RELATIONSHIP BETWEEN NORTHERN PIKE AND WALLEYE CPUE IN MINNESOTA LAKES

Simon Oslund
Department of Biology, Aquatic Biology Program
Bemidji State University
Bemidji, MN, USA
simon.oslund@live.bemidjistate.edu
Faculty Sponsor: Dr. Andrew W. Hafs (andrew.hafs@bemidjistate.edu)

Abstract **– Northern pike *Esox lucius* and walleye *Sander vitreus* are both top predators in freshwater systems. Due to their predatorial nature, high populations of one species can prohibit populations of the other species from thriving, specifically northern pike foraging on walleye. This information is tracked by the Minnesota Department of Natural Resources through catch per unit effort (CPUE). CPUE data was gathered for all lakes in Beltrami County, Minnesota, and a regression analysis was done to test for a relationship between pike and walleye. It was found that the relationship between northern pike and walleye CPUE was significant (*P* = 0.02). As northern pike CPUE increased, walleye CPUE decreased. A relationship between both northern pike (*P* = 0.02) and walleye (*P* < 0.01) CPUE and lake size was also found. As lake size increased, walleye CPUE increased and northern pike CPUE decreased. Northern pike were found to be more abundant in smaller lakes, and walleye were more abundant in larger lakes.**

I. INTRODUCTION

Every ecosystem, terrestrial or aquatic, consists of a trophic pyramid that shows how energy is transferred by the organisms living in it. At the top of these pyramids are the predators in the system. Walleye *Sander vitreus* and northern pike *Esox lucius* are two of the most prominent predator species of fish in Minnesota. Northern pike, being the most widespread game fish in the state, are known to be highly aggressive and a popular target for anglers (Paukert et al. 2001).

Fish populations are often estimated by relative abundance and catch per unit effort (CPUE). Abundance is the total number of fish in a population or biomass collected over a specific period of time and space. Catch per unit effort is compared to abundance by being a measure of relative density of the fish population (Dunn et al. 2000).

Northern pike and Walleye occupy many of the same bodies of water and because of this, they share a lot of the same food sources. A study done in Minnesota shows that there is an overlap in walleye and northern pike diets by 33%-53% (Herwig et al. 2021). Part of this diet overlap includes walleye as prey. Walleye, like many other fishes, are known to exhibit cannibalism (Zhou 2017). Pike will also regularly consume walleye, especially during the spring and fall seasons (Ahrenstorff and Holbrook 2016).

Walleye fry and fingerlings are great forage for northern pike. Being that fry and fingerlings are usually what is stocked into systems with minimal or no natural walleye reproduction, pike can be quick to eat those small fish. This is why lakes with high northern pike CPUE usually cannot support much of a walleye population (Raabe et al. 2020). The objective of this study was to test for a relationship between northern pike and walleye CPUE in Minnesota lakes.

II. METHODS

This study was based off gill net CPUE data of all lakes in Beltrami County, provided publicly by the Minnesota Department of Natural Resources (MNDNR 2023). There were 183 lakes in Beltrami County, Minnesota, 36 lakes had gill net data for both northern pike and walleye, only these lakes were used. Data was collected from these lake surveys alphabetically and recorded in an excel spreadsheet.

Surveys of these lakes took place at various times of the year, usually being spring through early fall. Surveys were only used if they have taken place since 2010. Gill nets were set on a one-day basis, though the survey itself may last a week or longer. Nets are set one morning and left in the water for 24 hours. Then they are retrieved at roughly the same time the following day to be processed. This is when lengths, weights, counts, and aging structures of fish are taken. CPUE is calculated by taking the total number of fish caught per species and dividing that number by the total number of nets set throughout the survey. CPUE of both northern pike and walleye were recorded for this study, along with which lake they were surveyed from and the size of that lake in acres.

Three separate regression analyses were performed. The first regression analysis was to directly test for a relationship between northern pike and walleye CPUE. The second and third regression tests were analyzing the potential relationship between total acreage of a lake and how that may influence CPUE of northern pike or walleye.

III. Results

Data was collected from 36 lakes in Beltrami County. Northern pike CPUE had a significant influence on walleye CPUE (P=0.016). As northern pike CPUE increased, walleye CPUE decreased (Figure 1). Northern pike CPUE significantly decreased as lake size increased ($P = 0.02$; Figure 2). Black Lake was 271 acres and had the highest CPUE of northern pike with 19.25 fish/net. Big Bass Lake was 337 acres and had the second highest CPUE of northern pike with 18.89 fish/net. Grant Lake was 214 acres and had the third highest CPUE of northern pike with 17.33 fish/net.

Walleye CPUE significantly increased in lakes of larger sizes ($P < 0.01$; Figure 3). Blackduck Lake was 2,711 acres and had the highest CPUE of walleye with 18.47 fish/net. Balm lake was 537 acres and had the second highest CPUE of walleye with 15.67 fish/net. Lake Bemidji was 6,596 acres and had the third highest CPUE of walleye with 13.67 fish/net.

