Bond Lake - Fishery Survey Report
Douglas County, Wisconsin, 2001-2002
WBIC Code: 2693700

Cordell H. Manz
Fisheries Technician
Wisconsin Department of Natural Resources
Northern Region – Brule

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Executive Summary

The fisheries of Bond Lake (Douglas County, WI) were surveyed during 2001 and 2002. Survey objectives were to determine population densities, growth, size structure, and harvest of walleye. In addition, we hoped to determine some population parameters and harvest of other gamefish and panfish in Bond Lake. Sampling followed standard Treaty Assessment protocol and included spring fyke netting, spring and fall electrofishing, panfish netting, and a creel survey. Walleye continue to be more abundant in Bond Lake after the discontinuation of stocking in 1968. Results indicate a population density of adult walleye (≥ 15.0 in and all sexable fish) at 2.3 fish/acre. Despite being below statewide management objects (3.0 fish/acre) for walleye, abundance is considered good for an oligotrophic lake such as Bond Lake. Size structure of walleye has increased significantly since 1988, with natural reproduction providing a sustainable fishery. Largemouth bass abundance (≥8.0 in) in Bond Lake of 2.6 fish/acre in 2001 is a significant increase from 1988 when it was 0.6 fish/acre. Smallmouth bass abundance remains low (0.2 fish/acre), but they contribute to a high quality bass fishery with good or excellent growth rates and size distribution for both bass species. Northern pike are not abundant in Bond Lake, although they have good growth and an adequate size structure. However, so far there appears to be no obvious benefit from the 32 in minimum length limit adopted in 1995. Panfish populations in Bond Lake appear to be low-density, with very good to excellent growth rates and size structure. Angling pressure in 2001-2002 was 10.6 hrs/acre, of which 67.7% occurred during the open water period. Creel survey results indicate walleye were the most sought after fish species (64.5% of all directed angling effort) and most heavily exploited (26% of the adult population) gamefish species by anglers. Anglers harvested an estimated 272 walleye in 2001 – 2002 averaging 17.6 in. Bluegill were the most sought after panfish species, with 18.9% of anglers targeting bluegill during the open water season. No tribal spearing occurred in either 2001 or 2002. Management recommendations include: maintaining the existing regulations for walleye, northern pike, and bass species; working with local residents and the lake association to improve water quality, near-shore habitat, and buffer zones; changing the bag limit for panfish from 25 to 10 fish in total per day; and future comprehensive assessment of the fishery to be coincided with the regular treaty assessment rotation.

Introduction

Bond Lake is a 292-acre seepage lake with a maximum depth of sixty-seven feet. It has soft water and excellent water clarity. The mean summer secchi disk depth (TSI) value for the deep hole on Bond Lake between 1991 and 2004 was 33.4 (SD = 2.69, n = 75). Mean summer chlorophyll-a and total phosphorus TSI values were 36.9 (SD = 2.49, n = 29) and 43.9 (SD = 2.52, n = 22) respectively, over the same time period. [Trophic state index (TSI) values were calculated for water clarity (secchi disk measurements), chlorophyll-a, and total phosphorus values on Bond Lake for the time period between 1991 and 2004. TSI is an index for evaluating the trophic state or nutrient condition of lakes and represents a continuum ranging from very clear, nutrient poor water (low TSI's) to extremely productive, nutrient rich water (high TSI's).] Overall, data from Bond Lake shows that it is oligotrophic when considering secchi disc and chlorophyll-a values, and mesotrophic when considering total phosphorus TSI values.

Lake levels in Bond Lake are maintained as a result of the water table, although it has intermittently flowing inlets from an unnamed lake and nearby Leader Lake, as well as an intermittent outlet to the Minong Flowage in the Totagatic River system. However, water levels may fluctuate annually up to two feet or more. Littoral substrates are primarily sand (>90%), with gravel and muck present in some areas (Sather and Johannes 1972). Aquatic vegetation is sparse, consisting primarily of bulrush (*Scirpus sp*.) along much of the shoreline, as well as minor amounts of pondweed (*Potamogeton sp*.) and water lily (*Nymphaea sp*.). The shoreline of Bond Lake is highly developed, with remaining riparian vegetation made up mainly of jack pine (*Pinus nigra*) and scrub oak (*Quercus sp*.). Adequate public access exists on the east side of the lake off of Estates Road.

Bond Lake's fishery is made up of walleye (*Sander vitreus*), northern pike (*Esox lucius*), largemouth bass (*Micropterous salmoides*), smallmouth bass (*M. dolomieui*), bluegill (*Lepomis macrochirus*), black crappie (*Pomoxis nigromaculatus*), and yellow perch (*Perca flavescens*). Other fish species documented as present from past surveys of Bond Lake include: white sucker, (*Catostomus commersoni*), pumkinseed sunfish (*L. gibbosus*), green sunfish (*L. cyanellus*), yellow bullhead (*Ictalurus natalis*), black bullhead (*I. melas*), golden shiner (*Notemigonus crysoleucas*), common shiner (*Notropis* *cornutus*), spottail shiner (*N. hudsonius*), bluntnose minnow (*Pimephales notatus*), creek chub (*Semotilus atromaculatus*), johnny darter (*Etheostoma nigrum*), cisco (*Coregonus artedii*) and topminnow (*Fundulus sp*.).

Historic management of Bond Lake has included fishery surveys, stocking, and various length and bag limit regulations. Past surveys on Bond Lake include shocking and fyke nets surveys in 1959 and 1968 to evaluate the walleye population, inventories conducted in 1974 (one spring and one fall electrofishing run) to determine changes in fish populations occurring since 1968, and fishery surveys in 1988 to assess the walleye population using methods as outlined by Staggs (Intradepartmental Memo, April 12, 1989) for Treaty Assessment work. The 1988 survey also included assessment of other gamefish and panfish populations. Recent management has included fall electroshocking surveys (1993, 1997, and 2000) to estimate year class strength of young-of-the-year (YOY) and yearling walleye, and also a spring fyke netting survey in 1994 to evaluate northern pike populations prior to a regulation change.

Bond Lake was stocked regularly from 1933 to 1954 with either largemouth bass or northern pike, but also on occasion with either walleye (1933 and 1934), black crappie (1937), or sunfish (1938 and 1941). After fishery surveys conducted in 1959 indicated no apparent survival or reproduction of walleye stocked in 1933-34, it was recommended walleye be stocked starting in 1959 at three year intervals. As a result, approximately 15,000 walleye fingerlings (2-3 in) were stocked triennially in 1959, 1962, and 1965, with another 2,000 in 1968. However, stocking of walleye was discontinued after the 1968 survey indicated very poor survival of stocked walleye and no evidence of natural reproduction (Table 1). Fishery surveys in 1974 indicated an increase in the walleye population since 1968 and evidence of some natural reproduction, even though stocking had been discontinued (Kampa 1991). As a result of those findings, stocking has not occurred on Bond Lake since 1968.

Fishing regulations for walleye have changed over time in Bond Lake. Until 1989 these changes had been in concurrence with statewide bag and length limit changes for walleye. This included a minimum length of 13 in from 1966 through 1974 and a change back to no minimum length for walleye from 1974 through 1989. Recent management however, has included bag limits that have had to be adjusted annually (to a two, three, or five bag daily limit) according to tribal harvest declarations that began in 1988. Also, in 1990, the length limit for walleye was again changed to the present statewide minimum length of 15 in.

Northern pike, bass, and panfish regulations have generally followed that of statewide bag and length limits in place at the time. The one exception is for northern pike, which starting in 1995 has had a minimum length limit of 32 in and a daily bag limit of one. This regulation change was part of a larger statewide WDNR effort to increase the quality of the northern pike fisheries on select waterbodies in Wisconsin.

The objective of the 2001-2002 survey of Bond Lake was to determine the present status of walleye populations; specifically, to determine population densities, growth, size structure, and harvest of walleye in order to update safe harvest levels and evaluate current harvest regulation strategies. In addition, we hoped to determine some population parameters and harvest of other gamefish and panfish in Bond Lake.

Methods

Bond Lake was sampled during 2001-2002 following the Wisconsin Department of Natural Resources treaty assessment protocol (Hennessy 2002). Comprehensive sampling included: spring fyke netting (4 x 6 ft frames, 0.5 in bar mesh) and electroshocking (A.C. boomshocker) to estimate walleye and bass abundance, late June fyke netting to estimate panfish abundance, mini-fyke netting (3 x 3 ft frames, 3/16 in bar mesh) in August for juvenile and non-game fish species, fall electroshocking to estimate year class strength of YOY walleye, and a creel survey (both open water and ice). Mini-fyke netting and fall electroshocking surveys followed protocols given by Stewart (2001) for Wisconsin’s statewide baseline monitoring program.

Walleye were captured for marking in the spring immediately after ice out on Bond Lake using fyke nets. Each fish was measured to the nearest one-tenth inch total length (TL), sexed, fin clipped, and observed for other marks. For aging purposes, the second dorsal spine was removed from ten walleye per inch group and sex. Adult (mature) walleyes were defined as any fish for which sex could be determined, or any walleye fifteen inches or greater. Walleyes of unknown sex less than fifteen inches in length were classified as juveniles (immature) and were marked with a secondary fin clip, rather than the primary fin clip given to adults. Marking effort for walleyes was based on a goal of marking 10% of the anticipated spawning population estimate.

To estimate walleye abundance, walleyes were recaptured during two electrofishing runs. The first run (to estimate adult abundance) occurred one day after fyke netting was complete, and a second recapture run (required to estimate total walleye abundance) took place nine days after the first. Because of the short interval between marking and recapture events, the entire shoreline was sampled to ensure equal vulnerability for capturing both marked and unmarked walleyes. All walleyes collected during recapture runs were measured and examined for marks. Unmarked walleyes were given the appropriate mark so that a total population estimate could be calculated upon completion of the second electrofishing run. However, because only five walleye were captured during the first recapture run and only fourteen sexable walleyes were collected during the second recapture run, performing population estimates using the methodology described - with the intention of using the Chapman version to the Petersen formula (Ricker 1975) for calculations - were not appropriate due to resulting large confidence intervals and coefficients of variation. To achieve a better approximation of the walleye population an estimate using the Schnabel method (Ricker 1975) was performed. Age and growth of walleye was determined from dorsal spine cross sections viewed microscopically at 100 X (Margenau 1982). Growth rates of male and female walleye were compared separately to Douglas County averages obtained from the Spooner, WI Treaty Assessment Unit.

Largemouth and smallmouth bass were collected, measured, and marked during fyke netting and subsequent electrofishing runs for walleye. Scales were also taken for age interpretation. Bass ≥12.0 in were given the same primary (adult) fin-clip given to walleye for that lake. Bass 8.0 -11.9 in were given the secondary (juvenile) fin-clip for the lake. Bass were then recaptured during third and fourth electrofishing runs conducted on May 22 and May 30, 2001, following the second recapture run for walleye. Bass populations were estimated after both the third and fourth runs using the Chapman version of the Petersen estimate (Ricker 1975). Estimates were made for each species in three length classes: 8.0- 13.9, 14.0- 17.9, and ≥18.0 in. The recapture run yielding the lowest coefficient of variation was the population estimate reported. Age and growth for bass and other fish species (northern pike and panfish) were determined by viewing acetate scale impressions under a 30 X microfilm projector. Growth rates were compared to northern region averages obtained from the WDNR statewide fisheries database. Length distributions were summarized using proportional (PSD) and relative stock (RSD) 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 (Table 3). Changes in size distribution of walleye was determined using Kolmogorov-Smirnov tests.

Creel census data was collected during the open water and ice-fishing season in 2001–2002 beginning the first Saturday in May and continuing through March 1st of the following year (the open season for game fish angling in Wisconsin). Creel survey methods used a stratified random design (Beard et al. 1997; Rasmussen et al. 1998). The survey was stratified by month and day-type (weekend/holiday or weekday) and was conducted on all weekends and holidays, and also on two or three randomly chosen weekdays for each week of the census. Only completed-trip interview data was used in analysis. The clerk recorded effort, catch, harvest, and targeted species from anglers, also measuring any harvested fish and examining them for fin-clips.

Results

Total survey effort in 2001 included sixty-one fyke net lifts targeting spawning gamefish (April 23 - 30), twelve fyke net lifts targeting adult panfish (June 12 – 13), and sixteen mini-fyke net lifts targeting juvenile gamefish and panfish, and non-game fish species (August 7 – 8). In addition, four spring electrofishing surveys of the entire shoreline (May 1, 10, 22, and 30) totaling 6.3 hrs and one fall electrofishing survey (September 26) totaling 1.4 hrs were also conducted. Over 4,550 fish representing twenty-one different species were captured, using various gear types for all sampling events (Table 2). Non-game fish species accounted for a majority of the diversity with thirteen different species sampled, while gamefish and panfish species were most abundant overall, making up approximately 86% of the total fish sampled.

