year classes over the past decade.

Predation on early life stages of walleye may be affecting year class strength and subsequent adult densities. Brooking et al. (2001) stated that when other top predators such as largemouth bass and northern pike increase in relative abundance in a lake, the likelihood of increased predation on small fingerling walleye is high and likely hinders stocking success. Largemouth bass have also been found to be effective predators on other stocked fish such as esocids (Stein et al. 1981). This study found that largemouth bass predation accounted for up to 45% of stocked hybrid muskellunge (Esox masquinongy x E. lucius) within 40 d of stocking. In addition, Nate et al. (2003) indicated that high largemouth bass and northern pike densities characterized lakes with walleye populations that are maintained by stocking versus natural reproduction. Considering largemouth bass in Half Moon Lake were relatively abundant (9.8 fish/acre ≥ 8.0 in), with abundance increasing over the past decade, it's reasonable to assume largemouth bass may be utilizing walleye as prey items. Some circumstances may require the stocking of larger fish to improve survival if predation by other fish is considered to be a major limiting factor (WDNR 1999). Such

scenarios may also prove more cost-effective. In 2001, the WDNR quota of small fingerling walleye was 100 fish/acre or 57,900 @ $0.06/fish. The estimated cost of this effort in 2001 was $3,474. Converting to extended growth fingerling at 10 fish/acre or 5790 @ $0.65/fish would cost approximately $3,764 (WDNR 1999).

Increased growth of walleye in Half Moon Lake may be a consequence of lower densities and hence greater food resources per fish. Improved growth is also reflected in the mean length of angler harvested walleye. The average length of walleye harvested increased from 16.2 in to 18.2 in from 1991 to 2001. In addition, the initiation of a 15-inch walleye minimum length limit in 1990 could have also played a factor in the increase in the average length of angler harvested walleye in 2001 compared to 1991.

Largemouth Bass**.** Largemouth bass were the most popular gamefish for sport anglers on Half Moon Lake in 2001-2002. Although no historic population estimates are available, Cornelius (1993) evaluated a 14-inch minimum length limit implemented in 1989, for largemouth bass on six Polk County Lakes, including Half Moon Lake. Largemouth bass ($\geq$ 8.0 in) CPUE for Half Moon Lake was 12 fish/hr before the initiation of the 14-inch size limit and 38 fish/hr, five years after the initiation of the 14-inch length limit. This suggests an increase in largemouth bass relative abundance over the past decade. In addition, there has been a 20% increase in largemouth bass angling effort over the entire angling season from 1991 to 2001. Angler catch/hr has also increased over four-fold (0.30 fish/hr to 1.31fish/hr) during the open water season during the same time period. Nevertheless, the average length of largemouth bass harvested has increased from 1991 to 2001 from 0.5 in and 1.0 in during the open water and ice fishing seasons, respectively. However, growth of largemouth bass was slower than the local and regional means indicating that high densities are likely reducing growth, but the size structure of bass was still good based on RSD_{14} values of 39%.

Of special concern is the potential for the largemouth bass population to get so high that it creates a high-density stunted fishery. Nearby Balsam and Big Round Lakes, which are similar to Half Moon Lake, are examples of the potential consequences of high-density largemouth bass populations. In 2002, a new bass regulation went into effect for Balsam and Big Round Lakes, which allowed one bass less than 14 in to be part of the 5 daily bag limit. This regulation went into effect because recent fisheries surveys documented high-density largemouth bass populations with a sub-optimal size structure and very slow growth when compared to past surveys (Cornelius 1999; Cornelius 2000). Considering that the current largemouth bass fishery is at 9.8 fish/acre $\geq$ 8 in and growth rates are below average for the local and regional means, there

is evidence that a similar situation may be occurring on Half Moon Lake. The status of the largemouth bass fishery should be re-evaluated in 2006 as part of a scheduled treaty assessment survey.

