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

Waterbody Identification Code 0672900

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Florence

December, 2012

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Lake and location:
Keyes Lake, Florence County, T.40N. R.17E.
Located just southwest of the intersection of highways 101 and 70, between Florence and Tipler. Keyes Lake flows downstream to the Pine River and is located within the Menominee River watershed.

Physical/Chemical attributes: (Young, 2006)

Morphometry:	202 acres, maximum depth of 77 feet
Lake type:	Spring (one outlet to Sea Lion Lake)
Basic water chemistry:	Med. Hard – alkalinity 49 mg/l, conductance 157 umhos
Littoral Substrate:	45% sand, 45% gravel, 10% muck
Water clarity:	Clear
Aquatic vegetation:	Common in shallow areas
Shoreline character:	100% upland
Shoreline development:	High (avg. 1 dwelling every 200 feet of shoreline)
Winterkill:	None reported or likely
Boat landing:	One public boat landing
Shoreline Length:	3.2 miles

Purpose of Survey: Comprehensive fisheries survey.

Dates of fieldwork:

Walleye/northern pike netting:	3/22-29/2012
Walleye recapture surveys:	3/30, 4/10 and 4/12/2012
Bass electrofishing:	4/30, 5/5, 5/8, 5/30 and 6/7/2012
Panfish netting:	6/28-29/2012
Summer experimental gill netting:	9/4-7/2012
Fall electrofishing:	9/24/2012
Fall experimental spotlighting/netting:	11/12, 11/16 and 11/18-20/2012

ACKNOWLEDGEMENTS

Brad Shucha, Aaron Nelson, Pat Smith, Nick Neuens, Bill Tuck, Derrick Raspor, Rudy Vassar, Sonja Matzke, Tristan Ziolkowski and Andy Nault assisted in the field. Brad Shucha and Aaron Nelson assigned game and panfish age from scales, spines and rays.

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I. EXECUTIVE SUMMARY

Keyes Lake 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 walleyes and other adult gamefish, followed by three early spring electrofishing surveys to estimate the adult walleye population. Electrofishing continued to assess the bass populations followed by summer fyke netting for panfish, experimental gill netting for cold water fish species, fall electrofishing to assess gamefish recruitment and the survey was wrapped up with spotlighting and netting surveys for lake whitefish.

Four cool water gamefish species were captured during our survey of Keyes Lake. Of these, walleye is the only gamefish that is currently not capable of maintaining its population naturally. The main cause for failed walleye recruitment is the presence of rainbow smelt (documented in 2000). Northern pike, largemouth and smallmouth bass have sufficient natural reproduction to maintain their current populations. Largemouth bass are the most abundant gamefish species, likely followed by smallmouth bass, and northern pike which have much smaller populations.

The walleye population is at its lowest documented abundance (0.45 adults/acre). While walleye abundance had been decreasing since the late 1970s, the introduction of rainbow smelt halted natural recruitment around the year 2000. Starting in 2006, large fingerling walleyes have been stocked into Keyes Lake in an attempt to maintain a fishable population without natural recruitment. Most of these stocked fish have not yet reached adulthood and that is reflected in the low adult population. With steady stocking the adult density should increase over the upcoming years. The largemouth bass population has increased drastically over the last decade, creating a population with many quality sized fish. However, the percentage of fish $\geq$ 15 inches is relatively low, likely due in part to below average growth rates. Smallmouth bass are just the opposite. Abundance of smallmouth bass has been declining, leaving a population with average growth and good size structure. Northern pike appear to be similar in abundance when compared to smallmouth bass. The sample of the northern pike population taken in 2012 showed average growth and poor size structure.

Two cold water gamefish species, brown trout and lake whitefish, were captured during the 2012 survey. Brown trout do not appear to be capable of natural reproduction and a small adult population is maintained through yearly stocking events, which started in 2002. The brown trout population was created to provide a cold water predator in hopes that their presence would control the rainbow smelt population. Lake whitefish are native to Keyes Lake and have been capable of maintaining their population through natural reproduction. However, all of the lake whitefish sampled were very large/old fish which leaves some questions about the viability of the population.

Five panfish species were captured during the 2012 survey. Bluegill is the most abundant panfish species in Keyes Lake. Rock bass and black crappie also offer angling opportunities, but have much smaller populations than bluegill. Yellow perch are extremely rare and pumpkinseed is likely present although none were sampled during 2012. Of the three major panfish species bluegill and black crappie have above average growth rates with very good size structure. Rock bass are slow growing and have relatively poor size structure in Keyes Lake.

Five non-game species were captured during our survey work. These species were rainbow smelt, white sucker, creek chub, yellow and black bullhead. None of these species were captured with any frequency suggesting low population levels. However, rainbow smelt have proven the ability to

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become very abundant and have had negative impacts on the Keyes Lake fishery. The current rainbow smelt population is being held in check by a number of cold and cool water predators, but even at the current low population level rainbow smelt are greatly reducing walleye recruitment.

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II. PAST MANAGEMENT AND SURVEYS

Known Stocking History:

Bluegill	- adults, 1939
Black Crappie	- adults, 1938
Brook Trout	- fingerling, 1957
Brown Trout	- lg. fingerlings, 2002-2012
Lake Trout	- fry, 1937 and 1946
	- lg. fingerlings, 1977 and 1980
Largemouth Bass	- fingerlings, 1937
Rainbow Trout	- lg. fingerlings, 1955-59 and 1961-62
	- yearlings, 1960 and 1963-65
Smallmouth Bass	- fingerlings, 1941-44 and 1949-50
Splake	- yearlings, 1966-1968
Walleye	- fry, 1937-44,
	- sm. fingerlings, 2002-2004
	- lg. fingerlings, 1950, 1952-54, 2004-2009 and 2011
Yellow Perch	- fingerlings, 1939
	- adults, 1939

Past Management Activities:

- 1949 (Burdick) – Fyke net survey/rock bass removal (1,890 rock bass were removed during 13 days of netting; abundant, slow-growing panfish population was found)
- 1949 (Burdick) – Gill net survey for coldwater fishes (no coldwater fish captured).
- 1956 (L.F.) – Gill/fyke net survey (showed large/fast growing whitefish population and good rainbow trout population).
- 1959 (Burdick) – Winter creel during a fishing tournament (RBT was main catch followed by YP, anglers were pleased with the fishing on the lake).
- 1965 (Burdick) – Gill/fyke net survey and electrofishing used to evaluate whitefish, rainbow trout and lake trout populations (captured only a single whitefish and no trout – recommended discontinuing rainbow trout stocking and suggested experimental splake stocking).
- 1970 – A check on the whitefish sport fishery (showed only moderate fishing pressure and success, with large whitefish taken each year).
- 1972 (Burdick) – Electrofishing Survey found naturally reproducing walleye, smallmouth bass, largemouth bass and panfish populations. Also documented failed attempts to manage Keyes Lake as a two-story fishery.
- 1975 – Keyes Lake Improvement Association and Florence County construct a dam on the outlet of Keyes Lake, raising water level and increasing surface acreage.
- 1979 (Thuemler) – Comprehensive fisheries survey (found abundant walleye population, along with naturally reproducing LMB and SMB populations, NP existed in low numbers).
- 1979-1980 – Lake trout assessment (captured no lake trout from the 1977 and 1980 stockings, whitefish were fairly abundant with fish of all sizes).
- 1987-1990 – Aquatic macrophyte study.
- 1990 (Heizer) – Survey to determine species and abundance. (walleye population estimated at 2.3 adults/acre)
- 1997 (Heizer) – Comprehensive fisheries survey (walleye population had declined to < 1 adult/acre).
- 1998 – December whitefish electrofishing survey.
- 2000 – Gamefish population estimate (walleye: 1.8/acre, lmb: 1.7/acre, smb: 2.2/acre).
- 2005 – Largemouth bass survey (found a low density of LMB).
- 2006 (Young) – Walleye rehabilitation project started
- 2006 (Lyons) – Gill net survey in November (Captured 2 brown trout, 32 rainbow smelt, no other cold water species).
- 2007 (Young) – Comprehensive fisheries survey (walleye: 1.8/acre, lmb: 3.9/acre, smb: 1.5/acre)
- 2011 – Experimental brown trout fyke netting (no brown trout captured).
- 1979-2011 – Fall recruitment surveys 15 of 23 years

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III. METHODS

The survey began on 3/21 when 6 standard fyke nets (3/4" stretch mesh) were set in Keyes Lake to sample walleye and northern pike. These 6 nets were fished for 8 nights and pulled from the lake on 3/29/2012. After removal of the fyke nets, a WDNR standard, alternating current, electrofishing boat was used to recapture walleyes along the entire shoreline of Keyes Lake after dark on 3/30 and 4/10/2012. A third walleye recapture survey was attempted on 4/12/2012, however, catch was poor and the entire shoreline was not sampled, so this survey was not used as part of the population estimation process. Five more electrofishing surveys were conducted to sample northern pike, smallmouth and largemouth bass between 4/30 and 6/7/2012. On 6/27, six standard fyke nets were set and fished for two days to analyze the relative abundance, size structure and growth of panfish populations. A few months later three 300-foot by 6-foot (2.5" stretch mesh) gill nets were set on 9/4/2012 and lifted every hour in an attempt to analyze the lake whitefish and brown trout populations. A fourth 300' x 6' (3/4" and 1" stretch mesh) gill net was set on 9/5 in an attempt to sample the rainbow smelt population. The four gill nets were left overnight and checked daily until 9/7/2012 when they were removed from the lake. Gamefish recruitment was sampled on 9/24/2012 by electrofishing the entire shoreline. Two shallow water spotlighting surveys, looking for spawning lake whitefish, were conducted on 11/11 and 11/16/2012. Two seine drags were conducted prior to the spotlighting survey on 11/16 and a third drag was conducted after locating a small school of lake whitefish. The 2012 survey culminated with one more attempt to sample lake whitefish; fyke nets (5) were set on the primary whitefish spawning area on 11/17/2012 and fished from 11/18 to 11/20/2012.

During the survey, length or length category (nearest half-inch), was recorded for all gamefish and panfish (6/28-29/2012). 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 length groups 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; any discrepancies were then read by a third blind reader 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.

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IV. RESULTS AND DISCUSSION

Catch Summary

Six gamefish, 5 panfish and 5 non-game fish species were captured during the 2012 survey of Keyes Lake (Figure 1). There is more detailed information at the back of this report (Table 6, Appendix C).

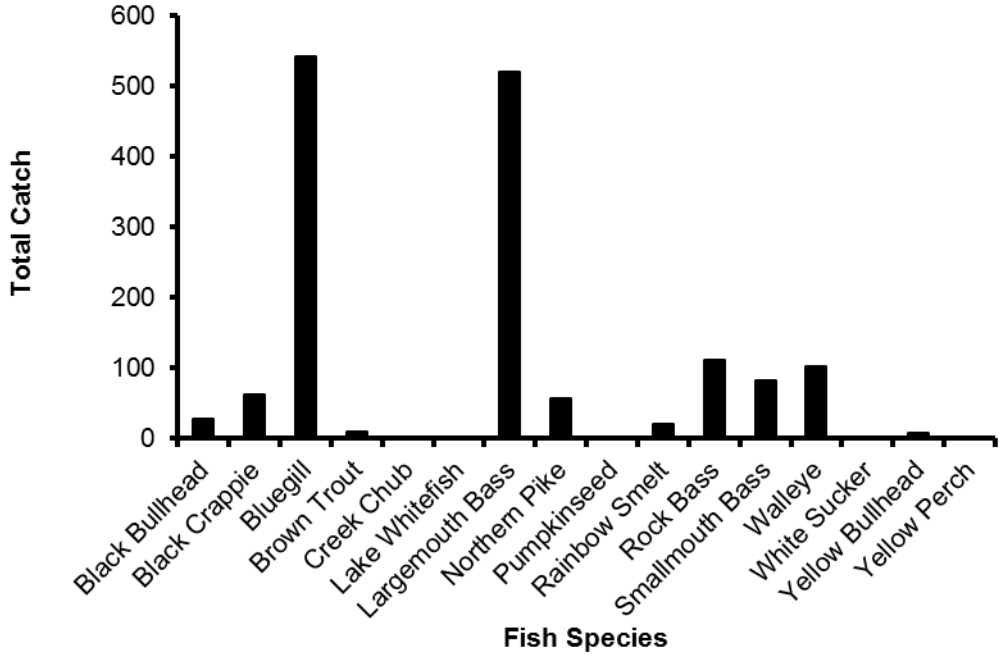

Figure 1. Fish species and number captured during fyke netting and electrofishing surveys of Keyes Lake, Florence County, 2012.

Gamefish:

Northern Pike

Abundance

Northern pike were the third most abundant game fish species captured during spring fyke net surveys (Table 1, Appendix C). Northern pike were also the third most abundant fish species during early spring electrofishing surveys with a catch rate of 0.22 fish per mile (Table 5, Appendix C). The only gamefish species that had a lower catch rate during spring surveys was smallmouth bass, which generally do not show up in shallow water surveys until later in the season. Since only 28 northern pike were sampled during spring surveys we were not able to estimate adult abundance. The only other spring electrofishing survey where northern pike were sampled was in 1990. During the 1990 survey northern pike were captured at a rate of 0.48 fish per mile, suggesting that northern pike were slightly more abundant in 1990 than today. However, spring fyke net catch rates suggest that the northern pike population may have increased since 1990 (Table 1). Whether the pike population is increasing or decreasing is unclear, however, the catch rates during spring netting and electrofishing surveys have been very low for the past few decades, indicating that northern pike are the least abundant cool water gamefish in Keyes Lake, with an adult density seemingly below 1 adult/acre.

Table 1. Abundance of northern pike, indexed using the catch rate of adult fish during spring surveys, during 2012 compared to previous surveys of Keyes Lake, Florence County.

	2012	1997	1990	1979
Adults/mi.	0.22	---	0.48	---
Fish/net-lift	0.58	0.82	0.19	0.05

Size Structure

Only 28 different northern pike were captured during early spring surveys in 2012. Another 17 northern pike were captured during late spring electrofishing surveys giving a total sample of 45 different northern pike ranging from 11.4 to 29.4 inches in length (Figure 2). The average length of northern pike measured in 2012 was 17.5 inches with a mode of 13 to 15 inches. Both of these numbers were substantially less than the 21.6 inch average size and modal length of 25 inches measured during the last northern pike survey in 1997 (Figure 3). Size structure, indexed using relative stock density (RSD), also shows a substantial decrease since the 1990's. RSD21, 24 and 28 values have decreased by approximately 41%, 57% and 45% respectively from the 1990s average (Table 2). The current size structure is surprisingly poor when you consider the low density population that currently exists as well as the history of good size structure and the lakes reputation for trophy northern pike potential.

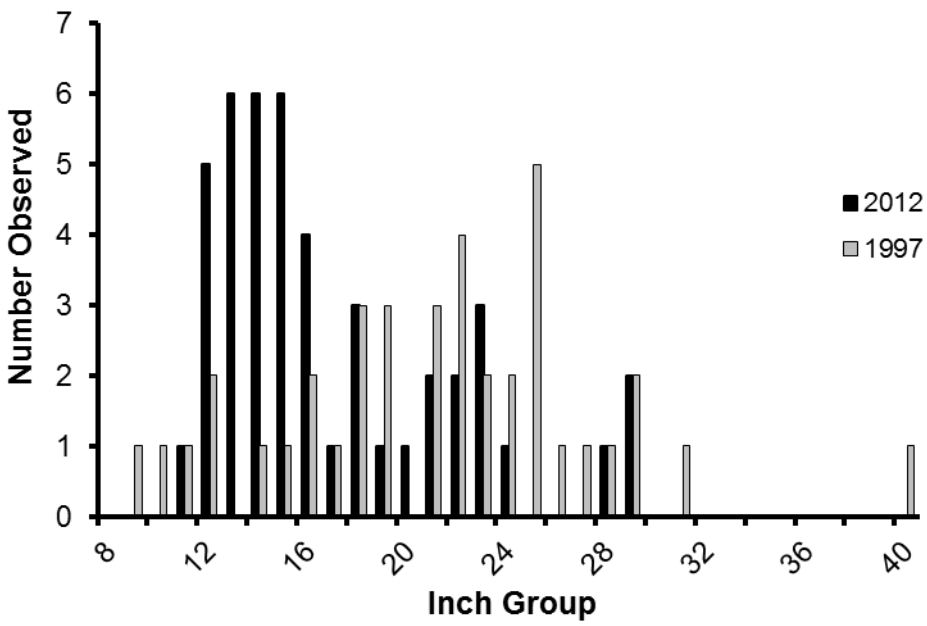

Figure 2. Length frequency of northern pike captured during spring surveys of Keyes Lake, Florence County, during 2012 compared to a similar survey conducted in 1997 (2012: N=45, 1997: N=40).