Several changes in species composition were noted in Bond Lake. Species found in previous investigations, but not found in 2001 include green sunfish, black bullhead, creek chub, and cisco. Previously unreported for Bond Lake, but sampled in 2001 were Iowa darter (*Etheostoma exile*), brown bullhead (*Ictalurus nebulosus*), tadpole madtom (*Noturus gyrinus*), and blacknose (*Notropis heterolepis*) and mimic shiners (*N. volucellus*). Banded killifish (*Fundulus diaphanus*), also found in 2001, are most likely what previous fish inventories reported as “topminnow”.

Gamefish present in order of abundance, included walleye, largemouth bass, smallmouth bass and northern pike. Bluegills were the most abundant panfish species, followed by yellow perch and black crappie. Only one pumkinseed sunfish was collected. White sucker, blacknose and spottail shiner, and bluntnose minnow were the most common non-game fish species, and along with bluegill and yellow perch (and possibly cisco) may comprise the bulk of the forage base in Bond Lake.

Walleye. Walleye were the most abundant gamefish sampled with a combined total of 796 collected for all gear types and sampling events. A total of 180 walleyes >10.0 in were marked during the marking period. Walleye abundance (≥ 15.0 in and all sexable fish) was 674 (95% C.I. = 484<N<1108; CV = 0.20) or 2.3 fish/acre. This estimate is greater than the 1988 estimate (also using the Schnabel method), when walleye abundance (≥15.0 in and sexable fish) was estimated at 373 (95% C.I. = 285<N<537; CV = 15.6%) or 1.3 fish/acre. However, a high variance in estimates (due to low number of recaptures) makes it necessary to conclude that abundance between the two periods is similar (Figure 1).

Lengths of walleye captured in fyke nets in 1988, 1994, and 2001 indicate a significant trend of increasing size structure (1988 vs. 2001, $D = 0.47$, $P < 0.0001$) in Bond Lake (Figure 2). Mean length of walleye >10.0 in collected while spring fyke netting increased from 16.0 in (n = 168, SD = 2.2) in 1988, to 16.9 in (n = 60, SD = 2.3) in 1994, and to 18.0 in (n = 180, SD = 2.5) in 2001. Comparing proportional stock density (PSD) and relative stock density (RSD) for 1988 and 2001 further substantiate an increase in walleye size structure. PSD has increased from 70 to 88, and RSD-20 has increased from 4 to 14 from 1988 to 2001, respectively. In addition, walleye ≥ 20.0 in have increased in numbers by approximately ten percent in 2001 when compared to the number sampled in 1988 and 1994 (Figure 3).

Age of adult walleye sampled during 2001 ranged from III to XVI. Male and female walleye first reached maturity at age III and IV, respectively. Growth was dimorphic, with female walleye reaching 15 in at age III or IV, while males reached 15 in at age IV or V (Figure 4). The absence of any males between ages VIII to XI in 2001, and only five females at ages VIII to XI suggests the possibility of poor survival from the 1990 to 1993 year classes. Growth rates of male walleye (Figure 5) were fast up to age VII and better than growth rates in 1988, which were very similar to the Douglas County average for male walleye. Sometime after age VII, male walleye growth rates appear to shift to be slightly lower than Douglas County averages for male walleye. Growth rates of female walleye (Figure 6) were also faster than the Douglas County average up to about age VII. After age VIII, their growth rates appear to be slower than both 1988 and the Douglas County averages for female walleye, but this may reflect small sample sizes for both 1988 and 2001 female walleye ages VIII and older.

Although natural reproduction for walleye is variable from year to year, there is evidence for above average year classes (for Bond Lake) in 1996 and 2000 (Figure 7). Catch rates of age I walleye were 7.9, 42.4, and 79.5 fish/mi for spring electrofishing runs on May 10th, 22nd, and 30th, 2001, respectively, and may indicate good first-year survival from the 2000 year-class. Catch rates of age 0 and age I+ walleye during fall electrofishing in 2001 were 5.0 and 3.2 fish/mi (Figure 7). These are lower than fall catch rates in 2000 for YOY walleye (23.2 fish/mi), but are still relatively similar to catch rates for YOY walleye from 1993 and 1997, which were 8.2 and 2.6 fish/mi, respectively (Figure 7). Average catch rates of YOY and age I+ walleye for all four years of fall electrofishing between 1993 and 2001 was 9.8 fish/mi (SD = 9.2) and 2.0 fish/mi (SD = 2.0). The highest catch rates for age I+ walleye was 4.2 fish/mi in 1997, and may indicate good first-year survival for the 1996 year-class.

Largemouth and smallmouth bass. Largemouth and smallmouth bass were the second and third most abundant predator fish sampled in 2001, respectively. In all, largemouth bass accounted for 90.2% (n = 578) of the bass collected (all gear types combined), whereas smallmouth bass represented only 9.8% (n = 63) of the bass sampled.

Population abundance for largemouth bass ≥8.0 in was 758 ± 167 (2.6 fish/acre; CV = 11.2%). The 2001 estimate is significantly higher than the 1988 estimate of 175 largemouth bass (0.6 fish/acre) for Bond Lake (Figure 8), despite wide 95% confidence intervals and a high coefficient of variation (75 < N <275; CV = 29.0) in 1988 (Kampa 1991). Catch per effort for largemouth bass was also higher in 2001 than in previous surveys during 1974 and 1988. Total CPE for largemouth bass in 2001 for all four, spring electrofishing runs was 58.9/hr. However, the final electrofishing run on May 30, 2001 was 110.7/hr, which was substantially higher than electrofishing runs conducted for bass on June 3, 1974 and on June 6 and 7, 1988, where CPE was 58.8/hr and 22.1/hr, respectively.

Even with the increase in largemouth bass density, size structure still remains desirable in Bond Lake (Figure 9). The average length of largemouth bass sampled during the four spring electrofishing runs in 2001 was 11.3 in (n = 371, SD = 3.04), with a size range of 5.2 – 20.7 in. A PSD of 35 for largemouth bass in 2001 was lower when compared to previous PSD values in 1974 of 47, and in 1988 of 50. However, numbers of large bass appear to be relatively similar to 1988, and higher than in 1974 as indicated by an RSD-15 in 2001 of 17. RSD-15 for largemouth bass in 1974 and 1988 was 7 and 18, respectively (Kampa 1991).

Growth rates for largemouth bass also appear to have remained relatively unchanged from what they were in 1988 and 1994 in Bond Lake (Figure 10), and compare favorably with northern region averages for largemouth bass. Kampa (1991) had previously indicated that largemouth bass in Bond Lake grow considerably faster than other northern region Wisconsin Lakes up through age VII, before becoming roughly comparable. Data from 2001 does not suggest this, however.

Smallmouth bass were not very abundant in Bond Lake with resulting estimates for fish ≥8.0 in (Figure 8) at 0.2 fish/acre (22 < N < 108; CV = 33.7%). In 1988, smallmouth bass were present, but not considered abundant enough to calculate density estimates. Although not very abundant, size distribution of smallmouth bass in Bond Lake is excellent, with a PSD of 97 and an RSD-14 of 55 (Figure 11). The mean length of smallmouth bass collected during spring electrofishing runs in 2001 was 14.4 in (n = 38, SD = 2.47), with a size range of 10.7 – 18.2 in. Growth rates for smallmouth bass in

Bond Lake are also very good, and appear to be better than in 1988 and above northern region averages (Figure 12).

Northern pike. Northern pike were not abundant while sampling in 2001. A total of nineteen fish were collected in the spring either by fyke netting (n = 14) and electrofishing (n = 5). A 16.2 in individual captured during panfish netting was the only other northern pike collected while sampling in 2001. Catch per effort of northern pike sampled by fyke netting after ice-out decreased from 1.67 fish/net lift to 0.23 fish/net lift from 1994 to 2001. Catch per effort from 1988 (0.61 fish/net lift) was also higher than that of 2001.

Mean length of northern pike captured while fyke netting and electrofishing in 2001 was 19.7 in (n = 19, SD = 5.23), with a size range from 11.0 – 27.8 in. Size distribution of northern pike was relatively similar in 2001 to northern pike collected while fyke netting and electrofishing during the spring of 1988 (n = 28, $\bar{x}$ = 20.6, SD = 5.24) and to northern pike sampled with fyke nets in 1994 (n = 50, $\bar{x}$ = 19.4, SD = 2.4), where size ranges were 12.1 – 30.7 in for 1988 and 14.0 – 27.0 in for 1994 (Figure 13). PSD values for the three survey years were 53, 23, and 64 for 2001, 1994, and 1988, respectively. No northern pike longer than 30 in were sampled in any of these years.

Growth of northern pike sampled from 2001 appears to be similar to northern region averages (Figure 14). At age V or age VI, there may be a shift starting towards higher than average growth rates, but with only one northern pike aged at seven years of age or older, it cannot be determined from 2001 data whether this trend continued. However, past surveys of Bond Lake have reported northern pike growth rates to be excellent and higher than average for Bond Lake (Kampa 1991), although because scales were used for aging, age interpretation for all years may be suspect.

Panfish. A total of twelve fyke net lifts targeting adult panfish on June 12 – 13, 2001 resulted in capturing a total of 500 fish and eight different species. Four hundred and fifty-eight (91.6%) of these were bluegill (Table 2). Catch per effort of bluegill at 38.2 fish/net lift indicates that relative abundance of adult bluegill is low in Bond Lake. Bluegill sampled ranged in length from 2.4 to 10.0 in in length (Figure 15). Size structure of bluegill was very good ($\bar{x}$ = 7.2 in; SD = 1.53) with a PSD of 85 and RSD-8 of 38. Growth rates for adult bluegill were excellent (Figure 16) and similar to growth rates in 1988 (Kampa 1991) when PSD and RSD values were 62 and 5 respectively, and lower than those from 2001.

No yellow perch, and only one black crappie and pumpkinseed sunfish each were collected while panfish netting. However, 106 black crappie were captured while fyke netting (after ice out) and 375 yellow perch were captured either by fyke netting or electrofishing in the spring, suggesting yellow perch are still relatively abundant and black crappie are present to some extent. No length data was recorded for black crappie or yellow perch while fyke netting, but yellow perch collected during spring electrofishing runs (n = 219) had a mean size of 2.9 in (size range = 1.5 – 8.5 in; SD = 1.11). PSD and RSD-8 for yellow perch was 7.7 and 0.0, respectively, and combined CPE was approximately 300 fish/hr.

Sport and tribal fishery. Anglers fished an estimated 3,108 hours (10.6 hrs/acre) during open-water and ice-fishing seasons of 2001 – 2002. Bond Lake angling pressure was much lower than the average of 23 hrs/acre for Bayfield and Douglas County walleye lakes (WDNR unpublished data, Brule field office). Open water anglers accounted for 67.7% of the fishing effort. Direct fishing effort targeting a specific fish species was highest for walleye, accounting for 51.3% of the total effort during the open water season (Table 4), and 64.5% of all effort when including the ice-fishing season (Table 5). During the ice-fishing season, 92.1% of fishing effort was directed toward walleye (Table 6). The most sought after panfish species was bluegill, with 18.9% of anglers targeting bluegill during open water, and 15.3% of total fishing effort directed towards bluegill with ice fishing included. Fishing for bluegill accounted for 7.9% of all directed effort during the ice-fishing season. No previous creel surveys have been conducted on Bond Lake.

Walleye were the most heavily exploited gamefish by sportsman in Bond Lake. An estimated 272 walleye were caught by anglers in 2001 – 2002 of which 175 (64.3%) were harvested. This amount of harvest represents an exploitation rate of approximately 26% of the adult population (≥ 15.0 in and all sexable fish), based on the 2001 population estimate for walleye. The open water season contributed 92.6% to the total number of walleyes caught, and accounted for 96.0% of all walleyes harvested. Mean length of walleyes measured during the creel survey was 17.6 in (n = 42, SD = 1.56, range = 13.8 –

21.8 in) and was very similar to the average size of walleye captured while fyke netting, which was 18.0 in. There was no tribal harvest of walleye in 2001, even though Bond Lake has been declared for tribal harvest nearly annually. Bond Lake has actually been speared only twice since tribal declarations for harvest began in 1988: in 1995 and 1996, with sixty-seven and fifty-one walleye harvested respectively by spearing in those years.

