LONG TERM TRENDS IN MORTALITY RATES OF A SMALLMOUTH BASS POPULATION

Caleb D. Anderson
Department of Biology, Aquatic Biology Program
Bemidji State University
Bemidji, MN, USA
caleb.anderson@live.bemidjistate.edu
Faculty Sponsor: Dr. Andrew W. Hafs (andrew.hafs@bemidjistate.edu)

***Abstract*—Smallmouth bass *Micropterus dolomieu* are known as a popular sport fish for anglers. When a known smallmouth bass fishery appears to have a dwindling population, it raises questions about the population health. A common indicator of the health of the population is the mortality rate. By comparing mortality, conclusions can be made on whether smallmouth bass are dying at a different rate in the system over time. Therefore, the objective of this study was to see if there had been a significant change in smallmouth bass mortality over a span of thirty years in Round Lake (DOW:010204), Aitkin County, Minnesota. Smallmouth were sampled using Minnesota Department of Natural Resources standard gillnets, trap nets, and electrofishing gear following their procedures for a standard lake survey. Once data was collected, annual mortality was calculated. Catch curves were analyzed using regression analysis and graphed with 95% confidence intervals. There was not a significant trend in mortality rates through time (P = 0.37), and there was overlap of confidence intervals among years. Mortality ranged from 0.05 to 0.61 with a mean of 0.29 (SD = 0.20) over the years sampled. It appears the mortality rates reported in this study are similar to those previously published for smallmouth bass in similar systems.**

I. INTRODUCTION

Smallmouth bass *Micropterus dolomieu* have been found to have a relative annual mortality, due to natural cause and in an unexploited system, of about 0.16 (Reed and Rabeni 1989). Knowing the mortality gives a good measure of how healthy a population is in a system. If the mortality rate is too high, it can lead to extinction or a low abundance of fish in the system. If mortality is low, then the population may become stunted in growth with low variance in size. Knowing how changes in mortality can affect the structure or condition of fish populations is important for analyzing overall species health.

Since mortality is an important statistic for fish populations, it has been calculated for many different systems. In some systems smallmouth bass mortality has been recorded at higher levels than previously discussed, at around 0.3-0.4 (Beamesderfer and North 1998). This variability in mortality may also be related to productivity, water quality, type of habitat available, or prey abundance (Forney 1972; Coutant 1975). Another influence on mortality is how far north the system is, as it has been found that mortality rates are generally lower the farther north it is. This was theorized to be related to the lower average temperature (Beamesderfer and North 1998). Different studies have shown that high fishing pressure can lead to higher mortality rates due to angling mortality. This would be non-natural mortalities but is something to take into consideration in lakes or streams that receive heavy fishing pressure. All the variables mentioned influence mortality and can cause it to change over time in a system.

Mortality gives a relative answer to how much of the population is dying yearly and could be compared to see trends over time. The objective of this study was to compare mortality rates over multiple lake surveys done by the Minnesota DNR from 1988 to 2018. This was done to see if the perceived loss of smallmouth was truly due to an increase in mortality rates.

II. METHODS

This study was conducted on Round Lake (DOW:010204) located near Garrison, MN in Aitkin County. Round Lake is a 767-acre lake with a maximum depth of 125 ft. The study used a collection of lake survey data sets, from the Minnesota Department of Natural Resources. The surveys were from 1988 through 2018 and were conducted every five years.

Standard gillnets and trap nets were all used to collect smallmouth bass in the lake surveys. Gillnets were set at twelve locations around the lake and had five different mesh sizes. The mesh sizes were ¾, 1, 1 ¼, 1 ½, and 2 in. The trap nets were standard ¾ in double frame nets, and there were twelve set sites spread around the lake as well. The sites for all the sampling techniques remained the same for each of the individual gear types. The collecting each year was conducted within a work week or until all the sites had been set and worked. The exception to this was in 1993, when a population assessment was done. During the population estimate there was an increased effort to catch fish, with increased net sets and manpower.