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

	2012	1997	1990
RSD21	33.33	67.65	63.64
RSD24	12.12	38.24	18.18
RSD28	9.09	14.71	18.18
RSD34	0.00	2.94	9.09
RSD40	0.00	2.94	0.00

Growth

Age was estimated by examining anal ray cross sections and scale samples from a subsample of 44 northern pike captured during the 2012 survey of Keyes Lake. Northern pike typically exhibit sexually dimorphic growth with females growing faster and larger than males, this was the Pattern seen in the Keyes Lake population with female growth above (and male growth below) the average for combined sex northern pike in the Northern Region (NOR) of Wisconsin (Figure 3). Combining both sexes of northern pike allows for a better comparison to the NOR average. Combined sex northern pike in Keyes Lake exhibited above average growth until age 6 and below average growth beyond age 6 (Figure 4). The growth rate beyond age 6 is highly questionable because only 3 fish were sampled over age 6 (two age 7, and a single age 11 fish) allowing these 3 fish to control the growth curve beyond age 6. A small sample of northern pike were captured during a late summer gill net survey, since these fish had underwent most of the 2012 growing season they were not added to the sample used to index growth. However, there were two notable fish captured during the gill net survey. These two fish were a 25.9-inch fish estimated to be 10.5 years old and a 30.7 inch fish estimated to be 6.5 years old. The variance in growth rates between these two fish is a perfect example of why you should not put much stock in a small sample size. The small sample size beyond age 6 is most likely not representative of the entire population.

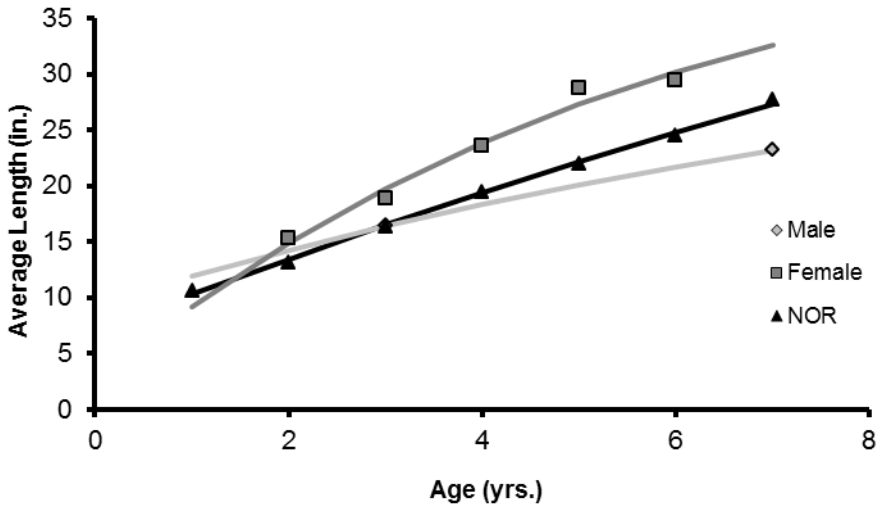

Figure 3. Average length at age for northern pike captured from Keyes Lake during 2012 spring surveys, fit with von Bertalanffy growth curves and compared to the average length at age for both sexes combined in the Northern Region of WI (Male: N=16, Female: N=6).

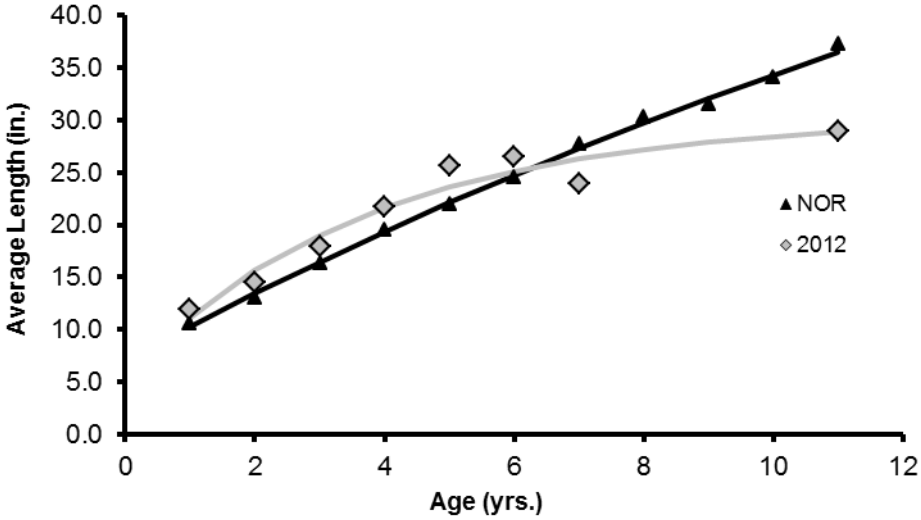

Figure 4. Average length at age for combined sex northern pike captured during spring surveys of Keyes Lake during 2012, fit with von Bertalanffy growth curves and compared to the average length at age for combined sex northern pike in the Northern Region of WI (Male: N=16, Female: N=6, Unknown: N=22).

Body Condition

Every northern pike determined to be male or female was weighed during our spring survey to assess body condition. Body condition was indexed using relative weight (W_r). The W_r for male northern pike ranged between 75.6 and 106.3, averaging 100.4 (Figure 5). Female W_r was very similar with values ranging from 79.7 to 116.7, with an average of 101.6. A sample of unknown sex northern pike was also weighed because of the small number of fish of identified sex captured during spring surveys. Northern pike of unknown sex had very similar relative weight to known sex northern pike, with W_r ranging from 80.2 to 108.5 with an average of 97.7. In this region of Wisconsin it is very rare to have an average W_r value of 100, showing that northern pike in Keyes Lake have very impressive body condition.

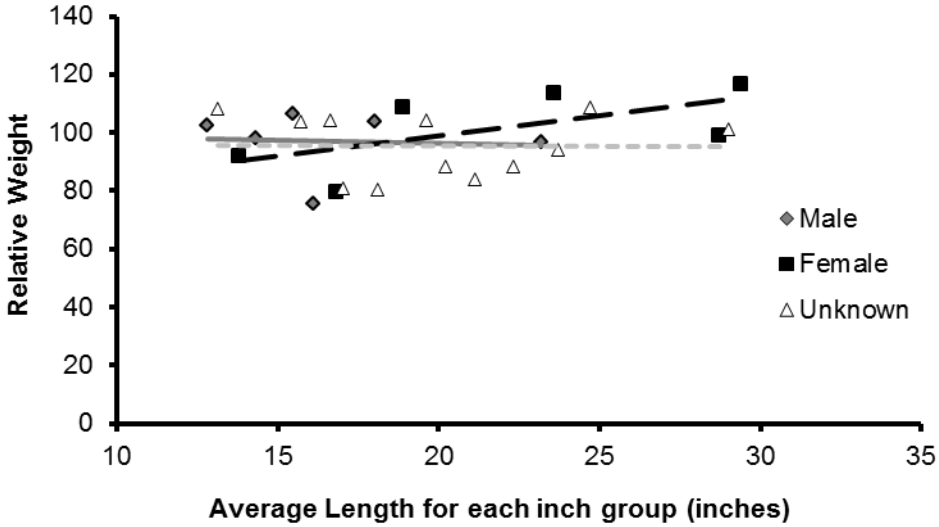

Figure 5. Average relative weight at length, measured from a sub sample of northern pike captured during spring surveys of Keyes Lake, Florence County, 2012 (Male: N=16, Female: N=6, Unknown: N=20).

Recruitment

During the fall electrofishing survey we collected all young-of-the year (YOY) gamefish. A single YOY northern pike was captured during this survey, suggesting that natural reproduction of northern pike is occurring at low levels. This YOY northern pike along with a good representation of northern pike between ages 1 and 6 captured during other surveys conducted in 2012 (including 3 age-1 and 20 age-2 fish) suggest that the northern pike population is capable of maintaining the currently small population through natural reproduction (Table 1, Appendix B).

Walleye

Abundance

A total of 48 different walleye were captured during our spring fyke netting survey making them the most encountered gamefish species during that survey. However, the 2012 catch rate of 1.33 fish per net-lift was the lowest catch rate, which has steadily declined since 1979, ever measured during spring fyke netting surveys of Keyes Lake (Table 1, Appendix C). Three electrofishing surveys were conducted immediately after our spring netting survey to estimate the adult walleye population. The 3rd walleye electrofishing survey was not used for population estimation because the spawning event had concluded and the entire shoreline was not surveyed. During the first two recapture surveys a total of 27 different walleyes were captured, 11 of these fish were previously captured during our netting survey. These surveys estimate the adult population at 91 fish (0.45/acre) with a 95% confidence range of 52 to 140 fish. An adult density of 0.45/acre is approximately 25% of the last two walleye population estimates for Keyes Lake and only 8% of the measured peak which occurred in 1979 (Table 3). The current walleye population is well below our management goals for stocked walleye fisheries.

Table 3. Abundance of walleye, indexed by the number of estimated adults per acre and catch rate of adult fish per mile, in Keyes Lake, Florence County.

	2012	2007	2000	1997	1990	1979
Adults/Acre	0.45	1.80	1.80	1.00	n/a	5.80
Adults/mi.	3.66	21.56	15.00	8.75	5.20	n/a

Size Structure

A total of 65 different walleyes were captured and measured during our spring netting and electrofishing surveys in 2012. These fish ranged from 7.8 to 29.7 inches in length (Figure 6). The mean length of walleyes caught this year was 18.0 inches, 4.1 inches shorter than the mean length of 22.1 inches measured in 2007. The modal size of 16 inches during 2012 was also 4 inches shorter than the 20-inch modal size measured in 2007. Decreased mean and modal size of walleyes is not expected in populations with decreasing abundance, like Keyes Lake.

Size structure, indexed using relative stock density (RSD), is currently at the 2nd highest level documented in Keyes Lake, with 2007 being the highest size structure ever recorded (Table 4). The 2007 size structure was artificially high due to 9 years of poor recruitment prior to the survey and could not be maintained at that level. Many of the larger/older fish present in 2007 have now lived out their life. The loss of these larger fish along with negligible natural reproduction and poor survival of stocked walleyes prior to 2006 accounts for the decline in size structure from 2007 to the

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present. This does not mean that all of the large fish are gone from Keyes Lake. In fact, 2 of the 65 different walleyes measured during 2012 were ≥ 28 inches giving an RSD28 value of 3.28, indicating the current population has more trophy potential than previous survey years. Overall, the size structure of walleyes in Keyes Lake is above average and attractive to anglers, creating a quality fishing opportunity.

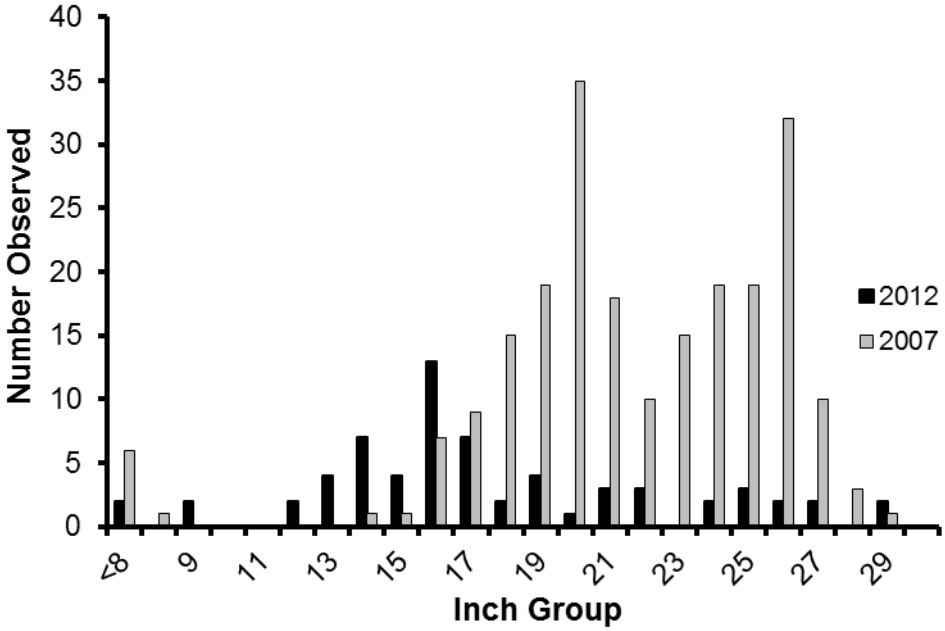

Figure 6. Length frequency of walleye captured during spring surveys of Keyes Lake, Florence County, during 2012 compared to 2007 (2012: N=65, 1998: N=221).

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

	2012	2007	*2000	1997	1990	1979
RSD15	78.69	99.53	47.02	79.82	75.00	49.07
RSD20	29.51	75.70	4.17	21.05	12.50	6.87
RSD25	14.75	30.38	?	3.51	0.76	1.00
RSD28	3.28	1.87	?	0.00	0.00	0.00
RSD30	0.00	0.00	?	0.00	0.00	0.00

*Highest length category measured was ≥ 20.0 in.

Growth

Age was estimated by examining dorsal spines and scales from a subsample of 70 walleyes during the spring electrofishing and fyke netting surveys. Walleye exhibited sexually dimorphic growth with females growing faster and achieving larger overall size than males. Growth of male walleye was below average and female growth above average when compared to combined sex walleye in the Northern Region (NOR) of WI (Figure 7). Female walleye in Keyes Lake reach the minimum size limit of 18 inches between their 6th and 7th year, while male walleye reach the minimum size sometime after age 10. By combining the sexes of walleyes a better comparison can be made to previous surveys of Keyes Lake and the NOR average (Figure 8). Combined sex walleye in Keyes Lake show slower and below average growth throughout most of their life when compared to the NOR average and the 1997 Keyes Lake growth rate. However, a few older/larger female walleyes

were captured showing good growth, allowing fish the opportunity to reach trophy size (Table 2, Appendix B).

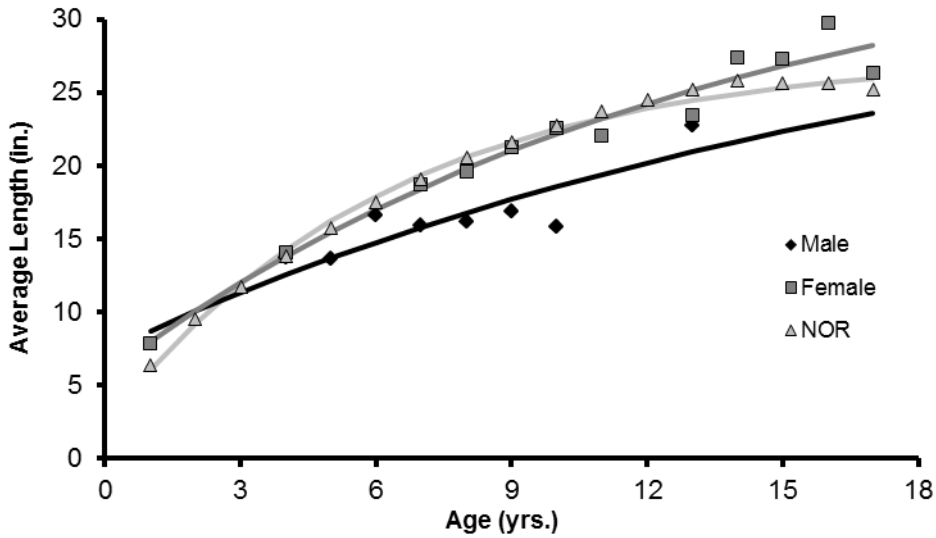

Figure 7. Average length at age for walleye captured from Keyes Lake during 2012 spring surveys, fit with von Bertalanffy growth curves and compared to the average length at age for both sexes combined in the Northern Region of WI (Male: N=29, Female: N=28).

