

Comprehensive Fisheries Evaluation of Silver Lake, Forest County, Wisconsin 2011

Water body Identification Code 0555700



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October, 2012

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Lake and location:

Silver Lake, Forest County, T.36N. R.14E.

Located just south of highway 8, between Laona and Crandon. Silver Lake is part of the Peshtigo River watershed.

Physical/Chemical attributes: (AveLallemant, 2000)

Morphometry:	320 acres, maximum depth of 20 feet
Lake type:	Drained
Basic water chemistry:	Soft
Water clarity:	Clear
Littoral substrate:	Mainly sand and gravel
Aquatic vegetation:	Very little near shore
Shoreline character:	Predominantly upland
Shoreline development:	High
Winterkill:	None reported or likely
Boat landing:	One public boat landing

Purpose of Survey: Comprehensive fisheries survey.

Dates of fieldwork:

Walleye/northern pike electrofishing, 5/2/2011

Muskellunge netting (marking), 5/4-11/2011

Panfish netting, 6/28-29/2011

Bass electrofishing, 5/17, 6/8, 6/16, and 6/23/2011

Fall electrofishing, 9/19/2011

Muskellunge netting (recapture), 4/1/2012-4/15/2012

ACKNOWLEDGEMENTS

Brad Shucha, Dave Wittlinger, Nick Neuens, Derrick Raspor, Greg Cisar, John Aschenbrenner, Jeff Aromi, Joey Clark and Jason Mollen assisted in the field. Brad Shucha and Aaron Nelson assigned game and panfish age from scales, spines and rays. Aaron Nelson conducted laboratory analysis on young-of-the-year walleyes. Allen Bluhm allowed the usage of his waterfront for boat storage.

I. EXECUTIVE SUMMARY

Silver Lake was surveyed during 2011 with a variety of sampling gear to assess the status of the fishery. Sampling began with early spring electrofishing for adult gamefish, followed by late spring fyke netting for muskellunge, late spring bass electrofishing, summer fyke netting for panfish and sampling was completed with a fall electrofishing survey to assess gamefish recruitment. A follow-up fyke netting survey was conducted during late spring 2012 as part of a two year muskellunge population assessment.

Five gamefish species were captured during our survey of Silver Lake. Walleye and muskellunge appear to have no natural reproduction and would not be capable of maintaining their populations naturally. Northern pike, largemouth and smallmouth bass have sufficient natural reproduction to maintain their current populations. Northern pike are the most abundant gamefish species, followed by largemouth bass (1.48 adults/acre), smallmouth bass, walleye and muskellunge (0.11 adults/acre).

Walleye, largemouth bass, smallmouth bass and muskellunge have very good size structure with many quality and preferred sized fish in the population. Walleye size structure is artificially high due to no stocking events between 2007 and 2010 along with seemingly poor survival of the 2004-2006 stocking events. This size structure is not sustainable and should reduce itself if the population were to grow through stocking. Northern pike size structure is extremely poor and appears to be negatively affected by overabundance of this species. The current northern pike population does not provide much angling opportunity and may be having negative impacts on other fish species.

Six panfish species were captured during the 2011 survey. Bluegill is the most abundant panfish species in Silver Lake. Pumpkinseed and rock bass also offer angling opportunities, but have much smaller populations than bluegill. Black crappie are relatively rare, but have excellent size structure offering a quality fishing opportunity. In general panfish have average to good growth rates, but lack preferred size fish. This suggests that angler harvest is limiting panfish potential of Silver Lake. A more restrictive regulation on all panfish would improve the quality of the panfish populations.

Only two non-game species were captured during our survey work. These species were yellow bullhead and white sucker. White sucker were not captured with any frequency suggesting low population levels, however some very large individuals were captured showing the ability to reach very good size. Yellow bullhead are very abundant, more abundant than all species except bluegill, and have good size structure. The combination of good size structure and abundance leads me to believe there is more biomass in the form of yellow bullheads than any other fish species in Silver Lake.

II. PAST MANAGEMENT AND SURVEYS

Known Stocking History:

Bluegill	- fingerlings, 3 of 4 years between 1937-40 - adults, 3 of 5 years between 1937-41
Bullhead	- fingerlings, 1941 - adults, 1937 & 1941
Hybrid Muskellunge	- sm. Fingerling, 1963
Largemouth Bass	- sm. Fingerling, 10 of 14 years 1937-50 - adults, 1937
Muskellunge	- sm. fingerlings, 1961-65, even years between 1966-70 & 2000
Muskellunge	- lg. fingerlings, 22 of 40 years between 1972-2011
Northern Pike	- fry, 1942
Northern Pike	- adults, 1937 & 1951-53
Smallmouth Bass	- fingerlings, 1942 & 1943
Walleye	- sm. fingerlings, 1993, 1996, 1999-2005 & 2011
Walleye	- lg. fingerlings, 1992-98, 2003 & 2005-06
Walleye	- adults, 1937
Yellow Perch	- fingerlings, odd years 1937-1941 - adults, 1939, 1941 & 2011

Past Management Activities:

- 1935-36 – 26 brush refuges, 130 sapling tangles, 72 “spawning boxes” and 650 “minnow spawners” were installed.
- 1951 – Lake reconnaissance, spawning area assessed.
- 6/9-12/1952 – General fish abundance survey (Bluegill and perch were most abundant fish).
- 1956 (L.F.) – Seining survey to look at northern pike and panfish (recommended to discontinue NP stocking because panfish size structure had not improved).
- 1958 - 18 “Jack Shelters” were put in place on Silver Lake
- 1961 - Public petitioned the state to stock muskellunge (muskellunge were stocked).
- 7/25/1961 (Burdick) – Summer electrofishing survey (recommended high numbers of muskellunge to control panfish population).
- 4/25-7/19/1967 (Theis) – Assessment of the gamefish populations (Found a good abundance of muskellunge but felt natural reproduction was not taking place. Assessed spawning areas for gamefish finding LMB and panfish to have the best spawning potential).
- 1969 – Public petitioned the state to stock walleye (walleye were not stocked until 1992).
- 5/6-9/18/1975 (Carlson) – Evaluation of muskellunge stocking and the status of the fishery (abundant/slow growing panfish population was found; recommended continuing muskellunge stocking at 1 fish/acre).
- 4/9-9/28/1998 (AveLallemant) – Comprehensive fisheries survey.
- 8/26/2005 (Young) – Mini fyke net survey (found natural reproduction of panfish, minnows, northern pike, largemouth bass and smallmouth bass).
- Fall Recruitment Surveys – Eight electrofishing surveys were conducted from 1975-2005 (found little evidence of natural reproduction of walleyes and poor survival of stocked walleyes).

III. METHODS

The survey began on 5/2/2011 when a WDNR standard, alternating current, electrofishing boat was used to sample adult gamefish along the entire shoreline of Silver Lake. The next day, 7 standard fyke nets (3/4" stretch mesh) were set in Silver Lake to sample muskellunge. These 7 nets were fished for 6 nights and pulled from the lake on 5/11/2011. Four more electrofishing surveys were conducted to sample northern pike, smallmouth and largemouth bass between 5/17 and 6/23. On 6/27, five standard fyke nets were set and fished for two days to analyze the relative abundance, size structure and growth of panfish populations. The 2011 survey culminated with an electrofishing survey on 9/19/2011 to assess gamefish recruitment. Fyke nets (6) were again set in Silver Lake on 3/31/2012 and fished from 4/1 to 4/15/2012 as part of a two year process to estimate the muskellunge population.

During the survey, length or length category (nearest half-inch), was recorded for all gamefish and panfish (6/21-23/2012). 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.

IV. RESULTS AND DISCUSSION

Catch Summary

Five gamefish, 6 panfish and 2 non-game fish species were captured during the 2011 survey of Silver Lake (Figure 1). There is more detailed information at the back of this report (Table 7, Appendix C).

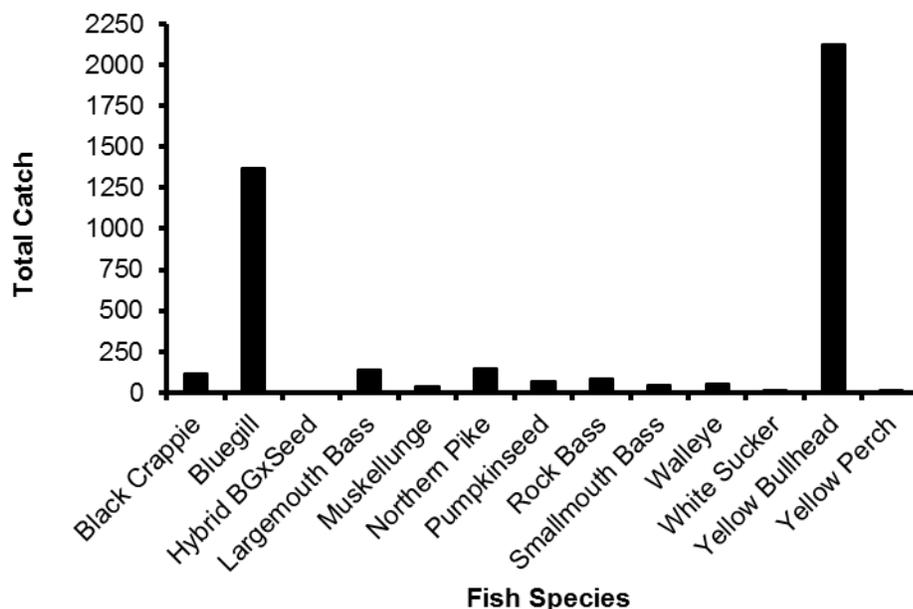


Figure 1. Fish species and number captured during a comprehensive survey of Silver Lake, Forest County, 2011.

Gamefish:

Northern Pike

Abundance

Northern pike were the most abundant game fish species captured during the 2011 and 2012 spring fyke net surveys (Table 1, Appendix C). This was surprising because we did not set our nets immediately after ice out, when pike are more likely to be in shallow, this left only a small portion of the population was vulnerable to our gear. The survey that best displays the current northern pike population is the spring electrofishing survey. During this electrofishing survey we captured 15.26 northern pike per mile electrofished (Table 5, Appendix C), this catch rate would have been even higher had northern pike been the target fish, instead of walleye. The same electrofishing survey was conducted during the last comprehensive survey of Silver Lake in 1998. The 2011 catch rate is nearly four times higher than the 4.21 pike per mile captured in 1998 (Table 6, Appendix C). Northern pike appear to be very abundant in Silver Lake and the most abundant gamefish present in the system.

Size Structure

A total of 139 northern pike ranging from 9.0 to 24.9 inches were measured for total length during the spring fyke netting and electrofishing surveys in 2011 (Figure 2). The average length of northern pike measured in 2011 was 19.6 inches, nearly four inches larger than the average length of 15.7 inches measured in 1998. The modal length of northern pike followed the same trend, increasing four inches from 15 inches in 1998 to 19 inches in 2011. Size structure, indexed using relative stock density (RSD), shows an increase in RSD21 since 1998 (Table 1). However, this slight increase is not representative of what is happening with the northern pike population. Since 1975 northern pike size structure has decreased in every category except for the relatively minor increase in RSD21 between 1998 and 2011. The current size structure of northern pike is incredibly poor and does little to increase the quality of fishing in Silver Lake.

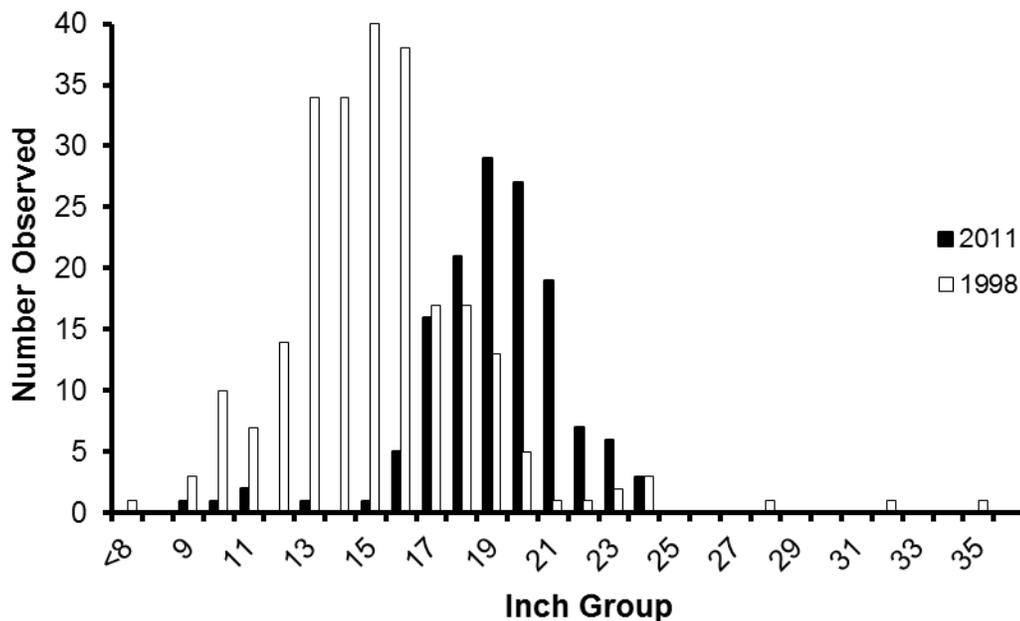


Figure 2. Length frequency of northern pike captured during spring surveys of Silver Lake, Forest County, during 2011 compared to 1998 (2011: N=139, 1998: N=243).

Table 1. Size structure, indexed using relative stock density, for northern pike captured during 2011 compared to previous surveys for Silver Lake, Forest County.

	2011	1998	1975	*1967
RSD21	26.12	5.75	77.27	80.00
RSD24	2.24	3.45	18.18	40.00
RSD28	0.00	1.72	13.64	0.00
RSD34	0.00	0.57	4.55	0.00
RSD40	0.00	0.00	0.00	0.00

*8 fish sample

Growth

Age was estimated by examining scales from a subsample of 45 northern pike captured during spring surveys of Silver Lake. Northern pike typically exhibit sexually dimorphic growth with females growing faster and larger than males. However, this was not seen in the Silver Lake population. Both male and female northern pike in Silver Lake have incredibly poor growth rates, much lower than the average for combined sex northern pike in the Northern Region of Wisconsin (Figure 3). Combining both sexes of fish gives an even clearer image of the unacceptable growth rates displayed by Silver Lake northern pike (Figure 4). Incredibly slow growth is normally indicative of an overabundance of northern pike, which increases competition for limited resources.