IV. Discussion

The key finding of this study shows that northern pike CPUE has a significant negative relationship with walleye CPUE. A Wisconsin study on stocked walleye and their competition with other game fish found that not only do northern pike prey on juvenile walleye, but they also regularly compete with them for food (Fayram et al. 2005). These findings can be inferenced for Minnesota lakes as well. Suggesting the inverse relationship of northern pike and walleye abundance could be due to predation or the fact that northern pike are outcompeting walleye for food. Either result leads to an increase in natural mortality rates for walleye found in lakes with high abundance of northern pike.

The results also show opposite relationships between northern pike CPUE and walleye CPUE when compared to lake size. The correlation between lake size and walleye CPUE got stronger as lake size increased. This positive relationship was also found in a study on walleye abundance and lake surface area in northern Wisconsin (Nate et al. 2000). One factor found that could influence walleye recruitment in these smaller lakes is lack of spawning habitat (Moyle 1946; Kitchell et al. 1977). In order to spawn, walleye require gravel or cobble found on shorelines, mid-lake humps or reefs, point bars, or island shoreline (Bozek et al. 2011).

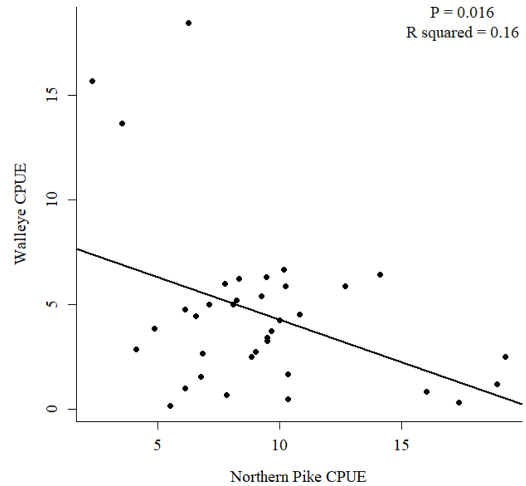

Fig. 1. Scatterplot depicting lakes in Beltrami County, Minnesota, and their respective northern pike and walleye CPUE values.

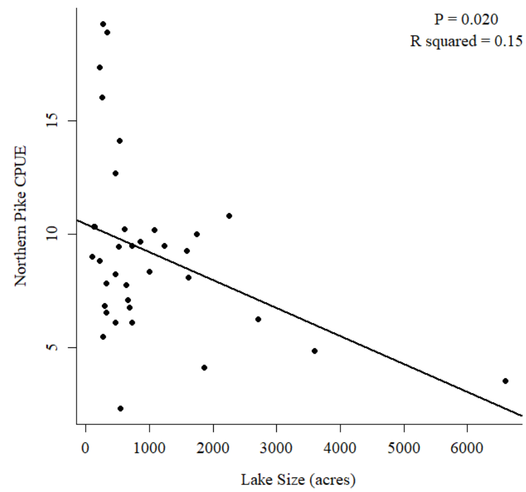

Fig. 2. Scatterplot depicting lakes in Beltrami County, Minnesota, plotted by size in acres and northern pike CPUE values.

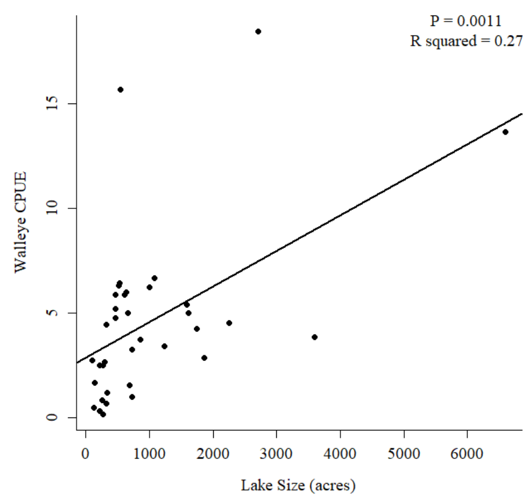

Fig. 3. Scatterplot depicting lakes in Beltrami County, Minnesota, plotted by size in acres and walleye CPUE values.

These types of habitats are not as common in small lakes as in large lakes because many smaller lakes have a higher littoral area, allowing the sun to reach the substrate, causing vegetation to grow with ease. However, these shallow, vegetation dense areas are ideal for northern pike spawning.

Northern pike generally spawn in shallow patches of flooded vegetation, preferably grasses and sedges, but other aquatic plants are used as well (Casselman and Lewis 1996). The recent introduction of zebra mussels into new bodies of water could also influence the ability of fish to spawn. Zebra mussels are filter feeders, feeding on phytoplankton suspended in the water column. In the absence of these phytoplankton, water clarity can increase. This improves the ability of the sun to penetrate to depths otherwise no sun light would reach, increasing plant growth, creating more habitat suitable for northern pike to spawn, and eliminating potential walleye spawning habitat.

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