Fishery Survey – Lower Eau Claire Lake
Douglas County, 2007-2008
WBIC Code – 2741600

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Executive Summary

Lower Eau Claire Lake has supported diverse fish communities and a popular sport fishery. With the exception of muskellunge, good natural reproduction supports all species. A 2007 fishery survey suggests shifts in species abundance may be beginning to occur.

Walleye abundance in Lower Eau Claire Lake is below regional averages and statewide management objectives and appears to be driven by occasional strong year classes. Year class variation is common among walleye lakes and may be due to several factors. These factors include but are not limited to; spring water temperature variation, differential larval survival in the Eau Claire River, lake size, habitat alterations and largemouth bass increases. The current regulation of a 15 in minimum length has met the objective of preventing over harvest and maintaining a good length frequency of the walleye population.

Largemouth bass abundance more than doubled from 1993 to 2007 in Lower Eau Claire Lake and anglers estimated catch indicate the same trend of increasing largemouth bass abundances after 1993. Further evaluation in the future will be necessary to discern whether the trend continues. The reasons for the change in largemouth bass abundance may include climate change, species interaction and habitat shifts. Since angler harvest of both smallmouth and largemouth bass has remained relatively stable (especially in light of changes in estimated catches), angling likely has had little impact on the changes occurring in Lower Eau Claire Lake.

Bluegill are a important part of the sport fishery on Lower Eau Claire Lake and all metrics used to measure this species are indicating a healthy population along with good

to excellent angler opportunities. The 2012 survey should continue to monitor this success story through panfish netting and creel surveys.

Management recommendations include: 1) Retain 15 in minimum length limit for walleye, 2) Continue to monitor bass populations in light of the increase of largemouth bass since 1993 and discuss with stakeholders future management options if abundance continue to increase, 3) Continue to monitoring bluegill populations which are important to the fishery and are seeing positive trends, 4) Collect information on northern pike and muskellunge in future surveys, 5) Work with local residents, associations and groups to develop a lake management plan and aquatic plant management plan that addresses fisheries management goals, habitat protection and rehabilitation as well as education of users and riparian residents.

Introduction

Lower Eau Claire Lake is an 802 acre drainage lake that is the lower most lake in the 12 lakes that comprise the Eau Claire Chain of lakes and from which the Eau Claire River flows. The Eau Claire River begins in the town of Barnes then flows from a series of small lakes into the main Eau Claire lakes of Upper and Middle Eau Claire Lakes prior to entering Lower Eau Claire Lake. In addition, Cranberry Lake flows into Lower Eau Claire Lake from the east. Upstream of Lower Eau Claire Lake there is a dam with a hand operated lock which acts as an incomplete barrier to fish passage. The river from the dam downstream to Lower Eau Claire Lake is designated as a fish refuge from April 15th to May 15th due to the presence of spawning walleye. An additional dam is located on the outlet of Lower Eau Claire Lake on Douglas County property. The Douglas/Bayfield County line evenly splits Lower Eau Claire Lake from north to south. The Eau Claire River watershed originates in south western Bayfield County and flows into the St. Croix River in Gordon, Wisconsin. Maximum depth of Lower Eau Claire Lake is 41 feet with an alkalinity of 70 mg/L. The lake has a highly developed shoreline with a total shoreline length of 7.8 miles. A county park is located on the south side of the dam and provides public access as well as two undeveloped platted accesses (Johannes and Sather, 1973).

Water quality measurements taken on Lower Eau Claire Lake indicate medium levels of nutrients. Average summer secchi disk depth, total phosphorus and chlorophyll-a trophic state index (TSI) values for the deep hole on Lower Eau Claire Lake were 39.5 (SD = 6.75, N = 119), 49.2 (SD = 4.30, N = 51) and 44.4 (SD = 8.25, N = 52) for the time period between 1988 and 2009. TSI is an index for evaluating trophic state or nutrient condition of lakes (Carlson 1977; Lillie et. al. 1993). 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). The data on Lower Eau Claire Lake indicate the nutrient condition was mesotrophic (medium productivity) when considering secchi disk, total phosphorus and chlorophyll-a TSI indices.

Lower Eau Claire Lake has 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 *L. gibbosus*, rock bass *Ambloplites rupestris*, black crappie *Pomoxis nigromaculatus*, yellow perch *Perca flavescens*, warmouth *Chaenobryttus gulosus,* white sucker *Catostomus commersoni*, yellow bullhead *Ictalurus natalis*, creek chub *Semotilus atromaculatus*, tadpole madtom *Noturus gyrinus*, brook stickleback *Culaea inconstans*, johnny darter *Etheostoma nigrum*, Iowa darter *E. exile*, brook silverside *Labidesthes sicculus,* bluntnose minnow *Pimephales notatus,* common shiner *Luxilus cornutus,* spottail shiner *Notropis hudsonius,* mimic shiner *N. volucellus,* blackchin shiner, *N. heterodon* and golden shiner *Notemigonus crysoleucas*. Historic records indicate the presence of lake sturegeon *Acipenser fulvescens* and cisco *Coregonus artedi*, however recent surveys have not recorded the presence of these species. Rainbow trout *Oncorhynchus mykiss* were stocked in the mid-1980s to early 1990s but are no longer expected to be present in Lower Eau Claire Lake.

Historic fisheries management of Lower Eau Claire Lake has included surveys, stocking, and various length and bag regulations. Historic surveys for walleye occurred in 1993 and 1995 utilizing Wisconsin Department of Natural Resources (WDNR)

standardized treaty protocols (Hennessey 2002) and a survey in 1983 which utilized fyke nets for both mark and recapture periods for estimating population abundnace. Additional walleye surveys estimating adult population were conducted by the Great Lakes Indian Fish and Wildlife Commission (GLFWC) in 1991 and 2001 using a different sampling protocol, i.e. electrofishing to both mark and recapture walleye. A historic panfish survey was conducted by WDNR in 1983. Basic fishery surveys utilizing a variety of gear types were conducted by WDNR in 1948, 1965 and 1971-1972. Fall electrofishing surveys were conducted annually to assess recruitment of walleye from 1985 to 2007, with the exception of 1989.

Lower Eau Claire Lake has a long stocking history and has been stocked with a number of fish species, including walleye, muskellunge, largemouth bass, bluegill and rainbow trout, since at least 1936 (Table 1). Nearly annual walleye and muskellunge stocking occurred from at least 1936 to 1971, when over 10,600,000 fry and over 208,900 small fingerling walleye were stocked and 246,500 fry and 5,400 fingerling muskellunge were stocked into Lower Eau Claire Lake. Since 1971, muskellunge have been stocked generally on an every other year basis. The only walleye stocking that has occurred since 1971 was in 1992 and 1993 when the Eau Claire Conservation Club cooperatively stocked fingerling walleye. Walleye stocking was discontinued after 1971 based on the appearance of good natural reproduction reported in the 1973 fishery survey report (Wistrom 1973). Muskellunge stocking which occurred nearly annually from 1939 to 1947 and then discontinued for unknown reasons was initiated again in 1984 due to a recommendation from a 1984 fishery survey report that called for an additional shallow water predator that would help control abundant slow growing panfish (Schram 1984).

Since 2002, muskellunge stocking has occurred on an alternate basis at a rate of 0.5 fish/acre, with the exception of 2006 which had a stocking rate of 0.25/acre. Also, due to a recommendation from the 1984 fishery survey report rainbow trout were stocked in 1985, 1988 and 1991 but since survival was considered to be poor the stocking was discontinued after 1991.

Fishing regulations have been managed via statewide length and bag limits over time on Lower Eau Claire Lake, with the exception of muskellunge. There was no minimum length limit for walleye until 1990 when a 15 in minimum length limit was instituted statewide. Bag limits for walleye have been adjusted annually according to tribal harvest declarations that began in 1991. Muskellunge regulations for minimum length increased from 30 in to 32 in in 1983, and to 40 in in 1996. Largemouth and smallmouth bass regulations have also changed over time. In 1989, a northern bass zone was created with an opening of the harvest of bass starting the 3rd Saturday in June with a 12 in minimum length limit. In 1998, the minimum length limit for bass was increased to 14 in.

