Investigational Review of Walleye and Muskellunge Management in Upper Eau Claire Lake, Bayfield County, 1983 – 2006.
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Executive Summary

Upper Eau Claire Lake is large, clear water, drainage lake in southeastern Bayfield County. The lake supports popular sport fisheries for walleye, muskellunge, northern pike, largemouth bass, smallmouth bass, black crappie, and bluegill. Recent fisheries management activities have largely focused on walleye and muskellunge. Past and present surveys suggest Upper Eau Claire Lake supports a low density, fast growing, walleye population supported largely by natural reproduction. Efforts to bolster walleye abundance through stocking were largely ineffective. Supplemental stocking of over 325,000 small walleye fingerling failed to achieve any positive effect on walleye abundance or recruitment. Poor pond production and less than ideal rearing techniques hampered cooperative efforts to stock and evaluate large fingerling walleye. Despite low stocking rates (≤ 4 fish/acre), six stockings of cooperatively reared large walleye fingerling contributed 11% to the adult stock and 17% to the cohorts affected by stocking. Although walleye abundance remained stable, chronically high total rates of exploitation from substantial sport and tribal fisheries appear to be resulting in size structure declines. Stocking and harvest management strategies aimed at muskellunge appear largely successful. Relative abundance of muskellunge increased eight fold since the initiation of stocking in 1984. Size structure was good. Legal length muskellunge (> 40 in) comprised 27% of the adult stock. Major management changes recommended for Upper Eau Claire Lake include 1) discontinuation of small walleye fingerling stockings and further evaluation of large fingerling stockings, 2) increased surveillance of walleye abundance and recruitment to more accurately determine safe harvest levels and the potential impacts of high harvest rates on natural reproduction and 3)

promoting educational initiatives that instill the importance of wise shoreland management to healthy water resources in Upper Eau Claire Lake.

Introduction

Upper Eau Claire Lake is a 944 acre drainage lake in southeastern Bayfield County, situated at the headwaters of a series of interconnected lakes collectively known as the Eau Claire Lakes Chain (Figure 1). The chain forms the headwaters of the Eau Claire River which drains into the upper reaches of the St. Croix River. Upper Eau Claire Lake has a maximum and mean depth of 92 and 29 ft, respectively. Water clarity and quality are excellent and generally reflective of the lake's late oligotrophic early mesotrophic status. Mid summer secchi disc visibility commonly approach 18 ft. Chlorophyll-*a* and total phosphorous average 3.2 ug/l and 12.6 ug/l, respectively (Self-Help Monitoring 2005). Littoral substrates are predominately sand. With the exception of a few shallow flats and isolated bays, aquatic plants are sparse. Water levels in Upper Eau Claire Lake are maintained above natural lake elevations by a 3-foot dam at the outlet. Much of the lake's 7.9 square mile watershed is forested and privately owned. Public frontage is restricted to one state-owned island and a township boat landing on the lake's north side. The area in general has a wealth of high quality aquatic and shoreland resources that have been increasingly targeted for development in recent decades.

Fisheries management activities have primarily focused on stocking, periodic surveys, and habitat enhancement. Stockings dating back to 1936 have primarily focused on walleye *Sander vitreus* and muskellunge *Esox masquinongy*. Early stockings of largemouth bass *Micropterus salmoides* and panfish (centrachidae) during the late 1930s likely stemmed from fish rescue and transfer operations on the Mississippi River (Becker 1983). Attempts at two-story management through semi-annual rainbow trout *Salmo gairdneri* stockings during the late 1980s were discontinued due to poor survival and return to the angler. Recent stocking has focused solely on walleye and muskellunge. With the exception of 2,000,000 walleye fry in 1982, no walleye were stocked between 1969 and 1987. Walleye stockings since 1988 stemmed from comprehensive stock assessments in 1983 and 1993 which found walleye abundance to be below statewide management objectives (Staggs et al.1990). This prompted intensive stockings of both small and large walleye fingerlings utilizing state and tribal hatcheries and cooperative rearing ponds managed by a local conservation club (Sand 2004). Through the combined effort, 509,066 walleye of various sizes have been stocked (Table 1). Habitat enhancement efforts have included construction of a spawning reef aimed at improving walleye reproductive success and fish crib projects. Muskellunge have been stocked semi-annually since 1984.

Upper Eau Claire Lake supports popular recreational fisheries for walleye and muskellunge, northern pike *E. lucius,* largemouth bass, smallmouth bass *M. dolomieui*, black crappie *Pomoxis nigromaculatus*, and bluegill *Lepomis macrochirus*. With the exception of walleye and muskellunge, sport harvest has been largely managed through statewide length and bag restrictions. A tribal spear fishery for walleye has been in effect since 1988. The combined fishery (sport and tribal) is managed through spear quotas derived from annually adjusted safe harvest levels and angler bag limits reductions (Staggs et al.1990). Walleye regulations include a 15 in minimum length limit and five fish bag, however since the onset of the tribal fishery bag limits have largely been two walleye per day. A 40 in minimum length limit on muskellunge aimed at improving size structure was enacted in 1996. The purpose of this report is to evaluate the current status and management of walleye and muskellunge stocks in Upper Eau Claire Lake.

Methods

Walleye stocks were sampled in 1993 and 2004 according to Hennessy (2002). Walleye were captured with fyke nets (4 x 6 ft frames, 0.5 in bar mesh) set in spawning areas immediately after ice out. Lead length varied and generally equaled the distance between shore and the 4-foot contour. Water temperatures in both years ranged from 38 – 46 F. Gamefish captured were measured to the nearest 0.1 in total length (TL). For aging purposes, the second dorsal spine was sub-sampled from 10 walleye per in group, per sex. Sexable and unsexable walleye ≥ 15 in were given a primary fin-clip and released. Juvenile walleye and muskellunge were given a top-tail clip and released. Immediately after marking a sufficient number of spawning walleye, a single night of electrofishing was conducted to estimate the adult stock. The entire shoreline was sampled utilizing two variable voltage AC boomshockers with two dippers. Unmarked walleye and muskellunge were fin-clipped according to procedures utilized during the netting period. Electrofishing was similarly conducted again in May to obtain estimates of total walleye abundance. All gamefish were measured, observed for fin clips, but only muskellunge were fin-clipped prior to release.