Northern Pike. Northern pike were an important component of both the open water and ice fishery of Half Moon Lake. Directed effort, catch, and harvest rates were similar to those noted for 55 northern Wisconsin lakes by Margenau et al. (2003). However, mean length of harvested northern pike was longer than the average reported by Margenau et al. (2003). While targeted effort and harvested northern pike length in Half Moon Lake remained similar from 1991 to 2001, catch rates increased. Considering this, the northern pike fishery is currently considered adequate and should provide above average angling opportunities.

Panfish**.** Panfish data collected from this survey was limited since it was not a major component of the sampling scheme. Overall, length of harvested bluegill was good. The bluegill and black crappie harvested in 2001 appear to be of desirable size, but total directed effort decreased from 47% to 27% for these two species combined from 1991 to 2001, respectively. The reason for the decrease in bluegill and black crappie effort is unknown. Similar decreases in bluegill and black crappie directed effort were also documented on nearby Big Round Lake in a 1997-1998 creel survey (WDNR 1998).

Management Recommendations

1. It is recommended that the adult walleye population goal be set at a range of 2.0-3.0 adults/acre. This will provide a target range and not a finite number to be achieved. The walleye management goal of 3.0 adult fish/ acre may be somewhat optimistic for Half Moon Lake.
2. The walleye stocking strategy of small fingerlings is not meeting management goals and objectives that it was intended to accomplish when it was initiated in 1990. In an effort to make better use of Department hatchery production, converting walleye stocking from small fingerling to extended growth fingerlings is warranted. Therefore, it is recommended that on a trial basis during the years 2005, 2007, 2009 and 2011 extended growth fingerling walleye ($\geq$ 6 in) stocking should occur at a rate of 10 fish/acre. Stocking extended growth fingerling walleye at a reduced density for almost the same cost should improve recruitment of stocked walleye into the fishery and hence be more cost-effective. An evaluation of this stocking modification should take place to document any improvement. The next treaty assessment survey is scheduled for 2006**.** Final assessment of extended growth fingerling stocking should be scheduled following the 2011 stocking.

3. The largemouth bass population is abundant and is a priority for management. The current 14-inch minimum length limit appears to be resulting in a high-density fishery with below average growth but quality size bass are present based on high RSD_{14} values. Considering this, no changes are recommended at this time. However, the status and future management of the largemouth bass fishery should be re-evaluated based on the results of an upcoming treaty assessment survey scheduled for 2006-2007.
4. The northern pike population seems stable and harvest suggests fish are larger than average for many northern Wisconsin waters. No management changes are recommended at this time.
5. The existing panfishery appears to stable, but open water and ice season harvest has decreased considerably when compared to 1991. This should be monitored and re-evaluated following the next survey (2006).
6. Littoral zone areas should be protected to provide critical spawning, nursery and overwintering habitat for the existing fish community in Half Moon Lake. No large-scale chemical treatment of aquatic plants are recommended, unless deemed appropriate at some future point. Minor chemical treatments for navigational purposes should be considered on a case by case basis.
7. Lake shore property owners should maintain or restore at least a 35 foot vegetative buffer to maintain near shore habitat and to protect the water quality of Half Moon Lake. Elimination of protective lakeshore buffers will likely lead to an increase in nutrient loading. Increased nutrient loading will cause more frequent algae blooms and a decrease in overall water quality and fish habitat.
8. An evaluation of walleye spawning habitat should be conducted to determine if adequate spawning substrate is available to allow successful natural reproduction to occur.

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Table 1. Walleye stocking and fall fingerling catch per unit of effort (CPUE) from electrofishing for Half Moon Lake, Polk County, Wisconsin. Fall fingerling CPUE may also include naturally reproduced walleye.