Recent management has focused on fishery surveys and woody habitat restoration. In addition, a critical habitat designation survey was begun in the summer of 2008. The objective of the 2007-2008 survey was to determine the status of the walleye and bass populations, along with sport and tribal use of these species. More specifically, we were interested in determining population abundance, growth, size structure and harvest of walleye and abundance and size structure of panfish.

Methods

Lower Eau Claire Lake was sampled during 2007-2008 following the Wisconsin Department of Natural Resources comprehensive treat assessment protocol (Hennessey 2002). This sampling included spring fyke netting and electrofishing to estimate walleye and bass (both largemouth and smallmouth) abundance, late June fyke netting for panfish abundance, fall electrofishing to estimate year class strength of walleye young-of-the-year (YOY), and a creel survey (both open water and ice).

Walleye were captured for marking in the spring shortly after ice out with fyke nets on the main lake and electrofishing in the Eau Claire River from the mouth upstream to the lock and dam. Each fish was measured (total length; inches and tenths) and fin-clipped. Adult (mature) walleyes were defined as all fish for which sex could be determined and all fish 15 in or longer. Adult walleyes were given a lake-specific mark. Walleyes of unknown sex less than 15 inches in length were classified as juveniles (immature) and were marked with a different lake-specific fin clip. Marking effort was based on a goal for total marks of 10% of the anticipated spawning population estimate. To estimate adult abundance, walleyes were recaptured 1-2 days after netting and river electrofishing. Because the interval between marking and recapture was short, electrofishing of the entire shoreline and river was conducted to ensure equal vulnerability of marked and unmarked walleyes to capture. All walleyes in the recapture run were measured and examined for marks. Population estimates were calculated with the Chapman modification of the Petersen Estimator using the equation:

$$N = \frac{(M+1)(C+1)}{(R+1)}$$

where N is the population estimate, M is the total number of marked fish in the lake, C is the total number of fish captured in the recapture sample, and R is the total number of marked fish captured. The Chapman Modification method is used because simple Petersen Estimates tend to overestimate population sizes when R is relatively small (Ricker 1975). Abundance and variance were estimated by the total for walleye that were ≥ 15 in and sexable.

Largemouth and smallmouth bass encountered during the second electrofishing run were marked. 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. The entire shoreline of the lake was sampled. For comparison purposes catch per unit effort (CPUE: the number of largemouth or smallmouth bass caught/hour of electrofishing) was calculated from the second electrofishing survey. Size structure for the 2007 survey utilized all largemouth and smallmouth bass captured from the second electrofishing survey.

No survey data was collected for northern pike or muskellunge. Data was not collected for northern pike or muskellunge due to a miscommunication between staff prior to the sampling season in 2007.

Walleye age and growth were 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. Growth rates for walleye were compared to age at length data from lakes in the ceded territory since 1990. Growth rates for all species were compared to an 18 county regional mean (Northern Region) using the Fisheries and Habitat database. 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 surveys used a random stratified roving access design (Beard et al. 1997; Rasmussen et al. 1998). The survey was stratified by month and day-type (weekend / holiday or weekday), and the creel clerk conducted interviews at random within these strata. The survey was conducted on all weekends and holidays, and a randomly chosen two or three weekdays. Only completed-trip interview information was used in the analysis. The clerk recorded effort, catch, harvest, and targeted species from anglers completing their fishing trip. The clerk also measured harvested fish and examined them for fin-clips.

Results

Total survey effort in 2007 included 24 fyke net lifts targeting spawning gamefish. In June a second fyke-netting period targeted spawning panfish and included 13 fyke net lifts. Three electrofishing surveys of the entire shoreline totaling 9.2 hours in spring (river supplemental, first and second surveys) and 2.5 hours in fall (walleye recruitment survey) were conducted.

Walleye. Adult walleye abundance (≥ 15 in and sexable fish) was 1,989 (CV = 7%; 2.5 adults/acre) in 2007. Adult walleye density has fluctuated since 1983 (Figure 1). Density estimates during this period ranged from 2.2 to 4.6 fish/acre and averaged 3.3 fish/acre in six sampling periods. Adult walleye density in 1991 was the lowest of all

surveys conducted and 2001 was the highest, both surveys were conducted by GLIFWC utilizing electrofishing for both mark and recapture.

Length of walleye captured in fyke nets in 1983, 1993, 1995 and 2007 suggests no significant shifts in size structure between all years with the exception of 1995 vs. 2007 (1983 vs. 1993, D = 0.07, P = 0.11; 1993 vs. 1995, D = 0.09, P = 0.07; 1995 vs. 2007, D = 0.11, P = 0.02; 1983 vs. 2007, D = 0.07, P = 0.15; Figure 2). Proportional stock density (PSD) values of 82, 85, 85 and 90 for 1983, 1993, 1995 and 2007 indicated a high quality size structure of the walleye population. In addition, RSD-20 values of 9 for both 1983 and 1993 indicated a fair proportion of large walleye. In 1995 and 2007 RSD-20 values increased to 15 and 14 showing an increase in the proportion of fish over 20 in in length indicating a high quality size structure.

Age of adult walleye sampled during the 2007 survey ranged from III to XV. Male and female walleye first reached maturity at III and IV, respectively. Age V walleye accounted for 30% of the adult stock. Age distribution by abundance data from 1993, 1995, and 2007 indicate consistent naturally reproduced year classes (Figure 3). Growth rates for both sexes were dimorphic with males and females reaching 15 inches between ages V and VI in the 2007 survey. Growth rates in 1993, 1995 and 2007 were predominately above Northern Region averages (Figure 4).

Relative abundance of Young of Year (YOY) walleye in Lower Eau Claire Lake in 2007 was 14.9 fish/mile (46.4 fish/hour). The average walleye YOY/mile was 65.6 (SD = 49.3, N = 23) for surveys completed from 1985 to 2008 by both WDNR and GLIFWC. However, fingerling relative abundance has been highly variable from 1985 to 2004 with a range of 2.7 fish/mile to 180.5 fish/mile (9.0 fish/hour to 491.0 fish/hour;

Figure 5). Mean relative abundance of YOY walleye for naturally reproducing walleye lakes surveyed by WDNR in Bayfield and Douglas Counties from 1991 to 2007 was 24.0 fish/mile (SD = 53.1, N = 88).

Largemouth and Smallmouth Bass. In 2007, largemouth bass represented 65% and smallmouth bass 35% of the total number of bass surveyed (N = 101) in contrast to 1993 where no smallmouth were found during the second electrofishing survey. Relative abundance for largemouth bass for the second electrofishing surveys more than doubled and was 3.2 and 8.5 fish/mile for 1993 and 2007. Size structure for the 2007 survey was excellent with a mean length of 14.5 in (SD = 3.66; N = 66) and PSD and RSD-15 values of 82 and 57, respectively.

Relative abundance for smallmouth bass in Lower Eau Claire Lake for the second electrofishing survey was 0 and 4.4 fish/hour for 1993 and 2007 and was considered low for 2007. Mean length of smallmouth bass for the 2007 survey was considered average with a mean length of 11.7 in (SD = 4.36; N = 35) and had PSD and RSD-14 values of 50 and 38, respectively.

Panfish. Bluegills were the most abundant panfish species sampled (N = 2,044) in Lower Eau Claire Lake during the panfish fyke netting survey of 2007. Relative abundance of bluegill captured in panfish survey fyke nets nearly tripled from 57.6 to 157.2 fish/net lift in 1983 and 2007, respectively. Length frequency of bluegill captured in fyke nets in 1983 and 2007 suggests a significant increase in size structure between 1983 and 2007 (1983 vs. 2007, D = 0.44, P < 0.001; Figure 6). Mean total length of bluegill (panfish netting survey) increased from 4.8 (SD = 1.68, N = 691) to 6.3 in (SD = 1.42, N = 1,151) from 1983 to 2007. PSD for bluegill increased from 34 to 75 for survey

years 1983 and 2007. RSD-8 for bluegill was 4 and 7 for survey years 1983 and 2007. PSD values for bluegill indicate a good size structure for the 2007 survey.

