Comprehensive Fisheries Evaluation of Lake Ellwood, Florence County, Wisconsin 2012

Waterbody Identification Code 0650500

Gregory Matzke
Senior Fisheries Biologist
Wisconsin Department of Natural Resources
Florence

February, 2013

Gregory Matzke
Fisheries Biologist
Wisconsin Department of Natural Resources
Florence

February, 2012

Lake and location:
Lake Ellwood, Florence County, T.39N. R.19E.
Located south of US2, in the town of Spread Eagle (between Florence and Iron Mountain). When at normal water level Lake Ellwood drains to the Pine River, located within the Menominee River watershed.

Physical/Chemical attributes: (Young, 2003)

Morphometry:	135 acres, maximum depth 25 feet, estimated mean depth 11 feet
Lake type:	Drained (no inlet, one outlet to Pine River - not flowing in 2012)
Basic water chemistry:	Hard – high alkalinity and conductance (98mg/l and 210 umhos)
Littoral Substrate:	85% sand, 10% gravel, 3% rubble, 2% muck
Water clarity:	Clear
Aquatic vegetation:	Rare during 2012
Shoreline character:	100% upland
Shoreline development:	Intense (avg. 1 dwelling every 155 feet of shoreline)
Winterkill:	No oxygen problems reported or likely. Significant fish kills from other causes reported in 1972 and 2002
Boat landing:	One public boat landing
Shoreline Length:	2.9 miles

Purpose of Survey: Comprehensive fisheries survey.

Dates of fieldwork:
Northern pike netting, 3/22-29/2012
Bass electrofishing 5/7, 5/9, 5/14, 5/30, 6/7 and 6/13/2012
Panfish netting, 6/26-29/2012
Fall electrofishing, 10/11/2012

ACKNOWLEDGEMENTS

Brad Shucha, Aaron Nelson, Pat Smith, Nick Neuens, Bill Tuck, Derrick Raspor, Rudy Vassar, Greg Cisar, Kenneth Smith, Sonja Matzke and John Nowicki assisted in the field. Brad Shucha and Aaron Nelson assigned game and panfish age from scales, spines and rays.

I. EXECUTIVE SUMMARY

Lake Ellwood was surveyed during 2012 with a variety of sampling gear to assess the status of the fishery. Sampling began just after ice out, with early spring fyke netting for northern pike and other adult gamefish. A total of six electrofishing surveys were conducted to assess the bass populations followed by summer fyke netting for panfish. The survey culminated with a fall electrofishing survey to assess gamefish recruitment.

Four gamefish species were captured during the 2012 survey of Lake Ellwood. Of these, smallmouth bass appear to be the only gamefish capable of maintaining its populations naturally. The main cause for failed northern pike and largemouth bass recruitment appears to be the loss of aquatic vegetation. Walleye are not native to Lake Ellwood and stockings have not been permitted since 1941, it is believed that the few walleye captured during the 2012 survey are the product of illegal fish transfers. Smallmouth bass are the most abundant gamefish species (4.41 adults/acre), followed by largemouth bass (2.31 adults/acre), northern pike (0.32 adults/acre) and walleye.

The smallmouth bass population has increased drastically over the last decade, creating a population with many quality sized fish. However, the percentage of fish $\geq$ 17 inches is relatively low, likely due in part to below average growth rates. While the smallmouth bass population is seemingly stable, the same cannot be said for largemouth bass. The current largemouth bass population is in serious trouble. It appears that natural reproduction of largemouth bass has not occurred since 2007. Largemouth bass are still surprisingly abundant with the bulk of the population being 7 to 9 years of age and measuring between 14 and 17 inches in length. As these older/larger fish move through the population a significant reduction in largemouth bass abundance will take place, with the potential for the complete loss of this species of fish unless the current situation changes.

Like both bass species, northern pike are native to Lake Ellwood. Northern pike have always existed at fairly low levels through natural reproduction. The current northern pike population is very low with an estimated 42 adult fish left in Lake Ellwood. Like largemouth bass, the northern pike population is no longer capable of sustaining itself through natural reproduction. This lack of new recruits leaves a population consisting of older/larger individuals, creating an artificially high size structure. Northern pike grow incredibly fast in Lake Ellwood, allowing fish to grow beyond trophy size. Changes to the current Lake Ellwood management are necessary to maintain a northern pike population for the future.

Five panfish species were captured during the 2012 survey. Bluegill abundance has dropped drastically over the last 10 years. The drop in bluegill abundance can be attributed to a steady decrease in recruitment which brings the sustainability of this population into question. The current bluegill population has good size structure; however, with such a small population it currently does not offer a quality angling opportunity. Rock bass is the only other panfish species that exists in any significant numbers. Like bluegill, rock bass have a good size structure, but a recent decline in the abundance of rock bass leaves little angling opportunity. Black crappie have not displayed significant natural reproduction since 2006, leaving a population consisting of very few older/larger individuals that are no longer capable of sustaining their population. Yellow perch and pumpkinseed are quite rare, with only a few individuals sampled during the 2012 survey. In general, Lake Ellwood does not contain desirable panfish populations, and like northern pike and largemouth bass, changes are necessary to enhance panfish populations.

Two non-game species were captured during our survey work in 2012. These species were white sucker and bluntnose minnow. There appears to be a large population of adult white sucker, however, little sampling effort was directed toward this species.

II. PAST MANAGEMENT AND SURVEYS

Known Stocking History:

Bluegill	- adults, 1939
Northern Pike	- lg. fingerlings, 1998-2002
Rock Bass	- adults, 1939
Smallmouth Bass	- fingerlings, 1941-42, 1952 and 1973
Walleye	- fry, 1939-41
Yellow Perch	- fingerlings, 1939
	- adults, 1939

Past Management Activities:

- 1949 (Burdick) – Summer fyke net survey (found large population of LMB, smaller population of SMB and documented panfish abundance and size structure. Management recommendations where to manage Lake Ellwood for smallmouth bass.).
- 1971 (Burdick) – Summer electrofishing survey (found good SMB and LMB populations sustained by natural reproduction, a fine yellow perch population was also noted).
- 1971 (Burdick) – A significant fish kill caused by a diatom bloom occurred in mid-November.
- 1972 (Burdick) – Spring fyke netting survey (found LMB, NP and WE to be present, winterkill of 1971 may have seriously affected SMB population, panfish in order of abundance were BG, RKB, PS, BC).
- 1979 – Comprehensive fishery and creel survey (LMB were common, ranging from 6.5 to 17.4 inches in length. SMB were less common than LMB, the populations appears to be made up of young individuals ranging from 6.0 to 12.4 inches in length. Only seven northern pike were captured during the survey, all of which being 7 or 8 years old and ranging from 27 to 32.9 inches in length. Northern Pike had never been stocked and are seemingly native to Lake Ellwood. Bluegill, yellow perch and pumpkinseed were the most abundant panfish species, all reproducing naturally. No special management was recommended.).
- 1995 (Heizer) – Fall recruitment survey (found naturally reproducing populations of smallmouth bass and largemouth bass. Yellow perch were most abundant panfish followed by RKB and BG).
- 2002 (Young) – Comprehensive survey (SMB most encountered gamefish followed by NP and LMB, walleye are present in very low numbers. Bluegill provide the majority of the panfishing opportunity followed by rock bass.).

III. METHODS

The survey began on 3/22 when 4 standard fyke nets (3/4" stretch mesh) were set in Lake Ellwood to sample northern pike. These 4 nets were fished for 7 nights and pulled from the lake on 3/29/2012. Six electrofishing surveys, using a WDNR standard alternating current boom shocker, were conducted to sample smallmouth and largemouth bass between 5/7 and 6/13/2012. On 6/25, four standard fyke nets were again set in Lake Ellwood and fished for four days to analyze the relative abundance, size structure and growth of panfish populations. The 2012 survey culminated with a gamefish recruitment survey on 10/11/2012 by electrofishing the entire shoreline.

During the survey, length or length category (nearest half-inch), was recorded for all gamefish and panfish (6/26-29/2012). Adult walleye were given bottom caudal fin clips while all other adult gamefish were given left pelvic fin clips and juvenile gamefish were given a top caudal fin clip for use in mark-recapture population estimates. Aging structures were removed and weight was measured from five gamefish and panfish for each species, sex and half-inch group.

Different aging structures were used for different species and size of fish. Dorsal spines were used to age walleye $\geq$ 12.0 inches as well as largemouth and smallmouth bass $\geq$ 8.0 inches. Anal rays were used for northern pike $\geq$ 18.0 inches and yellow perch $\geq$ 5.0 inches in length. Anal spines were removed from black crappie $\geq$ 7.0 inches and all other panfish species $\geq$ 4.0 inches. Cross sections of these structures were blind read by two different readers; all discrepancies were then triple blind read to remove as much error as possible from the aging process. Fish below the length cutoff for spine/ray removal had scales removed, which were blindly read by a single reader.

IV. RESULTS AND DISCUSSION

Catch Summary

Four gamefish, 5 panfish and 2 non-game fish species were captured during the 2012 survey of Lake Ellwood (Figure 1). There is more detailed information at the back of this report (Table 7, Appendix C).

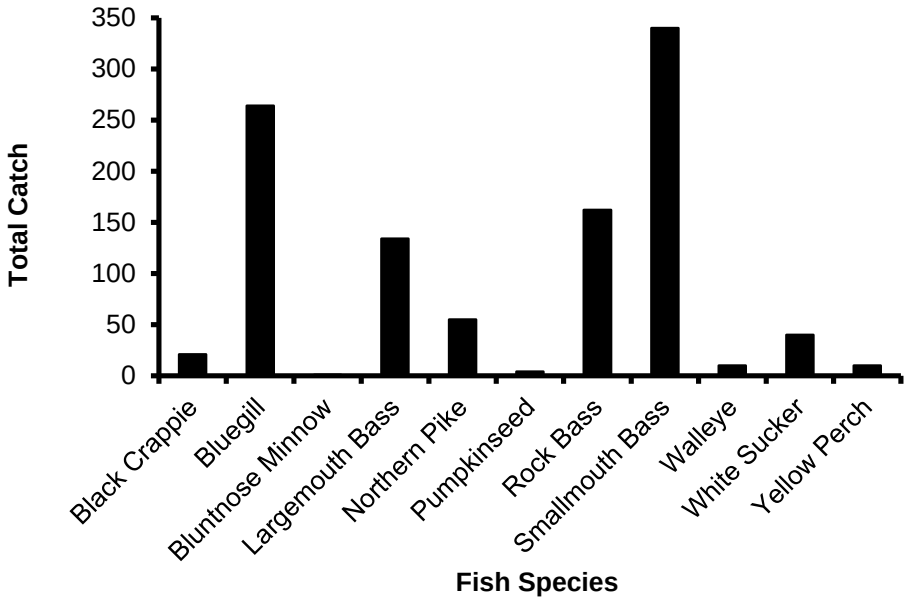

Figure 1. Fish species and number captured during a 2012 comprehensive survey of Lake Ellwood, Florence County, 2012.

Gamefish:

Northern Pike

Abundance

Northern pike were the most abundant game fish species captured during the 2012 spring fyke net survey with a catch rate of less than 2 fish per net-lift (Table 1, Appendix C). Since northern pike tend to be a tough species to sample with electrofishing gear (especially larger fish), fyke nets were used for the marking and recapture portions of the 2012 northern pike survey. This survey estimates the adult northern pike population (fish ≥ 12.0 inches) to be approximately 42 fish (0.32/acre) (Table 1). At less than a third of an adult fish per acre Lake Ellwood has an extremely small northern pike population. The 2012 estimate shows a decline since the last population estimate was conducted in 2002. The make-up of the current population is predominantly male with a sex ratio of 4 to 1. Northern pike were not targeted during spring electrofishing surveys due to their low numbers and large body size.

Table 1. Abundance of northern pike, indexed using the estimated number of adults per acre, in Lake Ellwood during 2012 compared to the last survey of Lake Ellwood, conducted during 2002.

	2012	2002
Adults/Acre	0.32	0.50

Size Structure

Only 29 different northern pike were captured during early spring surveys in 2012, ranging from 26.1 to 42.5 inches in length (Figure 2). The average length of northern pike captured during 2012 was 30.8 inches with modes of 26 and 33 inches. Both of these numbers were similar to the 28.6 inch average size and modal length of 30 inches measured during the last northern pike survey in 2002. Size structure, indexed using relative stock density (RSD), also shows a very similar size structure to the population 10 years ago, with the exception of the largest fish (those ≥ 34.0 inches). RSD34 and 40 values have both increased by over 130% respectively since 2002 (Table 2). The current size structure is extremely high, with over 10% of the northern pike being ≥ 40.0 inches, showing Lake Ellwood's incredible potential for trophy northern pike.

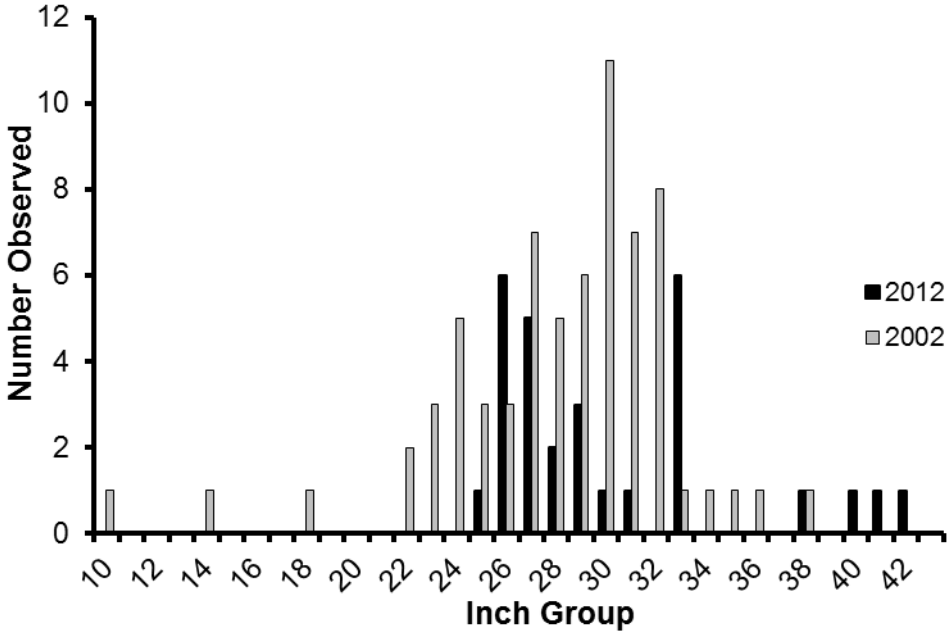

Figure 2. Length frequency of northern pike captured during spring surveys of Lake Ellwood, Florence County, in 2012 compared to a similar survey conducted in 2002 (2012: N=29, 2002: N=68).

Table 2. Size structure, indexed using relative stock density, for northern pike captured during 2012 compared to a previous survey of Lake Ellwood, Florence County.

	2012	2002
RSD21	100.00	97.01
RSD24	100.00	89.55
RSD28	58.62	62.69
RSD34	13.79	5.97
RSD40	10.34	0.00

Growth

Age was estimated by examining anal ray cross sections from all 29 northern pike captured during the 2012 survey of Lake Ellwood. Northern pike typically exhibit sexually dimorphic growth with females growing faster and larger than males. Differing growth rates between sexes did not allow for a good comparison for combined sex northern pike in Lake Ellwood to the Northern Region of Wisconsin (NOR) average because the population is made up primarily of male fish (76%) which incorrectly reduces northern pike growth (Figure 3). By separating the sexes it is easy to see that the Lake Ellwood population has very high growth rates. Male northern pike grow near the average for combined sex northern pike while female growth is well above average for the NOR of Wisconsin (Figure 4).

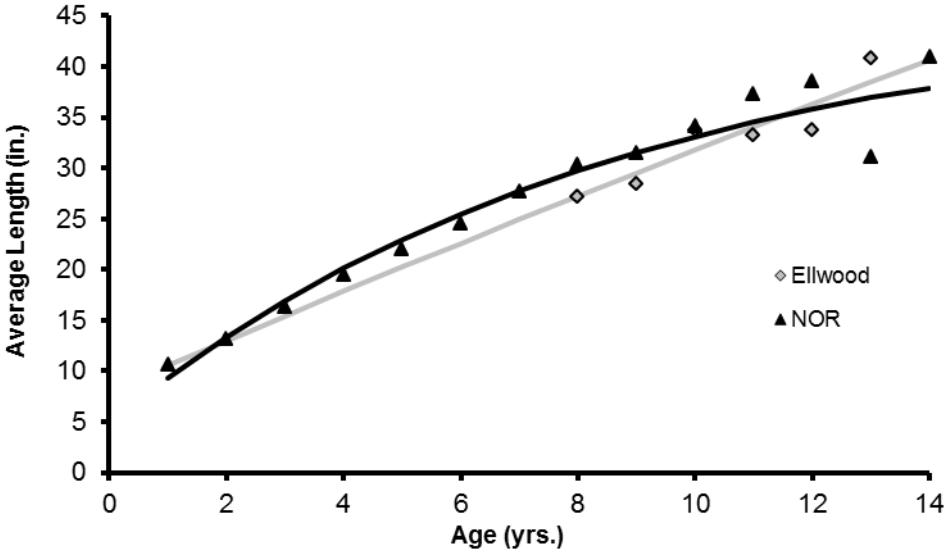

Figure 3. Average length at age for combined sex northern pike captured during spring surveys of Lake Ellwood during 2012, fit with von Bertalanffy growth curves and compared to the average length at age for combined sex northern pike in the Northern Region of WI (Male: N=22, Female: N=7).

