Relationship between Zooplankton and Walleye Rearing Pond Success

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Walleye *Sander vitreus* are an important sport fish in Minnesota. This has led to the raising of Walleye in ponds to later be stocked into lakes. This study was done to determine the relationship between Walleye prey (zooplankton) and the success of Walleye in 11 stocked ponds in the Ortonville, MN area. There was no management of the ponds until harvest, which starts in late September and ends in November. There were significant positive relationships between rotifer density ($P = 0.03$) and nauplii density ($P = 0.04$) to kg of Walleye harvested. The setting where nauplii and rotifer density are high in rearing ponds plays a significant role in determining the overall harvest in Walleye rearing ponds and should be an important consideration in future pond selections.

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Introduction

The growth of young Walleye *Sander vitreus* and many other young fishes depend greatly on their access to food. Walleye diet changes throughout their first year of life. So, the availability of their changing food resources can influence growth and survival. After Walleye finish absorbing the nutrients from their egg they begin feeding on zooplankton. Walleye are about 8 mm total length (TL) at that time. Then they switch to macroinvertebrates at 35-50 mm TL and eventually to fish at 60-80 mm TL (Priegel 1969; Mathias and Li 1982; Galarowicz and Wahl 2005). Walleye growth and survival are correlated with planktonic prey densities and nutrient levels (Knoll and Galarowicz 2011). An increase in zooplankton density has been shown to affect both growth and survival of larval Walleye (Mayer and Wahl 1997; Hoxmeier et al. 2011).

The Minnesota Department of Natural Resources (MNDNR) stock Walleye into approximately 900 lakes throughout the state. Walleye populations have continued to increase in stocked lakes since 1977, even though fewer Walleyes are stocked now than in the 1980's (MNDNR 2017). Most lakes that are stocked receive an average of 1,000 fry or 1.12 kg of fingerlings per hectare (1 pound/acre). About two-thirds of the fry are stocked a few days after hatching. The rest are reared over the summer to fingerling size (90-150 mm) in over 200 rearing ponds within the state. Rearing ponds are winterkill wetlands and small lakes (MNDNR 2017). Many times, throughout a region a certain size of fish is stocked because of its availability or increased potential for survival (Brooks et al. 2002). Economic reasons are another reason why MNDNR raise fingerlings rather than just stocking fry. Knowing what type of conditions produce more Walleye in rearing ponds will help with stocking efficiency. Prey availability, predators, and abiotic factors could all affect growth and survival of stocked Walleye. This study focuses on the prey of age-0 Walleye.

The objective of this study was to see if there were any relationships with zooplankton densities and the success of age-0 Walleye in rearing pond harvest. Success of the ponds was measured by kg per Ha harvested. Specifically, the study examined the relationships of the kg per Ha of Walleye caught at the end of harvest against both total zooplankton density and individual species densities.

Methods

Samples of zooplankton were collected every three weeks from 26 May - 20 July 2016. Samples were collected from 11 rearing ponds within the Ortonville Fisheries area. The ponds were preselected by the Ortonville crew. A vertical zooplankton cylinder with a known volume of three liters was taken from a boat at three sites on each pond. The three sites at each pond were randomly selected to prevent bias. The sample was then filtered through an 80-micron screen and the zooplankton were preserved with alcohol.

Zooplankton within the samples were then counted under a dissecting scope using a zooplankton wheel and counters. Three mL were pipetted into the wheel. If there were more than 80 individuals in the three mL, then the sample was sub-sampled. If there were less than 80 individuals in the first three mL, then the sample was counted in its' entirety. If the sample had more than 80 individuals, it would be made into a 100-mL solution with distilled water. Then, two mL would be taken from the solution, placed into the wheel and enumerated. This was done three separate times. The total count of all three was then averaged and multiplied by 50 to get the final count for that sample.

Walleye in the ponds were harvested starting in late September through the end of November, or until no more Walleye were caught. The total area of the ponds was measured. The total harvest weight and number of age-0 Walleye were obtained. From those numbers, we calculated how many kg/Ha of Walleye there were in each pond.