Rock bass were the second most abundant panfish species (N = 104) sampled in Lower Eau Claire Lake during the panfish fyke netting survey of 2007. Relative abundance of rock bass captured decreased from 13.7 to 8.0 fish/net lift from 1983 to 2007. Mean length of rock bass (panfish netting survey) increased from 6.5 (SD = 1.57, N = 164) to 7.2 (SD = 1.57, N = 104) inches from 1983 to 2007. The third most abundant panfish species (N = 99) sampled were pumpkinseed. Relative abundance of pumpkinseed captured increased slightly from 5.3 to 7.6 fish/net lift from 1983 to 2007. Mean length of pumpkinseed increased from 4.8 (SD = 1.30, N = 64) to 5.4 (SD = 1.16, N = 99) inches from 1983 to 2007. Remaining panfish species encountered during the panfish netting period were not sampled in high enough numbers to warrant analysis, which was true for both 1983 and 2007.

Sport and Tribal Fishery. Anglers fished an estimated 20,523 hours (25.6 hrs/acre) during the 2007-2008 season in Lower Eau Claire Lake, which is near the average of 26.3 (SD = 14.61, N = 49) hrs/acre for Bayfield and Douglas County walleye lakes from 1990 to 2007 and below the Ceded Territory of Northern Wisconsin (21 counties) average of 33.2 (SD = 24.48, N = 415) hrs/acre. Open water anglers accounted for 79% of all fishing effort. The directed effort, i.e. effort targeted toward a specific fish, among gamefish was highest for walleye (17.8%). The most sought after panfish species was bluegill, with 33.4% of the directed effort (Figure 7). Fishing pressure has decreased slightly since 1993. Total fishing pressure for both open water and ice fishing (hrs/acre) was 28.6, 24.4 and 25.6 for 1993, 1995 and 2007, respectively.

Walleye were the most heavily exploited gamefish in Lower Eau Claire Lake. An estimated 552 walleye were caught in the open water and ice season of 2007-2008 of which 51% (280) were harvested. The open water season accounted for 79% of the total walleye harvest, which was below values from 1993 (96%) and similar to values from 1995 (77%). Average length of angler harvested walleye was 17.9 in (SD = 1.84, N = 63) in 2007. Average length of angler harvested walleye has remained similar and was 17.5 in (SD = 1.78, N = 53) and 17.6 in (SD = 2.39, N = 170) in 1993 and 1995. Projected total harvest of walleye by anglers has decreased since 1993 (harvest = 332) and 1995 (harvest = 620; Figure 8). Angler exploitation, calculated by the estimated number of marked walleye harvested divided by the total number of marked walleye, was 4.6% in 2007, which was a decrease from 1995 (14.4%) and an increase from 1993 (1.0%).

Tribal harvest accounted for 186 walleye in 2007 (Krueger 2008). Tribal harvest has averaged 211 walleye (SD = 67.67, N = 19) from 1989 to 2007. Walleye harvested in 2007 ranged from 12.1 to 23.7 in. Tribal harvest represented 40% of the combined total harvest (sport angling plus tribal spearing) and tribal exploitation of the adult walleye population was 9.4%. The mean length of tribally harvested walleye was 16.2 in (SD = 1.82, N = 186) and 24% were < 15 in. Male and female walleye represented 79% and 20% of the total tribal harvest, respectively. The remaining 1% were walleye of unknown sex. Total adult walleye exploitation (sport and tribal) increased from 3.9% to 23.4% from 1993 to 1995 and then decreased to 14.0% in 2007. Exploitation levels below 35% are generally thought to be sustainable and are the exploitation levels that are used to determine total allowable catch for the combined fishery of angler and tribal

harvest for walleye in the state of Wisconsin. Exploitation levels on Lower Eau Claire Lake have remained below 35%.

Northern pike were the second most sought after gamefish with 14.2% of the directed effort in 2007-2008 on Lower Eau Claire Lake and had the highest harvest (N = 500). Estimated catch of northern pike was 2,947 in 2007. Directed effort for northern pike increased from 22.4% to 25.0% from 1993 to 1995 and decreased to 14.3% in 2007. Northern pike estimated catch fluctuated from 2,023 to 3,458 to 2,947 and estimated harvest decreased from 770 to 704 to 500 fish from 1993 to 1995 to 2007. Mean length of harvested northern pike was 21.0, 20.6 and 22.4 inches in 1993, 1995 and 2007 respectively.

In 2007, muskellunge accounted for 6.6% of the directed angling effort. In comparison, the directed effort for muskellunge was 1.6% and 2.4% in 1993 and 1995. In the open water season of 2007 an estimated 81 muskellunge were caught, none of which were harvested. Tribal harvest accounted for 1 muskellunge in 2007 (Kruger 2008). The length of the tribally harvested muskellunge was 41.0 in. Five musky have been tribally harvested since 1990 on Lower Eau Claire Lake.

Largemouth bass were the third most sought after gamefish by anglers in Lower Eau Claire Lake in 2007-2008 with 10.0% of directed effort. Estimated catch of largemouth bass was 877 of which 79 (9%) where estimated to be harvested. Catch of largemouth bass increased 3-fold from 1993 to 1995, however catch remained similar to 1995 in 2007 (Figure 8). Average length of harvested largemouth bass has increased from 14.8 to 15.4 to 16.7 in from 1993 to 1995 to 2007. Smallmouth bass were the least sought after gamefish in 2007 on Lower Eau Claire Lake with 3.4% of directed effort.

Although directed effort for smallmouth bass was low in 2007 it was an increase from 0% in 1993 and 0.6% in 1995. An estimated 589 smallmouth were caught, 54 (9%) of which were estimated to be harvested in 2007.

Anglers pursuing panfish fished an estimated 14,629 hours and accounted for 48.0% of the total directed angling effort for the 2007-2008 open water and winter seasons combined. Bluegill was the most sought after fish species (gamefish and panfish combined) by anglers in 2007-2008 with 33.4% of directed effort. Directed effort for bluegill has declined from 1993 (44.4%) and increased from 1998 (31.1%). Bluegill has remained the most sought after fish species in Lower Eau Claire Lake. Angler harvest of bluegill was higher in 2007 (15,331) than in both 1993 (12,462) and 1995 (10,565). Mean length of harvested bluegill increased from 7.1 to 7.2 to 7.5 inches in the same time period. Estimated catch of bluegill decreased from 31,118 in 1993 to 23,920 in 1995 and then almost doubled to 46,521 in 2007. Black Crappie were the second most sought after panfish species in 2007 on Lower Eau Claire Lake with 10.3% of directed effort. Catch and harvest of black crappie has increased in all survey years (Figure 7). Mean length of harvested black crappie increased from 9.6 to 10.1 to 10.3 inches from 1993 to 1995 to 2007. Yellow perch were the least sought after panfish species by anglers in 2007 with 4.2% of the directed effort. Directed effort for yellow perch has decreased from 1993 (4.4%) and 1998 (8.2%). Average length of harvested yellow perch increased and was 8.9, 9.0 and 9.7 in for 1993, 1995 and 2007, respectively. Catch of yellow perch has increased and harvest has been variable over the three survey periods (Figure 7).

Discussion

Lower Eau Claire Lake has supported, and continues to support diverse fish communities and popular sport fisheries. With the possible exception of muskellunge, good to excellent natural reproduction supports all species. Shifts in species abundance appear to be occurring and mirror trends in lakes of similar type in the region. This shift includes increased abundances of centrarchid species bluegill and largemouth bass, while percid species walleye and yellow perch abundances have declined or remained low. Harvest management aimed at maintaining self-sustaining stocks has been largely successful.