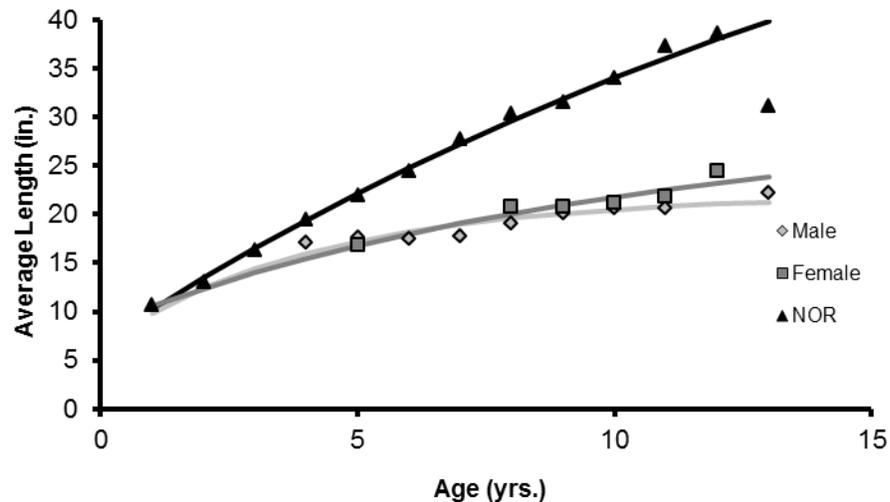


Figure 3. Average length at age for northern pike captured from Silver Lake during 2011 spring surveys, fit with von Bertalanffy growth curves and compared to the average length at age for both sexes combined in the Northern Region of WI (Male: N=36, Female: N=9).

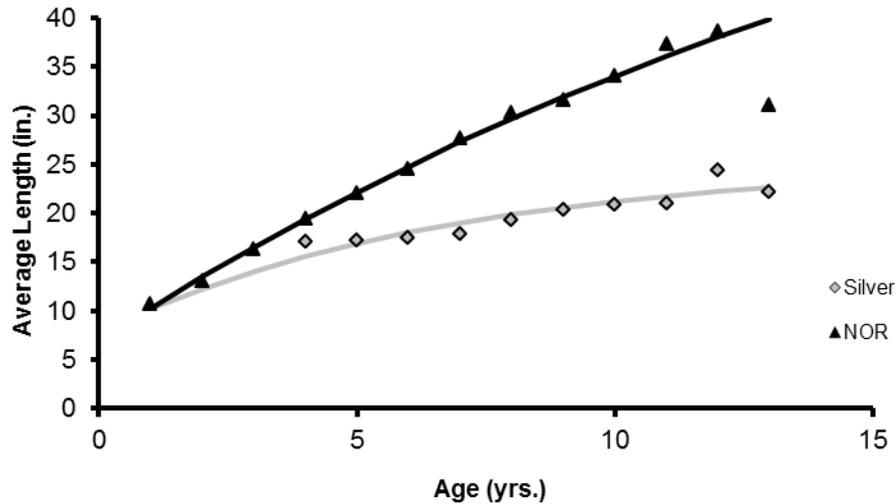


Figure 4. Average length at age for combined sex northern pike captured during spring surveys of Silver Lake during 2011, fit with von Bertalanffy growth curves and compared to the average length at age for combined sex northern pike in the Northern Region of WI (Male: N=36, Female: N=9).

Body Condition

A random sample of sexually mature male and female northern pike 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 71.9 and 87.9, averaging 83.8 (Figure 5). Female W_r was more variable with values ranging from 43.1 to 76.2, with an average of 69.5. Male northern pike had better body condition than female northern pike in Silver Lake. This may be due to the timing of the sample, which was taken a week or so after the peak spawning time for northern pike, leaving few sexable female northern pike for the sample, allowing one outlier to affect the average body condition more than normal. However, if you remove the outlying female from the sample the average female W_r is still 72.9, well below the standard of 100. Poor body condition is another indication of overabundance of northern pike in Silver Lake.

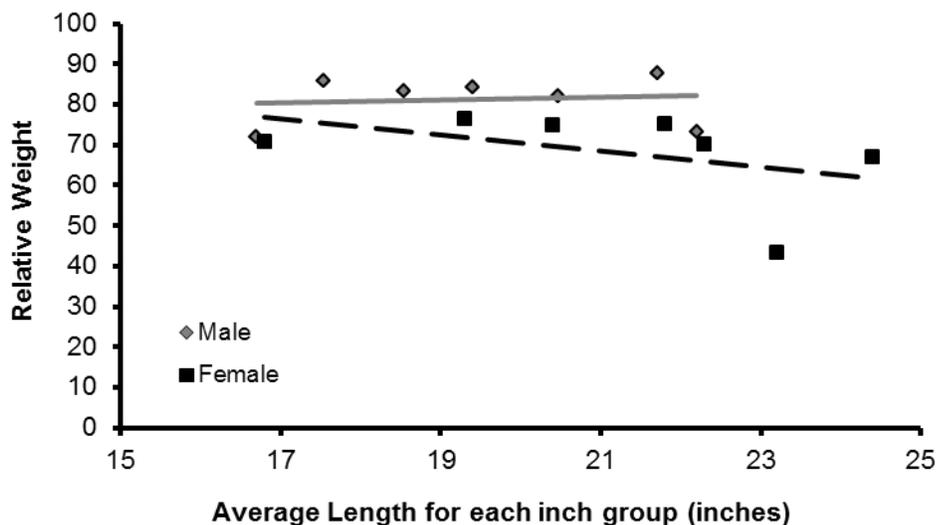


Figure 5. Average relative weight at length, measured from a sub sample of northern pike captured during spring surveys of Silver Lake, Forest County, 2011 (Male: N=38, Female: N=9)

Recruitment

During the fall electrofishing survey we collected all young-of-the year (YOY) gamefish. No YOY northern pike were observed, however, a good representation of ages 2 through 13 during all surveys conducted in 2011 along with a seemingly overabundant adult population leave no reason to be concerned over lack of natural reproduction (Table 1, Appendix B).

Walleye

Abundance

A walleye netting survey was not conducted during 2011; instead walleye abundance was indexed using a single electrofishing survey and walleye bi-catch data during the 2011-12 muskellunge survey. Walleye were the second most encountered gamefish species during our late spring fyke netting surveys in 2011 and 2012. However, catch rates of 1.08 and 0.67 fish per net-night, in 2011 and 2012 respectively, indicates a fairly small walleye population in Silver Lake (Table 1, Appendix C). An electrofishing survey on 5/2/2011 caught 10 walleyes over the entire length of shoreline at a rate of 2.63 fish per mile (Table 2). The 2011 walleye catch rate was approximately 18% lower than the last walleye electrofishing survey conducted in 1998. In 1998 the walleye population was estimated to be approximately 0.30 adults per acre. Based on the 2011 catch rate it is safe to assume the adult walleye population to be similar or slightly lower than it was in 1998. The current walleye population appears to be below our management goals for stocked walleye fisheries and proves that previous stocking efforts have not been very successful at establishing a fishable walleye population.

Table 2. Abundance of walleye, indexed by the number of estimated adults per acre and catch rate of adult fish per mile, in Silver Lake, Forest County.

	2011	1998
Adults/Acre	n/a	0.30
Adults/mi.	2.63	3.20

Size Structure

A total of 40 different walleyes were captured and measured during our spring electrofishing and muskellunge netting surveys in 2011. These fish ranged from 18.7 to 25.7 inches in length (Figure 6). The mean length of walleyes caught in spring fyke nets was 21.6 inches, 2.4 inches longer than the mean length of 19.2 inches measured in 1998. The modal size of 21 inches during 2011 was also larger than the 18 to 19 inch modal size documented in 1998. Increased mean and modal size of walleyes is expected in populations with decreasing abundance, like Silver Lake.

Size structure, indexed using relative stock density (RSD), is currently at the highest level documented on the Silver Lake for RSD15, RSD20 and RSD25 (Table 4). No fish were captured over 28 inches during the 2011 survey giving an RSD28 value of 0 indicating the current population has less trophy potential than previous survey years. Overall, the size structure of walleyes in Silver Lake is incredibly high and very attractive to anglers, creating a quality fishing opportunity. However, size structure is artificially high due to no stocking events between 2007 and 2010 along with seemingly poor survival of the 2004-2006 stocking events creating very few up and coming year classes of walleye, making this size structure unsustainable.

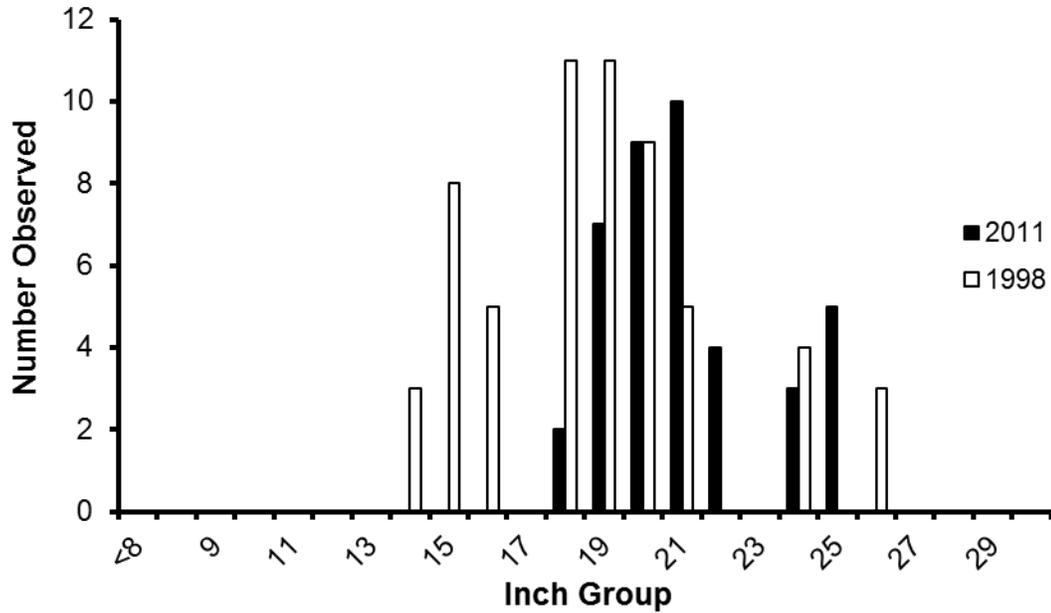


Figure 6. Length frequency of walleye captured during a spring fyke net survey of Silver Lake, Forest County, during 2011 compared to 1998 (2011: N=40, 1998: N=59).

Table 3. Size structure, indexed using relative stock density, for walleye captured during 2011 compared to previous surveys of Silver Lake, Forest County.

	2011	1998	1975
RSD15	100.00	94.92	97.14
RSD20	77.50	35.59	51.43
RSD25	12.50	5.08	5.71
RSD28	0.00	0.00	5.71
RSD30	0.00	0.00	0.00

Growth

Age was estimated by examining scales and spines from a subsample of 32 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 both male and female walleye was below the average growth for combined sex walleye in the Northern Region (NOR) of WI (Figure 7). No walleye were captured that were less than eight years old. The non-existence of these younger year classes make it impossible to look at early growth, but it appears that males reach the minimum size limit of 15 inches sometime during their fifth year, and females reach the minimum size by year four. By combining the sexes of walleyes a better comparison can be made to the previous surveys of Silver Lake and the NOR average (Figure 8). Combined sex walleye in Silver Lake show below average growth throughout their entire life. Growth rates calculated during 1998 showed growth rates much higher than the current population (Table 2, Appendix B). Typically low density walleye populations exhibit above average growth. However, in Silver Lake the majority of the population and our sample was composed of relatively slow growing males (only 5 females), which provides falsely low growth rates for the entire population.

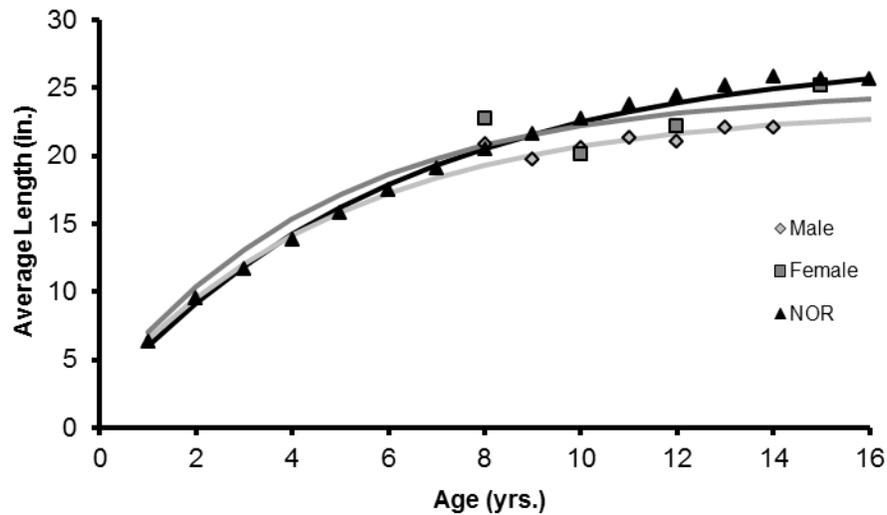


Figure 7. Average length at age for walleye captured from Silver Lake during 2011 spring surveys, fit with von Bertalanffy growth curves and compared to the average length at age for both sexes combined in the Northern Region of WI (Male: N=27, Female: N=5).

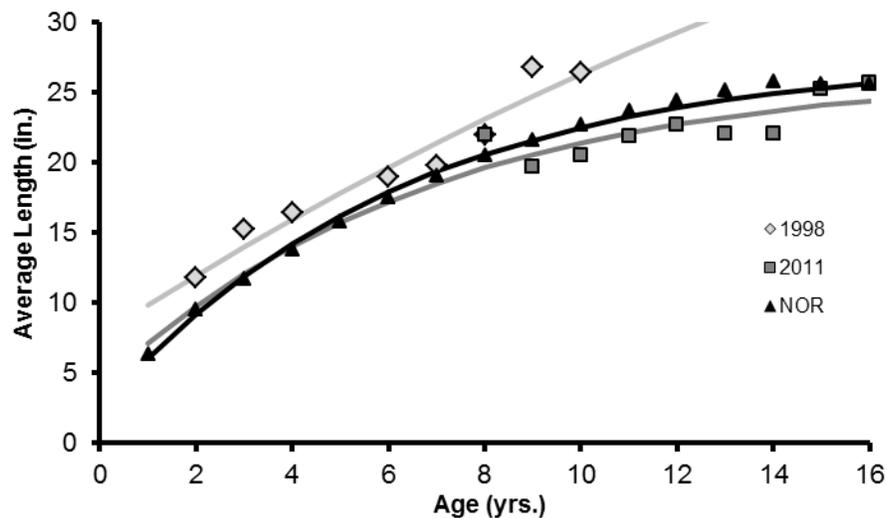


Figure 8. Average length at age for combined sex walleye captured from Silver Lake during 2011 spring surveys, fit with von Bertalanffy growth curves and compared to a 1998 survey and the average length at age for both sexes combined in the Northern Region of WI (2011: N=32, 1998: N=49).