Additional fyke netting targeting muskellunge was conducted in 2005. Muskellunge collected were measured to the nearest 0.1 in and observed for fin-clips. Abundance of muskellunge ≥ 30 in was calculated using 2004 and 2005 as the marking and recapture sample, respectively (Hanson 1986). Numbers in the recapture sample were adjusted for recruitment over a 1-year period using average Wisconsin growth rates.

Annual fall electrofishing surveys (1988 – 2006) to determine the relative abundance of age-0 walleye (year-class strength) were conducted by the Wisconsin Department of Natural Resources (WDNR) and the Great Lakes Indian Fish and Wildlife Commission (GLIFWC). Methodologies of these surveys are described in detail by Sand (2004).

With the exception of 1983, abundance estimates for walleye and muskellunge were calculated using the Chapman and Bailey modifications of the Petersen formula, respectively (Ricker 1975). Multiple census procedures (Schnabel estimate) were used to determine walleye abundance in 1983. Abundance estimates for walleye in 1991 and 1999 were conducted by

GLIFWC utilizing methodologies described by Ngu and Kmiecik (1993) and Rose et al. (1999). Abundance estimates by length and age were obtained by proportioning length and age frequencies obtained with fyke nets to the estimated abundance of walleye $\geq$ 10.0 in. The variance (of a proportion) for these estimates was calculated using the formula:

$$var\ (p \cdot pe) = p^2 \cdot var(pe) + pe^2 \cdot var(p) - var(p) \cdot var(pe),\ \text{where}$$

var = variance

p = the proportion of fish sampled in length group

pe = population estimate for fish $\geq$ 10 in.

The Mann–Whitney Rank Sum Test (SPSS 2003) was used to test for differences in the abundance of walleye age-classes originating from stocked and non-stocked years. Large fingerling walleye (> 4 in) were marked with a discreet fin clip annually to determine their contribution to each cohort. The microcomputer software FishCalc89 (FishCalc89 1989) was used to generate length and age distributions. Proportional (PSD) and relative (RSD) stock densities for walleye were calculated according to Anderson and Gutreuter (1983). The PSD and RSD values were calculated using 30 in as stock size for muskellunge (Hanson 1986). Walleye spines were cross-sectioned and viewed microscopically at 100X according to Margenau (1982). Growth rates were compared to a regional average (18 county Northern Region) using the statewide database.

Creel census data were collected during the open water and ice fishing season in 2004-2005 beginning the first Saturday in May and continuing through 1 March of the following year (the open season for game fish angling in Wisconsin). No creel survey data was collected during November because thin ice created dangerous fishing conditions. Creel survey methods followed a stratified random design as described by Rasmussen et al. (1998).

Results

Walleye. Past and present surveys suggest Upper Eau Claire Lake supports a low density walleye population. Walleye abundance since 1983 has remained relatively stable; abundance of adult walleye ranged from 1,800 (1.7 adults/acre) in 1999 to 2,660 (2.5 adults/acre) in 1993 (Table 2). Relative to other Bayfield and Douglas County lakes, adult density in all years for Upper Eau Claire Lake was less than in lakes supported entirely by natural reproduction (mean = 4.1 adults/acre, n = 11 lakes, SD = 2.2) but similar to stocked lakes (mean = 2.0 adults/acre, n = 11 lakes, SD = 0.9).

Walleye stocking has had little effect on adult walleye densities. Pre and post stocking densities of adult walleye were similar (1983 = 2.0 adults/acre, 2004 = 1.9 adults/acre). Total walleye abundance in 1993 and 2004 was 6,995 and 12,380, respectively. Non stocked year-classes in 2001 – 2003 contributed to higher total abundances in 2004.

Walleye size structure in Upper Eau Claire Lake has historically been good; however there have been shifts in the length distribution (Figure 2). Proportions of adult walleye ≥15 in declined from near 90% in 1983 and 1993 to 72% in 2004. Mean length declined from 18.5 in (n = 797, SD = 3.0) in 1983 and 19.6 in (N = 406, SD = 3.5) in 1993 to 17.3 in (N = 655, SD = 3.6) in 2004. Smaller size structure in 2004 was largely attributable to two-fold increases in adult walleye ≤ 15 in (Table 3). In addition, abundance of fish between 15 and 25 in declined 40% between 1993 and 2004 (Table 3). Trophy walleye (≥ 25.0 in) were more common since 1983 (Table 3). Estimated abundance of these large fish increased from 2.9% of the adult population in 1983 to 7.9% and 6.0% in 1993 and 2004, respectively.

Age of adult walleye sampled ranged from 3 – 18 yrs in 1993 and 2 – 15 yrs in 2004. Initiation of maturity for male walleye declined from age 3 in 1993 to age 2 in 2004. In both years female walleye initiated maturity at age 4. Recent populations appear increasingly dominated by younger walleye (Figure 3). Walleye age 7 yrs and older comprised 45% and 23%

of the adult stock in 1993 and 2004, respectively. Modal age of adult male and female walleye declined from age 5 and age 7 in 1993 to age 3 and 4 in 2004. Abundance of walleye age 5 and older declined 52% since 1993.