Walleye abundance appears to be driven by occasional strong year classes on Lower Eau Claire Lake. Year class variation is common among walleye lakes and may be due to several factors. Kallemeyn (1987) and Hansen et al. (1998) found that water temperature in May explained recruitment variation in four lakes in Voyagers National Park and Escanaba Lake in Vilas County Wisconsin. According to the Wisconsin Initiative on Climate Change Impacts (WICCI) Lower Eau Claire Lake has had increases in spring mean temperatures of 2.25 F from 1950 to 2006. WICCI predicts that from 1980 to 2055 the mean spring temperatures will increase by 5.25 F, the effects on spawning success of walleye on Lower Eau Claire Lake could be affected by this change.

In Lower Eau Claire Lake an important source of walleye recruitment is thought to be the Eau Claire River, especially in the area directly below the lock and dam where numerous walleye can be seen spawning in early spring. Mion et al. (1998) found that larval walleye survival and resulting year class strength was driven by river discharge in rivers connected to Lake Erie in Ohio. They found high discharge events correlated with

low larval walleye survival and recommended that managers work in the watershed to alleviate high flow fluctuations due to impervious surfaces and sediment loads to the rivers. Limiting impervious surfaces in the watershed or infiltrating runoff could help to alleviate high discharge events in the future as well as reducing sediment input into the Eau Claire River. Preventing shoreline erosion caused by human activities such as boats creating wakes and destabilization of banks through vegetation removal could also help prevent sediments from entering the Eau Claire River.

Explanation of walleye recruitment affecting year class strength of walleye has been described in relation to lake size. Nate et al. (2000) found that lake size explained 61% of the variation in self sustaining walleye populations in 172 northern Wisconsin walleye lakes. Larger lake size is correlated positively with higher walleye year class strength. The size of Lower Eau Claire Lake is unlikely to not change significantly, however, knowing that the size of the lake alone predicts lower walleye abundances is useful when considering population goals appropriate for the lake. Although walleye abundance in Lower Eau Claire Lake was lower than in 1983, 1993 and 2001 it was similar to abundances in 1991 and 1995. Some of the factors affecting walleye population variability outlined above are things that can be affected by local shoreline use and watershed management; others may be affected by actions taken within and outside the watershed and in a much larger geographical, like climate change; and yet others like lake size are factors we can learn from but do little to change. Perhaps the largest impact to the walleye populations and the fishery in general would be the restoration of near shore habitat and the protection of areas deemed important to the health of the fishery.

Largemouth bass abundance more than doubled from 1993 to 2007 in Lower Eau Claire Lake and anglers estimated catch indicate the same trend of increasing largemouth bass abundances after 1993. Although the increases in the largemouth bass population on Lower Eau Claire Lake are not as dramatic as Lake Owen in Bayfield County or lakes in counties south of Douglas County, future evaluations will be necessary to discern whether the trend continues. The reasons for the change in largemouth bass abundance may include climate change, species interaction and habitat shifts. Since angler harvest of both smallmouth and largemouth bass has remained relatively stable (especially in light of changes in estimated catches), angling likely has had little impact on the changes occurring in Lower Eau Claire Lake.

Climate change has been identified as a potential shift of cold, cool and warmwater species to more northern areas where they had been uncommon in the past. Shuter et al. (2002), Jackson and Mandrak (2002), Chu et al. (2005) and Sharman et al. (2007) predicted increases in water temperature in response to climate change will have large implications for aquatic ecosystems in Canada, such as altering thermal habitat and potential range expansion of fish species. They surmised that warmwater fish species may have access to additional favorable thermal habitat under increased surface-water temperatures, thereby shifting the northern limit of the distribution of the species further north and potentially negatively impacting native fish communities.

Negative species interactions have been identified between largemouth bass and walleye populations. Nate et al. (2003) indexed relative abundance of five gamefish species on the basis of general angler catch rates from creel surveys on 60 lakes in northern Wisconsin during 1990-2001. Analysis revealed higher angler catch rates

(presumably greater abundance) of largemouth bass and northern pike on 30 lakes with "stocked" walleye populations (demonstrably lower walleye density), and higher angler catch rates for walleye and muskellunge on 30 lakes with "self-sustaining" walleye populations where angler catch rates (and presumed abundance) of largemouth bass were lowest. In a more recent analysis of 20 northern Wisconsin lakes with at least 50% natural recruitment of walleye, Fayram et al. (2005) reported a significantly negative relationship between adult walleye density and multi-season electrofishing capture rate of largemouth bass. They concluded, "Given the seemingly strong predatory interaction between walleyes and largemouth bass, management of both species in the same water body may be difficult. In addition, walleye stocking may be ill advised in lakes with even moderate abundances of largemouth bass, given their potentially large impact on survival of juvenile walleyes."

Bluegill abundance, size structure, angler harvest and length of angler harvested fish defy common knowledge and patterns in lakes with bluegill populations by increasing in each metric over time on Lower Eau Claire Lake. Bluegill is the most sought after fish species by anglers in Lower Eau Claire Lake making it an important species to the lake's fishery. Panfish netting relative abundance, size structure, angler catch, angler harvest and length of angler harvested bluegill are all at historic highs. Abundance of bluegill caught in panfish netting surveys in 1983 and 2007 nearly tripled (57.6 to 157.2 fish/net lift) while the length frequency increased significantly and mean length increased by 1.5 in, typically the higher the abundance of bluegill the lower the size structure of the population (Cross and McInerny 2005). Also, Beard and Kampa (1999) found from a large data set of panfish netting samples from Wisconsin lakes

collected from 1967 to 1991 that average size of bluegill had decreased. Modeling of angler harvest of bluegill has shown that increased angler harvest can reduce mean size of harvested bluegill by four times (Beard and Essington 2000); bluegill harvest on Lower Eau Claire Lake increased by 50% from 1995 to 2007 while mean length of angler harvested bluegill increased. In addition, Jacobson (2005) found in eight Minnesota lakes that if angler harvest of bluegill was reduced through more restrictive bag limits length frequency of the population increased. Angler harvest of bluegill on Lower Eau Claire Lake increased yet the mean length of bluegill also increased going against what the above studies have shown. Ultimately, the anomaly that the bluegill population on Lower Eau Claire represents gives anglers who value fishing for bluegill more opportunity to catch and harvest fish and those that are harvested are of a higher quality size structure. Nevertheless, fish populations are dynamic and the probabilities of this situation remaining stable are uncertain. A slight change in exploitation or recruitment may quickly alter the present size structure. The 2012 survey should collect panfish netting data to continue to monitor this important fishery.

Muskellunge and northern pike populations were not surveyed during the 2007 with the exception of the creel survey. Both species represent an important part of the predator fish community in Lower Eau Claire Lake and from a harvest and directed effort standpoint an important part of the sport fishery. In the future fishery survey, scheduled for 2012, a muskellunge population estimate should be attempted to estimate muskellunge abundance and size structure and data on northern pike should also be gathered to assess relative abundance and size structure.

Summary and Management Recommendations

1. Walleye abundance in Lower Eau Claire Lake is below regional averages and statewide management objectives. Exploitation of walleye in 2007 was average although fishery abundance and relating angler harvest seems to be driven by large year classes. Although year class strength of young-of-year walleye is good to excellent these abundances do not seem to translate to the adult fishery on a consistent basis. The current regulation of a 15 in minimum length has met the objective of preventing over harvest and maintaining a good length frequency of the walleye population. Since the major factor affecting walleye abundance appears to be year class strength, following the recommendations of the Critical Habitat Areas (http://dnr.wi.gov/lakes/criticalhabitat/; accessed June 2010) that include the major walleye spawning areas on Lower Eau Claire Lake may help to preserve and possibly enhance walleye recruitment into the future. Remedies for other factors that may affect walleye recruitment such as the potential effects of global warming and lake size may be partially remedied by policies and decisions in a larger geographic area or beyond our control.

