Fishery Survey - Namakagon* and Jackson Lakes,
Bayfield County, 2002-2003
WBIC Code (Namakagon Lake - 2732600, Jackson Lake - 2734200)

* The lake names of Namakagon and Namekagon are often used interchangeably.

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August, 2004

Executive Summary

The fisheries of Namakagon and Jackson Lakes (Bayfield County) were surveyed during 2002 and 2003. Survey objectives were to obtain an estimate of the walleye, muskellunge, and other game and panfish populations, and determine angler and tribal use of the fishery. Sampling followed standardized Treaty Assessment protocol and included spring fyke netting, spring and fall electrofishing, and a creel survey. Results indicated population density of walleye 10 in and larger was 5.3 fish/acre (5.1 adults/acre), a slight decrease from historic estimates, yet higher than the statewide objective of 3 fish/acre. The walleye size structure declined from previous surveys in spite of a regulation change that shifted harvest toward fish < 15 in. Muskellunge density was 0.12 fish/acre ($\geq$ 30 in) and is considered low in comparison to northern Wisconsin muskellunge lakes. Information on relative abundance and angler catch rates from previous surveys suggest muskellunge numbers have declined from 1989 to 2003. While muskellunge size structure has increased since 1989, low numbers of fish < 36 in in the 2002 survey warrants concern. Northern pike, large and smallmouth bass, and panfish populations remain stable in comparison with previous surveys. Angling pressure during the 2002-2003 fishing season was 25 hr/acre, of which a high majority (91%) was during the open water period. Creel survey results indicated muskellunge and walleye were the most sought after gamefish species (25.2% and 23.5% respectively of directed effort) by anglers in 2002. Anglers harvested a total of 2,900 walleye averaging 14.1 in. Estimated exploitation of walleye ≥ 15 in was 15% in 2002. Tribal spearers harvested 847 walleye averaging 14.1 in and accounted for 5% of the total stock. Management recommendations include, 1) Maintaining existing walleye regulations, 2) Maintain muskellunge stocking rates at 0.8 fish/acre/bianually, 3) Work with local residents, associations and groups to develop a lake

management plan that addresses fisheries management goals, habitat protection and rehabilitation as well education of users and riparian residents.

Introduction

Namakagon Lake is a 3,227 acre drainage lake at the headwaters of the Namakagon River in Bayfield County. Namakagon Lake is a mesotrophic lake with moderately stained water, has a mix of private and public riparian ownership and is popular recreational lake in the area. Jackson Lake is a 142-acre drainage lake with a navigable outlet channel to Namakagon Lake. [For management purposes, Namakagon and Jackson Lakes are managed as one water body, and hereafter survey results include both lakes unless otherwise noted.] Namakagon Lake has a maximum depth of 50 feet and mean depth of 16 feet. Total alkalinity is 38 mg/l. Average summer secchi disk depth trophic state index (TSI) value for the deep hole on Namakagon Lake was 46.6 (SD=4.7, N=43) for the time period between 1993 and 2003. TSI is an index for evaluating trophic state or nutrient condition of lakes. TSI values can be computed for water clarity (secchi disk measurements), chlorophyll-a, and total phosphorus values. TSI values represent a continuum ranging from very clear, nutrient poor water (low TSIs) to extremely productive, nutrient rich water (high TSIs). Jackson Lake maximum depth is 13 feet and mean depth is 8 feet. Total alkalinity is 18 mg/l. Average summer secchi disk depth TSI value for the deep hole on Jackson Lake was 60.0 (SD=3.4, N=20) for the time period between 1998 and 2001. TSI values for Jackson Lake indicate a eutrophic state, however, the water is highly stained which could decrease transparency of the water and positively skew secchi disc TSI values.

Namakagon and Jackson Lakes have a diverse fishery consisting of walleye *Sander vitreus*, muskellunge *Esox masquinongy*, northern pike *E. lucius*, largemouth bass *Micropterus salmoides*, smallmouth bass *M. dolomieui*, bluegill *Lepomis macrochirus*, pumpkinseed

Lepomis gibbosus, rock bass *Ambloplites rupestris*, black crappie *Pomoxis nigromaculatus*, yellow perch *Perca flavescens*, white sucker *Catostomus commersoni*, yellow bullhead *Ictalurus natalis*, black bullhead *I. melas*, trout perch *Percopsis omniscomaycus*, tadpole madtom *Noturus gyrinus*, common shiner *Notropis cornutlus*, golden shiner *Notemigonus crysoleucas*, and spottail shiner *N. hudsonius*.

Historic management of Namakagon Lake has included fishery surveys, stocking, and various length and bag regulations. Historic surveys for walleye occurred in 1989 and 1993 utilizing Wisconsin Department of Natural Resources (WDNR) standardized treaty protocols (Hennessey 2002). Walleye surveys were also conducted in 1976 and 2000 using a different sampling protocol, i.e. electrofishing to both mark and recapture walleye for a population estimate.

Fish stocking in Namakagon Lake has involved primarily walleye and muskellunge (Table 1). Walleye stocking was discontinued in Namakagon Lake following the 1993 survey due to evidence of strong natural reproduction (Scholl 1996). Muskellunge were stocked from 1937 to 1947 and then discontinued until 1983. Muskellunge were stocked annually from 1983 to 1993 at a rate of 0.8 fish/acre (2,500 fish total), with the exception of 1987 when no stocking occurred. Also, no stocking of muskellunge occurred from 1994 through 1996 due to hatchery renovations at Spooner. Starting in 1997 muskellunge have been stocked in alternate years at a rate of 0.8 fish/acre.

Walleye fishing regulations have changed over time in Namakagon Lake. There was no minimum length limit for walleye until 1990 when a 15-inch minimum length limit was instituted statewide. A no length limit, but only one walleye over 14-inch bag limit was instituted in 1997 when survey data indicated that there was a harvestable population of walleye under 15 inches and that protection was needed for larger walleye (Scholl 1996). Bag limits for walleye have been adjusted annually according to tribal harvest declarations that began in 1988.

Muskellunge regulations for minimum length increased from 30 inches to 32 inches in 1983. A 40-inch minimum length limit was instituted in 1992, and in 1997 the minimum length limit increased to 50 inches. With the exception of walleye and muskellunge, other species have largely been managed via statewide size and bag limits.

Recent management has largely focused on public outreach and education, and habitat protection. Protecting spawning areas by efforts to remove beaver dams in tributaries has been used to attempt to regenerate lost riverine walleye spawning areas that had been historically used. Also, a sensitive area designation was completed in 2002 to help protect areas that are considered high value to aquatic biota and wildlife. In an attempt to increase habitat complexity in areas that had little vegetative cover 24 fish cribs were cooperatively installed in 2002 and 2003.

The objective of the 2002-2003 survey in Namakagon Lake was to determine the status of the walleye and muskellunge populations. More specifically, we were interested in determining population densities, growth, size structure, and harvest of walleye and muskellunge. We also hoped to determine some population parameters of other important game and panfish in Namakagon Lake.

Methods

Namakagon Lake was sampled during 2002-2003 following the Wisconsin Department of Natural Resources treaty assessment protocol (Hennessy 2002). This sampling included spring fyke netting and electroshocking to estimate walleye 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 ≥ 10 in population and separately for adult fish. Adult walleye were defined as being $\geq$ 15 in or sexable (Hennessy 2002), $\geq$ 10 in was calculated for comparison with historic surveys and included all walleye $\geq$ 10 in. Walleye age and growth was determined from dorsal spine cross-sections viewed microscopically at 100X

(Margenau 1982). Age and growth of other fish species were determined by viewing acetate scale impressions under a 30X microfilm projector. The microcomputer software FishCalc89 (Missouri Department of Conservation 1989) was used to generate length and age distributions. Historic surveys to estimate walleye abundance followed two separate protocols. Surveys completed by the Wisconsin Department of Natural Resources (WDNR) in 1989 and 1993 utilized fyke nets to mark walleye and electrofishing for the recapture sample, which is the same protocol used by WDNR in the 2002 survey. Surveys in 1976 by WDNR and 2000 by the Great Lakes Indian Fish and Wildlife Commision (GLIFWC) utilized electrofishing for both the marking and recapture of walleye. In addition, GLIFWC utilized direct current electrofishing equipment and WDNR utilized alternating current electrofishing equipment.

