

Undergraduate Thesis

**ZOOPLANKTON POPULATION DYNAMICS IN CLAYTON COUNTY WATER
AUTHORITY RESERVOIRS**

by

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ABSTRACT

Reservoirs supply most of Georgia's drinking water, and plankton dynamics can greatly influence the water quality of these reservoirs. Therefore, understanding the dynamics of zooplankton as well as phytoplankton is necessary. Unlike reservoirs in the northern United States, zooplankton dynamics in reservoirs in the South remain largely uncharacterized. Samples were collected from the Clayton County Water Authority reservoirs to study correlations between zooplankton taxa distribution and environmental variables. Population count data has demonstrated that the zooplankton dynamics in southern lakes vary from the dynamics typically seen in northern lakes. While temperature noticeably shaped seasonal densities in some species, other species had variable dynamics and seemed to not be affected by this environmental factor or other taxa of zooplankton, suggesting additional factors may regulate population composition and abundance.

1. INTRODUCTION

Studies of zooplankton dynamics have been conducted widely in the northern United States (Carpenter et al. 1987, Wetzel 1983) but not in the South. Zooplankton have vital roles in lake food webs because they regulate the populations of phytoplankton by consuming them (Wetzel 1983). Consequently, changes in the density of zooplankton will result in an alteration of phytoplankton dynamics (Carpenter et al. 1987). Previous research in the Duffy Lab at Georgia Tech has found that zooplankton dynamics in southern lakes exhibit different trends than the dynamics typically seen in northern lakes, which may be attributed to the different climates. In the North, zooplankton have greatly reduced densities during the winter months (Sommer et al. 1986). However, in the South, zooplankton are abundant throughout the winter.

Reservoirs provide much of the drinking water supplied to Georgia, and plankton can greatly influence the water quality of these reservoirs. Uncontrolled growth of certain species of phytoplankton can increase toxicity levels in the water (Watson 2004). This can lead to an unpleasant taste, especially if these toxins are produced in drinking water and if poor filtration systems exist (Watson 2004). Similarly, diseases can be spread through zooplankton. For instance, cholera outbreaks in developing countries have been linked to zooplankton that support the growth of *Vibrio cholerae*, the infectious agent of cholera, and can aid in its spread through unfiltered or poorly filtered drinking water (Huq et al. 1996). It has been observed that cholera outbreaks are rampant after plankton blooms (Huq et al. 1996).

Although improving water quality can certainly be an application of this research, the initial goal should be to understand the dynamics of zooplankton and phytoplankton. Then the drivers of plankton dynamics can be identified. Furthermore, as stated previously, the dynamics of zooplankton in the South are less familiar. Population count data would provide a greater understanding of the zooplankton community that exists in the South, clarifying the role of these zooplankton in reservoir systems.

The objective of this research is to study the dynamics of zooplankton in Georgia reservoirs, specifically the Clayton County Water Authority reservoirs. Seasonal trends in zooplankton dynamics and overall densities along with relative densities of different zooplankton taxa are of particular interest.

The analysis of zooplankton dynamics can be used to infer the environmental conditions of the reservoirs in Georgia (Jeppesen et al. 1999). By characterizing the zooplankton dynamics of the Clayton County reservoirs, the ecological or trophic status of the system can be assessed (Jeppesen et al. 1999). This will allow an appropriate treatment plan to be devised if adverse conditions are indicated. Furthermore, understanding their dynamics will reveal the factors regulating population composition and abundance.

2. LITERATURE REVIEW

Seasonal distributions of zooplankton are difficult to generalize in some regions. Variations in seasonal distribution commonly exist, and furthermore, little is known about seasonal succession in warm regions (Wetzel 1983). This study will help characterize zooplankton dynamics in the South, particularly in Georgia, and will provide an overview on the variations in seasonal succession of zooplankton in warm regions. Here, we will study zooplankton to analyze their seasonal dynamics and to investigate possible environmental drivers for the changes in their population.

2.1 Zooplankton Taxa

Zooplankton in lakes are classified into three major groups: the Rotifera and the Cladocera and Copepoda, which are both subclasses of the Crustacea (Wetzel 1983).