Year	Length (in)	Number Stocked	Stocking rate (no/acre)	Fall Electrofishing (no YOY/mile)
1970	< 3	21,494	37	
1971	Fry	1,400,000	2417	
1972	Fry	1,700,000	2936	
1973	Fry	1,350,000	2331	
1973	< 3	15,000	26	
1974	Fry	2,000,000	3454	
1974	< 3	15,088	26	
1977	Fry	384,000	663	
1982	Fry	934,000	1613	
1990	< 3	28,724	50	
1991	< 3	28,906	50	2.0
1992	< 3	37,093	64	0.1
1993	5	3,093	5	0.0
1994	< 3	34,996	60	
1996	< 3	20,622	36	
1997	< 3	11,750	20	0.0
1998	< 3	26,521	46	
1999	< 3	57,900	100	0.0
2000	---	None	----	0.0
2001	< 3	90,361	156	7.8

Table 2. Projected angling pressure 1991 and 2001, Half Moon Lake, Polk County, Wisconsin.

Season	Year	Hrs/Acre
Open water	1991	13.8
	2001	27.9
Ice	1991	5.9
	2001	6.8
Total	1991	19.7
	2001	34.7

Table 3. 1991 and 2001 creel survey data by season for major game and panfish species, Half Moon Lake, Polk County, Wisconsin.

Species	Season	Year	Directed Effort %	Catch rate (fish/hr)	Harvest rate (fish/h)	Mean len. (in) harvested
Walleye	Open water	1991	19.0	.0613	.0156	16.2
		2001	14.2	.0419	.0119	18.2
	Ice	1991	24.0	.0124	.0083	17.4
		2001	30.0	.0014	.0014	21.5
Largemouth bass	Openwater	1991	17.8	.3036	.0203	14.6
		2001	38.7	1.3183	.1065	15.1
	Ice	1991	3.0	.1557	.0213	15.5
		2001	19.3	.1189	.0815	16.5
Northern pike	Openwater	1991	5.7	.0970	.0517	22.8
		2001	9.5	.2702	.0742	22.6
	Ice	1991	27.0	.1196	.0913	23.0
		2001	34.4	.2097	.0824	22.3
Bluegill	Openwater	1991	29.0	1.5953	1.4404	N/A
		2001	18.9	2.7456	.7555	7.2
	Ice	1991	33.0	2.1522	1.2873	N/A
		2001	1.7	.0539	0	N/A
Black crappie	Openwater	1991	20.6	.6413	.5970	N/A
		2001	12.1	.7587	.2602	9.6
	Ice	1991	8.0	.2436	.2322	N/A
		2001	12.6	.2362	.2027	10.3

Table 4. Northern pike, largemouth bass and bluegill mean length at age (in), Half Moon Lake, Polk County, Wisconsin.

Species	Age	Half Moon Lake Mean 2001	Barron & Polk County (Local Mean)	Northern Region (Regional Mean)
Northern pike	3	18.4	18.0	17.4
	4	20.0	19.8	20.0
	5	21.9	22.9	22.7
	6	25.2	23.6	24.5
	7	27.6	27.6	27.3
Largemouth bass	3	8.7	9.3	9.0
	4	10.6	11.7	11.0
	5	11.8	13.2	12.7
	6	13.0	14.9	14.6
	7	13.9	16.6	16.0
	8	14.7	18.3	17.3
Bluegill	3	3.3	5.1	4.7
	4	5.0	5.9	5.6
	5	5.7	6.8	6.4
	6	6.8	7.1	6.9
	7	7.7	7.8	7.5
	8	8.2	8.2	7.9

