Changing Body Condition in Walleye with Reference to Ideal Sample Size Requirements

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The objective of this study was to determine if walleye *Sander vitreus* percent dry weight, a measure of condition, differed among summer months of 2014 on Maple Lake, Minnesota. A second objective was to determine if there was a relationship between condition and body temperature, total length, or wet weight. Between three and six walleyes were collected per month by hook and line methods. All fish had internal body temperatures taken at the time of capture and were oven dried in the laboratory at 80 °C in order to measure percent dry weight. There was no relationship between condition and wet weight, month, total length, or body temperature. Due to the lack of significant trends questions about small sample sizes arose. Ideal sample size was calculated with a power analysis. Widths of confidence intervals were plotted in relation to sample size. The inflection point of the plot provided evidence to suggest a minimum sample size of seven fish per month should have been collected to obtain more accurate result. Future studies attempting to detect trends in percent dry weight of walleye should use a sample size of 7-10 fish per treatment group in order to detect biologically meaningful differences.

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Introduction

As summer progresses, fish are exposed to large fluctuations in environmental conditions including but not limited to drastic changes in water temperature. During May after ice melt temperatures of lakes in Northern Minnesota have been recorded as low as 1.4 ºC (Stefan et al. 1998). During the summer temperatures between 26 and 34 ºC have been measured in shallow lakes and ponds potentially causing stress or mortality in walleye (Hokanson and Koenst 1986). Additionally, warm water conditions can affect an ecosystem by causing large algal blooms decreasing water clarity (Svobodova et al. 1993) potentially reducing walleye performance (Pickering 1993).

Previous research has demonstrated there can be a relationship between body condition and internal body temperature (Jobling 2006). Fish that are subject to high water temperatures can begin to show a decline in health due to lipid membrane fluidization. This can result in membranes experiencing a condition known as hypoosmolality (Arts and Kohler 2009). Hypoosmolality can have symptoms such as cerebral edema, disorientation, focal neurologic deficits and seizures.

Walleye experience the highest growth rates at an optimum temperature around 17ºC (Summerfelt and Summerfelt 1996). During the summer months shallow bodies of water such as Maple Lake, MN can become subject to above optimum temperatures possibly causing stress and in extreme cases mortality (Mount 1973). These stressful periods should greatly affect the percent dry weight of fish. Percent dry weight can be an important aspect in managing a fishery because it can be used as a reliable predictor of fat reserves (Hartman and Margraf 2008). For this experiment percent dry weight was estimated in order to test if there is a difference between percent dry weights throughout the summer. In order to be able to accurately sample lakes an ideal sample size must be used.

Calculating the ideal sample size is important for any study in order to obtain accurate results with the fewest specimens possible (Sandelowski 2007). By calculating the ideal sample size accurate results can be obtained without collecting unnecessary samples. Information on ideal sample size could be very helpful for others who are conducting research on walleye percent dry weight.

Methods

Maple Lake is a 638 ha lake located 4.8 km south of Mentor, Minnesota in Polk County. According to the Minnesota Department of Natural Resources, Maple Lake is an exceptional fishery compared to other lakes of the same size class. Over the years Maple Lake has experienced heavy development, heavy use by motor craft, and periodical algal blooms. Do to the lake having a maximum depth of 4.27 m, Maple Lake experiences periodically low dissolved oxygen levels during harsh winters which has resulted in large winter kills in the past. According to the Minnesota Department of Natural Resources LakeFinder[1] database there is very little natural walleye reproduction present in Maple Lake. Therefore, stocking of fingerlings each year must take place in order to maintain a healthy walleye population. Additionally, when comparing trap netting results from lakes of similar size, Maple Lake was found to have a slightly above normal population of walleye present even though it has very little natural reproduction occurring.

Fish for this experiment were collected using hook and line between May and August 2014. Between 3 and 6 fish per month were collected via hook and line sampling. Fish had their internal body temperature taken immediately upon capture. Fish were individually labeled and placed in bags to be frozen for later examination. In the lab, carcasses were thawed then weighted to obtain a wet weight before being dried in a blast furnace at 80°C (Bernard et al. 2010). After 60-72 hours all water content was eliminated and dry weight was measured.