2.1.1 Rotifera

Rotifers vary widely in their morphology, but most species have distinguishable head, trunk, and foot regions as well as an elongated body (Wetzel 1983). Feeding occurs by moving organic matter to the mouth cavity by using cilia (Wetzel 1983). This ciliated region around the mouth, called a corona, is also used for locomotion. All rotifers have a muscular pharynx, the mastax, which contains a set of jaws called trophi (Wallace and Snell 2010). Rotifers mostly have asexual reproduction via cyclical parthenogenesis, but sexual reproduction can occur when there is a switch from an amictic phase, where males are absent, to a mictic phase, where males are produced (Wallace and Snell 2010).

Although most rotifers are nonpredatory, the largest rotifers, the *Asplanchna*, feed on algae and other rotifers. Species of the genus *Asplanchna* draw in prey by creating suction with the mastax and then squeeze the prey into the stomach by using the trophi (Wallace and Snell 2010). Furthermore, *Asplanchna*, which lack both an intestine and anus, use the trophi to remove undigested matter from the stomach (Wallace and Snell 2010). Though most rotifers are oviparous (that is, having embryos that develop outside the body), *Asplanchna* are ovoviviparous, and embryos develop within the body until hatched. In the mictic phase, *Asplanchna* produce males that are structurally reduced and possess certain degenerate organs, a condition known as male dwarfism (Wallace and Snell 2010). Rotifers can be free-swimming, sessile, or a combination of both throughout their life period. Locomotion is important for *Asplanchna* because this rotifer actively acquires its food (Wallace and Snell 2010).

Conochilus, another species that will be studied, can exist alone or as a colony. Colonial rotifers usually form colonies of only a few individuals or of intermediate sizes. Larger colonial formation may be an adaptive response to heavy predation (Walsh et al. 2006). *Conochilus* form colonies autorecruitively in which the young join their parental colony, increasing the size of the colony (Wallace and Snell 2010). Consequently, genetic relatedness is high in autorecruitive colony formation, and possible consequences include a higher vulnerability to parasitic infections and a reduced genetic diversity among diapausing embryos (Wallace and Snell 2010). However, colonial forms display a longer lifespan and an enhanced ability to avoid engulfment by predators than solitary individuals (Walsh et al. 2006, Wallace and Snell 2010).

Rotifers have widely served as biological indicators and in previous studies, the relationship between toxins and rotifer predator-prey interactions and composition has been explored (Lagadic and Caquet 1998, Wallace and Snell 2010). Such toxicity tests included exposing the rotifers to insecticides, crude oil, heavy metals, and petrochemicals (Radix et al. 2000). Previous studies have found rotifers to be good indicators of water quality (Lagadic and Caquet 1998, Wallace and Snell 2010).

2.1.2 Cladocera

Crustacean arthropods are largely aquatic, and in freshwater systems, cladocerans and copepods are the most prevalent of the Crustacea. Physical characteristics include jointed appendages and a segmented body, but this noticeable segmentation has been lost in the cladocerans (Wetzel 1983). Cladocerans, commonly known as “water fleas,” have a distinct head, a single compound eye, and a large mandible for grinding food particles (Wetzel 1983).

Cladocerans reproduce mostly asexually via parthenogenesis but can reproduce sexually based on the environmental conditions (Zadereev 2003). Resting eggs from fertilization or, in some species, asexual reproduction can be produced if the presence of crowding or toxic food is signaled (Dodson et al. 2010, Zadereev 2003). This causes the carapace, an extension of its back, to thicken, called the ephippium. These eggs are resistant to desiccation and can survive on dry land or in water sediments for lengthy periods of time (Mort 1991). Leaving diapause, which is a halt in its growth cycle, requires favorable stimuli from the environment (Dodson et al. 2010).

Development in size occurs through molting. The rate at which they develop depends on the amount of stored energy. Cladocerans feed on algae, small rotifers, and copepod nauplii (Dodson et al. 2010). Their metabolic rate is variable with temperature, and death can occur above the required optimal temperature (Dodson et al. 2010). Under food limiting conditions, a smaller body size is favored (Dodson et al. 2010). For example, *Bosmina* may be able to out-compete a larger species because it could grow faster when food is limited (Sommer et al. 1986). Additionally, cladocerans that have a larger body size seem to be scarce when fish are present as fish are visual predators (Sommer et al. 1986).