2. Largemouth and smallmouth bass abundances were both considered low for Lower Eau Claire Lake in 2007. However, largemouth bass abundance has increased over time. The 2012 survey should continue to monitor bass populations and if abundances of largemouth bass continue to increase discussions with local citizen groups should begin to assist in deciding what management approach should be taken. Other initiates being tested to control bass abundances are being tested in numerous lakes in northwest Wisconsin.

Results from these studies will be useful in guiding further management actions for Lower Eau Claire Lake.

3. Bluegill are a important part of the sport fishery on Lower Eau Claire Lake and all metrics used to measure this species are indicating a healthy population along with good to excellent angler opportunity. The 2012 survey should continue to monitor through panfish netting and creel surveys this success story.

4. Data was not collected for muskellunge or northern pike in 2007, the 2012 survey should collect data on these important predator species. In the interim stocking of muskellunge at the rate of 0.5 fish/acre should continue using an alternate fin clipping strategy to determine contribution of stocking and prevalence of natural reproduction in the future..

5. Protection of inshore habitat is important for long-term health of fisheries. Schram (1984) recognized the importance of monitoring development to ensure that aquatic plants, spawning substrates and water quality were protected. Work with local residents, the Eau Claire Lakes Conservation Club, the Eau Claire Lake Property Owners Association and the WDNR lake grants program to create and adopt a lake management plan and aquatic plant 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) where the public is willing implement recommendations from the critical habitat designation process, 3) continue restoring woody habitat along conducive shorelines working with willing riparian landowners, 4) formally establish exotic species survey and control programs targeting satellite infestations, 5) provide educational and

participation forum for environmentally sensitive shoreline living, 6) identify uses and user groups to facilitate all recreational uses on the lake, 7) continue water quality monitoring through the self help lake monitoring program. No amount of regulation or stocking 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. Preserving and enhancing the ecosystem and 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.

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Table 1. Fish stocking history of Lower Eau Claire Lake, Douglas County, Wisconsin.

Year	Species	Number Stocked	Age/Size
1936	Bass	600	Unknown
	Bluegill	120	Unknown
	Sunfish	120	Unknown
	Walleye	1,058,400	Fry
1939	Muskellunge	25,000	Fry
	Walleye	300,000	Fry
1940	Muskellunge	60,000	Fry
	Walleye	2,200,000	Fry
1941	Muskellunge	1,000	Fingerling
1942	Muskellunge	58,531	Fry
	Muskellunge	1,000	Fingerling
	Walleye	4,000	Fingerling
1943	Muskellunge	60,000	Fry
	Muskellunge	1,000	Fingerling
	Walleye	500,000	Fry
	Walleye	6,000	Fingerling
1944	Muskellunge	18,000	Fry
	Muskellunge	500	Fingerling
	Walleye	400,000	Fry
	Walleye	2,000	Fingerling
1945	Muskellunge	24,225	Fry
	Muskellunge	250	Fingerling
	Walleye	1,400,000	Fry
	Walleye	3,650	Fingerling
1946	Muskellunge	663	Fingerling
	Walleye	700,000	Fry
	Walleye	2,095	Fingerling
1947	Muskellunge	1,050	Fingerling
	Bass	1,000	Unknown
1948	Walleye	2,100,000	Fry
	Walleye	7,900	Fingerling
1949	Walleye	1,948,396	Fry
	Walleye	2,900	Fingerling
	Largemouth Bass	122	Fingerling
1950	Walleye	8,350	Fingerling
1951	Walleye	7,640	Fingerling
1952	Walleye	11,670	Fingerling
1953	Walleye	7,300	Fingerling
1954	Walleye	11,410	Fingerling

Table 1 (continued). Fish stocking history of Lower Eau Claire Lake, Douglas County, Wisconsin.

Year	Species	Number Stocked	Age/Size
1955	Walleye	3,650	Fingerling
1956	Walleye	7,300	Fingerling
1957	Walleye	7,300	Fingerling
1958	Walleye	2,433	Fingerling
1959	Walleye	21,900	Fingerling
1962	Walleye	21,900	Fingerling
1965	Walleye	22,236	Fingerling
1968	Walleye	9,000	Fingerling
1970	Walleye	7,300	Fingerling
1971	Walleye	7,300	Fingerling
1984	Muskellunge	800	Fry
1985	Rainbow Trout	2,500	Yearling
	Rainbow Trout	33	Adult
1988	Rainbow Trout	2,500	Yearling
1989	Muskellunge	400	Fingerling
1991	Muskellunge	800	Fingerling
	Rainbow Trout	2,500	Yearling
1992	Muskellunge	800	Fingerling
	Walleye*	23,435	Fingerling
1993	Muskellunge	800	Fingerling
	Walleye*	293	Fingerling
1996	Muskellunge	800	Fingerling
1997	Muskellunge	400	Fingerling
1998	Muskellunge	700	Fingerling
2000	Muskellunge	800	Fingerling
2002	Muskellunge	401	Fingerling
2004	Muskellunge	401	Fingerling
2006	Muskellunge	221	Fingerling
2008	Muskellunge	401	Fingerling

* Eau Claire Lakes Conservation Club cooperative stockings.

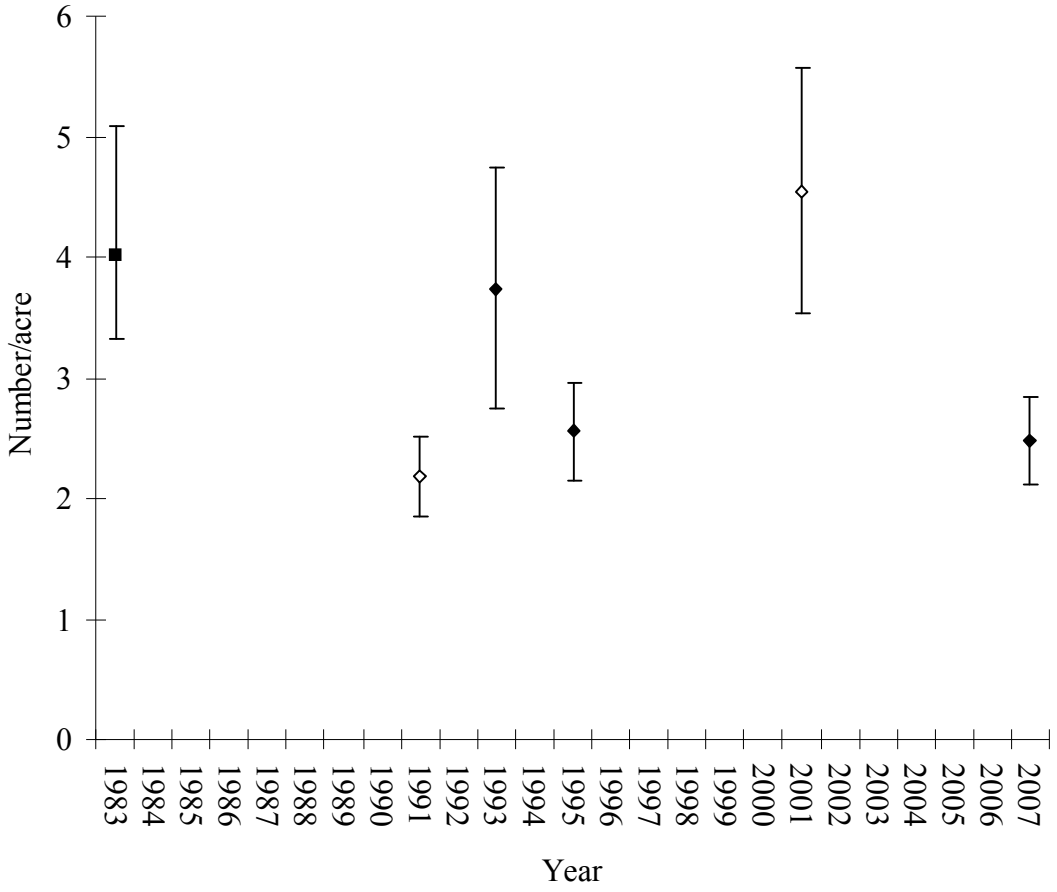

Figure 1. Estimated density and 95% confidence intervals of adult walleye by year, Lower Eau Claire Lake, Douglas County, Wisconsin. Schnabel procedures utilizing fyke nets were used to estimate walleye density in 1983. The Chapman modification of the Petersen estimator was used to calculate walleye density after 1983 with GLIFWC surveys (open diamonds) utilizing electrofishing for both the marking and recapture samples and WDNR surveys (solid diamonds) utilizing fyke netting and electrofishing for the marking and recapture samples, respectively.