Once the smallmouth bass were captured, total length and wet weight were recorded. If possible, otoliths and scales were taken from ten fish in every ten-millimeter length class for each survey. Otoliths and scales were later analyzed to calculate the age of each fish and relative growth rates. Otoliths were aged using the crack and burn method, and scales were aged by back calculating using a body-scale constant of 36 mm. Aging was done by Minnesota DNR fisheries specialists at the Aitkin office.

All analyses were done with program R (R Core Team 2023). Using von Bertalanffy's growth model (von Bertalanffy 1957) the aged fish were used to generate estimated ages of fish that were sampled and then released without aging structures being taken. A catch curve model was used to show the number of fish of each age that were caught. Then a regression analysis was done on the catch curve to determine mortality with a 95% confidence interval. This process of finding mortality was done for each year that the lake was surveyed. Once mortality was calculated for each of the survey years, a regression analysis was run to test for a significant trend in mortality rates through time.

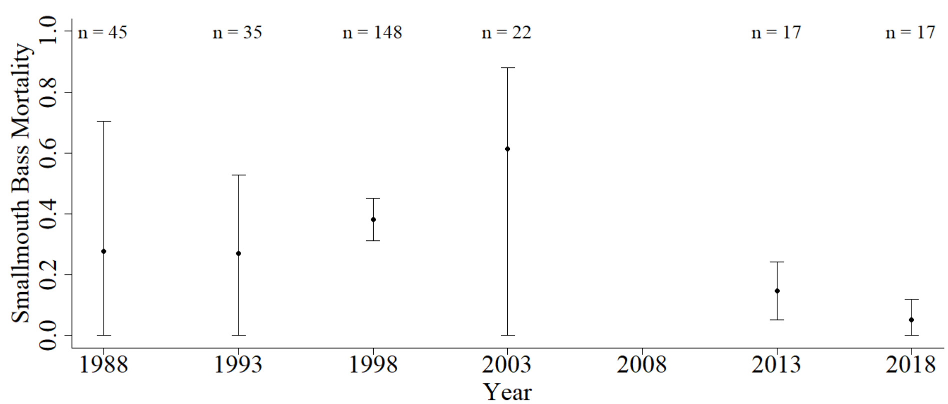

Fig. 1. Estimated smallmouth bass mortality calculated using a regression analysis with 95% confidence intervals. Collection years, shown on the x-axis, were between 1988 and 2018. Mortality is on the y-axis and ranges from zero, meaning no mortality, to one, meaning all fish have died.

III. Results

The number of specimens collected each year ranged from 17 to 148. Overall, the smallmouth bass sampled ranged from 0 to 15 years old. Most fish were three or four years old. In 2008, there was no data recorded regarding age because of miscommunication on what fish structures were to be collected. Mortality ranged from 0.05 to 0.61 with a mean of 0.29 (SD = 0.20) over the years sampled. There was overlap among the confidence intervals (Figure 1). There was not a significant trend in mortality through time (P = 0.37). All individuals were graphed to create a historical growth curve (Figure 2). The maximum length of smallmouth bass was between 400 and 500 mm.

IV. Discussion

The estimated average mortality for the system of 0.29 (SD = 0.20) falls almost exactly in the middle of the lowest and highest mortalities listed in literature of 0.16 and 0.40 (Beamesderfer and North 1998; Reed and Rabeni 1989). No trend was found in the recorded mortalities. However, in 2013 and 2018 the mortality was lower than the previous years. This may indicate a trend toward a change in mortality in recent years.

The mortalities calculated for the last two years are close to the mortality, 0.16, calculated in a study of an unexploited system (Reed and Rabeni 1989). A decrease in the amount of fishing pressure on smallmouth bass could be a factor in this, and conducting a creel survey would further help to get an understanding of harvest mortality.

Smallmouth bass sampled in Round Lake reached quality lengths between two and six years of age and had a maximum length between 400 and 500 mm. The growth of smallmouth bass aligns with that found in literature. One study found that age at quality length, 280 mm, ranged from two to nine years for smallmouth bass (Beamesderfer and North 1998). A study done on smallmouth introduced into Nebraska lakes found that age seven smallmouth averaged 380 mm (Shall et al. 2016). Smallmouth at age seven in Round Lake averaged 424 mm. Growth of smallmouth bass and size at age seven indicate that Round Lake is a quality smallmouth fishery.

