THE GROWTH OF YELLOW PERCH IN RELATION TO ENVIRONMENTAL FACTORS

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***Abstract*—Yellow perch *Perca flavescens* is one of the major fishes in northern Minnesota. These fish are important to the ecosystems they live in but, these ecosystems are subject to change at anytime if the factors present themselves. Research was done in the past that studied water temperature, air temperature, climate events, and human activity showing their effect on fish growth. This study looks at the same four factors that influence the ecosystem in Lake Bemiji during the month of September in the years of 2017-2024. Each factor is compared to the average total lengths of yellow perch to test for a correlation between them to see how each factor impacts the growth from year to year. The only factor that indicated significance was age-3 water temperature ($P = 0.05$). Age-3 air temperature produced results that were non-significant ($P = 0.14$). Both age-0 water and air temperature also produced non-significance ($P = 0.94$, $P = 0.79$). Age-0 weather and docks exhibited non-significance as well ($P = 0.99$, $P = 0.43$). Age-3 of the same factors produced results that were non-significant ($P = 0.44$, $P = 0.18$).**

I. Introduction

Yellow perch *Perca flavescens* play a large role in the ecosystem of Lake Bemidji. This role includes being a major prey fish and a popular game fish. This means there is an abundance of yellow perch in the lake to keep up with the many roles. Thus, the population needs specific habitat conditions to reach these numbers. Factors that can influence these conditions include but are not limited to water temperature, air temperature, human activity, and storm events. Each of these factors can directly influence the growth of yellow perch and the change of one of the factors can influence a change within another. The change of these factors can decrease overall growth and could cause death, depending on the shift.

Many studies in the past used these factors as an impact on growth. Researchers found the optimal water temperature for yellow perch is 24 – 28 °C, any lower or higher indicated reduced conditions (Tidwell et al. 1999; McCormick 1976). Because of the optimal range of temperatures yellow perch need this suggests that their behavior could also change, such as feeding habits and reproduction periods (Jeppesen et al. 2010). Growth of yellow perch can also be affected through the air temperature. Results of an experiment on largemouth bass *Micropterus salmoides* showed the best climate was accumulated degree-days over 10 °C (McCauley and Kilgour 1990). Because air temperature can influence thermal habitats, the fish that are able to adjust to the temperatures will continue to grow as usual, but the fish that cannot adjust will experience decreased growth (Hill and John 1990). Though yellow perch do grow better in consistent temperatures (King et al. 1999) the shift could greatly affect them. Changes to these temperatures could be linked to extreme weather events caused by climate change.

Native species in a system can suffer from extreme weather events through fluctuating temperatures affecting growth. (Ilarri et al. 2022; Macusi et al. 2015). Due to the changes of environment from extreme weather events different conditions appear in many waterbodies and change population demographics (Spurgeon et al. 2020). Changes in waterbodies can also be due to human activity such as residential development along lakeshores. Heavy development along lakeshores can cause decreased growth in fish species and makes some species less productive (Schindler et al. 2000). Although some organisms can grow faster under these conditions because of different temperatures and lower competition (Barrett et al. 2010). Fish growth can also be pointed towards fisheries management and how fish are used as a resource. Fished populations experience increased growth and increased recruitment, which introduces a balance within the population. Unfished populations show the opposite but have balanced natural mortality and recruitment.

Because these factors have the potential to affect fish growth, correlations to freshwater fish populations need to be made. This study's main purpose is to correlate the growth of yellow perch within Lake Bemidji to water temperature, air temperature, storm events, and human activity.

II. METHODS

This study was done on Lake Bemidji using multiple different resources to collect necessary data. The device used to collect water temperature data was a YSI device that measured water temperature (C°) at 4, 11 and 16 m until the device hit the bottom. The data used in this study was the first four meters of temperatures at each predetermined site during the last two weeks of September. Yellow perch were captured using three different nets. Seine nets were either 15 x 1.2 m or 16 x 1.2 m with 6 mm mesh. Two seine hauls were pulled at six randomly selected sites perpendicular to the shore 50 m away or as far as two people could go without breaching their waders. Fyke nets were 1.2 x 1.8 m, 12 m lead, and 10 mm mesh. Gill nets were about 14.6 m long and 1.8 m high. The sizes of the mesh varied from 9.5, 12.7, 15.9, 19.1, 25.4, or 31.8 mm. One fyke and gill net was set on different dates at the six random locations on the lake.