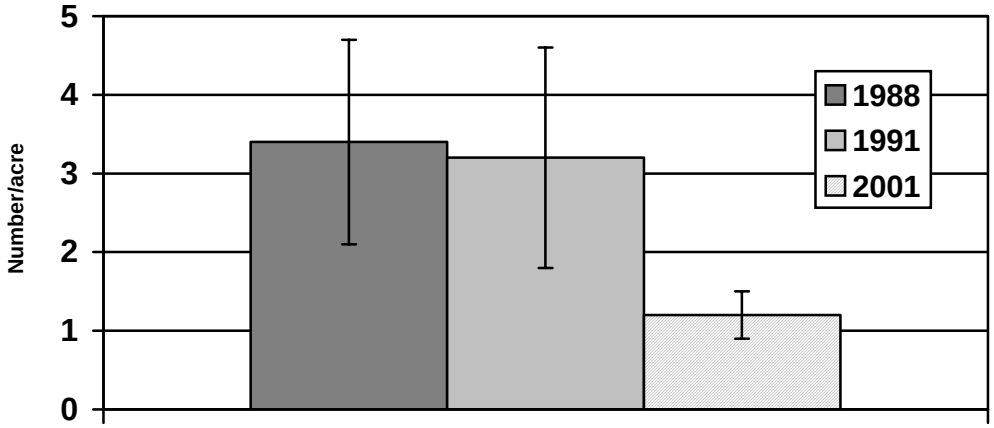

Figure 1: Total walleye population density, 1988, 1991 and 2001. Half Moon Lake, Polk County, Wisconsin.

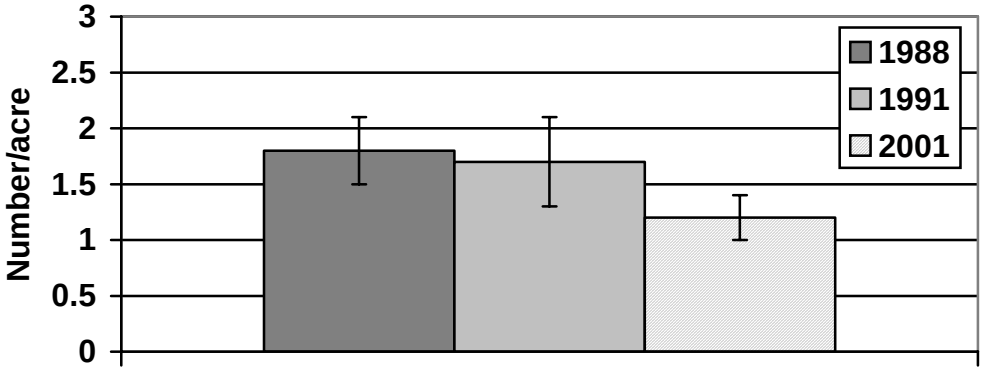

Figure 2: Adult walleye population density, 1988, 1991 and 2001. Half Moon Lake, Polk County, Wisconsin.