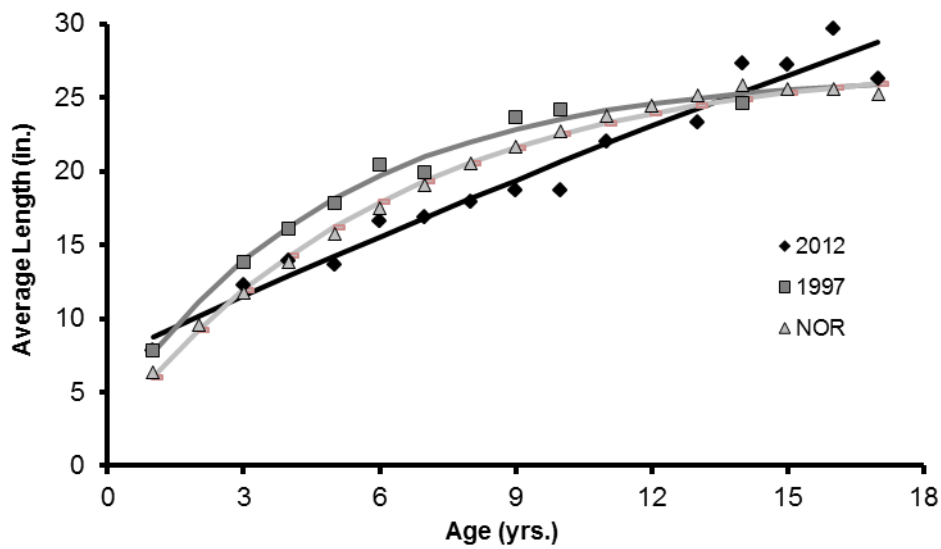

Figure 8. Average length at age for combined sex walleye captured from Keyes Lake, fit with von Bertalanffy growth curves, during spring surveys in 2012 compared to a previous survey and the average length at age in the Northern Region of WI (2012: N=70).

Body Condition

A random sample of fish was weighed during our spring fyke netting survey to assess body condition of walleye in Keyes Lake. Relative weight (W_r) was used to index body condition for both sexes of walleye. W_r of male walleye ranged between 94.9 and 110.5 for individual inch groups, with an average of 105.3 (Figure 9). Female W_r was slightly higher ranging from 87.6 to 123.8, averaging 108.1. Both male and female W_r had a negative correlation with total length. However, only female W_r showed a statistically significant negative correlation with total length (P=0.0003). This suggests that conditions are better, including the amount of metabolic energy used to capture

each unit of forage, for smaller/younger individuals within their own sex. Like northern pike the average W_r values exceed the standard of 100 which is very good for populations in Northern Wisconsin.

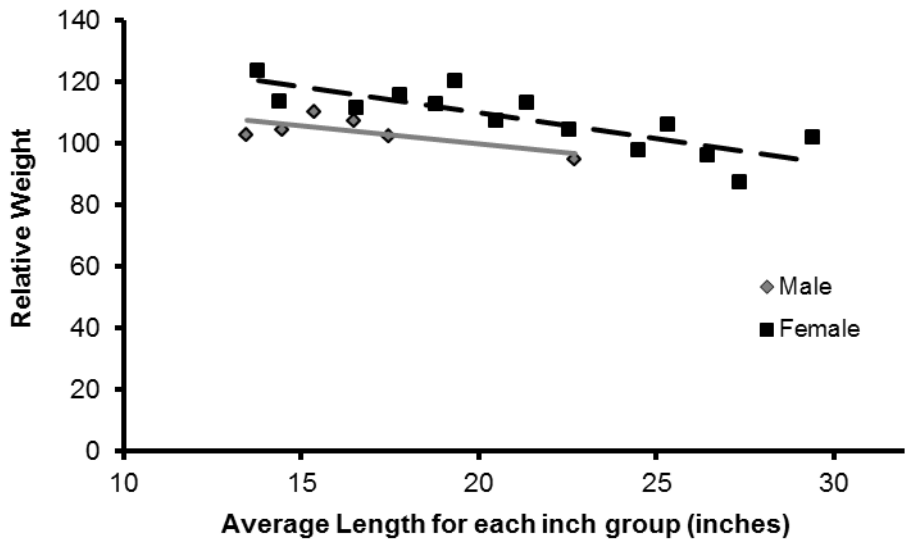

Figure 9. Average relative weight at length, measured from a sub sample of walleye captured during spring surveys of Keyes Lake, Florence County, 2012 (Male: N=29, Female: N=28).

Recruitment

Keyes Lake maintained a fishable walleye population through natural reproduction since the introduction of walleyes in 1937 until 1997. Over the past 15 years natural reproduction of walleyes has been nearly non-existent. The main cause of failed natural reproduction is thought to be the introduction of rainbow smelt. This is not the first walleye population that crashed after the introduction of rainbow smelt, an exotic species, which was first documented in Keyes Lake during 2000. The fish that were found in 2000 were adult fish and they were likely present in the lake for a few years before their discovery, right about the time of the last naturally reproduced year class of walleyes. After the discovery of rainbow smelt, Keyes Lake was put on an annual stocking rotation and gamefish recruitment surveys have been conducted on a general every-other-year rotation to monitor walleye recruitment.

A gamefish recruitment survey was conducted on 9/24/2012. During this survey we captured a single young-of-the-year (YOY) walleye, a catch rate of 0.3 YOY walleyes/mile, measuring 7.9 inches in length. No walleye stocking occurred during 2012, so this walleye along with 10 YOY walleyes captured during 2010 (another non-stocked year) are proof that a low level of natural reproduction is happening in Keyes Lake. However, eight other gamefish recruitment surveys conducted since 1998 suggest that Keyes Lake is no longer capable of creating a sizeable year class of walleyes through natural reproduction (Table 5). In fact, surveys conducted during the fall of 2002 and 2004 suggest that the stocking of small fingerling walleye (at a rate of 35 fish/acre) will also not be successful. As of now, stocking of large fingerling walleye is the best option for maintaining a walleye population in Keyes Lake. A high catch rate of YOY walleyes during the 2008 fall survey along with the presence of age-1 walleye, which were likely stocked large fingerling walleyes from 2011, throughout the 2012 survey suggests that large fingerling walleyes will survive at a high enough rate to maintain a walleye population in Keyes Lake.

Table 5. Recruitment of walleyes, indexed by catch per mile of age-0 walleyes during fall electrofishing surveys, in Keyes Lake, Florence County, 1979-2012.

	2012	2010	**2008	*2004	*2002	2000	1999	1998	1997	1996	1995	1993	1992	1991	1990	1979
Age 0/mi.	0.3	3.0	20.0	0.0	0.6	0.3	0.0	1.9	25.9	7.2	4.1	2.5	64.4	15.3	0.0	23.1
	*Small fingerling walleyes stocked before the survey event							**Large fingerling walleyes stocked before the survey event								

Largemouth Bass

Abundance

Spring netting, early spring electrofishing along with five other spring electrofishing surveys were conducted to estimate the abundance of adult largemouth bass in Keyes Lake during 2012. These surveys captured 418 different largemouth bass (Table 3, Appendix A). The data obtained from these surveys estimate the adult largemouth bass population to be approximately 1,000 fish ≥ 8.0 inches (4.95/acre) with a 95% confidence range between 712 and 1,288 fish. This largemouth bass population is nearly three times the size of the population during the early 2000's and the largest population every measured in Keyes Lake (Table 6).

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

	2012	2007	2005	2000	1990
Adults/Acre	4.95	3.90	1.70	1.70	n/a
Adults/mi.	22.18	n/a	n/a	11.09	22.9

Size Structure

During 2012 we sampled a total of 418 different largemouth bass up to 18.5 inches in total length (Figure 10). The average length of largemouth bass captured (≥ 8.0 inches) during 2012 was 12.6 inches, almost one inch larger than the average size of 11.7 inches in 2000. During 2012, the majority of the bass sampled (67.7%) were between 11.0 and 14.9 inches showing that the bulk of the fish present are substantially larger than in 2000 when 62% of the catch was between 9.0 and 11.4 inches.

Size structure, indexed using relative stock density (RSD), has increased since 2000 when comparing RSD12 values, which have doubled (Table 7). However, RSD15 and 18 values have decreased by approximately 50% since 2000. At present, approximately 67% of the stock length largemouth bass are larger than 12.0 inches, 8% ≥ 15.0 inches and less than 1% ≥ 18.0 inches in length. The current size structure is below average and is something that could use improvement.

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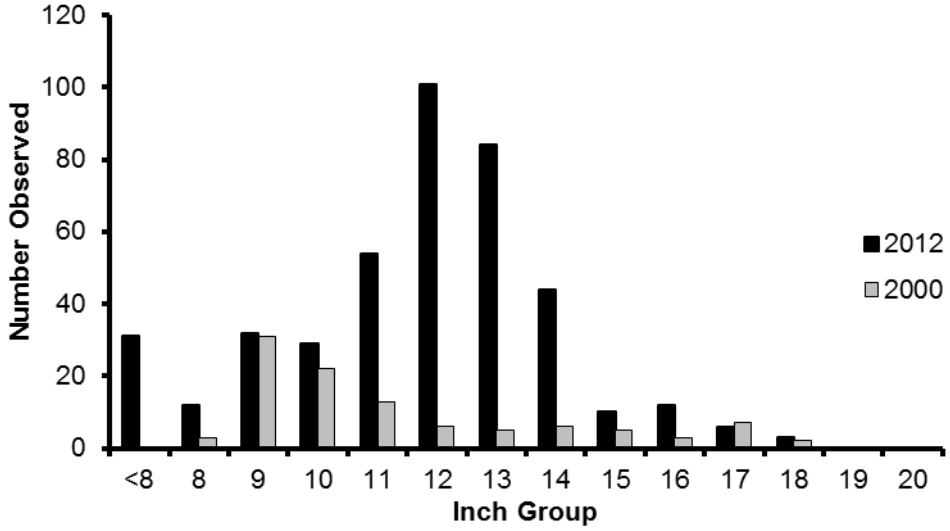

Figure 10. Length frequency of largemouth bass captured during spring surveys of Keyes Lake, Florence County, in 2012 compared to 2000 (2012: N=418; 2000: N=103).

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

	2012	2000	1990
RSD12	67.18	33.01	15.38
RSD15	8.01	16.50	3.30
RSD18	0.78	1.94	2.20
RSD20	0.00	0.00	0.00

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 $\geq$ 8.0 inches and scales were collected from fish $\leq$ 7.9 inches. A total of 109 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). Keyes Lake largemouth bass exhibited below average growth throughout their entire life; when compared to other populations in the NOR of Wisconsin (Table 3, Appendix B). Growth of Keyes Lake largemouth bass has been pretty steady since 1997. On average it takes largemouth bass in Keyes Lake just over 7 years to reach the minimum size limit of 14 inches.

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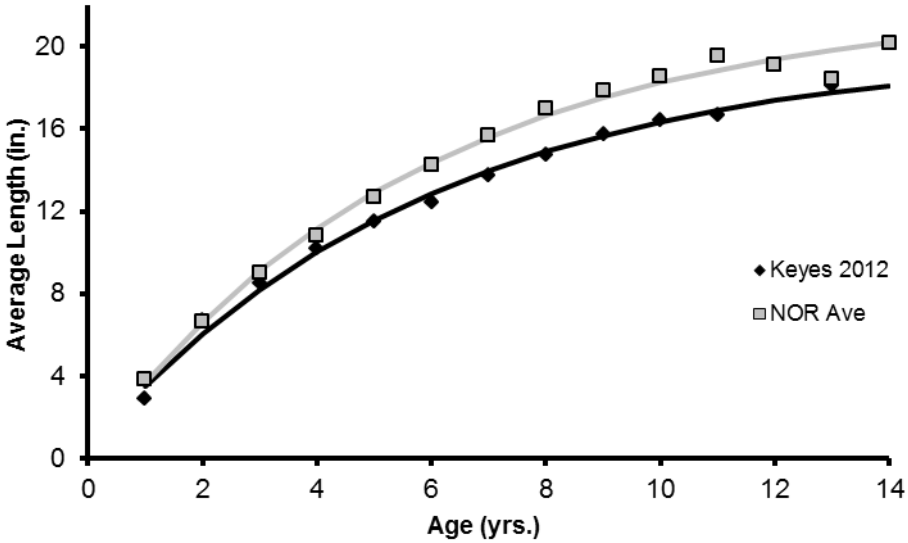

Figure 11. Average length at age for largemouth bass captured from Keyes Lake during 2012 spring surveys, fit with von Bertalanffy growth curves and compared to the average length at age for the Northern Region of WI (2012: N=109).

Body Condition

A total of 73 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 106.0 to 121.8, with an average value of 112.3 (Figure 12). This average is well above the target of 100, showing that largemouth bass have very good body condition in Keyes Lake. There is no correlation between W_r and body length suggesting that conditions are great for all sizes of largemouth bass in Keyes Lake.

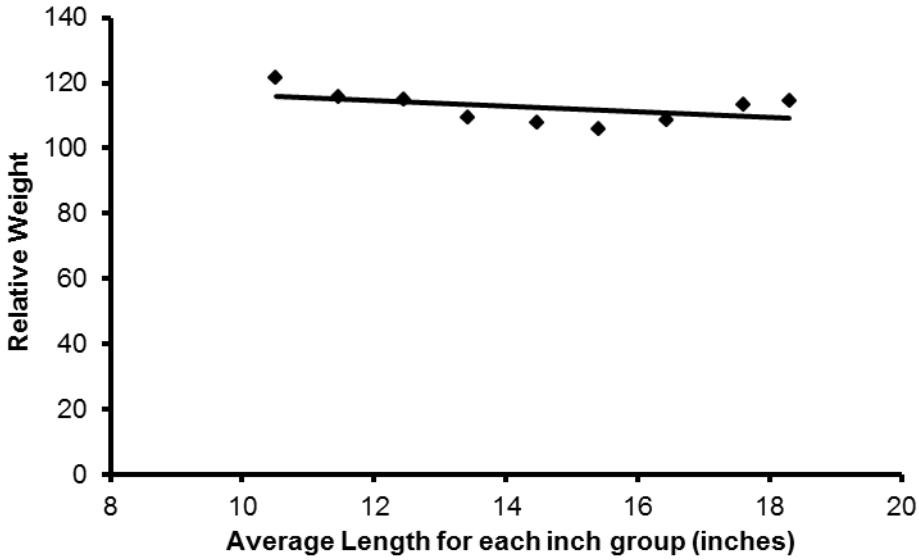

Figure 12. Average relative weight at length, measured from a sub sample of largemouth bass captured during spring surveys of Keyes Lake, Florence County, 2012 (N=73).

Recruitment

During our fall electrofishing survey we attempted to index recruitment of all gamefish using average catch per mile of young-of-the-year (YOY) gamefish. However, the survey had an emphasis on walleye so other gamefish, including largemouth bass, were only captured if walleyes were not present, which does not allow us to obtain the best sample of YOY and Age-1 largemouth. We did capture 1 YOY largemouth bass, which was 5.6 inches long, during our recruitment survey. This single fish and the presence of all year classes age 1-11 during our survey, along with an abundant adult population, suggests largemouth bass are capable of sustaining their population at or near the current level.