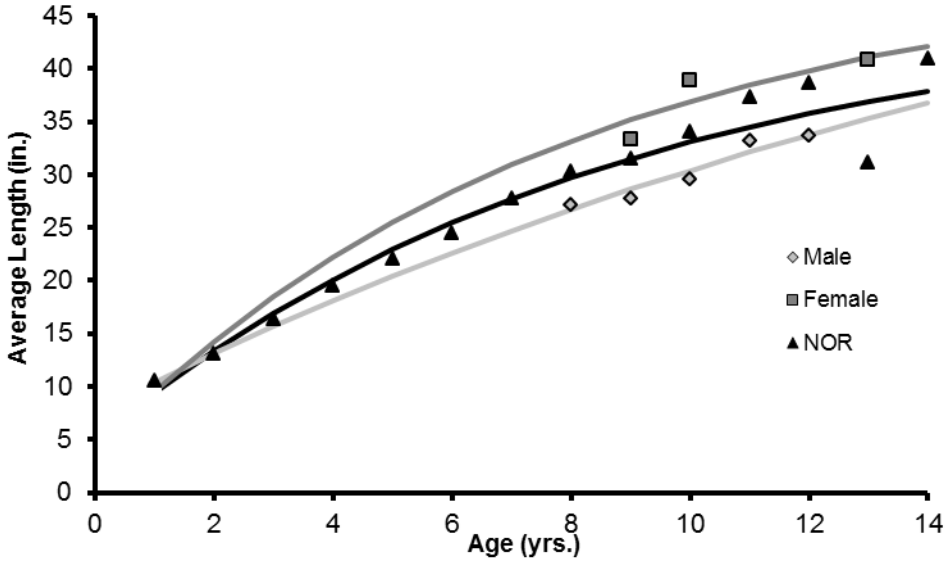

Figure 4. Average length at age for northern pike captured from Lake Ellwood during 2012 spring surveys, fit with von Bertalanffy growth curves and compared to the average length at age for both sexes combined in the Northern Region of WI (Male: N=22, Female: N=7).

Body Condition

Every northern pike captured during 2012 was weighed to assess body condition. Body condition was indexed using relative weight (W_r). W_r for male northern pike ranged between 84.0 and 101.8, averaging 93.1 (Figure 5). Female W_r was much higher with values ranging from 100.5 to 121.4, with an average of 111.7. The "benchmark" for good body condition is a score of 100; however, in this region of Wisconsin it is rare to have an average W_r score of 100 for northern pike. The average W_r for combined sex northern pike in Lake Ellwood is 97.6 showing that northern pike in Lake Ellwood have above average body condition for this part of the state. While neither male nor female

W_r was statistically related to overall body length, there was a pretty clear trend of increased body condition with overall length for female northern pike. This trend suggests that Lake Ellwood has the right conditions for producing trophy northern pike.

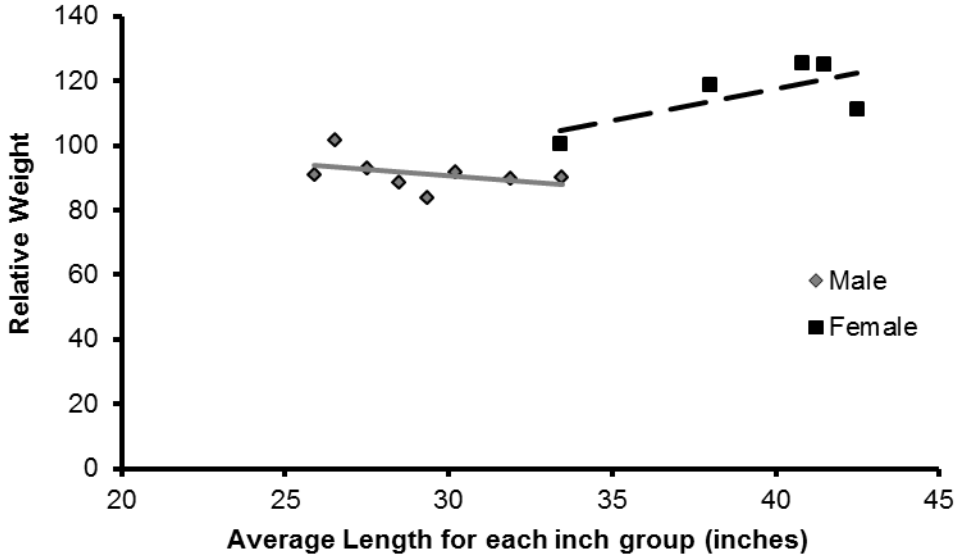

Figure 5. Average relative weight at length, for northern pike captured during spring surveys of Lake Ellwood, Florence County, 2012 (Male: N=22, Female: N=7).

Recruitment

During a fall electrofishing survey we collected all young-of-the year (YOY) gamefish. No YOY northern pike were captured during this survey, the lack of YOY northern pike, along with the non-existence of smaller/younger fish during the 2012 survey suggests that natural reproduction of northern pike is not occurring in Lake Ellwood (Table 1, Appendix B).

During the 2012 survey a total of 22 male northern pike were captured, all of these fish were between 26.1 and 33.7 inches in length, while 7 females were captured between 33.0 and 42.5 inches in length. This is not a typical length distribution for northern pike in WI. Northern pike tend to mature very early in life (age 2 for males and 3 for females) making them vulnerable to our gear at a very small size/young age, since our gear is designed to catch mature fish during the act of mating. Since no smaller fish were present in the population, it was a fair assumption that these fish were the product of six stocking events which took place between 1998 and 2002. After analyzing cross sections of anal spines from all 29 northern pike captured during 2012 it was a surprise to find that the majority of the northern pike (58.6%) are estimated to have been conceived during years when no stocking of northern pike took place, making them naturally reproduced fish (Figure 6).

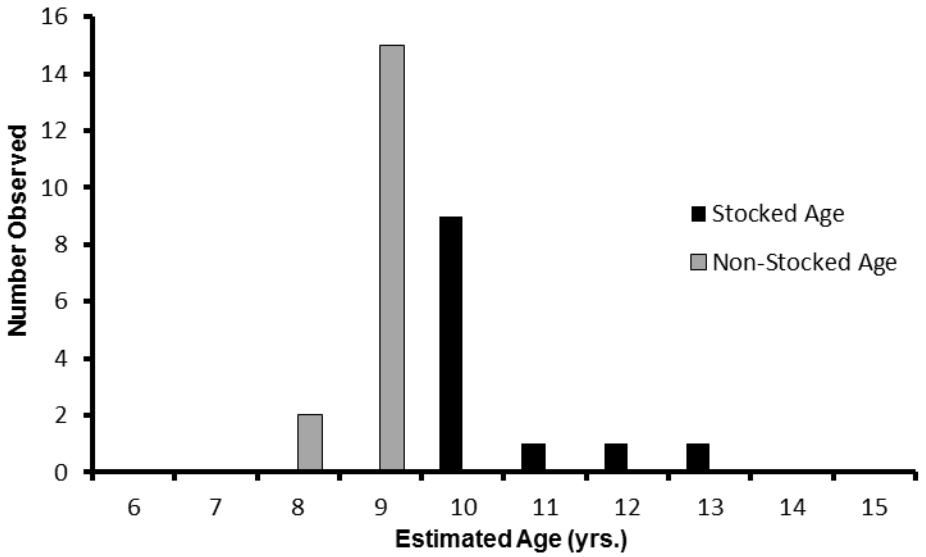

Figure 6. Age frequency for all northern pike captured during the 2012 survey of Lake Ellwood, Florence County (N=29).

Northern pike are native to Lake Ellwood and prior to 1998 existed in low numbers without the aid of stocking. The presence of a significant number of fish that cannot be tracked back to a stocking event also proves that the lake was capable of natural reproduction. However, the fact that no fish were captured less than 8 years old strongly suggests that northern pike are no longer capable of maintaining their population naturally.

Walleye

Abundance

Walleye are not native and have not been stocked in Lake Ellwood since 1941. Past surveys have documented walleye being present in Lake Ellwood, but never more than a handful of fish have been captured during a single survey. During 2012 we captured a total of 9 different walleye during our spring survey which equated to 0.32 fish per net-lift (Table 1, Appendix C). These fish most likely are the product of an illegal fish transfer, or from a non-permitted stocking event. Since there are very few walleyes present this population offers very little fishing opportunity.

Size Structure

The nine walleyes captured during 2012 ranged from 20.2 to 24.5 inches in length (Figure 7). The mean length of walleyes caught this year was 21.7 inches, and a mode of 21 inches. Size structure of these 9 fish was very high, as expected in populations without natural recruitment or consistent stocking (Table 4).

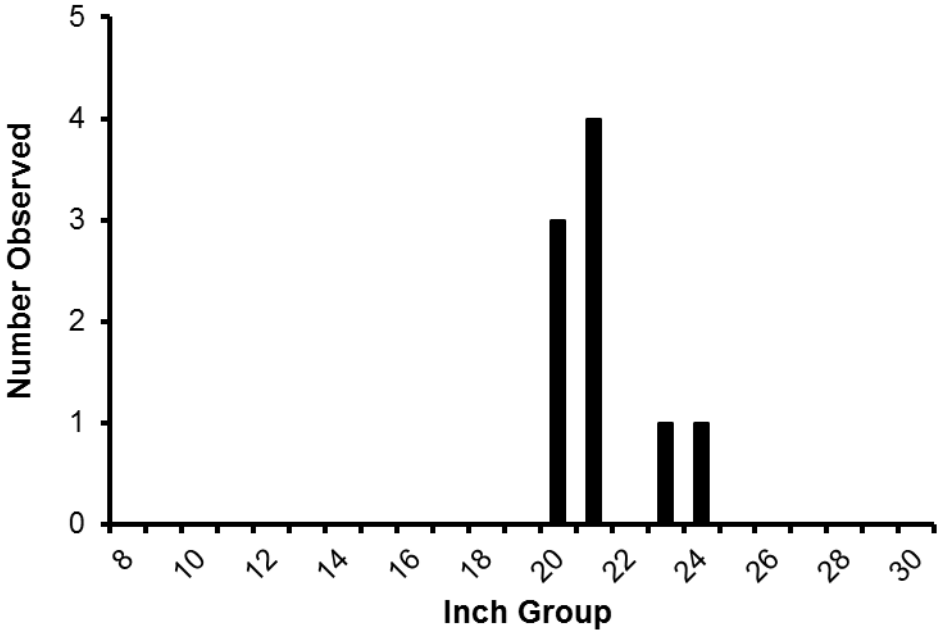

Figure 7. Length frequency of walleye captured during spring surveys of Lake Ellwood, Florence County, during 2012 (N=9).

Table 4. Size structure, indexed using relative stock density, for walleye captured during 2012 compared to a previous survey of Lake Ellwood, Florence County.

	2012	*2002
RSD15	100.00	100.00
RSD20	100.00	0.00
RSD25	0.00	0.00
RSD28	0.00	0.00
RSD30	0.00	0.00

*2 fish sample

Growth

Dorsal spines were taken from the 9 walleyes captured during our survey. All of the fish were estimated to be from two year classes and were 6 or 7 years old. As expected in a very low density population, walleyes in Lake Ellwood show well above average growth, achieving lengths of greater than 20 inches by age 6 (Table 2, Appendix B).

Body Condition

Very few walleye were captured in Lake Ellwood during 2012, however we did measure body weight on 6 walleyes to attempt to index body condition. Relative weight (W_r) of the 4 male walleyes ranged between 97.2 and 113.6 for individual inch groups, with an average of 102.7. W_r for the 2 female walleye that were weighed was 94.7 and 95.4, averaging 95.1. The sample size is much too small to make any conclusions, but it does appear that walleye in Lake Ellwood have acceptable body condition.

Recruitment

Walleye are not native to Lake Ellwood and have not been stocked since 1941. It is extremely unlikely that the walleye found in Lake Ellwood during 2012 are descendants of previous WDNR stockings. No young-of-the-year (YOY) walleye were captured during our fall electrofishing survey in 2012. The lack of YOY walleye and the extremely poor age distribution of the adult walleye captured during 2012 suggest that walleye are not naturally reproducing in Lake Ellwood (Figure 8). It is my opinion that these walleyes most likely came to be in Lake Ellwood through non-permitted stocking events.

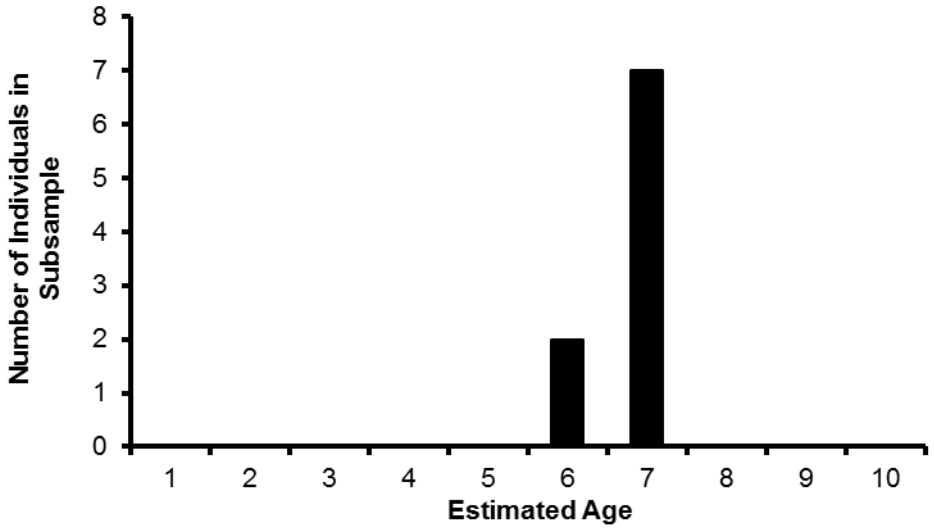

Figure 8. Estimated age of all walleye captured during the 2012 survey of Lake Ellwood, Florence County (N=9).

Largemouth Bass

Abundance

Spring netting, early spring electrofishing along with six other spring electrofishing surveys were conducted to estimate the abundance of largemouth bass in Lake Ellwood. During these surveys we captured 105 different largemouth bass (Table 3, Appendix A). The data obtained from these surveys estimate the adult largemouth bass population to be approximately 305 fish $\geq$ 8.0 inches (2.31/acre) with a 95% confidence range between 155 and 455 fish. During electrofishing surveys of Lake Ellwood during 2012 we captured approximately 7.2 adult largemouth bass per mile electrofished. The 2012 catch rate suggests a nearly 3-fold increase in abundance of adult largemouth bass over the last decade (Table 6). The current population is made up entirely of larger/older individuals; the smallest largemouth sampled during 2012 was 12.9 inches and 5 years old.

Table 6. Abundance of largemouth bass, indexed using population estimation and catch rate during spring electrofishing surveys, in Lake Ellwood during 2012 compared to a previous survey of Lake Ellwood.

	2012	2002
Adults/Acre	2.31	n/a
Adults/mi.	7.21	2.59

Size Structure

During 2012 we sampled a total of 105 different largemouth bass up to 18.4 inches in total length (Figure 10). The average length of largemouth bass captured during 2012 was 15.4 inches, much larger than the average size of 13.6 and 9.7 inches measured during the 2002 and 1979 surveys respectively. During 2012, the majority of the bass sampled (91.4%) were between 14.0 and 16.9 inches showing that the bulk of the fish present are substantially larger than in 2002 (when 65.0% of the catch was 12.0-14.9 inches) or in 1979 (when 65.8% of the catch was $\leq$ 9.9 inches).

Size structure, indexed using relative stock density (RSD), has increased with each survey since 1979 (Table 7). At present, all largemouth bass are larger than 12.0 inches, 71% $\geq$ 15.0 inches and less than 1% $\geq$ 18.0 inches in length. The current size structure is artificially high and cannot be maintained long-term.

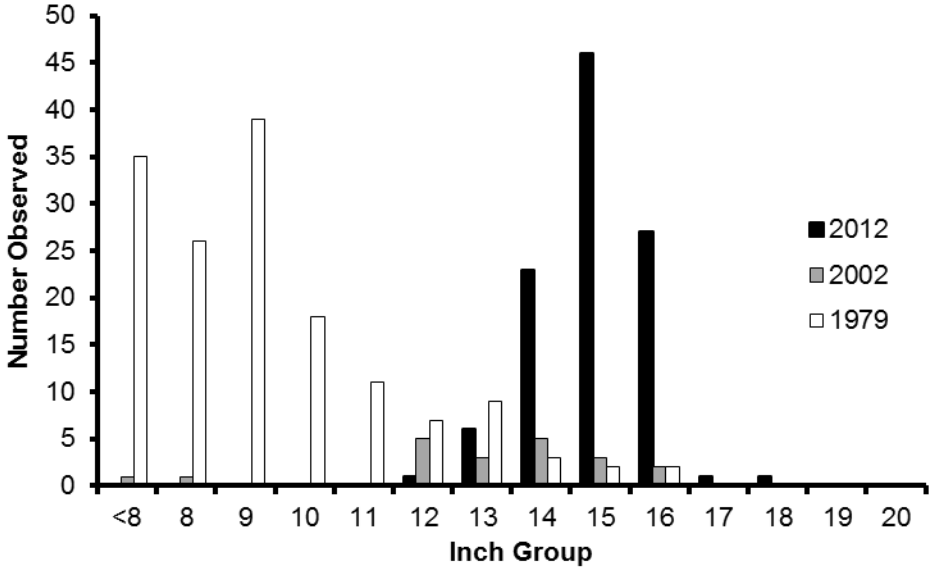

Figure 10. Length frequency of largemouth bass captured during spring surveys of Lake Ellwood, Florence County (2012: N=105, 2002: N=20, 1979: N=152).