Cladoceran populations expand in conjunction with algae bloom (Abrantes et al. 2006). They are most abundant in the spring in northern areas and in the rainy season in southern areas. Growth is limited during cold conditions (Abrantes et al. 2006, Dodson et al. 2010). *Daphnia* and, to a lesser extent, *Bosmina* can effectively graze on large abundances of algae, and therefore, contribute to improving water quality, which is dependent on algae dynamics (Dodson et al. 2010).

2.1.3 Copepoda

The free-living copepods are divided into three suborders: the Calanoida, the Cyclopoida, and the Harpacticoida (Wetzel 1983). Copepods have a segmented body with an exoskeleton and five pairs of jointed appendages (Reid and Williamson 2010). The first antennae, one of the notable appendages, have roles in reproduction, locomotion, and feeding. Calanoids and cyclopoids can be distinguished by their first antennae, with calanoids possessing the longer antennae (Wetzel 1983).

Copepods live in a variety of aquatic habitats, such as marine and freshwater environments. They feed on algae, other invertebrates, and larval fish. Cyclopoids grasp their prey and eat larger prey than calanoids, which create currents to bring in food (Reid and Williamson 2010). The relative abundances of calanoids versus cyclopoids can change based on food availability. When productivity increases, calanoids decrease in abundance while cyclopoids and cladocerans increase in abundance (Soto and Hurlbert 1991). Calanoids may survive on lower densities of food than cyclopoids, which may contribute to this difference (Reid and Williamson 2010).

Unlike cladocerans and rotifers, copepods only reproduce sexually and have a larval stage called the nauplius. Temperature, food availability, and predation heavily influence their mating behavior and variations in their dynamics (Reid and Williamson 2010, Varpe et al. 2007). Egg development and clutch size have been known to be dependent on temperature for copepods (Devreker et al. 2009). They are also known to have a broad adaptation to unfavorable environmental conditions. They respond by reducing their metabolic rate and entering diapause (Reid and Williamson 2010).

Copepods comprise most of the biomass and productivity of freshwater environments (Reid and Williamson 2010). Since they are omnivorous, they are important in aquatic food chains because they can regulate both algae and zooplankton populations (Reid and Williamson 2010). Predatory copepods can impose high pressure on their prey and can inhibit the growth of other invertebrates, such as smaller rotifer species (Brandl 2005). Copepods also support other copepod and fish populations (Reid and Williamson 2010). However, copepods do serve as intermediate hosts for parasites,

such as flukes and tapeworms. Their exoskeleton acts as a reservoir for pathogenic bacteria including *Vibrio cholerae* (Huq et al. 1996) and *Enterococcus faecalis*. If the infected copepod is consumed in the drinking water, serious illnesses can occur in humans (Reid and Williamson 2010).

2.2 Population Dynamics and the Variations

Much of the plankton dynamics studies have been performed in northern, temperate lakes. The seasonal succession of phytoplankton and zooplankton communities in temperate lakes has been addressed in the Plankton Ecology Group (PEG)-model (Sommer et al. 1986). The succession is influenced by three variables: nutrients, predation, and competition (Sommer et al. 1986). In the winter, a lack of light is responsible for a minimum of phytoplankton and a lack of food for a minimum of zooplankton (Sommer et al. 1986). With an increase in light and nutrients, there is a spring bloom of phytoplankton as well as a zooplankton bloom due to the abundance of edible phytoplankton species (Sommer et al. 1986). A clear-water phase, which is characterized by a minimum of phytoplankton biomass following the spring bloom, occurs in early summer when zooplankton grazing rates upon phytoplankton are higher than the growth rates of phytoplankton, causing a decline in phytoplankton biomass (Sommer et al. 1986). Zooplankton densities reach their annual maximum during this time of the year (Sommer et al. 1986). Subsequently, zooplankton densities decline due to food shortage and even fish predation pressure (Sommer et al. 1986). This favors the growth of mostly inedible algal species during the summer period (Sommer et al. 1986). Small-sized zooplankton become predominant as they are less vulnerable to fish

predation (Sommer et al. 1986). Lastly, with decreased temperatures and light availability in the fall, there is a reduction in zooplankton and phytoplankton populations (Sommer et al. 1986). The PEG model proposes a generalized succession pattern, but there are variations.

