Comparison of a Length Size Limit of Northern Pike Population on Two Lakes in North Central Minnesota

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Fisheries managers use length size limits on northern pike (*Esox lucis)* to improve the size structure in select lakes. The objective of this study was to compare two similar lakes, one with a length size limit and one without, to determine if a length size limit is improving the northern pike size structure. Blueberry Lake showed a higher abundance of larger fish than Stocking Lake. Of the fish caught, 25% in Blueberry Lake were over 600 mm (24 in), and were in the protected slot. Stocking Lake had a smaller portion of fish of this size with only 7% over 600 mm. In Stocking Lake there was a significant negative relationship between length and W_r indicating the more abundant small fish in are out-competing the larger fish for prey. Higher abundance of larger size northern pike with higher levels of W_r were found in Blueberry Lake indicating the length size limit is having a positive influence on the size structure in Blueberry Lake.

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Introduction

Northern pike (*Esox lucius*) are found throughout Minnesota and are prized both as a trophy and table fare. In 2012 a total of almost 1.2 million fishing licenses were sold to anglers in Minnesota (MNDNR 2013). With northern pike harvest near 4.6 million pounds a year, fisheries managers need accurate information of the fish communities to maintain this important natural resource (MNDNR 2013). Currently northern pike regulations are a daily three fish bag limit with one over 76.20 cm (30 in) in possession. Large northern pike are highly susceptible to angling harvest with fish 60.96 cm (24 in) and over making up a high percentage of the harvest. Numbers of trophy fish present in typical water bodies are usually low as result from a high rate of harvest (Cook and Younk 1998). Blueberry Lake in northern Wadena County, MN has a surface area of 215 ha (532 acres), and is known for having a high population of northern pike. It currently is being managed with a length size limit to increase the size of pike found in its population.

The size limit on Blueberry Lake was implemented in 2003, and requires northern pike between the length of 60.96 cm (24 in) and 91.44 cm (36 in) be released. This slot limit protects the larger northern pike while also allowing smaller fish and a few of the trophy size fish to be kept. This type of slot limit works in a few different ways. It provides a higher angling harvest of the smaller fish allowing for higher growth rates due to less competition (Noble and Jones 1999). The slot also allows the population to hold a higher amount of large fish that may cannibalize on the smaller sized fish further reducing competition and allowing for higher growth rates of the surviving fish. Pierce (2010) found that a slot length limit increased the proportion of northern pike 76.20 cm (30 in) and longer by 9 %, showing that a slot length limit can help increase the size structure of a northern pike population. Stocking Lake in northern Wadena County, MN has a surface area of 144.5 ha (357 acres) in size and does not have a special size regulation on northern pike. Stocking Lake also has a high population of northern pike, but has never had any special length size limit. Comparing the northern pike from both of these lakes will help give perspective if the length size limit increased the northern pike size in Blueberry Lake.

The objective of this study is to compare the northern pike populations of Blueberry and Stocking Lakes to determine if the slot limit is improving the size structure and age distribution of northern pike found in Blueberry Lake. This understanding can then be applied to other water bodies where managers are looking to improve northern pike populations.

Methods

Northern pike were collected by two anglers, each with five years or more experience northern pike angling, from 2 June - 10 June 2012. The collection was limited to a nine day period to reduce size variability due to the rapid growth rate of northern pike in the month of June. Each lake was fished on alternate dates or times of day. On the weekend days, the morning was fished on the 1st lake and the evening was fished on the 2nd lake. The next day was opposite where the 2nd lake was fished in the morning and the 1st lake was fished in the evening. Weekdays were only fished in the evenings and each lake was fished on alternate evenings. Angling method used was casting and trolling crank baits and spinner baits along the edge of weed beds ranging 0.5 - 3.0 m deep. Medium action fishing rods spooled with 4.5 kg monofilament and a 15 cm steel leader were used.

