

**Status of the Muskellunge Fishery  
Bone Lake, Polk County, WI, 2005  
MWBIC Code: (2628100)**



**By**

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## Executive Summary

Bone Lake was chosen as a muskellunge (*Esox masquinongy*) trend monitoring lake by the Wisconsin Department of Natural Resources. Since 1990, muskellunge fishing regulations have consisted of a 40-inch minimum length limit, with a daily bag of one fish. Data from six sampling periods (1964, 1982, 1985, 1990, 1995 and 2005) were available to monitor trends in muskellunge population parameters.

Muskellunge adult densities ( $\geq 30.0$  in) ranged from 0.18 to 0.98 fish/acre during the period 1964-2005. In 2005, muskellunge adult densities decreased to 0.55 fish/acre from 0.98 fish/acre in 1995. Although adult densities decreased, the number of legal length muskellunge ( $\geq 40$  in) remained similar between the two sampling periods (0.11 fish/acre). Muskellunge condition improved from 1995 to 2005. The mean relative weight of adult muskellunge in 1995 was 96 compared to 104 in 2005.

A 62% reduction in muskellunge stocking from 1994-2004 is likely responsible for the decrease in muskellunge abundance. In addition, the stabilized number of muskellunge  $\geq 40$  in is likely related to the existing protective regulation along with changes in angler attitudes toward the harvest of muskellunge. Low numbers of muskellunge recruiting into the adult fishery and the limited number of larger trophy size fish ( $\geq 45$  in) may be related to a combination of mortality, intraspecific competition affecting available food resources, and the current minimum length limit. Increasing the muskellunge minimum length limit to 50 in is recommended to increase the abundance of 45 in and larger fish. Additional monitoring of the muskellunge population should occur within the next 8-10 years.

## Introduction

Bone Lake is a 1,781-acre drainage lake with a maximum depth of forty-three feet and a mean depth of twenty two feet located in western Polk County near Balsam Lake, Wisconsin (Figure 1). Bone Lake is the headwaters of Fox Creek which flows into the Apple River. Private residential development is common along most of the shoreline of Bone Lake.

Muskellunge management began in Bone Lake in 1935. Muskellunge are not native to Bone Lake or any Polk County lakes (Becker 1983). Bone Lake is a Class A2 muskellunge water (WDNR 1996). The A2 classification is for waters that provide the most consistent angling action, and have the potential to produce some larger fish. The reproductive classification for Bone Lake is a Category 3 muskellunge water. This classification describes waters where natural reproduction of muskellunge is absent and stocking is necessary to provide maintenance of the population (WDNR 1996). Stocking of large fingerling muskellunge ( $\geq 7$  in) in Bone Lake has varied considerably since the mid 1950s (Cornelius and Margenau 1999). Inconsistent fingerling stocking occurred from 1993-2000 largely due to the closure/renovation of the hatchery in Spooner (Figure 2). Alternate year stocking of muskellunge at a rate of 1-2 fingerlings per acre began in 2001. The changes have resulted in a 62% reduction of muskellunge stocking between 1983 and 2004. From 1983 to 1993, 28,600 large fingerling muskellunge were stocked compared to 10,754 from 1994-2004. In addition, fry stocking occurred every year from 1983 to 2005 with the exception of 1984, 1991, 1994, 1997 and 1998. Fry stockings have traditionally occurred in waters used as egg sources for propagation (plant-backs).

Sport fishing regulations for muskellunge on Bone Lake have changed several times. In 1983, the minimum length limit was increased from 30- to 34-in. Seven years later (1990) the minimum length limit was increased again from 34- to 40-in. Daily bag limit during this time remained at one fish.

Tribal spring spear harvest of muskellunge on Bone Lake began in 1993 and has occurred annually from 1996-2006. In addition, a tribal winter spear harvest occurs. However, harvest is not recorded during winter spearing and it is unknown what level of harvest occurs from this effort.