Smallmouth Bass

Abundance

A total of 75 different smallmouth bass were captured during our spring surveys in 2012 (Table 4, Appendix A). Smallmouth bass were the least abundant gamefish species captured during the 2012 spring fyke net survey (Table 1, Appendix C). A catch rate of just under 4 adult smallmouth bass per mile was found during spring electrofishing surveys; making smallmouth bass the 2nd most abundant fish species captured during these surveys (Table 5, Appendix C). Less than 4 fish per mile is quite low, this low catch rate prevented us from being able to estimate the abundance of the population. After comparing the 2012 catch rate to previous bass surveys it appears that the smallmouth bass population is decreasing in Keyes Lake (Table 8). Surveys conducted during 1990 and 2000 showed similar catch rates of smallmouth bass, indicating a fairly stable population size at that time. The 2012 catch rate is approximately 57% lower than the average catch rate during 1990 and 2000, suggesting that the smallmouth bass population has declined to near 1 adult/acre.

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

	2012	2007	2000	1990
Adults/Acre	n/a	1.50	2.20	n/a
Adults/mi.	3.92	n/a	9.38	9.00

Size Structure

The 75 different smallmouth bass captured during 2012 ranged in size from 5.6 to 20.5 inches in length (Figure 13). The mean length of smallmouth bass captured during spring surveys was 11.5 inches, very close to the 11.3 inch average measured during 2000. Modal length of smallmouth bass during 2012 (13 inches) was substantially higher than during 2000 (8 inches). Size structure, indexed using relative stock density (RSD), has improved since 2000 (Table 9). The current size structure is acceptable, with 25% of the stock length fish being $\geq$ 14.0 inches and 1.5% of trophy length ($\geq$ 20.0 in.).

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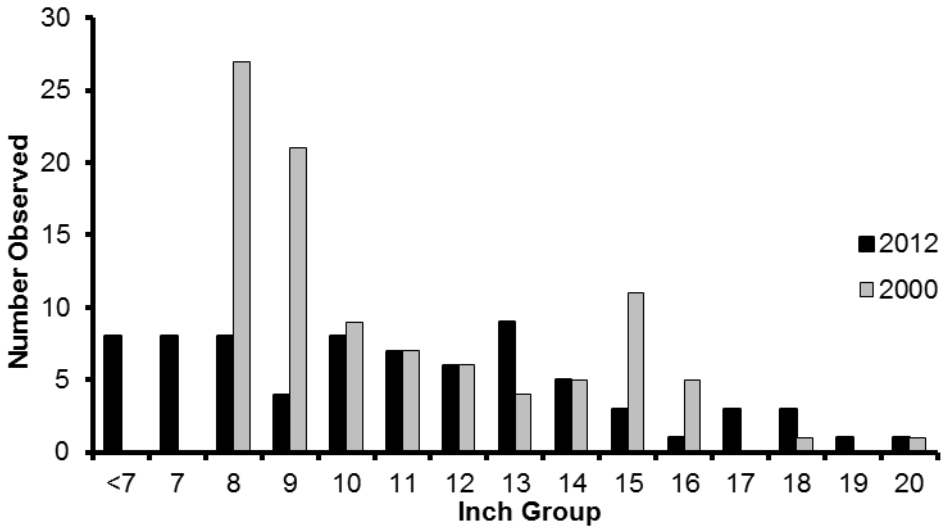

Figure 13. Length frequency of smallmouth bass captured during spring surveys of Keyes Lake, Florence County, in 2012 compared to 2000 (2012: N=75; 2000: N=97).

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

	2012	2000	1990
RSD11:	58.21	41.24	51.22
RSD14:	25.37	23.71	34.15
RSD17:	11.94	2.06	12.20
RSD20:	1.49	1.03	0.00

Growth

Growth was indexed using average length at age from a subsample of 71 smallmouth bass captured during the 2012 survey (Figure 14). Keyes Lake smallmouth bass showed growth rates slightly below the Northern Region average. The 2012 growth data is similar to growth rates measured during previous surveys of Keyes Lake (Table 4, Appendix B).

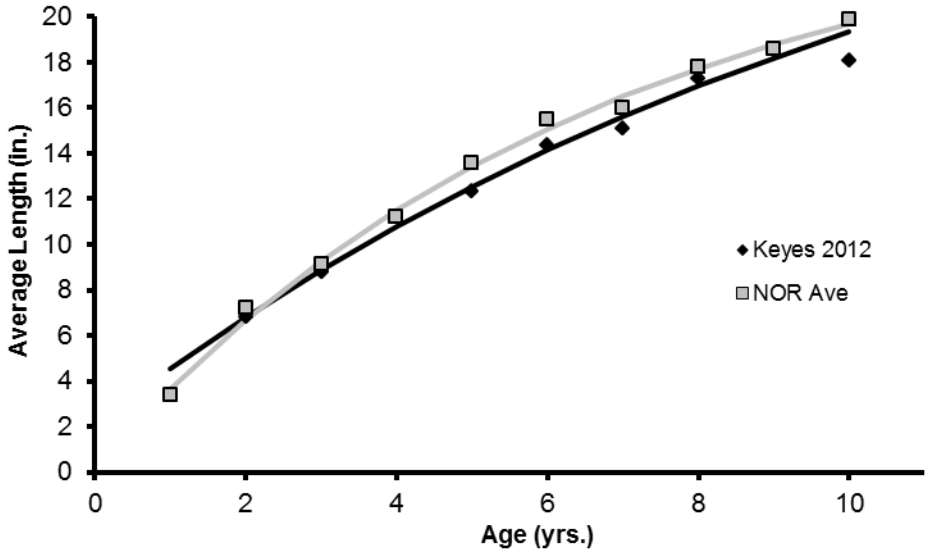

Figure 14. Average length at age for smallmouth bass captured from Keyes Lake during 2012 spring surveys, fit with von Bertalanffy growth curves and compared to the average length at age for the Northern Region of WI (2012: N=71).

Body Condition

During our sampling efforts we obtained weight measurements from 65 of the 75 different smallmouth captured. Relative weight (W_r) was used to index body condition of smallmouth bass. W_r values for both sexes combined ranged from 132.0 to 72.5, with an average of 109.1 (Figure 15). The average W_r for smallmouth bass sampled is above the target of 100, however, the sample was biased toward shorter/younger individuals with 53 of the 65 fish sample $\leq$ 15.0 inches in length. A statistically significant negative correlation was found between body length and W_r ($P=2.4x10^{-8}$, $R^2=0.93$). 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/older 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 12 fish $\geq$ 15.0 inches was 88.9, an acceptable value for our northern climate.

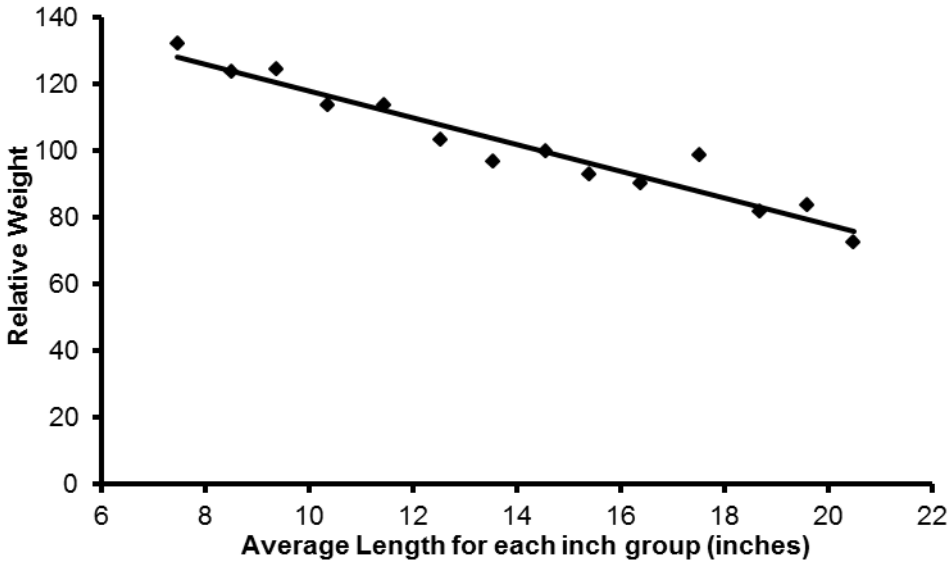

Figure 15. Average relative weight at length, measured from a sub sample of smallmouth bass captured during spring surveys of Keyes Lake, Florence County, 2012 (N=65).

Recruitment

Recruitment was indexed using catch per mile of YOY and age 1 fish during a fall electrofishing survey. Smallmouth bass recruitment is present but appears to be low in Keyes Lake with three age-0 and two age-1 fish sampled. Like largemouth bass, this does not show great natural reproduction of smallmouth bass, however, the presence of all year classes 1 through 10 during the survey suggest that there is enough natural reproduction to support this small population.

Panfish:

Bluegill

Relative Abundance

Bluegill was the most abundant panfish species during summer fyke netting with a total of 270 fish captured (24.5 fish/net-lift). Similar catch rates of bluegill were measured during previous surveys of Keyes Lake (Table 4, Appendix C). The relative abundance of bluegill for Keyes Lake was just shy of the average (27.0 bluegill/net-lift) for Florence County lakes surveyed during 2011-12 (Figure 16).

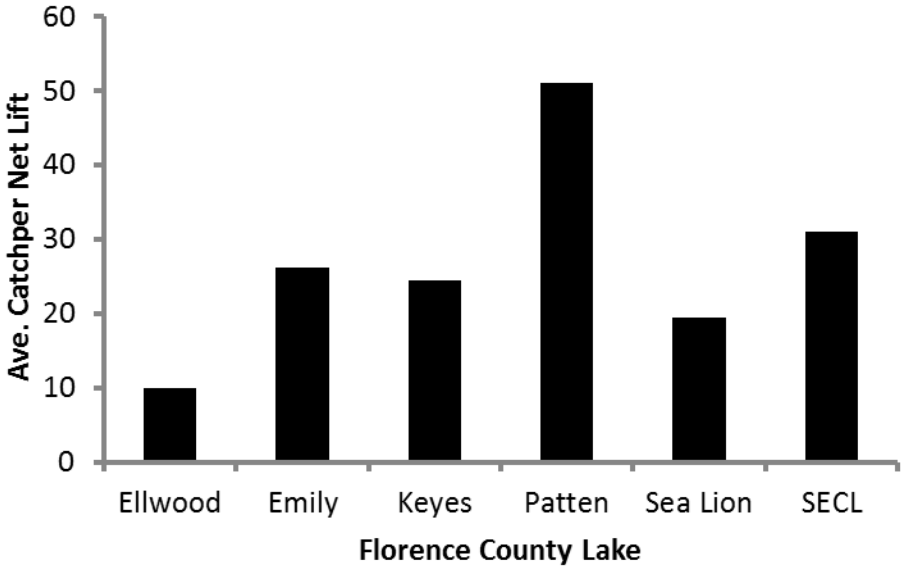

Figure 16. Average bluegill catch per net lift during summer fyke net surveys of Florence County lakes, 2011-2012.

Size Structure

All 270 bluegill were measured during our summer panfish survey. These fish ranged from 3.7 to 9.3 inches in length with an impressive modal length of 7 inches (Figure 17). Size structure was indexed using relative stock density (RSD), which showed very good size structure with RSD6, RSD7 and RSD8 values of 80.7, 54.8 and 13.4 respectively. The current size structure is similar to, or better than, the size structure measured during previous surveys of Keyes Lake (Table 10). This suggests that bluegill size structure is generally as good now as it has been since 1949.

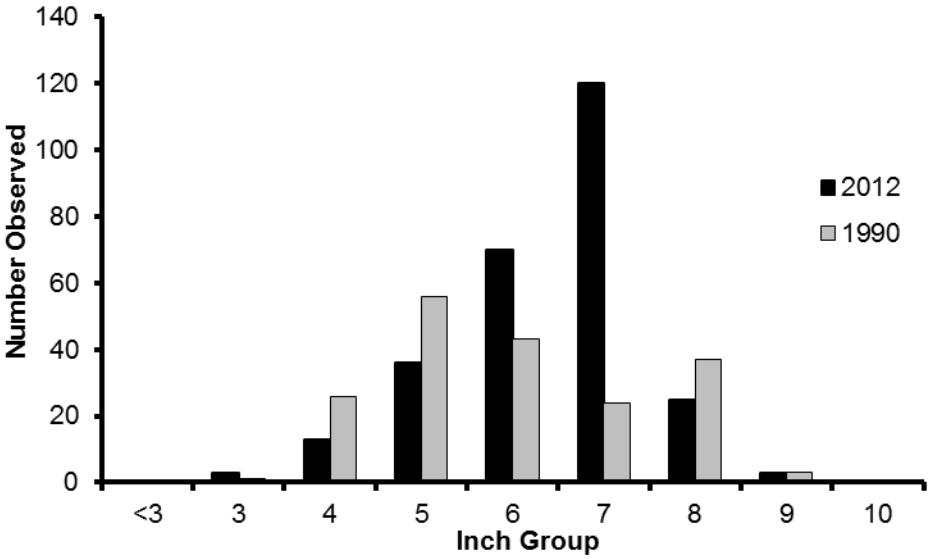

Figure 17. Length frequency for a subsample of bluegill captured during a summer fyke net survey of Keyes Lake, Florence County, during 2012 compared to a spring survey from 1990 (2012: N=270; 1990: N=190).

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

	2012	***1997	*1990	*1979	**1972	1949
RSD6	80.74	26.28	56.32	92.75	25.80	76.35
RSD7	54.81	12.41	33.68	68.12	12.90	50.68
RSD8	13.37	1.46	21.05	47.83	0.00	17.23
RSD9	1.11	0.00	1.58	21.74	0.00	1.35
RSD10	0.00	0.00	0.00	0.00	0.00	0.00

*Spring Sample **Electrofishing Survey ***Spring Net and Summer EF

Growth

Anal spines and scales were removed from a sample of 54 bluegill to estimate age. Growth was then indexed using average length at age. Bluegill in Keyes Lake showed above average growth when compared to the Northern Region of Wisconsin (Figure 18). On average it takes a bluegill 5 to 6 years to achieve 7 inches in length (Table 5, Appendix B).

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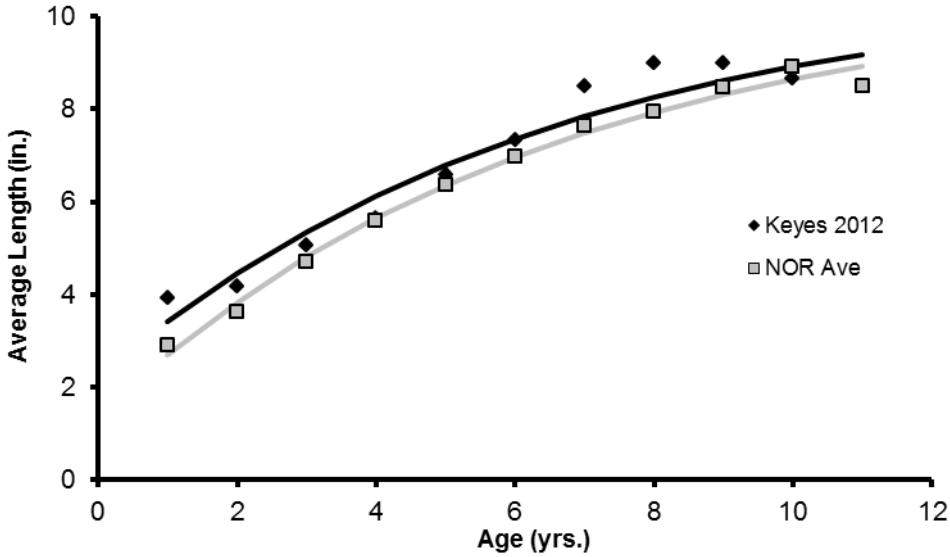

Figure 18. Average length at age for a subsample of bluegill captured during a 2012 summer fyke net survey of Keyes Lake, fit with von Bertalanffy growth curves and compared to the average length at age for the Northern Region of WI (N=54).

Rock Bass

Relative Abundance

Rock bass were the 2nd most abundant panfish species captured during our summer survey. A total of 51 rock bass (4.6 fish/net-lift) were captured in 2012. This suggests a decrease in abundance since the 2007 and 1949 surveys of Keyes Lake, which had over 9 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 3.7 to 8.3 inches, with a modal length of 6 inches (Figure 18). Rock bass size structure during 2012 was average or above average when compared to previous surveys of Keyes Lake (Table 11).