Body Condition

A random sample of fish was weighed during our spring fyke netting survey to assess body condition of walleye in Silver Lake. Relative weight (W_r) was used to index body condition for both sexes of walleye. W_r of male walleye was steady ranging between 76.4 and 86.9 for individual inch groups, with an average of 84.7 (Figure 9). Female W_r was slightly more variable ranging from 86.3 to 98.0, averaging 93.8. Neither male nor female W_r had a significant correlation with total length. This suggests that conditions are similar, including the amount of metabolic energy used to capture each unit of forage, for male and female walleye as other sized individuals within their own sex. Like northern pike the W_r values are below the standard, however the W_r values for walleye, unlike northern pike, are very adequate for waters in Northern Wisconsin.

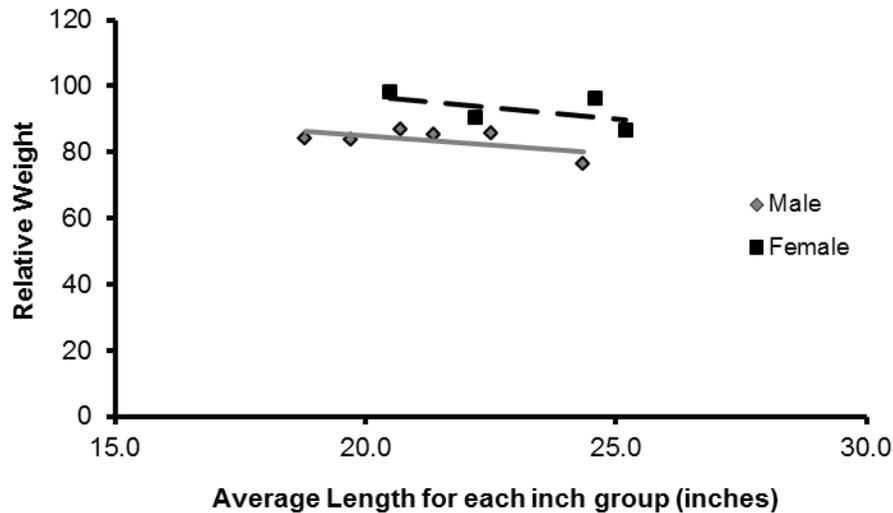


Figure 9. Average relative weight at length, measured from a sub sample of walleye captured during spring surveys of Silver Lake, Forest County, 2011 (Male: N=25, Female: N=5).

Recruitment

A gamefish recruitment survey was conducted on 9/19/2011. During this survey we captured 7 young-of-the-year (YOY) walleyes, a catch rate of 1.89 YOY walleyes/mile, these fish were 6.3 to 7.0 inches in length. All of these fish were sacrificed and sent to our lab for OTC analysis. The analysis showed that all of these fish were from the 2011 stocking of small fingerling walleye which occurred in June. This survey, along with eight other surveys conducted from 1975 to 2005 confirm that natural reproduction of walleyes in the Silver Lake is nearly non-existent and certainly not high enough to maintain a population without stocking (Table 4).

Table 4. Recruitment of walleyes, indexed by catch per mile of age-0 walleyes during fall electrofishing surveys, in Silver Lake, Forest County, 1975-2011.

	*2011	*2005	*2000	1998	*1997	*1996	1995	1994	1975
Age 0/mi.	1.89	0.26	0.00	0.30	0.00	0.00	0.30	0.00	0.00

*Stocked years

Largemouth Bass

Abundance

Early spring electrofishing along with four other spring electrofishing surveys were conducted to estimate the largemouth bass population of Silver Lake, during these surveys we captured 118 different largemouth bass (Table 3, Appendix A). The largemouth bass catch rate during spring surveys was approximately 62% lower than that measured in 1998 (Table 5). However, the data collected during our mark-recapture survey estimated the largemouth bass population to be approximately 472 fish \geq 8.0 inches (1.48/acre) within Silver Lake, a decrease of only 33%. At only 1.5 adult bass per acre Silver Lake has a low density of largemouth bass.

Table 5. Abundance of largemouth bass, indexed using population estimation and catch rate, in Silver Lake, Forest County, in 2011 compared to a previous survey conducted in 1998.

	2011	1998
Adults/Acre	1.48	2.20
Adults/mi.	7.68	20.09

Size Structure

During 2011 we sampled a total of 118 different largemouth bass up to 18.9 inches in total length (Figure 10). The average length of largemouth bass captured during 2011 was 13.5 inches, nearly two inches larger than the average size of 11.6 inches in 1998. In 2011, the majority of the bass sampled (67.8%) were between 12.0 and 15.9 inches showing that the bulk of the fish present during 2011 are substantially larger than in 1998 when 79% of the catch was between 10.0 and 12.9 inches.

Size structure, indexed using relative stock density (RSD), has vastly increased since 1998 (Table 6). At present, approximately 82% of the stock length largemouth bass are larger than 12.0 inches, 24% ≥ 15.0 inches and nearly 2% ≥ 18.0 inches in length. The current size structured is very acceptable and should become the size structure goals for this population going forward.

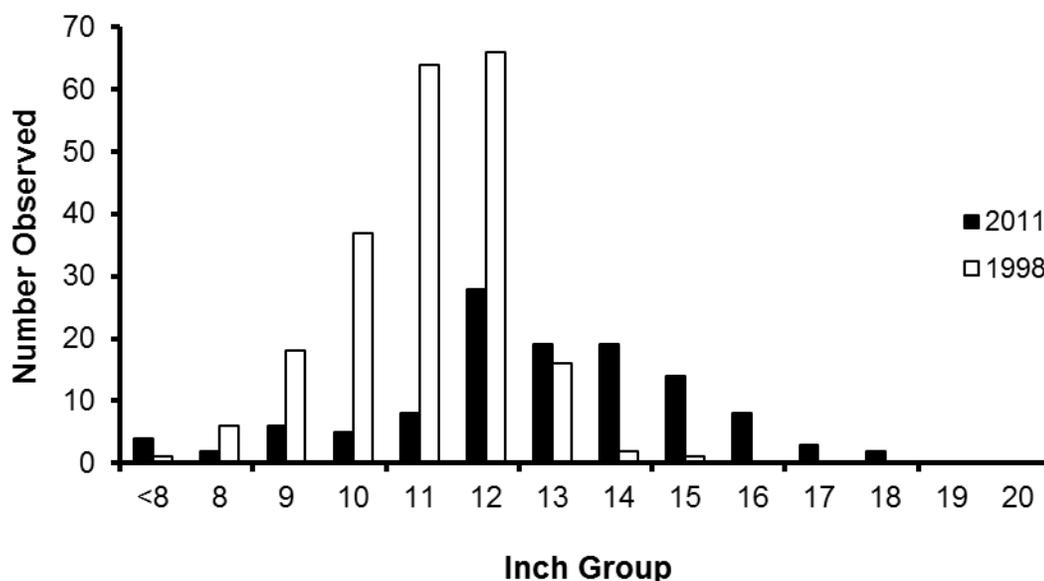


Figure 10. Length frequency of largemouth bass captured during spring electrofishing surveys of Silver Lake, Forest County, in 2011 compared to 1998 (2011: N=118; 1998: N=211).

Table 6. Size structure, indexed using relative stock density, for largemouth bass captured during 2011 compared to previous surveys of Silver Lake, Forest County.

	2011	1998	*1967
RSD12	81.58	40.48	100.00
RSD15	23.68	0.48	100.00
RSD18	1.75	0.00	18.18
RSD20	0.00	0.00	0.00

*11 fish sample

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. Scales were collected from a subsample of 86 largemouth bass to estimate age. Growth was then inferred using average length at age and compared to the average for the Northern Region (NOR) of Wisconsin (Figure 11). Silver Lake largemouth bass exhibited slightly above average growth until age 3 and below average growth beyond age 4 when compared to other populations in the NOR of Wisconsin (Table 4, Appendix B). Growth of Silver Lake bass has increased since the last survey in 1998. On average it takes largemouth bass in Silver Lake just over 6 years to reach the minimum size limit of 14 inches.

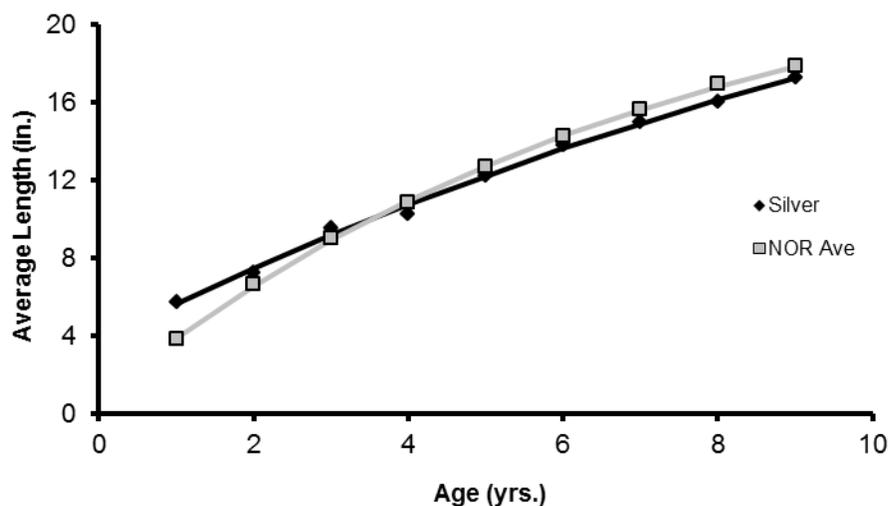


Figure 11. Average length at age for largemouth bass captured from Silver Lake during 2011 spring surveys, fit with von Bertalanffy growth curves and compared to the average length at age for the Northern Region of WI (2011: N=86).

Body Condition

A total of 75 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 88.1 to 111.1, with an average value of 98.4 (Figure 12). This average is very close to the target average of 100 showing that bass have good body condition in Silver Lake. However, there is a statistically significant negative correlation between W_r and body length ($p=0.0004$). This suggests that conditions decrease for largemouth bass as they increase their body length in Silver Lake, the likely problem is a lack of forage or habitat for larger individuals.

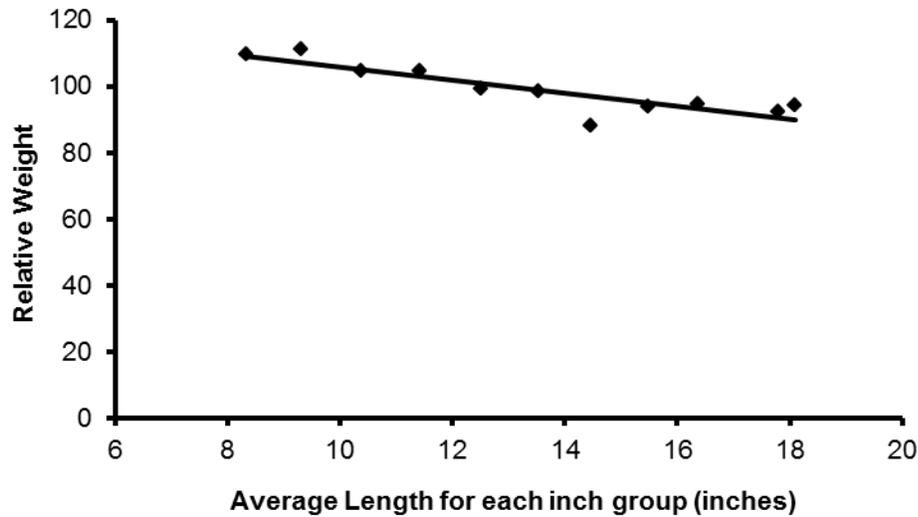


Figure 12. Average relative weight at length, measured from a sub sample of largemouth bass captured during spring surveys of Silver Lake, Forest County, 2011 (N=75).

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 10 (age-0 and 1) largemouth bass ranging from 5.0-7.9 inches in length during our recruitment survey. This small sample of juvenile bass captured along with the presence of all year classes age 1-9 during our survey, with no documented stocking of largemouth bass since 1950, suggests the population is capable of sustaining itself at or near the current level.

Smallmouth Bass

Abundance

Only 33 different smallmouth bass were captured during our spring electrofishing surveys in 2011 (Table 4, Appendix A). Smallmouth bass were the least abundant gamefish species captured during the 2011 and 2012 spring fyke net surveys (Table 1, Appendix C). Even the low catch rate of just over 2 fish per mile made smallmouth bass the 2nd most abundant fish species during our spring electrofishing surveys (Table 7). This low catch rate prevented us from being able to estimate the abundance of the population. After comparing the 2011 catch rate to the last major bass survey in 1998 all indications point to a reduction in smallmouth bass abundance from the 0.5 adults/acre estimated in 1998; this puts smallmouth bass abundance near that of walleye.

Table 7. Abundance of smallmouth bass, indexed using population estimation and catch rate, in Silver Lake, Forest County, during 2011 compared to a previous survey conducted in 1998.

	2011	1998
Adults/Acre	n/a	0.50
Adults/mi.	2.24	4.56

Size Structure

The 33 different smallmouth bass captured during 2011 surveys ranged in size from 5.0 to 20.0 inches in length (Figure 13). The mean length of smallmouth bass captured during spring surveys was 14.9 inches, three inches larger than the 1998 average, with a very impressive mode of 17 inches. Size structure, indexed using relative stock density (RSD), has improved tremendously since 1998 (Table 8). The current size structure is very good with nearly 37% of the stock length fish being ≥ 17.0 inches and over 3% of trophy length (≥ 20.0 in.).