This study is part of a statewide long-term monitoring effort of muskellunge populations in Wisconsin. Specific parameters of muskellunge populations to be monitored include population abundance, size structure and growth. Knowledge of these population parameters allows for responsible management of the

muskellunge fishery and sets the foundation for future management of muskellunge in Bone Lake. The objective of this study was to assess the muskellunge population in Bone Lake, and changes that may have occurred since 1995.

### **Methods**

Adult muskellunge were captured in two consecutive years using fyke nets (24-h sets) during the spring spawning period (Hanson 1986). Fyke nets had 4 X 6 ft frames with 1-in bar mesh and leads from 50 to 100 ft. Muskellunge were measured to the nearest 0.1 in (total length) and marked with a fin clip. All muskellunge handled were sexed (when possible) by presence of eggs or milt or by visual inspection of the urogenital pore (LeBeau and Pageau 1989). A subsample of muskellunge was also weighed to the nearest ounce. No growth information was collected as scale interpretations are often unreliable for accurate age determination of esocids and cleithra require sacrificing fish.

Abundance of adult muskellunge ( $\geq 30$  in) was estimated using Bailey's modification of the Petersen method (Ricker 1975). Muskellunge captured in the first year were marked for recapture in the second year. Numbers of fish captured in the second year were adjusted for recruitment over a 1-year period using sex-specific growth rates. Because no growth information was collected during 2005-2006, growth rates were used from the 1995-1996 sampling period. Several independent estimates were calculated: (1) mature muskellunge of each sex 30 in and greater and (2) mature muskellunge, sexes combined and unknowns, 30.0-33.9 in, 34.0-37.9 in, 38.0 in and greater, and 40.0 in and greater. Number of adult muskellunge 40 in and greater was determined from the proportion of muskellunge 40 in and greater handled in the marking run times the abundance estimate for fish 38 in and greater.

Size structure and condition of muskellunge were determined from spring sampled fish. Relative stock density (RSD) was used to describe population size structure (Anderson and Gutreuter 1983), with 30 in as stock size (Hanson 1986), and relative weight ( $W_r$ ; Neumann and Willis 1994) to describe condition of muskellunge. RSD represents the percent of fish larger than the stock length that are larger than a specified length (e.g. RSD-34). Changes in population size structure were determined using a Kolmogorov-Smirnov test and changes in mean length using *t*-tests. Linear regression was used to test the relationship between muskellunge relative weight and population density.

In an effort to get some insight into angler catch and harvest rates, 54 legal length ( $\geq 40$  in) muskellunge were tagged with numbered Floy anchor tags during the 2006 spring sampling period. All known public access points (public and private) were posted with a sign indicating whom to contact if an angler caught a tagged muskellunge.

## Results

Abundance of adult muskellunge ( $\geq 30$  inches) in 2005 decreased since 1995 (Table 1). Abundance of adult muskellunge in 2005 was 973 (0.55 fish/acre). In comparison, abundance in 1995 was 1,743 (0.98 fish/acre). Abundance was lower in all length groups  $< 40$  in.. For example, abundance of 30.0-33.9 in muskellunge was 284 in 2005 compared to 427 (1995; Table 1). Similarly, abundance of 34.0-37.9 in muskellunge decreased from 740 in 1995 to 368 in 2005 (Table 1). However, abundance of large muskellunge ( $\geq 40$  in) remained similar. In 1995, large muskellunge abundance was estimated at 196 fish (0.11 fish/acre) compared to 190 fish (0.11 fish/acre) in 2005 (Table 1).

Mean length of muskellunge sampled in Bone Lake decreased since 1995. Mean length of all adult muskellunge (sexes combined) decreased from 36.0 in in 1995 to 34.9 in in 2005 ( $t = 5.1$ ,  $P < 0.001$ ; Table 2). This decrease was the first significant decrease in mean length documented for the Bone Lake muskellunge since 1964 (Table 2). The decrease was largely due to a change in mean length of male muskellunge. Mean length of male muskellunge decreased significantly from 34.8 in to 33.2 in ( $t = 7.6$ ,  $P < 0.001$ ; Table 2). The mean length of female muskellunge increased slightly from 37.7 in (1995) to 38.3 in (2005), however this change was not significant ( $t = 1.8$ ,  $P = 0.07$ ; Table 2).