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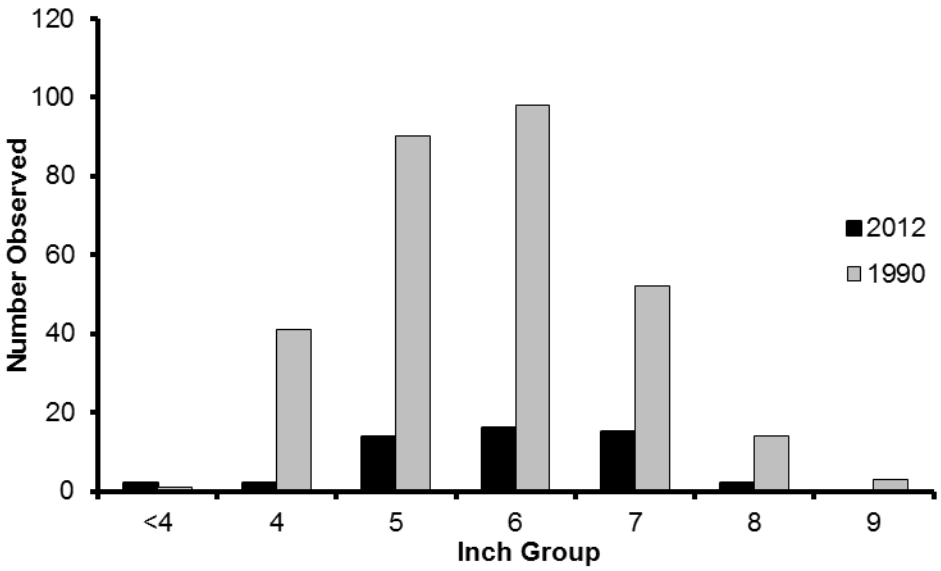

Figure 18. Length frequency of all rock bass captured during a summer fyke net survey of Keyes Lake, Florence County, in 2012 compared to a spring survey from 1990 (2012: N=51; 1990: N=299).

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

	2012	**1997	*1990	*1979	**1972	1949
RSD7	34.69	17.31	23.15	32.56	11.90	4.08
RSD8	4.08	0.00	5.70	2.23	0.00	2.95
RSD9	0.00	0.00	1.01	0.00	0.00	0.23
RSD10	0.00	0.00	0.00	0.00	0.00	0.00

*Spring Sample **Electrofishing survey

Growth

Anal spine cross sections and scale samples from 37 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 Keyes Lake is well below the state average (Figure 19). On average it takes about 8 years for a rock bass in Keyes Lake to reach 8 inches in length (Table 8, Appendix B).

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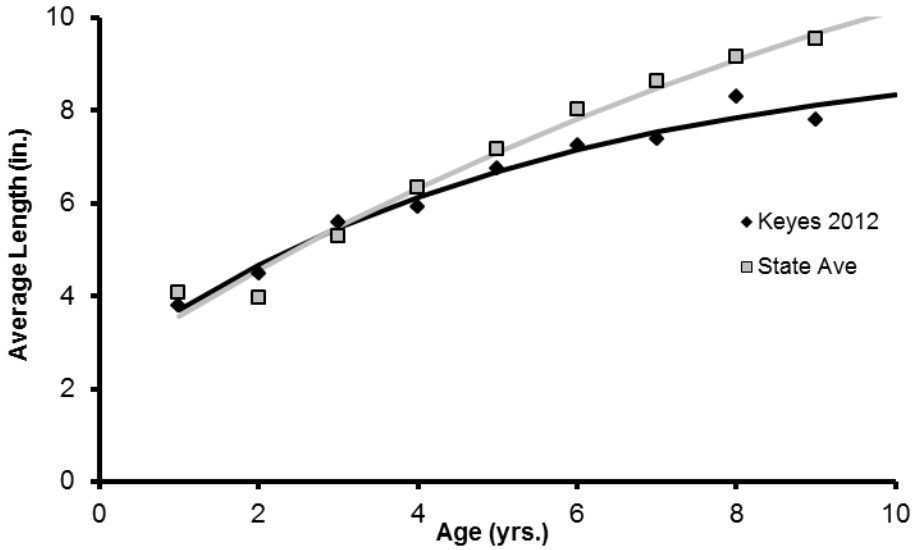

Figure 19. Average length at age for a subsample of rock bass captured during a 2012 summer fyke net survey of Keyes Lake, fit with von Bertalanffy growth curves and compared to the state average (N=37).

Black Crappie

Relative Abundance

Only 12 black crappie (1.1 fish/net-lift) were captured during summer panfish netting. This was similar to the summer catch rate during the 1949 survey (Table 4, Appendix C). Like yellow perch, black crappie catch is typically low during summer because of their early spawning period. Black crappie were also captured at a low catch rate during the spring netting survey (Table 2, Appendix C). However, a good number of crappie were seen during our spring electrofishing surveys, which leads me to believe there is a larger population of black crappie than our netting surveys indicate.

Size Structure

All black crappie captured during spring and summer netting surveys along with a random sample of 29 fish captured during spring electrofishing were measured, making a total of 61 fish used to analyze size structure. These fish ranged from 4.2 to 12.1 inches in length (Figure 20). Black crappie in Keyes Lake show very good size structure with approximately 85% ≥ 8.0 inches and over 58% ≥ 10.0 inches. This current size structure is better than it was during the last comparable survey of Keyes Lake, conducted in 1990 (Table 12).

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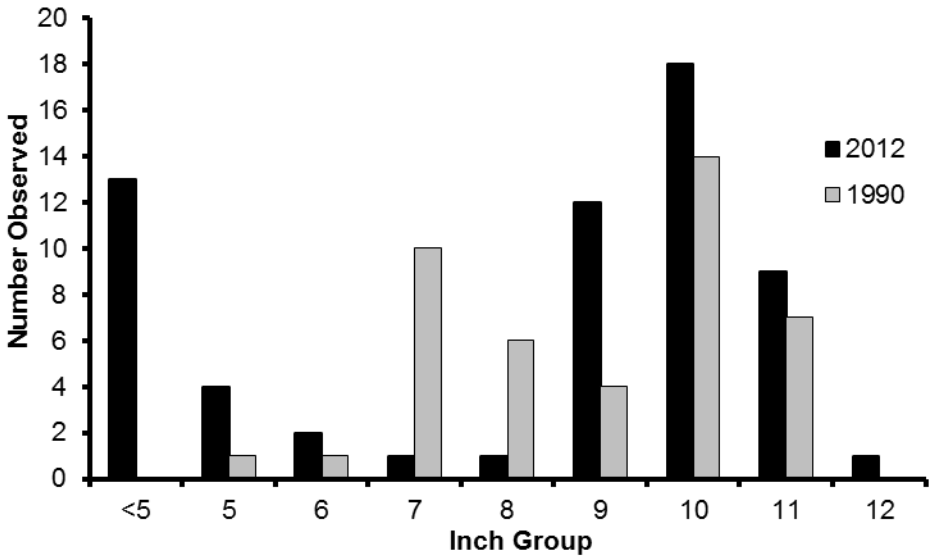

Figure 20. Length frequency for a subsample of black crappie captured during spring surveys of Keyes Lake, Florence County, in 2012 compared to 1990 (2012: N=61; 1990: N=43).

Table 12. Size structure, indexed using relative stock density, for black crappie captured during 2012 compared to a 1990 survey of Keyes Lake, Florence County.

	2012	1990
RSD8	85.42	72.09
RSD10	58.33	48.84
RSD12	2.08	0.00
RSD14	0.00	0.00

Growth

Black crappie growth, indexed using average length at age, was above the average for the Northern Region of Wisconsin (NOR). This impressive growth rate is without a doubt one of the reasons for the good size structure in Keyes Lake (Figure 21). On average it takes only 3 years for a Keyes Lake black crappie to reach 8 inches in length and 5 years to reach 10 inches (Table 7, Appendix B).

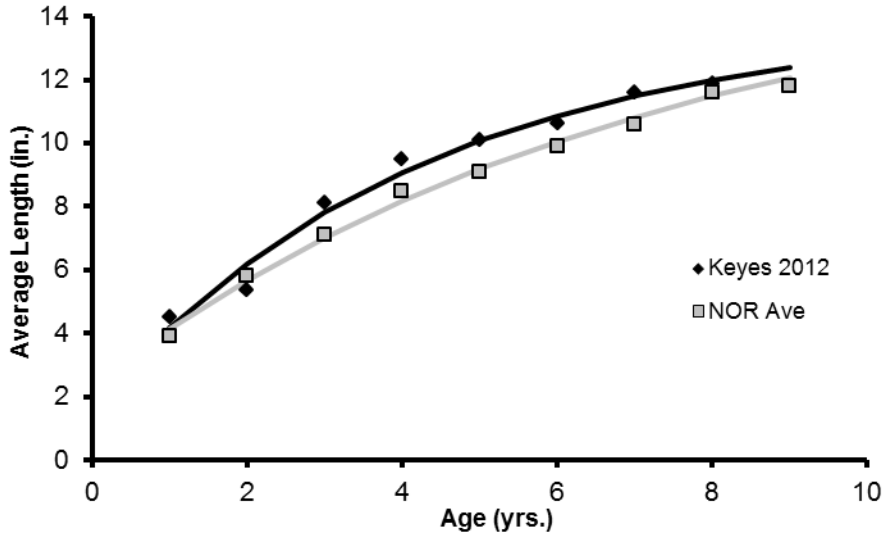

Figure 21. Average length at age for a subsample of black crappie captured during 2012 spring surveys of Keyes Lake, fit with von Bertalanffy growth curves and compared to the average length at age for the Northern Region of WI (N=39).

Yellow Perch

Relative Abundance

No yellow perch were captured during our summer panfish netting survey. 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, only a single yellow perch was captured during our spring surveys. While yellow perch are still present in the lake they appear to be a minor portion of the panfish population. Previous surveys in 1990 and 1979 suggest that Keyes Lake once had a sizeable yellow perch population that has been declining since the late 1970's, potentially even before that (Table 2, Appendix C).

Size Structure

The only yellow perch captured during the 2012 survey was 6.5 inches in length. By analyzing data from previous surveys it appears that Keyes Lake has always had poor size structure of yellow perch (Figure 22 & 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.

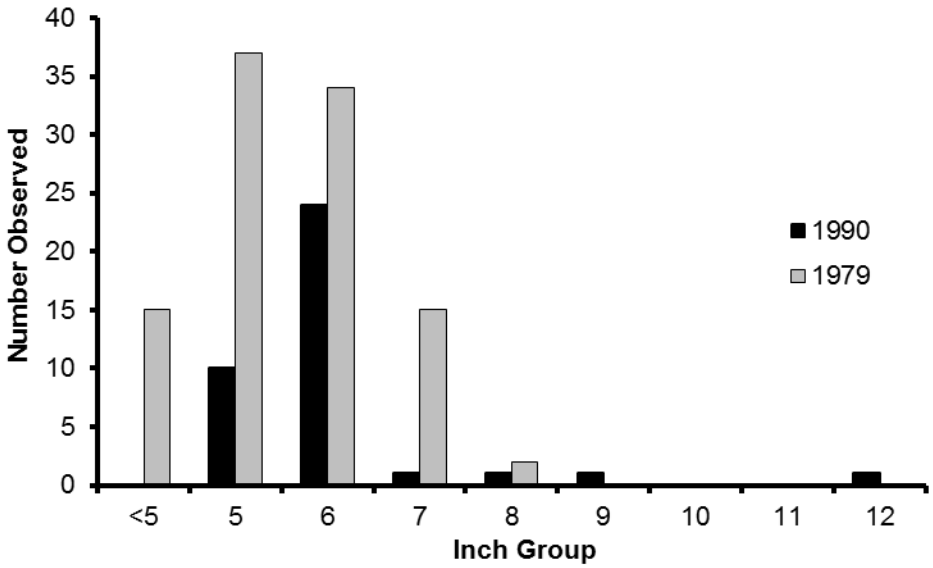

Figure 22. Length frequency of all yellow perch measured during previous spring fyke net surveys of Keyes Lake, Florence County (1990: N=38, 1979: N=103).

Table 13. Size structure, indexed using relative stock density, for yellow perch captured during previous surveys of Keyes Lake, Florence County.

	*1997	1990	1979	*1972
RSD8	0.00	7.89	2.27	35.71
RSD10	0.00	2.63	0.00	0.00
RSD12	0.00	2.63	0.00	0.00

*Summer electrofishing survey

Pumpkinseed

Relative Abundance

Like yellow perch, only a single pumpkinseed was captured throughout our sampling efforts in 2012. Unlike yellow perch, pumpkinseed were never sampled in high numbers during either spring or summer netting surveys going back to 1979 (Table 2 & 4, Appendix C). Pumpkinseed should be considered the least abundant panfish species in Keyes Lake.

Other Species:

Lake Whitefish

Relative Abundance

A total of 11 lake whitefish were captured during our 2012 survey. Ten of these fish were captured during a summer gill net survey directed toward cold water fish species (brown trout, lake whitefish and rainbow smelt). Spotlighting surveys were conducted during November which did locate a group of lake whitefish in shallow water. Three seine drags were completed, the seine drag in the exact area of the spotlighted group yielding a single fish. The number of lake whitefish captured during 2012 was less than previous surveys. The amount of effort put forth during previous surveys was not always documented, making it hard to make a good comparison. However, descriptions written by biologists performing the previous surveys lead me to believe the whitefish schools (and probably the entire population) are not as large as they use to be.

Local fishermen use to seine and dip net lake whitefish from Keyes Lake during the spawning run in late November. Many of these fishermen have stopped netting lake whitefish because they believe the whitefish population has been declining. Other anglers who fish for lake whitefish via hook and line share these same concerns.

Size Structure

A relatively small sample of 11 lake whitefish was measured during 2012 to index size structure. This sample had fish from 21.0 to 23.9 inches in length with an average length of 22.5 inches (Figure 23). The current size structure is incredibly high with 100% of the fish measured being ≥ 21.0 inches in length (Table 14). Previous surveys of Keyes Lake show that size structure of the lake whitefish population has increased drastically since the first whitefish survey in 1956.

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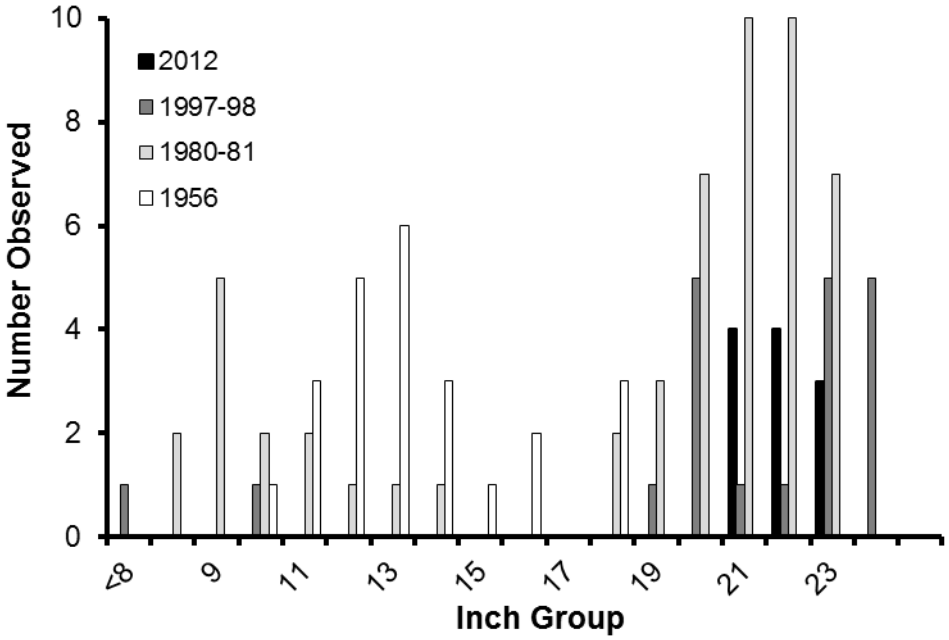

Figure 23. Length frequency of all lake whitefish captured during summer gill netting and various fall sampling surveys during 2012 compared to previous surveys of Keyes Lake, Florence County (2012: N=11; 1997-98: N=20, 1980-81: N=53, 1956:N=24).