Walleye growth in 1993 and 2004 was similar and above the regional average (Figure 4). Growth in both years was dimorphic; male and female walleye attained legal harvestable length (15 in) during their fourth and third growing season, respectively. Trophy length (25 in) was generally attained in 11 growing seasons.

Fall electrofishing surveys from 1988 - 2006 indicate abundance of age-0 walleye was variable with strong and weak year-classes occurring in both stocked and non-stocked years (Table 4). Relative abundance of age-0 walleye in stocked years ranged from 0.8 – 80.5 fish/hour (average = 23.8 fish/hour, SD = 25.8) and from 0.4 – 29.0 fish/mile (average = 9.4 fish/mile, SD = 9.74). Relative abundance of age-0 walleye in non-stocked years ranged from 0.2 – 117.7 fish/hour (average = 33.6 fish/hour, SD = 42.7) and from 0.1 – 37.1 fish/mile (average = 12.1 fish/mile, SD = 14.7). Abundance of age-0 walleye in stocked and non-stocked years was not significantly different (Mann-Whitney, age-0/hr: P = 0.96; age-0/mile: P = 0.96).

Natural reproduction occurred in all non-stocked years. Since the last fingerling stocking in 2000, strong natural year-classes were produced in 2001 and 2005 and 2006. The contribution of fry stocking to the strong 2004 year-class was likely negligible, but remains unclear.

Survival of six large fingerling stockings to their respective adult cohort in 2004 was generally poor (Table 5). Contribution ranged from 0% to 27.2% (x = 11.6%, SD = 11.02). No fingerlings (0%) stocked in 1996 survived to age 8. Only 141 (3.3%) fingerlings stocked in 2000 were estimated to have survived to age 4. Overall, walleye stocked as large fingerlings comprised 11.3% of the adult stock and 17.2% of the age-classes affected by stocking. Of the 18,826 large fingerlings stocked between 1995 and 2000 only 257 (1.4%) were estimated to survive. Most mortality appears to occur the first year at large. Only 3.3% of the large fingerlings stocked in 2000 survived one-year post stocking (Sand 2004).

Muskellunge. Fyke nets captured a total of 63 muskellunge in 2004 and 2005. Size structure of muskellunge was good. Mean length and range of male muskellunge was 33.8 in (N = 38, SD = 4.5) and 23.8 – 41.4 in, respectively. Mean length and range of female muskellunge was 39.6 in (N = 24, SD = 5.7) and 30.8 – 50.5 in, respectively. Legal length muskellunge (≥ 40 in) comprised 27% of the adult (≥ 30 in) catch. RSD-34 and RSD-40 was 66 and 27, respectively

Abundance of adult muskellunge was 125 (0.13 fish/acre; CV = 22.5). Muskellunge have become increasingly common since the initiation of stocking in 1984. Relative abundance of adult muskellunge increased from 0.07 fish/lift in1983 and 0.16 fish/lift in 1993 to 0.58 fish/lift in 2004 and 0.64 fish/lift in 2005 (Figure 5). Fall electroshocking inventories in 1993 and 2004 suggest recruitment is highly driven by stocking; 93% of the age-0 muskellunge sampled were fin-clipped fingerlings of hatchery origin. Historical surveys indicate a small self-sustaining population of muskellunge was present prior to stocking. (Weiher 1970).

Sport and Tribal Fishery. Fishing pressure over the last decade has remained stable. Anglers fished an estimated 20,227 hours and 20,545 hours during the 1993-1994 and 2004-2005 fishing seasons, respectively. Open water anglers accounted for between 84% and 93% of the annual fishing effort. Walleye and northern pike were the most sought after gamefish, accounting for over half (55%) of the effort directed at gamefish. Angler effort for walleye in 1993 (6,194 hrs) and 2004 (6,309 hrs) was similar. Since 1993, muskellunge grew increasingly popular. Angler effort targeting muskellunge, increased from 1,759 hours in 1993 to 3,711 hours in 2004.

Next to northern pike, walleye were the second most harvested gamefish. Total catch of walleye in 1993 and 2004 was 390 and 688, respectively. Anglers harvested 288 or 74% of their catch in 1993 and 325 or 47% of their catch in 2004. Mean length of angler walleye harvested declined from 20.4 in (SD = 3.2) in 1993 to 18.5 in (SD = 3.3) in 2004. Walleye between 15.0

and 20 in comprised 53% and 71 % of the angler harvest in 1993 and 2004, respectively. Despite increases in total harvest (sport + tribal), anglers harvested 37% fewer walleye > 20 in in 2004 compared to 1993 (Table 6). Higher walleye catches but similar harvests suggest catch of sub-legal fish was higher in 2004. Angler exploitation of the adult stock was 11% and 16% in 1993 and 2004, respectively (Table 6).

Tribal spearers harvested 148 walleye and 349 walleye in 1993 and 2004, respectively (Kruger 2005). Male walleye comprised more than 85% of the tribal harvest in both years. Mean length of speared walleye was 17.6 in (SD = 2.5) in 1993 and 16.4 in (SD= 2.3) in 2004. Spearing accounted for 34% and 52% of the total harvest in 1993 and 2004 (Table 6). Spearing exploitation of the adult stock was 6% and 18% in 1993 and 2004.

Total exploitation (sport + tribal) of the adult stock in 1993 and 2004 was 16% and 34%, respectively (Table 6). Variations in total exploitation were largely due to methodologies of establishing safe harvest levels. Safe harvest levels in 1993 were determined using the 1991 population estimate. In 2004, safe harvest levels were determined using a regression model which estimates walleye abundance by lake size.