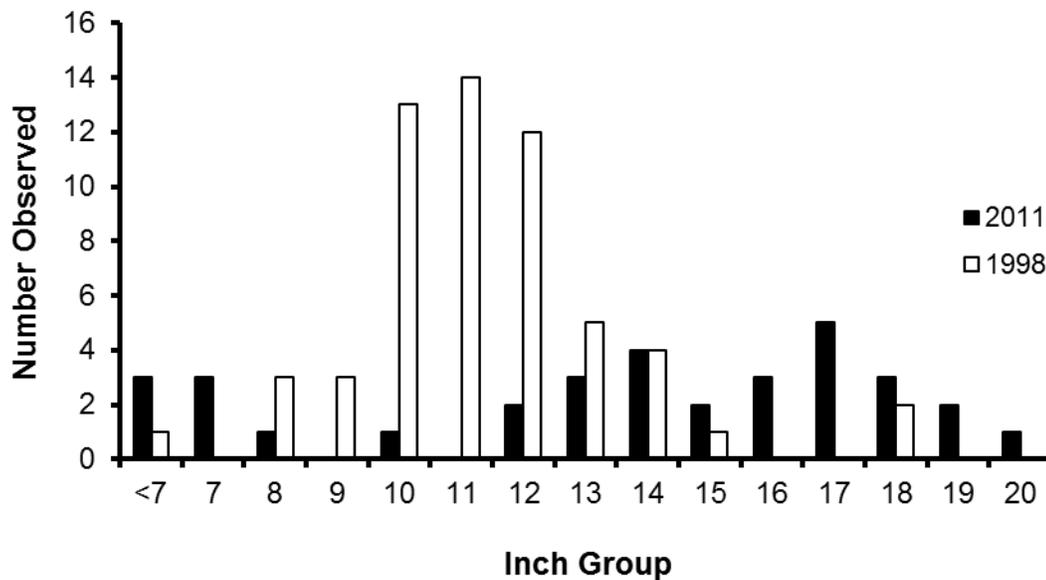


Figure 13. Length frequency of smallmouth bass captured during spring electrofishing surveys of Silver Lake, Forest County, in 2011 compared to 1998 (2011: N=33; 1998: N=57).

Table 8. Size structure, indexed using relative stock density, for smallmouth bass captured during 2011 compared to a previous survey of Silver Lake, Forest County (2011: N=33; 1998: N=57).

	2011	1998
RSD11:	83.33	66.67
RSD14:	66.67	12.28
RSD17:	36.67	3.51
RSD20:	3.33	0.00

Growth

Growth was indexed using average length at age from a subsample of 28 smallmouth bass during the 2011 survey (Figure 14). Silver Lake smallmouth bass showed growth that was nearly identical to the Northern Region average, and much higher than the growth rates measured in 1998 (Table 3, Appendix B).

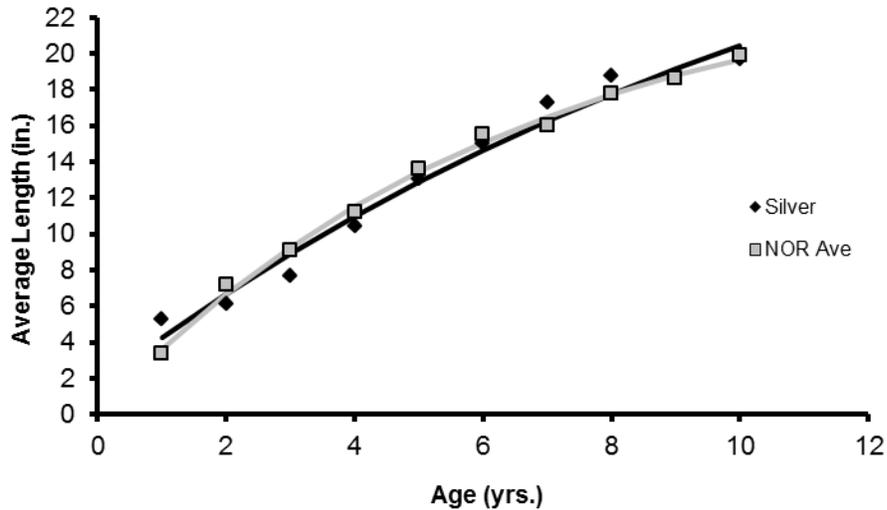


Figure 14. Average length at age for smallmouth bass captured from Silver Lake during 2011 spring surveys, fit with von Bertalanffy growth curves and compared to the average length at age for the Northern Region of WI (2011: N=28).

Body Condition

During our sampling efforts we obtained weight measurements from 27 of the 33 smallmouth captured. Relative weight (W_r) was used to index body condition of smallmouth bass. W_r values for both sexes combined ranged from 79.8 to 109.6, with an average of 91.7 (Figure 15). These are acceptable values of W_r for smallmouth bass in our northern climate. Except for the relatively good body condition of fish between 12 and 14 inches; body condition was extremely steady averaging approximately 88.

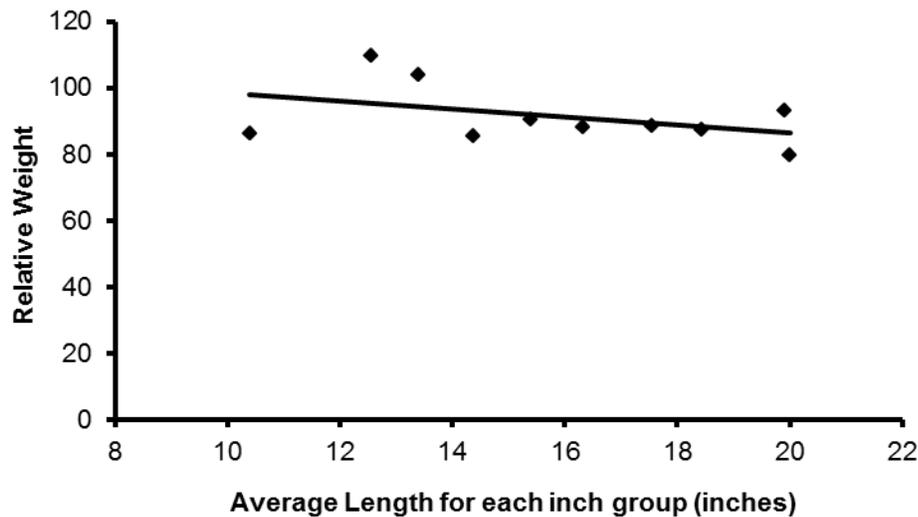


Figure 15. Average relative weight at length, measured from a sub sample of smallmouth bass captured during spring surveys of Silver Lake, Forest County, 2011 (N=27).

Recruitment

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

Muskellunge

Abundance

Muskellunge abundance was assessed using a two year mark-recapture process. A total of 34 muskellunge were marked during the 2011 survey. Nets were set again in 2012; during 2012 a total of 26 muskellunge were captured, 10 of which were recaptured fish from 2011. After analyzing the data I estimate there to be approximately 32 adult muskellunge (≥ 30.0 inches) in Silver Lake (0.10 fish/acre). This is a low density of muskellunge, but it is a fishable population with potential for trophy sized fish. I estimate there to be approximately 42 fish (20.0-29.9 inches) in the system currently. The majority of these fish should survive to add to the adult population within the next few years.

Size Structure

During the 2011 comprehensive survey a total of 36 muskies were captured ranging from 15.4 to 46.8 inches in length with an average length of 33.3 inches (Table 9). In 2012, a total of 26 muskies were captured during the recapture survey ranging from 10.2 to 49.0 inches in length, with an average length of 36.2 inches. A total of 52 different muskellunge were measured over the two year survey (Figure 16 & Table 5, Appendix A). Size structure, indexed using relative stock density (RSD), is very good in Silver Lake. In fact, RSD values of all size classes above RSD35 were at an all-time high in 2012 (Table 10). The 2011 and 2012 muskellunge netting surveys revealed a high percentage of muskellunge ≥ 40.0 inches; creating a great quality muskellunge angling opportunity. This type of size structure is likely only possible at low adult densities.

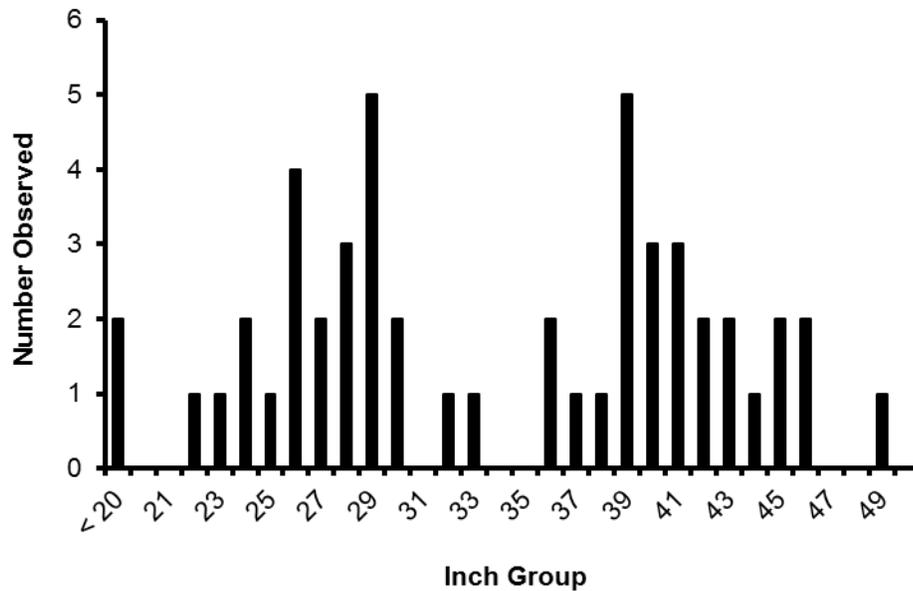


Figure 16. Length frequency of muskellunge captured during surveys of Silver Lake, Forest County, 2011-2012 (N=52 (unmarked fish only)).

Table 9. Average and median length of muskellunge by sex that were captured during surveys of Silver Lake, Forest County, 2011-2012 (2011: N=36, 2012: N=26).

	2011			2012		
	Male	Female	All Fish	Male	Female	All Fish
Mean Length	33.01	40.98	33.28	34.95	42.59	36.20
Median Length	30.00	40.50	31.90	31.40	42.80	39.10

Table 10. Size structure, indexed using relative stock density, for muskellunge captured from Silver Lake, Forest County, in 2011-2012 and compared to previous surveys.

	2012	2011	1998	1975	1967
RSD30	79.17	55.88	77.78	82.35	57.69
RSD35	66.67	50.00	66.67	52.94	19.23
RSD40	50.00	29.41	44.44	11.76	0.00
RSD45	20.83	2.94	11.11	0.00	0.00
RSD48	4.17	0.00	0.00	0.00	0.00
RSD50	0.00	0.00	0.00	0.00	0.00

*Introduced in 1961

Growth

Age was estimated by examining scales and anal rays from all muskellunge captured during 2011 and 2012. Muskellunge in Silver Lake exhibited sexually dimorphic growth with females growing faster and larger than males, especially beyond age 5 (Figure 17). In fact, females reach 40 inches at some point during their 7th year while males take approximately 10 years to reach the minimum size limit of 40 inches (Table 5, Appendix B). This muskellunge population is showing impressive growth rates, with both male and female muskellunge well above the average for combined sex muskellunge in the Northern Region of Wisconsin (NOR), until age 10. After age 10, male muskellunge grow slower than the average for combined sex fish in the NOR, while females continue to grow at higher rates.

The largest fish captured during the two year survey was 49.0 inches and was estimated to be an impressive 25 years old. This was the only female in the sample estimated to be over 15 years of age, because of the small sample of older females this single fish has a lot of influence on the growth curve, essentially showing slower growth than the NOR average beyond age 18. This extremely small sample of female muskellunge over age 15 may not be indicative of the actual growth of older female fish in Silver Lake.

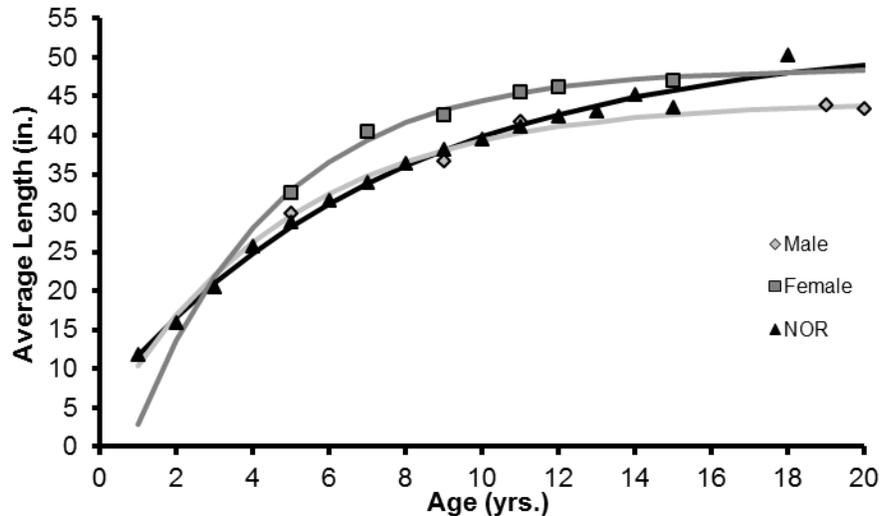


Figure 17. Average length at age for muskellunge captured during 2011-12 spring surveys of Silver Lake, fit with von Bertalanffy growth curves and compared to the average length at age for the Northern Region of WI (Male: N=28, Female: N=17).

By combining the sexes we can make a better comparison to the NOR average (Figure 18). Combined sex muskellunge in Silver Lake have fast growth rates. Muskellunge are reaching an average of 39.9 inches by age 8, nearly 10% longer than the average of 36.4 inches. The same trend is seen in the older fish in Silver Lake; 12 year old fish average 44.6 inches which is more than 5% longer than the average of 42.3 inches in the NOR.

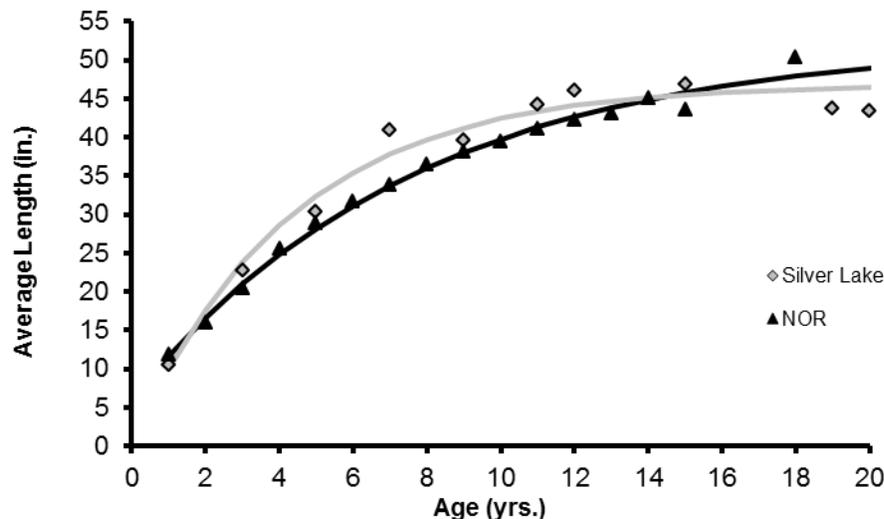


Figure 18. Average length at age for combined sex muskellunge captured during 2011-12 spring surveys of Silver Lake, fit with von Bertalanffy growth curves and compared to the average length at age for the Northern Region of WI (N=45).