In rotifers, some species are abundant only in the early summer in temperate regions, and others are clearly seasonal, in which one group has the greatest densities in the winter or early spring and another group in the late summer, with greater abundances of blue-green algae (Wetzel 1983). Cladocerans ingest food mainly by filtering the water, and filtering rates have a positive correlation with increasing temperatures. Similarly, the reproductive rates of cladocerans and rotifers are largely determined by the abundance of food as well as temperature. In copepods, higher temperatures correspond with a greater rate of egg production (Wetzel 1983).

Rotifers and cladocerans strongly compete for the same limiting food resources (Kirk and Gilbert 1990). They have different adult body sizes, with cladocerans typically being the larger one. The larger cladocerans limit the abundance of rotifer species and thus, are usually the more competitively dominant taxa (Kirk and Gilbert 1990). When different taxa compete for the same limited food resources, some populations may experience a decline due to the involvement between food supply, feeding capabilities, and temperature effects on reproduction (Kirk and Gilbert 1990). This decline may lead to a dormant or resting stage for the zooplankton rather than its complete removal (Wetzel 1983).

Other factors, such as differences in breeding, may also influence the population dynamics of zooplankton. Whereas copepods reproduce sexually, cladocerans and rotifers display cyclical parthenogenesis and can have both sexual and asexual reproduction during the cycle. Sexual reproduction in cladocerans usually occurs under unfavorable conditions and so, may not be seen in large, stable lakes (Mort 1991). In copepods, the timing of diapause may be an adaptation to avoid predation (Mort 1991). Moreover, their diapause eggs can restore the population at times (Mort 1991).

3. METHODS

Reservoirs at the Clayton County Water Authority were initially sampled biweekly, beginning in January 2010. Samples were collected from Lake Blalock and Lake Shamrock on each sampling date. Lake J.W. Smith and Lake Hooper were each sampled monthly. Since May 2010, sampling occurred monthly for all four lakes. Each sample contained one vertical tow from each of three different locations within the lake. Sampling locations were separated by at least 20 meters. Samples were collected using a 153 μm Wisconsin net. Chlorophyll *a* concentration, phycocyanin concentration, dissolved oxygen concentration, temperature, conductivity, salinity, and the pH of the water were collected using a Hydrolab DataSonde (Hach Company, Loveland, CO (USA)). Additionally, the Secchi depth was measured using a Secchi disk.

Two of the three samples were preserved in 50-90% ethanol until they were counted. The third sample was examined immediately by another lab member for the prevalence of parasites in *Daphnia* and *Ceriodaphnia*, which are cladoceran species. The parasites of *Daphnia* can influence zooplankton and phytoplankton dynamics (Duffy 2007). Samples were either entirely counted or subsampled, based on the perceived densities. When subsampling, the samples were diluted to 150 mL and two scoops of 2.87 mL were placed on a counting wheel. This was done a second time, and the densities were measured again. The densities in each sample were calculated based on the average of the two subsamples.

The following taxa were counted to determine population densities:

Copepod: calanoid and cyclopoid

Cladoceran: *Bosmina*, *Chydorus*, and *Diaphanosoma*

Rotifer: *Asplanchna* and *Conochilus*

Data was entered into a lab notebook and an excel spreadsheet containing the following information: Sample date, sample number, subsample number, subsample volume, and count data for all taxa. Areal and volumetric densities for analysis were calculated based on the proportion subsampled, plankton net size, and number of tows. Pearson correlations were used to analyze population count data, using the statistical software package SYSTAT 12. Though correlations do not indicate causation, they can imply possible factors for further examination.

The densities were plotted in a logarithmic scale. To adjust for this scale, a zooplankton density of zero was replaced with one-half multiplied by the lowest nonzero value for that category. This adjustment was conditional and was only applied to the densities of zooplankton that were once present but later had a density of zero. This would not apply to any densities that were zero throughout the sampling duration. For example, in Lake J.W. Smith, *Asplanchna*, *Conochilus*, and *Diaphanosoma* initially had zero densities in the sampling duration (Figure 3).

Please note that the surface temperature vs. density plots do not include the sampling dates in which the Hydrolab equipment malfunctioned and temperature values could not be measured. Furthermore, only temperature was plotted because correlational tests revealed this to be the most significant factor.