In order to calculate the ideal sample size of walleyes a power analysis was conducted. The data from the eighteen fish captured in this study were used to generate random data sets with sample sizes ranging between three and seventeen. Twenty random data sets were generated for each individual sample size. For each sample size the average 95% confidence interval width of percent dry weight was estimated based on the 20 random data sets. Average confidence interval widths were calculated for each sample size, these values were then plotted against each other to determine if there is a relationship between confidence interval width and sample size. By analyzing the inflection point, an ideal sample size was estimated. For this study, ideal sample size was defined as the lowest number of individual specimens needed to obtain accurate results with minimum effort.

Results

Percent dry weight was not significantly different among months ($p = 0.87$, Figure 1). There was not a significant relationship between percent dry weight and wet weight ($p = 0.97$, Figure 2). No relationship was observed between walleye length and percent dry weight ($p = 0.79$, Figure 3). Finally, no relationship was observed when comparing internal body temperature and percent dry weight ($p = 0.97$, Figure 4).

The inflection point of the relationship between sample size and confidence interval width occurred at a sample size of seven (Figure 5). As sample size increased past seven additional decreases in confidence interval width were minimal.

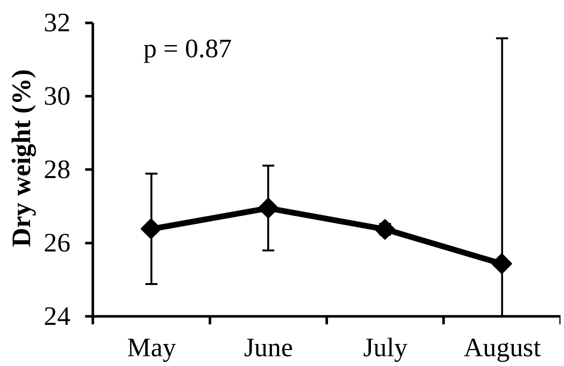

Figure 1.– Average percent dry weight of walleyes caught in Maple Lake, Minnesota during the summer months of 2014.

Discussion

There was not enough statistical evidence to suggest that the condition of walleye changed from May to August in Maple Lake during 2014. Walleyes need to consume more prey during warmer water conditions due to an increase in metabolic activity (Sogard and Olla 2005). Therefore, one possible explanation why a change in walleye condition was detected is that an ample supply of forage is available in Maple Lake, Minnesota. If enough forage is present in a body of water to support the increase in metabolic activity during the summer months, a change in body

[1] http://www.dnr.state.mn.us/lakefind/index.html

condition may not occur. Similar studies have compared changes in body condition between year classes. According to Porath and Peters (2011), changes in body condition can be difficult to detect if there is a wide size range of forage available. This could explain why no trend was detected in this study when comparing body condition and lengths. This also provides a good explanation as to why no trend was detected when comparing body condition to wet weight. If fish do not experience a lack in prey availability as they become larger their body condition should not change as they grow.

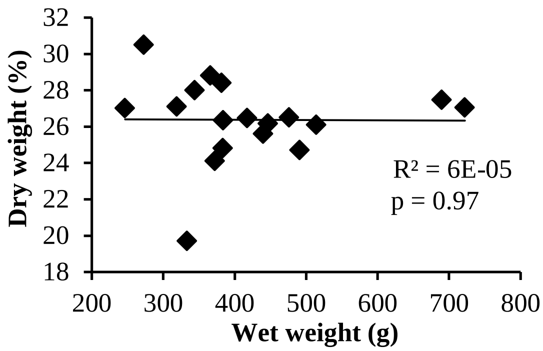

Figure 2.– Wet weights of walleyes caught throughout the summer months on Maple Lake, Minnesota 2014 in relation to percent dry weight.