The overall size structure of adult muskellunge sampled in 2005-2006 shifted since the 1995-1996 survey ( $D = 0.17$ ,  $P < 0.001$ ; Figure 3). Changes in the size structure of muskellunge were also evident with stock density indices (RSD). RSD-34 values decreased from 75 ( $\pm 3$ ) to 66 ( $\pm 3$ ) between 1995 and 2005 (Table 3). In 1995-1996 a large percent (64%) of the adult muskellunge were between 34- and 40 in (Figure 3). The 2005-2006 population had a lower percent (39%) of fish in this length group but was better represented with smaller fish ( $< 34$  in) and RSD-40 values nearly doubled from 10 ( $\pm 3$ ) to 19 ( $\pm 5$ ).

Adult muskellunge in Bone Lake were in excellent condition in 2005. In 2005, mean relative weight of adult muskellunge was 104 compared to 96 in 1995. Relative weight of muskellunge 30-33.9 in was 107 (SE = 0.7, N = 121). Larger muskellunge length groups had mean relative weights that were slightly lower

(34 –37.9 in,  $W_r = 104$ ,  $SE = 0.8$ ,  $N = 100$ ; 38+ in,  $W_r = 99$ ,  $SE = 1.7$ ,  $N = 68$ ), however still considered to be in good condition. A strong negative relationship existed ( $R^2 = -0.87$ ) between mean relative weight and adult muskellunge density (Figure 4).

Angling pressure, catch, and harvest of muskellunge in Bone Lake was unknown without a creel survey, however tagging information did provide some insight on angling behavior and demographics. Tag return data indicated that 24% ( $N=13$ ) of the tagged muskellunge were caught during the 2006 angling season. Of those fish captured and reported, 85% ( $N=11$ ) were released, while one fish (41.5 in) was harvested and one fish (40.2 in) found dead from natural causes or hooking mortality. Interestingly, one fish was captured and released three times during the angling season. Anglers from 4 states returned tag information. Wisconsin residents reported the highest number of tag returns ( $N=10$  or 67%) followed by Minnesota ( $N=2$  or 13%), Iowa ( $N=1$  or 7%), Illinois ( $N=1$  or 7%) or unknown state of residency ( $N=1$  or 7%).

Spring tribal spear harvest of muskellunge was higher in 2006 ( $N=16$ ) compared to 2005 ( $N=12$ ). However, mean length of muskellunge harvested was larger in 2005 (mean = 38.5 in, range 30.1 – 43.6 in) compared to 2006 (mean = 37.6 in, range 26.0 - 45.5 in). No information was available on harvest during the winter spear fishery.

## Discussion

Abundance of adult muskellunge in Bone Lake has decreased since 1995. Nevertheless, the current population (0.55 fish/acre) is slightly above the mean range (0.36-0.42 fish/acre) reported by Margenau and AveLallemant (2000) for 15 northern Wisconsin lakes. In 1995, Bone Lake harbored a high-density muskellunge population. By 2005, the population decreased by nearly half. The reduction in muskellunge numbers was likely caused by a change in stocking practices. Following 1993, muskellunge stocking was sporadic and less than half of what it had been in prior years. This change in stocking has likely reduced recruitment of muskellunge into the fishery, subsequently lowering adult densities.