4. RESULTS

In Lake Blalock, Lake Hooper, and Lake J.W. Smith, *Bosmina* had the greatest density (Figures 1-3). The copepods (calanoid and cyclopoid) were the next most prevalent groups (Figures 1-3). Conversely, in Lake Shamrock, the copepods were the most prevalent, but with cyclopoid copepods being generally more common than the calanoid copepods (Figure 4). *Bosmina* had the next largest density (Figure 4). In Lake Blalock, a significant, positive correlation was found between temperature and densities of calanoid copepods ($r = 0.933$, $p < 0.001$) as well as between temperature and densities of *Diaphanosoma* ($r = 0.905$, $p = 0.001$; Figure 1B). *Diaphanosoma* densities were also significantly correlated with temperature in Lake Shamrock ($r = 0.704$, $p = 0.023$; Figure 4B). In addition, *Conochilus* ($r = -0.596$, $p = 0.069$) and *Chydorus* ($r = -0.629$, $p = 0.051$) had marginally significant correlations with temperature in Lake Shamrock (Figure 4B). However, a correlation between temperature and densities of *Conochilus* ($r = -0.101$, $p = 0.795$) and *Chydorus* ($r = 0.500$, $p = 0.170$) was not seen in Lake Blalock (Figure 1B). Correlations between density and the Hydrolab measurements, such as temperature, were not performed for Lake J.W. Smith because fewer data were collected from this lake and therefore, the correlations would not be reliable. No Pearson correlations were performed for Lake Hooper due to infrequent sampling at this lake.

The correlations between densities of the different zooplankton taxa were also calculated. In Lake Blalock, *Conochilus* densities ($r = 0.678$, $p = 0.045$) were significantly correlated with densities of *Asplanchna* (Figure 1A). *Diaphanosoma* ($r = 0.778$, $p = 0.014$) had significant, positive correlations with densities of calanoid

copepods (Figure 1A). Although densities of *Bosmina* ($r = 0.516$, $p = 0.155$) and calanoid copepods ($r = 0.633$, $p = 0.067$) were moderately correlated with densities of cyclopoid copepods, these correlations were not significant (Figure 1A). Similarly, the density correlation between *Asplanchna* and *Diaphanosoma* ($r = 0.506$, $p = 0.164$) was not significant (Figure 1A). In Lake Shamrock, *Conochilus* densities ($r = 0.644$, $p = 0.045$) were significantly correlated with densities of *Chydorus* (Figure 4A). While *Asplanchna* had a strong, significant, positive correlation with *Diaphanosoma* densities ($r = 0.868$, $p = 0.001$), *Chydorus* had a significant, negative correlation with *Diaphanosoma* densities ($r = -0.658$, $p = 0.039$; Figure 4A). In contrast with Lake Blalock, calanoid copepods ($r = 0.595$, $p = 0.070$) did not have a significant correlation with *Diaphanosoma* densities (Figure 4A). The density correlation between *Bosmina* and calanoid copepods ($r = -0.525$, $p = 0.119$) and the density correlation between *Chydorus* and cyclopoid copepods ($r = -0.543$, $p = 0.105$) were not significant (Figure 4A). In Lake J.W. Smith, *Asplanchna* ($r = -0.835$, $p = 0.010$) had a strong, negative correlation with densities of cyclopoid copepods, whereas *Bosmina* ($r = 0.863$, $p = 0.006$) had a strong, positive correlation with densities of cyclopoid copepods (Figure 3A). Similarly, *Bosmina* ($r = -0.819$, $p = 0.013$) had a strong, negative correlation with densities of *Diaphanosoma* (Figure 3A). Conversely, *Bosmina* ($r = -0.604$, $p = 0.113$) had insignificant correlations with densities of *Asplanchna* (Figure 3A). The density correlation between *Diaphanosoma* and cyclopoid copepods ($r = -0.541$, $p = 0.167$) was not significant (Figure 3A). Additionally, *Bosmina* ($r = -0.521$, $p = 0.185$) and calanoid copepods ($r = -0.632$, $p = 0.092$) were not significantly correlated with densities of *Chydorus* (Figure 3A).

As shown in Figures 1-4, *Bosmina* and cyclopoid copepods densities had higher densities during the winter and spring months. The areal densities of both *Bosmina* and cyclopoid copepods in Lakes Blalock, J.W. Smith and Shamrock began to decline in May. However, *Asplanchna*, *Diaphanosoma*, and *Conochilus* reached peak densities in late-May/early-June (with temperatures above 25°C).