Data Analysis

Both Walleye harvest weight per Ha and zooplankton densities were natural log transformed to normalize the data. Linear regression models were then run to test if Walleye harvest weight per Ha was related to total zooplankton density and/or the density of individual species throughout the summer.

Results

The total mean zooplankton density was comprised of: rotifers, cyclopoids, calanoids, *Daphnia sp.*, *Bosmina sp.*, *Diaphanosoma sp.*, nauplii, and *Chydorous sp.* throughout the summer. Rotifers had the most individuals per pond on average, followed by nauplii then cyclopoids. There was an average of 467 individual zooplankton per liter per pond with a range of 73.79-1264.45 individuals and a variance of 120,653.8. The average kg per Ha harvested per pond was 152.57 with a range of 0.12-27.46 kg per Ha, and a variance of 67.93. Total zooplankton density had a positive relationship compared to kg of Walleye harvested but was insignificant ($P = 0.08$; Figure 1).

There was a positive significant relationship between kg of Walleye harvested and mean rotifer density ($P = 0.03$; Figure 2). There was an average of 151.67 individual rotifer per liter per pond through the summer. Rotifer mean density had a range of 0.47-637.56 individuals and a variance of 52,113.98. There was also a positive significant relationship between kg of Walleye harvested and mean nauplii density ($P = 0.04$; Figure 3). There was an average of 109.12 individual nauplii per liter per pond through the summer. Nauplii mean density had a range of 11.22-344.92 individuals and a variance of 11,166.51. Cyclopoids did not have a significant relationship but did have a positive relationship with a low p-value ($P = 0.06$; Figure 4). None of the other organisms showed any significance in relation to Walleye weight harvested.

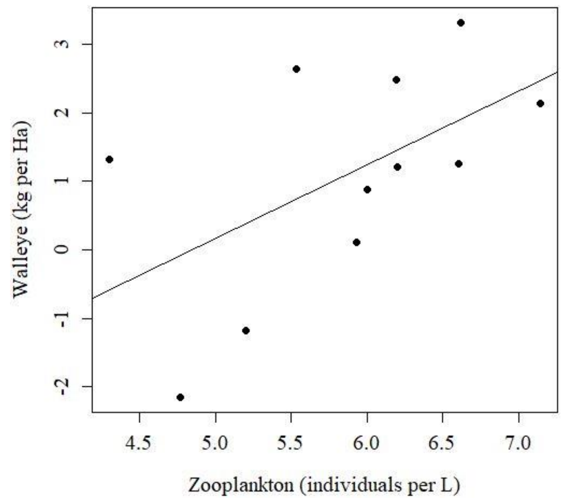

Figure 1. The relationship between natural log transformed mean zooplankton density from 26 May - 20 July 2017 and natural log transformed mean weight of Walleye per Ha ($P = 0.08$).

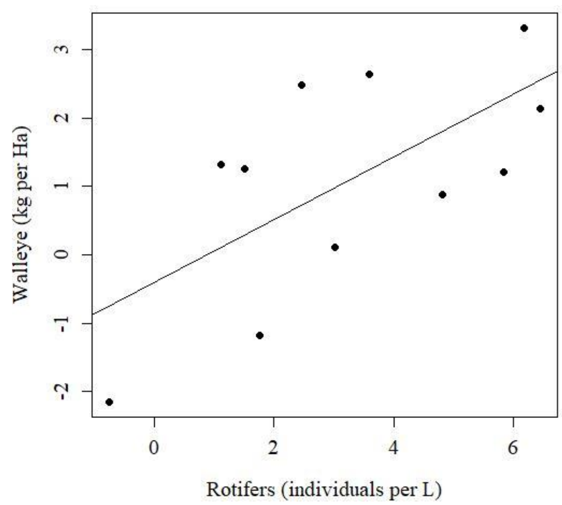

Figure 2. The relationship between natural log transformed mean rotifer density from 26 May - 20 July 2017 and natural log transformed mean weight of Walleye per Ha ($P = 0.03$).

Discussion

The larger the total zooplankton count the more kilograms of total Walleye were harvested from the ponds. Prey availability is an important factor influencing Walleye survival (Hoxmeier et al. 2011). Juvenile Walleye growth can also be regulated by the density of available prey (Fox 2011). The higher the zooplankton density the more fish survive and grow. This can lead to the higher mass of Walleye harvested in the ponds.