Captured fish were measured for total length (mm), weighed (g) and had scales collected for age determination. For age determination, scales were used in place of bone structures so that fish could be released. Laine et al. (1991) reported that using scales or cleithera are both equally suitable for aging northern pike. To obtain growth parameters for various stock assessment procedures the data was used to calculate a von Bertalanffy growth equation (Van Den Avyle 1999). Data was used to calculate a length-weight regression, as well as relative weight (W_r) (Anderson and Nueman 1996). Using data collected a catch per unit effort (CPUE) for each of the two lakes was calculated. Size structure for the two lakes was calculated using traditional and incremental relative stock densities (RSD) as well as a proportional stock density (PSD) (Ney 1999). T-tests were used to calculate statistical differences between the two lakes for mean total length, mean age, and mean W_r. A regression was performed to test for a relationship between of W_r and length (Aron et al. 2008)

Results

A total of 115 fish were caught in 54.75 hours, with 69 fish from Blueberry Lake in 27.00 hours and 46 fish from Stocking Lake in 27.75 hours. The mean length of Blueberry Lake northern pike was 532 mm (21 in), and Stocking Lake had a mean length of 442 mm (17 in). An independent samples t-test was performed on the lengths of the two populations resulting in a p value of <0.01 indicating a statistical difference in the lengths of the two populations, with Blueberry Lake having the larger mean length. The mean age of fish from Stocking Lake was 3, and the mean age of fish for Blueberry Lake was 4.

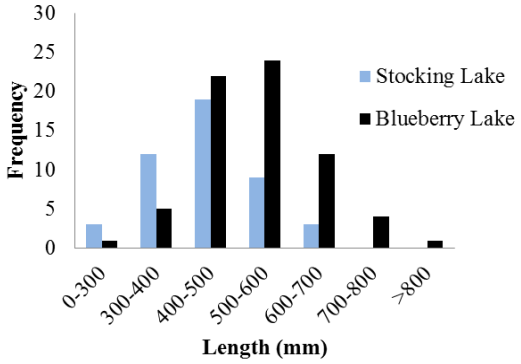

Figure 1. Length frequency distributions of Blueberry and Stocking Lakes. Blueberry Lake has a higher abundance of larger fish than Stocking Lake.

Figure 1 shows that the portion of larger fish is greater in Blueberry than in Stocking Lake. Of the fish sampled in Blueberry Lake over half (59%) were larger than 500 mm (20 in) and 25% of the fish were >600 mm (24 in). Stocking Lake had a much smaller portion of fish over 500 mm (26%) and only 7% of the fish were larger than 600 mm. The average length of fish for the two lakes also shows that Blueberry Lake has a higher portion of larger fish than Stocking Lake. Blueberry Lake had an average length of 532 mm (21 in) and Stocking had an average length of 442 mm (17 in).

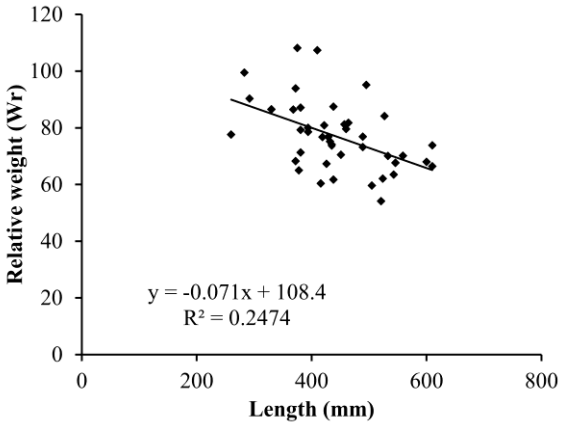

Figure 2. Relative weight plotted against total length on Stocking Lake shows a downward trend of W_r as length increases. This trend indicates that as a fish gets larger it becomes less healthy.