Estimated angler catch of muskellunge in 1993 (n = 67) and 2004 (n = 65) was similar. On the average, one muskellunge was caught for every 49 hours of targeted angling effort in 1993 compared to 75 hours in 2004. An estimated 10 muskellunge were harvested in 1993. Mean length and range of muskellunge harvested was 42.3 in (SD = 7.4) and 33.9 – 48.0 inches, respectively. No muskellunge were recorded as harvested in 2004. Tribal harvest of muskellunge was generally low. A total of 13 muskellunge have been harvested since the onset of the tribal fishery in 1988. No muskellunge were harvested in 1993 and only 4 fish were speared in 2004 and 2005 fishing seasons combined.

Discussion

Past and present survey data suggest Upper Eau Claire Lake supports a low density walleye population supported largely by natural reproduction. Natural reproduction appears low and variable, however recent strong natural year classes are encouraging. Efforts to improve recruitment through stocking have been largely unsuccessful. Despite nearly a decade of near annual stocking, pre- and post stocking densities of adult walleye remained essentially unchanged and supplemental stockings failed to have any measurable impact on year-class strength.

Whether stocked fingerlings are displacing native fingerlings (Jennings et al. 2005) or succumbing to poor survival remains unclear. The relative similarity in year-class strength between stocked and non-stocked years suggests any contribution from stocking may have suppressed natural reproduction. Survival of stocked walleyes however is known to be highly variable (Kampa 1998) and subject to a gamut of influences including predation (Santucci and Wahl 1993), forage availability (Feilder 1992), competition (Fayram et al. 2005), physical characteristics of stocked waterbodies (Nate et al. 2003), and size and condition of stocked fingerlings (Olson et al. 2000).

Certainly, poor survival of the mostly small fingerlings stocked may have contributed to poor stocking success. More than 90% of the 359,066 walleye fingerlings stocked in this investigation measured less than 2.0 in in length. Efforts to stock and evaluate large (> 4.0 in) fingerling were hampered by poor pond production and less than ideal rearing and distribution techniques. As a result, large fingerling walleye stockings evaluated were stocked at rates of 4 fish/acre or less and those stocked varied widely in size, age, and condition. Despite the low numbers and variable condition, large fingerling stockings comprised 11% of the adult stock and 17% of the adult age-classes affected by stocking. Whatever the reasons for lack of stocking success in Upper Eau Claire Lake, these findings agree with Li et al. (1996), who found that supplemental stocking of small fingerlings was largely ineffective at increasing walleye abundance in Minnesota lakes with natural reproduction.

Good walleye growth and size structure appears to be density dependent (Sass et al. 2004). Despite static growth and abundance, age at maturity and size structure of walleye appear to be declining. Whether these changes are symptomatic of the cumulative effects of high exploitation or natural variations in recruitment remain unclear. Upper Eau Claire Lake supports substantial sport and tribal harvests totaling 400 to 700 walleye annually. Although safe harvest levels derived from population estimates in 1993 resulted in relatively low rates of total exploitation, use of lake area models in 2004 provided higher numbers for safe harvest and resulted in a two-fold increase in spear harvest, and total harvest which approached the 35% total allowable catch (Staggs et al. 1990). Lake area models were developed to provide conservative estimates of safe harvest in the absence of recent population estimates (Hansen 1989). Although the high safe harvest quotas that resulted from the use of these models seem contrary to their intent, there is no evidence to suggest total harvest has exceeded levels which would risk population decline. Given the reliance on lake area models in recent years however, walleye populations were likely subject to relatively high rates of total exploitation in 6 out of the last 10 years. Although stable walleye abundance and 3 strong naturally reproduced year-classes since 2000 suggest current harvest management regimes have maintained a generally healthy, self-sustaining population, higher exploitation in recent years may have contributed to size structure declines and not allowed abundance to increase.

Efforts to improve the muskellunge fishery in Upper Eau Claire Lake through stocking and harvest regulation appear successful. Relative abundance data suggest muskellunge have increased eight-fold since the initiation of stocking in 1984. Despite increases in abundance, muskellunge density remains low (0.13 fish/acre $\geq$ 30 in) but within density ranges (0.05 - .0.99

fish/acre) reported by Hanson (1986) and Margenau and AveLallemant (2000). Size structure of recent populations was better than average; RSD-34 and RSD-40 were 66 and 27, respectively. Mean RSD-34 and RSD-40 on 15 Wisconsin lakes studied by Margenau and AveLallemant (2000) was 59 and 13, respectively.

Effects of the 40 in minimum length limit on population abundance and size structure remain unclear due to the low numbers of muskellunge sampled in earlier surveys and stocking induced influences on recruitment. Increased relative abundance of nearly all size and age-classes of muskellunge however, was likely aided by the apparent reductions in harvest since implementation of the regulation in 1996. Changes in angler attitudes regarding live release have increased with time and have subsequently helped reduce harvest and improve muskellunge size structures (Simonson and Hewett 1999; Margenau and Petchenik 2004).

Summary and Management Recommendations

1). Discontinue small fingerling stockings. Supplemental stockings totaling over 325,000 small walleye fingerling since 1988 failed to achieve any appreciable effect on year-class strength or walleye abundance. Results of this investigation confirm previous findings (Sand 2004) that to date, natural reproduction has been the largest factor influencing walleye abundance in Upper Eau Claire Lake.

2). Monitor trends in walleye recruitment through annual fall electrofishing inventories. Monitoring the strength of naturally recruited year-classes may be the most practical and upfront means of determining the impact of high harvest rates on walleye reproduction. Continued monitoring of year-class strength in non-stocked years may also shed light on the recent trend of strong year classes in 4 of the last 6 years. If three consecutive years of low natural reproduction are found during fall surveys in the future, stocking of large walleye fingerlings with fin clips should be considered to better discern their impact on year class contribution and overall abundance. Although past large fingerling walleye stockings had no apparent effect on walleye abundance, the programs effectiveness may have ultimately been limited by the low numbers of large fingerlings stocked and the variable condition of the fingerlings at the time of stocking. Walleye genetic studies are currently underway in Wisconsin, results and recommendations from these studies should be considered before future stocking of walleye into Upper Eau Claire Lake occurs.