Body Condition

Weight measurements were taken from 35 of 36 muskellunge in 2011 and 23 of 26 captured in 2012. Body condition was then indexed using relative weight (W_r) for known and unknown sex muskellunge. W_r of male muskellunge ranged from 64.0 to 89.1 with an average of 75.9, while females ranged from 79.5 to 95.0 with an average of 85.4 during 2011 (Figure 19).

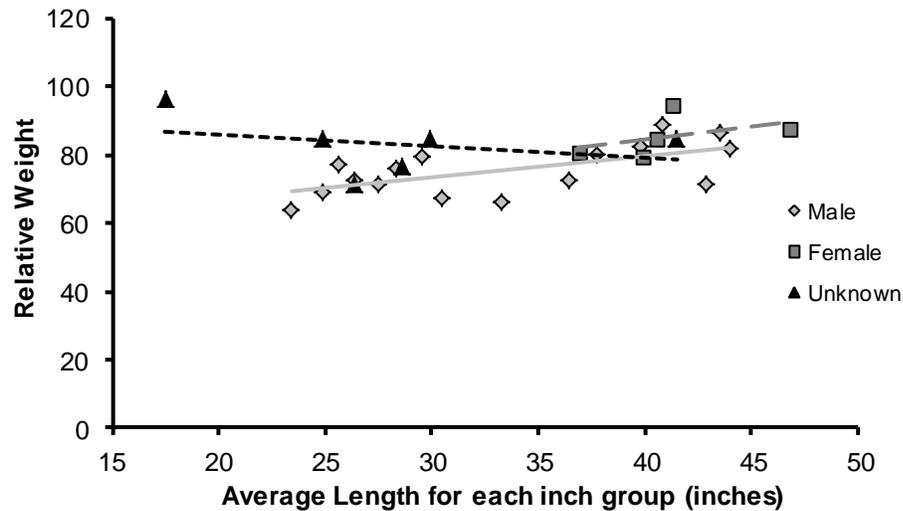


Figure 19. Average relative weight at length, measured from a sub sample of muskellunge captured during spring surveys of Silver Lake, Forest County, 2011 (Male: N=22, Female: N=6, Unknown: N=7).

The same process was used to index body condition during the muskellunge recapture survey in 2012, showing very similar results. W_r for males ranged from 68.3 to 93.0 with an average of 77.3; females ranged from 75.2 to 96.0 with an average of 79.0 (Figure 20). Body condition was expected to stay similar from one year to the next since it normally takes a change in the fish community to trigger a response in body condition.

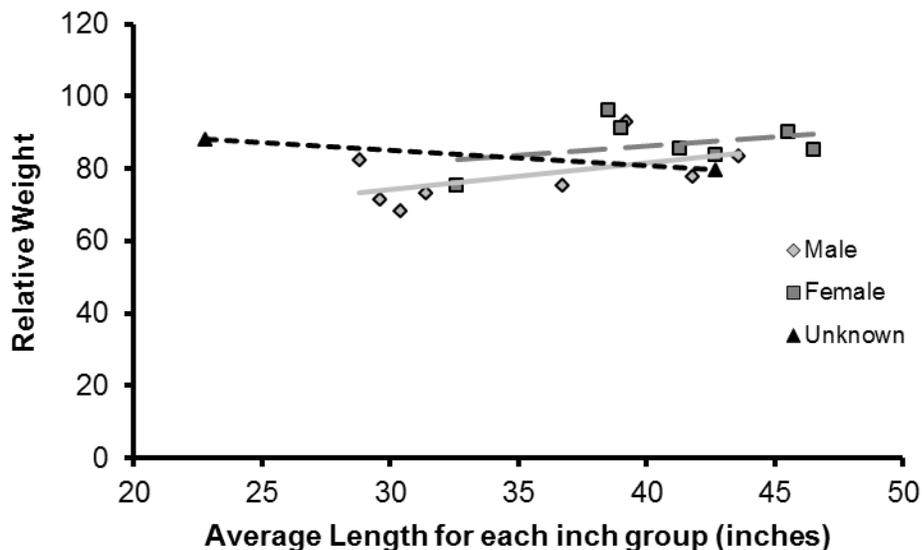


Figure 20. Average relative weight at length, measured from a sub sample of muskellunge captured during a spring fyke net survey of Silver Lake, Forest County, 2012 (Male: N=11, Female: N=10, Unknown: N=2).

In both 2011 and 2012 there was an increasing trend in body condition with total length for male and female muskellunge and a decreasing trend for fish of unknown sex. This correlation was only statistically significant for male muskellunge captured during 2011 ($p=0.009$, $R^2=0.40$). The 2011 male sample was the largest of a given sex in a single survey, indicating that sample size could be the cause for the insignificant trends in other single year samples. After combining all the fish captured during the two year survey and running the same analysis a significant positive correlation is seen for males ($p=0.003$, $R^2=0.42$), but the correlation for females was not statistically significant ($p=0.18$, $R^2=0.24$). Even though body condition of females is not statistically correlated to body length there is a clear trend of increasing body condition as a fish grows longer which suggests that conditions are better for larger fish than smaller fish, and is an indicator that Silver Lake may have the ability to produce trophy sized muskellunge.

Recruitment

A single Age-0 muskellunge was captured during our gamefish recruitment survey in 2011. Two more Age-1 muskellunge were captured during our netting survey in 2012. These juvenile fish are likely a product of the 2011 stocking of large fingerling muskellunge. All fish aged from 2011 and 2012 could all be traced back to a year of a muskellunge stocking event, indicating that natural reproduction of muskellunge does not occur in Silver Lake.

Panfish:

Bluegill

Relative Abundance

Bluegill was the most abundant panfish species during summer fyke netting with a total of 1,321 fish captured (110.1 fish/net lift). This is an above average catch rate for our area, over three times higher than the catch rate measured in 1998 (Table 4, Appendix C).

Size Structure

A random sample of 282 bluegill was measured during our summer panfish survey. These fish ranged from 3.4 to 9.2 inches in length with a modal length of 4 inches (Figure 21). Size structure was indexed using relative stock density (RSD), which showed very poor size structure with RSD6 and RSD8 values of 11.0 and 2.1 respectively. The RSD6 value is substantially less than previously documented bluegill size structure in Silver Lake (Table 11). Panfish size structure has always been the main fisheries concern in Silver Lake and has been the reason for most management actions historically.

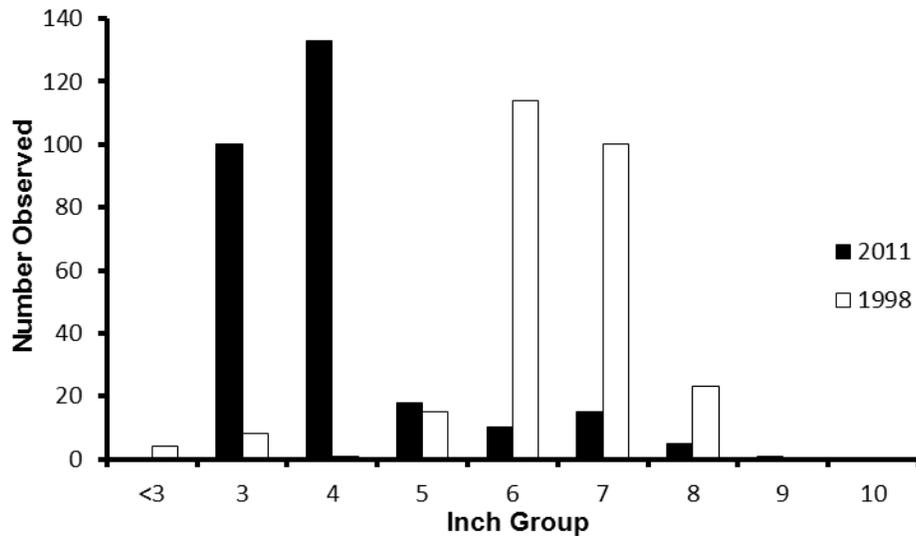


Figure 21. Length frequency for a subsample of bluegill captured during a summer fyke net survey of Silver Lake, Forest County, during 2011 compared to the same survey in 1998 (2011: N=282; 1998: N=265).

Table 11. Size structure, indexed using relative stock density, for a subsample of bluegill captured during 2011 compared to previous surveys of Silver Lake, Forest County.

	2011	1998	1975	*1967	1952
RSD6	10.99	90.80	50.00	17.96	64.29
RSD7	7.45	47.13	4.88	1.06	58.93
RSD8	2.13	8.81	0.00	0.00	32.14
RSD9	0.35	0.00	0.00	0.00	0.00
RSD10	0.00	0.00	0.00	0.00	0.00

*Spring Sample

Growth

Scales were removed from a sample of 49 bluegill to estimate age. Growth was then indexed using average length at age. Bluegills in Silver Lake showed average to above average growth when compared to the Northern Region of Wisconsin (Figure 22). On average it takes a bluegill 6 years to achieve 7.5 inches in length (Table 6, Appendix B).

During previous surveys of Silver Lake it was concluded that poor bluegill size structure was a result of low growth rates caused by bluegill overabundance. This is no longer the case. The current bluegill size structure is not a product of the inability of fish to grow to quality size quickly, since bluegills grow at a very acceptable rate in Silver Lake.

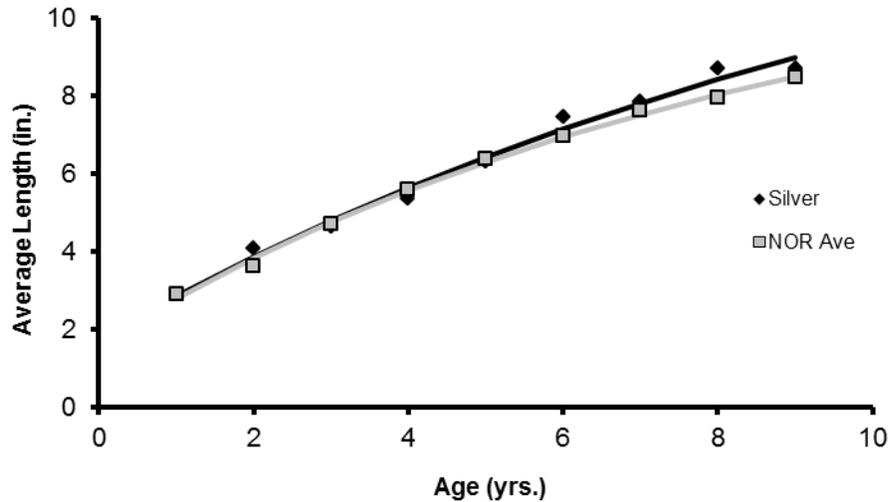


Figure 22. Average length at age for a subsample of bluegill captured during a 2011 summer fyke net survey of Silver Lake, fit with von Bertalanffy growth curves and compared to the average length at age for the Northern Region of WI (N=49).

Pumpkinseed

Relative Abundance

Pumpkinseed was the second most abundant panfish species during summer fyke netting with a total of 62 fish captured (5.33 fish/net lift). Just like bluegill, the pumpkinseed catch rate is much higher than the last survey in 1998 (Table 4, Appendix C).

Size Structure

The 62 pumpkinseeds that were captured during summer netting ranged from 3.8 to 7.6 inches in length (Figure 23). While abundance of pumpkinseed has gone up in Silver Lake, size structure has decreased; this is due to young fish entering the population and not a cause for concern (Table 12).

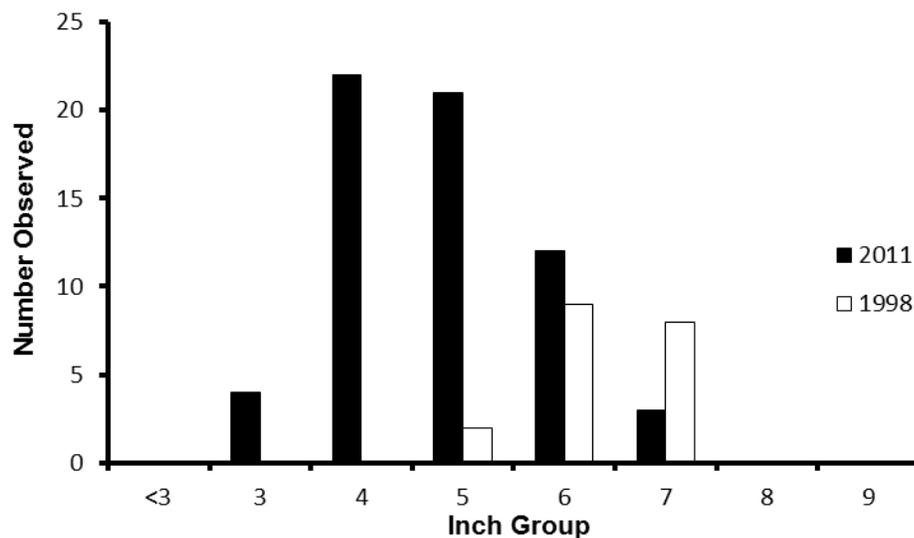


Figure 23. Length frequency for a subsample of pumpkinseed captured during a summer fyke net survey of Silver Lake, Forest County, in 2011 compared to 1998 (2011: N=62; 1998: N=19).

Table 12. Size structure, indexed using relative stock density, for pumpkinseed captured during 2011 compared to previous surveys of Silver Lake, Forest County.

	2011	1998	1975	1952
RSD6	24.19	89.47	0.00	23.53
RSD7	4.84	42.11	0.00	17.65
RSD8	0.00	0.00	0.00	0.00

Growth

Pumpkinseed in Silver Lake grow slower than the state average through their first 4 years of life and display above average growth beyond age 5 (Figure 24).