Table 7. Size structure, indexed using relative stock density, for largemouth bass captured during 2012 compared to previous surveys of Lake Ellwood, Florence County.

	2012	*2002	**1979	1971	***1949
RSD12	100.00	94.74	19.66	54.55	8.86
RSD15	71.43	26.32	3.42	18.18	1.27
RSD18	0.95	0.00	0.00	0.00	1.27
RSD20	0.00	0.00	0.00	0.00	0.00

*20 fish sample
**Derived from a scale drawing
***Summer fyke net survey

Growth

During most of our sampling effort we were unable to visually determine the sex of largemouth bass, so fish of both sexes were grouped into a single category of unknown sex largemouth bass. Dorsal spines were collected from all fish and cross sections of these spines were used for age estimation. A

total of 36 largemouth bass were aged during 2012. Growth was then inferred using average length at age and compared to the average for the Northern Region (NOR) of Wisconsin (Figure 11). Lake Ellwood largemouth bass exhibited below average growth beyond age-6 when compared to other populations in the NOR of Wisconsin (Table 3, Appendix B). Since no largemouth bass were captured less than 5 years of age little can be known about early life growth.

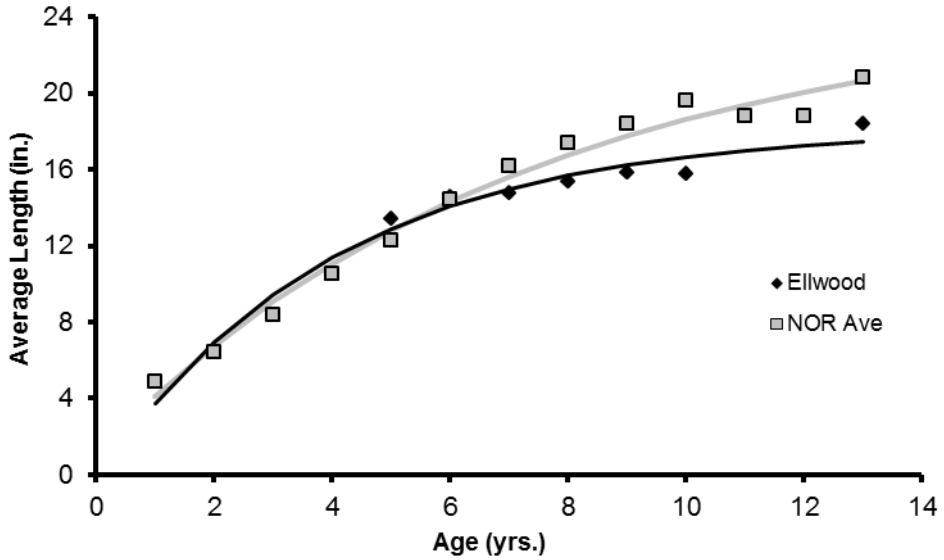

Figure 11. Average length at age for largemouth bass captured from Lake Ellwood during 2012 spring surveys, fit with von Bertalanffy growth curves and compared to the average length at age for the Northern Region of WI (2012: N=36).

Body Condition

A total of 37 randomly selected fish were weighed during our spring surveys to assess body condition of largemouth bass via relative weight (W_r) analysis. W_r values for both sexes combined ranged from 84.0 to 109.1, with an average value of 102.2 (Figure 12). This average is slightly above the target of 100 showing that largemouth bass have good body condition in Lake Ellwood. There is a statistically significant negative correlation between W_r and body length suggesting that conditions, most likely preferred food and habitat, are better for smaller/younger fish than longer/older largemouth bass in Lake Ellwood ($P=0.05$, $R^2=0.65$).

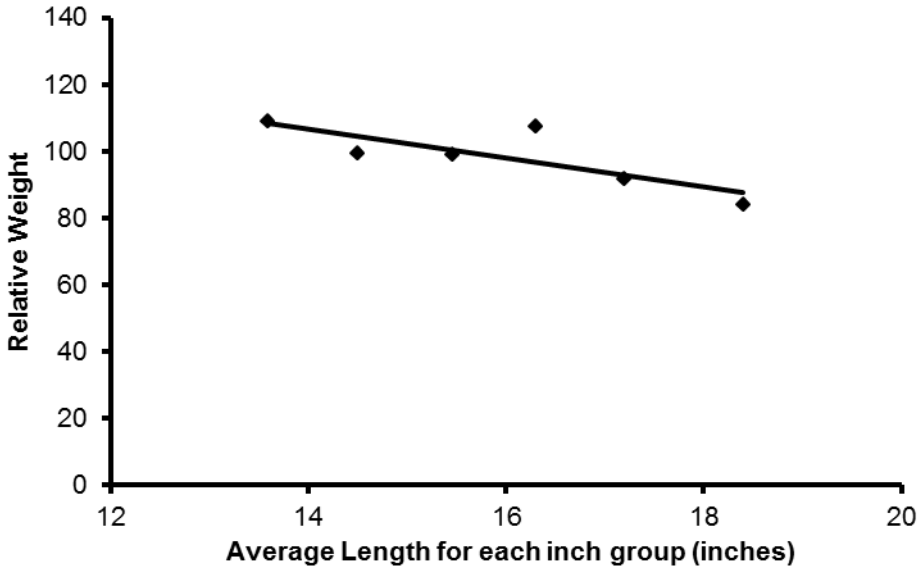

Figure 12. Average relative weight at length, measured from a sub sample of largemouth bass captured during spring surveys of Lake Ellwood, Florence County, 2012 (N=37).

Recruitment

As mentioned above, the 1979 survey showed a much lower largemouth bass size structure. This is because smaller/younger largemouth bass were much more abundant and a large part of their sample. Nearly 66% of the bass captured during spring surveys (which are bias toward adult fish) were ≤ 9.9 inches; this strongly suggests that largemouth bass recruitment was very high and capable of not only sustaining the population but also growing the largemouth bass population. Twenty-three years later, in 2002, another spring bass survey was conducted. The 2002 spring survey included less effort directed toward largemouth bass sampling and only 20 fish were captured. This relatively small sample contained two fish ≤ 9.9 inches (10% of sample), which is a significant decline from 66% in 1979. However, spring surveys target largemouth bass while in the process of building nests and are designed for sampling adult fish, because of this it is not uncommon to see a low catch of juvenile fish. To account for the sampling bias the 2002 protocol used mini fyke nets to sample juvenile fish. During 2002, five 3' x 3' mini fyke nets were deployed for two days in Lake Ellwood and checked daily. A total of 73 young-of-the-year (YOY) largemouth bass were captured, ranging in size from 1.70 to 3.59 inches in length. YOY largemouth bass were the third most abundant fish species captured during this recruitment survey at 7.3 fish/net-lift, only below YOY bluegill (57.9/net-lift) and bluntnose minnow (9.6/net-lift). This suggests that while there were much fewer small/young largemouth bass captured during spring surveys that largemouth bass were still reproducing at good levels and were capable of maintaining a population naturally in Lake Ellwood.

Due to a change in protocol we no longer use mini fyke net surveys to index fish recruitment. The current protocol uses a fall electrofishing survey to index gamefish recruitment. During our fall electrofishing survey we attempted to index recruitment of all gamefish using average catch per mile of YOY gamefish. During this survey our crew was directed to capture all fish (instead of all gamefish), to be certain not to miss any YOY fish and obtain an accurate sample of YOY largemouth bass. However, we did not capture, or observe, a single largemouth bass ≤ 14.0 inches. The lack of juvenile largemouth bass during our fall survey along with many missing year classes, including all year classes less than age-5 (Figure 13), suggests that something has changed

drastically in Lake Ellwood leaving a moderately abundant largemouth bass population that is no longer capable of sustaining itself naturally.

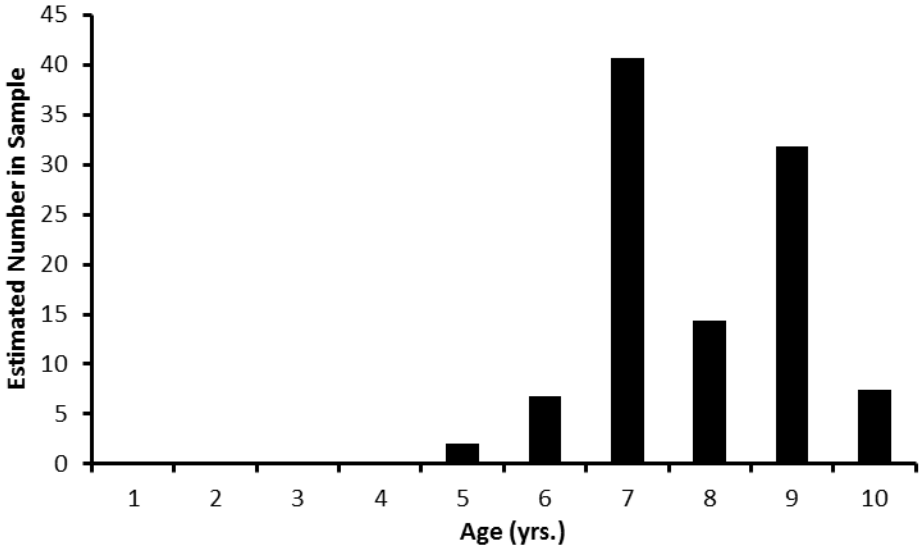

Figure 13. Estimated age frequency for all largemouth bass captured during the 2012 survey of Lake Ellwood, Florence County (N=104).

Smallmouth Bass

Abundance

A total of 290 different smallmouth bass were captured during our spring surveys in 2012 (Table 4, Appendix A). Smallmouth bass were the most abundant gamefish sampled during spring electrofishing surveys during 2012 (Table 5, Appendix C). During a similar survey in 2002 the smallmouth bass catch rate was only about one-third the level measured in 2012, indicating a nearly 3-fold increase in smallmouth bass abundance over the past 10 years (Table 8). A mark-recapture survey was conducted during 2012, which estimates the adult ($\geq$ 8.0 inches) smallmouth bass population to be approximately 583 fish (4.41/acre) with a 95% confidence range between 352 and 814 fish. Smallmouth bass are now the most abundant gamefish species in Lake Ellwood, with twice the abundance of the second most abundant gamefish (largemouth bass).

Table 8. Abundance of smallmouth bass, indexed using population estimation and catch rate during spring surveys, in Lake Ellwood, Florence County, during 2012 compared to a previous survey.

	2012	2002
Adults/Acre	4.41	n/a
Adults/mi.	13.74	4.66

Size Structure

The 290 different smallmouth bass captured during the 2012 survey ranged in size from 2.9 to 20.4 inches in length (Figure 14). The mean length of smallmouth bass captured during spring surveys was 10.8 inches, nearly 2 inches shorter than the 12.7 inch average measured during 2002. Modal length of smallmouth bass during 2012 (7 inches) was substantially lower than during 2002 (14 inches). Size structure, indexed using relative stock density (RSD), has decreased since 2002 (Table 9). Size structure is expected to decrease when abundance increases, in fact, the main cause for

decreased size structure is very good recruitment in the past few years, which is adding many smaller fish to the population. While the current size structure could be improved upon it is acceptable, with nearly 29% of the stock length fish being ≥ 14.0 and 2% ≥ 17.0 inches.

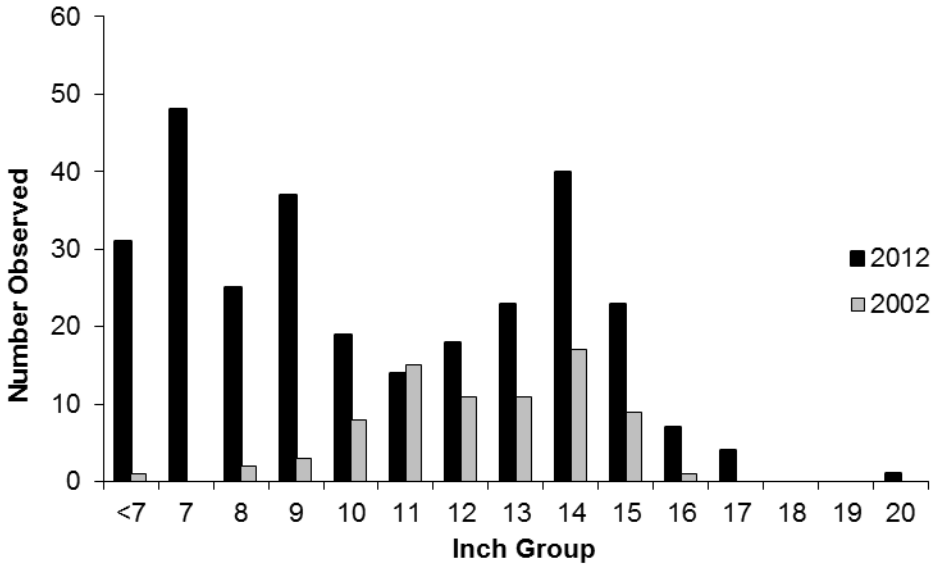

Figure 14. Length frequency of smallmouth bass captured during spring surveys of Lake Ellwood, Florence County, in 2012 compared to 2002 (2012: N=290; 2002: N=78).

Table 9. Size structure, indexed using relative stock density, for smallmouth bass captured during 2012 compared to previous surveys of Lake Ellwood, Florence County.

	2012	*2002	1971	**1949
RSD11:	50.19	83.12	21.74	42.42
RSD14:	28.96	35.06	13.04	18.18
RSD17:	1.93	0.00	0	0.00
RSD20:	0.39	0.00	0	0.00

*Fish kill affected SMB winter 2001-02
**Summer fyke net survey

Growth

Growth was indexed using average length at age from a subsample of 113 smallmouth bass during the 2012 survey (Figure 15). Lake Ellwood smallmouth bass showed growth rates near the Northern Region (NOR) average early in life, but by age 5 growth rates decline showing growth below the NOR average late in life (Table 4, Appendix B).

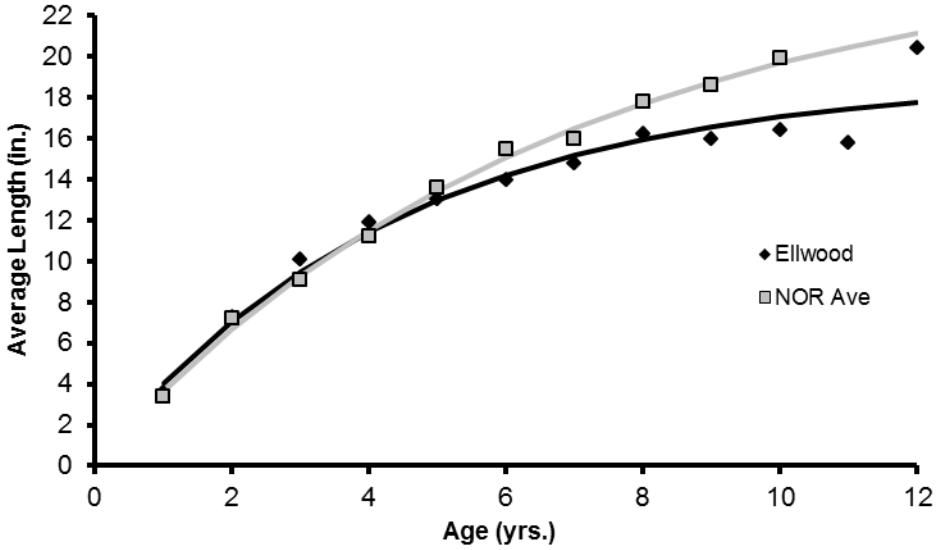

Figure 15. Average length at age for smallmouth bass captured from Lake Ellwood during 2012 spring surveys, fit with von Bertalanffy growth curves and compared to the average length at age for the Northern Region of WI (2012: N=113).

Body Condition

During our sampling efforts we obtained weight measurements from 97 randomly selected smallmouth bass. Relative weight (W_r) was used to index body condition of smallmouth bass. W_r values for both sexes combined ranged from 135.6 to 78.3, with an average of 104.2 (Figure 16). The average W_r for smallmouth bass sampled is above the target of 100, however, the sample was biased toward shorter/younger individuals with 89 of the 97 fish sample being $\leq$ 15.9 inches in length. A statistically significant negative correlation was found between body length and W_r ($P=4.6x10^{-5}$, $R^2=0.82$). This suggests that conditions are better for shorter/younger individuals than they are for longer/older individuals in the population. Some of the more likely conditions that are worse for longer individuals are forage supply and quality, space, and ideal water temperature. A negative relationship between body length and body condition has been seen in many different waters in this region of Wisconsin. While it is not desirable to have a negative relationship between total length and body condition, the average W_r for the 10 fish $\geq$ 16.0 inches was 83.5, which I consider to be on the lower end of an acceptable range for our northern climate.