The measurement of fish growth was the comparison of total length (TL (mm)) across the collection years of age-0 and age-3 yellow perch. Measurement of each fish was taken by using a measuring board and pinching the tail to get a total length measurement. Air temperature data was found at the National Weather Service website (NOAA 2025). Weather information was found at the National Centers for Environmental Information (NOAANCEI 2025). This site provided data about weather events that occurred during the study month. These weather events are any type of storm that could occur around this time of year, such as thunder or lightning storm. Human activity was measured through estimates of docks on and along the lake, this data was found on an ArcGIS website of Bemidji (Esri 2025). This site had arial images of Bemidji every three years, these years were 2017, 2020, and 2023. Estimates provided a gradual increase in dock amounts over the given years, so the gaps in the data were approximated.

Water temperature, air temperature, and weather information consisted of data from 2017 through 2024 during the months of September. All factors used the same metric of total length to measure growth to correlate each factor using a regression analysis.

III. RESULTS

Average age-0 lengths through 2017-2024 during September ranged from 55-68 mm. Average age-3 lengths during the same times ranged from 195-221 mm. Average water temperature from this time frame ranged from 16.73 – 20.19 °C.

The comparison of yellow perch total length to water temperature shows enough evidence that water temperature is not a significant factor to growth at age-0 (P = 0.94). Age-3 comparison indicates that water temperature is a significant factor at this stage (P = 0.05; Figure 1).

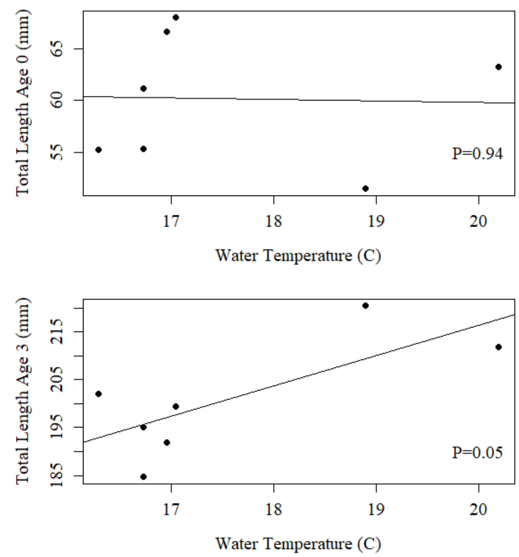

Fig. 1. The comparison of water temperature to age-0 (Top) and age-3 (Bottom) yellow perch total length through 2017-2024 during September

The air temperature comparison resulted in non-significance in both age-0 (P = 0.01) and age-3 growth. (P = 0.21; Figure 2). Average air temperature ranged from 55.5 - 65.1 °C.

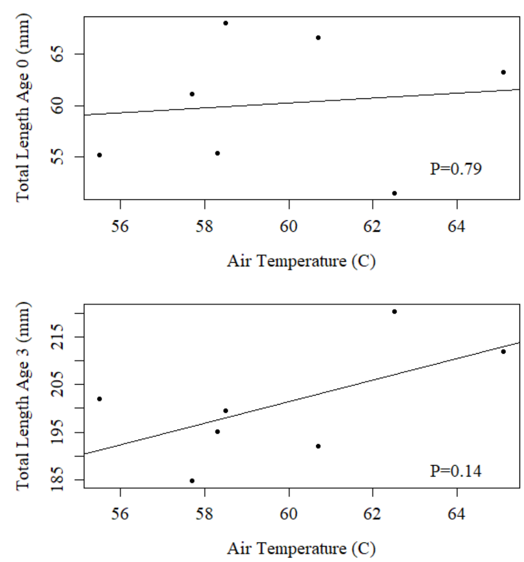

Fig. 2. The comparison of air temperature to age-0 (Top) and age-3 (Bottom) yellow perch total length through 2017-2024 during September

Both age-0 and age-3 comparison to the amount of weather events showed no significance to growth. Age-0 had a p-value of 0.99, age-3 had a p-value of 0.44 (Figure 3). The total amount of weather events in September ranged from 0 – 2.