Adult muskellunge were captured in two consecutive years (2002-2003) using fyke nets during the spring spawning period (Hanson 1986). Muskellunge were measured to the nearest 0.1 in and marked with a finclip. Abundance of adult muskellunge ($\geq$ 30 in) was estimated using the Bailey modification of the Petersen method (Ricker 1975). Muskellunge captured in the first year made up the marking sample, and those in the second year composed the recapture sample. Numbers in the recapture sample were adjusted for recruitment over a 1-year period using growth rates determined from cleithrum interpretations. Cleithra were collected from muskellunge found dead in the lake by the creel clerk during 2002 and from several fish sacrificed (N = 4) during the 2003 recapture sampling. We compared muskellunge aging information from scales and cliethra to assess differences in aging techniques and compared them to cleithra data collected in the United States and Canada (Casselman and Crossman 1986). Condition of muskellunge was determined from spring-sampled fish using relative weight (W_r) index (Neumann and Willis 1994). Relative weight is the ratio of a fish's weight to the weight of a "standard" fish of the same length. Length comparisons for muskellunge were analyzed using data obtained during spring fyke netting surveys for all survey years. Length information from muskellunge sampled during 2002 and 2003 was pooled (excluding previously handled fish) to increase sample size.

Survey data was also collected to estimate abundance and angler catch information on other species such as bass, northern pike, and panfish. Panfish population data were collected in the spring fyke-netting period of both 2002 and 2003. Panfish were identified to species and measured in TL. Traditional survey periods for panfish surveys are most often at warmer water temperatures and related to observed spawning locations. In addition, the sampling protocol did not include panfish targeted fyke netting. Therefore the data gathered may not best represent panfish populations.

Size structure quality of species sampled was determined using the indices proportional (PSD) and relative (RSD) stock densities (Anderson and Gutreuter 1983). The PSD and RSD value for a species is the number of fish of a specified length and longer divided by the number of fish of stock length or longer, the result multiplied by 100 (Appendix Table 1). Changes in population size structure were determined using Kolmogorov-Smirnov tests.

Creel census data were collected during the open water and ice fishing season in 2002-2003 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).

Results

Total survey effort in 2002 included 221 fyke net lifts targeting spawning gamefish. In May a second fyke-netting period targeted spawning muskellunge and included 36 fyke net lifts. Three electrofishing surveys of the entire shoreline totaling 31.7 hours in spring (first and second recapture surveys) and 13.0 hours in fall (walleye recruitment survey) were conducted.

Total survey effort in 2003 included 187 net lifts for the recapture of muskellunge, 117 net lifts for other gamefish species and 52 net lifts for panfish and non-game species.

Walleye. Walleye abundance (≥ 10 in) was 17,188 (CV = 0.04; 5.3 fish/acre) and adult walleye abundance (≥ 15 in and sexable fish) was 16,574 (CV = 0.04, 5.1 adults/acre) in 2002 for Namakagon Lake. Jackson Lake adult walleye abundance was 155 (CV = 0.5; 1.1 fish/acre), which was a slight decrease from the 1993 value of 1.5 fish/acre.

The density of walleye ≥ 10 in Namakagon Lake surveys from 1989, 1993, and 2002 has declined but is not outside 90% confidence intervals (Figure 1). Density by length group suggests there is an increase in the number of walleye in the 10 to 14.0 in group and a decrease of walleye in the 15 in group and greater in 2002 compared to 1989 and 1993 (Figure 2).

Length of walleye captured in fyke nets in 1989, 1993 and 2002 suggests a trend of declining size structure (1989 vs. 1993, D = 0.06, P = 0.009; 1993 vs. 2002, D = 0.19, P < 0.0001). Mean length for sexable walleye decreased from 15.5 in (SD = 2.4, N = 2,050), 15.3 in (SD = 2.3, N = 1,494) to 14.5 in (SD = 2.1, N = 3,046) in for survey years 1989, 1993 and 2002. Proportional stock density (PSD) decreased from 52, 52, to 35 during the same time period, while RSD-20 decreased from 5, 4, to 2. The mean length of walleye in Jackson Lake was 14.8 in (SD = 3.3, N = 43).

Age of adult walleye sampled during the 2002 survey ranged from II to XV. Male and female walleye first reached maturity at II and IV, respectively. Age IV and V walleye accounted for 57% of the adult stock. Age composition of walleye sampled in fyke nets differed for all years sampled (1989 vs. 1993, D = 0.37, P <0.0001; 1993 vs. 2002, D = 0.32, P <0.0001, 1989 vs. 2002, D = 0.08, P < 0.0001). Growth rates for both sexes remained relatively consistent for all survey years. In 1993 and 2002 growth rates were below regional averages (Figure 3), while growth was dimorphic, male and female walleye reaching 14 in sometime during the fourth and fifth growing season, respectively.

Relative abundance of YOY walleye in Namakagon Lake in 2002 was 4.4 fish/mile (14.6 fish/hour), less than the mean from previous surveys from 1990 to 2001 of 9.6 fish/mile (25.5 fish/hour). However, fingerling relative abundance values have been highly variable from 1990 to 2002 with a range of 1.6 fish/mile to 33.9 fish/mile (4.9 fish/hour to 100.0 fish/hour; Figure 4).

Muskellunge. Adult muskellunge abundance ($\geq$ 30 in) was 419 (CV = 21.6; 0.12 fish/acre), or about 1 muskellunge for every 8 acres of water. Catch per unit effort (CPUE; the number of muskellunge caught with each fyke net lift) decreased from 0.68 to 0.49, to 0.30 from 1989 to 1993 to 2002.

Since 1989 the muskellunge size structure in Namakagon Lake has shifted to larger fish (1989 vs 1993, D = 0.30, P =0.002; 1993 vs 2002, D = 0.44, P < 0.0001; Figure 5). The average length of muskellunge in Namakagon Lake increased from 31.1 (SD = 3.9, N = 71), 34.5 (SD = 4.5, N = 80) to 40.0 (SD = 5.2, N = 125) inches for survey years 1989, 1993 and 2002. The RSD (34) was 46, 65 and 90 in the three survey periods, 1989, 1993 and 2002. RSD (40) was 0, 15 and 54 in the three survey periods. However, the larger PSD and RSD values also reflect paucity in the number of smaller stock length fish. Only 16% of adult muskellunge handled during 2002 were in the length group 30 – 36 in, and 4% in the length group 20 – 29 in. While muskellunge in the smaller length group (20 – 29 in) are often not mature and vulnerable to fyke net capture, the top-sided size structure of 2002 muskellunge is evident.

Muskellunge relative weight (W_r) in Namakagon Lake averaged 91 (SD = 10.3, N = 79) in 2003. When separated by length groups, muskellunge 38.0 – 41.9 in had mean relative weights less than fish smaller (30.0 – 37.9 in) and larger ($\geq$ 42.0 in; Figure 6). Mean relative weight for Namakagon Lake muskellunge was lower in all length groups compared to mean relative weight data collected from 10 northern Wisconsin lakes (Neumann and Willis 1994, Figure 6).

Muskellunge growth information derived from scales and cleithra constructed similar growth curves (Figure 7). Relative agreement between the two structures is not surprising considering Namakagon Lake's mesotrophic status and forage community. Interpretations made with scales are more likely to be problematic where poor growth results from scale resorption and erosion. Growth rates were slower than the cleithra data from the United States and Canada (Casselman and Crossman 1986), however care must be taken with direct comparisons due to bias contained in the larger data set. Cleithra data obtained by Casselman and Crossman (1986) was from taxidermists and contained a high ratio of females and was furthered biased by better growth in Canada samples in comparison to United States samples. Comparison of growth information from scales with eight study lakes in Northern Wisconsin for both males and females (Hanson 1986) indicate that males from Namakagon Lake exhibit above average growth rates and females from Namakagon Lake exhibit average growth (Figures 8 and 9).

