Seasonal Fluctuations of Zooplankton, Dissolved Oxygen, and Temperature in Lake Bemidji, Minnesota

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With the current influx of aquatic invasive species in Minnesota lakes, the status of zooplankton has become vital. Zooplankton are at the base of all food chains in aquatic ecosystems, ecosystems that vary greatly throughout a year's time. The objectives of this study were to 1) track the location of zooplankton throughout the water column for an entire year, and 2) establish relationships between zooplankton location and specific water column characteristics. Zooplankton, dissolved oxygen, and temperature samples were collected bi-monthly at various depths at the deepest point in the southern basin of Lake Bemidji. Zooplankton were most abundant in the summer with densities ranging from 5-31 specimens per liter, with the highest densities being found in 3-8 meters of water. Densities during the winter ranged from 3-14 specimens per liter while being more homogenous in the water column. Dissolved oxygen remained high in the epilimnion throughout the year, peaking at 14.91 mg/L on 2 May 2017. A steady decline of dissolved oxygen as depth increased was observed in both winter and summer months with the lowest reading being 0.01 mg/L at 15 meters of depth on 15 September 2017. Temperature peaked in the epilimnion at 21.5 °C in the summer with it ranging from -0.5-3.4 °C in the winter. Hopefully these results will help fisheries managers and others interested in this field better understand the trends in zooplankton densities in lakes.

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Introduction

Recruitment of larval fishes is a critical point in ensuring a successful fishery for the future, with both biotic and abiotic factors having major influences. Forage abundance and type have been determined as important biotic factors (Morris and Mischke 1999) with the important abiotic factors being temperature and oxygen (Claramunt and Wahl 2000). Both factors vary spatially and temporally, with different trends following seasonal patterns both short and long term.

Zooplankton provide important forage for larval fishes, however their populations fluctuate over time. Predation is the major limiting factor of zooplankton populations, with other factors such as light intensity and water viscosity also influencing the populations (Gliwicz and Pijanowska 1989). Low dissolved oxygen levels can directly affect zooplankton, causing them to migrate horizontally or vertically in the water column (Decker et al. 2004). These shifts in position and density may greatly affect predator-prey relationships and feeding behaviors of larval fish.

Dissolved oxygen concentrations and water temperatures are major driving forces for fish growth and development (Jobling 2008). Understanding the effects of oxygen levels and temperature variation may lead to a better understanding of larval fish recruitment. Therefore, the objective of this study is to measure zooplankton densities for the duration of a year and correlate the findings to dissolved oxygen and temperature.

Methods

Zooplankton, dissolved oxygen, and temperature readings were conducted bimonthly in the southern basin of Lake Bemidji (47°28.602' N, 94°51.690' W) with sampling taking place on approximately the 1st and 15th of each month. Sampling began on 15 November 2016 and concluded on 1 November 2017. Access to this area depended on the season, with a watercraft being used during open water periods and vehicle or foot travel during ice cover.

Dissolved oxygen (mg/L) and temperature (°C) were measured with a YSI Professional Plus meter. Dissolved oxygen and temperature measurements were recorded concurrently at 1-meter intervals beginning at the surface of the water. Sampling