Largemouth bass were the most frequently caught gamefish in Bond Lake in 2001 – 2002, with an estimated 467 caught during the open water season (none were reported caught while ice-fishing). Estimated harvest of largemouth bass was just twelve, which is less than 2% of the estimated population (fish ≥8.0 in). This is an exploitation rate of only about 8.5% of the population estimate of largemouth bass in Bond Lake that are over the legal size limit of 14.0 in, which was about 142 ± 31 (0.5 fish/acre). The average length of largemouth bass measured was 16.1 in (n = 2, SD = 0.57). Seventy-eight smallmouth bass and seven northern pike were also caught in 2001 – 2002; however, no harvest for either of these species was reported during the creel survey. One 25.5 in northern pike was measured during the creel survey.

Anglers pursuing panfish specifically fished an estimated 572 hours in 2001 - 2002, and accounted for 16.5% of all directed fishing effort. Bluegill were the most frequently caught (n = 1,590) and most heavily exploited panfish species in Bond Lake, with an estimated harvest of 653. The average length of bluegill harvested was 7.4 in (n = 85, SD = 1.12), and ranged in length from 4.1 - 10.0 in. Although an estimated 88 hours was spent fishing specifically for bluegill during the ice-fishing season, none were reported caught or harvested. Black crappie were the only other panfish species harvested. An estimated 50 black crappie were harvested, with 62 caught in all. Black crappie ranged in size from 7.7 - 11.7 in, with a mean length of 10.0 in (n = 10, SD = 1.15). Ten yellow perch were caught by anglers in 2001 – 2002.

Discussion

Bond Lake supports a healthy fish community and a desirable sport fishery as determined from the fishery survey in 2001-2002. Several fish species previously documented were not sampled, and several other species were sampled for the first time. Much of this presence/absence is likely due to low species abundance and/or timing and type of sampling gear used. Most notable of those species absent from sampling in 2001-2002 was cisco.

Management of a sport fishery aimed at maintaining self-sustaining stocks has been largely successful, with natural reproduction supporting game and panfish species without the need for stocking. Growth rates and size structure of gamefish range from average to very good, and compare favorably with either northern region averages or lakes in Bayfield and Douglas Counties. Overall, a good balance exists between predator and prey in Bond Lake.

Walleye continue to be more abundant in Bond Lake after the discontinuation of stocking in 1968. For an oligotrophic lake such as Bond Lake, an adult walleye abundance of 2.3 fish/acre can be considered good, despite being below statewide management objectives for walleye lakes (3.0 fish/acre), and being below the Bayfield and Douglas County average (3.7 fish/acre).

Results from the 2001–2002 fishery survey suggests that increased walleye size structure over time may reflect decreased harvest as a result of a change from no minimum length limit (1974 – 1989) to a fifteen in minimum length limit in 1990, as well as reduced bag limits of two or three walleye/day for years since 1988 when tribal spearing declarations were in effect. The reduced bag limit may also be a contributing factor to any potential increase in the walleye population since 1988. Changes in size structure and population density may also reflect other factors such as: natural variations in recruitment, unknown changes in angling pressure, and changes in habitat and/or fish community interactions. In conclusion, natural reproduction and recruitment is providing a sustainable walleye fishery without need of supplementing it through stocking efforts, and supports a fairly high angler exploitation rate of approximately 26% for adult walleye in Bond Lake. Without additional tribal harvest on walleyes, this exploitation rate falls within safe guidelines for harvest levels.

A significant increase in the largemouth bass population in Bond Lake, while maintaining good size structure with large fish present has provided a very good largemouth bass fishery. Changes to the minimum length limit in the northern zone for bass in Wisconsin to 12.0 in in 1989, and to 14.0 in in 1998, may have contributed to an increase in population abundance as well as helping to maintain quality size structure as densities increased. Other factors such as the practice of voluntary catch-and-release may have also contributed to higher densities and good size structure. Although smallmouth bass are not nearly as abundant as largemouth bass, they contribute to a high quality bass fishery with high growth rates and a very good size distribution, with larger fish present.

Northern pike have been, and continue to occur at low densities in Bond Lake. Reasons for low abundance could be due to a very limited amount of adequate spawning habitat within the main basin of Bond Lake; northern pike typically require marshy backwater areas to spawn. During years or time periods when lake water levels are higher than normal, there is potential for a northern pike spawning area in a marsh area between Bond and Leader Lake (Weiher 1969). Low water levels in recent years could therefore be another contributing factor to the present low northern pike densities. While the few fish present have good growth and an adequate size structure, there seems to be no obvious benefit (in numbers or size structure) from the 32 in minimum length limit in providing a trophy northern pike fishery. Nevertheless, the regulation should continue to provide protection for those northern pike present and offer anglers additional diversity in their angling experience. In addition, there has not been any public pressure for change regarding the current regulation.

Panfish species, with the exception of yellow perch, appear to be low-density populations with very good to excellent growth rates and size structure in Bond Lake. Lakes with low-density populations of panfish, such as Bond Lake, can be susceptible to overharvest, especially bluegill greater than seven inches; and especially while bluegill are concentrated on spawning beds. Low black crappie densities remain somewhat a cause for concern in Bond Lake, although there may have been some improvement in the population since 1988 when they were reported to be nearly nonexistent (Kampa 1991).

When considering the amount of recreational use and high degree of development surrounding Bond Lake, possibly the most important aspect to the future management of the lake concerns water quality and protecting sensitive aquatic and shoreline habitats, with the need for shoreline protection and restoration. Monitoring for the establishment of exotic species and developing control programs to stop their spread and occurrence is also very important. It is important that landowners develop vegetative, shoreline buffer zones. Buffer zones help reduce and interrupt nutrient runoff from associated yards and groundwater that would otherwise enter the lake, thus improving water quality. Buffer zones allowing the growth of trees, shrubs, and grasses also help to prevent erosion from wave and ice action that can occur, which is responsible for the destruction of important spawning and rearing habitat for fish species. Rip-rapping of shoreline areas is also discouraged because of its similar nature to be detrimental to habitat important for spawning and nursery areas of fish species, through the wave action it usually generates along shorelines. Buffer zones also enhance the appearance of the lakeshore by giving it a more natural profile as well as providing added fish and macroinvertebrate habitat in nearshore areas. Home owners should also avoid activities such as excessive fertilization of lawns, clearing shoreline areas of aquatic plants to make “swim-beaches”, dumping raked leaves or lawn clippings into the lake, high speed boating in shallow lake areas, and other similar activities.

Management Recommendations

1. Continue managing Bond Lake primarily as a walleye, largemouth bass, and panfish community, while working with local residents and the lake association to improve water quality, near-shore habitat, and buffer zones. Preventing the spread of exotic species, as well as shoreline protection and restoration activities such as those mentioned above will help to protect Bond Lake’s water quality and maintain its high quality sport fishery, and safeguard this valuable resource.
2. Walleye abundance is good for an oligotrophic lake such as Bond, and is higher than in previous years when stocked. Size structure has increased since 1988 and natural reproduction is currently providing a sustainable walleye fishery. Retain the current regulation strategy for walleye, with bag limits dependent on tribal harvest, and continuing under the current 15 in minimum length limit.
3. Continue to leave Bond Lake under the current statewide length and bag limits for largemouth and smallmouth bass of 5 fish in total per day, with a minimum length of 14 in. If increased harvest rates or higher exploitation of bass species are documented in future surveys, consideration of reduced bag limits or other special regulations can be made at that time to protect or maintain an excellent bass fishery.

4. Maintain present management of northern pike in Bond Lake as a "trophy" fishery, leaving the bag limit regulation at 1 per day, with a minimum length limit of 32 in until further evaluation of the effects of this special regulation can be appropriately assessed.
5. Because of relatively low densities for panfish species in Bond Lake, consider changing the panfish bag limit to 10 fish in total per day, or potentially to 25 in total per day, of which only 10 can be black crappie. However, if the current statewide bag limits for panfish species of 25 in total per day is kept in place, anglers should consider voluntarily limiting their harvest of panfish to ten in total, in an effort to maintain the quality of the bluegill fishery and improve the black crappie fishery.
6. Future comprehensive assessment of the fishery should coincide with the regular treaty assessment rotation. Another creel survey to determine any changes in angling pressure, catch, and harvest rates should be conducted also at that time. If Bond Lake is not on the treaty rotation by approximately 2013, it is recommended that it should be moved up for evaluation as time permits. In addition to performing population estimates for walleye and bass species, special attention should be paid to the status of northern pike, and more attention to panfish species also, especially black crappie, considering their low density levels. Sampling for cisco with appropriate timing and gear types could also be considered in that year. Also, fall electrofishing surveys monitoring YOY walleye year-class strength should be continued every other year, or at least every third year starting in 2006.

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I would like to thank Scott Toshner and Cris Sand for their help and guidance by providing valuable comments, suggestions, and advice or assistance in either analyzing data and/or preparation of the manuscript, and also Terry Margenau for providing critical review of the manuscript. The WDNR treaty assessment unit provided field collection of data and data entry; creel survey data collection, data entry, and completion of the creel survey report; and age interpretation of scales.

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Table 1. Stocking history of Bond Lake, Douglas County, Wisconsin.

Year	Species	Number Stocked	Size
1933	Black Bass	1,050	-
	Walleye	147,668	-
1934	Walleye	150,588	-
1936	Bass	1,500	-
1937	Crappie	650	Adult
1938	Sunfish	7,800	Fingerlings
	Largemouth Bass	4,464	Fingerlings
1939	Largemouth Bass	500	Fingerlings
1940	Largemouth Bass	4,000	Fry
1941	Sunfish	1,000	Adult
1942	Largemouth Bass	2,500	Fingerlings
1943	Largemouth Bass	2,000	Fingerlings
1944	Largemouth Bass	870	Fingerlings
1945	Largemouth Bass	1,340	Fingerlings
1946	Northern Pike	24,000	Fry
	Largemouth Bass	250	-
	Largemouth Bass	790	Fingerlings
1947	Northern Pike	50,000	Fry
	Largemouth Bass	1,500	Fingerlings
1949	Northern Pike	50,000	Fry
	Largemouth Bass	2,240	Fingerlings
	Largemouth Bass	500	Fingerlings
1952	Northern Pike	53,200	Fry
1954	Northern Pike	53,200	Fry
1959	Walleye	15,600	Fingerling
	Walleye	15,600	Fingerling
1962	Walleye	7,650	2-Inch Fingerling
	Walleye	7,650	3-Inch Fingerling
1965	Walleye	4,060	3-Inch Fingerling
	Walleye	10,940	2-Inch Fingerling
1968	Walleye	2,000	3-Inch Fingerling

Table 2. Species composition of the fish community in Bond Lake, Douglas County, Wisconsin.

Common Name	Scientific Name	Fyke Netting	Spring Shocking	Panfish Netting	Mini-fyke Netting	Fall Shocking	**Total Sampled**
Gamefish							
Walleye	*Sander vitreus*	183	575	4	1	33	796
Largemouth Bass	*Micropterus salmoides*	29	371	12	166	-	578
Smallmouth Bass	*Micropterus dolomieui*	2	38	0	23	-	63
Northern Pike	*Esox lucious*	14	5	1	0	-	20
Panfish							
Yellow Perch	*Perca flavescens*	156	219	0	7	-	382
Bluegill	*Lepomis macrochirus*	1,267	86	458	157	-	1,968
Pumpkinseed	*Lepomis gibbosus*	0	0	1	0	-	1
Black Crappie	*Pomoxis nigromaculatus*	106	0	1	0	-	107
Non-game fish							
White Sucker	*Catostomus commersoni*	202	8	0	1	-	211
Yellow Bullhead	*Ictalurus natalis*	4	0	20	1	-	25
Brown Bullhead	*Ictalurus nebulosus*	0	0	4	0	-	4
Tadpole Madtom	*Noturus gyrinus*	0	1	0	6	-	7
Common Shiner	*Notropis cornutus*	22	1	0	0	-	23
Golden Shiner	*Notemigonus crysoleucas*	0	1	0	1	-	2
Spottail Shiner	*Notropis hudsonius*	0	78	0	7	-	85
Blacknose Shiner	*Notropis heterolepis*	0	0	0	153	-	153
Mimic Shiner	*Notropis volucellus*	0	0	0	7	-	7
Bluntnose Minnow	*Pimephales notatus*	0	43	0	9	-	52
Banded Killifish	*Fundulus diaphanus*	0	0	0	25	-	25
Johnny Darter	*Etheostoma nigrum*	0	35	0	0	-	35
Iowa Darter	*Etheostoma exile*	0	14	0	0	-	14
Total sampled:	21 Species	1,985	1,475	501	564	33	**4,558**

Table 3. Proportional and relative stock density values.