Abundance of legal length ( $\geq 40$  in) muskellunge has remained similar from 1995 to 2005 even with the decrease in total adult abundance ( $\geq 30$  in). The 40-inch minimum length limit initiated in 1990 has provided protection to fish  $< 40$  in and likely lead to the maintenance of fish  $\geq 40$  in. Another factor that may contribute to the maintenance of larger muskellunge is changes in angler attitude. Margenau and

Petchenik (2004), in an opinion survey of anglers who fish muskellunge in Wisconsin, indicated that both muskellunge and general anglers were more likely to release a legal length muskellunge in 1999 than they were only ten years earlier in 1989. Considering the Bone Lake data set represents a similar time period (1995-2005) it is reasonable to assume that this change in angler attitude could also likely play a role in the maintenance of larger muskellunge in Bone Lake.

Mean length of Bone Lake muskellunge decreased from 1995 to 2005. This is the result of a larger proportion of smaller muskellunge in the 28-34 inch range and possibly recruitment shortfalls during the mid-1990s when limited stocking occurred. Nevertheless, the mean length of female muskellunge remained similar, and the proportion of muskellunge over 40 in has nearly doubled.

The reduction in muskellunge densities over the past decade appears to have improved the overall condition of Bone Lake muskellunge. Fewer muskellunge reduces intraspecific competition for food resources. Cornelius and Margenau (1999) suggested a downward trend in Bone Lake muskellunge relative weight since 1964 was attributed to artificially high densities. Maintaining densities at or near existing levels (0.55 fish/acre) is important if muskellunge condition is an important factor in the future management of the fishery. With a desirable density of adult muskellunge in Bone Lake (0.55 fish/acre) and relative weight values improving (104), there is no need to re-initiate historic stocking rates and densities. A target stocking rate should be roughly half of what had been stocked based on historic stocking levels. If the stocking rate was changed to 1.5 fish/acre (2,671 fish) on an alternate year basis this stocking rate should be close in maintaining the abundance levels near 0.5 adult muskellunge/acre.

Trophy muskellunge management is an abstract goal that takes into account the perception and expectations of anglers and biologists of how a trophy is defined. Margenau and Petchenik (2004) noted that while nearly all muskellunge anglers felt a muskellunge needed to be at least 40 in to be considered a trophy, 62% felt a trophy needed to be longer than 50 in during a 1999 survey, considerably higher than 44% in a similar survey conducted in 1989. Increasing expectations for larger muskellunge is likely a product of angling experience, as more and more anglers catch fish longer than 40 in, they look to the next length barrier (45, 48, then 50 in).

The production of trophy muskellunge depends largely on growth rates and longevity (mortality), with ultimate size affected by slight alterations in either of these components. Because large muskellunge ( $\geq 40$  in) are usually low in abundance, loss of even a few individuals can reduce a lakes ability to produce fish  $\geq$

50 in. Casselman et al. (1996) suggested that with a 2% increase in mortality, recruitment would need to be doubled to maintain the number of trophy muskellunge in a population. Our survey indicated nearly 200 muskellunge  $\geq 40$  in reside in Bone Lake, however only few fish  $\geq 45$  in. Five muskellunge between 45-47.5 inches were handled during this survey, and no fish longer than 50 in. Because of Bone Lake's close proximity to a large metropolitan area (Minneapolis/St. Paul, Minnesota), it receives extensive angling pressure. Our finding that one tagged fish was handled three times on separate occasions by different anglers during the 2006 season provides some indication how this resource may be stressed. With such a high probability of encountering an angler, chances of a muskellunge being harvested as a trophy are expected to increase as fish length increases. In addition, incidental/delayed mortality from handling and hooking injuries on released fish can effect survival of muskellunge, and be of special importance in fisheries with high angling pressure.

Estimating the extent of mortality/exploitation on the Bone Lake muskellunge population is speculative as two of the three harvest components are unknown. Harvest information is only available for the spring spear fishery. No information is available for the winter spear fishery. No creel survey has been conducted on Bone Lake since 1985. Angler catch records from Muskies, Inc through 1996 suggested catch increased considerably since that period (Cornelius and Margenau 1999). If muskellunge are being harvested between 40- and 45 in the potential for a Bone Lake muskellunge to reach 50 in are limited. The two fish that were harvested or found dead during the 2006 angling season were 41.5 and 40.2 inches, respectively. It is reasonable to assume that the combined effects of sport angler harvest, indirect mortality from hooking/handling issues, along with tribal spear harvest (open water and ice) may limit muskellunge in the Bone Lake population from reaching lengths  $> 50$  in.