In this study, rotifer and nauplii densities were both strongly related to Walleye rearing pond success. Nauplii and rotifers are both rarely consumed by age-0 Walleye (Houde 1967; Mathias and Li 1982; Hoxmeier et al. 2004). The high number of nauplii could have been supplementing the calanoid and cyclopoid densities. Age-0 stomach content biomass has been shown to have 60 to 80% calanoids (Roseman 1997). While the calanoid and cyclopoids were being eaten and reproducing, the nauplii were growing to take the place of those that were eaten. A high nauplii density should lead to a high calanoid and cyclopoid density. The data did not show a high calanoid or cyclopoid density suggesting they may have been eaten. The high rotifer density throughout the summer may be due to low cladoceran density. Age-0 walleye also feed heavily on cladoceran, like *Daphnia sp*., *Bosmina sp.*, *Diaphanosoma sp*., and *Chydorous sp.* (Roseman 1997). Large cladoceran can suppress rotifers through competition for shared food resources (MacIsaac and Gilbert 1991). With a lower number of cladocerans, the rotifers likely flourished. Therefore, significant relationships of nauplii and rotifers to Walleye pond success may be the result of indirect relationships.

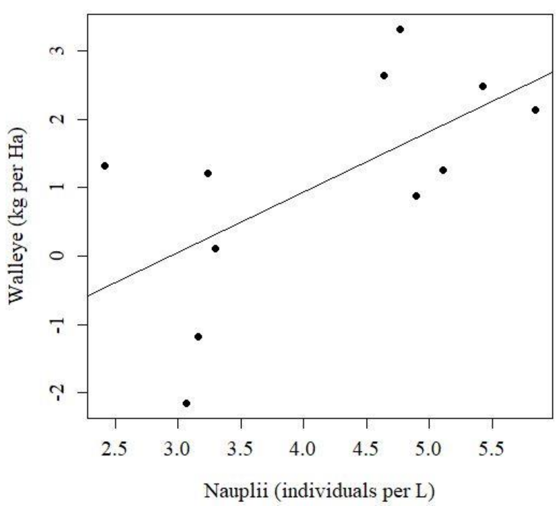

Figure 3. The relationship between natural log transformed mean nauplii density from 26 May - 20 July 2017 and natural log transformed mean weight of Walleye per Ha (*P* = 0.04).

Calanoida, cyclopoida, and *Daphnia sp.* density should be considered when selecting Walleye rearing ponds. Selecting for calanoida, cyclopoida, and *Daphnia sp.* high density ponds will give Walleye fry large prey availability. Prey availability is an important factor for walleye survival across all size groups (Hoxmeier et. al 2004). Having a larger total zooplankton density could also lead to a higher survival of Walleye. The higher survival could then lead to a higher harvest. Results from this study suggested that there was a positive relationship for rotifer and nauplii density compared to Walleye success throughout the summer. This may be due to Walleye eating calanoida, cyclopoida, and *Daphnia sp.*

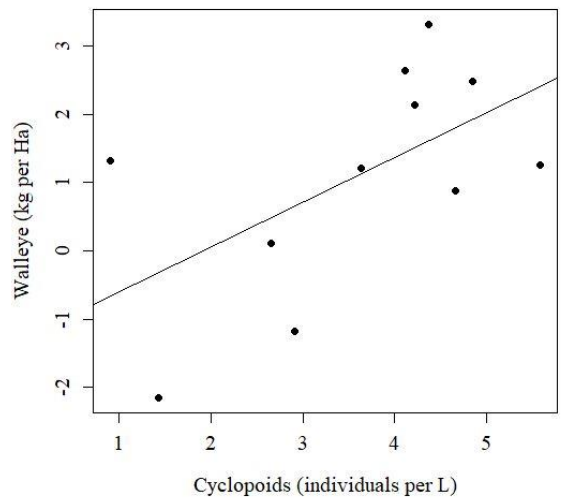

Figure 4. The relationship between natural log transformed mean cyclopoid density from 26 May - 20 July 2017 and natural log transformed mean weight of Walleye per Ha (*P* = 0.06).

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