An independent sample t-test was performed on the mean age of the two populations had a p value <0.01 indicating there is a statistical difference, with Blueberry Lake having the older aged fish. Fishing effort was calculated for the two lakes. The estimated CPUE for Stocking Lake was 1.7 fish/angler hr; the estimated CPUE for Blueberry Lake was 2.6 fish/angler hr. A mean W_r for Stocking Lake was calculated at 77 and the mean W_r for Blueberry Lake was 81. An independent sample t-test was performed on W_r and the resulting p value of <0.01 indicates a difference in W_r for the two lakes, with Blueberry Lake having a higher W_r value. Regressions were performed to determine if there was a relationship between W_r and total length for the two lakes. The regression for Stocking Lake, in Figure 2, had a p value of <0.01 indicating there is a significance relationship between W_r and total length. The regression for Blueberry Lake, in Figure 3, had a p value of 0.23, indication of no relationship between W_r and total length.

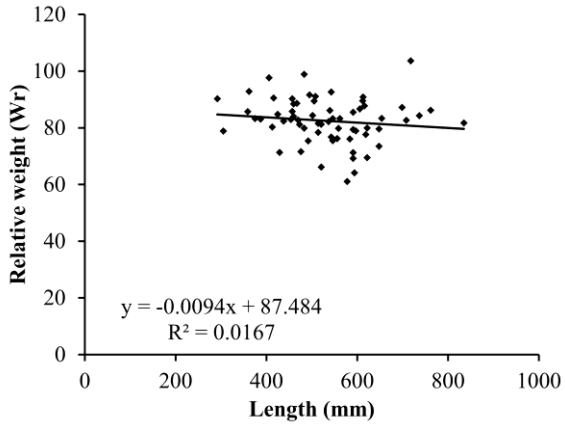

Figure 3. Relative weight plotted against total length on Blueberry Lake shows a slightly downward trend of W_r as length increases. Indicating that as a fish gets larger it becomes slightly less healthy. This relationship is not significant.

Stocking Lake conformed well to the growth equation with little error is shown in Figure 4. Blueberry Lake however didn't conform well to the von Bertalanffy growth equation, but when the parameters were changed manually a growth equation for the lake with little error was created (Figure 5). Mean length at age, plotted in Figure 6, shows evidence of similar growth rates between the two lakes. Weight to length relationships were similar between the two lakes.

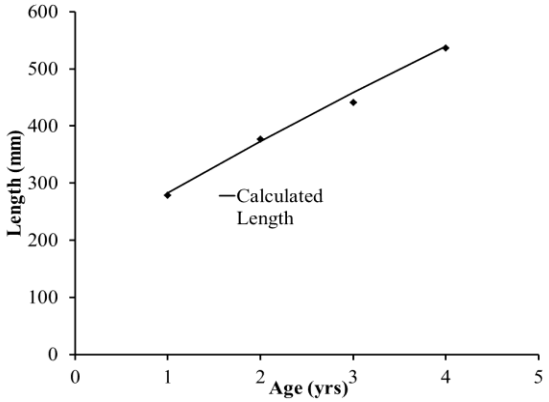

Figure 4. Shows total length compared to the calculated lengths obtained from the von Bertalanffy equation for Stocking Lake (L_t=2062.7[1-$e^{-0.05(t+2.5)}$]).

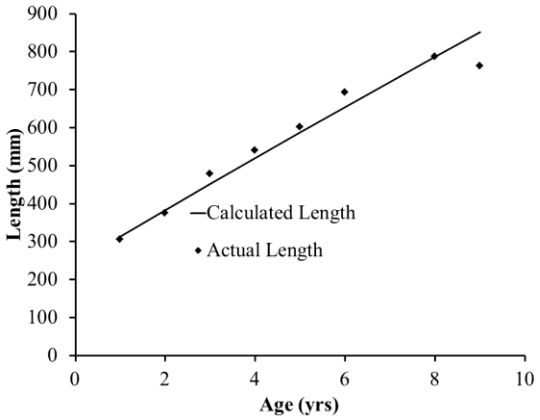

Figure 5. Shows total length compared to the calculated length obtained from the von Bertalanffy equation (L_t=7314.3[1-$e^{-0.01(t+3.4)}$]) for Blueberry Lake.