Restricting angler harvest of larger muskellunge ( $\geq 40$  in) warrants consideration. The maximum size of muskellunge in the population from our survey over the two year period appears to be in the 45-48 in range. A 45- or 50 inch minimum length limit could allow more muskellunge to reach their full length potential. While no growth information was available in 2005, previous growth analysis indicated good growth of Bone Lake muskellunge with female fish reaching 40 in by age 10 (Cornelius and Margenau 1999). However, success of high trophy length limits requires that anglers are able to handle and successfully release large ( $\geq 40$  in) muskellunge to decrease, to the greatest possible extent, delayed mortality. Special angler education efforts should be made to enhance this effort.



### **Summary and Management Recommendations**

1. The current 40-inch minimum length limit and daily bag limit of 1, has maintained a quality-sized muskellunge population. Muskellunge densities  $\geq 40$  inches have remained similar over the past 10 years, but the proportion of fish  $\geq 40$  in has nearly doubled. Considering the number of larger muskellunge ( $\geq 45$  in) is low, it is recommended that a 50 in minimum length limit with a daily bag of one be implemented. The adult muskellunge population ( $\geq 30$  in) should be maintained between 0.4-0.6 fish/acre. Abundance of large muskellunge ( $\geq 40$ ) should be maintained at least 0.10 fish/acre and preferably increase to 0.15 fish per acre. In addition, by 2019, RSD-45 and RSD-50 should increase to 5 and 1 respectively.
2. Muskellunge stocking should be lowered to 1.5 fingerlings/acre or 2,671 fingerlings on an alternate year basis. This management strategy provides constant recruitment of muskellunge into the fishery and should maintain or improve the desired density/quality-sized fishery present in 2005.
3. Periodic sampling of the muskellunge population on Bone Lake should continue. Bone Lake is in the existing muskellunge trends monitoring program and should be surveyed again within the next 8-10 years (2013-2015). Special attention should be given to changes in growth rates, condition, and size structure shifts that increase the number of muskellunge larger than 45 in as well as recruitment of muskellunge into smaller length groups. In addition, a creel survey should be conducted in conjunction with netting survey to determine angler pressure and harvest.
4. The Department should request the Great Lakes Fish and Wildlife Commission determine what level of winter spear harvest is occurring on Bone Lake. At this time, it is unknown if the unregulated winter spear harvest fishery might be impacting muskellunge harvest and size structure on Bone Lake.

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Table 1. Abundance estimates of adult muskellunge by sex and length-group for Bone Lake, Polk County. Coefficient of variation (CV = 100 X SD/mean) is in parenthesis.

Year	Sex		Length-group (in)			
	Male	Female	30-33.9	34-37.9	≥38.0	≥40.0
1964	175 (33.0)	150 (25.3)				
1982	493 (9.6)	468 (12.2)	475 (11.8)	328 (12.0)	156 (16.7)	76 (18.0)
1985	700 (6.6)	799 (8.1)	964 (7.3)	461 (8.3)	92 (12.3)	58 (15.6)
1990	554 (11.2)	651 (21.7)	432 (17.1)	426 (13.9)	243 (26.1)	114 (26.2)
1995	927 (11.6)	830 (15.4)	427 (18.2)	740 (12.4)	576 (20.2)	196 (20.2)
2005	487 (10.8)	546 (22.1)	284 (15.0)	368 (18.4)	321 (18.3)	190 (18.5)

Table 2. Mean (SE) total lengths (inches) of adult muskellunge sampled with fyke nets in Bone Lake, Polk County, Wisconsin. Whole numbers centered below means are sample size.