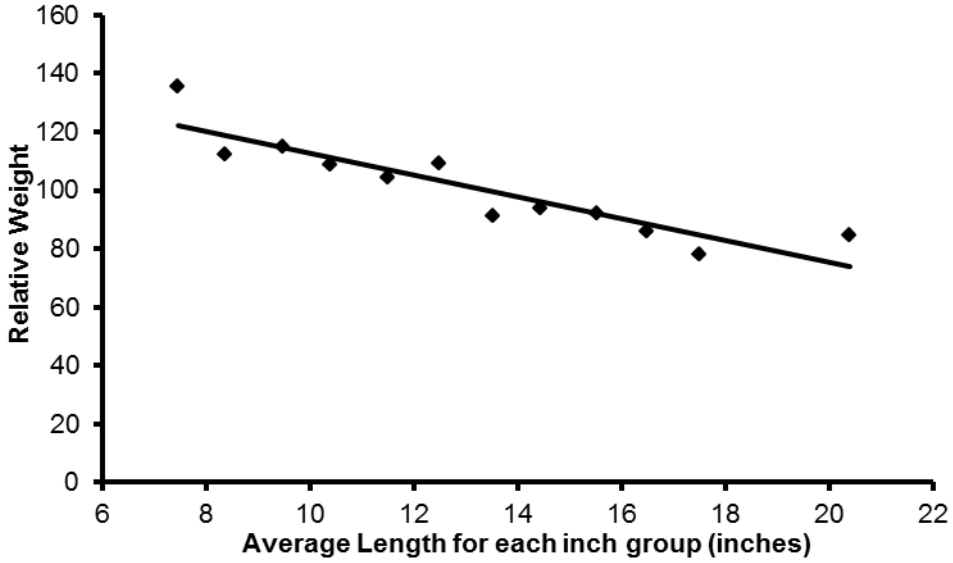

Figure 16. Average relative weight at length, measured from a sub sample of smallmouth bass captured during spring surveys of Lake Ellwood, Florence County, 2012 (N=97).

Recruitment

Recruitment was indexed using catch per mile of YOY and age 1 fish during a fall electrofishing survey. While YOY smallmouth bass were captured during spring surveys none were captured during our fall survey. However, a total of 11 age-1 fish were captured during fall 2012. The presence of YOY fish during other 2012 surveys, 11 age-1 fish captured during the fall survey, all year classes age 0-12 present throughout our survey along with a drastically increasing adult population suggest that there is enough natural reproduction to support this population.

Panfish:

Bluegill

Relative Abundance

Bluegill was the most abundant panfish species during summer fyke netting with a total of 148 fish captured (9.9 fish/net-lift). While bluegill is the most abundant panfish in Lake Ellwood, the overall bluegill abundance is well below the average of 27.0 bluegill per net-lift for lakes in this area (Figure 17). The last panfish survey, conducted in 2002, found bluegill abundance to be nearly three times what it is today, suggesting a major decline over the past 10 years (Table 4, Appendix C).

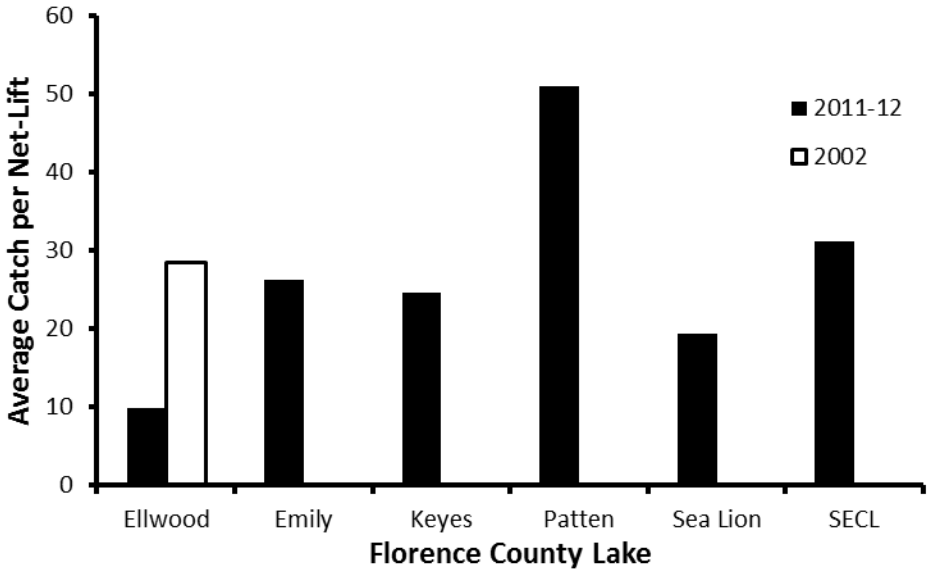

Figure 17. Average bluegill catch per net lift during summer fyke net surveys of Lake Ellwood compared to other Florence County lakes, 2011-2012.

Size Structure

All 148 bluegill were measured during our summer panfish survey. These fish ranged from 3.5 to 8.9 inches in length with an impressive modal length of 8 inches (Figure 18). Size structure was indexed using relative stock density (RSD), which showed very good size structure with RSD7 and RSD8 values of 60.8 and 35.1 respectively. The current size structure is similar to or better than the size structure measured during previous surveys, showing that bluegill size structure is generally as good now as it has been since 1949 (Table 10).

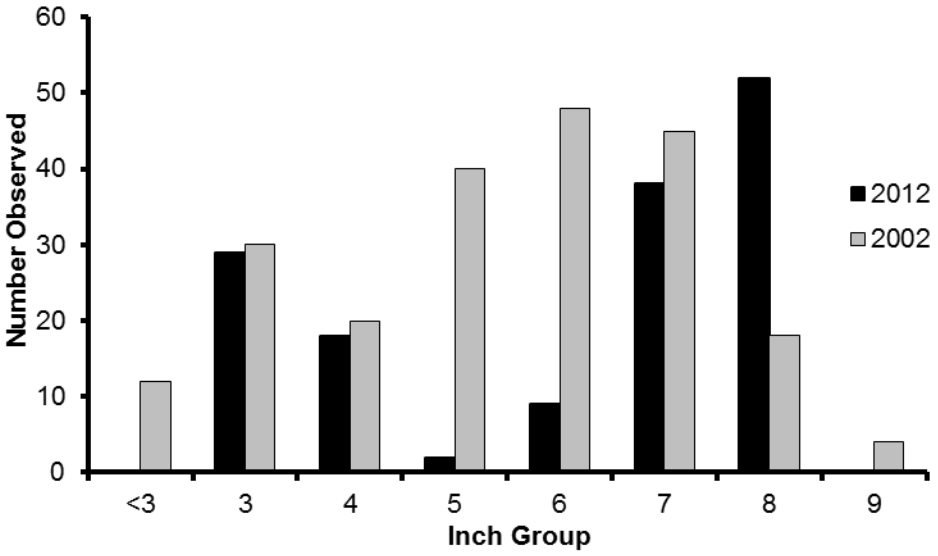

Figure 18. Length frequency for a subsample of bluegill captured during a summer fyke net survey of Lake Ellwood, Florence County, during 2012 compared to a similar survey from 2002 (2012: N=148; 2002: N=217).

Table 10. Size structure, indexed using relative stock density, for a subsample of bluegill captured during 2012 compared to previous surveys of Lake Ellwood, Florence County.

	2012	2002	**1979	*1972	1949
RSD6	66.89	56.10	80.52	85.43	80.00
RSD7	60.81	32.68	57.14	75.50	58.82
RSD8	35.14	10.73	10.39	41.72	24.71
RSD9	0.00	1.95	0.00	1.32	2.35
RSD10	0.00	0.00	0.00	0.00	0.00

*Spring sample
**Derived from a scale drawing

Growth

Anal spines and scales were removed from a sample of 38 bluegill to estimate age. Growth was then indexed using average length at age. Bluegill in Lake Ellwood showed above average growth when compared to the Northern Region of Wisconsin (Figure 19). On average it takes a bluegill 4 to 5 years to achieve 7 inches in length (Table 5, Appendix B).

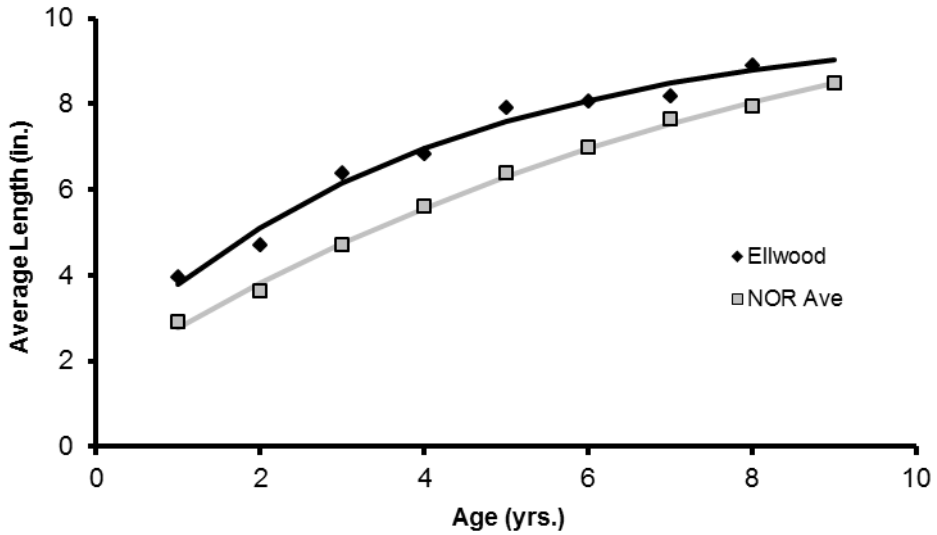

Figure 19. Average length at age for a subsample of bluegill captured during a 2012 summer fyke net survey of Lake Ellwood, fit with von Bertalanffy growth curves and compared to the average length at age for the Northern Region of WI (N=38).

Recruitment

The subsample of bluegill that was used to estimate age and growth was used to estimate the age structure of the 148 bluegill sample captured during summer fyke netting (Figure 20).

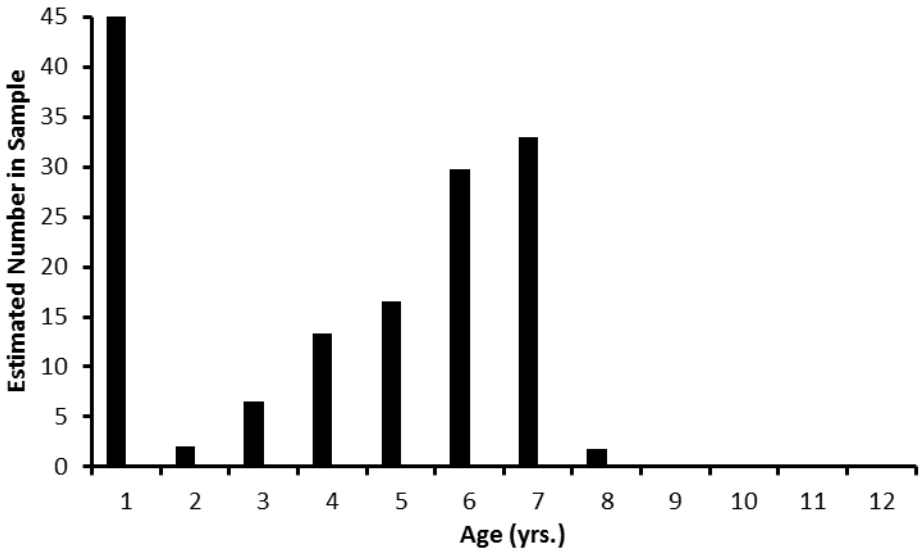

Figure 20. Estimated age frequency for all bluegill captured during the 2012 survey of Lake Ellwood, Florence County (N=148).

The number of age-1 individuals captured during 2012 is deceiving and may not be a sign of good recruitment in the future. Typically fish less than age 2 are not captured in standard sized fyke nets, like the ones used in this survey, because fish less than 3 inches in length typically swim straight through the mesh on the net. The age-1 bluegills sampled during this survey were surprisingly large, averaging approximately 4.0 inches in length, over an inch longer than the NOR average. At a catch rate of only 3 fish per net lift, these age-1 fish are still quite rare and even a moderate amount of predation/natural mortality would have a major effect on this year class. I expect a very high percentage of the age-1 fish will not live to age-2, and will likely be similar to the 2010 year class (shown as age-2 fish) as time passes.

To better quantify the reduction in bluegill natural reproduction in Lake Ellwood the age-1 fish must be removed. When you compare the year class strength of the fish estimated to be between 2 and 7 years old (the 2010-2005 year classes) the yearly reduction in bluegill recruitment is even more drastic, suggesting an average annual decline in recruitment of approximately 38.8% (Figure 21). If this trend continues bluegill will likely become incredibly rare, or removed from the fishery completely, as the older fish move out of the population, leaving an undesirable bluegill fishery.

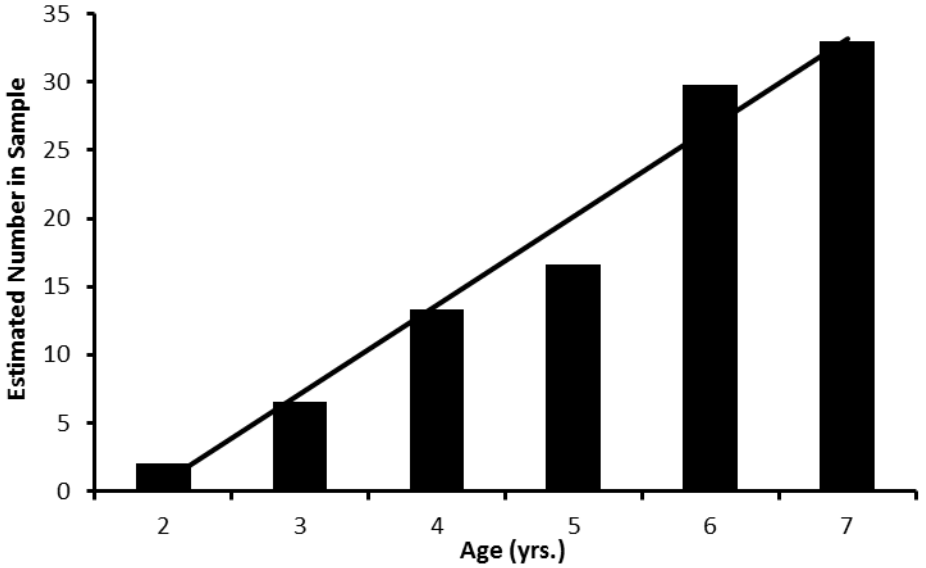

Figure 21. Estimated age frequency for all bluegill age 2-7 captured during the 2012 survey of Lake Ellwood, Florence County (N=101.2, R^2=0.97).

The abnormal age structure of the Lake Ellwood bluegill population is easier to understand if we compare it to another lake in Florence County, nearby Lake Emily which was also surveyed during 2012. When you plot the year class strength of bluegill populations in these two lakes the issue becomes quite clear (Figure 22). The year class strength of the current Lake Emily population decreases an average of 35.7% annually as you move from age 2 to 7; Lake Ellwood year class strength increases by an average of 38.8%, as you move from lower to higher year classes. This trend of decreased recruitment brings the longevity of the bluegill population in Lake Ellwood into question.

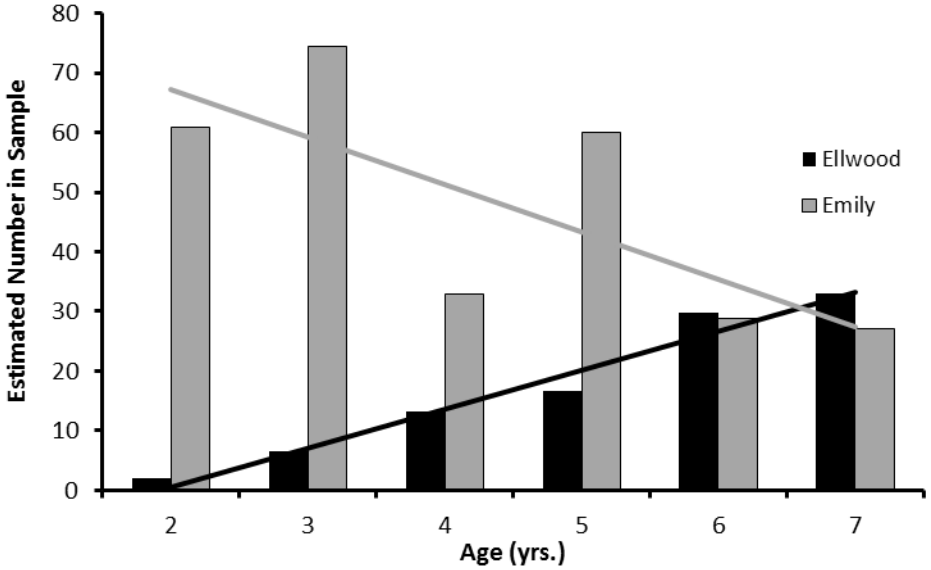

Figure 22. Estimated age frequency for all bluegill age 2-7 captured during the 2012 survey of Lake Ellwood compared to Lake Emily, a nearby Florence County Lake also surveyed in 2012 (Ellwood: N=101.2, Emily: N=284.2).

Rock Bass

Relative Abundance

Rock bass were the 2nd most abundant panfish species captured during our summer survey. A total of 31 rock bass (2.1 fish/net-lift) were captured in 2012. This suggests a nine-fold decrease in abundance since the 2002 survey, which had almost 19 fish per net lift (Table 4, Appendix C).

Size Structure

All rock bass captured during our 2012 summer survey were measured, ranging in size from 4.0 to 9.3 inches, with a modal length of 8 inches (Figure 23). Rock bass size structure during 2012 was above average when compared to previous surveys of Lake Ellwood (Table 11).