Table 14. Size structure, indexed using relative stock density, for lake whitefish captured during 2012 compared to previous surveys of Keyes Lake, Florence County.

	2012	*1998	1997	1981	1980	1956
RSD15	100.00	100.00	83.33	78.94	88.89	25.00
RSD18	100.00	100.00	83.33	78.94	88.89	12.50
RSD21	100.00	76.92	33.33	52.63	62.96	0.00
RSD24	0.00	38.46	0.00	0.00	0.00	0.00

*Late fall electrofishing survey

Growth

The ten lake whitefish captured during the 2012 summer gill netting survey died in our gill nets (common for this type of gear). The otoliths were removed from these fish, along with a single fish which was captured by a local angler, to estimate of age. Growth was then inferred using average length at age (Figure 24).

The youngest fish captured was estimated to be 13 years of age, so early life growth is unknown. However, a survey in 1956 documented fast growth of lake whitefish in Keyes Lake (Table 9, Appendix C). Every indication suggests that Keyes Lake whitefish continue to grow very quickly early in life, and then maintain their body size once they hit approximately 22-24 inches in length. The oldest lake whitefish in our sample was 28 years old, showing that these fish can live much longer than the population in Lake Michigan.

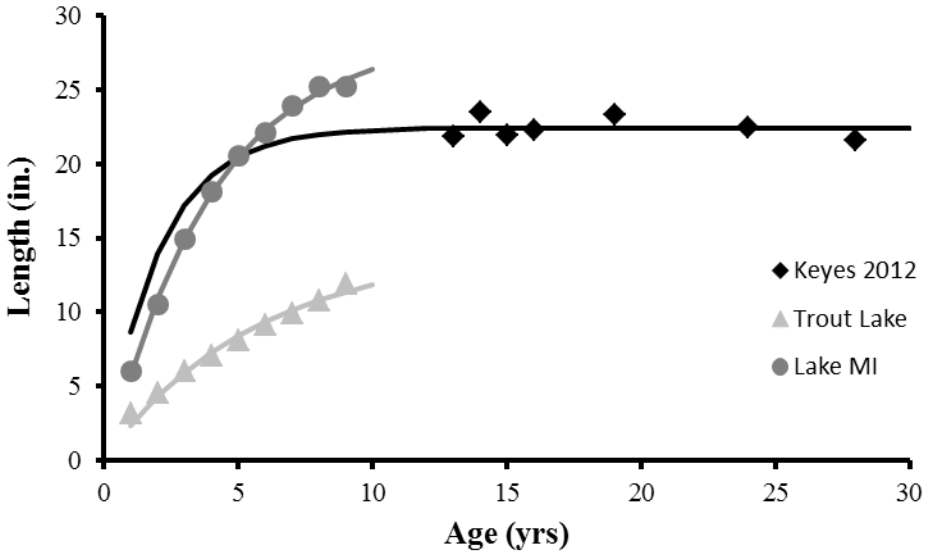

Figure 24. Average length at age for a subsample of lake whitefish captured during 2012 summer gillnet surveys of Keyes Lake, fit with von Bertalanffy growth curves and compared to the average length at age for Lake Michigan and Trout Lake populations (data from Becker 1983) (N=11).

Recruitment

No fish under age 13 were captured during the 2012 surveys of Keyes Lake. Size structure of lake whitefish is at an all-time high for Keyes Lake, which is indicative of poor recruitment. After carefully reading through the historic fisheries surveys conducted on Keyes Lake and talking with anglers who have fished for lake whitefish over the past few decades I believe the whitefish population is declining and probably at or near its lowest point. The lack of young fish, increased size structure and presumably decreasing abundance indicates that recruitment is not high enough to maintain the current population.

Brown Trout

Relative Abundance

Brown trout have been stocked annually into Keyes Lake since 2002 in an attempt to create a pelagic predator that could help reduce the exotic rainbow smelt population. Throughout the 2012 survey we found what appeared to be yearling brown trout in fairly high numbers. However, no fish were captured beyond age one. Occasionally fishermen catch large brown trout, but not with much frequency. The lack of larger adult fish leads me to believe that there is a very low abundance of adult fish, most likely due to poor survival beyond age one.

Recruitment

A fall fyke net survey was conducted in 2011 to attempt to locate spawning brown trout in Keyes Lake. During this survey no adult brown trout were captured or seen. Even if adult brown trout were found to be actively spawning it is highly unlikely that brown trout would be successful at hatching young of the year fish without a sizeable inlet stream or intense spring activity, which Keyes Lake does not have.

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Rainbow Smelt

Relative Abundance

Rainbow smelt were first identified in Keyes Lake in 2000. Within a few years of their discovery the rainbow smelt population increased to a point where large schools were witnessed near the ephemeral streams that flow into Keyes Lake in the spring. Ice fishing for rainbow smelt also became fairly popular because of the relatively small amount of effort that was needed to catch a large number of smelt. Then in the late 2000's the population seemed to crash to a point where fishermen and riparians were no longer encountering rainbow smelt.

During the 2012 survey rainbow smelt were only encountered during a single electrofishing survey on 3/30/2012. A total of 7 rainbow smelt were captured (all in one small area along the western shoreline) while sampling the entire shoreline. After the survey was complete the area that contained smelt was revisited and another 13 rainbow smelt were captured. The fact that smelt were not frequently encountered during spring surveys of Keyes Lake in 2012 suggests that the population is still very low.

Size Structure

All of the rainbow smelt captured during 2012 were measured to index size structure. The relatively small 20 fish sample had little variability ranging from 5.5 to 6.8 inches in length (Figure 24).

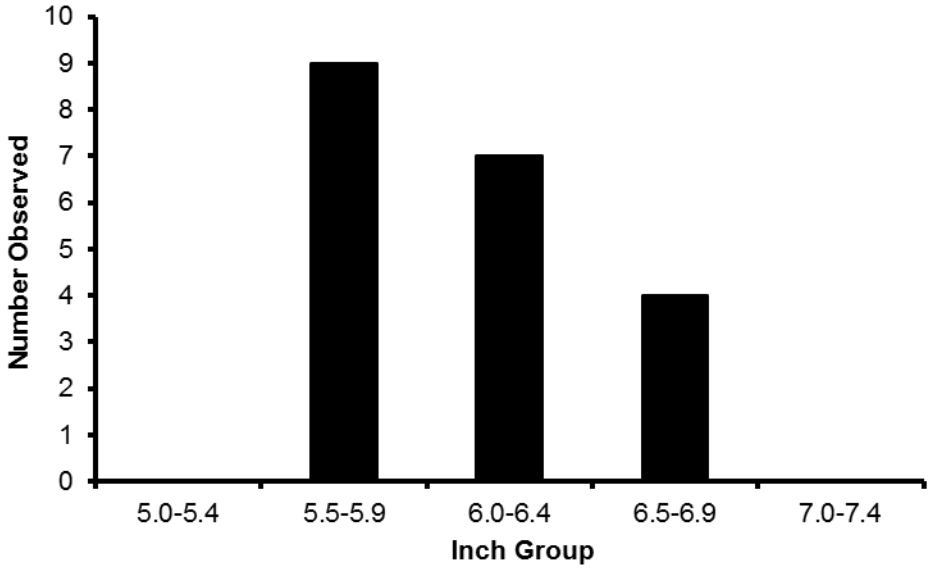

Figure 24. Length frequency of rainbow smelt captured during the 2012 survey of Keyes Lake, Florence County (N=20).

Recruitment

Rainbow smelt have proven they are capable of naturally reproducing at a very high level in Keyes Lake. Currently we do not have a protocol for monitoring smelt reproduction; however the species is capable of pulling off some large year-classes even at a low adult abundance, like the current population in Keyes Lake.

V. MANAGEMENT RECOMMENDATIONS

Northern Pike

Spring catch rates indicate that northern pike are quite rare in Keyes Lake. The only gamefish captured with less frequency during spring netting was smallmouth bass. The current size structure is surprisingly poor when you consider the current low density population. The modal size for northern pike captured in 2012 was 13-15 inches; these fish were approximately 2 years old, indicating that there is sufficient input into the population. Only a single northern pike was estimated to be older than 7 years old. Knowing the popularity of this lake for fishing during both summer and winter seasons it is entirely possible that the poor size structure is primarily due to high exploitation on this species preventing the majority of the population from achieving high age and length.

Body condition of northern pike is very good. An average W_r right near 100 indicates that resources are not limiting the current population. Growth of northern pike appears to be below average beyond age 6 from the sample collected during 2012. However, no female northern pike older than age 6 were captured during 2012, allowing the growth curve to be manipulated by a few relatively old male fish. All indications suggest that female northern pike are capable of reaching large size quickly. The low abundance of northern pike, matched with seemingly high fishing effort and aggressive nature of young northern pike (suggesting significant exploitation) is most likely keeping the species from reaching its potential in Keyes Lake.

I believe the current regulation (no minimum length limit, 5 fish daily bag) is too liberal to achieve the high potential that Keyes Lake has for northern pike size structure. A 26” minimum size limit with a 2 fish daily bag limit would be a good choice to improve size structure and abundance. However, I do not recommend a regulation change for northern pike. Keyes Lake is one of the very few waters in Florence County that are capable of natural reproduction of walleyes, and all management activities should be tailored toward rehabilitation of the walleye population. It is my belief that walleye will only benefit from decreased abundance of other gamefish, such as northern pike.

Walleye

The current population of walleye, approximately 0.45 adults/acre, is likely the lowest abundance of adult walleye since the initial population was established in the early 1940s. Less than 0.5 adults/acre is not considered a “fishable” population and does little to enhance the Keyes Lake fishery. The recent population decline can be directly linked to the presence of rainbow smelt, which were discovered in 2000. Rainbow smelt have been proven to have negative impacts on walleye populations throughout the Midwest United States via direct predation of young of the year walleye by rainbow smelt. The majority of the walleye predation happens after the newly hatched walleye consumes its yolk sack and moves to open water to feed on plankton. This deeper/cooler water is home to rainbow smelt, which can be incredibly abundant and mainly consume fish.

During 2006 a walleye rehabilitation plan was created for Keyes Lake. The main components of this plan were to stock a cold water predator of rainbow smelt (brown trout), stock larger walleyes (which do not have to worry about predation by smelt) and increase the minimum size limit on walleyes from 15-inches to 18-inches to maintain a spawning stock of walleyes in Keyes Lake. Since this plan was put into effect some positive changes have taken place in Keyes Lake. The smelt

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population has declined to the point where anglers rarely encounter smelt (only 20 were captured during the 2012 survey). With the reduction of rainbow smelt a minimal amount of natural reproduction has been documented during fall electrofishing surveys in 2010 and 2012. Stocking large fingerling walleye appears to be working, but with less success than I had expected. One year old walleyes were captured in nearly every survey of Keyes Lake in 2012, showing that stocked walleye are definitely surviving. However the abundance of spawning stock has not been maintained the way I expected, leading me to believe that the survival of large fingerling walleye may be below average in Keyes Lake.

The rehabilitation plan for Keyes Lake walleye population should be continued. Stocking of large fingerling walleye every other year at a rate of 10 fish/acre is mandatory to maintain a spawning stock that is now starting to naturally reproduce at very low levels. With the rainbow smelt population decreased I expect to see natural recruitment of walleyes continue to increase in Keyes Lake, especially as larger numbers of stocked walleyes begin to reach maturity. We are in the early stages of developing a walleye pond in Florence that would be used to raise small fingerling walleye into large fingerling walleye by holding them and feeding them from approximately June until September. Most of these fish will be used to improve walleye populations in the Spread Eagle Chain of Lakes and Sea Lion Lake. If there was ever a surplus of large fingerling walleye from the Florence pond, or if the operation ever expanded, Keyes Lake would be a good candidate for additional stocking.

Currently the abundance of adult walleye is well below the standard for stocked waters. I believe this problem is two-fold. It has now been 15 years since the last sizeable year class of walleyes was naturally reproduced in Keyes Lake (1997). Since the lake was never in need of stocking before the presence of smelt was documented no stocking took place until 2002. The first three stocking attempts, between 2002 and 2004, were of small fingerling walleyes (1.5-2” in length) which had incredibly low survival, and did not contribute significantly to the population. It was not until 2006 that large fingerling walleyes were stocked at a high enough rate to impact the population. These large fingerlings, stocked in 2006-09 and 2011, are present in the population, but many of them have not yet matured, and were not part of our estimate. The “lag time” between the end of natural reproduction and the start of significant stocking is now what is being represented in the adult population, hence the low adult density. With the steady stocking of large fingerling walleye and a fairly restrictive size limit (18-inches) I believe a good goal for the Keyes Lake walleye population is to achieve $\geq$ 2 adults per acre by the time the 2011 year class reaches maturity (likely 2015-17). This goal can be assessed with our next comprehensive survey, scheduled for 2017, allowing us to better understand the survival of stocked large fingerling walleye and impact they will have on the adult population.

The current 18-inch minimum size limit with a daily bag of 3 is the most appropriate regulation for Keyes Lake. This regulation will protect the majority of female walleyes, which are the most vulnerable to angling early in life, until maturity. This will allow female walleyes a better chance to have a successful spawning event before potential harvest by anglers. The current restrictive size limit is also imperative to reach our adult density goals for Keyes Lake. The statewide size limit would be less desirable because the 15-inch minimum size limit would not protect female walleyes to maturity. An even more liberal regulation, such as no minimum length limit, is not appropriate for stocked waters.

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Largemouth Bass

Largemouth bass are the most abundant gamefish in Keyes Lake. The bass population has nearly tripled in the past 8 years from a density of 1.7 to 4.95 adults per acre. At just under 5 adults per acre the Keyes Lake bass population would be considered abundant and if the population continues to grow it could become overabundant.

The average length of largemouth bass has increased since 2000. The increase in average size was reflected by a two-fold increase in RSD12 since 2000. However, RSD15 and 18 both decreased by approximately 50% since 2000. A decrease in size structure is usually expected in a population that is increasing its abundance. This is normally due to a higher level of competition between the species for resources. Body condition analysis shows that resources are not limited for largemouth bass, expressed by an average W_r of 112, suggesting that intraspecific competition is likely not a problem at this time. Length frequency analysis shows a large decline in the number of individuals captured beyond 14 inches. This leads me to believe that angler harvest is likely high for largemouth bass and is likely limiting size structure.

Like body condition, growth of largemouth bass does not appear to have been negatively affected by the recent increase in largemouth bass abundance. However, largemouth bass growth in Keyes Lake is below the average for the Northern Region of Wisconsin. With this slow growth rate a largemouth bass must live a very long time to achieve trophy size, because of this I do not see any reason to manage Keyes Lake for trophy largemouth bass, or with a restrictive regulation to manage for higher size structure.

The current 14-inch minimum size limit with a daily bag of 5 fish is appropriate for Keyes Lake at this time. If the Keyes Lake population continues to grow a more liberal regulation should be considered. Right now the best option would be, no minimum length limit with a protected slot on fish between 14 and 18 inches with a daily bag limit of 3 (only 1 of which can be $\geq$18 inches). If the option for a no minimum size limit, daily bag limit of 3 fish, with only 1 fish $\geq$ 14 inches (or something similar) became available it may be an even better option. Both of these more liberal regulations would allow for harvest of smaller individuals and protect larger fish which is appropriate for populations with high recruitment, which the expanding Keyes Lake population appears to have. Limiting harvest of the larger fish, instead of directing harvest toward larger fish like the current regulation, should also have positive impacts on size structure.

Smallmouth Bass

The smallmouth bass fishery in Keyes Lake is quite minor. Smallmouth bass exhibited better growth rates than largemouth bass. An effect of the good growth rates is a very respectable size structure with nearly 12% of fish being $\geq$ 17.0 inches.