Species	Stock Size (In.)	Quality Size (In.)	Preferred Size (In.)
Bluegill	3	6	8
Largemouth Bass	8	12	15
Northern Pike	14	21	28
Smallmouth Bass	7	11	14
Walleye	10	15	20
Yellow Perch	5	8	10

Table 4. Open water season (May 5 - October 31) creel survey synopsis in 2001 for Bond Lake, Douglas County, WI.

Species	Directed Effort Hours	Directed Effort %	Catch	Specific Catch Rate (Fish/Hr)	Harvest	Specific Harvest Rate (Fish/Hr)	Mean Length (In)
Walleye	1207	51.3	252	0.21	168	0.14	17.6
Largemouth Bass	394	16.8	467	0.87	12	0.03	16.1
Smallmouth Bass	257	10.9	78	0.19	0	0	***
Northern Pike	8	0.3	7	0	0	0	***
Bluegill	445	18.9	1590	3.42	653	1.47	7.4
Black Crappie	40	1.7	62	1.34	50	1.25	10
Yellow Perch	0	0	10	***	0	***	***
Total	2,351		Projected Fishing Pressure = 2,020 Hours (Hrs/Acre = 6.9)				

Table 5. Combined open water and ice-fishing season (May 5 - March 1) creel survey synopsis in 2001-2002 for Bond Lake, Douglas County, WI.

Species	Directed Effort Hours	Directed Effort %	Catch	Specific Catch Rate (Fish/Hr)	Harvest	Specific Harvest Rate (Fish/Hr)	Mean Length (In)
Walleye	2240	64.5	272	0.12	175	0.08	17.6
Largemouth Bass	394	11.4	467	0.87	12	0.03	16.1
Smallmouth Bass	257	7.4	78	0.19	0	0	***
Northern Pike	8	0.2	7	0	0	0	25.5
Bluegill	532	15.3	1590	2.85	653	1.23	7.4
Black Crappie	40	1.2	62	1.34	50	1.25	10
Yellow Perch	0	0	10	***	0	***	***
Total	3471		Projected Fishing Pressure = 3,108 Hours (Hrs/Acre = 10.6)				

Table 6. 2001-2002 ice-fishing season (December 1 - March 1) creel survey synopsis for Bond Lake, Douglas County, WI.

Species	Directed Effort Hours	Directed Effort %	Catch	Specific Catch Rate (Fish/Hr)	Harvest	Specific Harvest Rate (Fish/Hr)	Mean Length (In)
Walleye	1033	92.1	20	0.02	7	0.01	17.5
Northern Pike	0	0	1	0	0	0	25.5
Bluegill	88	7.9	0	0	0	0	***
Total	1,121	Projected Fishing Pressure = 1,088 Hours (Hrs/Acre = 3.7)					

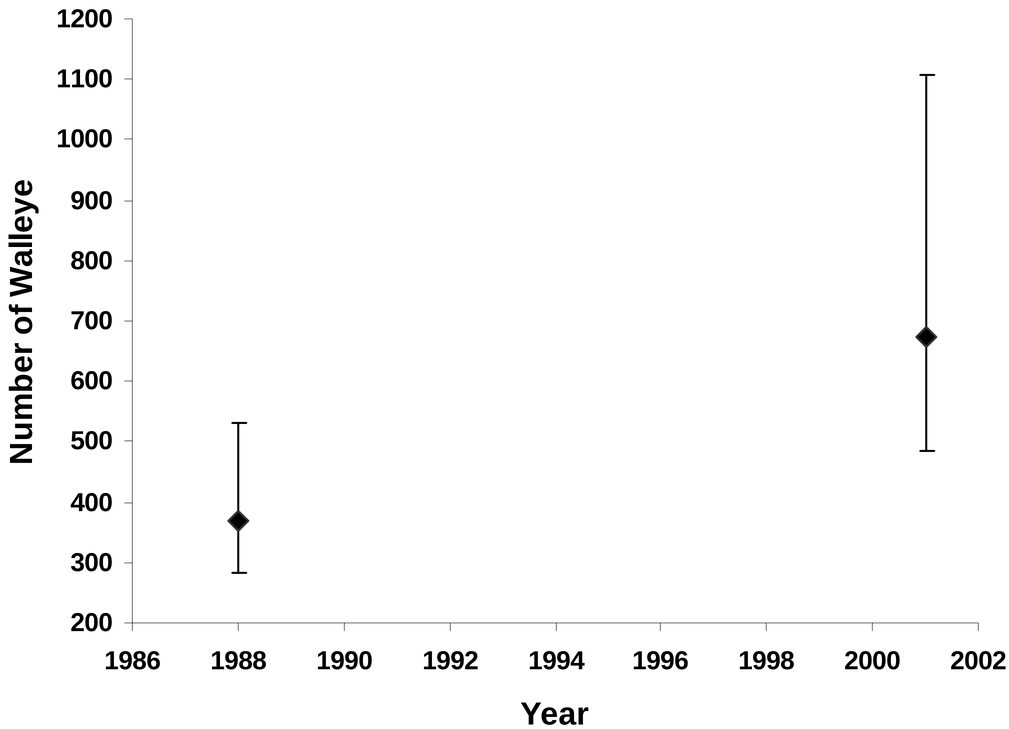

Figure 1. Walleye population estimates for Bond Lake, Douglas County, WI in 1988 and 2001 for fish ≥15 inches and all sexable walleye, with 95% confidence intervals.

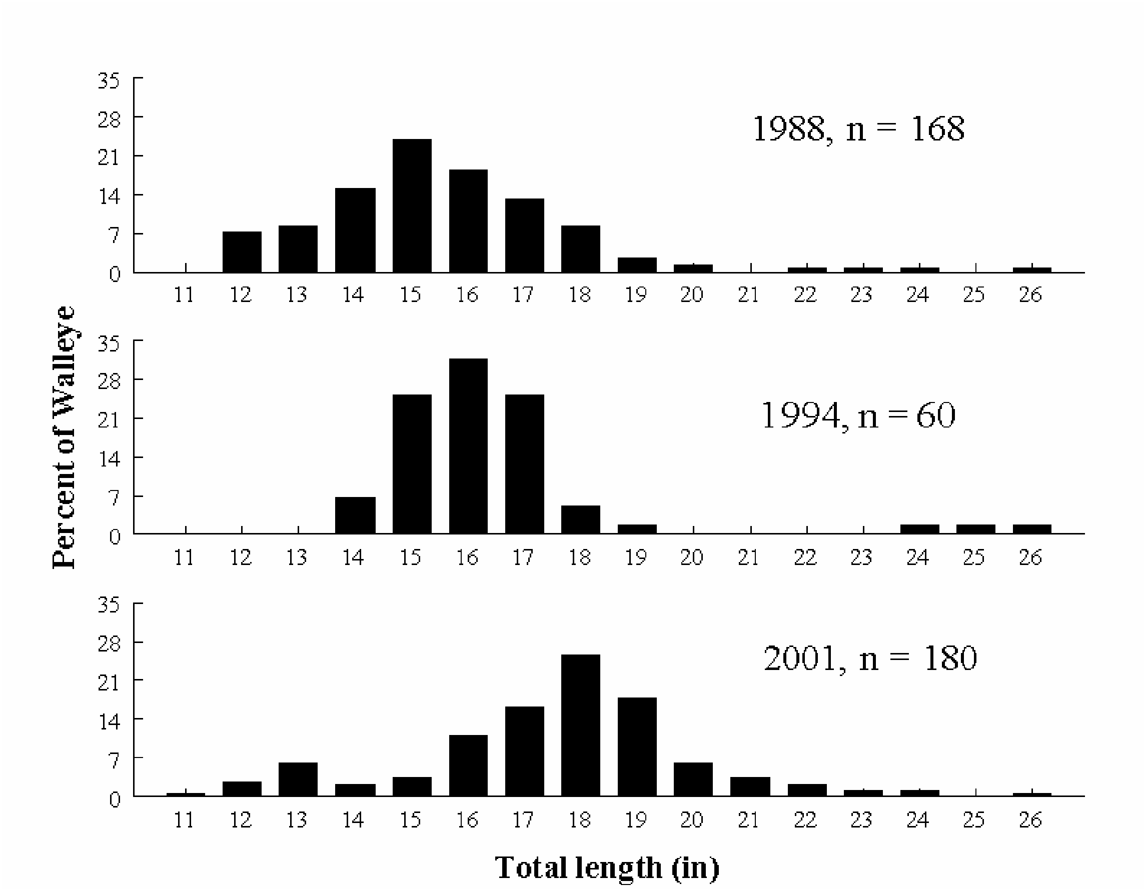

Figure 2. Percentage length frequencies for walleye >10 inches collected by fyke netting during the 1988 population estimate (net lifts = 36) for walleye, the 1994 northern pike pre-regulation survey (net lifts = 30), and for the 2001 walleye population estimate (net lifts = 61) for Bond Lake, Douglas County, WI.

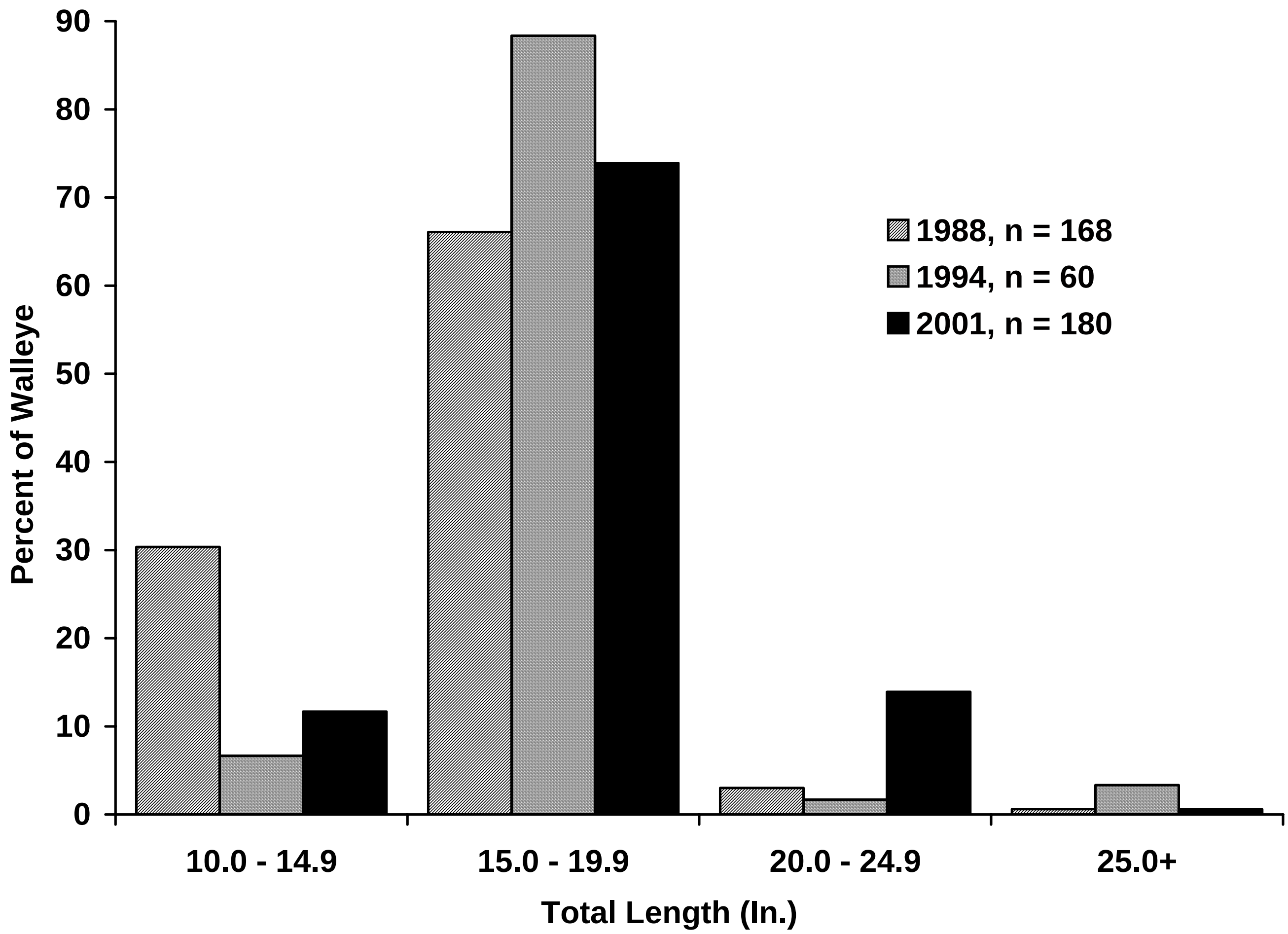

Figure 3. Percentage length frequencies by length interval for walleye >10 inches collected by fyke netting for Bond Lake, Douglas County, WI during the 1988 population estimate (net lifts = 36) for walleye, the 1994 northern pike pre-regulation survey (net lifts = 30), and for the 2001 walleye population estimate (net lifts = 61).