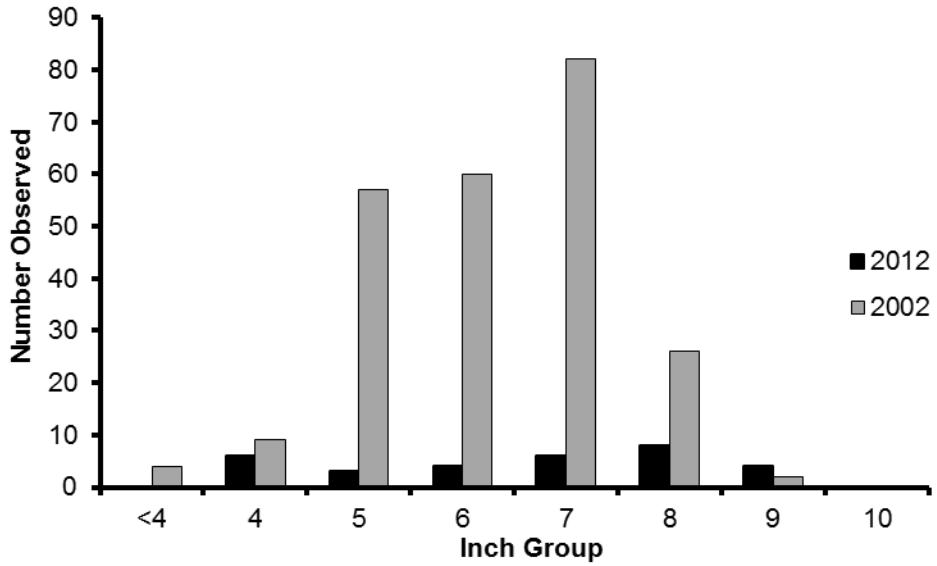

Figure 23. Length frequency of all rock bass captured during a summer fyke net survey of Lake Ellwood, Florence County, in 2012 compared to a similar survey from 2002 (2012: N=31; 2002: N=240).

Table 11. Size structure, indexed using relative stock density, for rock bass captured during 2012 compared to previous surveys of Lake Ellwood, Florence County.

	2012	2002	*1972	1949
RSD7	58.06	46.61	15.00	14.06
RSD8	38.71	11.86	1.00	4.69
RSD9	12.90	0.85	0.00	0.00
RSD10	0.00	0.00	0.00	0.00

*Spring Sample

Growth

Anal spine cross sections and scale samples from 28 rock bass were used to estimate age. Growth was then indexed using average length at age and compared to the state of Wisconsin average. Rock bass growth in Lake Ellwood is below the state average beyond age 5 (Figure 24). On average it takes about 6 years for a rock bass in Lake Ellwood to reach 8 inches in length (Table 8, Appendix B).

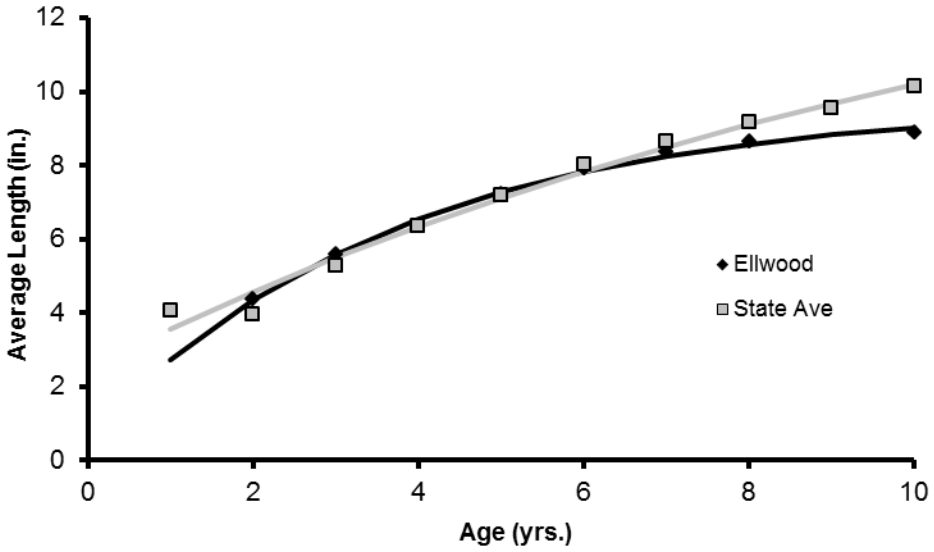

Figure 24. Average length at age for a subsample of rock bass captured during a 2012 summer fyke net survey of Lake Ellwood, fit with von Bertalanffy growth curves and compared to the state average (N=28).

Black Crappie

Relative Abundance

Only 2 black crappie (0.13 fish/net-lift) were captured during summer panfish netting. This low catch rate is similar to the summer catch rate during previous surveys (Table 4, Appendix C). Typically black crappie catch is low during summer because of their early spawning period. Black crappie were also captured at a low catch rate (0.64 fish/net-lift) during the spring netting survey (Table 2, Appendix C). Black crappie have never been very abundant in Lake Ellwood and provide little angling opportunity at the current abundance.

Size Structure

All black crappie captured during spring and summer netting surveys were measured to analyze size structure. These fish ranged from 4.1 to 14.4 inches in length (Figure 25). Black crappie in Lake Ellwood show extremely good size structure with nearly all fish $\geq$ 12.0 inches and approximately 45% $\geq$ 14.0 inches (Table 12). The current size structure, like that of northern pike and largemouth bass, is artificially high due to poor natural reproduction over the past five years and is not maintainable.

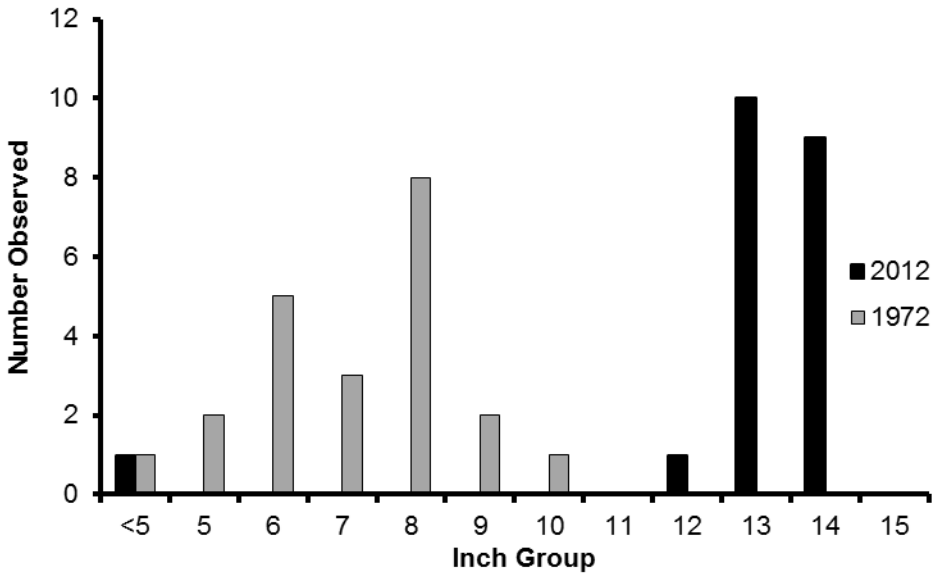

Figure 25. Length frequency of all black crappie captured during spring and summer surveys of Lake Ellwood, Florence County, in 2012 compared to a similar survey from 1972 (2012: N=21; 1972: N=22).

Table 12. Size structure, indexed using relative stock density, for black crappie captured during 2012 compared to previous surveys of Lake Ellwood, Florence County.

	2012	*2002	1972
RSD8	100.00	100.00	52.38
RSD10	100.00	100.00	4.76
RSD12	100.00	100.00	0.00
RSD14	45.00	0.00	0.00

*Summer survey (3 fish sample)

Growth

Black crappie growth, indexed using average length at age, was well above the average for the Northern Region (NOR) of Wisconsin. Lake Ellwood black crappie display an impressive growth rate which is without a doubt one of the reasons for the impressive size structure in Lake Ellwood (Figure 26). On average it takes only 3 years for a Lake Ellwood black crappie to reach 8 inches in length and 6 years to reach 14 inches (Table 7, Appendix B).

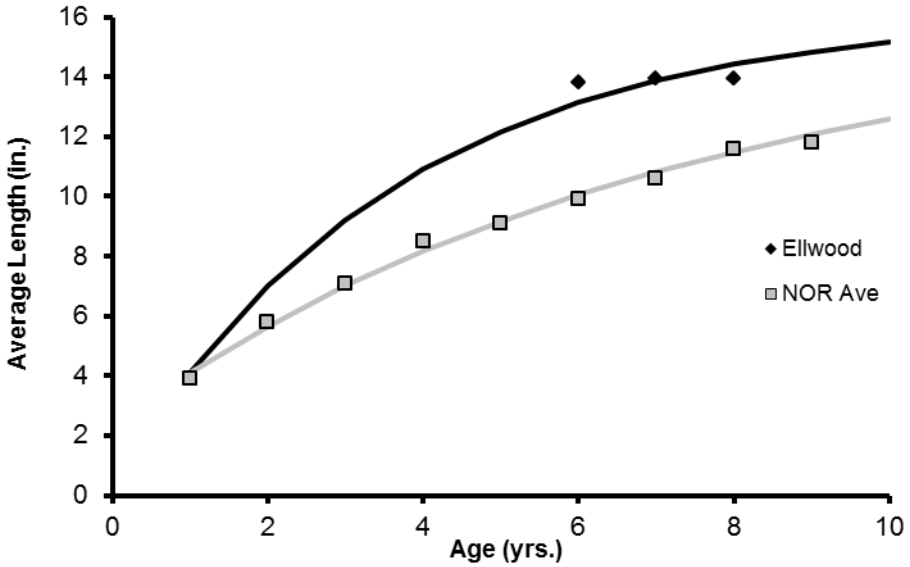

Figure 26. Average length at age for a subsample of black crappie captured during 2012 spring surveys of Lake Ellwood, fit with von Bertalanffy growth curves and compared to the average length at age for the Northern Region of WI (N=19).

Recruitment

As soon as we started the 2012 survey it was evident that there were not many black crappie in Lake Ellwood and the species may be having some reproductive problems. Throughout the entire 2012 survey our crew was instructed to collect every crappie, regardless of the target species for that particular survey, to better understand black crappie recruitment. No YOY black crappie were captured or seen during the entire survey.

During the 2012 survey a total of 21 black crappie were captured, all but one of these fish were larger than 12.8 inches in length. This is not a typical length distribution of black crappie. After analyzing cross sections of anal spines from all 21 black crappie captured during 2012 it shows that nearly all of the black crappie (95.2%) are estimated to be $\geq$ 6 years old (Figure 27).

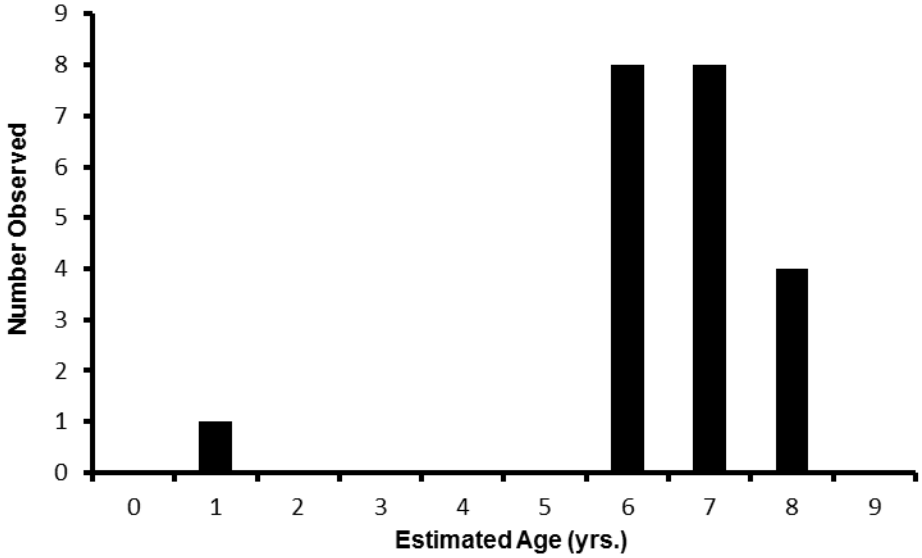

Figure 27. Age frequency for all black crappie captured during the 2012 survey of Lake Ellwood, Florence County (N=21).

Black crappie are native to Lake Ellwood and have always existed in low numbers. The presence of a significant number of fish age 6-8 proves that the lake was capable of natural reproduction. However, the fact that only a single fish was captured less than 6 years old strongly suggests that black crappie are no longer capable of maintaining their population naturally in Lake Ellwood.

Yellow Perch

Relative Abundance

Only two yellow perch were captured during our summer panfish netting survey. Like black crappie, typically catch rates of yellow perch are low during summer sampling since yellow perch have a much earlier spawning period than other panfish, leaving them less susceptible to our sampling gear. However, no yellow perch were captured during our spring surveys, indicating that the adult yellow perch population is currently very low. While yellow perch are still present in the lake they appear to be a minor portion of the panfish population. A previous survey conducted in 1971 suggests that Lake Ellwood once had a more sizeable yellow perch population.

Size Structure

A total of 5 yellow perch, ranging in size from 3.9 to 8.0 inches, were captured during the 2012 survey. By analyzing data from previous surveys it appears that Lake Ellwood has always had poor size structure of yellow perch (Figure 28, Table 13). Even when perch were much more abundant there were still very few over 8 inches in length, making the perch fishery undesirable from a size structure standpoint.

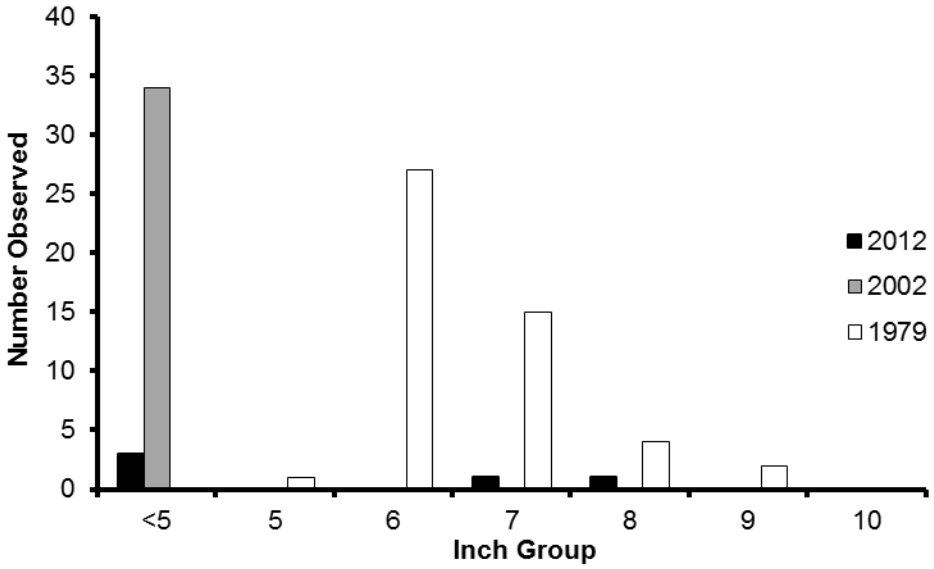

Figure 28. Length frequency of all yellow perch measured during previous surveys of Lake Ellwood, Florence County (2012: N=5, 2002: N=34, 1979: N=49).

Table 13. Size structure, indexed using relative stock density, for yellow perch captured during the 2012 survey of Lake Ellwood, Florence County, compared to previous surveys (2012: N=5, 2002:N=34, 1979: N=49).

	2012	*2002	**1979
RSD8	50.00	0.00	12.24
RSD10	0.00	0.00	0.00
RSD12	0.00	0.00	0.00

*Summer sample
**Derived from scale drawing

Pumpkinseed

Relative Abundance

Like yellow perch, only 4 pumpkinseed were captured throughout our sampling efforts in 2012. Pumpkinseed were also sampled in higher numbers during previous spring and summer netting surveys going back to 1972 (Table 2 & 4, Appendix C). Pumpkinseed should be considered the least abundant panfish species in Lake Ellwood.

Size Structure

Only 3 of the 4 pumpkinseed captured during 2012 were measured. These fish ranged from 6.7 to 8.2 inches in length (Figure 29 & Table 14). This was not a large enough sample size to analyze size structure. Previous surveys conducted during the 1970's show that pumpkinseed use to be much more abundant and had very good size structure.

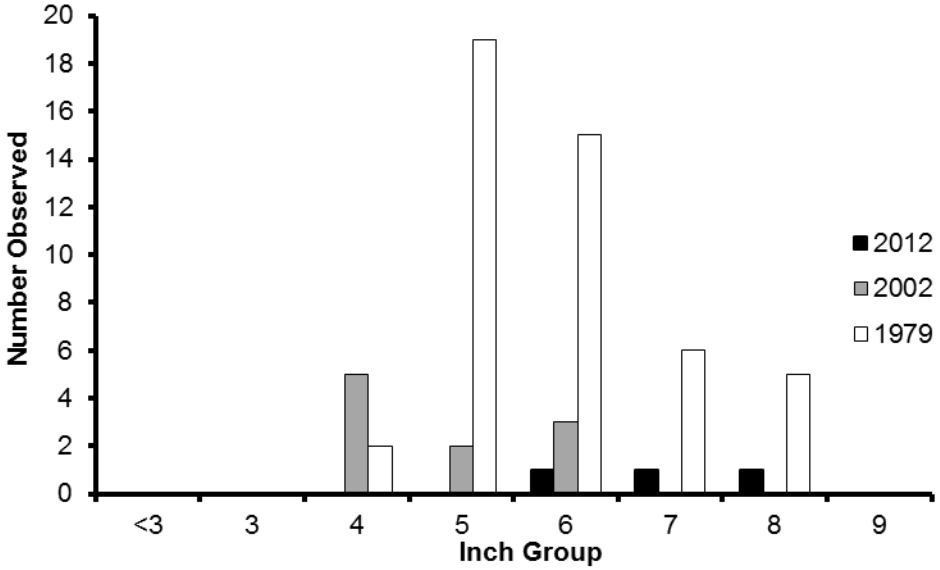

Figure 29. Length frequency of all pumpkinseed measured during previous spring and summer fyke net surveys of Lake Ellwood, Florence County (2012: N=3, 2002: N=10, 1979: N=47).