Year	Male	Female	Combined
1964	29.4 (0.23) 269	34.2 (0.41) 177	31.3 (0.24) 446
1982	31.5 (0.14) 558	36.8 (0.22) 303	33.4 (0.15) 861
1985	31.7 (0.10) 865	35.1 (0.15) 572	33.0 (0.09) 1437
1990	33.6 (0.15) 397	36.7 (0.24) 224	34.7 (0.14) 621
1995	34.8 (0.12) 500	37.7 (0.18) 337	36.0 (0.11) 837
2005	33.2 (0.19) 352	38.3 (0.31) 177	34.9 (0.20) 529

Table 3. Muskellunge relative stock density values, Bone Lake, Polk County, Wisconsin.

<u>Year</u>	<u>RSD-34</u>	<u>RSD-40</u>
1964	47	14
1982	56	9
1985	46	5
1990	65	9
1995	75	10
2005	66	19

LAKE SURVEY MAP

LAKE BONE (NORTH HALF)  
SECTIONS 5-6-7-8-12-18-20-31-32  
TOWNSHIP 35-36 N.  
RANGE 10 W.  
TOWN BONE LAKE-GEORGETOWN  
COUNTY POLK

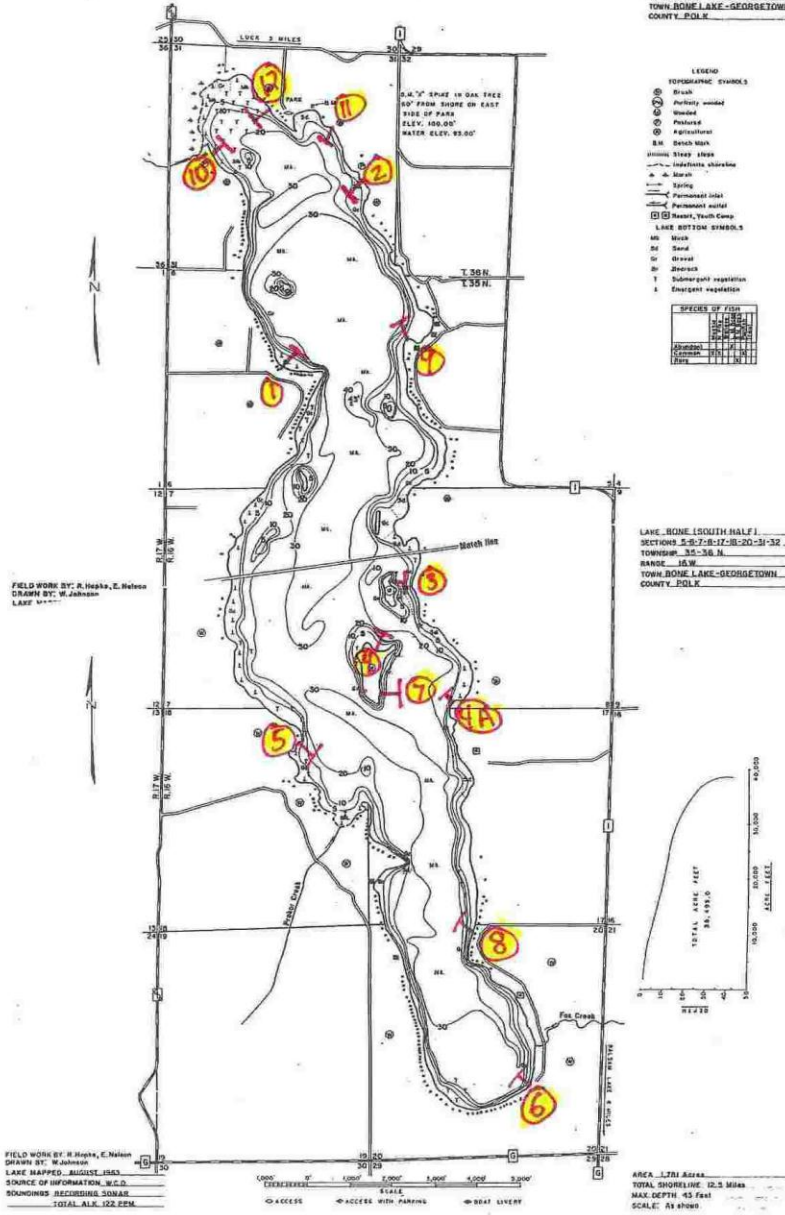


Figure 1. 2005-2006 fyke netting locations for muskellunge, Bone Lake, Polk County, Wisconsin.