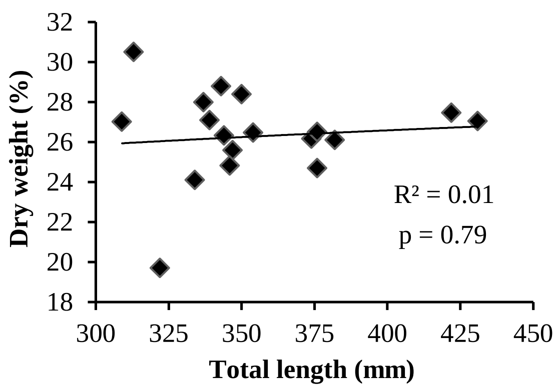

Figure 3.– Total length in comparison to percent dry weight of walleyes caught from Maple Lake, Minnesota during the 2014 year.

Another explanation as to why no changes in condition were detected could be due to many of the samples experiencing internal body temperatures close to the optimum growth rate temperature of 17ºC (Summerfelt and Summerfelt 1996). Previous studies have indicated that water temperatures over 26ºC can have effects on fish condition (Hokanson and Koenst 1986). Since no fish in this study were subject to extreme temperatures they may have not become exposed to stressful situations leading to a decrease in body condition.

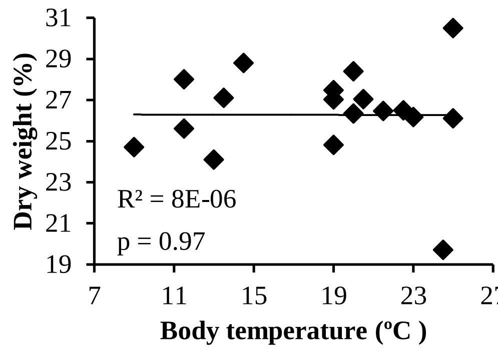

Figure 4.– Body temperature in relation to percent dry weight of walleyes caught during the summer months from Maple Lake, Minnesota 2014.

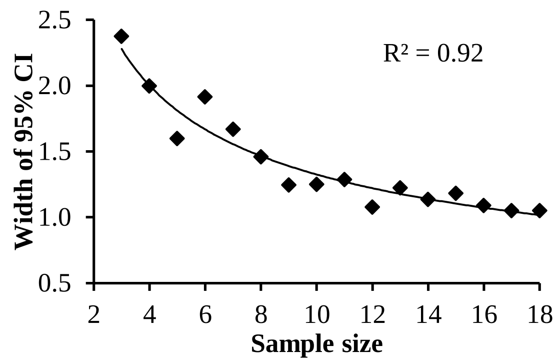

Figure 5.– Average percent dry weight confidence interval width in relation to sample size for walleyes captured on Maple Lake, Minnesota during the summer months of 2014.

A power analysis was conducted by comparing the mean confidence interval width for a range of samples sizes. Based on the results, there was evidence to suggest there is an increase in accuracy of the percent dry weight estimate with an increase in sample size. Previous studies have also shown that there is a positive correlation between sample size and accuracy of data (Stockwell and Peterson 2002). Similar studies that conducted ideal sample sizes showed that after the infection point all other samples analyzed had little effect to the accuracy of the data (Stockwell and Peterson 2002). In this study the inflection point occurred at a samples size of seven fish. Therefore, 7-10 fish per treatment group should be collected when attempting to detect changes in condition of walleye. Agencies such as the Minnesota Department of Natural Resources conduct extensive amounts of lake sampling to determine walleye condition in many lakes around the state. By using the information from this study related to ideal sample size, the amount of walleyes harvested for research purposes can be limited. Stocking and hatching fees can also be saved by limiting the amount of walleyes harvested for research. Smaller bodies of water such as Maple Lake that have very little natural reproduction could have a sharp decline in walleye population if too many fish were harvested for research purposes. By knowing the ideal sample size it could lower the chances of a fish population being over harvested. By analyzing the data it shows that the walleyes present in Maple Lake, Minnesota are healthy and have an ample forage base present to sustain the walleye population for years to come.

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