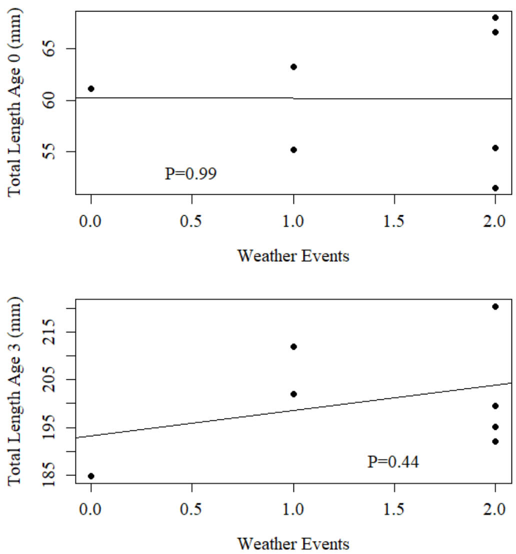

Fig. 3. The comparison of age-0 (top) and age-3 (bottom) yellow perch total length to the amount of weather events through 2017-2024 during September

The number of docks in the lake showed no significance to the total lengths of age-0 and age-3 yellow perch. Age-0 had a p-value of 0.43, age-3 had a p-value of 0.18 (Figure 4). The estimated number of docks ranged from 100 – 273.

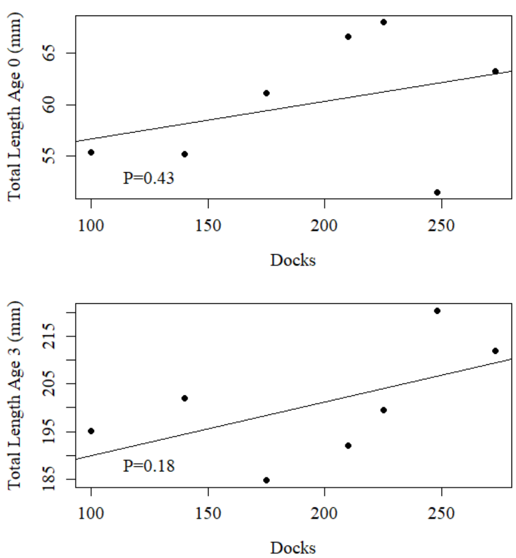

Fig. 4. The comparison of docks in and around the lake to the total lengths of age-0 (top) and age-3 (bottom) yellow perch through 2017-2024

IV. Discussion

One of the key findings of this study is that only the age-3 water temperature comparison indicated significance to growth. Age-0 water temperature showed much higher non-significance at 0.94. The difference in significance between age-0 and age-3 yellow perch could have been because of the optimal water temperature for growth could have shifted as the fish grew older. Although the average water temperature was lower than the previously studied optimal temperatures reported by Tidwell (1999) and McCormick (1976). Resulting in possible slower growth around this time of year. Air temperature could have also changed the thermal habitats of yellow perch shifting optimal growth temperature. Though the air temperature comparison showed non-significance in both age-0 and age-3 yellow perch. In this case the age-3 yellow perch comparison was closer to significance at 0.14.

Another key finding is that the amount of weather events and the number of docks in the lake has no significance to the growth of yellow perch in both age classes. Weather events were unlikely to have significance due to the short time frame of data that was used. Only using weather events during September may have not affected the growth of yellow perch enough to show significance in the analysis. Although weather events can change population demographics in a lake (Spurgeon et al. 2020) this would most likely be multiple events over an extended period of time. The number of docks produced results that were non-significant due to the docks themselves not impacting the ecosystem enough to cause change. This could have been because the development along the lakeshore was not as heavy as other areas in the state (Schindler et al. 2000). Though age-3 indicated that docks were closer to significance at 0.18. Although the docks themselves may cause little change near where they are placed, this is not enough the cause change in yellow perch. One thing that may cause change near the docks is the human development along the lakeshore as well as the people that own and use the docks (Schindler et al. 2000). This could be in the form of garbage, introduction of invasive species by boat, or general use by humans. This could impact the growth of yellow perch in a negative way.

Overall this study can provide data when monitoring yellow perch populations in lakes or when raising yellow perch in a hatchery. It could also provide data on how different factors influence yellow perch growth and could be intergrated into a management plan. It’s important to understand how many different factors can influence an animal’s growth , no matter how small the factor may seem. This is important because one factor could be the leading factor in that animal’s growth. Many of these factors can be changed very easily causing change within the animal for better or worse.

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