3). Conduct walleye stock assessments every six years to insure annually adjusted safe harvest levels more adequately reflect walleye population abundance. Safe harvest levels derived from population estimates result in more sustainable rates of exploitation and would protect the population from the damaging effects of over-harvest. Encourage a TWIG review of safe harvest levels derived from lake area models. Data from Upper Eau Claire Lake suggest the use of lake area models on low density walleye lakes may result in total exploitation rates which exceed over-harvest criteria set for ceded territory walleye stocks.

4). Retain the existing 15 in minimum length limit for walleye. Although low walleye density, fast growth and high exploitation are conducive to higher minimum length limits, added restrictions on the sport fishery would likely result in less than a 50/50 allocation of the total annual harvest. An 18 in minimum length limit for walleye should be considered however, if future investigations indicate size and age structure has further declined.

5). Continue alternate year stockings of 478 (0.5 fish acre) muskellunge fingerlings in even numbered years. Current stocking practices have resulted in a popular sport fishery and abundances that appear conducive to balanced predator-prey relationships. Maintain the current 40 in minimum length restriction on muskellunge pending future investigations into the restrictions impact on the species size structure and abundance.

6). Work with area residents and Bayfield County Zoning to create and adopt a lake management plan incorporating all phases of water resource and shoreland management. The plan should 1) develop strategies for identifying, protecting and enhancing sensitive aquatic and shoreland habitats; 2) implement self help water quality monitoring and provide mechanisms for control of satellite exotic infestations; and 3) provide an educational and interactive forum for environmentally sensitive shoreland living.

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Table 1. Walleye stocking history for Upper Eau Claire Lake, Bayfield County, 1988 - 2004. With the exception of a 1982 stocking of 2,000,000 walleye fry, no stocking occurred from 1969 - 1987. No walleye were stocked after 2004.

Year	Fry	Small Fingerling	Large Fingerling	Total
1988		50,318		50,318
1991		25,000		25,000
1992		58,750	14,025	72,775
1993			980	980
1994			1,858	1,858
1995		49,900	4,388	54,288
1996		5,519	1,620	7,139
1997		53,208	386	53,594
1998		20,118	3,926	24,044
1999		49,800	2,040	51,840
2000		13,000	4,230	17,230
2004	150,000			150,000
Total	150,000	325,613	33,453	509,066

Table 2. Estimates of abundance, density, coefficient of variation (C.V.) and 95% confidence intervals (C.I.) for adult (>10.0 in) walleye, Upper Eau Claire Lake, 1983-2004.

Year	Agency	Abundance	C. V.(%)	95% C.I.		No/Acre
1983	WDNR	2,034	7.5	1,772	2,387	2.0
1991	GLIFWC	2,412	22.0	1,551	3,273	2.3
1993	WDNR	2,660	14.0	1,936	3,383	2.5
1999	GLIFWC	1,800	6.0	1,600	2,001	1.7
2004	WDNR	1,993	7.0	1,737	2,249	1.9

Table 3. Estimated adult walleye abundance by length, Upper Eau Claire Lake, Bayfield County, 1983 - 2004. Percent coefficient of variation (CV) of estimated abundance in parenthesis for 1993 and 2004.

	1983		1993		2004	
Length Interval (in)	Percent	Estimated Abundance	Percent	Estimated Abundance	Percent	Estimated Abundance
10.0 - 14.9	10.7	217	8.4	223 (21.4)	27.8	554 (9.1)
15.0 - 19.9	61.4	1248	49.5	1316 (14.7)	52.2	1040 (7.6)
20.0 - 24.9	25.1	510	34.2	911 (15.4)	14.0	280 (11.7)
25.0+	2.9	59	7.9	210 (21.8)	6.0	119 (16.8)
Total	100.0	2034 (8.0)	100.0	2660 (14.0)	100.0	1993 (7.0)

Table 4. Relative abundance of YOY walleye in Upper Eau Claire Lake, Bayfield County, 1988 - 2005. Number stocked represents the number of walleye fingerlings (all sizes) stocked prior to electrofishing evaluations. Standard deviation in parenthesis.

		Natural		Combined	
Year	Number Stocked	Catch/ Hour	Catch/ Mile	Catch/ Hour	Catch/ Mile
1988	50,318			10.4	5.4
1990	0	0.2	0.1		
1991	0	4.6	1.9		
1992	59,700			60.7	25.1
1993	328			10.3	3.2
1994	0	2.1	0.7		
1995	49,919			21.5	8.9
1996	650			0.8	0.4
1997	49,800			8.9	4.2
1998	20,118			21.8	9.6
1999	51,840			9.4	3.1
2000	17,230			14.2	5.1
2001	0	74.9	31.8		
2002	0	14.3	5.7		
2003	0	10.5	3.8		
2004	*150,000			80.5	29.0
2005	0	44.7	15.3		
2006	0	117.7	37.1		
	Mean:	33.6 (42.6)	12.1 (14.7)	23.8 (25.8)	9.4 (9.7)

* Fry plant

Table 5. Survival and contribution of stocked large fingerlings by cohort, Upper Eau Claire Lake, 2004. Percent coefficient of variation in parenthesis.