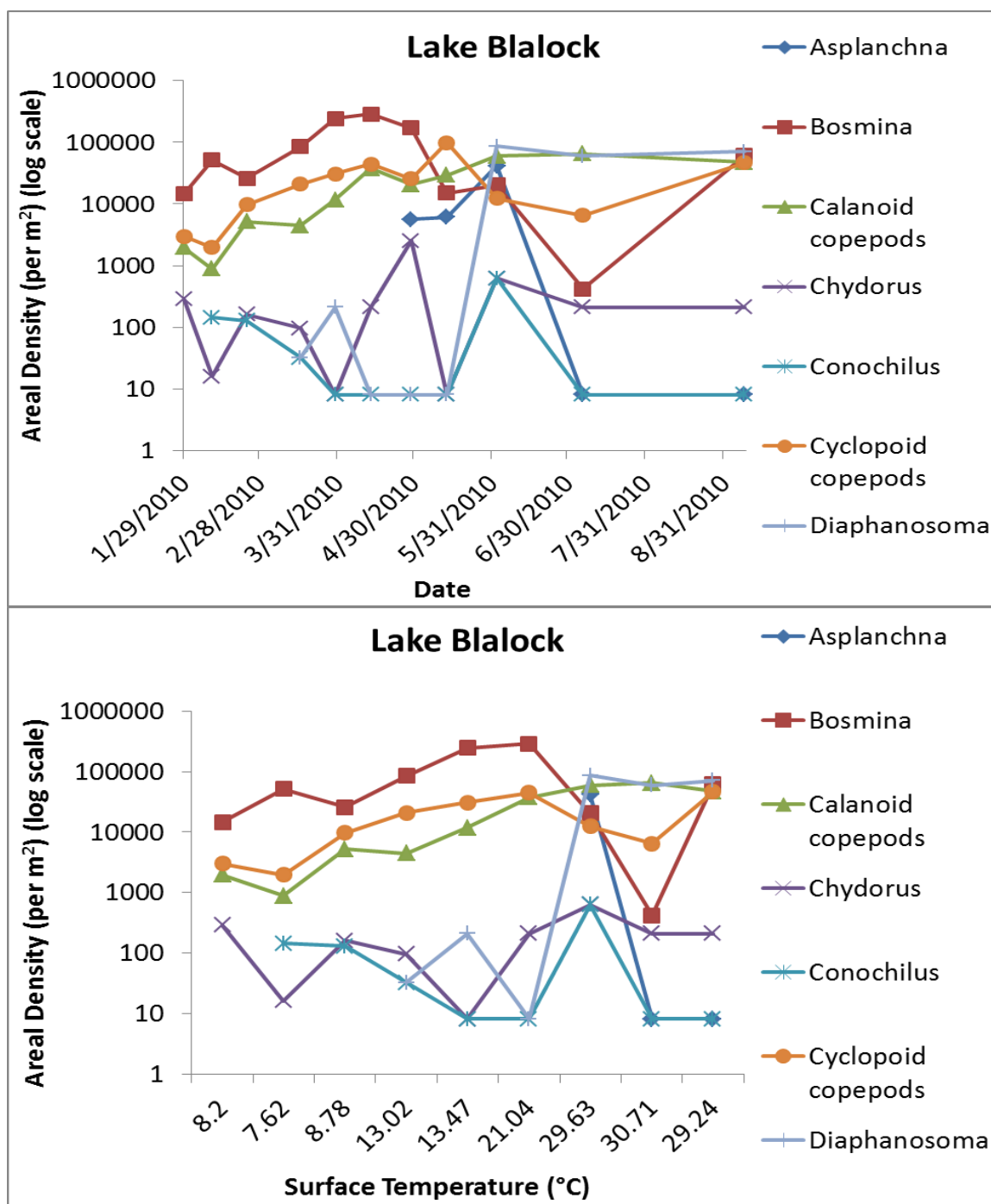


Figure 1: A) Average areal zooplankton densities in Lake Blalock from January to September 2010. (Sampling dates: 1/29; 2/9; 2/23; 3/16; 3/30; 4/13; 4/29; 5/13; 6/2; 7/6; 9/8) B) Average areal zooplankton densities plotted against temperature at 0 meters of depth. (Excludes 4/29 and 5/13)