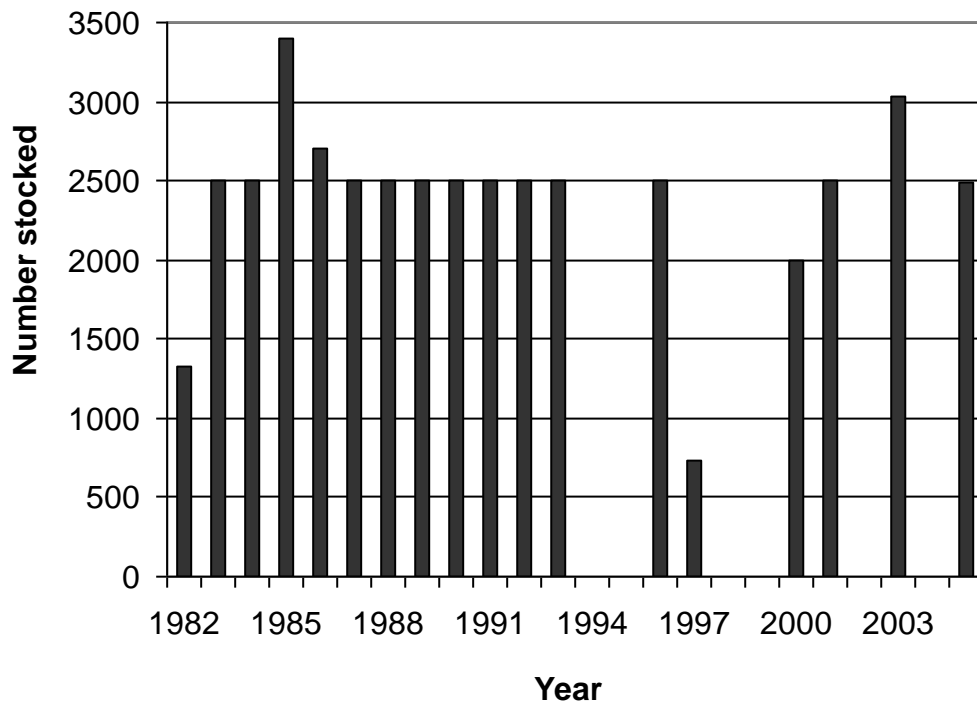


Figure 2. Large fingerling ( $\geq 7$ in ) muskellunge stocking in Bone Lake, Polk County, Wisconsin 1982-2005.