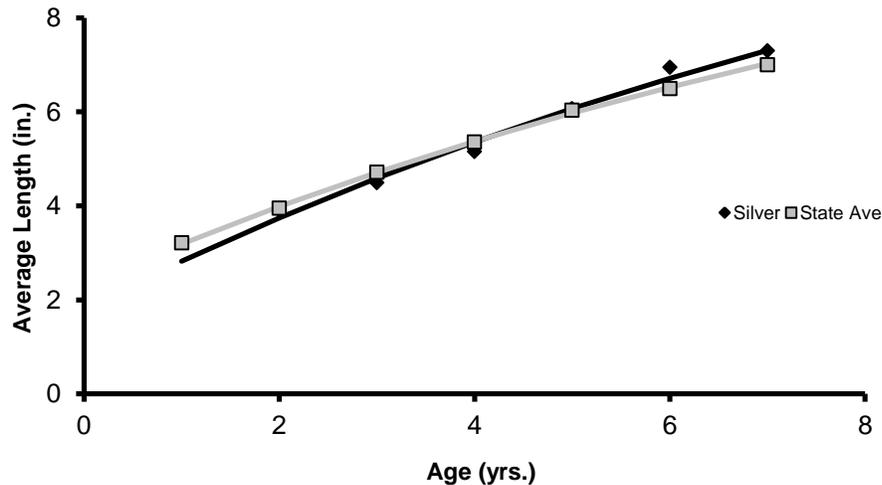


Figure 24. Average length at age for a subsample of pumpkinseed captured during a 2011 summer fyke net survey of Silver Lake, fit with von Bertalanffy growth curves and compared to the state average (N=36).

Rock Bass

Relative Abundance

Rock bass were less abundant than bluegill and pumpkinseed during our summer survey. A total of 35 rock bass (3.17 fish/net lift) were captured in 2011. This is a slight decrease in abundance compared to the 1998 survey of Silver Lake (Table 4, Appendix C).

Size Structure

A sample of 35 rock bass ranging in size from 3.8 to 9.5 inches, with a modal length of 7 inches were measured during 2011 (Figure 25). This was the first measured decline in size structure since the initial survey in 1952 (Table 13). However, Silver Lake still displays a good size structure of rock bass.

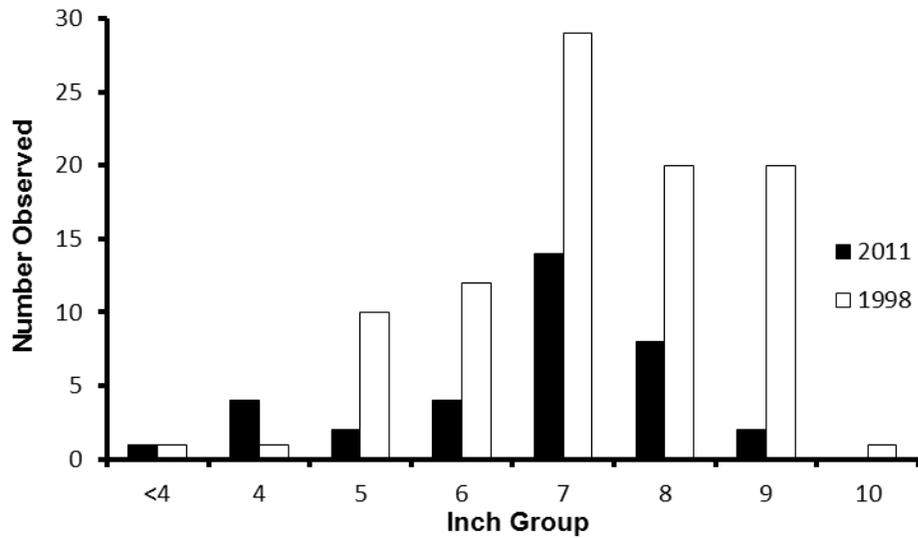


Figure 25. Length frequency of all rock bass captured during a summer fyke net survey of Silver Lake, Forest County, in 2011 compared to 1998 (2011: N=35; 1998: N=94).

Table 13. Size structure, indexed using relative stock density, for rock bass captured during 2011 compared to previous surveys of Silver Lake, Forest County.

	2011	1998	1975	*1967	1952
RSD7	70.59	75.27	34.14	22.22	13.73
RSD8	29.41	44.09	9.76	5.56	1.96
RSD9	5.88	22.58	0.00	1.85	0.00
RSD10	0.00	1.08	0.00	0.00	0.00

*Spring Sample

Growth

After analyzing scale samples from 29 rock bass to estimate age we determined rock bass growth to be slightly above the state average (Figure 26). This growth rate is acceptable with fish reaching 8 inches by age 6 (Table 9, Appendix B).

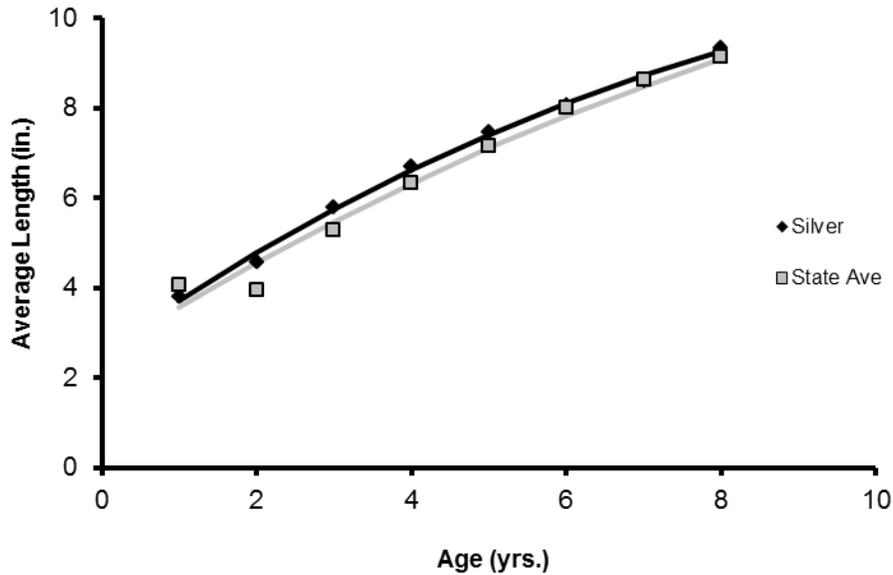


Figure 26. Average length at age for a subsample of rock bass captured during a 2011 summer fyke net survey of Silver Lake, fit with von Bertalanffy growth curves and compared to the state average (N=29).

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. Yellow perch were witnessed in higher numbers during our spring surveys (Table 2, Appendix C); however, they still appear to be a minor portion of the panfish population. A large year class of age-0 yellow perch was also observed during bass electrofishing surveys. This is a good sign for the future of the yellow perch population in Silver Lake.

Size Structure

Yellow perch were not measured during the 2011 survey of Silver Lake. By analyzing data from previous surveys it appears that Silver Lake has always had quite poor size structure of yellow perch (Figure 27, Table 14). It is my belief that it would take a significant change in the fishery to establish any type of desirable yellow perch fishery.

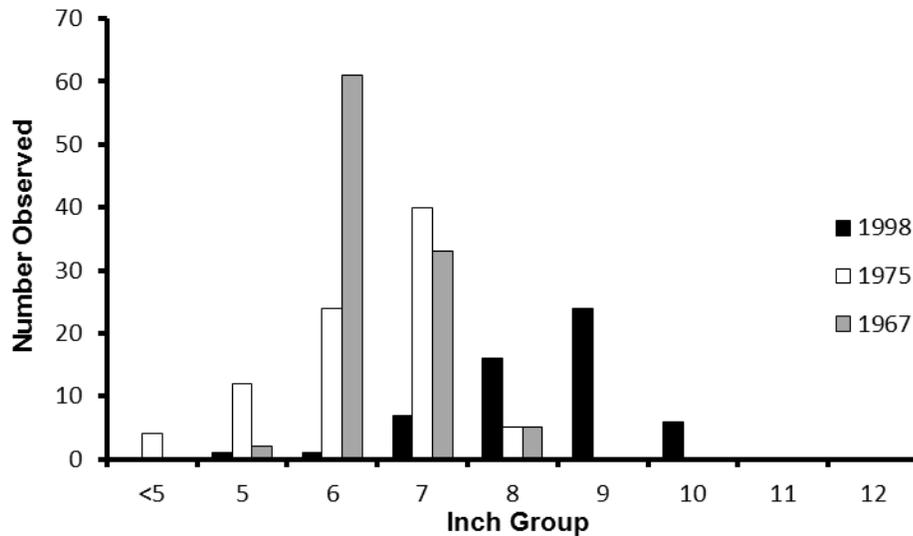


Figure 27. Length frequency of all yellow perch measured during previous spring fyke net surveys of Silver Lake, Forest County.

Table 14. Size structure, indexed using relative stock density, for yellow perch captured during previous surveys of Silver Lake, Forest County.

	1998	1975	1967	1952
RSD8	83.64	6.17	4.95	17.65
RSD10	10.91	0.00	0.00	0.00
RSD12	0.00	0.00	0.00	0.00

Black Crappie

Relative Abundance

Only 13 black crappie (1.0 fish/net-lift) were captured during summer panfish netting. This was similar to the summer catch rate during the 1998 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 seen during other portions of our 2011 survey and appear to make up a very small portion of the panfish population (Table 2, Appendix C).

Size Structure

A random sample of 38 fish captured during spring fyke netting and all 13 fish captured during the summer survey were measured, making a total of 51 fish used to analyze size structure. These fish ranged from 7.5 to 14.4 inches in length (Figure 28). Black crappie in Silver Lake show good size structure with nearly 90% ≥ 8.0 inches and over 31% ≥ 10.0 inches. This current size structure is better than it was during the last three surveys of Silver Lake (Table 15).

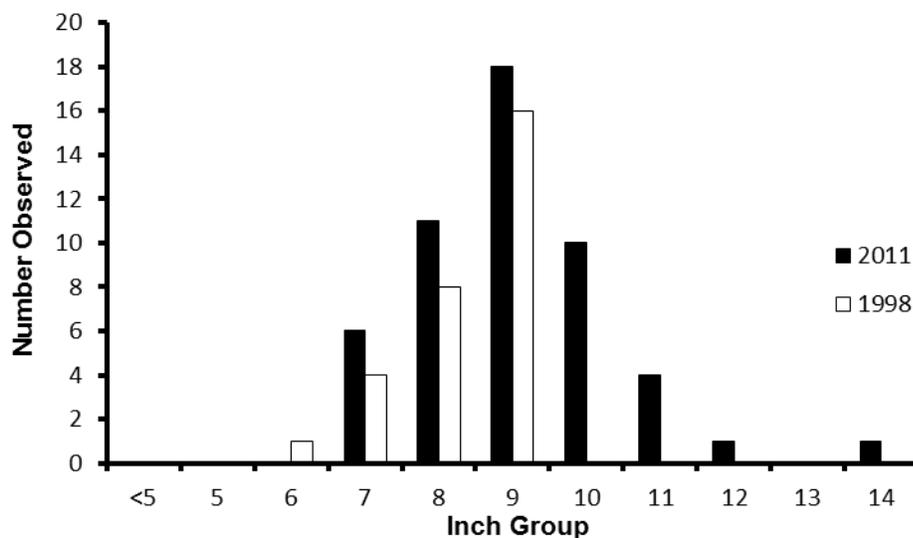


Figure 28. Length frequency for a subsample of black crappie captured during fyke netting surveys of Silver Lake, Forest County, in 2011 compared to 1998 (2011: N=51; 1998: N=29).

Table 15. Size structure, indexed using relative stock density, for black crappie captured during 2011 compared to previous surveys of Silver Lake, Forest County.

	*2011	1998	*1975	*1967
RSD8	88.24	82.76	12.90	20.00
RSD10	31.37	0.00	12.90	7.50
RSD12	3.92	0.00	9.68	0.00
RSD14	1.96	0.00	0.00	0.00

*Spring Sample Included

Growth

Black crappie growth, indexed using average length at age, was very similar to the Northern Region of Wisconsin (NOR) average. Growth begins to be slightly above average beyond age 5, this is a very acceptable growth rate and is without a doubt one of the reasons for the impressive size structure in Silver Lake (Figure 29). On average it takes about 4 years for a Silver Lake black crappie to reach 8 inches in length and 6 years to reach 10 inches (Table 8, Appendix B).

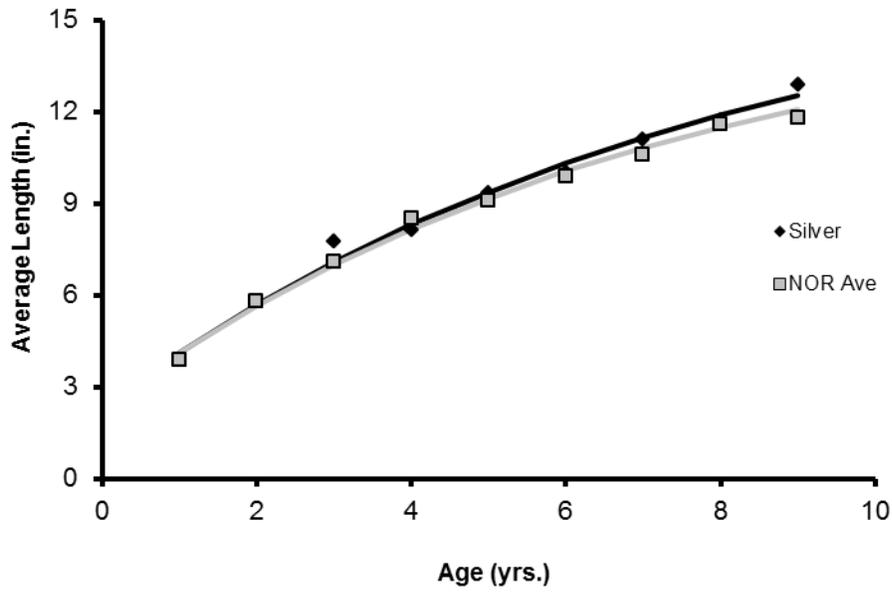


Figure 29. Average length at age for a subsample of black crappie captured during 2011 spring surveys of Silver Lake, fit with von Bertalanffy growth curves and compared to the average length at age for the Northern Region of WI (N=40).

Other Species:

Yellow Bullhead

Relative Abundance

Yellow bullhead was the most abundant fish species captured during spring fyke netting in 2011 and 2012 (Table 2, Appendix C), and was second only to bluegill during summer fyke netting with a catch rate of nearly 45 fish/net-lift (Table 4, Appendix C). The summer catch rate measured in 2011 was nearly triple the catch rate measured during the same survey in 1998. This type of bullhead abundance is not typically found in lakes that do not have oxygen issues and could be having negative impacts on the more “desirable” fish species in Silver Lake.