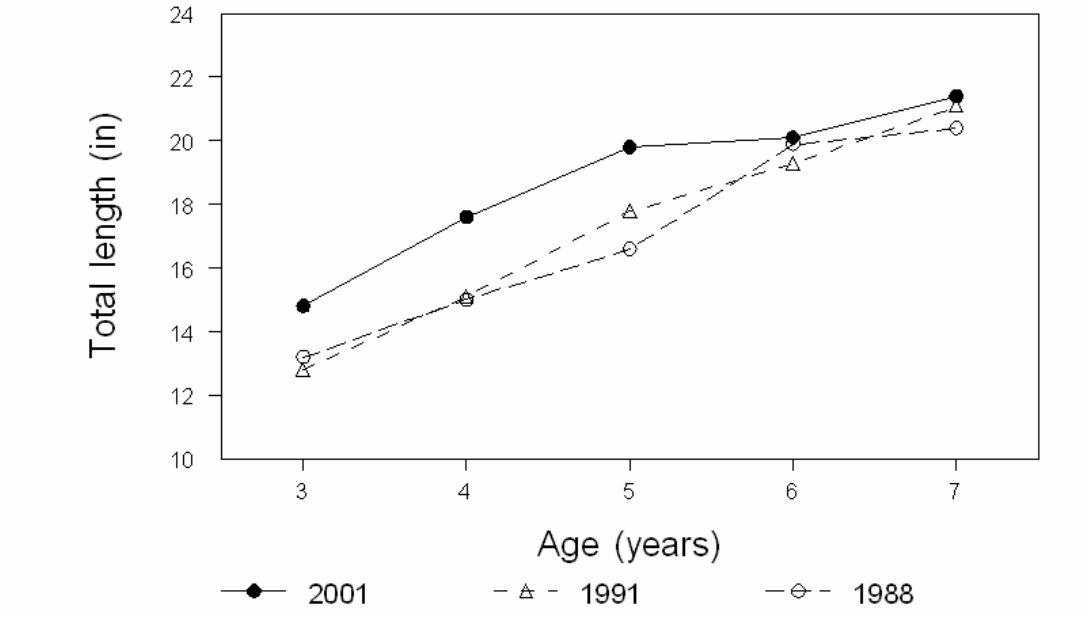

Figure 3. Mean length at age (in) for walleye in Half Moon Lake, 1988, 1991 and 2001, Polk County, Wisconsin.

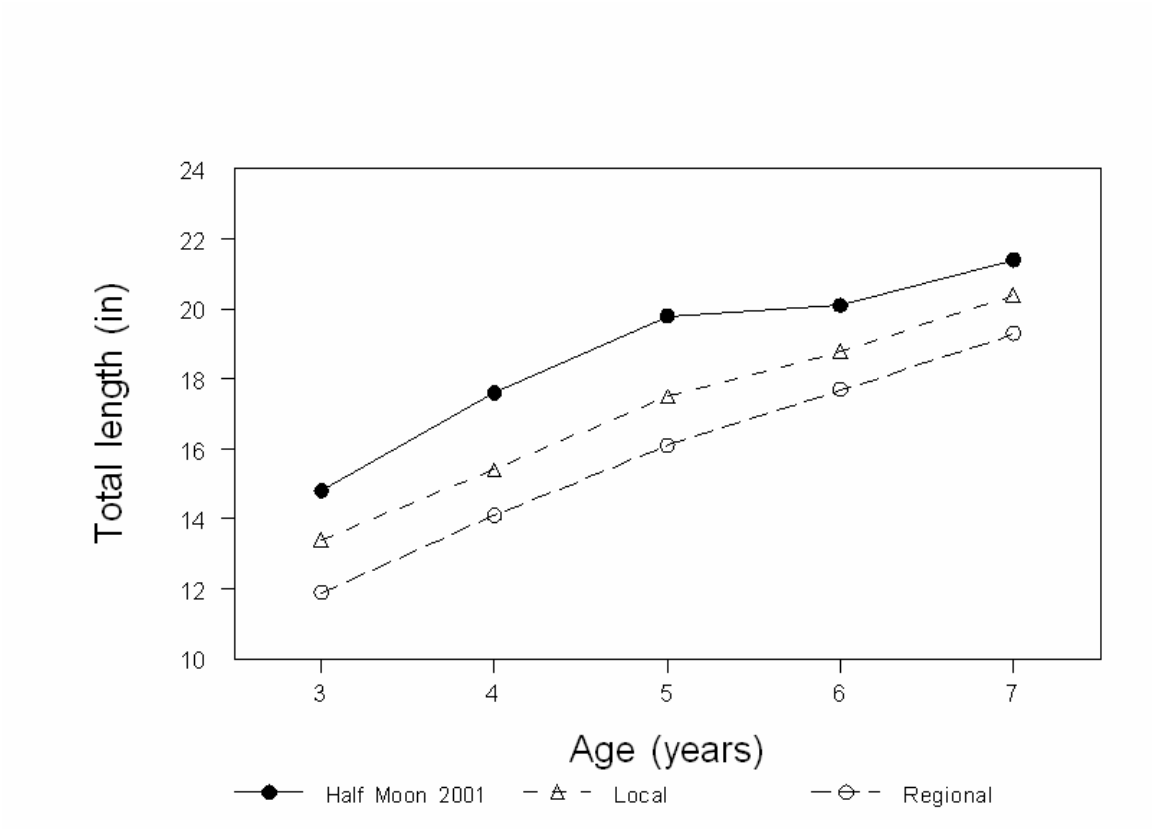

Figure 4. Mean length at age (in) for walleye in Half Moon Lake (2001) compared to local (Barron and Polk Counties), and Regional (Northern Region) means.