<u>Northern Pike.</u> Northern pike were the second most abundant predator in Namakagon Lake. Relative abundance for northern pike increased from 3.1 fish/net lift to 8.6 fish/net lift in 2002 for the spring fyke net survey. Mean lengths of northern pike (fyke net samples) were 21.0 in (SD = 3.5, N = 499) and 20.1 in (SD = 2.8, N = 1,804) 1993 and 2002. PSD and RSD-28 values indicated a declining size structure for northern pike ($D = 0.17$, $P < 0.0001$). PSD for spring fyke netting samples were 43 and 28 for 1993 and 2002. RSD-28 was 4 and 2 for 1993 and 2002. Respectively stock densities and percent length frequency both indicate a decrease in length between the two survey periods (Figure 10).

<u>Largemouth and Smallmouth Bass.</u> Both largemouth and smallmouth bass were sampled in relatively low in numbers in Namakagon Lake. The best sample of bass was obtained during

the second electrofishing survey for both 1993 and 2002. In 2002, largemouth bass represented 22% and smallmouth bass 78% of the total number of bass surveyed (N = 51). Although sample size for both species was small (range = 11 to 40 for 1993 and 2002) size structure was excellent for both species of bass. Largemouth bass PSD values were 82 and 91 for 1993 and 2002. Largemouth bass RSD-15 values were 37 and 18 for both survey years. Number of smallmouth bass caught increased in 2002 compared to the 1993 survey. Smallmouth bass PSD values were 100 in both survey years and RSD-14 values were 68 and 58 in survey years 1993 and 2002. However, due to the small sample size it is difficult to determine if the slight decline in stock density values are a reflection of the real population.

Panfish. Bluegill were the most abundant panfish species sampled in Namakagon Lake (N = 976). PSD and RSD-8 values of 70 and 16 indicate excellent size structure for bluegill. Yellow perch were the second most abundant panfish sampled (N = 430). PSD and RSD-10 values of 9 and 1 indicate a poor size structure for perch. Black crappie (N = 167) and pumpkinseed (N = 165) were sampled in nearly equal proportions. The PSD and RSD-10 values of 78 and 39 for black crappie indicate excellent size structure. The PSD and RSD-8 values of 67 and 2 for pumpkinseed indicate a slightly above average size structure.

Sport and Tribal Fishery Anglers fished an estimated 80,578 hours (25hrs/acre) during the 2002-2003 season in Namakagon Lake, which is slightly higher than the average of 23hrs/acre for Bayfield and Douglas County walleye lakes (WDNR unpublished data, Brule field office). Open water anglers accounted for 91% of all fishing effort. The directed effort, i.e. effort targeted toward a specific fish, was highest for muskellunge, which accounted for 25.2% of the total. Directed effort for walleye accounted for 23.5% of the total. The most sought after panfish species was bluegill, which had 14.3% of the total directed effort. Fishing pressure has remained relatively stable over the previous decade. The open water fishing pressure (hrs/acre) was 8.4, 28.9 and 22.8 for 1989, 1993 and 2002 respectively.

Angling in Jackson Lake for 2002-2003 resulted in 5,203 hours (36.6 hrs/acre) of projected pressure. Black crappie was the most sought after species in Jackson Lake with 58% of the directed effort. The second most popular species among anglers was northern pike with 15% of the directed effort. Directed effort for walleye and muskellunge was 2% and 3% respectively. Black crappie comprised the greatest majority of harvest with 3,249 or 97% of all fish species being harvested. Only 7 walleye were harvested in Jackson Lake and 37 northern pike.

Walleye were the most heavily exploited gamefish in Namakagon Lake. An estimated 7,326 walleye were caught in 2002-2003 of which 40% (2,900) were harvested. The open water season accounted for 98% of the total walleye harvest, an increase from 1993 (94%) and 1989 (68%). Average length of angler harvested walleye was 14.1 in (SD = 2.4, N = 163, Table 2). This represented a decline compared to previous surveys and likely a result of the length limit change. Projected total harvest has increased over the same time period, yet remains a small portion of the total stock (17%). Angler willingness to keep smaller walleye has led to increased harvest overall. Angler harvest of walleye ≥ 15 in has declined by 58% from 1993. In addition, exploitation of walleye ≥ 15 in has declined from 21% in 1993 to 15% in 2002 (Table 2). Nevertheless, the reallocation of harvest from walleye ≥ 15 in to walleye < 15 in, and the reduced harvest of walleye ≥ 15 in, has not increased abundance of walleye ≥ 15 in.

Tribal harvest accounted for 847 walleye in 2002 (Krueger 2003). Walleye harvested ranged from 10.0 in to 25.9 in. Tribal harvest represented 23% of the combined total harvest (sport angling plus tribal spearing) and 5% of the total stock. The mean length of tribally harvested walleye was 14.1 in and 71% were < 15 in. Length of harvested walleye by tribal spearers was similar to that of sport anglers (D = 0.03, P = 1.00; Figure 11). Male and female walleye represented 91% and 8% of the total tribal harvest, respectively. The remaining 1% were walleye of unknown sex.

Since 1993, muskellunge have surpassed walleye as the most popular gamefish. Fishing an estimated 24,655 hours in the open water season of 2002, anglers targeting muskellunge represented the largest source of fishing pressure. Total catch of muskellunge was 307 fish. This represented a decline of 53% and 67% when compared to 1993 and 1989, respectively. The catch rate of muskellunge has also declined throughout the three creel surveys. In 2002, it took anglers 92 hours to catch a muskellunge in 2002 compared to 54 hours in 1993 and 14 hours in 1989. No harvest of muskellunge was recorded in the 2002 creel survey. Tribal spearing harvested two muskellunge with an average length of 38.5 in (Krueger 2003).

Northern pike were the third most popular and the second most exploited gamefish species in both the openwater and winter seasons of 2002-03. The mean length of northern pike that were harvested was 22.2 in (SD = 2.9, N = 287) and ranged from 14 to 39 in. Twenty two percent of harvested northern pike were $\geq$24 in. Largemouth and smallmouth bass harvest comprised only 1% of all gamefish harvested.

Anglers pursuing panfish fished an estimated 28,863 hours and accounted for 30% of the total directed angling effort for the 2002-03 open water and winter seasons combined. Harvest of bluegill decreased from 11,535 in 1993-1994 to 8,356 in 2002-2003, but the average total length increased from 6.7 in to 7.2 in. In contrast, harvest of black crappie increased from 2,991 in 1993-1994 to 5,188 in 2003-2004 and the average total length harvested decreased from 10.6 to 10.1. Yellow perch harvest increased from 404 in 1993-1994 to 2,094 in 2003-2004.

Discussion

Namakagon and Jackson Lakes have supported and continue to support diverse fish communities and popular sport fisheries. With the exception of muskellunge, good to excellent natural reproduction supports all species. Harvest management aimed at maintaining self-sustaining stocks has been largely successful.

Results from the 2002-2003 survey suggest that the objectives of the regulation change for walleye that included no minimum length limit but only one fish over 14 in were accomplished. Overall harvest of walleye increased from 1993 surveys and was a result of anglers' willingness to harvest walleye 15 in and less. Seventy percent of walleye harvested by anglers in 2002-2003 were less than 15 in and total harvest increased nearly 30% from 1993. In addition, harvest of walleye 15 in and greater declined 58% from 1993 to 2002. However, size structure continued to decline. The size structure decline may reverse or continue depending on natural variations in recruitment and other variables that are not readily defined such as angler intensity in the future, habitat degradation or improvement and fish community interactions. Nevertheless, walleye densities have remained relatively stable from 1989 to 2002, and remain above the state walleye management objective of 3.0 adults/acre and the Bayfield and Douglas County average for walleye lakes of 3.7 fish/acre.

Muskellunge have become the most sought after gamefish in Namakagon Lake. However, muskellunge abundance in 2002 was low (0.12 fish/acre $\geq$ 30 in), and fyke net catch data and angler catch rates suggest abundance has declined since 1989. Some of this decline may be attributed to a 58% reduction in fingerling stocking from the periods 1983-1993 to 1994-2003, due to hatchery renovations at Spooner, and implementation of alternate year stocking. In comparison with other muskellunge waters in northern Wisconsin, Namakagon Lake is at the low end of the reported range. Hanson (1986) found a mean density of 0.33 fish/acre (range 0.16 – 0.61 fish/acre) in eight lakes. Margenau and AveLallemant (2000) found mean densities of 0.42 fish/acre and 0.38 fish/acre for fifteen lakes during two separate sampling periods. Density range during these periods for the fifteen lakes was from 0.05 fish/acre to 0.99 fish/acre.