Table 14. Size structure, indexed using relative stock density, for pumpkinseed captured during the 2012 survey of Lake Ellwood, Florence County, compared to previous surveys (2012: N=3, 2002: N=10, 1979: N=47).

	2012	2002	*1972
RSD6	100.00	30.00	55.32
RSD7	66.67	0.00	23.40
RSD8	33.33	0.00	10.64

*Spring sample

Other Species:

White Sucker

White sucker were not captured at a very high rate during either of our fyke netting surveys of Lake Ellwood during 2012 (Table 2 & 4, Appendix C). Large (15-20 inch) white suckers were observed in high numbers during all electrofishing surveys, and are likely a very important food source for the large northern pike and other fish in Lake Ellwood.

Aquatic Vegetation:

Aquatic vegetation has never been considered to be abundant in Lake Ellwood. During a comprehensive fisheries survey conducted during 2002 aquatic vegetation was listed as "sparse" (Young 2002). A 2005 aquatic plant survey conducted by WDNR research personnel found similar results with aquatic plants only present at 29 of 201 sampling locations (Figure 30). However, the 2005 survey was conducted after a chemical treatment to control Eurasian Water Milfoil and this treatment (100lbs) may have had some impact on the plant community near the treatment area.

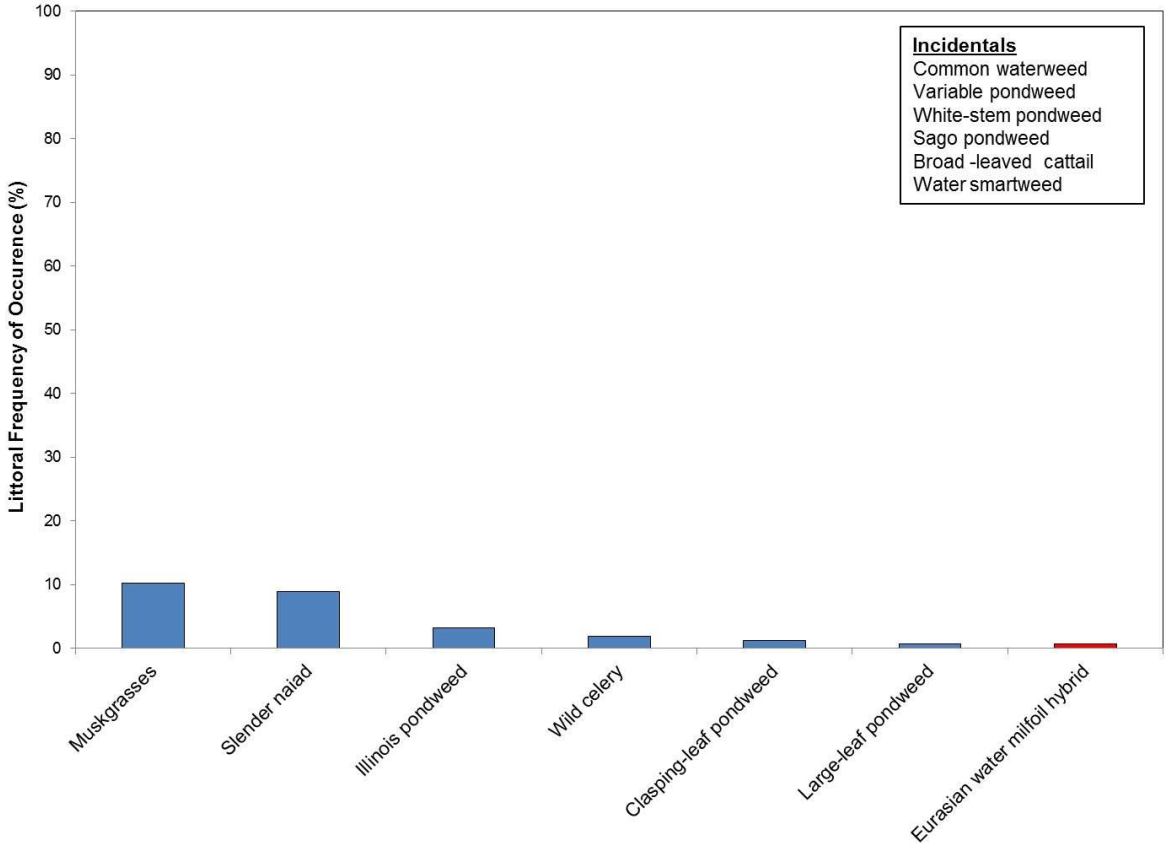

Figure 30. Abundance of aquatic plants, by species, measured during a 2005 plant survey of Lake Ellwood, Florence County (provided by Onterra, LLC).

Eurasian water milfoil (EWM), an exotic invasive species, was first found in Lake Ellwood during 2002. Since the discovery of EWM Lake Ellwood has received chemical treatments of 2,4-D acid to control EWM in the lake (Table 15). Annual chemical treatments have ranged from 4 pounds of chemical used to 2,800 pounds used during 2011. These levels of chemical treatment are considered to be "spot treatments", meaning that drastic effects should not be seen at the whole-lake level, and have reached a maximum whole-lake concentration of just over 0.14 ppm 2,4-D in 2011 (based on a

2012 water volume estimate by Onterra LLC.). Even at the peak chemical concentration there was likely no whole-lake plant impact, but each one of these treatments likely had an impact to the plant community near the point of treatment.

Table 15. Chemical treatment history of Lake Ellwood along with possible whole lake treatment levels based on the 1968 volume of water and current volume of water (provided by Onterra, LLC).

Year	Acres	Product	Lbs of Product	Whole-Lake 2,4-D ppm ae (1968 WDNR)	Whole-Lake 2,4-D ppm ae (2012 Onterra)
05/13/2003	0.5	Navigate (ester)	4	0.000	0.000
07/13/2004	0.25	Navigate (ester)	25	0.001	0.001
09/07/2004	1	Navigate (ester)	100	0.004	0.005
05/23/2005	1	Navigate (ester)	100	0.004	0.005
07/12/2005	1	Navigate (ester)	100	0.004	0.005
05/31/2006	6	Navigate (ester)	600	0.022	0.030
05/29/2007	9.9	Navigate (ester)	990	0.036	0.050
06/18/2008	14.2	Navigate (ester)	2130	0.078	0.108
06/02/2009	13.1	Navigate (ester)	1965	0.072	0.100
05/15/2010	2.3	Navigate (ester)	350	0.013	0.018
06/01/2011	9.5	SculpinG (amine)	*2800	0.090	0.140
05/08/2012	2.1	SculpinG (amine)	1045	0.033	0.053
Proposed 2013	0.5	SculpinG (amine)	264	0.008	0.013

*# of lbs according to DNR records

Total Volume of Lake Ellwood (WDNR Lake Survey Bathy Map, 1968)	1908	acre-feet
Actual Volume of Ellwood based upon hydro-accoustics (Onterra, 2012)	1379	acre-feet
	-28%	reduction

Navigate - acid equivalent (ae) of product: 19%

SculpinG - acid equivalent (ae) of product: 16.5%

It has been mentioned throughout this report that many native fish species that have always been capable of maintaining their populations via natural reproduction appear to now be incapable of maintaining their populations naturally. The four species that appear to have been most drastically impacted over the past decade are northern pike, black crappie, largemouth bass and bluegill. Vegetation is important for spawning and/or nest location for these four species (Becker 1983). That being said, it is not surprising that reproduction of these three species in Lake Ellwood has declined as chemical treatments began occurring on a yearly basis. By estimating the age of all individual fish, of these three species, captured during the 2012 survey we were able to place all fish captured into corresponding years of conception, or year class. By plotting year class strength against the amount of chemical used during aquatic plant management it is easy to see a clear trend of decreased year class strength for these four species as chemical treatments have increased in size and have been sustained annually (Figure 31). It is important to note that the only black crappie less than 6 years old, and a small year class of bluegill appear the year following the first "small" chemical treatment since 2005 and could have been created as a response to a decrease in chemical treatment during 2010. What is not clear is which stage of reproduction has been unsuccessful for these three species. Aquatic vegetation plays a major role in nest building (BG, BC & LMB), egg and YOY survival along with being a major source of habitat and food for prey items, including invertebrates and

minnow species. Likely an alteration to one or all of these important "phases" of reproduction is taking place in Lake Ellwood.

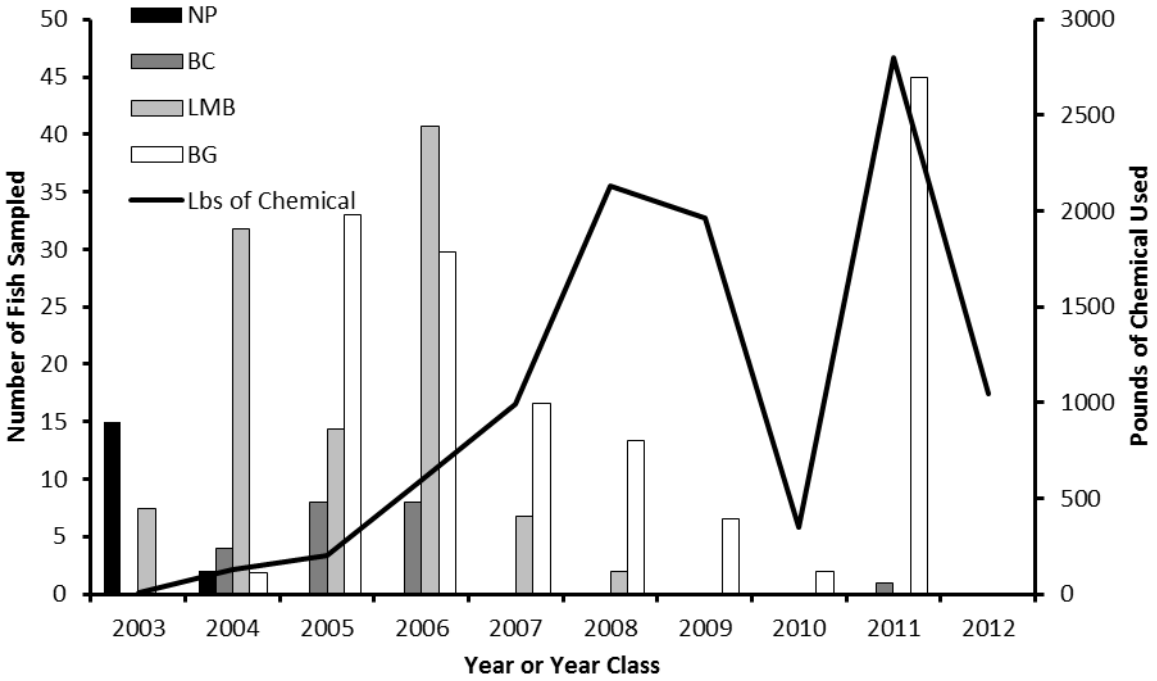

Figure 31. Year class strength, indexed using age estimation to determine number of individuals of each year class captured during a 2012 comprehensive survey, for northern pike, black crappie, largemouth bass and bluegill plotted against the number of pounds of 2,4-D used to treat aquatic plants in Lake Ellwood, Florence County, 2003-2012.

The active ingredient in the chemicals used during treatments of lake Ellwood is 2,4-dichloro-phenoxyacetic acid, which is sold under trade names Navigate and SculpinG (from table 15). This chemical is registered with the EPA and was re-reviewed in 2005 (DNR Fact Sheet 2012) and there are no restrictions on eating fish, pet/livestock drinking or human drinking water from treated water bodies (Appendix E). There have been studies conducted to measure the amount of chemical and the amount of time needed to cause death of a few water related species (Table 16).

Table 16. Acute toxicity levels for common aquatic species (provided by Onterra, LLC.).

Accute Toxicity (2,4-D acid) - 2,4-D Human Health and Ecological Risk Assessment, Final Report, USDA Forest Service, September 30, 2006
Fathead Minnow: 96 hr, 263 ppm
Leopard frog tadpole: 96 hr, 359 ppm
Water flea: 2 days, 36.4 ppm
Crayfish: 4 days, 1,389 ppm

The levels that have proven to be lethal to the water-related species in Table 16 above are many times higher than the estimated levels of 2,4-D in Lake Ellwood during previous chemical treatments. So it is not believed that the chemicals are directly linked to decreased reproduction of any fish species in Lake Ellwood. However, it is very likely that chemical treatments have indirectly resulted in significant damage to northern pike, largemouth bass and black crappie reproduction through the loss of aquatic plant life associated with a decade of aquatic herbicide applications.

V. MANAGEMENT RECOMMENDATIONS

Northern Pike

The 2012 northern pike population estimate shows that northern pike in Lake Ellwood are quite rare. In fact, they are the least abundant gamefish species in the lake (besides walleye). The current size structure of northern pike is incredibly high, likely for a number of reasons. One of which is the fact that there has been no recruitment of northern pike in the last 8 years; this eliminates the possibility of small fish being in the population leaving only the older/larger individuals, hence increasing the size structure. The incredibly low population also reduces the intraspecific competition allowing northern pike to live without resource limitations. Lake Ellwood is home to a substantial white sucker population that is without a doubt contributing to the impressive growth rate of northern pike, another very important piece of the puzzle for obtaining good size structure.

Even though the size structure of northern pike in Lake Ellwood is up there with the best pike waters in Wisconsin, it is not reaching the lake's potential. The sex ratio is highly skewed toward males (76%). Male northern pike grow slower and achieve an overall smaller size than female northern pike. For example, a 10-year old northern pike in Lake Ellwood averages just less than 30 inches in length while a 10-year old female northern pike in Lake Ellwood averages nearly 39 inches in length. A male northern pike may never reach 35 inches in total length, whereas a female northern pike in Lake Ellwood is likely capable of reaching beyond 45 inches in length. Because of this fast growth female northern pike must consume more food than males, which makes them easier for anglers to catch. Females also reach a desirable length faster than males, which results in higher harvest of females while they are young. It is my belief that angler harvest is the main reason why the sex ratio is highly skewed toward male fish.

Body condition of northern pike in Lake Ellwood is very good. An average W_r right near 100 indicates that resources are not limiting the current population. Female W_r was much higher than that of males and generally increased with body length. The trend of increasing body condition with length proves that Lake Ellwood has the potential of creating some truly special trophy northern pike.

Even though the current northern pike population is considered extremely desirable to many anglers, there are many ways that we can improve the fishery. The low abundance is one of the reasons why pike grow to such large size; however, Lake Ellwood has the forage to support a larger pike population, without having significant impacts to northern pike body condition or growth. The current population is also made up of primarily male fish (76%), by bringing the population back to a normal sex ratio (50:50) we could tweak an already good fishery and make it an incredible trophy pike fishery.

Northern pike recruitment and subsequently overall pike abundance has been drastically reduced in Lake Ellwood, which appears to be related to the loss of aquatic vegetation. Encouraging aquatic plants in Lake Ellwood is the first step in bringing back a self-sustaining northern pike population. Lake Ellwood has never carried a high density of northern pike, so it is likely that bringing back natural reproduction will not create a high density population capable of having negative impacts on body condition and size structure. Encouraging aquatic plants should be the #1 priority to enhance the northern pike population.

Another way to increase northern pike abundance would be to increase the minimum size limit on northern pike. The current regulation, no minimum size limit, does not offer any protection to the northern pike population in Lake Ellwood. This liberal regulation on northern pike is likely the reason for the relatively low abundance of female northern pike. I recommend increasing the minimum size limit for northern pike to 40 inches and reducing the daily bag limit from 5 fish to 1 fish. A 40-inch minimum size limit will protect northern pike until they reach a trophy size. It will also reduce the harvest of the faster growing females, increasing their relative abundance in the population. This will bring the sex ratio back to a ratio near 50:50 and maximize the trophy potential of this unique population.

Since natural reproduction has not occurred over the past eight years I recommend supplemental stocking of northern pike in Lake Ellwood. Large fingerling northern pike should be stocked into Lake Ellwood every other year at a rate of 1 fish/acre (approximately 135 fish). This is a very low stocking rate for northern pike and it is intended to maintain a low density fishery to maximize trophy potential. As aquatic vegetation returns to the lake we will likely see natural reproduction return. Fall electrofishing surveys should be done on a regular basis (every 2-3 years) to look for evidence of natural reproduction. If natural reproduction does return the stocking rate should be adjusted or dropped completely (depending on the level of natural reproduction). Since northern pike reproduction has not occurred for a longer time period than any other current species in Lake Ellwood, the reduction in northern pike natural reproduction may also be related to the declining water level which has occurred over the past decade or so. If natural reproduction does not return with the return of aquatic plants a low level population would be easily maintained via stocking. A target population of 0.5-1 adult/acre is an appropriate goal for Lake Ellwood.