	Cohort					
	2000	1999	1998	1997	1996	1995
Number of Large Fingerling Stocked	4,230	2,040	3,926	3,794	513	4,323
Age at Determination	4	5	6	7	8	9
Estimated Number of Survivors	141 (29.1)	16 (35.1)	83 (31.3)	14 (35.9)	0 (0.0)	3 (78.4)
Survival (%)	3.3	0.8	2.1	0.4	0.0	0.1
Estimated Cohort Abundance	600 (8.9)	290 (9.8)	305 (11.3)	193 (13.6)	53 (18.1)	50 (25.4)
Stocked Contribution (%)	23.5	5.5	27.2	7.3	0.0	6.0

Table 6. Harvest and relative exploitation by length for Upper Eau Claire lake walleye, 1993 and 2004. Percent exploitation is the quotient of estimated harvest divided by the estimated number of fish present at the start of the fishing season.

	1993				2004			
Length Interval	Spear Harvest	Angler Harvest	Total Harvest	Percent Exploitation	Spear Harvest	Angler Harvest	Total Harvest	Percent Exploitation
10.0 - 14.9:	16	0	16	7.2	95	9	104	18.8
15.0 - 19.9:	112	154	266	20.2	235	231	466	44.8
20.0 - 24.9:	16	106	122	13.4	15	64	79	28.2
25.0+:	4	28	32	15.3	4	21	25	21.0
Total:	148	288	436	16.4	349	325	674	33.8

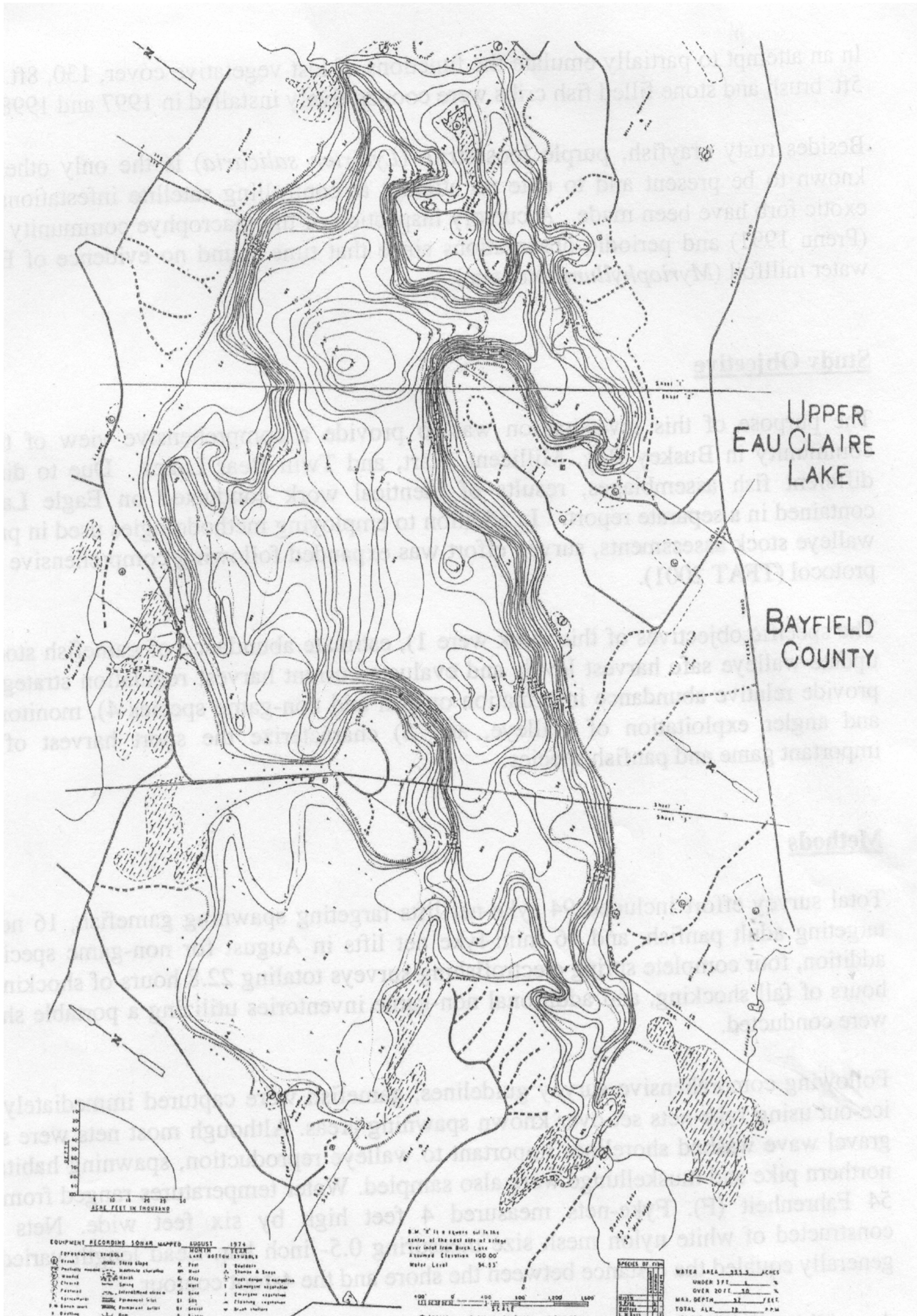

Figure 1. Upper Eau Claire Lake, Bayfield County, Wisconsin.