Muskellunge size structure in Namakagon Lake has increased considerably since 1989, and the 2002 sample contained the highest proportion of large fish ($\geq$ 40 in) reported for Wisconsin. In 2002, muskellunge had RSD (34) and RSD (40) values of 90 and 54 respectively. This compares to the 15 study lakes in northern Wisconsin that had an RSD (34) average of 59 and an RSD (40) average of 13 (Margenau and AveLallemant 2000). White Sand Lake (Vilas County) had the highest RSD (34) and (40) values of 78 and 40, respectively in the 15 study lakes (Margenau and AveLallemant 2000). High minimum length limits along with increasing voluntary release of muskellunge were likely responsible, at least in part, for this shift. However, of concern were the low number of fish $<$ 36 in sampled during 2002. Part of this may be due to a missed stocking year (1995) due to hatchery renovations at Spooner. These fish would have been age 7 in 2002 and likely in the mid-30 in length range. Another factor that may be affecting muskellunge recruitment is predation by resident predators. Northern pike are effective predators on stocked muskellunge (Margenau 1999), and their abundance seems to have expanded in Namakagon Lake. Relative abundance of northern pike suggests a nearly 3-fold increase since 1993. Low numbers of muskellunge recruiting into the adult population could cause long-term effects as the current adult stock moves out of the fishery in future years. It will be imperative in the future to continue monitoring the muskellunge population to acquire a better understanding of the ultimate growth potential and that relationship to population density.

There is a concern among a faction of sport anglers that muskellunge predation on walleye has resulted in lower walleye densities. Bozek et al. (1999) found walleye to made up only a small portion of muskellunge diet in 34 Wisconsin water bodies. Yellow perch and white sucker were the dominant prey items for muskellunge in their study. However, Bozek et al. (1999) sampled a low percentage of muskellunge $>$ 30 in, and larger muskellunge prefer/require larger prey items. Muskellunge diet is dependent on each water's fish community and the availability of prey within that system. It's reasonable to assume that some walleye in Namakagon Lake are utilized by muskellunge as prey, however considering the diverse fish community and low muskellunge population density, it is unlikely muskellunge effect overall walleye abundance. A muskellunge population estimate is scheduled for 2011-2012, at that time or before if funding and workload permits, diet analysis should be incorporated in the survey to provide information on muskellunge diet and relation to other species of fish present in the lake.

The panfish community, although not targeted in the surveys completed in 2002-2003 or historically, appear to be in good condition. With the exception of yellow perch, other species of panfish have good to exceptional size structures. The mesotrophic status of Namakagon Lake may be partially responsible for above average abundance and size structure of panfish along with a relatively balanced fish community as a whole.

Jackson Lake supports a low density walleye fishery which may be related to lack of habitat. However, creel survey information indicated a black crappie fishery that appears to be the main focus of anglers, especially during the ice fishing season. Walleye and muskellunge angler directed effort and harvest were low to nonexistent and is most likely the result of relatively sparse populations of these gamefish in Jackson Lake.

Summary and Management Recommendations

1. Walleye abundance in Namakagon Lake is above statewide goals and regional averages. Retain the current regulation strategy for walleye. Increased overall harvest and reduction of harvest of larger walleye has been achieved by the current regulation and should be afforded more time to assess affects on walleye abundance and size structure.
2. Muskellunge density is low and size structure is the highest in published literature. Set muskellunge stocking rates at 0.8/acre/biannually (2,500 every other year) to prevent

variation in the number stocked. Limiting stocking to 2,500 every other year would ensure that a stable stocking rate was maintained and make analysis of future survey densities more concise. If abundance declines to < 0.1 adult muskellunge/acre, future recommendations could include raising the stocking rate to 1 fish/acre/bianually, or utilizing larger/older hatchery products (e.g. yearlings) to enhance survival.

3. Explore dietary analysis of muskellunge as funding and future workload permits which could begin during the next muskellunge evaluation in 2011-2012. The lack of dietary information on large muskellunge is problematic and the current population in Namakagon Lake would be ideal for maximizing efforts in an attempt to fill the need for information.
4. Work with local residents, the Namakagon Lake Association, the Cable Area Chamber of Commerce and the WDNR lake grants program to create and adopt a lake management plan. 1) develop management objectives for fisheries including goals for densities and size structures for the various fish species found in the lake, 2) develop strategies for protecting and enhancing sensitive aquatic and shoreline habitats, 3) formally establish exotic species survey and control programs targeting satellite infestations, 4) provide educational and participation forum for environmentally sensitive shoreline living, 5) identify uses and user groups to facilitate all recreational uses on the lake. No amount of regulation or voluntary catch and release practices will change the need for healthy aquatic environments. Although water quality remains high, habitat loss, declining shoreline aesthetics, and exotic introductions are warning signs of cultural disturbances that are degrading ecosystem health. Currently, exotics have not been identified in Namakagon Lake and much of the shoreline remains in a natural condition, to preserve and enhance the ecosystem vigilance for exotic species must continue and shoreline restoration projects in areas that are currently lacking buffers should be explored. Preventing the spread of exotics and enhancing habitat through restoration projects, as well as preserving the existing habitat will be far more

beneficial than losing what is currently present and relying on stocking and artificial habitat improvements to maintain the fishery and ecosystem as a whole.

Acknowledgments

I would like to thank the biologists and technicians of the Wisconsin Department of Natural Resources who assisted with field collection of data, especially Cris Sand, Marty Kangas and Cordell Manz. The WDNR treaty assessment unit, especially Jamison Wendel, Scott Plaster and Todd Brecka for data collection and entry and creel survey data collection, data entry and completion of the creel survey report. Terry Margenau provided a critical review of the manuscript. Kent Bass provided age interpretation of cleithrum. Volunteers from the Namakagon Lake Association provided assistance with data collection.

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Table 1. Stocking history of walleye and muskellunge in Namakagon Lake, Bayfield County.

Year	Walleye		Muskellunge	
	Number Stocked	Size	Number Stocked	Size
1933	729,109	Fry		
1934	457,562	Fry		
1935	2,202,400	Fry		
1936	3,175,200	Fry		
1937	5,136,600	Fry	90,900	Fry
1938	6,238,560	Fry	1,750,000	Fry
1939	6,832,000	Fry	150,000	Fry
1940	6,000,000	Fry	300,000	Fry
1941	4,000,000	Fry	5,125	Fingerling
			50,000	Fry
1942	3,000,000	Fry	346,352	Fry
	10,000	Fingerling	2,700	Fingerling
1943	4,000,000	Fry	353,078	Fry
	13,400	Fingerling	2,500	Fingerling
1944	3,200,000	Fry	105,000	Fry
	7,860	Fingerling	1,250	Fingerling
1945	1,941,100	Fry	118,125	Fry
	8,000	Fingerling	625	Fingerling
1946	3,620,195	Fry	2,925	Fingerling
	8,295	Fingerling		
1947	4,000,000	Fry	2,200	Fingerling
	20,000	Fingerling		
1949	9,200	Fingerling		
1950	35,787	Fingerling		
1951	17,845	Fingerling		
1953	10,670	Fingerling		
1955	6,500	Fingerling		
1956	7,875	Fingerling		
1957	10,500	Fingerling		
1958	3,500	Fingerling		
1960	4,585	Fingerling		
1961	26,915	Fingerling		
1963	1,065	Fry		
1964	45,006	Fingerling		
	2,416	Large Fing.		
1967	10,500	Fingerling		
1977	384,000	Fry		
1983			1,000	Large Fing.
1984			1,000	Large Fing.
1985			4,000	Large Fing.
1986			2,500	Large Fing.
1988			5,000	Large Fing.
1989			2,500	Large Fing.
1990	600,000	Fry	1,250	Large Fing.
1991	6,500	Fingerling	2,500	Large Fing.
1992	11,100	Fingerling	2,500	Large Fing.
	150	Large Fing.		
1993	465	Large Fing.	3,300	Large Fing.
1997			2,500	Large Fing.
1999			2,500	Large Fing.
2001			3,227	Large Fing.
2003			2,500	Large Fing.