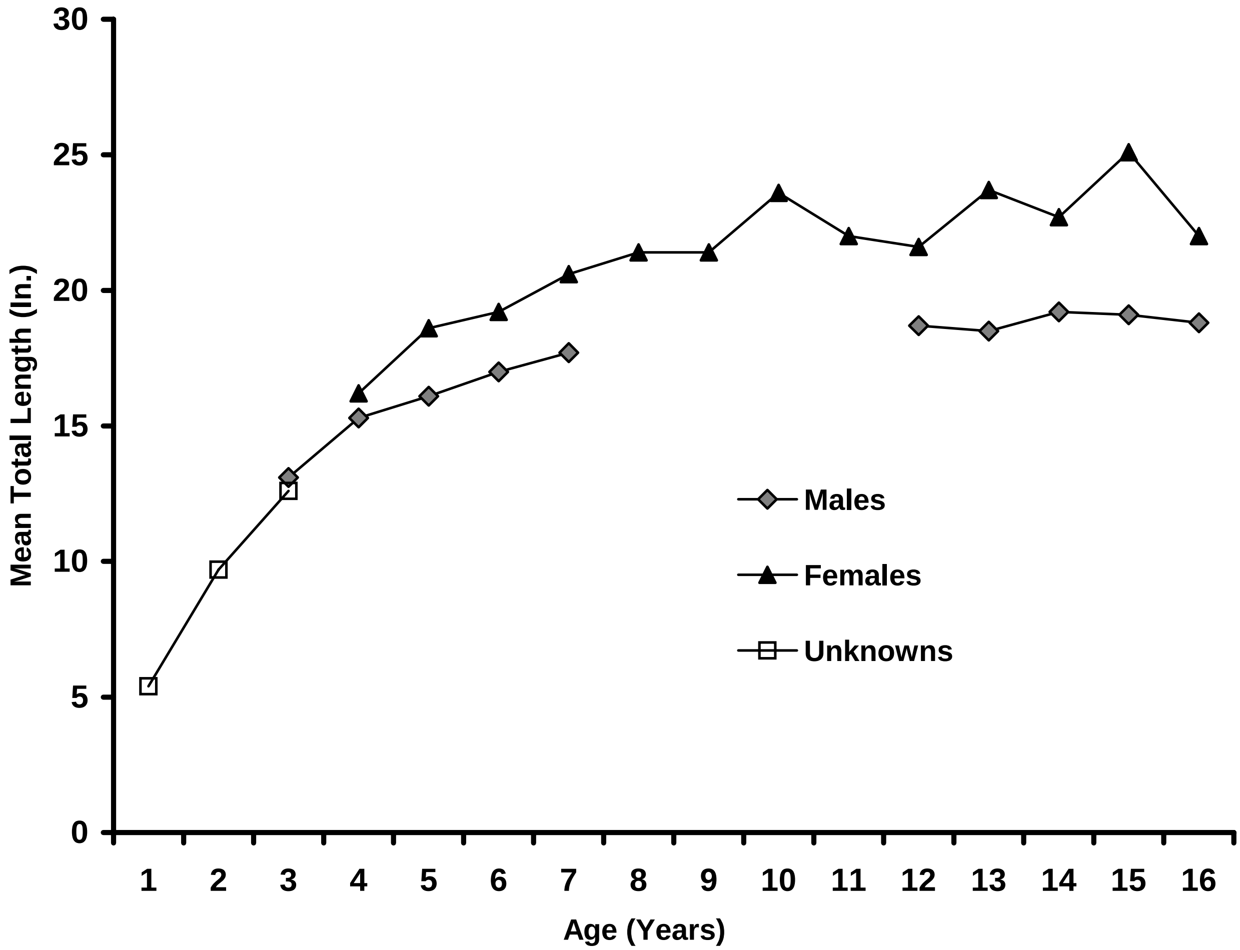

Figure 4. Mean total length at age for males, females, and unknown walleye from Bond Lake, Douglas County, WI in 2001. No male walleyes were aged between 8 and 11 years of age, and only 6 female walleyes in all were aged between 8 and 12 years of age.

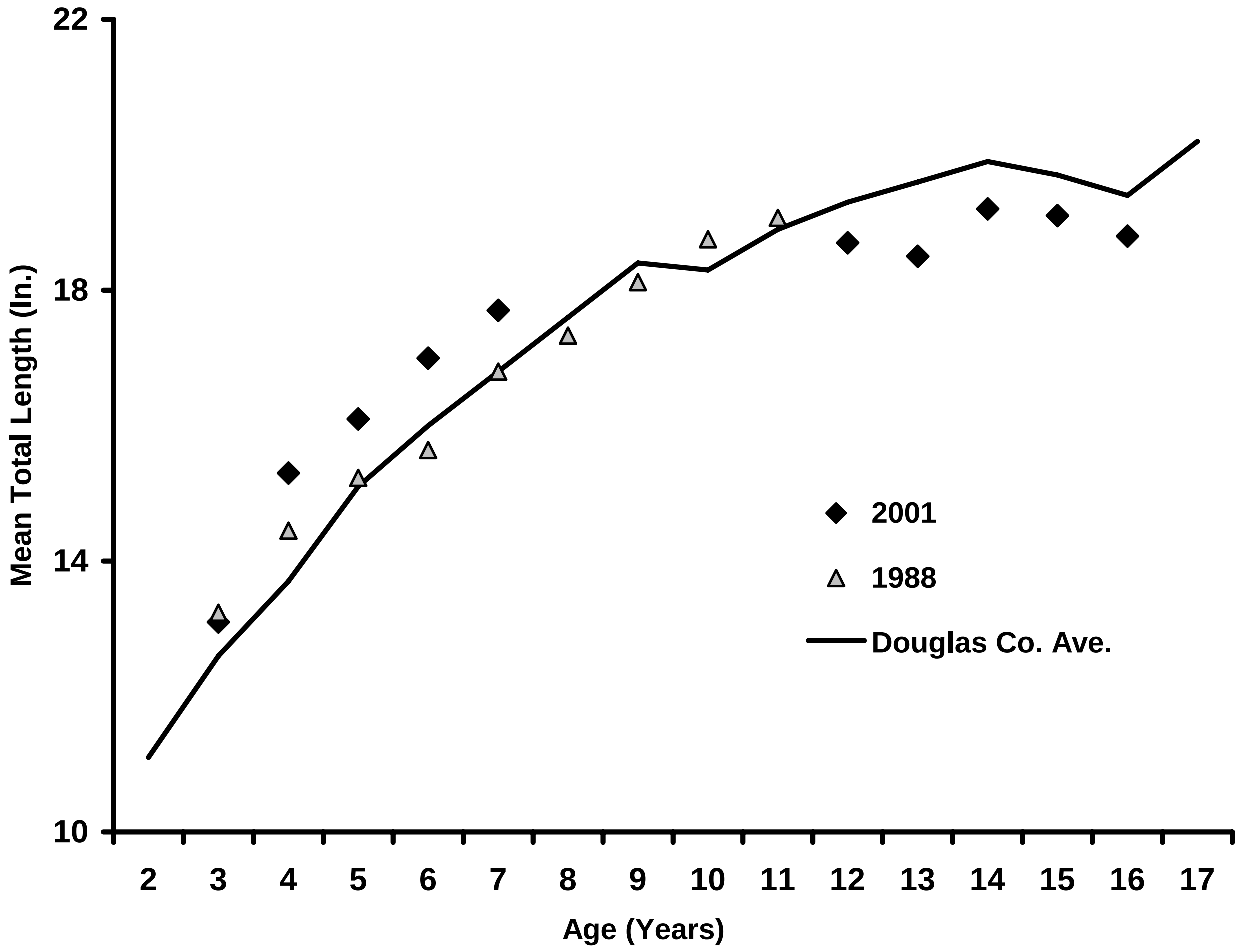

Figure 5. Mean total length at age for male walleye from Bond Lake, Douglas County, WI in 2001, compared to 1988 and also with Douglas County averages for mean length at age for male walleye.

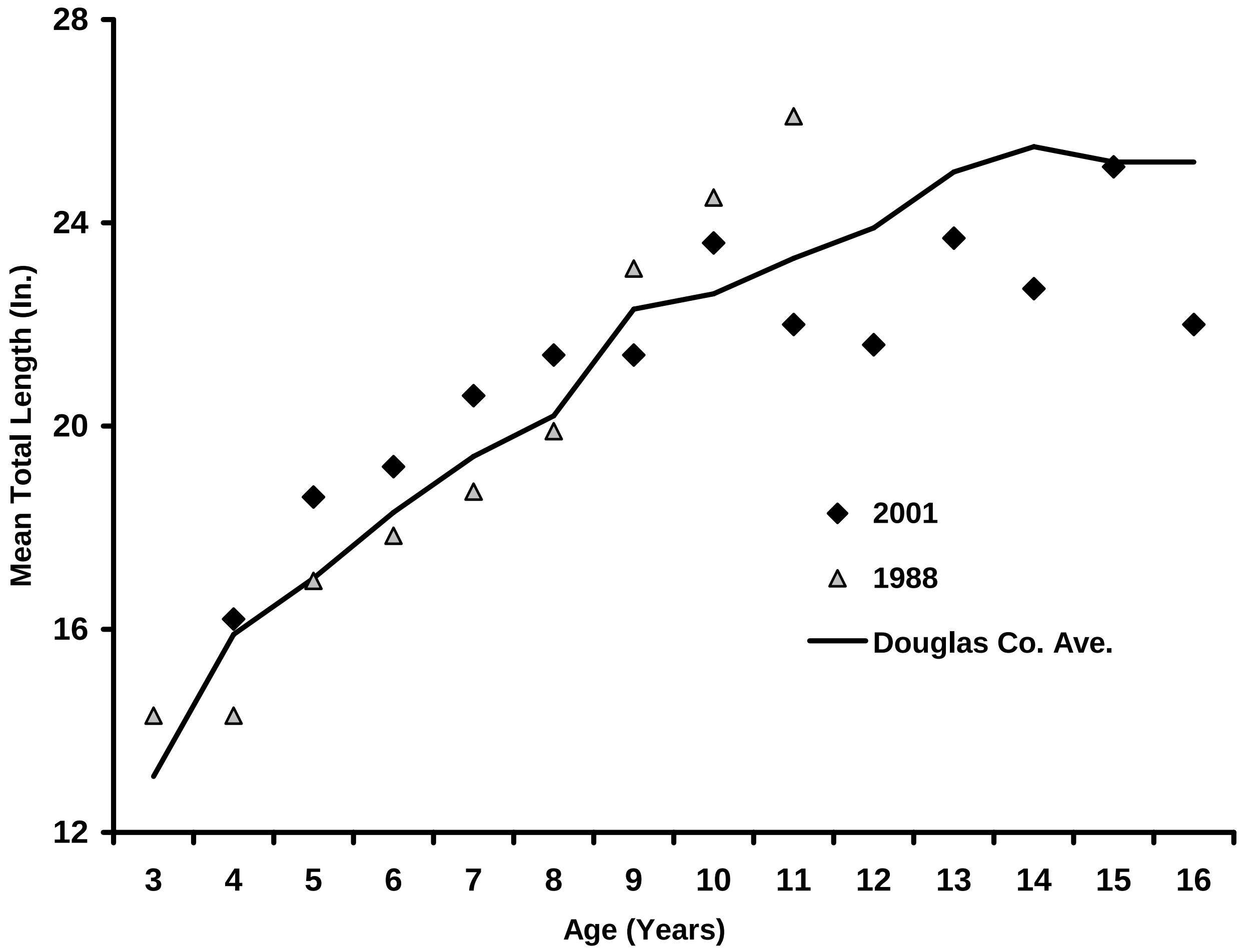

Figure 6**.** Mean total length at age for female walleye from Bond Lake, Douglas County, WI in 2001, compared to 1988 and also with Douglas County averages for mean length at age for female walleye.