Size Structure

A relatively small sample of 52 yellow bullhead was measured during 2011 to index size structure. This sample had fish from 8.0 to 12.4 inches in length with an average length of 9.7 inches (Figure 30). Size structure was quite good with over 90% of the fish measured being ≥ 9.0 inches in length (Table 16). Previous surveys of Silver Lake show similar size structure with the majority of the fish captured being ≥ 9.0 inches.

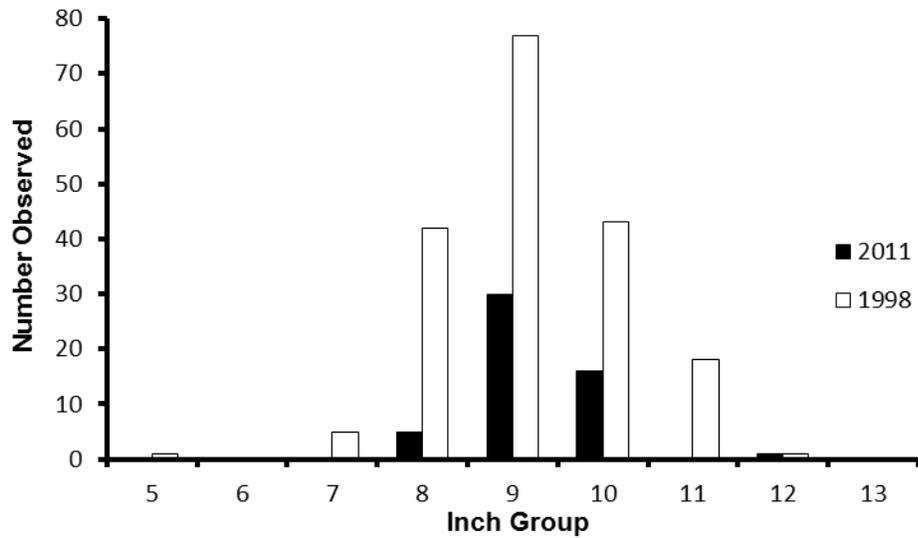


Figure 30. Length frequency for a subsample of yellow bullhead captured during summer fyke netting surveys of Silver Lake, Forest County, in 2011 compared to 1998 (2011: N=52; 1998: N=187).

Table 16. Size structure, indexed using relative stock density, for yellow bullhead captured during 2011 compared to previous surveys of Silver Lake, Forest County.

	2011	1998	1975	1967
RSD7	100.00	99.47	100.00	100.00
RSD9	90.38	74.33	100.00	66.67
RSD11	1.92	10.16	0.00	25.00
RSD14	0.00	0.00	0.00	0.00

V. MANAGEMENT RECOMMENDATIONS

Northern Pike

Spring catch rates indicate that northern pike are the most abundant gamefish species in Silver Lake. Size structure of northern pike is extremely poor showing that there are very few fish ≥ 24.0 inches. Body condition of northern pike is also poor, indicating that there is not enough food available for the current population. Growth of northern pike is even less impressive than body condition and size structure. It takes northern pike nine years to reach 20 inches in length, which is completely unacceptable and another major sign that there is a problem with this fishery.

With all of this information gathered in 2011 I am confident in saying that there is a problem with the northern pike population in Silver Lake. Northern pike population estimates can be tough to conduct and even tougher to gather a meaningful population estimate. This is the reason why no northern pike estimates have been conducted on Silver Lake. Even without a good handle on their abundance in Silver Lake the extremely poor body condition and growth is enough evidence that northern pike are overabundant in Silver Lake.

With the current size structure I do not believe any regulation change will have much of an effect on the overall pike population. The fish just do not reach a desirable size for anglers. I believe a physical removal of northern pike from Silver Lake is the correct management action for Silver Lake. Fyke nets would be the best gear to use during a removal project since they are passive capture instruments and will require the least amount of effort. In order to catch a large amount of northern pike, which would be required to have an actual impact on the overall population, a high number of nets should be used. These nets should be placed in Silver Lake immediately after ice-out for the best results. I am not sure if enough pike can be captured in a given year to solve the overabundance of northern pike and multiple years of removals may be necessary.

Northern pike were initially stocked in Silver Lake to control an overabundant, slow-growing panfish community. Now that pike are overly abundant they seem to be having the opposite effect on the panfish community. Direct predation by northern pike (along with other predators) may be preventing large numbers of panfish from reaching an old enough age to contribute to a quality panfishery.

Walleye

The current walleye population in Silver Lake is incredibly low. This indicates that the stocking of over 11,000 small fingerling walleyes every other year is having minimal impact on the population. Stocked walleyes have never fared well in Silver Lake; in fact, the average catch rate of fall fingerling walleyes during stocked years was only 0.07 fish/mile prior to 2011. During 2011 we did see a return of 1.89 fall fingerlings/mile, the best catch rate to date. This higher catch rate has me wondering if something is changing in the lake. Walleyes should continue to be stocked every other year and monitored for survival, if the lake continues to show catch rates similar to the catch rates before 2011 stocking should be ceased in Silver Lake.

Poor survival of stocked fish is typically linked to a strong fish community that has abundant fish populations. However, Silver Lake has a low abundance of all gamefish except northern pike and the only abundant panfish is bluegill, which tend to be too small to be considered a major predator on small fingerling walleye. Another possible predator of stocked walleye is an overabundant yellow

bullhead population. I have witnessed affective bullhead removals in our area on Lake Metonga and Patten Lake. Increased catch rates of stocked and/or naturally reproduced walleyes were documented after each bullhead removal. If a northern pike removal project is conducted on Silver Lake yellow bullheads should also be targeted and removed. If there is a positive impact on the walleye population it will be documented with higher catch rates of young-of-the-year walleyes during fall recruitment surveys going forward.

The current 15-inch minimum size limit with a daily bag of 5 is adequate for Silver Lake. Since Silver has never proven to be able to produce walleyes naturally an increased minimum size limit should not be entertained. A more liberal size limit is not appropriate for stocked waters and also should not be entertained.

The current size structure is artificially high, due to the lack of recruitment into the population, and is not sustainable. If we are able to stock a product that has better survival (due to fish community changes) look for the RSD15 to increase and RSD20 to decrease. This would mean that young fish are coming up in the population.

Largemouth Bass

Largemouth bass are the second most abundant gamefish in Silver Lake. However, with an adult population slightly less than 1.5 adults/acre, it is a relatively small population. The largemouth bass length frequency does not show a sharp decline in number observed beyond the minimum size limit; this leads me to believe that many anglers are practicing catch and release on largemouth bass. Currently Silver Lake has the best largemouth bass size structure ever documented, which does provide a quality fishing opportunity. I would like to use the current size structure to set benchmarks for this population. Future management should try to maintain a size structure greater than 50, 20 and 1 for RSD12, 15 and 18 respectively. These are not very high goals, however they are goals that can be achieved in a lake that has had a history of largemouth bass size structure problems.

Natural reproduction is adequate for maintaining a population of this size. Stocking should not occur on top of this population. However, a side effect of northern pike and yellow bullhead removals may be an increase in largemouth bass recruitment and abundance. All efforts should be made to monitor this population to assess the impacts of any removal project. I would recommend yearly gamefish recruitment surveys; during years where a walleye stocking event has not occurred bass and northern pike should become the targeted fish species.

The current 14-inch minimum size limit with a daily bag of 5 fish is appropriate for Silver Lake. Any suggestions of a no-minimum size limit should not be entertained unless largemouth bass recruitment and abundance increases drastically.

Smallmouth Bass

The smallmouth bass fishery in Silver Lake is quite minor. The low density of smallmouth bass is allowing for very good growth rates. The current size structure is very desirable with nearly 37% of fish \geq 17.0 inches. 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 Silver Lake, but is not

needed at this point in time. Like all other species the population should be closely monitored if fish removals take place to better understand the effects of a removal on this species.

Muskellunge

The muskellunge population in Silver Lake is a product of consistent stocking by the WDNR. The creation of this muskellunge population should be thought of as a success story for muskellunge management.

The current muskellunge population is seemingly more abundant than it was during previous surveys at approximately 0.10 adults/acre. Recent stocking events seem to have had good success as they have indicated a solid sub adult population that will be growing and becoming part of the future adult population.

Size structure of muskellunge is very good in Silver Lake with a high percentage of quality and memorable muskellunge present. This is likely a product of the relatively low adult abundance. Every effort should be made to maintain a low abundance of muskellunge to maximize growth and size structure of future populations. The 2011-12 size structure should be used as a benchmark for this population. I recommend 65, 55, 35, 10 and 2 should be target goals for RSD30, 35, 40, 45 and 48 respectively. If we see reduced size structure during future surveys it will likely be due to a higher abundance of muskellunge present and stocking should be reduced accordingly.

Body condition of muskellunge in Silver Lake is acceptable, with an overall trend of increased body condition with length. Northern pike, which are closely related to muskellunge, exhibit the exact opposite body condition. This leads me to believe there is a food source available to the muskellunge that is not readily available to northern pike. Along with large white suckers I believe the food source available to muskellunge and not northern pike are yellow bullheads and northern pike. Northern pike in Silver Lake do not grow fast enough to reach a size that can adequately consume large yellow bullheads or remove themselves from the diet of muskellunge. If this theory is correct a removal of either of these two species may change musky body condition, growth and size structure. A strict monitoring program should be put in place to monitor the muskellunge population. My hope is that by removing overabundant bullheads and northern pike other forage species will increase recruitment and provide plenty of forage options for the low abundance of muskellunge.

One of the female muskellunge captured during 2012 was estimated to be 25 years old using a cross section of an anal ray. While muskellunge can live up to 30 years of age, achieving an age over 20 years is uncommon in this region of Wisconsin. The ability to grow old, very good size structure and increasing body condition with length makes Silver Lake a good candidate for a "trophy" regulation for muskellunge. I would recommend a 50-inch minimum size limit with a daily bag limit of 1 fish. This regulation would truly maximize the size structure of this low density population. The inability to naturally recruit muskellunge allows the control needed to ensure that overabundance would not become a problem. Increasing the size limit to 50-inches would reduce harvest to near 0% and would also allow the state to stock less muskellunge (because the existing fish should remain in the population longer) into Silver Lake. While I believe a 50-inch minimum size limit will maximize the potential of this muskellunge population I would not consider a change until after the bullhead and/or northern pike removal was complete (if completed) and monitoring after the removal project showed similar or increased size structure, body condition and growth.

With the strong sub adult population coming up in Silver Lake and the recent increase of the statewide minimum length limit on muskellunge, from 34 to 40 inches, I recommend reducing the current stocking rate of 1 fish/acre to 0.75 fish/acre. This will be a change from 320 to 240 fall fingerling muskellunge stocked in Silver Lake every other year, starting in 2013.

Panfish

In general panfish populations are poor in Silver Lake, due to the lack of adult panfish. Panfish were historically overabundant and slow growing, but that is not the case anymore. In general, panfish in Silver Lake have relatively good to average growth rates but poor size structure. There is really no reason for poor size structure when you have the growth rates that Silver Lake has. These good growth rates along with poor size structure and a lack of older individuals captured in our survey makes me believe that the fishery is out of balance. I believe there is an overabundance of predators that keep the fairly abundant young panfish from reaching adulthood in high numbers. A northern pike and/or yellow bullhead removal would most likely increase the survival of young panfish. This would be beneficial to the current panfish situation. Since panfish have a history of overabundance special attention should be given to monitoring their abundance, size structure and growth rates if a fish removal is conducted.

A more restrictive bag limit is appropriate for Silver Lake. I do not believe overharvest by humans is having more impact than natural predation, but with an adult population this low, restricting harvest can only help. Studies have shown that panfish bag limits may not be as effective as once thought, typically dispersing the harvest instead of reducing harvest. That being said, I believe a 10 fish daily bag limit on all panfish is still warranted and should only improve panfish abundance and size structure. Once this restrictive bag limit is put in place an emphasis should be placed on monitoring relative abundance and size structure of panfish, this would mean conducting spring panfish assessments along with our typical summer fyke net assessments. If size structure does not improve within 5 years of applying the new regulation and growth rates are still adequate an even more restrictive bag limit should be considered.

Other Species

Yellow bullhead are very abundant in Silver Lake. In fact, they may claim more biomass than any other fish species in the lake. Since they are a less “desirable” fish species and may have a negative impact on the more “desirable” fish species an effort should be made to reduce the abundance of yellow bullheads. Bullheads have been successfully removed from Lake Metonga via boom shocker and from Patten Lake using fyke nets during spring and summer periods. During 2011 we had high catch rates of bullheads in spring and summer fyke net surveys. Since fyke nets require less effort than electrofishing I believe it is the best method for removal. Every effort should be made to conduct a removal that would target both northern pike and yellow bullheads, the only way to do this would be with early spring fyke netting, since it is the only time northern pike are truly vulnerable.

I would expect a positive response from a yellow bullhead removal. Most likely you would see an increase in panfish and forage fish abundance, creating a more diverse food web for gamefish. The removal of the fairly large bullheads should also drastically reduce predation on stocked walleye and could increase walleye abundance. The possible negative impacts that could be anticipated would be reduced body condition, size structure and growth of muskellunge and potentially reverting to an overabundance of panfish. However, with the diverse predator populations currently in place I think the likelihood of panfish overabundance is minimal.

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Appendix A – Length Frequencies

Table 1. Length frequency of northern pike captured during a 2011 survey of Silver Lake, Forest County (Unmarked fish only).

Inch Group	Musky Netting	Shock 5/2/11	Shock 5/17/11	Shock 6/8/11	Shock 6/16/11	Shock 6/23/11	Panfish Netting	Total
< 8.0								0
8								0
9						1		1
10			1					1
11						2		2
12								0
13		1						1
14								0
15	1							1
16	3	1			1			5
17	2	12			1	1		16
18	6	7	1	2	3		2	21
19	13	9		1	1	1	4	29
20	6	16		1	2		2	27
21	7	8	1		1	1	1	19
22	2	2		1	2			7
23	5	1						6
24	1	1		1				3
25								0
26								0
27								0
Totals	46	58	3	6	11	6	9	139

Table 2. Length frequency of walleye captured during a 2011 survey of Silver Lake, Forest Count (Unmarked fish only).