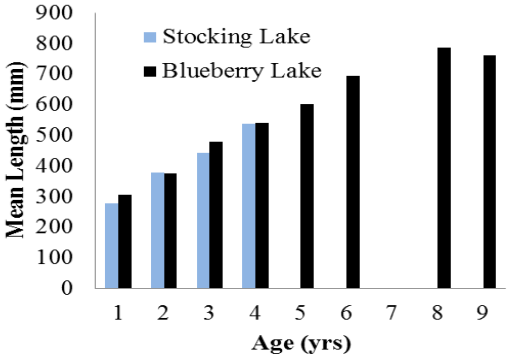

Figure 6. Mean length to age for Stocking Lake and Blueberry Lake shows evidence that growth of northern pike in these two lakes is very similar. Although these lakes have similar growth Stocking Lake had no fish ages 5 and up.

The two populations of northern pike showed differences in the calculated RSD and PSD values, these values can be found in Table 1. Stocking Lake

showed a very uneven distribution in size with a high number of fish in the stock size category. Blueberry Lake showed a more even distribution between stock size fish and quality size fish.

Discussion

A relationship between W_r and total length was present in the Stocking Lake population. A regression showed that as length of the fish increased the average relative weight decreased. This indicates that the larger fish are not as healthy as the smaller fish. The high density of smaller fish may be out-competing the larger fish (Diana 1987). In Blueberry Lake there was not a significant relationship between relative weight and total length. This indicates that the prey base is able to support the whole population of fish.

Growth for the two lakes appears to be similar. Mean length at age is shown in Figure 6 and shows how closely the two growth rates are. The weight to length ratio of the fish found in these two lakes is very similar as well indicating that growth is not a factor that limits the size of fish found in Stocking Lake. The average age of fish that were caught in Stocking Lake was 3 years and in Blueberry Lake was 4 years. The difference of the two ages shows that Blueberry Lake has an older population of fish.

This study showed that Blueberry Lake has larger fish and at a higher abundance than Stocking Lake did. This indicates that the length size limit is increasing both the size and age of northern pike found in Blueberry Lake. With the evidence of similar growth rates a length size limit on Stocking Lake may have the same effect of increasing mean length and age of the northern pike population. The stock density of these two lakes is very different. Stocking Lake had higher density of smaller fish and Blueberry Lake had a more evenly distributed size range. In this study we did not catch any fish in the memorable or trophy size classes in either lake. The lack of these larger fish could because of harvest. The slot size limit of 60.96 (24 in) and 91.44 cm (36 in) does not protect the larger fish. When the fish outgrow this slot protection they are then harvested (Cook and Younk 1998). A larger range in the length slot limit may increase the number of larger memorable to trophy size northern pike found in Blueberry Lake (Pierce 2010).

Further studies on the size structure of northern pike on these two lakes should continue. Studies of Blueberry Lake's northern pike need to continue in order to determine if the size slot limit is increasing the size structure. Total population estimates along with mortality estimates of these two lakes would be a valuable tool for fish managers. This could provide some evidence of why the size structure of these two lakes is different.

Table 1. Shows the proportional stock densities (PSD) and relative stock densities (RSD) of Blueberry and Stocking Lakes. Stocking Lake shows a high abundence of small fish. Blueberry lake shows a better distribution of size, but did not have any large fish in the memerable (860-1120 mm) to trophy (1120 mm and greater) size classes.

	Size Class	Length (mm)	Stocking	Blueberry
PSD	Quality	>530	17	49
RSD_S	Stock	350-529	76	48
RSD_Q	Quality	530-709	17	43
RSD_P	Preferred	710-859	0	6
RSD_m	Memorable	860-1119	0	0
RSD_T	Trophy	>1120	0	0

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