Table 2. Walleye angling catch and harvest by length group during openwater and ice fishing season, Namakagon Lake, Bayfield County. Percent of harvest by season is in parenthesis. Walleye regulations during sampling periods: 1989, no minimum size limit and 1 daily bag limit. 1993, 15 inch minimum size limit and 3 daily bag limit. 2002, no minimum size limit with only 1 over 14 inches and 2 daily bag limit.

Year	Season	Projected Catch	Projected Harvest	Mean Length (in) (SD)	Harvest By Length (in)			
					10.0-14.9	15.0-19.9	20.0-24.9	25.0 +
1989	Openwater	1,758	883	15.4 (2.4)	380 (40)	468 (53)	35 (4)	0 (0)
	Ice	521	426	17.2 (2.2)	70 (16)	313 (74)	43 (10)	0 (0)
1993	Openwater	13,100	1,919	17.0 (2.2)	0 (0)	1,733 (90)	165 (9)	21 (1)
	Ice	169	134	18.1 (2.4)	0 (0)	110 (82)	24 (18)	0 (0)
2002	Openwater	7,248	2,837	14.1 (2.2)	1,989 (70)	783 (28)	64 (2)	0 (0)
	*Ice	75	63	14.8 (2.8)	35 (56)	26 (41)	2 (3)	0 (0)

*Ice fishing harvest includes 4 walleye harvested less than 10 inches.

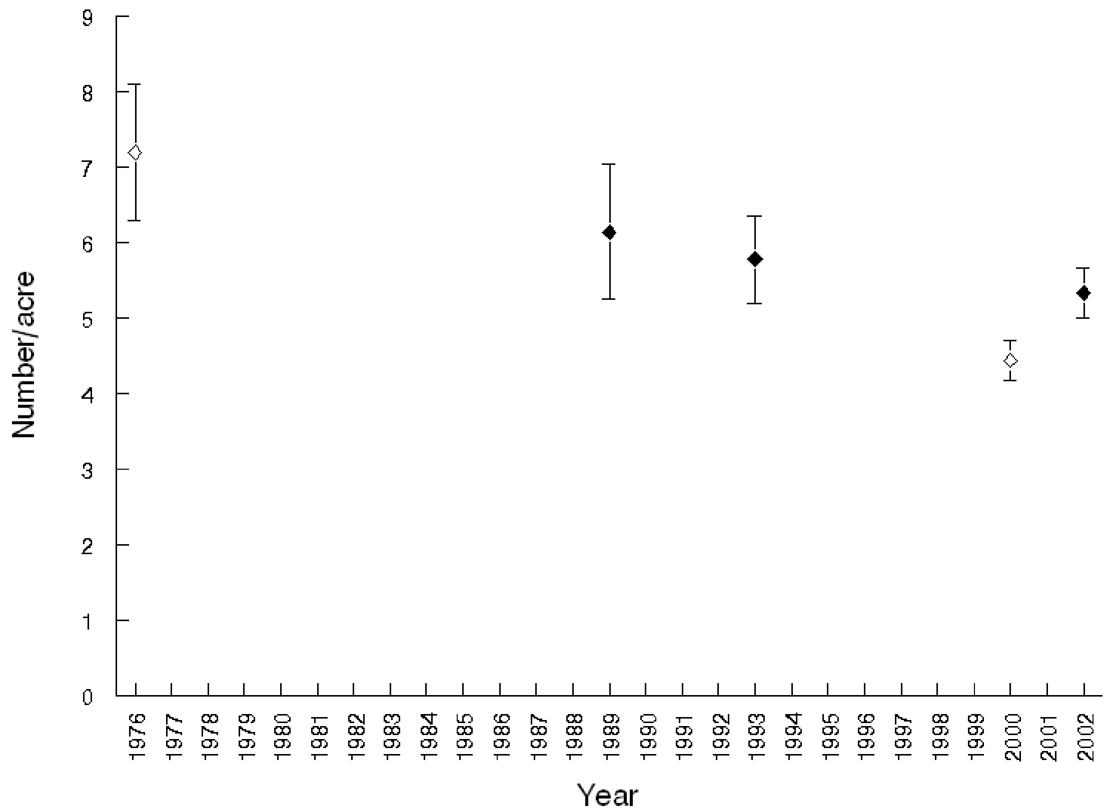

Figure 1. Number of walleye 10 inches and larger (number/acre ± 90% confidence intervals) by year in Namakagon Lake, Bayfield County, Wisconsin. Surveys in 1976 and 2000 utilized electrofishing for both marking and recapture. Surveys in 1989, 1993 and 2002 utilized fyke netting for marking and electrofishing for recapture.

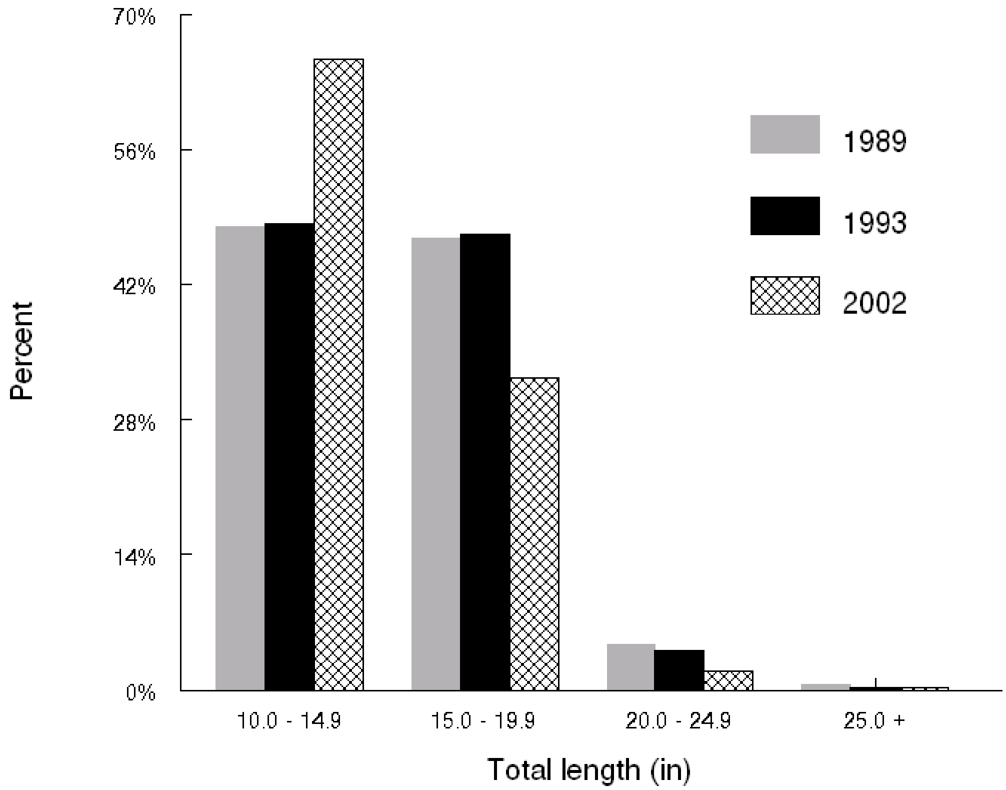

Figure 2. Percentage of the walleye population estimate by length interval in Namakagon Lake, Bayfield County, Wisconsin.