Inch Group	Spring Shocking	Musky Netting	Fall Shocking	Total
< 8.0			7	7
8				0
9				0
10				0
11				0
12				0
13				0
14				0
15				0
16				0
17				0
18	1	1		2
19		7		7
20	2	7		9
21	2	8		10
22	1	3		4
23				0
24	1	2		3
25	3	2		5
26				0
27				0
28				0
29				0
30				0
Totals	10	30	7	47

Table 3. Length frequency of largemouth bass captured during a 2011 survey of Silver Lake, Forest County (Unmarked fish only).

Inch Group	Shock 5/2/11	Shock 5/17/11	Shock 6/8/11	Shock 6/16/11	Shock 6/23/11	Total
< 8.0				4		4
8			1	1		2
9			1	4	1	6
10		1	1	3		5
11				8		8
12		2	4	14	8	28
13		3	4	8	4	19
14		1	6	9	3	19
15		2	4	8		14
16	1	3		3	1	8
17		1	1	1		3
18	1			1		2
19						0
20						0
21						0
22						0
Totals	2	13	22	64	17	118

Table 4. Length frequency of smallmouth bass captured during a 2011 survey of Silver Lake, Forest County (Unmarked fish only).

Inch Group	Shock 5/2/11	Shock 5/17/11	Shock 6/8/2011	Shock 6/16/11	Shock 6/23/11	Total
< 7.0				3		3
7				3		3
8				1		1
9						0
10		1				1
11						0
12		1		1		2
13				3		3
14	1	2	1			4
15		1		1		2
16		1		2		3
17	1	2	1	1		5
18		2		1		3
19		1		1		2
20			1			1
21						0
22						0
Totals	2	11	3	17	0	33

Table 5. Length frequency of muskellunge captured during spring netting and electrofishing surveys of Silver Lake, Forest County, 2011-2012 (Unmarked fish only).

Inch Group	2011			Total	2012	
	Shock 5/2/2011	MU Netting	Shock 5/17/11		MU Netting	Total
< 20	1		1	2	2	2
20				0		0
21				0		0
22				0	1	1
23		1		1		0
24	1	1		2		0
25		1		1		0
26	2	2		4		0
27	1	1		2		0
28	1	2		3		0
29	1	1		2	3	3
30		1		1	1	1
31				0		0
32				0	1	1
33		1		1		0
34				0		0
35				0		0
36		2		2		0
37		1		1		0
38				0	1	1
39	1	3		4	1	1
40	1	2		3		0
41		2		2	1	1
42		1		1	1	1
43		2		2		0
44		1		1		0
45				0	2	2
46		1		1	1	1
47				0		0
48				0		0
49				0	1	1
Totals	9	26	1	36	16	16

Table 6. Length frequencies for subsamples of panfish measured during a summer netting survey of Silver Lake, Forest County, 6/28-29/2011.

Inch Group	Bluegill	Pumpkinseed	*Black Crappie	Rock Bass	Yellow Bullhead
< 3.0	0	0		0	
3	100	4		1	
4	133	22		4	
5	18	21		2	
6	10	12		4	
7	15	3	6	14	
8	5	0	11	8	5
9	1	0	18	2	30
10	0	0	10	0	16
11			4		0
12			1		1
13			0		
14			1		
Sample Size	282	62	51	35	52

*Subsample of fish taken during muskellunge netting

Appendix B – Average Length at Age

Table 1. Mean length (inches) at age for northern pike captured during spring surveys of Silver Lake during 2011, compared to a previous survey of the Silver Lake and Northern Region of WI averages (2011: Male: N=36, Female: N=9).

Age	2011			1998	NOR Ave
	Male	Female	Combined	Combined	Combined
1					10.6
2	13.3		13.3	11.2	13.1
3				14.2	16.3
4	17.1		17.1	17.4	19.5
5	17.6	16.8	17.2	20.1	22.0
6	17.4		17.4	25.2	24.5
7	17.8		17.8	33.1	27.7
8	19.1	20.8	19.3		30.3
9	20.1	20.8	20.3		31.5
10	20.6	21.2	20.9		34.1
11	20.6	21.8	21.0		37.3
12		24.4	24.4		38.6
13	22.2		22.2		

Table 2. Mean length (inches) at age for walleye captured during spring surveys of Silver Lake during 2011, compared to a previous survey Silver Lake and Northern Region of WI averages (2011: Male: N=27, Female: N=5).

Age	2011			1998	NOR Ave
	Male	Female	Combined	Combined	Combined
1					6.4
2				11.8	9.5
3				15.2	11.7
4				16.4	13.8
5					15.8
6				19.0	17.5
7				19.8	19.1
8	20.9	22.75	21.9	22.0	20.5
9	19.7		19.7	26.8	21.6
10	20.6	20.1	20.5	26.4	22.7
11	21.3		21.9		23.7
12	21.1	22.2	22.7		24.4
13	22.1		22.1		25.2
14	22.1		22.1		25.8
15		25.2	25.2		25.6
16			25.7		25.6
17					25.2
18					25.6

Table 3. Mean length (inches) at age for smallmouth bass captured during spring surveys of Silver Lake during 2011, compared to a previous survey of Silver Lake and Northern Region of WI averages (2011: N=28).

Age	2011	1998	NOR Ave
1	5.3		3.4
2	6.2	6.2	7.2
3	7.7	8.8	9.1
4	10.4	10.9	11.2
5	13.1	12.5	13.6
6	15.0	12.7	15.5
7	17.3	13.8	16
8	18.8		17.8
9	18.6	16.1	18.6
10	19.7		19.9

Table 4. Mean length (inches) at age for largemouth bass captured during spring surveys of Silver Lake during 2011, compared to a previous survey of Silver Lake and Northern Region of WI averages (2011: N=86).

Age	2011	1998	NOR Ave
1	5.7		3.8
2	7.3		6.6
3	9.5	8.2	9.0
4	10.3	10.2	10.8
5	12.2	11	12.7
6	13.8	10.9	14.3
7	15.0	12.2	15.7
8	16.0	12.9	17.0
9	17.3	14.1	17.9

Table 5. Mean length (inches) at age for muskellunge captured during spring surveys of Silver Lake, Forest County, in 2011-2012 compared to a previous survey of Silver Lake and the Northern Region of WI averages (2012: N=25; 2011: N=31).

Age	*2012				2011				1998	NOR Ave
	Male	Female	Unknown	Combined	Male	Female	Unknown	Combined	Combined	Combined
1			10.6	10.6					11.9	11.8
2							17.5	17.5		15.9
3			22.8	22.8					21.6	20.5
4					25.5		27.5	26.3		25.6
5	29.9	32.6		30.3					30.6	28.8
6					29.3	38.4		31.8		31.6
7		40.4	42.7	40.9						33.8
8					37.7	40.4	41.5	39.9	35.5	36.4
9	36.7	42.6		39.7					40.5	38.2
10					42.9	40.6		41.8	37.5	39.4
11	41.8	45.6		44.3		41.3		41.3		41.1
12		46.1		46.1	43.1			43.1	44.2	42.3
13										43.1
14					43.9	46.8		45.4		45.1
15		46.9		46.9						43.5
16					44.0			44.0		
17										
18										50.3
19	43.8			43.8						
20	43.4			43.4						

*Cross sections of anal rays used to estimate age (other surveys used scale samples).

Table 6. Mean length (inches) at age for bluegill captured during a summer fyke net survey of Silver Lake during 2011, compared to a previous survey of Silver Lake and Northern Region of WI averages (2011: N=49).

Age	2011	1998	NOR Ave
1			2.9
2	4.1		3.6
3	4.7	2.9	4.7
4	5.4	3.2	5.6
5	6.3	4.7	6.4
6	7.5	6.3	7.0
7	7.8	7.1	7.6
8	8.7	7.8	7.9
9	8.7		8.5

Table 7. Mean length (inches) at age for pumpkinseed captured during a summer fyke net survey of Silver Lake during 2011, compared to a previous survey of Silver Lake and Northern Region of WI averages (2011: N=36).

Age	2011	1998	State Ave
1			3.2
2	3.9		3.9
3	4.5		4.7
4	5.2	6.1	5.4
5	6.1	6.3	6.0
6	6.9	7.1	6.5
7	7.3	7.4	7.0

Table 8. Mean length (inches) at age for black crappie captured during surveys of Silver Lake during 2011, compared to a previous survey of Silver Lake and Northern Region of WI averages (2011: N=43).

Age	2011	1998	NOR Ave.
1			3.9
2			5.8
3	7.8	7.2	7.1
4	8.1	8.8	8.5
5	9.4	9.2	9.1
6	10.0		9.9
7	11.1		10.6
8	11.7		11.6
9	12.9		11.8

Table 9. Mean length (inches) at age for rock bass captured during a summer fyke net survey of Silver Lake during 2011, compared to a previous survey of Silver Lake and Northern Region of WI averages (2011: N=29).

Age	2011	1998	State Ave.
1	3.8		4.1
2	4.6		4.0
3	5.8	3.5	5.3
4	6.7	6.0	6.3
5	7.5	7.5	7.2
6	8.1	7.9	8.0
7	8.6	8.7	8.6
8	9.4	8.8	9.2
9		9.3	9.5

Appendix C – Catch Per Unit Effort

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

Species	2012	2011	*1998	1975	1967
Largemouth Bass	0.06	0.4	0.06	0	0.55
Muskellunge	0.30	0.73	0.21	1.06	1.30
Northern Pike	0.73	1.15	5.15	1.38	0.40
Smallmouth Bass	0.01	0.23	0.06	0.13	0.00
Walleye	0.67	1.08	1.42	2.19	0.00

*immediately after ice-out (others were approx 1-2 weeks after ice-out).

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

Species	2012	2011	*1998	1975	1967
Black Crappie	1.09	2.63	1.27	4.56	**2.30
Bluegill	1.27	1.30	1.58	26.13	29.20
Hybrid BGxSeed	0.00	0.00	0.00	0.00	0.00
Pumpkinseed	0.06	0.15	0.00	0.56	**0.25
Rock Bass	0.61	1.15	0.64	2.63	2.70
Yellow Bullhead	11.99	39.65	---	0.06	---
Yellow Perch	1.27	0.43	1.67	12.00	11.15

*immediately after ice-out (others were approx. 1-2 weeks after ice-out).

**includes a 2-day summer fyke net survey

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

Species	2011	1998
Largemouth Bass	0.25	0.10
Muskellunge	0.08	0.15
Northern Pike	0.75	0.65
Smallmouth Bass	0.08	0.15
Walleye	0.00	0.10

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

Species	2011	1998
Black Crappie	1.00	1.50
Bluegill	110.08	34.80
Hybrid BGxSeed	0.42	---
Pumpkinseed	5.33	1.00
Rock Bass	3.17	4.70
Yellow Bullhead	44.83	15.30
Yellow Perch	0.00	0.00

Table 5. Gamefish catch per mile during electrofishing surveys of Silver Lake, Forest County, 2011.

Species	Spring	Bass Surveys	*Fall
Largemouth Bass	0.53	7.68	2.70
Muskellunge	2.37	0.06	0.27
Northern Pike	15.26	1.98	1.08
Smallmouth Bass	0.53	2.24	2.70
Walleye (All)	2.63	---	1.89
Walleye (Age 0+)	---	---	1.89
Walleye (Age 1+)	---	---	0.00

*Only juvenile fish collected during survey

Table 6. Gamefish catch per mile during electrofishing surveys of Silver Lake, Forest County, 1998.

Species	Spring	Bass Surveys	Fall
Largemouth Bass	2.63	20.09	5.00
Muskellunge	0.00	0.44	0.00
Northern Pike	4.21	5.18	8.42
Smallmouth Bass	1.05	4.56	4.74
Walleye (All)	3.16	---	0.60
Walleye (Age 0+)	---	---	0.30
Walleye (Age 1+)	---	---	0.00

Table 7. Summary of fish species, number and size range captured during a comprehensive survey of Silver Lake, Forest County, 2011.

Fish Species		Catch (and Size Range in Inches) by Sampling Period											
		Spring Electrofishing 1			Spring Netting 2			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 Crappie	<i>Pomoxis nigromaculatus</i>	---	---	---	105	7.5	14.4	---	---	---	12	8	12
Bluegill	<i>Lepomis macrochirus</i>	---	---	---	52	---	---	---	---	---	1321	3.4	9.2
Hybrid BGxSeed		---	---	---	0	---	---	---	---	---	5	---	---
Largemouth Bass	<i>Micropterus salmoides</i>	2	16.0	18.9	16	---	---	120	5.0	18.1	3	---	---
Muskellunge	<i>Esox Masquinongy</i>	9	19.5	40.4	29	23.0	46.8	1	15.0	15.4	1	---	---
Northern Pike	<i>Esox lucius</i>	58	13.0	24.4	46	15.5	24.4	31	10.0	24.9	9	18.5	21.4
Pumpkinseed	<i>Lepomis gibbosus</i>	---	---	---	6	---	---	---	---	---	64	3.8	7.6
Rock Bass	<i>Ambloplites rupestris</i>	---	---	---	46	---	---	---	---	---	38	3.8	9.5
Smallmouth Bass	<i>Micropterus dolomieu</i>	2	14.5	17.9	9	---	---	35	5.0	20.0	1	---	---
Walleye	<i>Sander vitreus</i>	10	18.5	25.6	43	18.5	25.6	---	---	---	0	---	---
White Sucker	<i>Catostomus commersoni</i>	---	---	---	12	---	---	---	---	---	0	---	---
Yellow Bullhead	<i>Ameiurus natalis</i>	---	---	---	1586	---	---	---	---	---	538	8.4	12.4
Yellow Perch	<i>Perca flavescens</i>	---	---	---	17	---	---	---	---	---	0	---	---



Silver Lake
 Spring Electrofishing Survey
 5/2/2011
 3.8 Miles



Mapped By: Jake Walcisak
 January 30th, 2012



Legend

- SN2 5/4-5/9 (42 Lifts)
- SN3 6/28-6/29 (12 Lifts)

Silver Lake
 Net Locations
 2011 Comprehensive Survey



Mapped By: Jake Walcisak
 January 30th, 2012



Silver Lake
Bass Electrofishing Survey #1
5/17/2011
3.77 Miles


Mapped By: Jake Walcisak
January 30th, 2012



Silver Lake
Bass Electrofishing Survey #2
6/8/2011
1.5 Miles


Mapped By: Jake Walcisak
January 30th, 2012



Silver Lake
Bass Recapture Survey
6/16/2011
4.85 Miles



Mapped By: Jake Walcisak
January 30th, 2012



Silver Lake
Fall Recruitment Survey
9/19/2011
3.7 Miles



Mapped By: Jake Walcisak
January 30th, 2012