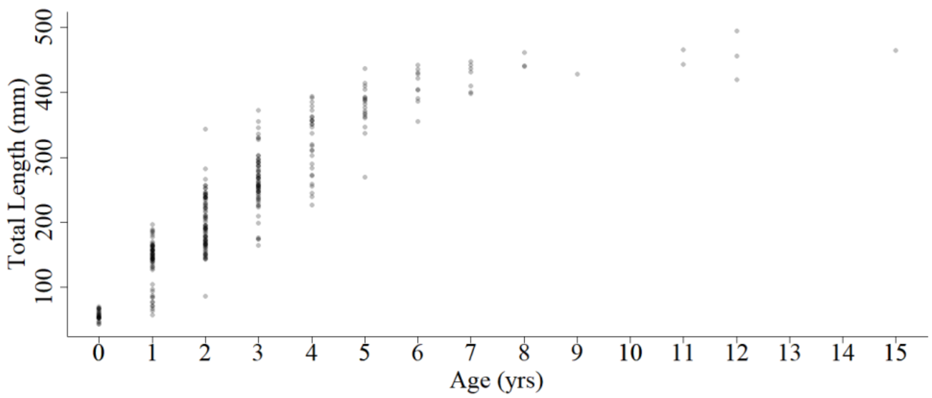

Fig. 2. Growth curve calculated using the von Bertalanffy method. Data was collected from 1988-2018. The data comprised of smallmouth bass ranging in age from zero to fifteen years, shown on the x-axis. The total lengths of each fish, in millimeters, was graphed on the y-axis.

During the last two years sampled, mortality rates were low which could potentially indicate the start of a trend. Future research should be done to further assess the mortality. If further sampling were to be done, it should be done at a higher level of consistency. The same sample gear should be used to capture all the specimens and not a combination of gear types. For optimal results of an accurate mortality estimate, it has been found that increasing sample size and at least ten fish per bin category is best (Coggins et al. 2013). The sample size achieved in 1998 of 148 fish and reaching ten fish per bin category should be used as goals for sample size in future years (Figure 1).

The perceived loss of smallmouth bass in Round Lake does not stem from a change in mortality. The smallmouth bass population has good growth rates and a quality size structure when compared with other smallmouth populations. Round Lake should continue to be monitored, to maintain the smallmouth fishery.

REFERENCES

[1] Reed, M.S. and C.F. Rabeni. 1989. Characteristics of an unexploited smallmouth bass population in Missouri Ozark stream. North American Journal of Fisheries Management 9:420-426.

[2] Beamesderfer, R.C.P. and J.A. North. 1995. Growth, natural mortality, and predicted response to fishing for largemouth bass and smallmouth bass populations in North America. North American Journal of Fisheries Management 15:688-704.

[3] Coutant, C.C. 1975. Responses of bass to natural and artificial temperature regimes. Oak Ridge National Lab., Tenn. (USA), No. CONF -750205- 1.

[4] Forney, J.L. 1972. Biology and management of smallmouth bass in Oneida lake, New York. New York Fish and Game Journal 19:132-154.

[5] von Bertalanffy, L. 1957. Quantitative laws in metabolism and growth. Quarterly Review of Biology 32:217-231.

[6] R Core Team. 2023. R: A language and environment for statistical computing. R Foundation for Statistical Computing. Vienna, Austria.

[7] Shall, B.J., K.D. Koupal, C.W. Schoenebeck, and K.L. Hurley. 2016. Assessment of smallmouth bass growth and mortality in Nebraska waters. The Prairie Naturalist 48:72-78.

[8] Coggins Jr., L.G., D.C. Gwinn, and M.S. Allen. 2013. Evaluation of age-length key sample sizes required to estimate fish total mortality and growth. Transactions of the American Fisheries Society 142:832-840.