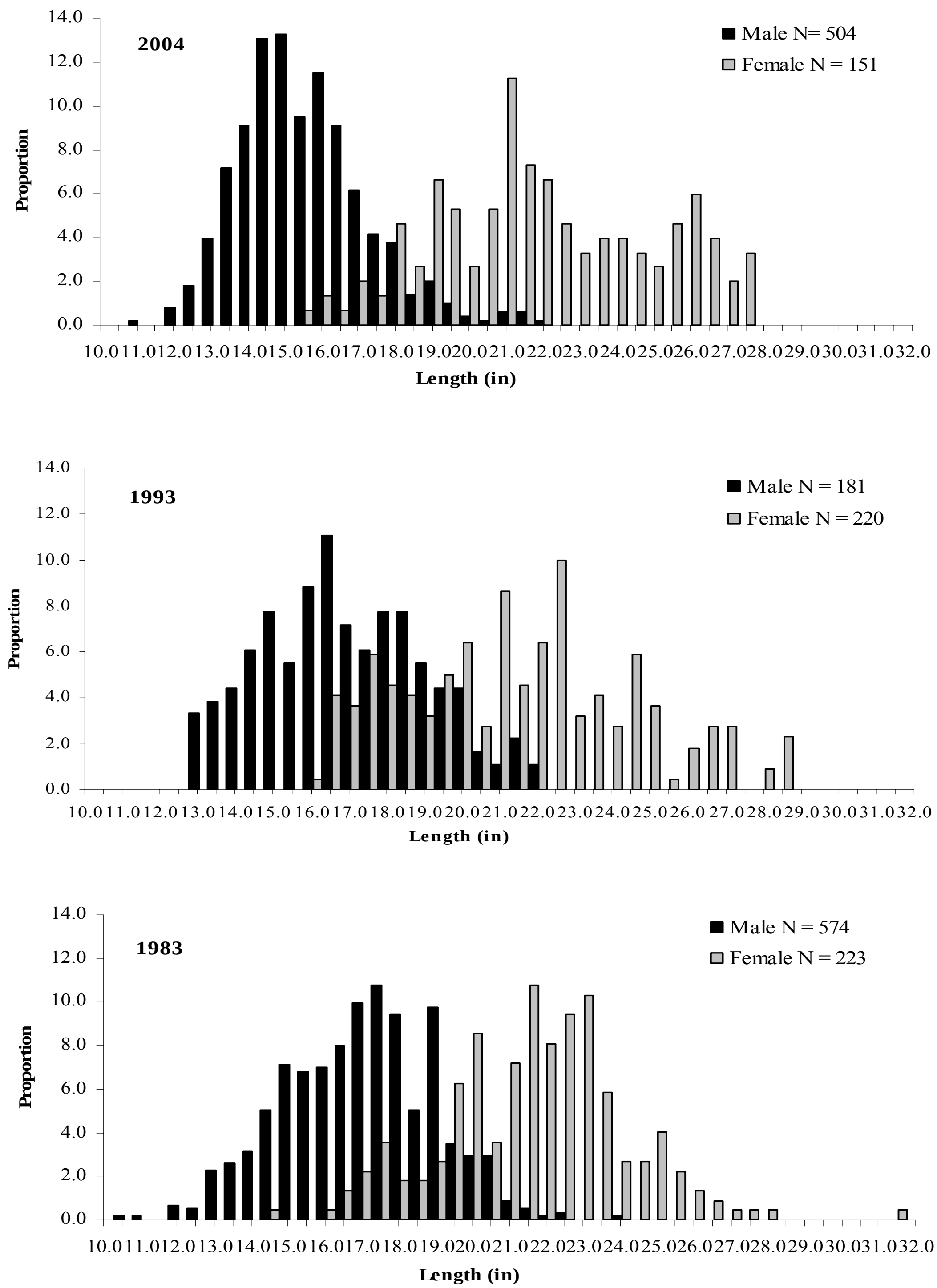

Figure 2. Length frequency of walleye captured fyke-netting in Upper Eau Claire Lake, Bayfield County, 1983 – 2004.

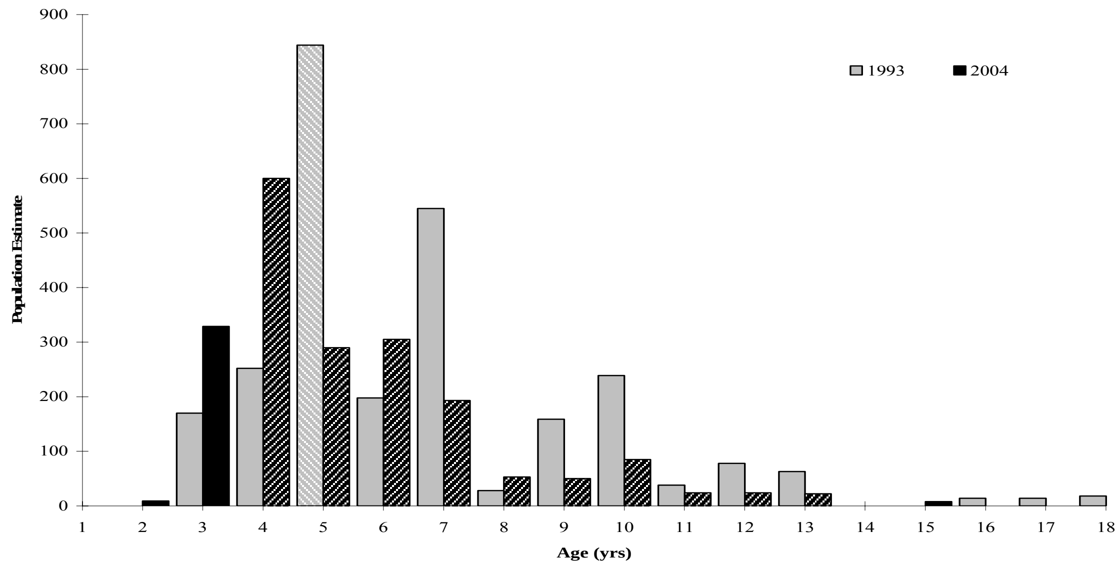

Figure 3. Age distribution of Upper Eau Claire Lake walleye, 1993 and 2004. Diagonal and solid bars represent cohorts stemming from stocked and non-stocked years, respectively.