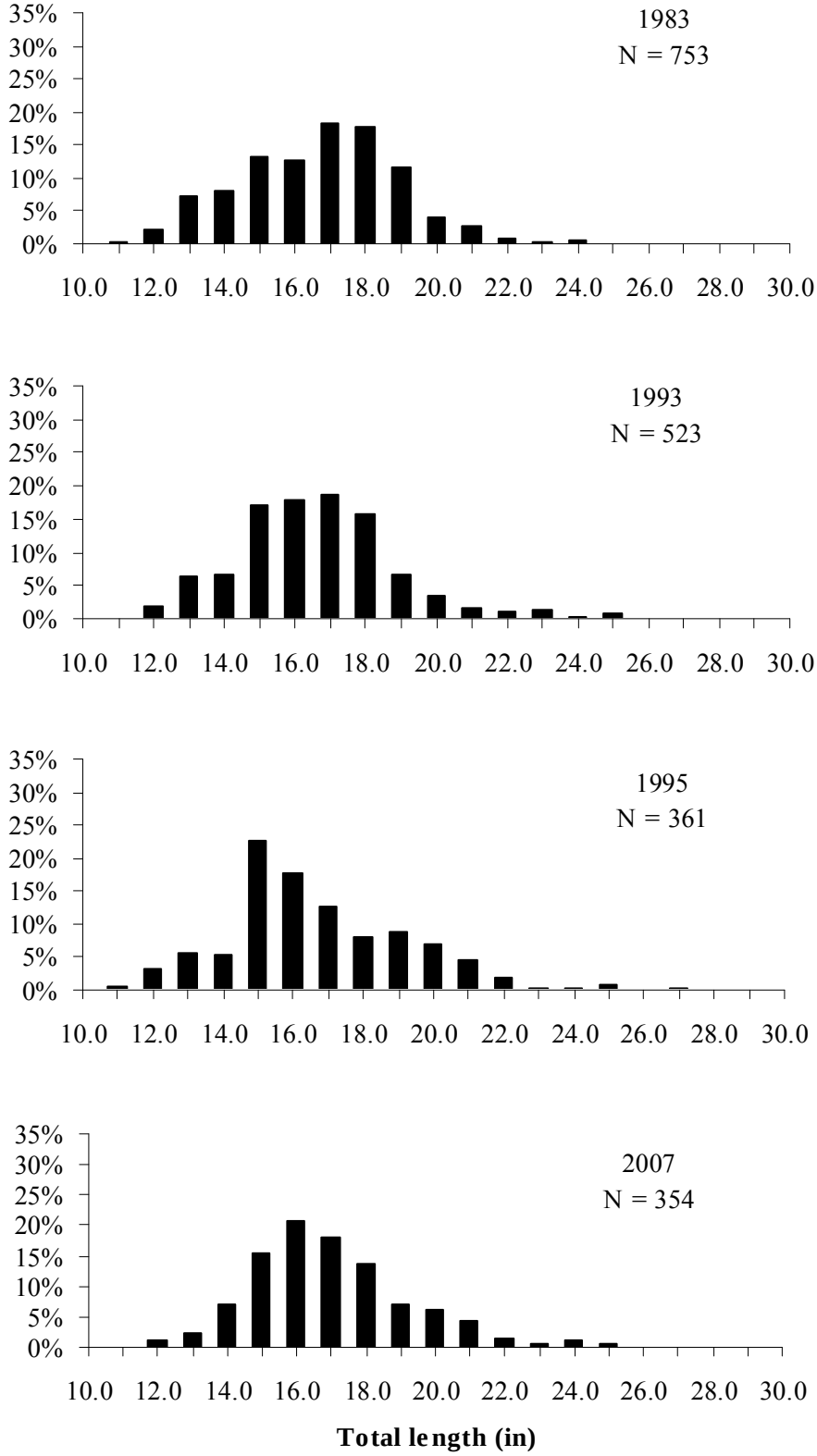

Figure 2. Percent length distribution of adult walleye sampled fyke-netting, Lower Eau Claire Lake, Douglas County, Wisconsin.

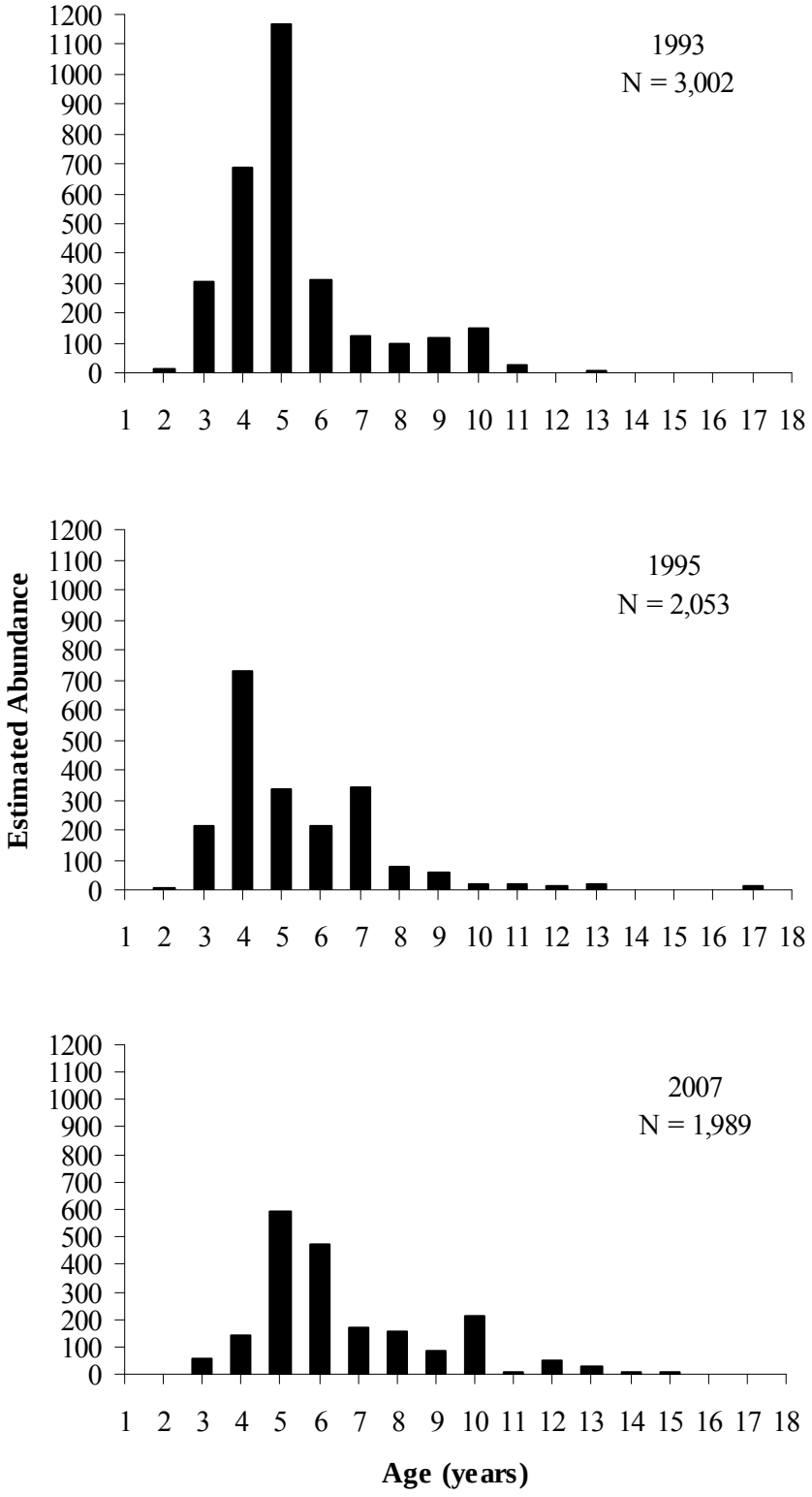

Figure 3. Estimated abundance of adult walleye by age, Lower Eau Claire Lake, Douglas County, Wisconsin.