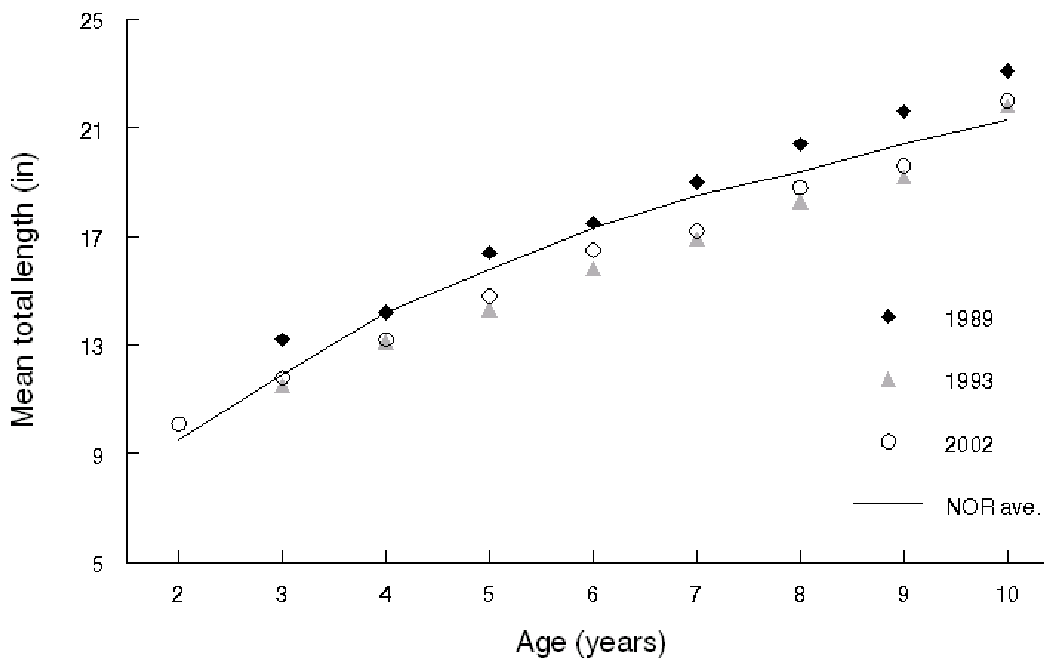

Figure 3. Age at length of walleye in Namakagon Lake, Bayfield County, Wisconsin.

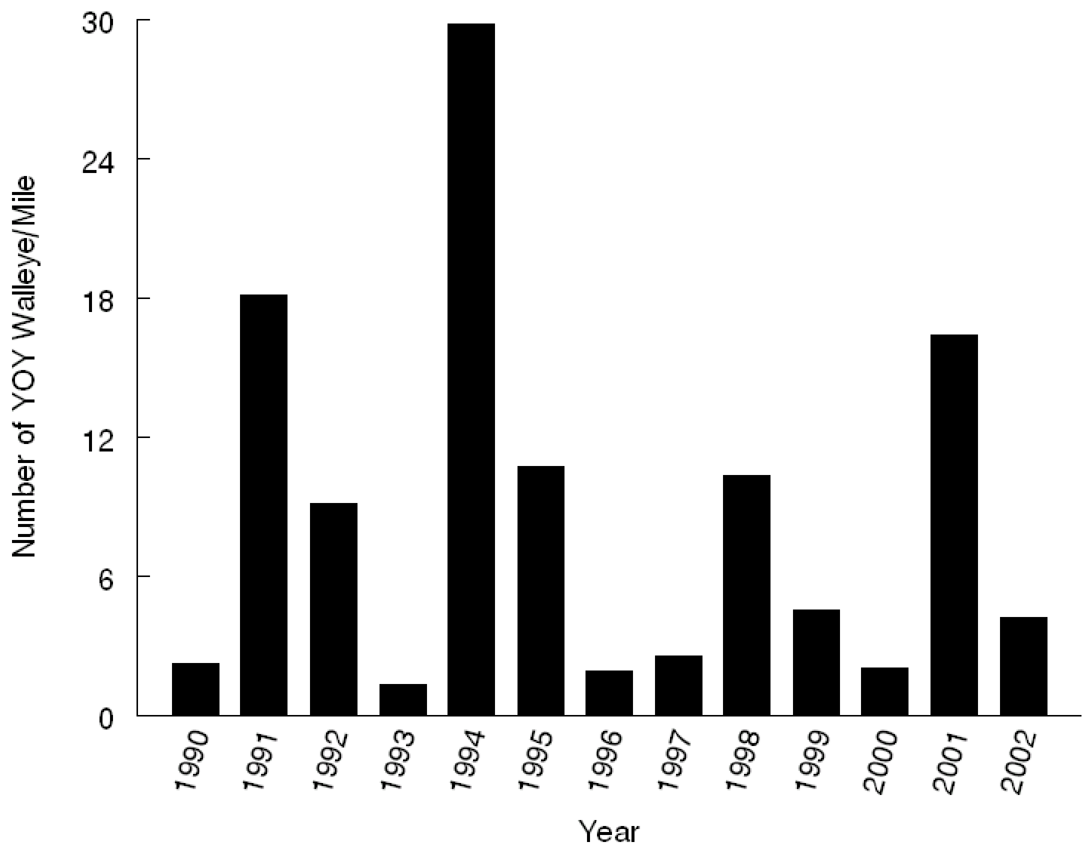

Figure 4. Young of year walleye relative abundance determined by fall electroshocking in Namakagon Lake, Bayfield County, Wisconsin.

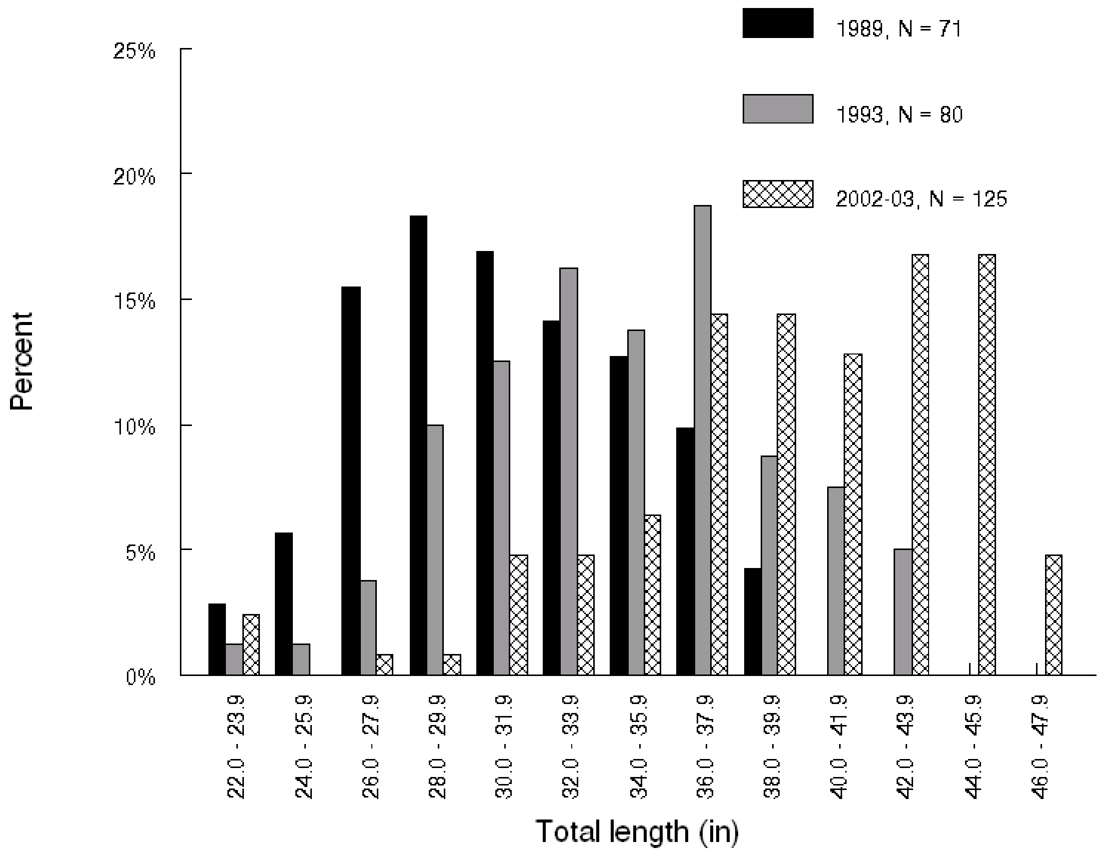

Figure 5. Percent length frequency of muskellunge in Namakagon Lake, Bayfield County, Wisconsin.