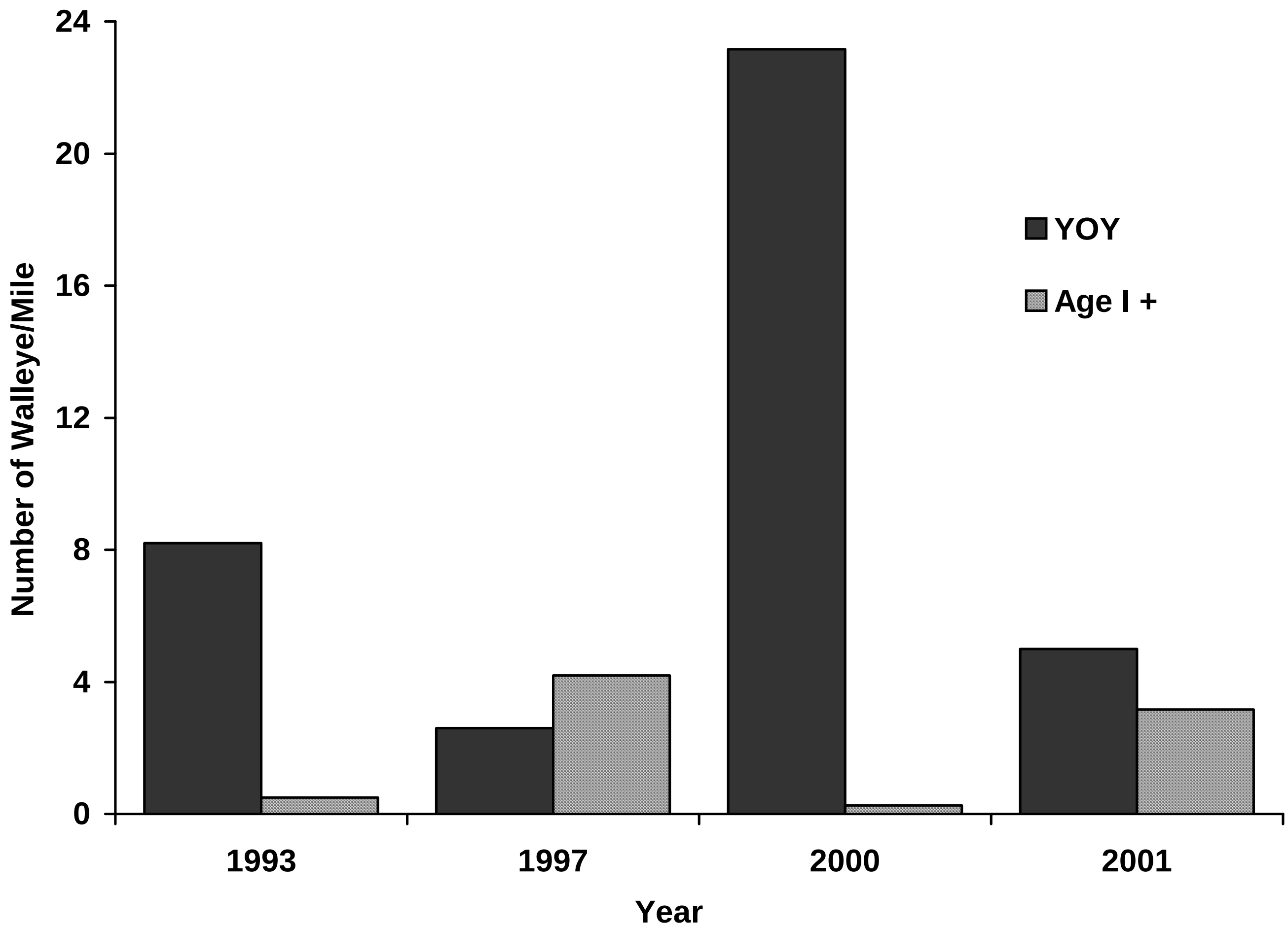

Figure 7. Young-of-the-year walleye and age-I+ relative abundance determined by fall electrofishing in Bond Lake, Douglas County, WI.

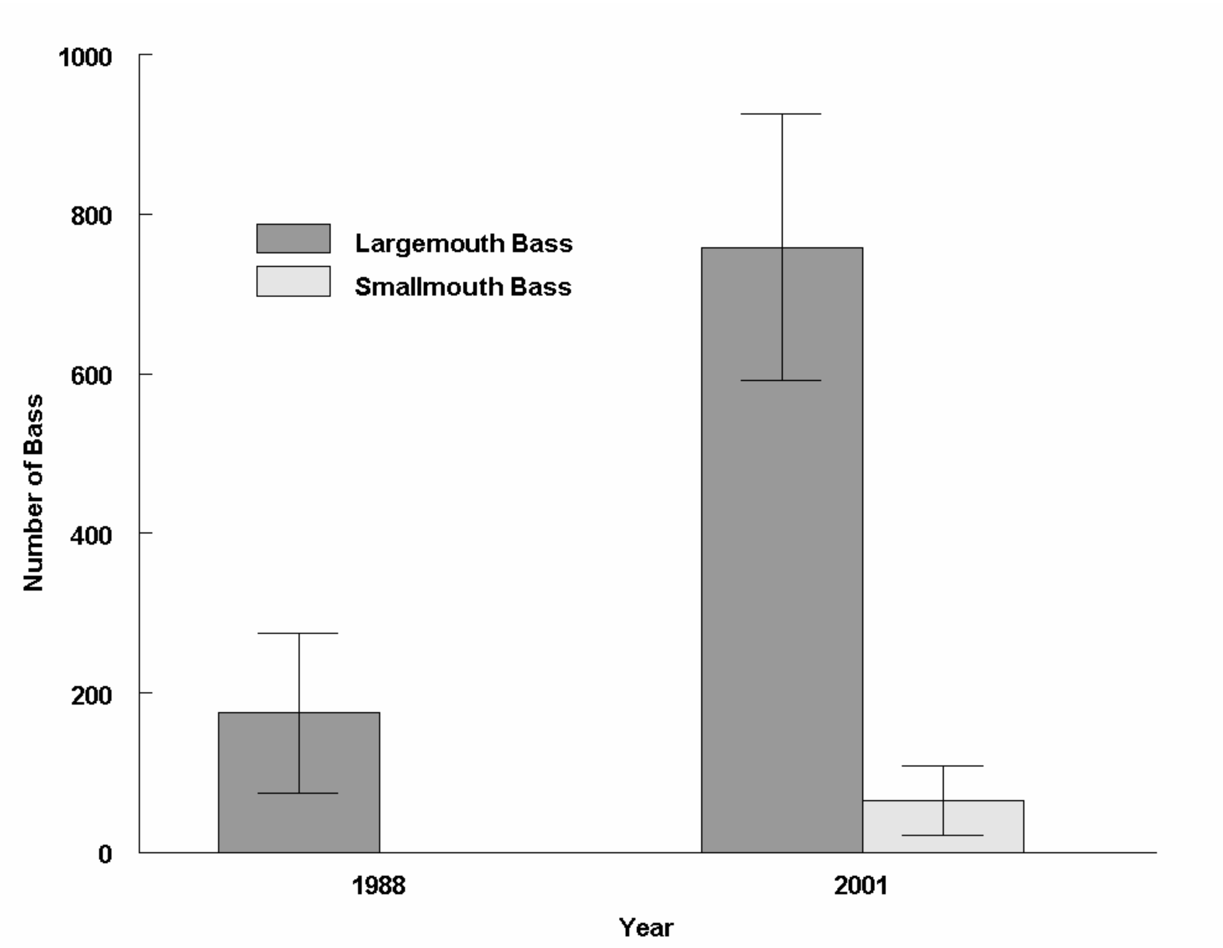

Figure 8. Population estimates of largemouth bass in 1988 and 2001, and for smallmouth bass in 2001 for Bond Lake, Douglas County, WI.

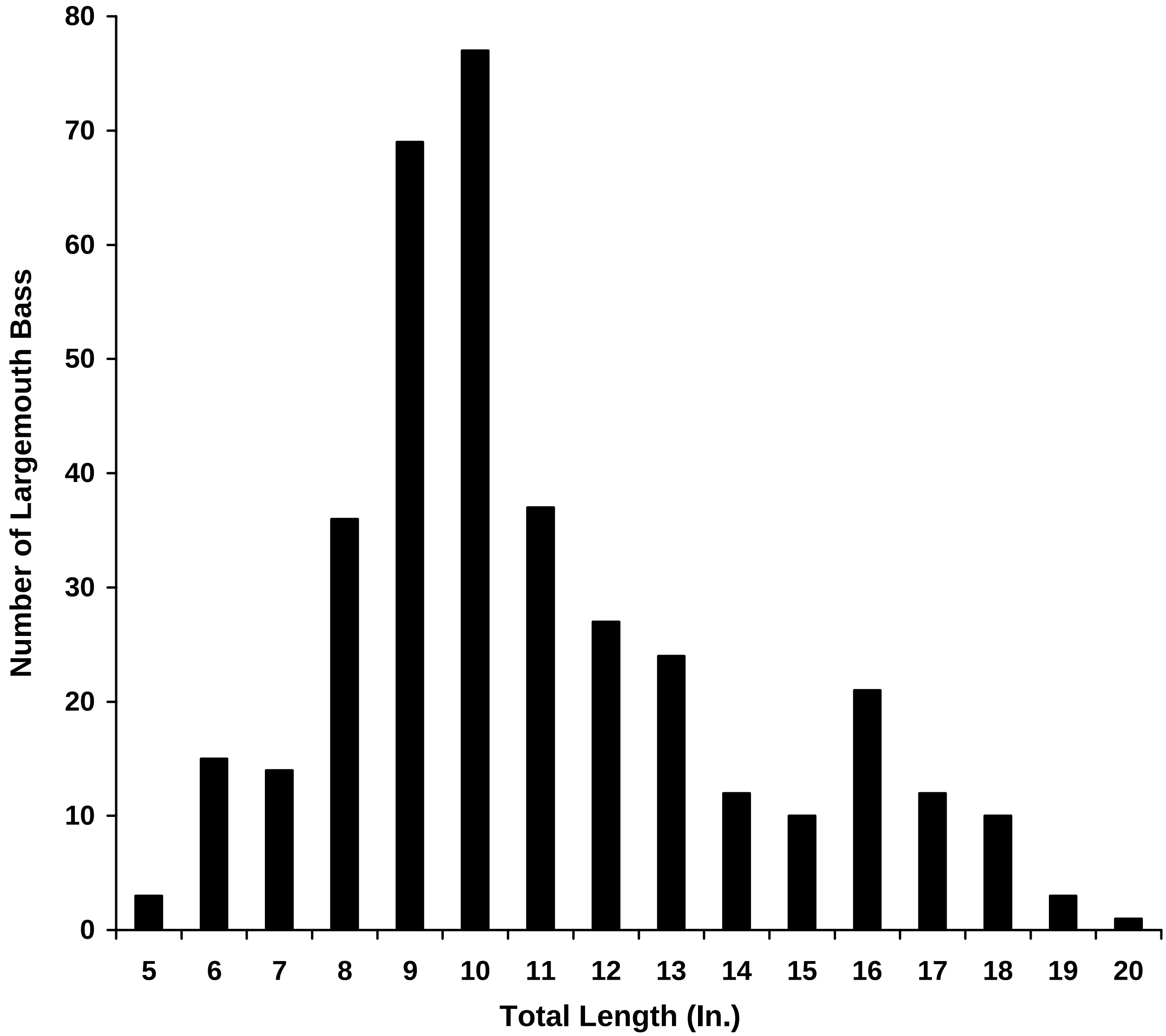

Figure 9. Length distribution per inch group for largemouth bass collected during spring electrofishing runs (n = 371) on May 1st, 10th, 22nd, and 30th, 2001, in Bond Lake, Douglas County, WI.