Body condition had a significant negative correlation with body length for smallmouth bass in Keyes Lake. 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 were still within the acceptable range of body condition for Northern Wisconsin.

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Since smallmouth bass are of such low abundance a minimum size limit should be maintained on smallmouth bass in an effort to maintain or grow the population and create a more diverse fishery. A special regulation restricting harvest would make sense on Keyes Lake, but is not needed at this point in time.

Panfish

The relative abundance of panfish in Keyes Lake is very average for Florence County. In fact, the average number of panfish captured per net-lift during summer surveys was 30.36 fish, very close to the 31.22 fish average for all Florence County lakes sampled the last two years (Figure 25). Very similar panfish abundance was measured during all panfish surveys going back to 1949, showing very stable panfish populations in Keyes Lake.

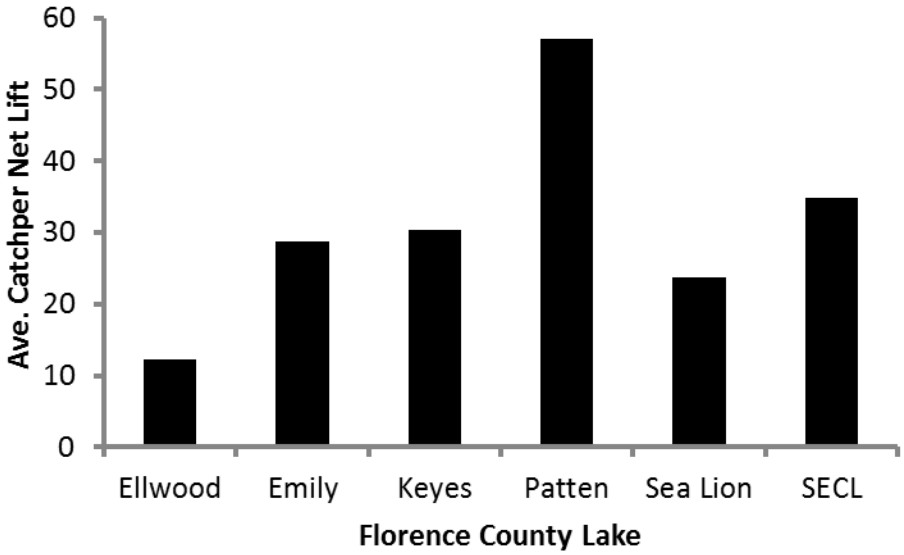

Figure 25. Panfish catch per net-lift during summer fyke net surveys of Florence County Lakes 2011-2012.

Bluegill accounted for nearly 81% of the panfish catch during the 2012 summer survey. Bluegill have above average growth and a very good size structure, with approximately 55% ≥ 7.0 inches. Bluegill size structure is surprisingly similar to size structure measured during previous surveys going back to 1949. Since size structure and abundance has remained relatively unchanged and the growth is above average no changes in the current panfish management are needed. Bench marks should be set to determine if the bluegill population is meeting management standards. Based on average size structure for the last 4 netting surveys in which bluegill size structure was indexed, bench marks values should be set at 75, 50, 15 and 1 for RSD6, 7, 8 & 9 respectively. Fyke nets, or other passive capture techniques, should be used to evaluate bluegill size structure. A minimum of 2 of these 4 size structure goals should be met in order to consider the bluegill population to be achieving management standards. If the bluegill population fails to meet the size structure goals the most likely cause would be over exploitation or increased panfish abundance and further analysis would be warranted in determining the cause.

Rock bass accounted for approximately 15% of the panfish catch during our summer fyke net survey. Size structure of rock bass is, and has always been, poor in Keyes Lake with very few fish ≥ 8.0 inches. Rock bass growth is also well below the state average, which is most likely contributing to the poor size structure of rock bass. Since rock bass are a relatively minor part of the panfish population I do not recommend any major management activity at this time.

Black Crappie were caught in low numbers during both spring and summer fyke net surveys. This is not uncommon as their typical spawning period is normally in between these two sampling events, which causes us to miss them in shallow water. A moderate abundance of black crappie were seen during spring electrofishing surveys, suggesting that black crappie may be a sizeable piece of the pan fishery (likely about as abundant as rock bass). Black crappie growth was above the Northern Region of Wisconsin average for all age classes sampled during 2012. The fast growth rates allow black crappies to reach 8 inches in only 3 years and provide anglers with a quality fishing opportunity. Since black crappie populations are quite cyclic, establishing bench marks for black crappie size structure is not appropriate. At this time no management change is necessary for black crappie in Keyes Lake.

Yellow perch and pumpkinseed are of very low abundance in Keyes Lake. Pumpkinseed have never been captured in high numbers, however, yellow perch use to be a significant panfish in Keyes Lake. The yellow perch population has likely been negatively affected by the introduction of rainbow smelt, however, data suggests the population was declining before the presence of rainbow smelt. Yellow perch should be monitored during future surveys. If yellow perch abundance rebounds it likely means that the rainbow smelt population has declined. Typically strong yellow perch populations go “hand-in-hand” with strong walleye populations and resurgence in yellow perch could indicate a potential walleye population rebound.

Lake Whitefish

The lake whitefish population in Keyes Lake appears to be at an all-time low. Lake whitefish are native to Keyes Lake and use to have a sizeable population that allowed for angling and netting opportunities. Recruitment of whitefish appears to be negligible or non-existent over the past decade or so. Since whitefish are pelagic fish and spend most of their life in deep cool water, failed recruitment is likely due, at least in part, to the presence of rainbow smelt. Every effort should be made to reduce the currently low smelt population.

A more restrictive regulation on whitefish harvest would be beneficial to this population, however, more information is needed to determine if restrictive regulations are needed.

Rainbow Smelt

The rainbow smelt population appears to be at its lowest level since they were documented in Keyes Lake. Rainbow smelt have greatly influenced the walleye population and are likely having a negative impact on the lake whitefish population. Very limited walleye natural recruitment has been documented in recent years, which may be a sign that the smelt numbers are reaching a critical level. Continuing to stock pelagic predators is the best way to control the population at this point.

Brown Trout

Brown trout have been stocked annually since 2002 as an attempt to control the smelt population. It is unknown if the smelt population has been significantly reduced due to the stocking of brown trout, but the smelt population does appear to be at an all-time low and brown trout have likely played a role. Age 0 and Age 1 brown trout are commonly seen during spring and fall surveys of Keyes Lake, but only one adult brown trout was witnessed by our fisheries team during the survey of Keyes Lake.

The lack of adult brown trout leads me to believe that the vast majority of stocked fish do not survive to adulthood.

From 2002-2009 the WDNR has stocked an averaged 28,610 large fingerings (141.6/acre) per year into Keyes Lake. Based on what I witnessed during the 2012 survey I believe that these fish are not surviving and creating a fishable population. This high stocking rate seems to be overkill, based on the number that actually survive beyond age-1. I recommend reducing the stocking quota to 10,000 large fingerlings (49.5/acre) annually. This stocking rate should be enough fish to control the currently low smelt abundance.

Walleye recruitment is negatively correlated with smelt abundance, so walleye recruitment should be monitored at least every other year. If walleye recruitment reduces back to a non-measurable number it should be taken as a sign of increased smelt abundance and the stocking rate of brown trout should be reevaluated.

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Appendix A – Length Frequencies

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

Inch Group	Spring Net	WE1	WE2	Bass 1	Bass 2	Bass 3	Total
<12	1						1
12	5						5
13	5	1					6
14	3		1			2	6
15	3			1	1	1	6
16	3					1	4
17						1	1
18	2				1		3
19						1	1
20					1		1
21				1		1	2
22					2		2
23	2					1	3
24				1			1
25							0
26							0
27							0
28	1						1
29	1				1		2
30							0
31							0
Totals	26	1	1	3	6	8	45

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

Inch Group	Spring Netting	Spring Electrofishing	Fall Shocking	Total
< 8.0	2		1	3
8				0
9	2		1	3
10			2	2
11				0
12		2		2
13	2	2		4
14	6	1		7
15	3	1		4
16	9	4		13
17	5	2		7
18	1	1		2
19	3	1		4
20	1			1
21	3			3
22	3			3
23				0
24	1	1		2
25	3			3
26	1	1		2
27	2			2
28				0
29	1	1		2
30				0
Totals	48	17	4	69

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

Inch Group	Spring Net	WE1	WE2	WE3	Bass 1	Bass 2	Bass 3	Bass 4	Bass 5	Total
< 8.0	12	1				1	1	4	12	31
8	3				1	3		3	2	12
9	2				2	8	3	4	13	32
10	2		1		4	11	2	4	5	29
11	3		3		4	11	14	11	8	54
12	5	1	9	4	19	23	20	13	7	101
13	8	1	7	9	20	27	6	4	2	84
14	4	1	3	4	11	11	6	3	1	44
15	1				2	2	2	2	1	10
16	4				3	3	1	1		12
17	1			1	1	1		1	1	6
18	1						2			3
19										
20										
Totals	46	4	23	18	67	101	57	50	52	418

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

Inch Group	Spring Net	WE1	WE2	WE3	Bass 1	Bass 2	Bass 3	Bass 4	Bass 5	Total
< 7.0								2	6	8
7					1	2			5	8
8						4			4	8
9						3			1	4
10					1	3	3		1	8
11					5		2			7
12					3		3			6
13	1		1		1	1	3	1	1	9
14					2	1	1	1		5
15					1		1	1		3
16					1					1
17	1					1	1			3
18						2	1			3
19	1									1
20	1									1
Totals	4	0	1	0	15	17	15	5	18	75

Table 5. Length frequencies for subsamples of panfish measured during a summer netting survey of Keyes Lake, Florence County, 6/28-29/2012.

Inch Group	Bluegill	Pumpkinseed	*Black Crappie	Rock Bass	*Yellow Perch
< 3.0					
3	3			2	
4	13		13	2	
5	36		4	14	
6	70		2	16	1
7	120	1	1	15	
8	25		1	2	
9	3		12		
10			18		
11			9		
12			1		
Sample Size	270	1	61	51	1

*Subsample of fish taken during spring netting and electrofishing surveys

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Appendix B – Average Length at Age

Table 1. Mean length (inches) at age for northern pike captured during spring surveys of Keyes Lake during 2012, compared to previous surveys of Keyes Lake and Northern Region of WI averages (2012: Male: N=16, Female: N=6).

	2012			1997			1990	NOR Ave
Age	Male	Female	Combined	Male	Female	Combined	Combined	Combined
1	11.9667		11.9667			6.7		10.6
2	14.2	15.3	14.5364	11.7	18.8	16.8	11.7	13.1
3	16.4333	18.9	17.9875	12.7	20.9	21.4	19.4	16.3
4		23.6	21.775		26.8	26.1	23.8	19.5
5		28.7	25.6		31.7	30.5	29.4	22.0
6		29.4	26.55					24.5
7	23.2		23.95				35.5	27.7
8								30.3
9					40.5	40.5		31.5
10								34.1
11			29					37.3

Table 2. Mean length (inches) at age for walleye captured during spring surveys of Keyes Lake during 2012, compared to previous surveys of Keyes Lake and Northern Region of WI averages (2012: Male: N=29, Female: N=28).

	2012			1997			1990			1956	1949	NOR Ave
Age	Male	Female	Combined	Male	Female	Combined	Male	Female	Combined	Combined	Combined	Combined
1			7.8									6.4
2												9.5
3			12.3	13.8		13.8				10.6		11.7
4	13.8	14.1	13.9	16.0	16.7	16.1	13.9	15.4	15.1	12.2	14.6	13.8
5	13.6		13.6	16.7	18.3	17.8	15.7	14.6	15.5	16.0	21.4	15.8
6	16.6		16.6	20.2	20.6	20.4	16.5	19.2	17.1	18.0	19.4	17.5
7	15.9	18.7	16.9	19.9		19.9	17.8	19.7	19.3	18.8	23.4	19.1
8	16.2	19.6	17.9				18.9	24.2	21.6		25.5	20.5
9	16.9	21.2	18.7		23.7	23.7	20.2	24.4	22.3	21.4		21.6
10	15.9	22.6	18.7		24.2	24.2						22.7
11		22.0	22.0					27.5	27.5			23.7
12												24.4
13	22.7	23.4	23.3									25.2
14		27.4	27.4	21.0	25.5	24.6						25.8
15		27.3	27.3									25.6
16		29.7	29.7									25.6
17		26.3	26.3									25.2

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Table 3. Mean length (inches) at age for largemouth bass captured during spring surveys of Keyes Lake during 2012, compared to previous surveys of Keyes Lake and Northern Region of WI averages (2012: N=109).

Age	2012	1997	1990	1956	1949	NOR Ave
1	2.9				3.9	3.8
2	6.7			5.3	7.2	6.6
3	8.5	9.1	8.8	7.4	10.7	9.0
4	10.7	9.7	10.6	9.6		10.8
5	11.5	11.2	12.3			12.7
6	12.4	11.7	13.6			14.3
7	13.8	14.2	17.1			15.7
8	14.8	15.4	19.5			17.0
9	15.8	16.2				17.9
10	16.4	15.7				18.5
11	16.7					19.5
12						19.1
13	18.1					18.4

Table 4. Mean length (inches) at age for smallmouth bass captured during spring surveys of Keyes Lake during 2012, compared to previous surveys of Keyes Lake and Northern Region of WI averages (2012: N=71).

Age	2012	1997	1990	1956	1949	NOR Ave
1		5.2			2.9	3.4
2	6.8	5.6				7.2
3	8.8	7.7	8.3	7.0	7.8	9.1
4	11.2	9.6	10.5	8.8	8.2	11.2
5	12.3	13.7	12.8		12.7	13.6
6	14.4	14.6	15.4		15.8	15.5
7	15.1	14.0	16.4			16
8	17.3		18.3			17.8
9	18.5	17.7				18.6
10	18.1					19.9

Table 5. Mean length (inches) at age for bluegill captured during a summer fyke net survey of Keyes Lake during 2012, compared to previous surveys of Keyes Lake and Northern Region of WI averages (2012: N=54).

Age	2012	1997	1990	1979	1949	NOR Ave
1	3.9					2.9
2	4.2				3.6	3.6
3	5.1	5.0	4.8	4.3	4.8	4.7
4	5.6	5.9	6.2	6.6	6.1	5.6
5	6.6	6.7	7.1	7.3	7.0	6.4
6	7.3	6.8	7.8	8.3	7.8	7.0
7	8.5	7.2	8.7	8.7	8.3	7.6
8	9.0		9.1	9.2	8.8	7.9
9	9.0			9.8		8.5
10	8.7					8.9
11	8.5					8.5

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

Age	2012	1949	State Ave
1			3.2
2		4.6	3.9
3		5.4	4.7
4		5.8	5.4
5		6.4	6.0
6	7.8	7.0	6.5
7			7.0

Table 7. Mean length (inches) at age for black crappie captured during surveys of Keyes Lake during 2012, compared to previous surveys of Keyes Lake and Northern Region of WI averages (2012: N=39).

Age	2012	1990	1949	NOR Ave.
1	4.5			3.9
2	5.4	6.0		5.8
3	8.1	7.8		7.1
4	9.5	10.0	8.7	8.5
5	10.1	10.9	9.7	9.1
6	10.6	11.4		9.9
7	11.6	11.5		10.6
8	11.9			11.6

Table 8. Mean length (inches) at age for rock bass captured during a summer fyke net survey of Keyes Lake during 2012, compared to previous surveys of Keyes Lake and Northern Region of WI averages (2012: N=37).

Age	2012	1997	1990	1979	1949	State Ave.
1	3.8					4.1
2	4.5	3.6			3.6	4.0
3	5.6	4.9	4.8	4.6	5.3	5.3
4	5.9	6.0	5.6	5.9	6.4	6.3
5	6.8	6.5	6.5	6.6	7.6	7.2
6	7.3	7.5	7.5	7.8	8.5	8.0
7	7.4	8.1	8.5	8.3	9.2	8.6
8	8.3	8.6				9.2
9	7.8					9.5

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Table 9. Mean length (inches) at age for lake whitefish captured during a summer gill net survey of Keyes Lake during 2012, compared to a previous survey of Keyes Lake (2012: N=11).