If significant natural reproduction does return there is a chance that the northern pike population could become more abundant than our management goals for the fishery under the very restrictive 40-inch minimum size limit. This is why it will be very important to monitor the northern pike population closely, starting with recruitment surveys. If young-of-the-year northern pike are captured during fall surveys at a rate of more than 2 fish/mile during non-stocked years stocking of northern pike should be commenced. It is also my recommendation that Lake Ellwood should be put on an 8-year survey rotation which should include a mandatory northern pike population estimation survey. A northern pike population estimate will be needed to assure we are achieving our management goal of 0.5-1 adult/acre. If the population is not meeting our goals stocking rates should be adjusted accordingly. If the northern pike population begins reproducing again it will be more difficult to control the population since the input will no longer be controllable. A protective slot limit, that would protect large adult females, would be appropriate if this situation occurs. However, no management change should be pursued until the population reaches a level above 1.5 adults/acre. Another possible solution to control the northern pike population if it does reach a level above 1.5 adults/acre through natural recruitment would be to remove male northern pike. By removing male northern pike the adult population could be reduced without the loss of the faster growing/larger females or the protection of these fish to a trophy size. The best way to conduct removals would be immediately after ice-off with fyke nets, this is when northern pike are most vulnerable and sex of the fish is easily determined with 100% accuracy. It may not take any additional work to control the population in this fashion, since removals every 8 years (when a survey is already being conducted) may be enough to keep the population low. The sacrificed fish could go to retirement homes, a community event or worst case scenario the fish could be donated to wildlife rehabilitation centers. Sacrificed fish should not be wasted. A fish removal may seem like a drastic action, but the potential of this northern pike population (if properly managed) completely justifies a removal (if necessary).

If natural reproduction of northern pike does not return and a protective regulation is not put in place active stocking of northern pike should not continue. If the current liberal regulations are maintained for Lake Ellwood the stocking of northern pike would not be cost-effective and harvest would likely limit the potential of the fishery.

Walleye

Walleye is the rarest of the major fish species in Lake Ellwood. These fish were likely illegally transferred from other neighboring water bodies. This small walleye population offers very little angling opportunity and the species should just be thought of as non-existent in Lake Ellwood unless a significant change in abundance occurs.

Lake Ellwood is one of the few lakes in Florence County that does appear to have appropriate substrate for a naturally reproducing walleye population. However, the shape of the lake does not allow for much wave action which is also necessary for successful natural reproduction. I do believe that Lake Ellwood would be one of the more successful lakes in Florence County for establishing a stocked walleye fishery, at least in its current state. Across the board (except for smallmouth bass and white sucker) Lake Ellwood lacks significant fish populations. This would probably allow for high survival rates of stocked walleye fingerlings. Florence County in general has very poor survival rates of stocked walleye and has very few lakes with naturally reproducing walleye populations, so even a modest return on stocked small fingerling fish would likely create a significant walleye fishery for the area.

Even though Lake Ellwood appears to be the best candidate for walleye stocking in the area I would choose not to stock walleye at the present. The potential for a trophy northern pike population is what is truly special about Lake Ellwood, and all management efforts should go toward achieving this goal. That being said, if there was overwhelming support from the community to establish a walleye population in Lake Ellwood the WDNR should be open to the idea.

Right now Lake Ellwood falls under the statewide 15-inch minimum size limit and 5 fish bag limit for walleye. This regulation is appropriate and should not be considered for adjustment unless some sort of walleye management occurs.

Largemouth Bass

Largemouth bass abundance was estimated at 2.31 adults/acre during the 2012 survey. The last bass survey, conducted during 2002, had electrofishing catch rates of approximately 1/3 the catch rate seen during 2012. However, this survey did not direct much effort at surveying the largemouth bass population and may not be a good comparison for largemouth bass abundance, leaving it unclear whether the bass population was higher or lower than the current population. By looking at the age structure of the population it is clear that the bass population has been declining since at least 2007.

The average length of largemouth bass has increased since 1979, with the current population having the highest recorded size structure. During the entire 2012 survey we attempted to sample smaller/younger largemouth bass and never observed or captured a largemouth bass smaller than 12.9 inches or younger than 5 years of age. This is incredibly rare, especially since largemouth bass typically mature around 8 inches in length and will be actively spawning at much smaller sizes than

we saw on Lake Ellwood. In fact, I have never seen a largemouth bass population of any significant abundance that appeared to have a lack of juvenile fish. The absence of any fish less than 12.9 inches or 5 years of age during all survey efforts on Lake Ellwood is sufficient proof to declare this population as no longer naturally reproducing. Largemouth bass are not particularly long-lived species and if something does not change soon this once prolific species could become extirpated from Lake Ellwood.

Largemouth bass is a species that is dependent on aquatic plants for spawning and survival of young fish. Largemouth bass is also a nest-building species, which are often relatively consistent when it comes to spawning success. Appropriate substrate and water depth are currently available for nest building and bass were actively building nests and attempting to spawn throughout late spring during 2012. Declining lake levels should only impact largemouth bass spawning success in drastic situations (like the complete loss of littoral habitat - which can really only occur in lakes with very steep topography), which leads me to believe that the lack of aquatic vegetation is the cause for the loss of natural reproduction. Encouraging the growth of aquatic vegetation is the first, and most important, step to rebuilding a naturally reproducing largemouth bass population.

Body condition analysis suggests that resources are not limited for largemouth bass, expressed by an average W_r of 102.2. However, there is a statistically significant negative correlation between body length and body condition, suggesting that resources are more limited for larger fish. One possible explanation for decreased body condition with length is intraspecific competition. While the overall largemouth bass population is not considered abundant, the large percentage of the population between 14 and 17 inches allows for quite a bit of competition between these like-sized fish which likely feed on very similar prey items. While body condition is worse for larger individuals it is still considered to be acceptable even for the largest fish sampled.

Largemouth bass growth in Lake Ellwood is below the average for the Northern Region of Wisconsin. Slow growth is not expected for populations with above average body condition. The reduced growth rates measured during 2012 may be reduced by the competition between the high abundance of like-sized individuals (as mentioned above) or it may be a characteristic of the Lake Ellwood fishery. I recommend every effort be made to return natural reproduction to the largemouth bass population and once a more “normal” age and size structure returns to the population growth analysis should be conducted again.

The current 14-inch minimum size limit with a daily bag of 5 fish is appropriate for long-term management of Lake Ellwood. One could easily make the point that the minimum size limit should be increased to protect largemouth bass from harvest until aquatic vegetation can be restored and natural reproduction has a chance to return. However, an increased minimum size limit would not be appropriate for long-term management, especially in a population that is displaying below average growth. Again, I recommend every effort be made to bring back natural reproduction and assess the bass population once it returns to a more natural population.

Smallmouth Bass

Smallmouth bass are the most abundant game fish in Lake Ellwood. At a density of nearly 4.5 adults/acre it is one of the most abundant smallmouth bass populations in Florence County. Abundance of smallmouth bass has been increasing and it is possible that the current population is

the most abundant smallmouth population Lake Ellwood has ever held. Smallmouth bass recruitment has not been affected by the lack of aquatic vegetation with many juvenile fish sampled throughout the 2012 survey. The fact that this species was not affected by the reduction in plant life is not a surprise since as a species smallmouth bass are less dependent on aquatic vegetation.

Like largemouth bass, smallmouth bass exhibited growth rates below the regional average. Poor growth rates probably play a role in the less than desirable size structure found during 2012. However, there are still many fish between 10 and 16 inches which offer a quality angling experience.

Body condition had a significant negative correlation with body length for smallmouth bass in Lake Ellwood. This same trend is seen on many of the other lakes in Florence County, suggesting something about this region is limiting body condition on longer/older fish. The most likely problem is a lack of preferred forage for larger smallmouth bass. That being said, larger smallmouth bass (those $\geq$ 16.0 inches) had an average W_r of 83.5, which I consider to be on the very low end of the acceptable range for body condition for Northern Wisconsin.

There is a considerable decline in smallmouth bass size structure beyond the minimum size limit, suggesting that harvest, along with poor growth, may be limiting the size structure of smallmouth bass in Lake Ellwood. It is my belief that size structure of smallmouth bass would benefit by a protective slot limit. If the regulation was changed to a no minimum length limit, but fish between 14 and 18 inches could not be kept, with a 3 fish daily bag limit (1 fish > 18”); harvest would increase on smaller individuals, while larger fish would be retained in the fishery. The increased harvest on smaller fish would likely drive the abundance down, relieve some of the competition between the species and allow for better growth rates and body condition. However, under the current 14-inch minimum size limit the smallmouth bass population is thriving. There are more important issues that need correcting in Lake Ellwood that should be the focus of management going forward, that being restoring healthy levels of reproduction to northern pike, largemouth bass and black crappie. So for the time being the 14-inch minimum size limit is adequate.

Panfish

The relative abundance of panfish in Lake Ellwood is very low for Florence County. The average number of panfish captured per net-lift during the summer survey in 2012 was 12.33 fish, well below the average of 31.22 fish measured from all Florence County lakes surveyed the past two years (Figure 32). Not only is the panfish abundance down compared to the rest of the county, panfish relative abundance has also dropped approximately 75.4% since 2002 and 55.9% since 1979.

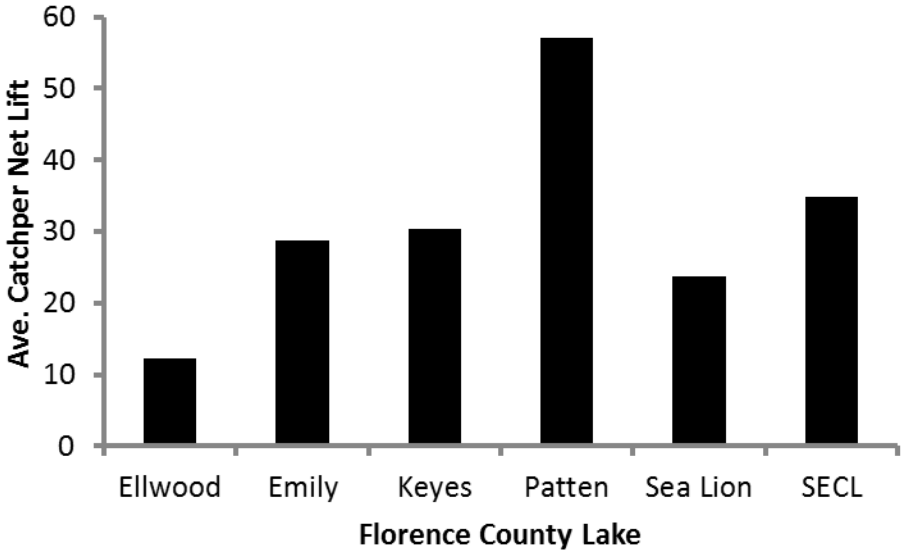

Figure 32. Panfish catch per net-lift during summer fyke net surveys of Florence County Lakes 2011-2012.

Bluegill accounted for nearly 80% of the panfish catch during the 2012 summer survey. However, like all panfish populations in Lake Ellwood currently, bluegill abundance has declined by over 65% since the last survey was conducted in 2002. Lake Ellwood bluegill display very fast growth and a very good size structure, with approximately 61% $\geq$ 7.0 inches. Bluegill size structure is similar to, or better than, size structure measured during previous surveys going back to 1949.

Rock bass accounted for approximately 17% of the panfish catch during our summer fyke net survey. Like bluegill, rock bass relative abundance has decreased drastically. Our data suggests that since 2002 rock bass abundance has dropped nearly 89%. However, the 2002 rock bass population appears to be a high point for rock bass abundance, with the 2012 relative abundance being at a more "normal" level for Lake Ellwood. Rock bass size structure is currently better than it has ever been with approximately 58% $\geq$ 7.0 inches and nearly 13% $\geq$ 9.0 inches. Rock bass growth was below the state average; however, it is a very acceptable growth rate for our northern climate.

Only two black crappies were captured during our summer survey. It is not uncommon to get a very low catch of black crappie because they spawn earlier than other panfish species and have no reason to be up shallow during our sampling period. Normally you see a higher number of black crappie during early spring netting surveys than summer surveys. This was the case for Lake Ellwood, however, even though our catch rate was higher than summer, we still captured less than 1 crappie per net lift. The size structure of black crappie captured during 2012 was very unusual, with all but one fish being between 12.8 and 14.4 inches in length. After age analysis the problem became much clearer. Significant natural reproduction of black crappie has not occurred since 2006. Like largemouth bass, northern pike and bluegill; black crappie are dependent on aquatic vegetation for spawning site location and cover. The reduction in aquatic vegetation is likely a major reason why black crappie natural reproduction is not occurring, and like largemouth bass, northern pike and bluegill, a significant population will cease to exist in Lake Ellwood if no changes are made.

Black crappie growth is exceptional in Lake Ellwood. The fast growth rates allow black crappies to reach 14 inches in only 6 years. However, the extremely low abundance of black crappie leaves very little angling opportunity. Without natural reproduction this population is not capable of sustaining

any level of harvest. This is why all efforts must be made to increase natural reproduction, starting with the promotion of aquatic plants.

Yellow perch and pumpkinseed are of very low abundance in Lake Ellwood. Pumpkinseed have never been captured in high numbers. However, by talking with anglers who use to fish Lake Ellwood I learned that yellow perch use to be a significant part of the fishery. We did see small yellow perch during some electrofishing surveys during 2012, but never in very high abundance. The yellow perch population should continue to be monitored during future surveys.

Changes are needed to properly manage the Lake Ellwood panfishery. First and foremost aquatic vegetation should be promoted and restored to Lake Ellwood. Aquatic vegetation is important for spawning and is also a primary producer for the lake. The loss of vegetation almost certainly resulted in the loss of many forage items for small and large panfish.

I recommend the bag limit be reduced from 25 to 5 panfish/person/day. This would greatly reduce harvest and help build a larger adult population that will likely be able to grow once significant plant life returns. The black crappie population in Lake Ellwood has truly special growth rates and is capable of producing a very special fishing opportunity. However, without any significant natural reproduction it is on the verge of complete collapse. This is why I recommend even stricter regulations on black crappie in Lake Ellwood. A minimum size limit should be used on populations without solid natural reproduction so I recommend we establish a minimum size limit of 12-inches for black crappie. This size limit will have no effect on the current population because they are all above the minimum size limit with no new fish on the way up. My hope is that as aquatic vegetation returns black crappie reproduction and survival will increase and a 12-inch minimum size limit will provide the protection for this population to grow. The current black crappie population achieves 12 inches in length in half the time it takes our average NOR populations, and there is no reason to believe that a significant number of fish will not surpass this minimum size limit and provide great catch and release as well as harvest opportunities once natural reproduction resumes.

Other Species

Visual observations during spring electrofishing surveys showed a large white sucker population in Lake Ellwood. No surveys were really geared toward capturing white sucker, and only small numbers of fish were captured during spring fyke netting. White sucker is most likely the most important forage fish in Lake Ellwood, and are probably a major reason why northern pike growth and size structure is so exceptional. I regret not organizing a survey geared toward the assessment of the white sucker population during 2012. It is very important to understand the white sucker population as much as possible, especially if the lake is managed for trophy northern pike. I recommend surveys be conducted to assess the white sucker population during future surveys of Lake Ellwood. It would be important to gather data to analyze relative abundance, size structure, growth and recruitment.

LITERATURE CITED:

Burdick, M.E. 1949. Fisheries Biology Section Investigational Report No. 814. Wisconsin Conservation Department, unpublished. 5 pages.

Carlson, et al. 1971. Surface water resources of Florence County. Department of Natural Resources, Madison, Wisconsin. 84 pages.

Burdick, M.E. 1973. Running Inventory – Elwood Lake, Florence County. Wisconsin Department of Natural Resources, unpublished. 1 page plus data sheets.

Heizer, R. 1980. Basic Inventory of Elwood Lake, Florence County. Wisconsin Department of Natural Resources, unpublished. 3 pages plus data sheets, figures and maps.

Becker, G.C. 1983. Fishes of Wisconsin. The University of Wisconsin Press. 1,052 pages.

Young, B. 2003. Wisconsin Department of Natural Resources Comrehensive Fisheries Survey Report. Wisconsin Department of Natural Resources, unpublished. 27 pages.

Nate, N. 2003. Mean Length at Age Summaries for Selected Species in Wisconsin. Electronic Spreadsheet.

Onterra, LLC. 2007. Lake Ellwood Management Planning Project. Onterra LLC, unpublished. 11 pages.

DNR PUB-WT-964. 2012. 2,4-D Chemical Fact Sheet. Wisconsin Department of Natural Resources. 2 pages.

Appendix A – Length Frequencies

Table 1. Length frequency of northern pike captured during a 2012 survey of Lake Ellwood, Florence County (Unmarked fish only).

Inch Group	Spring Netting	Total
<25		
25	1	1
26	6	6
27	5	5
28	2	2
29	3	3
30	1	1
31	1	1
32	0	0
33	6	6
34		
35		
36		
37		
38	1	1
39		
40	1	1
41	1	1
42	1	1
43		
44		
Totals	29	29

Table 2. Length frequency of walleye captured during a 2012 survey of Lake Ellwood, Florence County (Unmarked fish only).

Inch Group	Spring Netting	Spring Electrofishing	Fall Shocking	Total
< 20.0				
20	2	1		3
21	4			4
22	0			0
23	1			1
24	1			1
> 24.0				
Totals	8	1	0	9

Table 3. Length frequency of largemouth bass captured during a 2012 survey of Lake Ellwood, Florence County (Unmarked fish only).

Inch Group	Spring Netting	Bass #1	Bass #2	Bass #3	Bass #4	Bass #5	Bass #6	Total
< 10.0								
10								
11								
12						1		1
13		2	1	3		0		6
14	1	4	4	4	8	1	1	23
15	1	14	7	9	8	6	1	46
16	2	6	3	3	5	7	1	27
17					1			1
18					1			1
19								
20								
Totals	4	26	15	19	23	15	3	105

Table 4. Length frequency of smallmouth bass captured during a 2012 survey of Lake Ellwood, Florence County (Unmarked fish only).

