Comparing the Condition of Deformed and Non-deformed Walleyes in Long Lake, MN

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Walleye *Sander vitreus* is a popular game fish in Minnesota. Walleye's have become such a popular game fish for anglers that it has led agencies to raise Walleye in rearing ponds. Farm raised fish can show deformities due to environmental, genetic, nutritional, infectious, and toxic factors. Due to this phenomenon, the purpose of this study was to determine if the condition of the Walleye differed between those with and without deformities in Long Lake, MN. Angling was the method of capture during the months of September 2020 through July 2021. There was no evidence to suggest condition differed between non-deformed and deformed Walleyes (P = 0.56).

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Introduction

Vertebral column deformity in freshwater fish species is an indicator of genetic variation between fish of the same species. Deformities are caused by many different factors affecting the fish's physical state. One of those factors is inbreeding between genetic families. The established causes of deformity include genetic, environmental, nutritional, infectious, and toxic factors. For example, high inbreeding coefficients resulted in fry deformities in rainbow trout (Aulstad and Kittelsen 1971; Kincaid 1976a; Kincaid 1976b; Gjerde et al. 2005). Some examples of toxic or infectious substances that cause skeletal deformities include exposure to zinc, organophosphates, organochlorines, herbicide trifluralin, and bacterial infections (Gjerde et al. 2005).

The causes of such deformities can be attributed to many factors within a system. Studies on the genetic basis of skeletal deformities in fish species have not received much attention (Gjerde et al. 2005). Tave et al. (1982) concluded that a stump body deformity in Tilapia *Oreochromis aureus* was inheritable. More research has come out with fish having deformities that match genetic variability with other older generations of fish with the same deformity. Strong evidence that a spinal deformity occurs at a rate of 12.4% in caged farmed Atlantic salmon *Salmo salar* was heritable (Mckay and Gjerde 1986). Although previous studies have looked at genetics and environmental factors, few have looked to see how these deformities influence the fish's ability to succeed within its environment.

The purpose of this study will be to look at dorsal fin deformity trends in Walleye *Sander vitreus*. The Walleyes will be compared upon measurements of their weight, length, age, and vertebral column. This research project will determine if the condition of the Walleye differed among those with and without deformities.

Methods

Walleye sampled in this study were taken from Long Lake, Minnesota at a proximate location of 45° 22.103'N 96° 10.831'W. Fifty specimens were captured by the method of angling beginning in September 2020 and ending in July 2021. Walleyes were sampled specifically in the months of September, May, June, and July.

After the samples were caught, fish IDs were assigned. Weight, length, and dorsal fin observations were taken upon processing. Weights were measured in ounces and subsequently converted to grams. The length was recorded in inches to the nearest 1/16 of an inch and subsequently converted to millimeters. Age was recorded by extracting the opercular bone that supports the gill covers. The bone was removed with a sharp blade and placed into boiling water to remove the skin and unwanted tissue. The bones were then ordered, to keep the fish IDs accurate, and placed in an area where they could dry properly. After the bones dried, a scientific microscope was used to look at the growth rings on the opercular bones.

Kahn and Kahn (2009) determined the age and growth of fish from examining the opercular bone is well established in fishes of temperate waters. It has been found to be more satisfactory than other methods such as scales, vertebrae, spines, or other hard parts in Northern Pike *Esox lucius* (Frost and Kipling 1959) and European Perch *Perca fluviatilis* (Shafi and Maitland 1971).

A standard weight equation developed by Brown et al. (1990): log10(Ws) = -5.453 + 3.180 log10TL was used to calculate condition. Ten to the power of condition was used to find Ws. Relative weight (Wr) was found by using the following equation: Wr = (W/Ws) × 100. W is total fish weight, while Ws is the standard weight for a fish of that length. To test for a difference between the condition of non-deformed and deformed Walleyes a T-Test was used. Program R was used to create a vertical scatterplot showing the relationships between relative weight and non-deformed and deformed Walleyes and the Walleye age versus relative weight.

Results

Relative weight of the fish ranged from 70.93 to 105.86 and length ranged from 241 to 603 mm. Deformed Walleyes relative weight ranged from 76.02 to 88.46 and non-deformed Walleyes ranged from 72.7 to 105.9 (Figure 1). Relative weight mean for non-deformed Walleyes was 83.34 (SD = 7.60) and deformed Walleyes had a relative weight mean of 82.43 (SD = 3.82). There was not a significant difference between Walleye condition with or without deformity in their dorsal fins (P = 0.56).

Relative weight compared to age classes of deformed and non-deformed Walleyes did not show congruent patterns that deformity affected the Walleyes weight in a negative way or that deformity rates were more or less prevalent across ages (Figure 2).