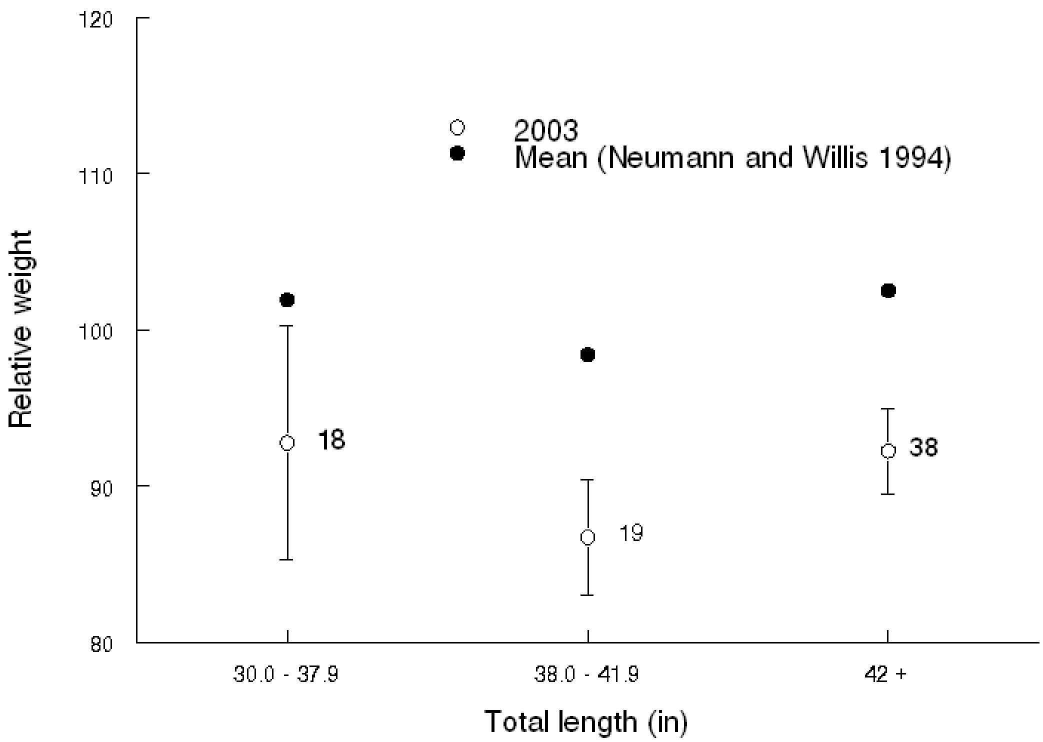

Figure 6. Mean relative weight (W_r ± 95% confidence intervals) of muskellunge by length category in Namakagon Lake, Bayfield County, Wisconsin. Numbers are sample sizes.

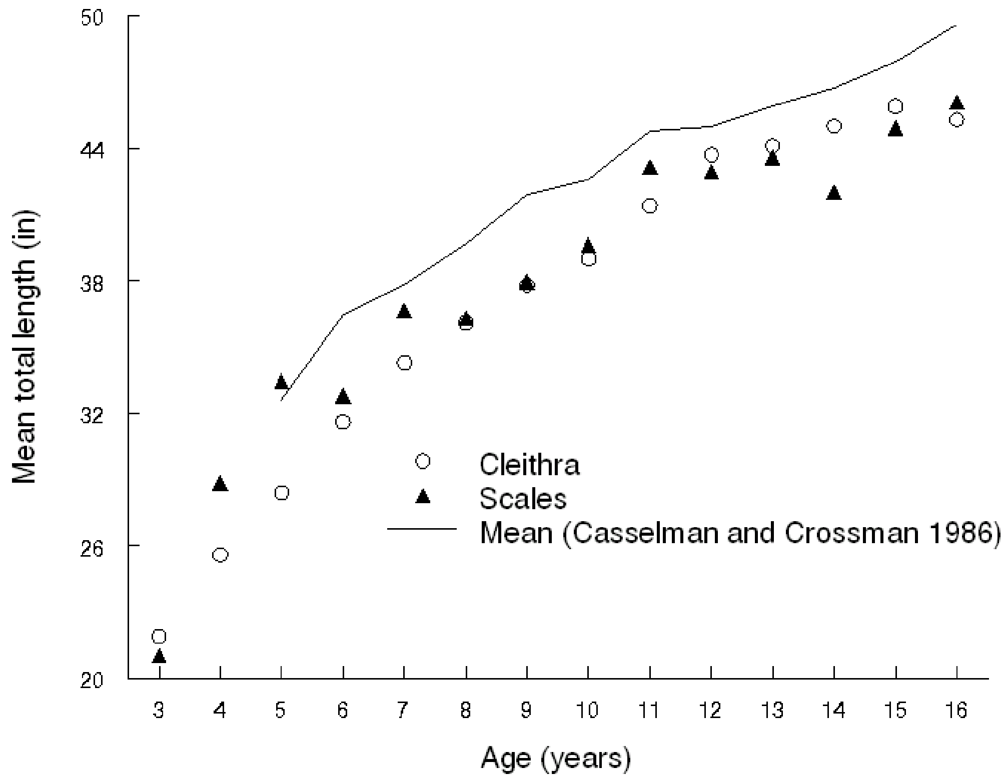

Figure 7. Mean total length at age of muskellunge derived from cleithra and scales from Namakagon Lake, and cleithra from Casselman and Crossman (1986) study lakes.

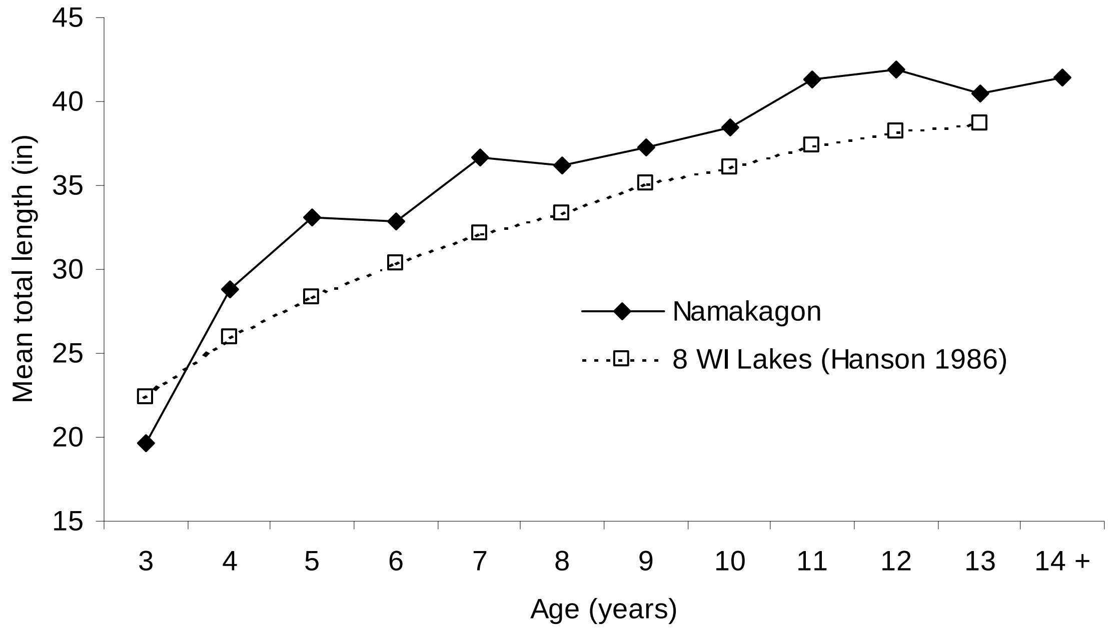

Figure 8. Mean total length at age of male muskellunge from Namakagon Lake compared to eight Northern Wisconsin study lakes. Namakagon Lake, Bayfield County, Wisconsin.