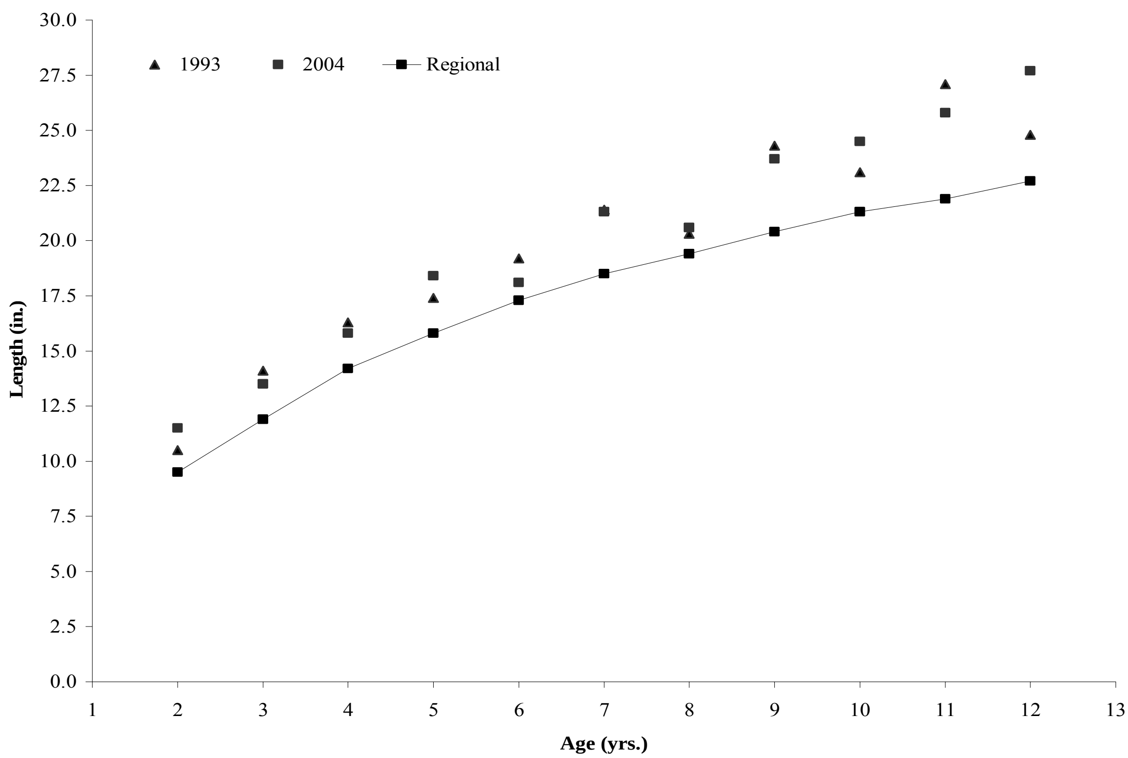

Figure 4. Walleye length at age, sexes combined, Upper Eau Claire Lake, Bayfield County, 1993 and 2004.

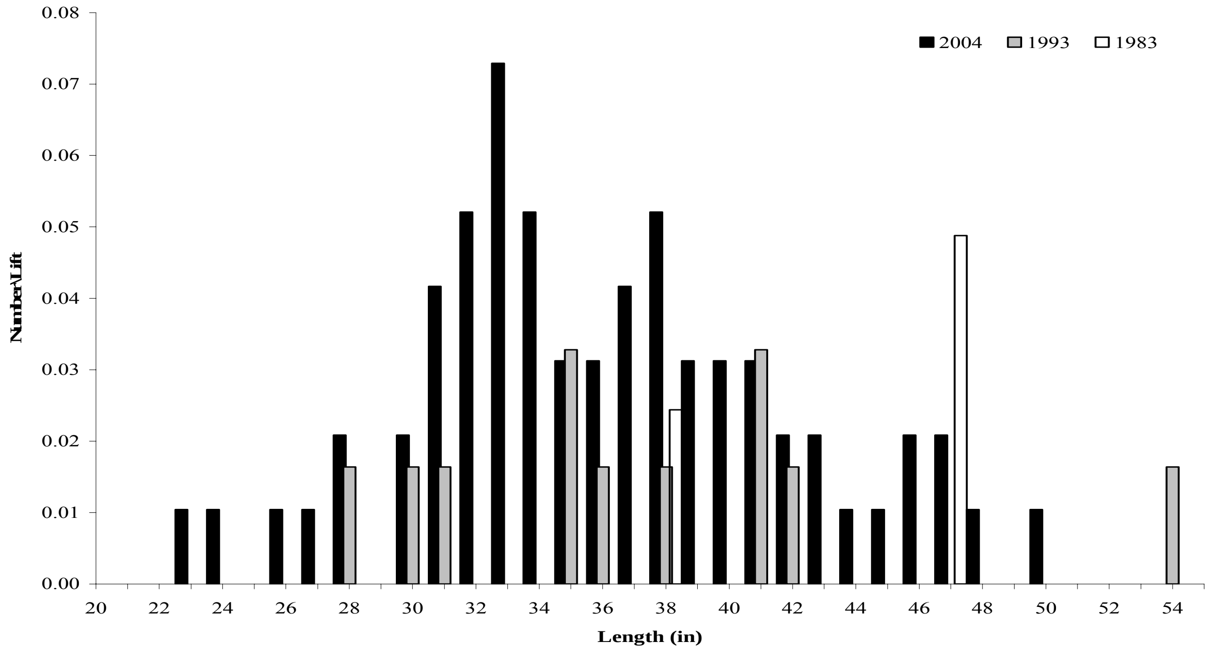

Figure 5. Fyke-netting relative abundance of muskellunge, Upper Eau Claire Lake, Bayfield County, 1983 – 2004.