Age	2012	1956
1		
2		
3		11.4
4		13.2
5		15.5
6		17.5
7		18.0
8		
9		
10		
11		
12		
13	21.8	
14	23.5	
15	21.9	
16	22.3	
17		
18		
19	23.3	
20		
21		
22		
23		
24	22.4	
25		
26		
27		
28	21.6	

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Appendix C – Catch Per Unit Effort

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

Species	2012	2007	1997	1990	1979
Largemouth Bass	1.06	---	0.12	0.56	0.08
Northern Pike	0.58	---	0.82	0.19	0.05
Smallmouth Bass	0.08	---	0.04	0.27	0.03
Walleye	1.33	6.5	2.57	2.90	12.74

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

Species	2012	1997	1990	1979
Black Bullhead	0.54	---	0.10	0.00
Black Crappie	0.46	---	5.40	0.13
Bluegill	5.67	1.61	23.80	8.63
Pumpkinseed	0.00	---	0.05	0.13
Rock Bass	1.25	---	37.40	5.38
Yellow Bullhead	0.00	---	0.00	0.00
Yellow Perch	0.02	---	4.80	12.88

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

Species	2012	1949
Largemouth Bass	0.50	---
Northern Pike	0.80	0.04
Smallmouth Bass	0.30	---
Walleye	0.40	0.10

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

Species	2012	2007	1949
Black Bullhead	0.18	---	---
Yellow Bullhead	0.64	---	---
Total Bullhead	0.82	---	0.58
Black Crappie	1.10	0.07	1.23
Bluegill	24.50	26.80	18.62
Pumpkinseed	0.10	0.60	---
Rock Bass	4.60	9.80	9.64
Yellow Perch	0.00	0.00	0.00

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

Species	Spring	Bass Surveys	*Fall
Largemouth Bass	4.84	22.18	0.58
Northern Pike	0.22	0.90	0.29
Smallmouth Bass	0.11	3.92	2.32
Walleye (All)	3.66	2.06	1.45
Walleye (Age 0+)	---	---	0.29
Walleye (Age 1+)	---	---	1.16

*Only juvenile fish collected during survey

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Table 6. Summary of fish species, number and size range captured during fyke netting and electrofishing surveys during a comprehensive survey of Keyes Lake, Florence County, 2012.

	Fish Species	Catch (and Size Range in Inches) by Sampling Period											
		Spring Netting			Spring Electrofishing 1			Spring ElectroFishing 2			Summer Netting		
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 Bullhead	Ameiurus melas	26	n/a	n/a	---	---	---	---	---	---	2	11.0	14.3
Black Crappie	Pomoxis nigromaculatus	22	4.2	10.5	---	---	---	29	7.7	12.1	12	7.7	11.3
Bluegill	Lepomis macrochirus	272	n/a	n/a	---	---	---	---	---	---	270	3.7	9.3
Brown Trout	Salmo Trutta	9	n/a	n/a	---	---	---	---	---	---	0	---	---
Creek Chub	Semotilus Atromaculatus	1	n/a	n/a	---	---	---	---	---	---	0	---	---
Lake Whitefish	Coregonus clupeaformis	0	---	---	---	---	---	---	---	---	0	---	---
Largemouth Bass	Micropterus salmoides	51	2.9	18.5	45	7.4	17.4	419	5.5	18.3	5	n/a	n/a
Northern Pike	Esox lucius	28	11.4	29.4	2	13.3	14.4	17	14.0	29.0	9	n/a	n/a
Pumpkinseed	Lepomis gibbosus	0	---	---	---	---	---	---	---	---	1	7.8	7.8
Rainbow Smelt	Osmerus Mordax	0	---	---	20	5.5	6.8	---	---	---	0	---	---
Rock Bass	Ambloplites rupestris	60	n/a	n/a	---	---	---	---	---	---	51	3.7	8.3
Smallmouth Bass	Micropterus dolomieui	4	13.8	20.5	1	13.0	13.4	74	5.6	18.8	3	n/a	n/a
Walleye	Sander vitreus	64	7.8	29.7	34	12.3	29.7	---	---	---	4	n/a	n/a
White Sucker	Catostomus commersoni	2	n/a	n/a	---	---	---	---	---	---	0	---	---
Yellow Bullhead	Ameiurus natalis	0	---	---	---	---	---	---	---	---	7	7.9	10.5
Yellow Perch	Perca flavescens	1	6.5	6.5	0	---	---	0	---	---	0	---	---

**0 indicates fish species would have been sampled during survey but were not captued; --- means fish species would not have been sampled even if present*

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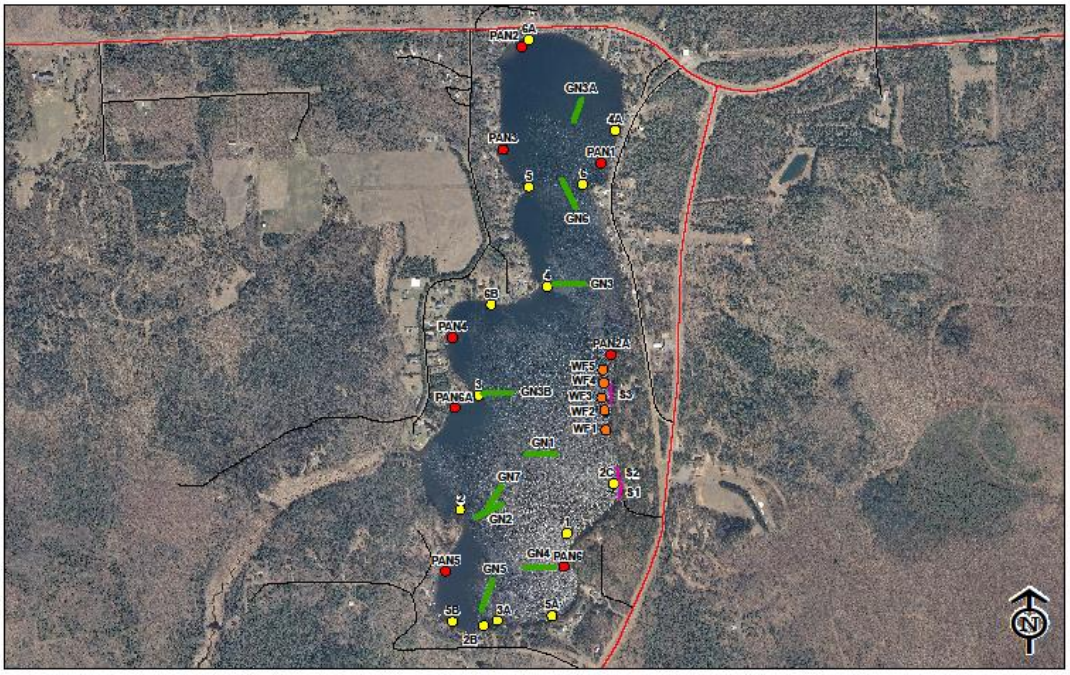


Legend

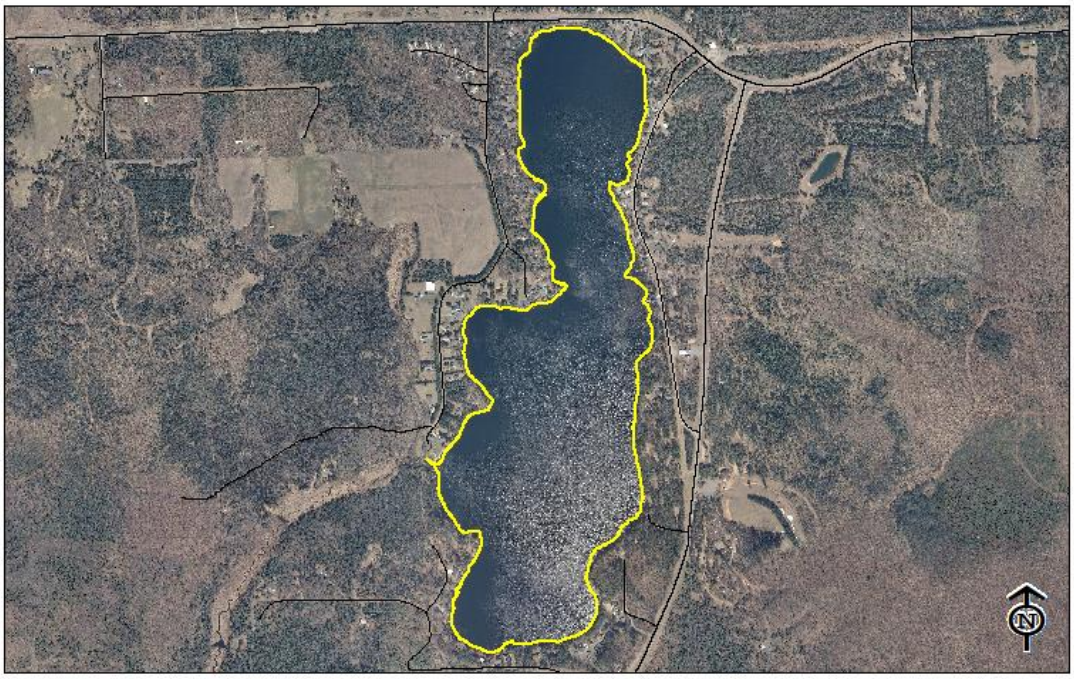
- SN1 3/22 - 3/29 (48 Lifts)
- SN3 6/28 - 6/29 (12 Lifts)
- WFN 11/18 - 11/20 (15 Lifts)
- Summer Gill Net 9/4 - 9/7
- Seine Drag 11/16 (3 Drags)

Keyes Lake

Net Locations

2012 Comprehensive Survey

Mapped By: Jake Walcisak
December 7th, 2012



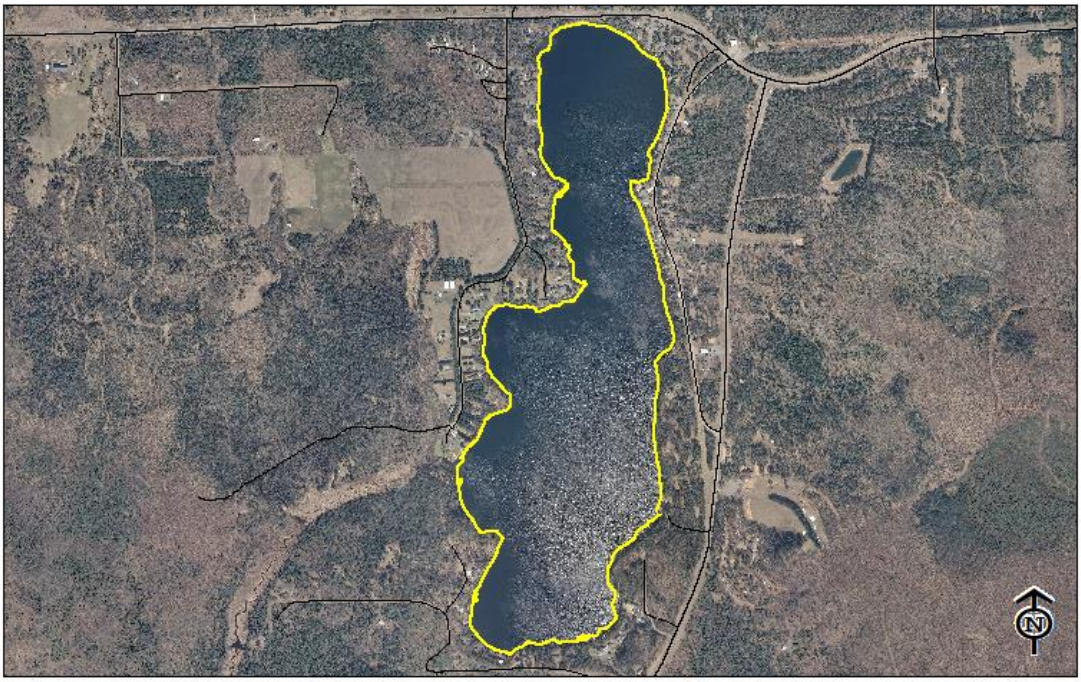
Keyes Lake

Walleye Recapture Survey #1

3/30/2012

3.7 Miles

Mapped By: Jake Walcisak
December 19th, 2012



Keyes Lake
Walleye Recapture Survey #2
4/10/2012
3.75 Miles

Mapped By: Jake Walcisak
December 19th, 2012

Keyes Lake
Walleye Recapture Survey #3
4/12/2012
1.85 Miles

Mapped By: Jake Walcisak
December 19th, 2012

Keyes Lake
Bass Electrofishing Survey #1
4/30/2012
3.85 Miles

Mapped By: Jake Walcisak
December 19th, 2012

Keyes Lake
Bass Electrofishing Survey #2
5/5/2012
4.4 Miles

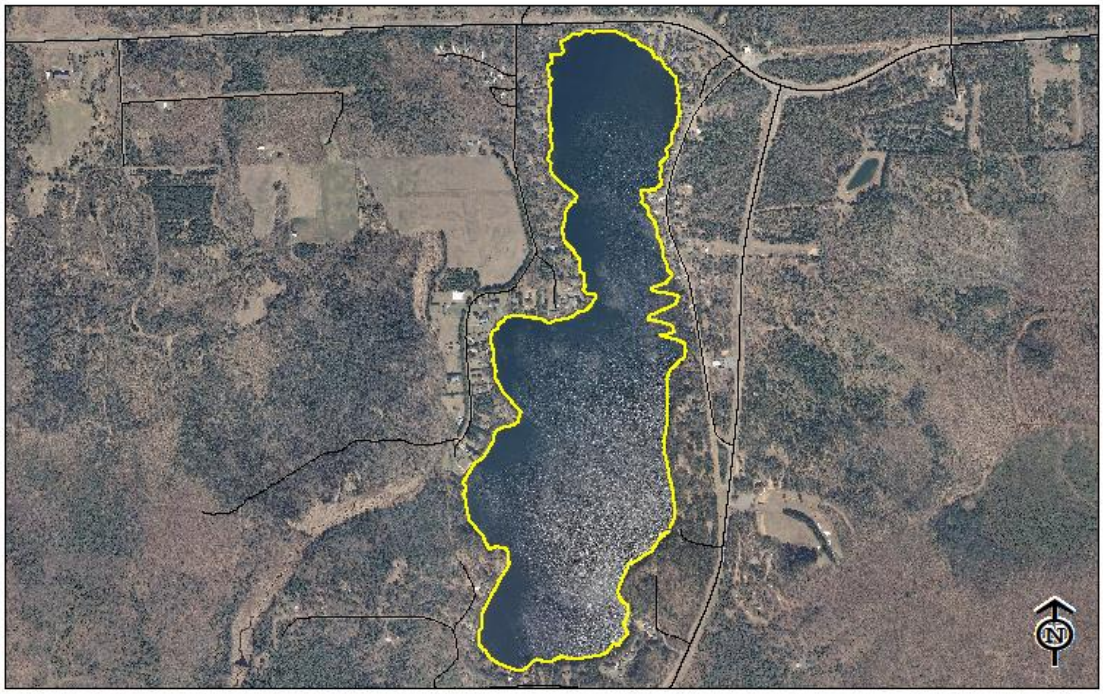
Mapped By: Jake Walcisak
December 19th, 2012

Keyes Lake
Bass Electrofishing Survey #3
5/08/2012
2.65 Miles

Mapped By: Jake Walcisak
December 19th, 2012

Keyes Lake
Bass Recapture Survey #1
5/30/2012
4.16 Miles

Mapped By: Jake Walcisak
December 19th, 2012



Keyes Lake
Bass Recapture Survey #2
6/7/2012
3.83 Miles

Mapped By: Jake Walcisak
December 19th, 2012

Legend
All Fish (0.5 mi)
Game Fish Only (2.95 mi)

Keyes Lake
Fall Recruitment Survey
9/24/2012
3.45 Miles

Mapped By: Jake Walcisak
October 17th, 2012