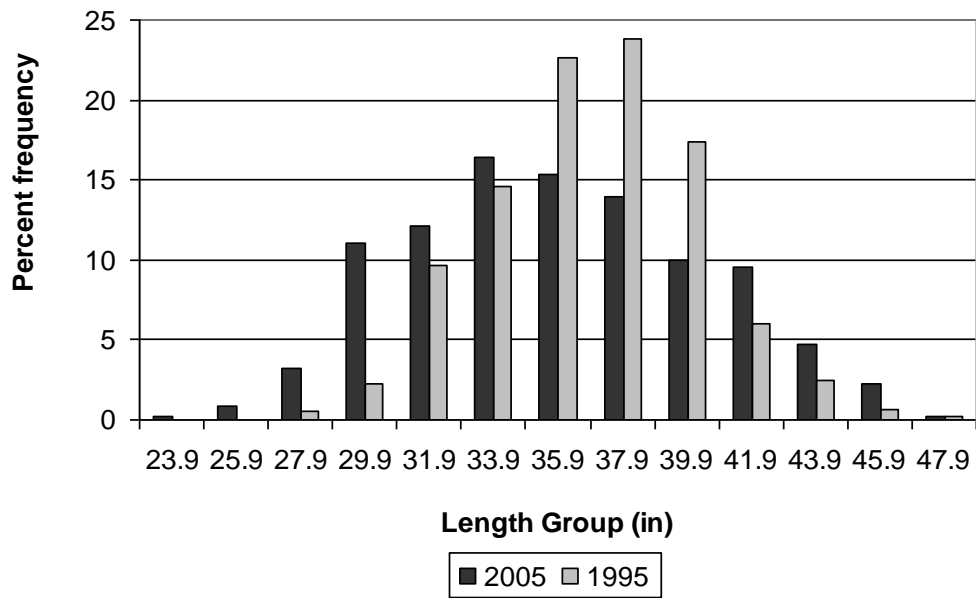


Figure 3. Percent length frequency distribution of muskellunge in Bone Lake, Polk County, 1995 (N = 837) and 2005 (N = 529). Length intervals on x-axis are two-inch groups with the upper increment listed (i.e. 39.9 length group includes fish measuring from 38.0 to 39.9 inches).



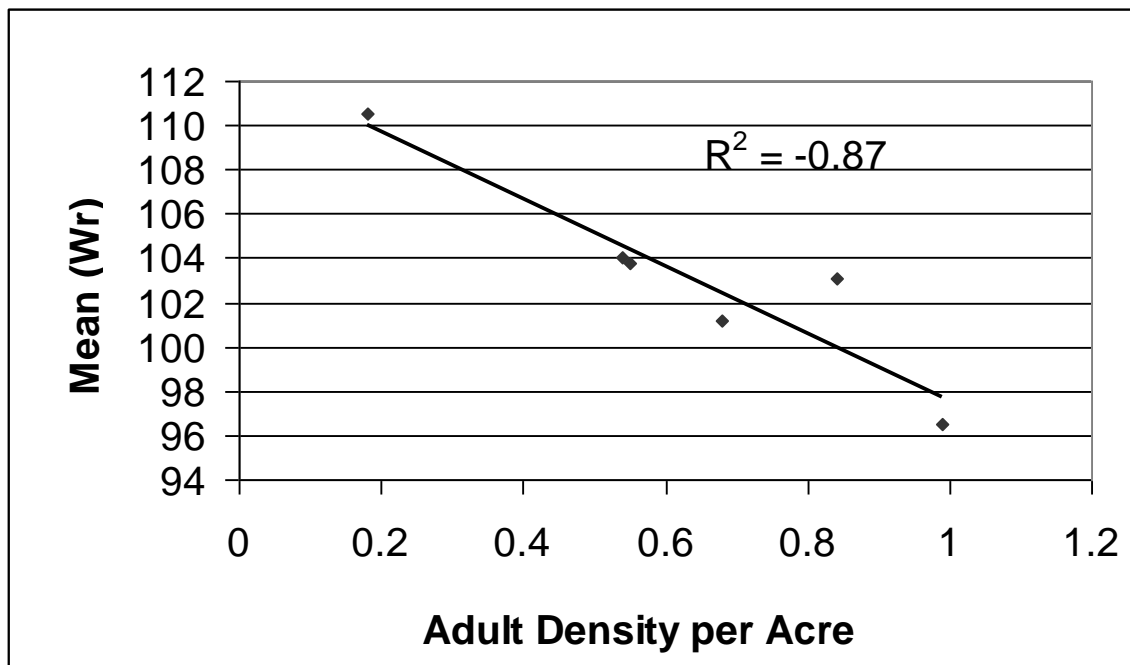


Figure 4. Muskellunge adult density in relationship to adult muskellunge mean relative weight. Bone Lake, Polk County, WI 1964-2005.