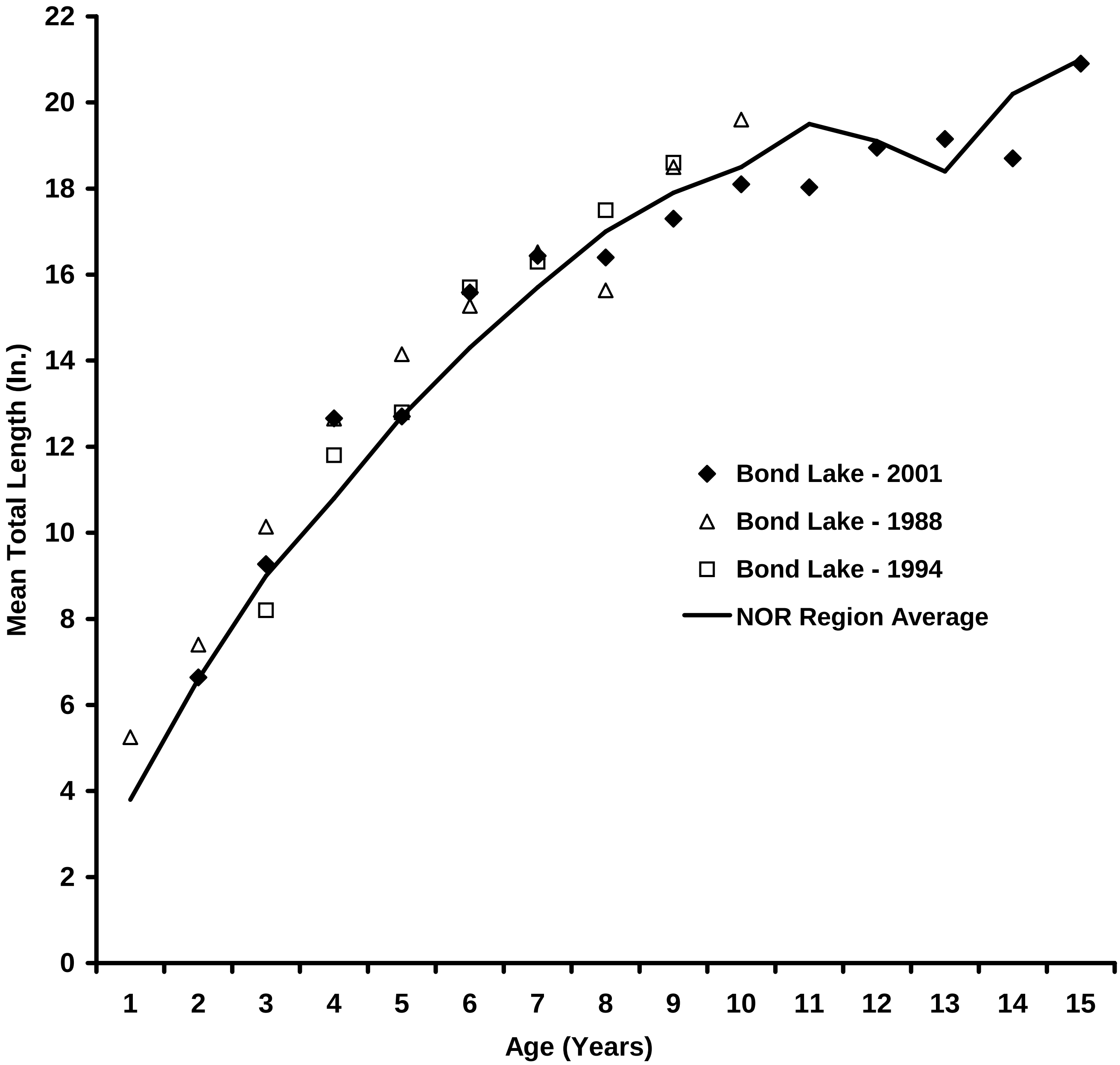

Figure 10. Mean total length at age for largemouth bass from Bond Lake, Douglas County, WI in 2001, compared to 1988 and 1994, and also with northern region averages of mean length at age for largemouth bass.

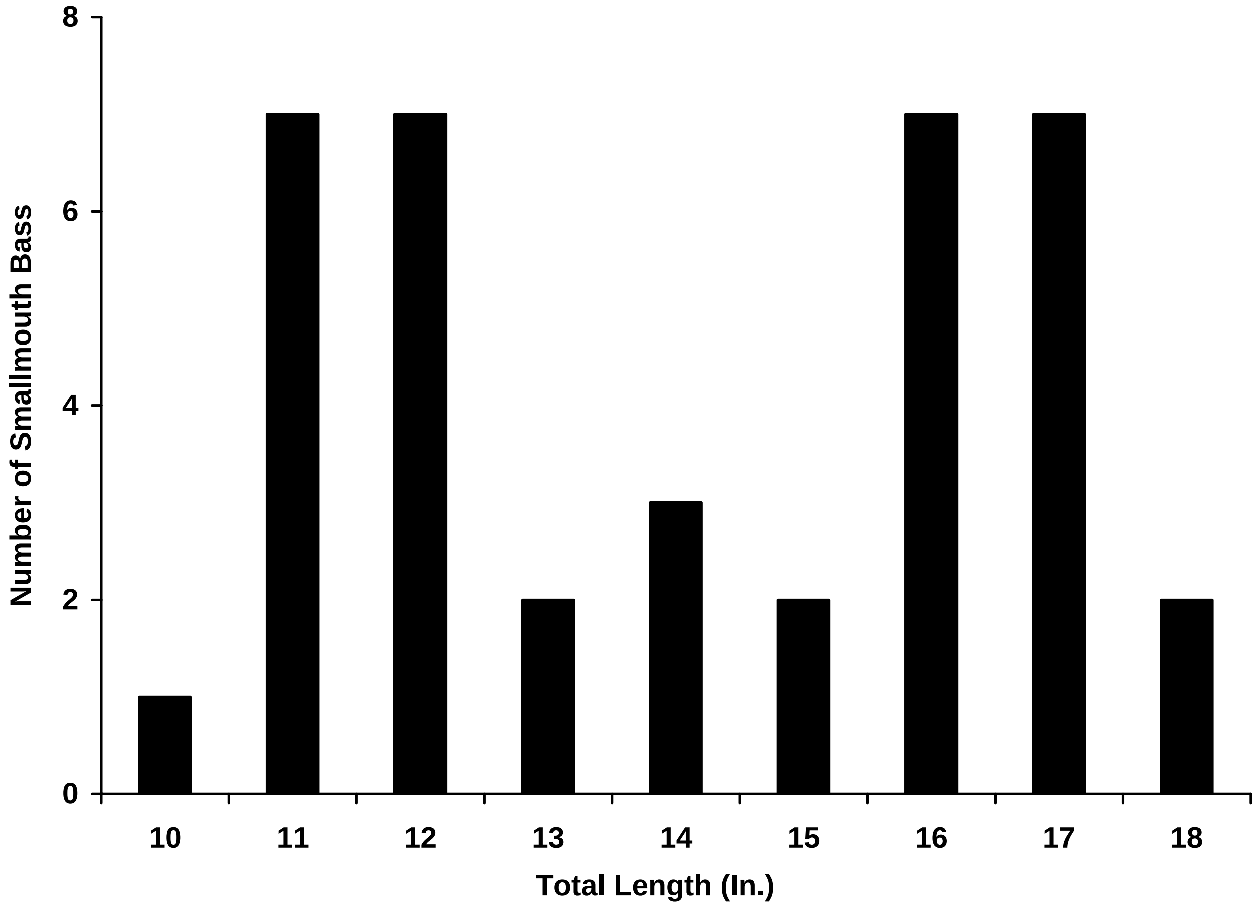

Figure 11. Length distribution per inch group for smallmouth bass collected during spring electrofishing runs (n = 38) on May 1st, 10th, 22nd, and 30th, 2001, in Bond Lake, Douglas County, WI.

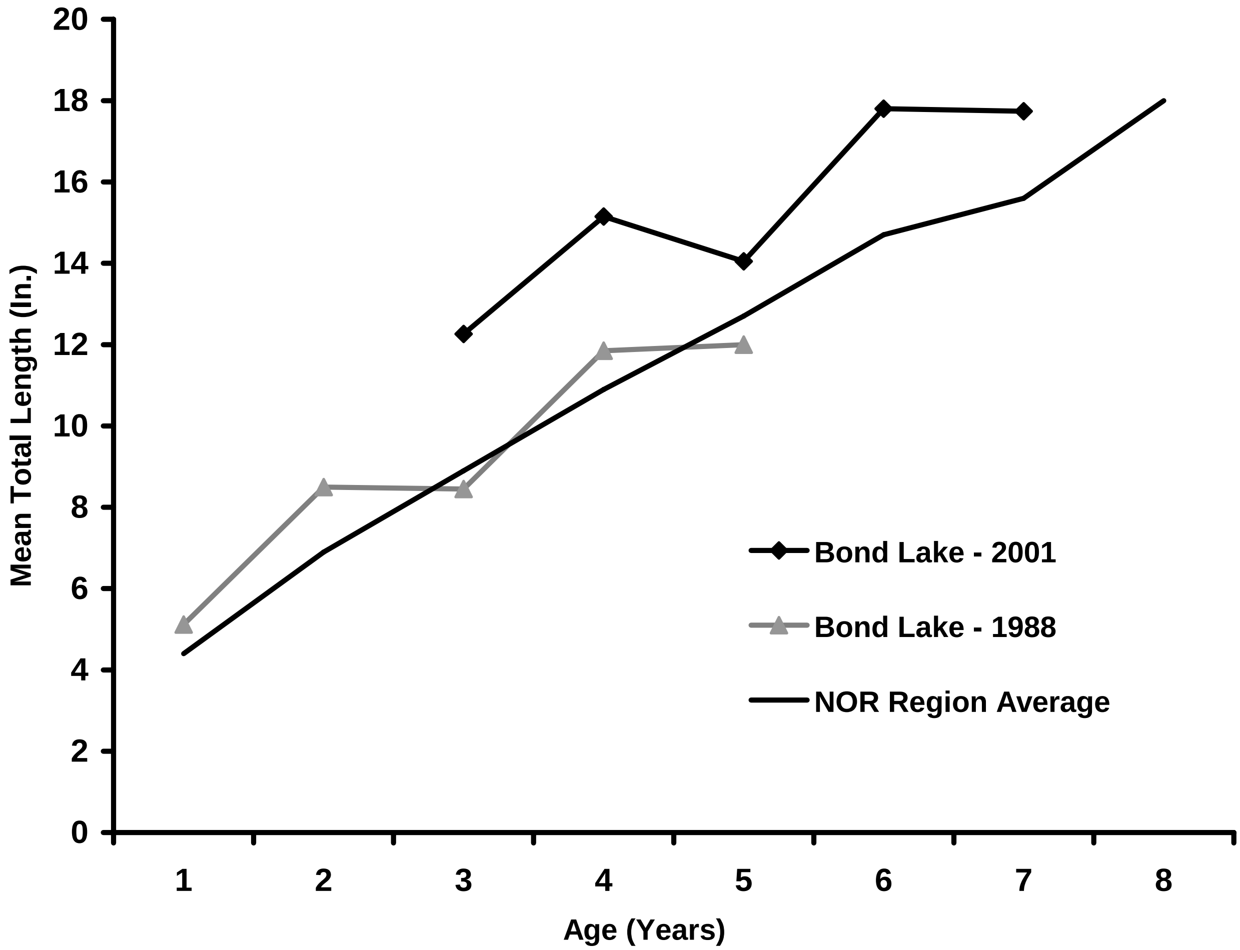

Figure 12. Mean total length at age for smallmouth bass from Bond Lake, Douglas County, WI in 2001, compared to 1988, and also northern region averages of mean length at age for smallmouth bass.

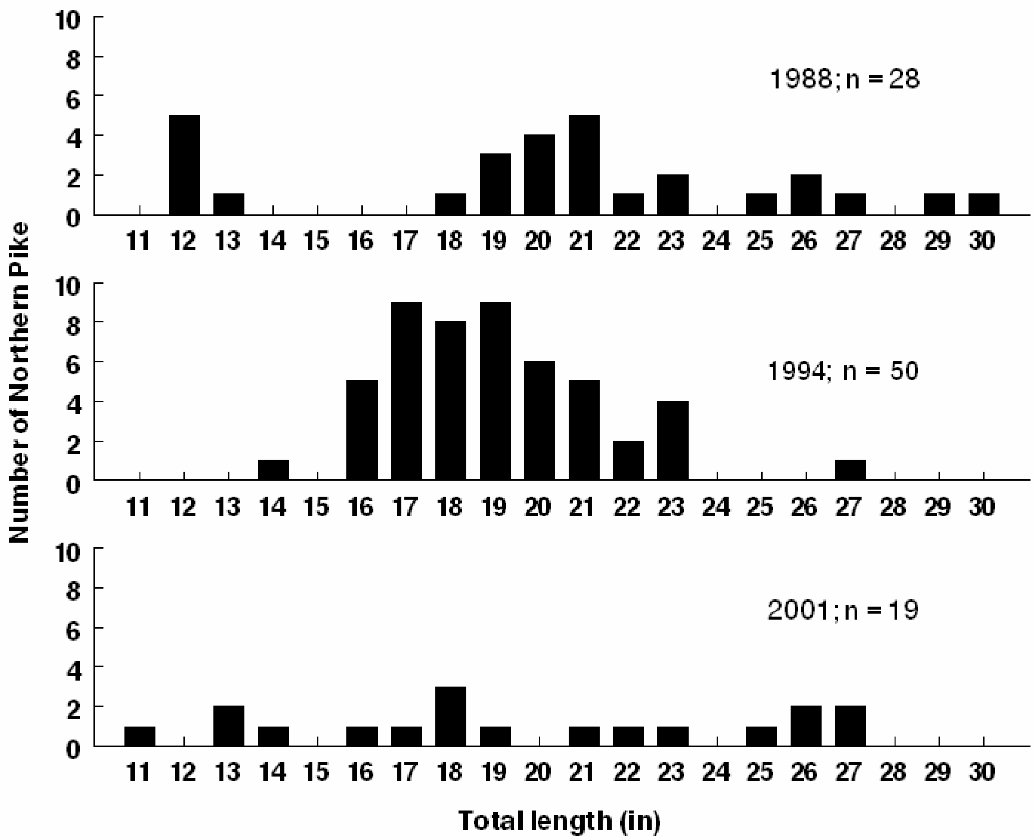

Figure 13. Length frequencies for northern pike collected during 1988 spring walleye and bass population estimates (fyke netting and electrofishing), 1994 northern pike pre-regulation survey (fyke netting), and during 2001 spring walleye and bass population estimates (fyke netting and electrofishing) for Bond Lake, Douglas County, WI.