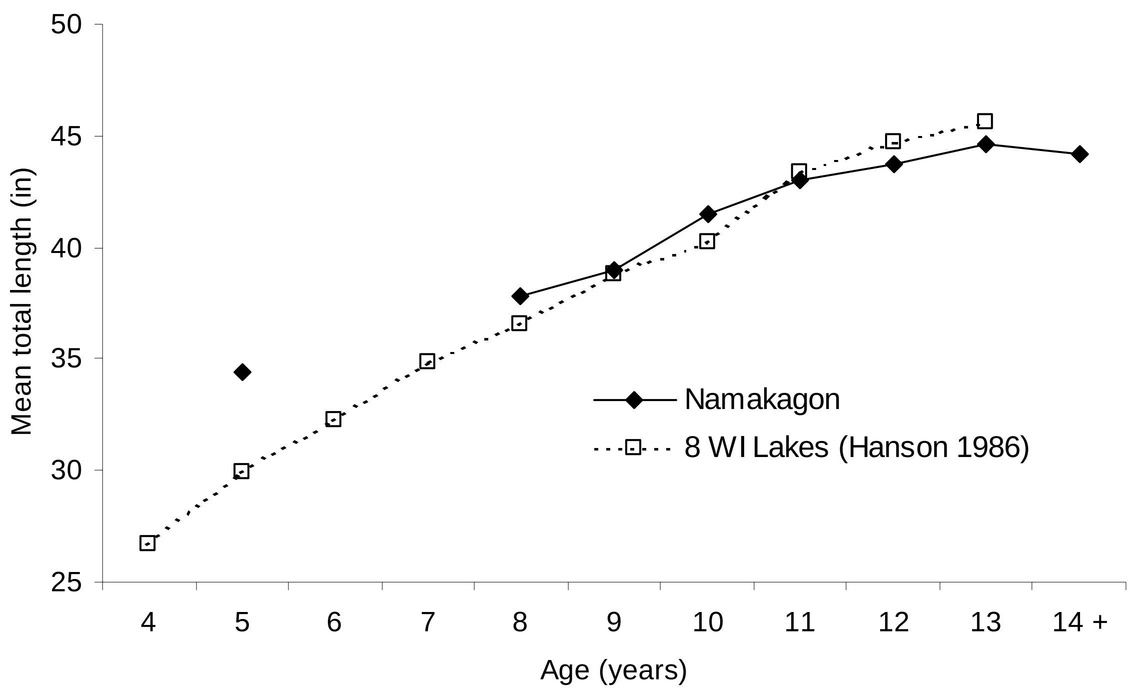

Figure 9. Mean total length at age of female muskellunge from Namakagon Lake compared to eight Northern Wisconsin study lakes. Namakagon Lake, Bayfield County, Wisconsin.

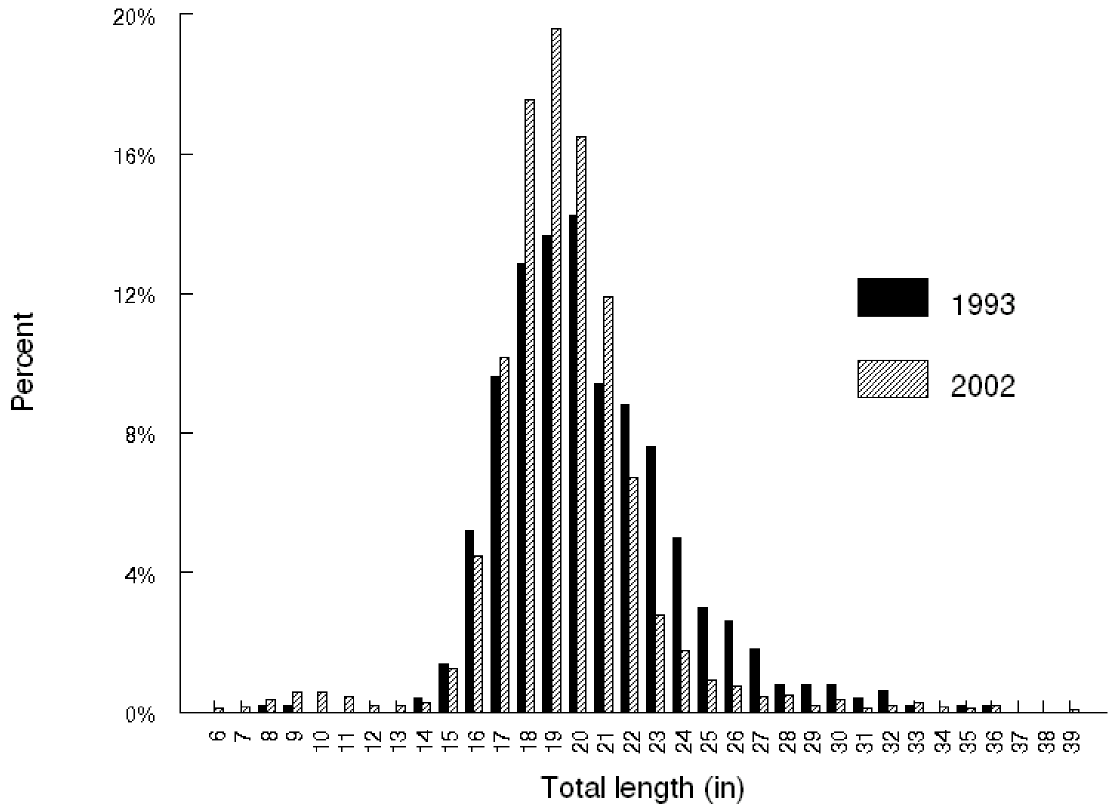

Figure 10. Percent length frequency of northern pike in Namakagon Lake, Bayfield County, Wisconsin.

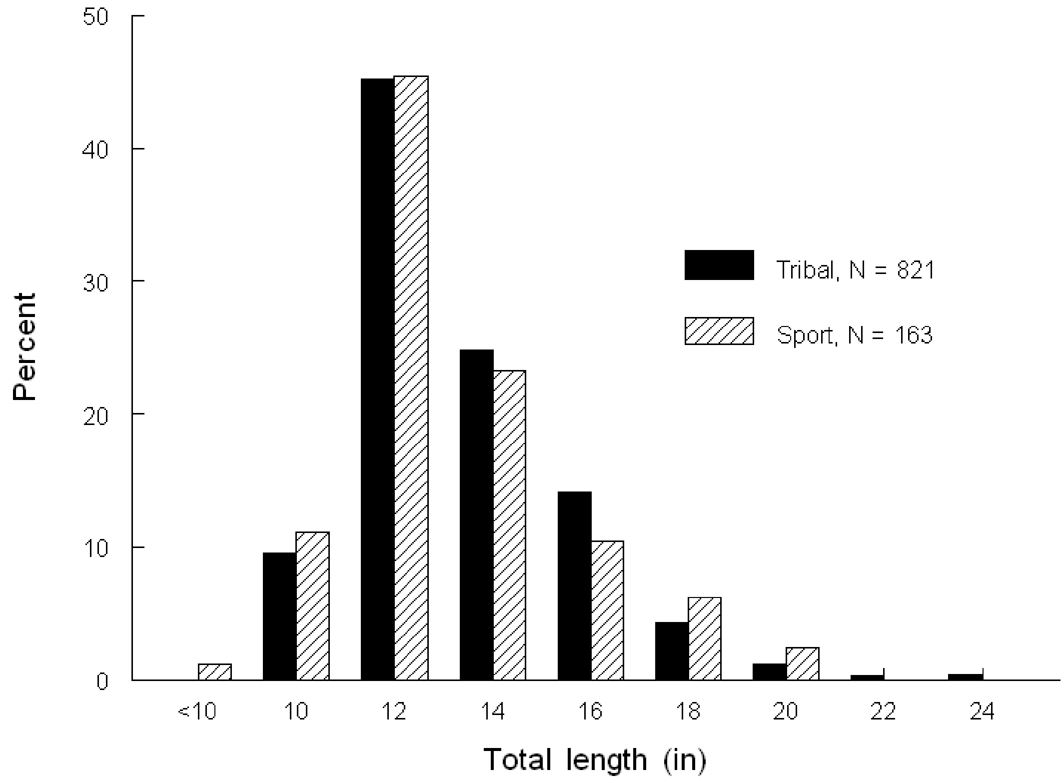

Figure 11. Tribal and sport harvest of walleye in Namakagon Lake, Bayfield County, Wisconsin. Numbers represent measured fish only.

Appendix

Table 1. Proportional and relative stock density values.

Species	Stock Size (in)	Quality Size (in)	Preferred Size (in)
Black Crappie	5	8	10
Bluegill	3	6	8
Largemouth Bass	8	12	15
Northern Pike	14	21	28
Smallmouth Bass	7	11	14
Yellow Perch	5	8	10