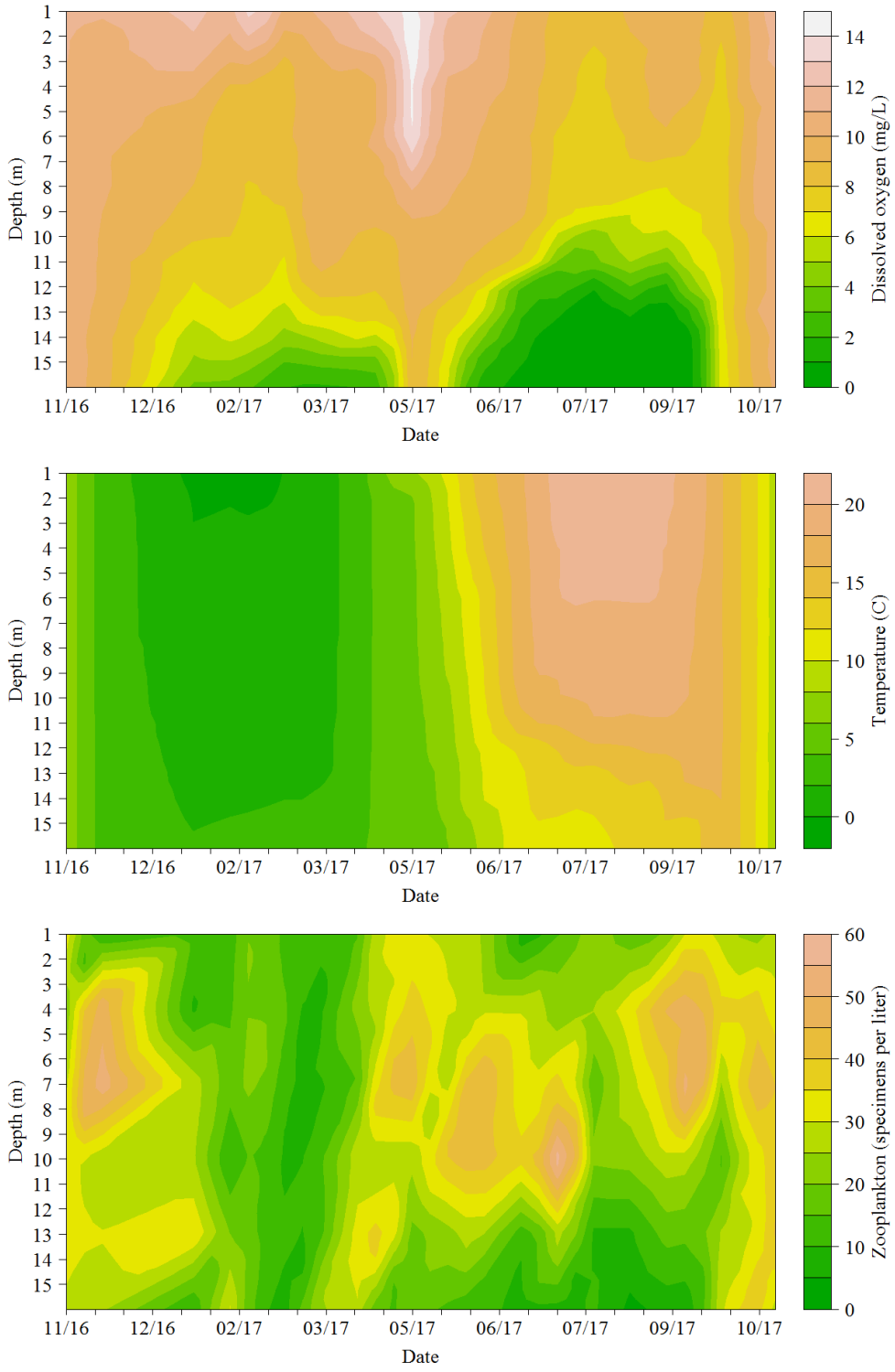

Figure 1. Dissolved oxygen, temperature, and zooplankton densities measured on Lake Bemidji from 15 November 2016 – 25 October 2017.

stopped at 15 meters for a total of 16 readings each sampling period.

Zooplankton were collected with a two-liter Kemmerer sampler at three-meter increments starting at the surface and ending at 15 meters for a total of six samples. Depths were marked on the rope attached to the Kemmerer with a meter stick and marker. After locking open the Kemmerer it was

lowered to the desired depth. A weight attached to the rope was released and descended, hitting the Kemmerer lid with enough force to close the device. The sample was then retrieved and the two liters of water were filtered through an 80-micron screen, removing any zooplankton. The 80-micron screen ensured that all copepods and cladocerans were captured (Fry and Osborne 1980). The screen was rinsed in 95% ethanol with its contents being emptied into a marked bottle also containing ethanol. This process was repeated for each of the six depths.

Zooplankton from each individual depth were counted. A dissecting scope was used during the process of counting. All data collected was arranged chronologically by date starting with 15 November 2016 and ending with 25 October 2017. Filled contour plots were created in Program R for dissolved oxygen, temperature, and zooplankton sampled, with depth on the y-axis and dates sampled on the x-axis.

Results

Lower zooplankton densities were observed during the ice over period with an average of 16 specimens per liter (SD = 12.31). Zooplankton were homogeneous in the water column with there being no distinct preference in temperature or dissolved oxygen (Figure 1). Dissolved oxygen stratified during this period with it being at the top of the water column with a peak at 13.90 mg/L and steadily decreased towards the bottom with 1.84 mg/L being the lowest reading (Figure 1). Temperature also stratified during this period with colder water temperatures at the surface with temperature increasing with depth (Figure 1).

Zooplankton densities appeared to be higher during summer sampling with the highest densities being found in the metalimnion with an average of 24 specimens per liter (SD = 7.48; Figure 1). Dissolved oxygen peaked in the epilimnion at 14.91 mg/L with the lowest reading being taken in the hypolimnion where it was found to be 0.01 mg/L (Figure 1). Temperature stratified the greatest during this period with the highest reading being 21.5 °C in the epilimnion and the lowest being 11.3 °C in the hypolimnion (Figure 1).

Discussion

The results of this experiment suggest that zooplankton densities fluctuated in the water column as dissolved oxygen and temperature changed throughout the sampling period. Zooplankton production is influenced by water temperature with colder temperatures often leading to a decrease in production, however, the strength of this relationship varies from species to species (Vijverberg 1980). Lower zooplankton densities during periods of ice and snow cover may have been the result of low light levels which in return lead to lower phytoplankton production.

Zooplankton densities peaked in mid-June in the metalimnion where the water was constantly mixing. The metalimnion provides the most diverse conditions for zooplankton because of the constant temperature change and high levels of dissolved oxygen (Miracle 1974). Migration of larval fishes from the littoral zone to the pelagic zone coordinate with the greatest abundance of zooplankton present, with zooplankton becoming forage for these fish.

Future monitoring of zooplankton densities could be beneficial for determining year class strength and survival of age-0 fish. Surveying and examining larval fish diets during zooplankton sampling may help better understand their utilization of these organisms. Expanding this experiment to more lakes, both different in size and chemistry, may show similar trends or identify unique differences.

References

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