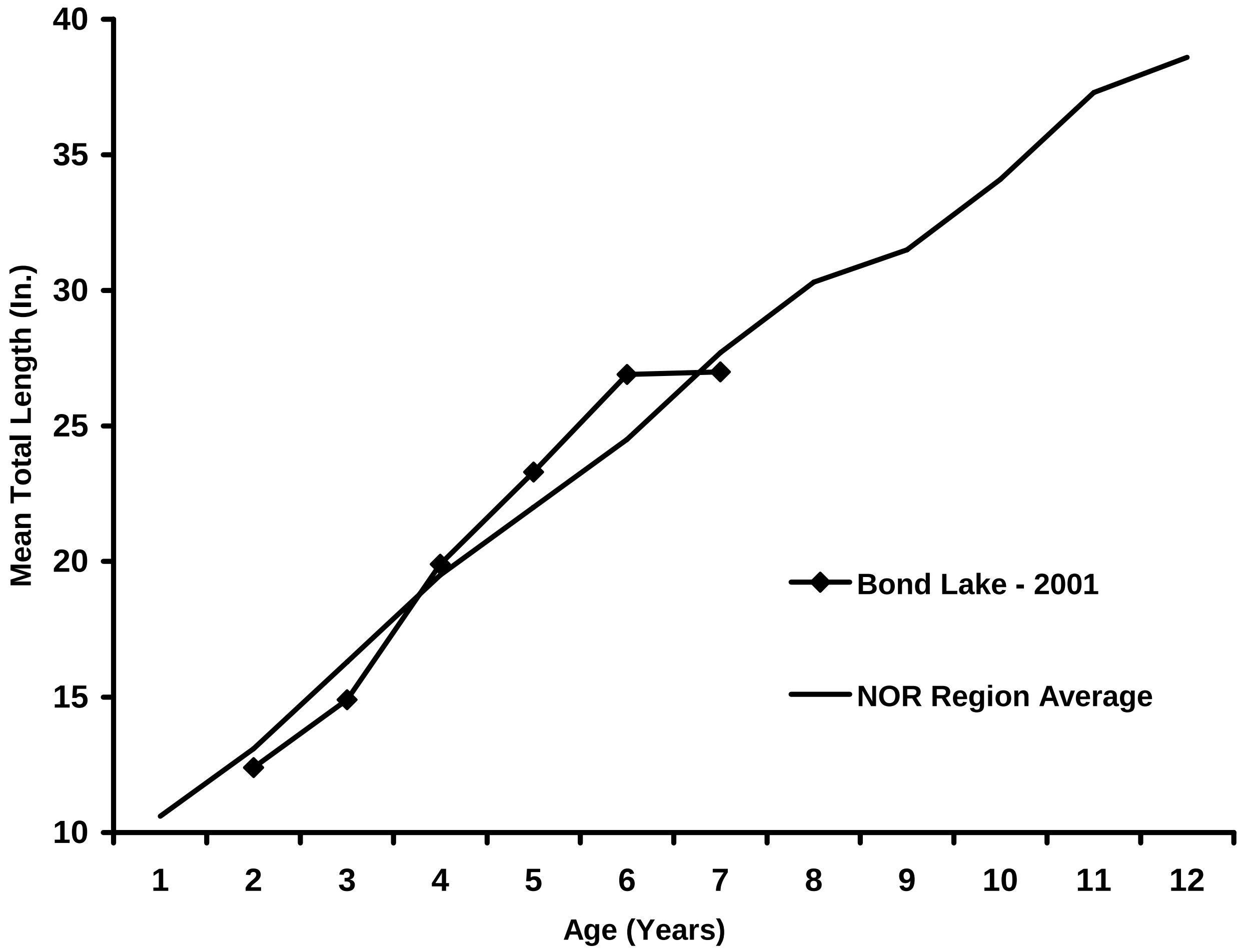

Figure 14. Mean total length at age for northern pike (sexes combined) from Bond Lake, Douglas County, WI in 2001, compared to northern region averages of mean length at age for northern pike. Only one northern pike was collected that was aged at 7 years of age.

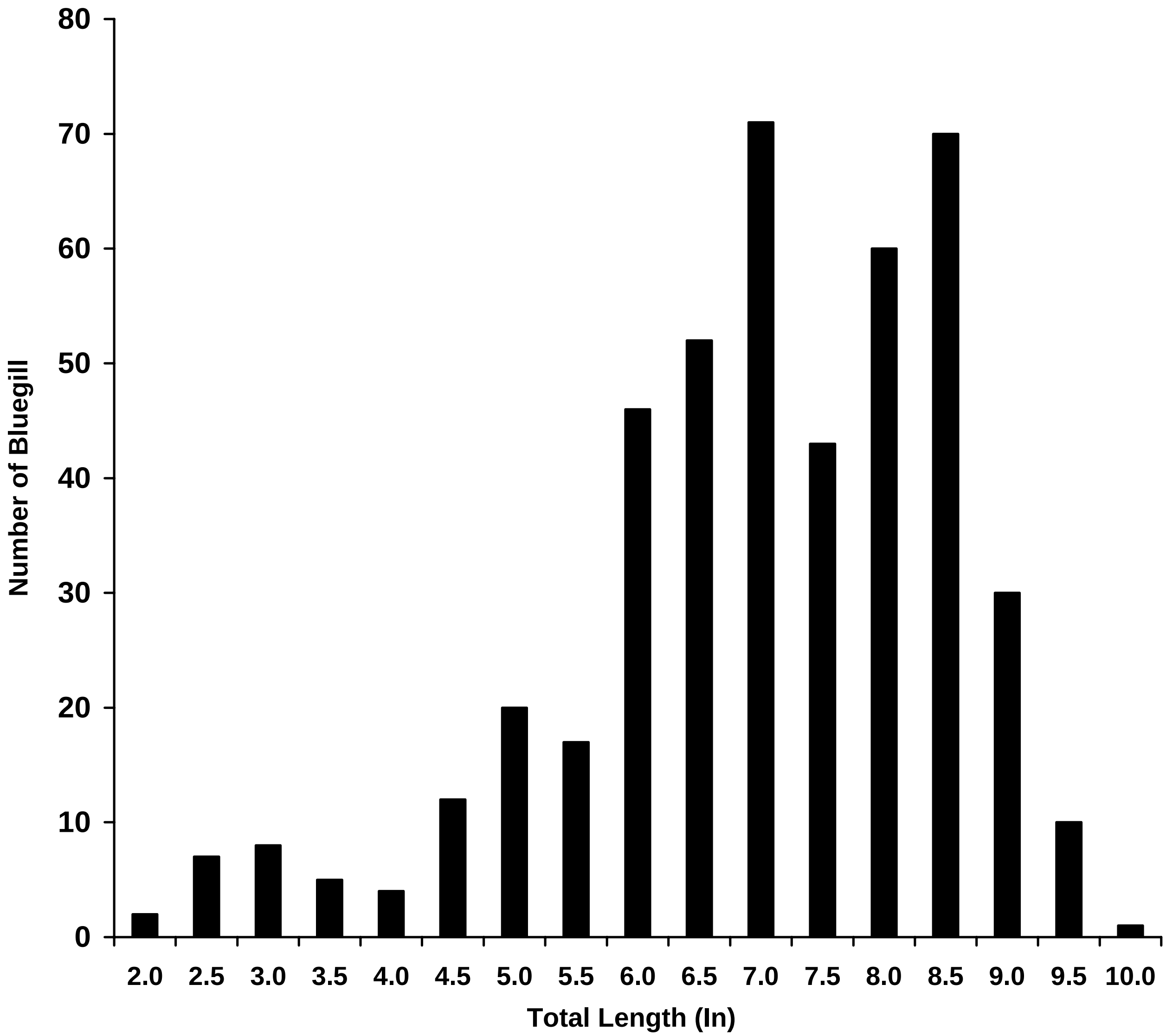

Figure 15. Length distribution per half-inch group for bluegill collected while panfish netting (n = 458) with fyke nets targeting adult panfish species on June 12-13th, 2001 on Bond Lake, Douglas County, WI.

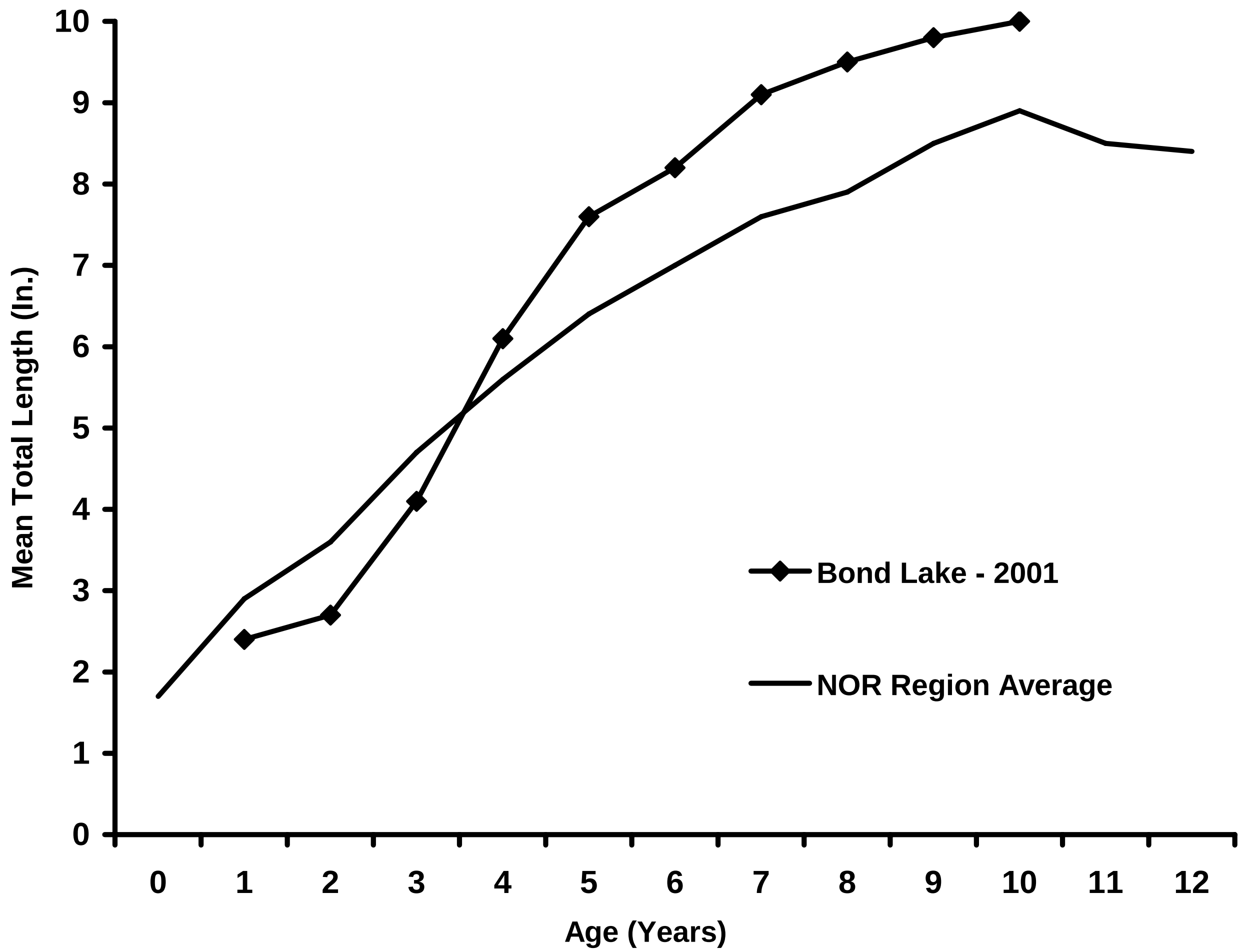

Figure 16. Mean total length at age for bluegill from Bond Lake, Douglas County, WI in 2001 compared to northern region averages of mean length at age for bluegill.