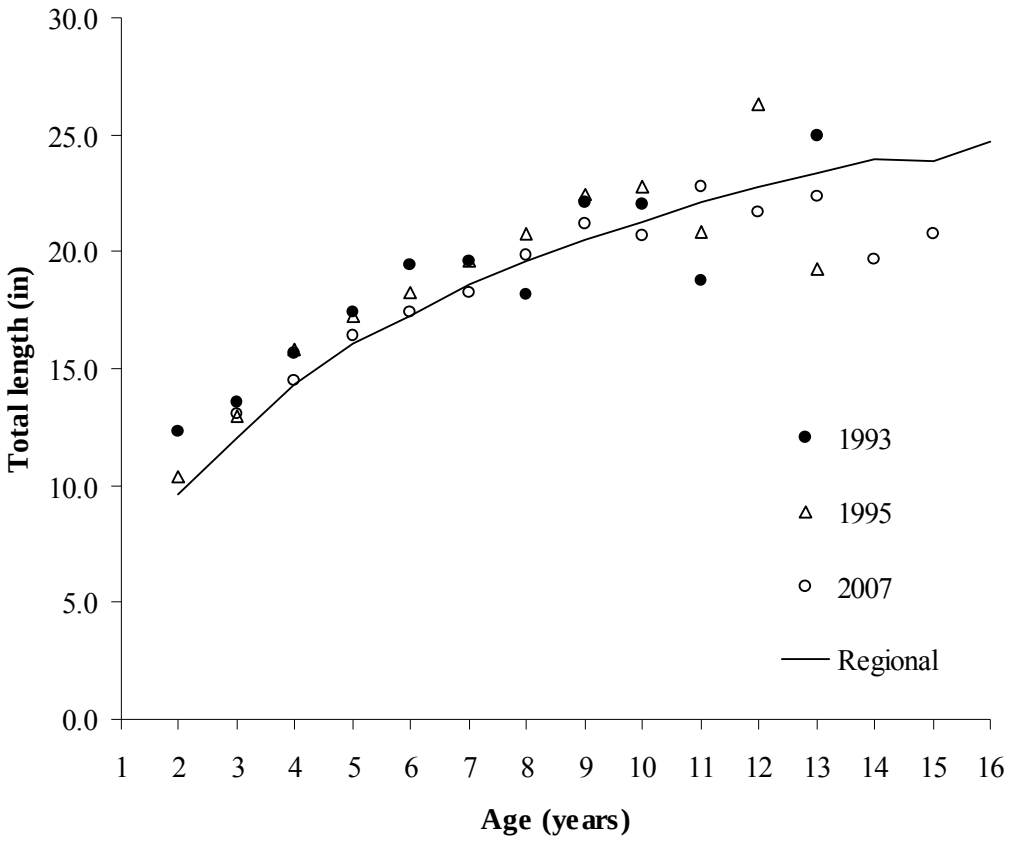

Figure 4. Length at age of Lower Eau Claire Lake walleye, Douglas County, Wisconsin. Regional length at age data obtained from WDNR Treaty Unit data sets for 221 western ceded territory lakes surveyed since 1990.

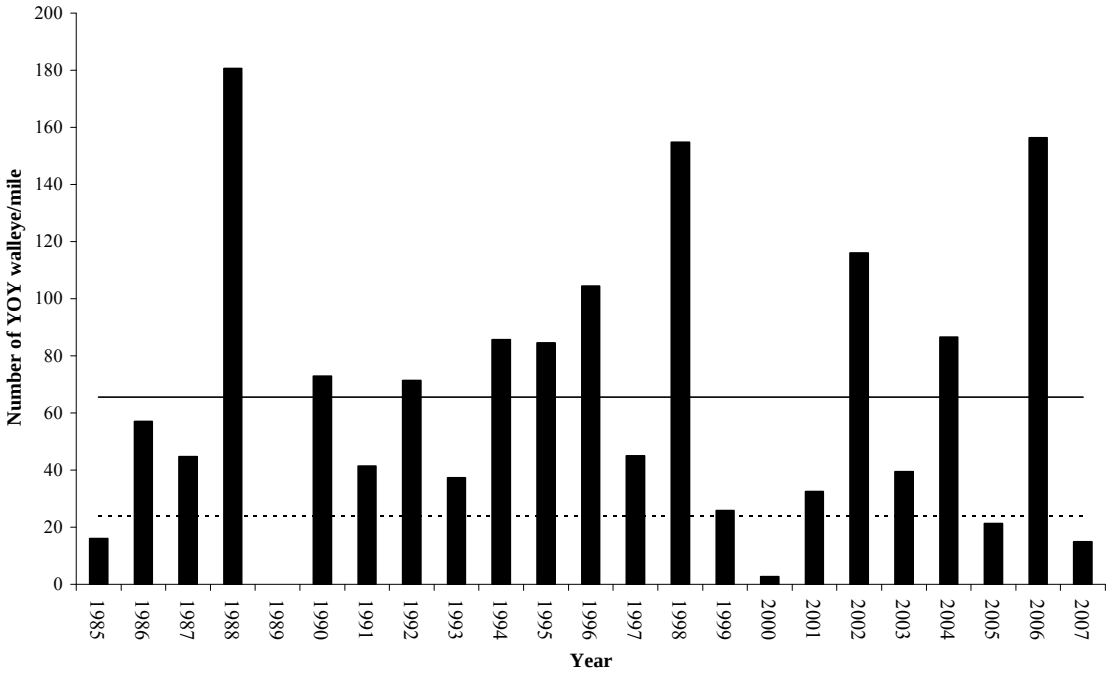

Figure 5. Young of the year walleye relative abundance determined by fall electrofishing in Lower Eau Claire Lake, Douglas County, Wisconsin. No survey completed in 1989. Solid line is the mean value for Lower Eau Claire Lake, dotted line is the mean value for naturally reproducing walleye lakes of Bayfield and Douglas Counties.