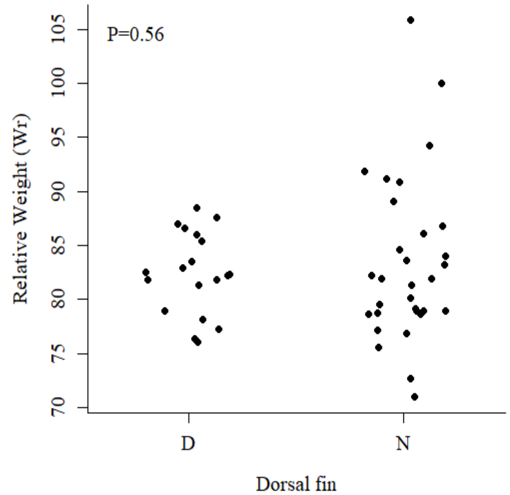

Figure 1: Comparing the relative weight of the Walleyes that have deformed (D) and non-deformed (N) dorsal fins. The Walleyes were caught on Long Lake, MN in the months of September through July 2020-2021.

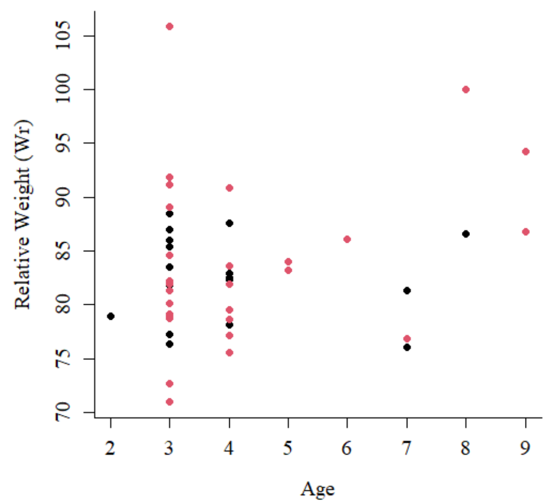

Figure 2: Relative weight compared to the age of the Walleyes. Black circles representing deformed dorsal fins and red circles representing the non-deformed dorsal fins of the Walleye. The Walleyes were caught on Long Lake, MN in the months of September through July 2020-2021.

Discussion

The data gathered from the study showed condition did not appear to be influenced based off whether the Walleyes showed deformity or not. Taylor et al. (2013) found that defining specific limits when vertebral deformities will affect welfare is difficult, as development of deformities is a dynamic process which can be stabilized or aggravated over time. In the case of the Walleyes looked at in this study, the deformity of their dorsal fins were stabilized. There was not a significant difference between Walleye condition with or without deformity in their dorsal fins ($P<0.56$). The Walleyes that showed deformity showed no apparent bumps or grooves where the spines should have been protruding.

While filleting the Walleyes, to get a better look at the dorsal fin, observations were made that there was not any spine growth under the skin of where the fish were missing parts of its spiny dorsal fin and soft-rayed dorsal fin. Gjerde et al. (2005) suggest that vertebral deformity is determined by a substantial additive genetic component. The process of inbreeding within a smaller aquatic ecosystem would suggest that inbreeding does occur at a higher rate.

According to Koumoundouros et al. (2001), of the most severe morpho-anatomical deformities is the partial or complete absence of the dorsal fin would be caused by saddleback syndrome. Saddleback syndrome affects a wide variety of species under natural and aquaculture conditions due to heritable and environmental reasons. Inbreeding could be the reason that the deformity is shown in a wide variety of age classes.

The Minnesota Department of Natural Resources regularly stocked the lake for Walleyes, Yellow Perch *Perca flavescens*, and Black Crappie *Pomoxis nigromaculatus*. The data showed 100,000 Walleye fry stocked in 2014. That batch of fry could have carried the gene for deformity with an eight-year-old specimen showing dorsal fin deformity. Other stocking efforts have been made since then. In 2016, 102,565 fry was stocked in the lake, 100,000 in 2018, and 200,000 Walleye fry in 2019 (MNDNR 2019). With age classes 2-4 showing the most dorsal fin deformity. It is speculated that the fry stocked in 2018 and 2019 had a higher rate of deformity than the stockings of 2014 and 2016.

The results of this study concluded that there was not a significant difference in condition between deformed and non-deformed Walleyes. Age classes suggests that the deformed trait goes all the way up to eight years in the Walleye's history with most of the deformed Walleye's ranging in 2-4 years of age. Relative weights are within the expected values; therefore, it is inferable that the two populations examined in this study possessed healthy condition with or without deformity being present.

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