Inch Group	Spring Netting	Bass #1	Bass #2	Bass #3	Bass #4	Bass #5	Bass #6	Total
< 7.0		4		1	6	12	8	31
7		4	5	5	6	25	3	48
8		2	0	1	2	18	2	25
9		7	2	11	2	14	1	37
10		6	2	4	1	6	0	19
11		7	1	4	1	1	0	14
12		10	0	5	2	0	1	18
13		9	4	6	1	2	1	23
14		13	11	15	1	0	0	40
15		5	6	5	3	4	0	23
16		1	2		3	1	0	7
17					2	1	1	4
18								0
19								0
20				1				1
21								
22								
Totals	0	68	33	58	30	84	17	290

Table 5. Length frequencies for subsamples of panfish measured during a summer netting survey of Lake Ellwood, Florence County, 6/26-29/2012.

Inch Group	Bluegill	Pumpkinseed	*Black Crappie	Rock Bass	*Yellow Perch
< 3.0					
3	29				1
4	18		1	6	2
5	2			3	
6	9	1		4	
7	38	1		6	1
8	52	1		8	1
9				4	
10					
11					
12			1		
13			10		
14			9		
Sample Size	148	3	21	31	5

*Subsamples of fish collected during spring netting and electrofishing surveys

Appendix B – Average Length at Age

Table 1. Mean length (inches) at age for northern pike captured during spring surveys of Lake Ellwood during 2012, compared to a previous survey of the Lake Ellwood and Northern Region of WI averages (2012: Male: N=22, Female: N=7).

	2012			2002	NOR Ave
Age	Male	Female	Combined	Combined	Combined
1	*9.8	*9.2	*9.5	10.4	10.6
2	*13.9	*14.8	*14.4	14.2	13.1
3					16.3
4					19.5
5				28.6	22.0
6				34.1	24.5
7				33.8	27.7
8	27.2		27.2		30.3
9	27.7	33.4	28.5		31.5
10	29.6	38.9	33.7		34.1
11	33.2		33.2		37.3
12	33.7		33.7		38.6
13		40.8	40.8		

*Back-calculated length at age

Table 2. Mean length (inches) at age for walleye captured during spring surveys of Lake Ellwood during 2012, compared to the Northern Region of WI averages (2012: Male: N=6, Female: N=2).

	2012			NOR Ave
Age	Male	Female	Combined	Combined
1				6.4
2				9.5
3				11.7
4				13.8
5				15.8
6		23.4	22.0	17.5
7	21.2	24.5	22.8	19.1
8				20.5
9				21.6
10				22.7

Table 3. Mean length (inches) at age for largemouth bass captured during spring surveys of Lake Ellwood during 2012, compared to previous surveys of Lake Ellwood and Northern Region of WI averages (2012: N=36).

Age	2012	2002	1979	1949	NOR Ave
1	*3.8				4.9
2	*4.5	7.2	7.3	7.4	6.4
3	*9.6		9.3	9.7	8.4
4		12.6	11	10.7	10.5
5	13.4	13.3	12.4	12	12.3
6	14.6	14.1	14		14.4
7	14.8				16.2
8	15.3	15.6			17.4
9	15.8				18.4
10	15.8			19	19.6
11					18.8
12					18.8
13	18.4				20.8

*Back-calculated length at age

Table 4. Mean length (inches) at age for smallmouth bass captured during spring surveys of Lake Ellwood during 2012, compared to previous surveys of Lake Ellwood and Northern Region of WI averages (2012: N=113).

Age	2012	2002	1979	1949	NOR Ave
1	3.5	3.3			3.4
2	7.3		6.7	7.7	7.2
3	10.1	8.9	9.6	10.5	9.1
4	11.9	11.1		14.1	11.2
5	13.0	12.3		15.6	13.6
6	14.0	14.2		17.9	15.5
7	14.8	15.1			16
8	16.2				17.8
9	16.0				18.6
10	16.4				19.9
11	15.8				
12	20.4				

Table 5. Mean length (inches) at age for bluegill captured during a summer fyke net survey of Lake Ellwood during 2012, compared to previous surveys of Lake Ellwood and Northern Region of WI averages (2012: N=38).

Age	2012	2002	1979	1949	NOR Ave
1	4.0	2.6			2.9
2	4.7	4.1		4.9	3.6
3	6.4	5.8	5.6	6	4.7
4	6.8	6.6	6.7	7.4	5.6
5	7.9	7.5	7.3	8.1	6.4
6	8.1	8.3		8.6	7.0
7	8.2				7.6
8	8.9		8.4		7.9
9					8.5

Table 6. Mean length (inches) at age for pumpkinseed captured during a summer fyke net survey of Lake Ellwood during 2012, compared to previous surveys of Lake Ellwood and Northern Region of WI averages (2012: N=1).

Age	2012	2002	1979	State Ave
1				3.2
2		4.4		3.9
3		6.1	5.4	4.7
4		6.2	7	5.4
5			7.7	6.0
6	8.2		7.8	6.5
7				7.0

Table 7. Mean length (inches) at age for black crappie captured during spring surveys of Lake Ellwood during 2012, compared to previous survey of Lake Ellwood and Northern Region of WI averages (2012: N=19).

Age	2012	2002	NOR Ave.
1	*4.4	4.4	3.9
2	*6.6		5.8
3	*9.1		7.1
4			8.5
5			9.1
6	13.8	12.3	9.9
7	13.9		10.6
8	13.9		11.6
9			11.8

*Back-calculated length at age

Table 8. Mean length (inches) at age for rock bass captured during a summer fyke net survey of Lake Ellwood during 2012, compared to a previous surveys of Lake Ellwood and Northern Region of WI averages (2012: N=28).

Age	2012	2002	1979	1949	State Ave.
1					4.1
2	4.4	3.5		4.5	4.0
3	5.6	5.3	4.8	5.9	5.3
4	6.4	6.8	5.9	6.9	6.3
5	7.2	7.5	7.1	7.8	7.2
6	7.9	8.0	7.9	8.7	8.0
7	8.4	8.8	8.3		8.6
8	8.7	9.3	8		9.2
9					9.5
10	8.9				10.2

Appendix C – Catch Per Unit Effort

Table 1. Gamefish catch per net-night during spring fyke netting surveys of Lake Ellwood, Florence County.

Species	2012	2002	*1972
Largemouth Bass	0.14	0.03	0.83
Northern Pike	1.89	3.97	0.17
Smallmouth Bass	0.00	1.63	0.00
Walleye	0.32	0.00	0.06

*Not immediately after ice-out

Table 2. Panfish catch per net-night during spring fyke netting surveys of Lake Ellwood, Florence County.

Species	2012	2002	*1972
Black Crappie	0.64	0.13	1.22
Bluegill	2.43	1.73	20.83
Pumpkinseed	0.04	0.00	2.61
Rock Bass	3.79	1.60	13.33
White Sucker	1.07	13.50	very high
Yellow Perch	0.00	1.23	0.28

*Not immediately after ice-out

Table 3. Gamefish catch per net-night during summer fyke netting surveys of Lake Ellwood, Florence County.

Species	2012	2002	1979	1949
Largemouth Bass	0.00	0.13	0.69	18.41
Northern Pike	0.07	0.19	0.22	0.00
Smallmouth Bass	0.07	0.00	0.00	2.83
Walleye	0.00	0.00	0.00	0.00

Table 4. Panfish catch per net-night during summer fyke netting surveys of Lake Ellwood, Florence County.

Species	2012	2002	1979	1949
Black Crappie	0.13	0.19	0.33	0.00
Bluegill	9.87	28.50	13.30	7.33
Pumpkinseed	0.13	0.63	4.20	0.00
Rock Bass	2.07	18.75	2.10	5.33
White Sucker	0.07	0.88	---	0.42
Yellow Perch	0.13	2.13	8.00	0.00

Table 5. Gamefish catch per mile during electrofishing surveys of Lake Ellwood, Florence County, 2012.

Species	Bass Surveys	Fall
Largemouth Bass	7.21	1.43
Northern Pike	---	0.36
Smallmouth Bass	18.78	7.86
Walleye (All)	0.06	0.00
Walleye (Age 0+)	---	0.00
Walleye (Age 1+)	---	0.00

Table 6. Gamefish catch per mile during electro fishing surveys of Lake Ellwood, Florence County, 2002.

Species	Bass Surveys	Fall
Largemouth Bass	2.76	0.00
Northern Pike	1.03	0.69
Smallmouth Bass	4.66	0.00
Walleye (All)	0.00	0.34
Walleye (Age 0+)	---	0.00
Walleye (Age 1+)	---	0.00

Table 7. Summary of fish species, number and size range captured during fyke net and electrofishing surveys during a comprehensive survey of Lake Ellwood, Florence County, 2012.

Fish Species		Catch (and Size Range in Inches) by Sampling Period											
		Spring Netting			Spring ElectroFishing			Summer Netting			Fall Electrofishing		
Common Name	Scientific Name	Catch	Min. Size	Max. Size	Catch	Min. Size	Max. Size	Catch	Min. Size	Max. Size	Catch	Min. Size	Max. Size
Black Crappie	Pomoxis nigromaculatus	18	12.8	14.4	1	13.8	13.8	2	4.1	13.1	0	---	---
Bluegill	Lepomis macrochirus	68	---	---	---	---	---	148	3.5	8.9	48	2.0	9.4
Bluntnose Minnow	Pimephales notatus	---	---	---	---	---	---	---	---	---	1	3.5	3.9
Largemouth Bass	Micropterus salmoides	4	14.5	16.9	126	12.9	18.4	0	---	---	4	14	16.4
Northern Pike	Esox lucius	53	25.9	42.5	---	---	---	1	---	---	1	25.5	25.9
Pumpkinseed	Lepomis gibbosus	1	---	---	---	---	---	3	6.7	8.2	0	---	---
Rock Bass	Ambloplites rupestris	106	---	---	---	---	---	31	4.0	9.3	25	1.5	9.9
Smallmouth Bass	Micropterus dolomieui	0	---	---	328	2.9	20.4	1	---	---	11	5.4	16.9
Walleye	Sander vitreus	9	20.2	24.5	1	20.5	20.5	0	---	---	0	---	---
White Sucker	Catostomus commersoni	30	---	---	---	---	---	1	---	---	9	18.0	22.2
Yellow Perch	Perca flavescens	0	---	---	3	3.9	4.4	2	7.9	8.0	5	3.0	4.4

Appendix D – Survey Maps

Legend

- SN1 (NP Mark) 3/23 - 3/27 (20 Lifts)
- SN1 (NP Recap) 3/28 - 3/29 (8 Lifts)
- SN3 6/26 - 6/29 (16 Lifts)

Lake Ellwood
Net Locations
2012 Comprehensive Survey

Mapped By: Jake Walcisak
December 7th, 2012

Lake Ellwood
Bass Electrofishing Survey #1
5/7/2012
2.97 Miles

Mapped By: Jake Walcisak
December 19th, 2012

Lake Ellwood
Bass Electrofishing Survey #2
5/9/2012
2.94 Miles

Mapped By: Jake Walcisak
December 19th, 2012

Lake Ellwood
Bass Electrofishing Survey #3
5/14/2012
2.9 Miles

Mapped By: Jake Walcisak
December 19th, 2012

Lake Ellwood
Bass Recapture Survey #1
5/30/2012
3.04 Miles

Mapped By: Jake Walcisak
December 19th, 2012

Lake Ellwood
Bass Recapture Survey #2
6/7/2012
2.89 Miles

Mapped By: Jake Walcisak
December 19th, 2012

*** Single Net Man ***

Lake Ellwood
Bass Recapture Survey #3
6/13/2012
2.73 Miles

Mapped By: Jake Walcisak
December 19th, 2012

Legend
All Fish (2.8 mi)

Lake Ellwood
Fall Recruitment Survey
10/11/2012
2.8 Miles

Mapped By: Jake Walcisak
October 17th, 2012

Appendix E – 2,4-D Chemical Fact Sheet

Wisconsin Department of Natural Resources

January 2012

2,4-D Chemical Fact Sheet

Formulations

2,4-D is an herbicide that is widely used as a household weed-killer, agricultural herbicide, and aquatic herbicide. It has been in use since 1946, and was registered with the EPA in 1986 and re-reviewed in 2005. The active ingredient is 2,4-dichloro-phenoxyacetic acid. There are two types of 2,4-D used as aquatic herbicides: dimethyl amine salt and butoxyethyl ester. Both liquid and slow-release granular formulations are available. 2,4-D is sold under the trade names Aqua-Kleen, Weedar 64 and Navigate (product names are provided solely for your reference and should not be considered endorsements nor exhaustive).

Aquatic Use and Considerations

2,4-D is a widely-used herbicide that affects plant cell growth and division. It affects primarily broad-leaf plants. When the treatment occurs, the 2,4-D is absorbed into the plant and moved to the roots, stems, and leaves. Plants begin to die in a few days to a week following treatment, but can take several weeks to decompose. Treatments should be made when plants are growing.

For many years, 2,4-D has been used primarily in small-scale spot treatments. Recently, some studies have found that 2,4-D moves quickly through the water and mixes throughout the waterbody, regardless of where it is applied. Accordingly, 2,4-D has been used in Wisconsin experimentally for whole-lake treatments.

2,4-D is effective at treating the invasive Eurasian watermilfoil (*Myriophyllum spicatum*). Desirable native species that may be affected include native milfoils, coontail (*Ceratophyllum demersum*), naiads (*Najas* spp.), elodea (*Elodea canadensis*) and duckweeds (*Lemna* spp.). Lilies (*Nymphaea* spp. and *Nuphar* spp.) and bladderworts (*Utricularia* spp.) also can be affected.

Post-Treatment Water Use Restrictions

There are no restrictions on eating fish from treated water bodies, human drinking water or pet/livestock drinking water. Following the last registration review in 2005, the ester products require a 24-hour waiting period for swimming. Depending on the type of waterbody treated and the type of plant being watered, irrigation restrictions may apply for up to 30 days. Certain plants, such as tomatoes and peppers and newly seeded lawn, should not be watered with treated water until the concentration is less than 5 parts per billion (ppb).

Herbicide Degradation, Persistence and Trace Contaminants

The half-life of 2,4-D (the time it takes for half of the active ingredient to degrade) ranges from 12.9 to 40 days depending on water conditions. In anaerobic lab conditions, the half-life has been measured up to 333 days. After treatment, the 2,4-D concentration in the water is reduced primarily through microbial activity, off-site movement by water, or adsorption to small particles in silty water. It is slower to degrade in cold or acidic water, and appears to be slower to degrade in lakes that have not been treated with 2,4-D previously.

There are several degradation products from 2,4-D: 1,2,4-benzenetriol, 2,4-dichlorophenol, 2,4-dichloroanisole, chlorohydroquinone (CHQ), 4-chlorophenol and volatile organics.

Impacts on Fish and Other Aquatic Organisms

Toxicity of aquatic 2,4-D products vary depending on whether the formulation is an amine or an ester 2,4-D. The ester formulations are toxic to fish and some important invertebrates such as water fleas (*Daphnia*) and midges at application rates; the amine formulations are not toxic to fish or invertebrates at application rates. Loss of habitat following treatment may cause reductions in populations of invertebrates with either formulation, as with any herbicide treatment. These organisms only recolonize the treated areas as vegetation becomes re-established.

Available data indicate 2,4-D does not accumulate at significant levels in the bodies of fish that have been tested. Although fish that are exposed to 2,4-D will take up some of the chemical, the small amounts that accumulate are eliminated after exposure to 2,4-D ceases.

On an acute basis, 2,4-D is considered moderately to practically nontoxic to birds. 2,4-D is not toxic to amphibians at application rates; effects on reptiles are unknown. Studies have shown some endocrine disruption in amphibians at rates used in lake applications, and DNR is currently funding a study to investigate endocrine disruption in fish at application rates.

As with all chemical herbicide applications it is very important to read and follow all label instructions to prevent adverse environmental impacts.

Human Health

Adverse health effects can be produced by acute and chronic exposure to 2,4-D. Those who mix or apply 2,4-D need to protect their skin and eyes from contact with 2,4-D products to minimize irritation, and avoid inhaling the spray. In its consideration of exposure risks, the EPA believes no significant risks will occur to recreational users of water treated with 2,4-D.

Concerns have been raised about exposure to 2,4-D and elevated cancer risk. Some (but not all) epidemiological studies have found 2,4-D associated with a slight increase in risk of non-Hodgkin's lymphoma in high exposure populations (farmers and herbicide applicators). The studies show only a possible association that may be caused by other factors, and do not show that 2,4-D causes cancer. The EPA determined in 2005 that there is not sufficient evidence to classify 2,4-D as a human carcinogen.

The other chronic health concern with 2,4-D is the potential for endocrine disruption. There is some evidence that 2,4-D may have estrogenic activities, and that two of the breakdown products of 2,4-D (4-chlorophenol and 2,4-dichloroanisole) may affect male reproductive development. The extent and implications of this are not clear and it is an area of ongoing research.

For Additional Information

Environmental Protection Agency
Office of Pesticide Programs
www.epa.gov/pesticides

Wisconsin Department of Agriculture, Trade, and Consumer Protection
http://datcp.wi.gov/Plants/Pesticides/

Wisconsin Department of Natural Resources
608-266-2621
http://dnr.wi.gov/lakes/plants/

Wisconsin Department of Health Services
http://www.dhs.wisconsin.gov/

National Pesticide Information Center
1-800-858-7378
http://npic.orst.edu/

Wisconsin Department of Natural Resources
Box 7921
Madison, WI 53707-7921

DNR PUB-WT-964 2012