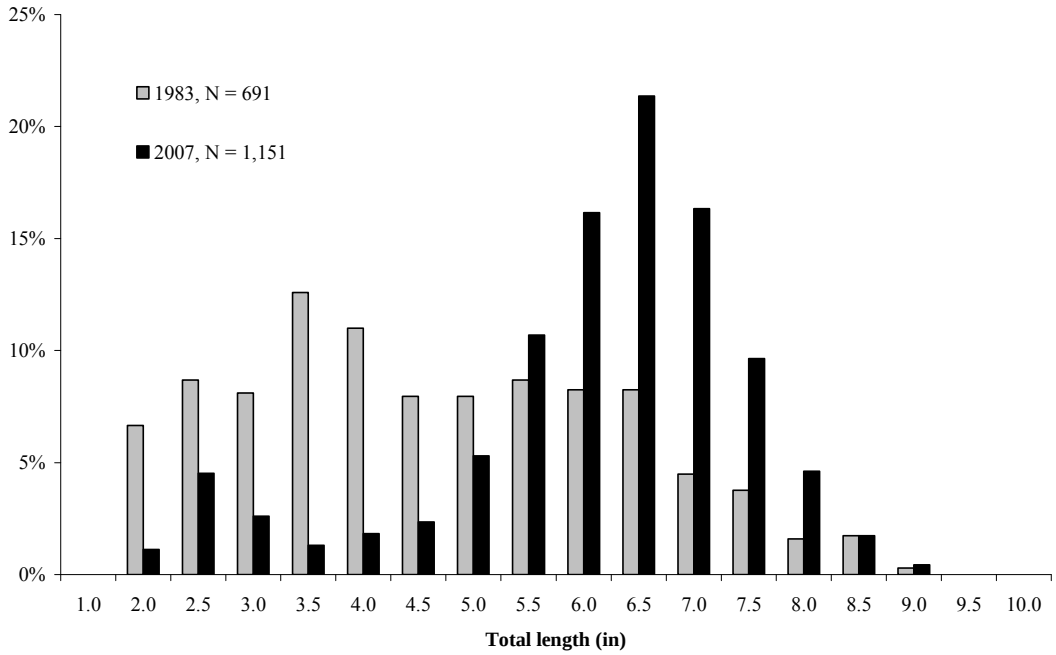

Figure 6. Percent length distribution of bluegill sampled fyke netting, Lower Eau Claire Lake, Douglas County, Wisconsin, 1983 and 2001.

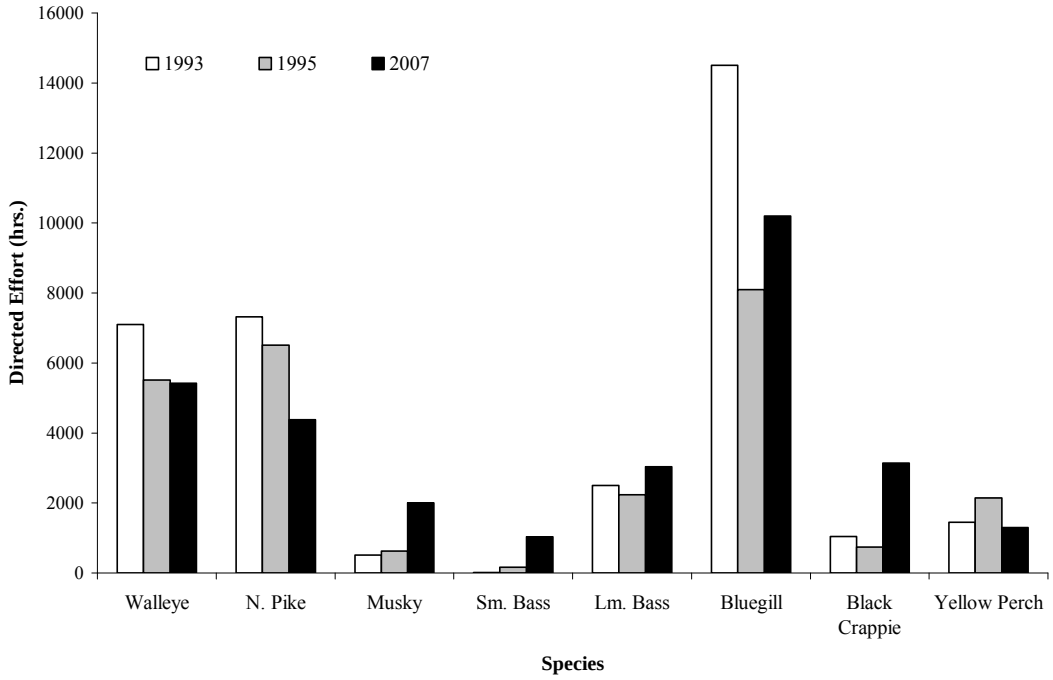

Figure 7. Directed fishing effort for sportfish in Lower Eau Claire Lake, Douglas County, Wisconsin.
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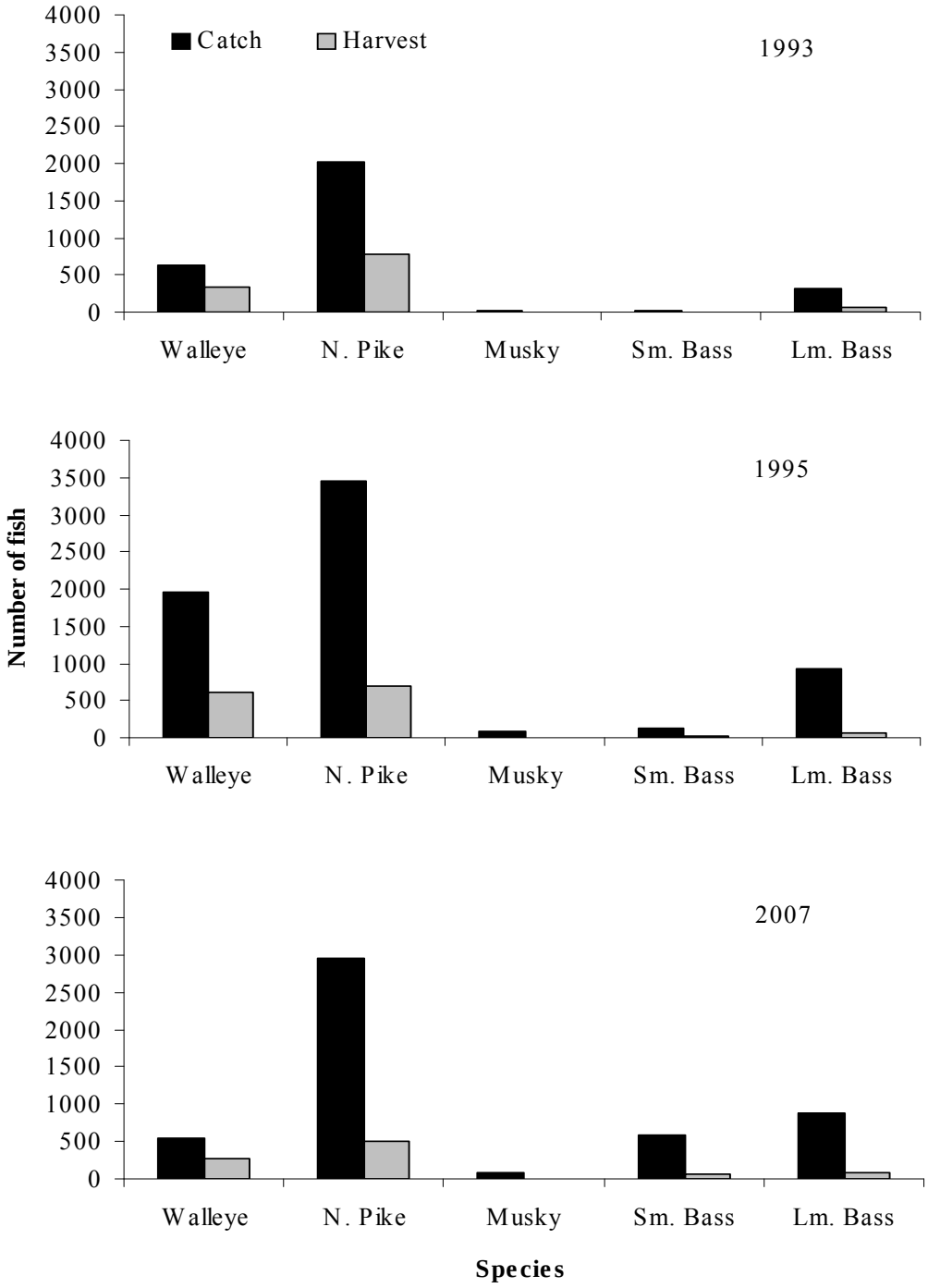

Figure 8. Catch and harvest of gamefish on Lower Eau Claire Lake, Douglas County, Wisconsin.

Appendix Table 1. 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
Smallmouth Bass	7	11	14
Walleye	10	15	20