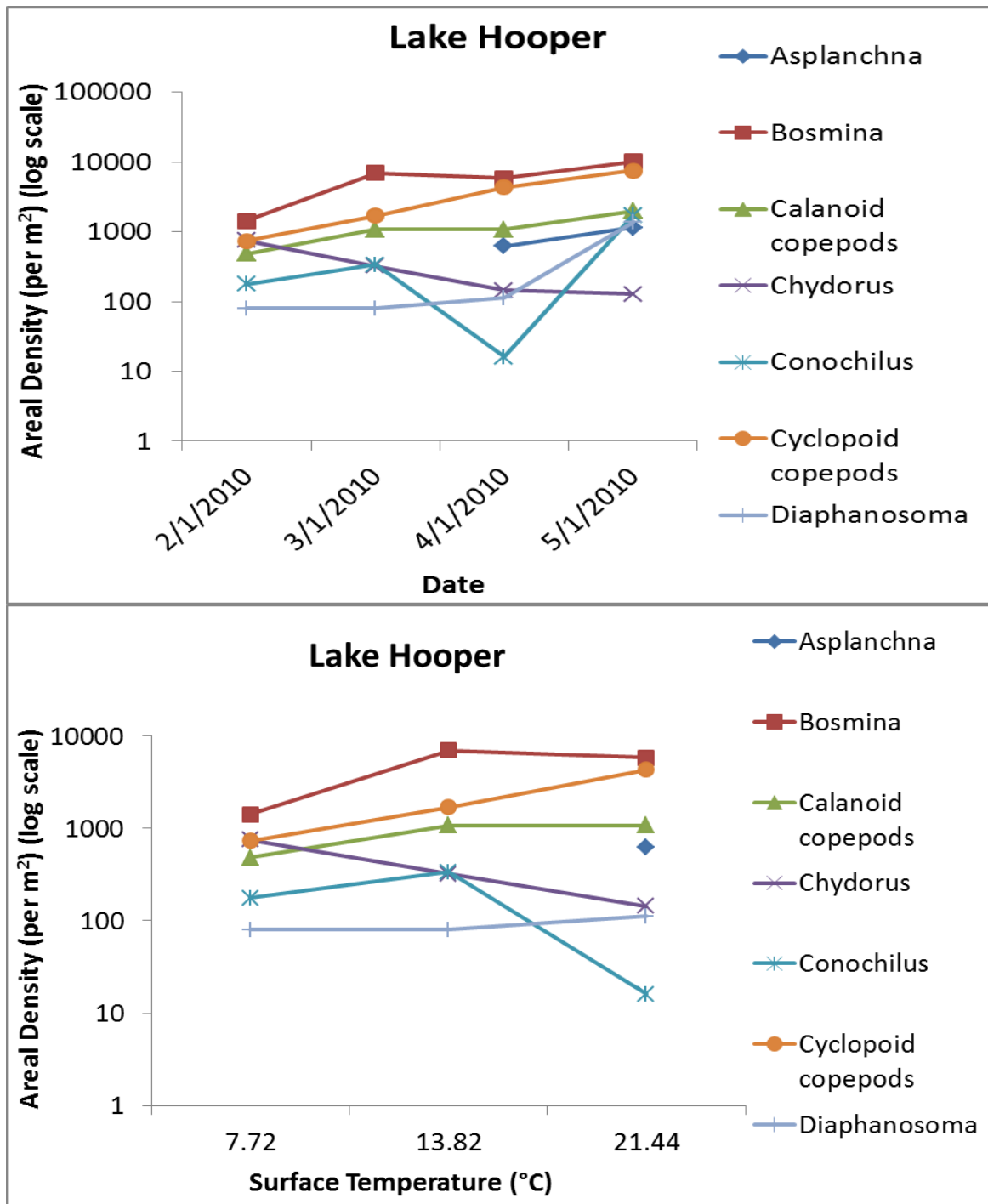


Figure 2: A) Average areal zooplankton densities in Lake Hooper from February to May 2010. (Sampling dates: 2/9; 3/16; 4/13; 5/13) B) Average areal zooplankton densities plotted against temperature at 0 meters of depth. (Excludes 5/13)

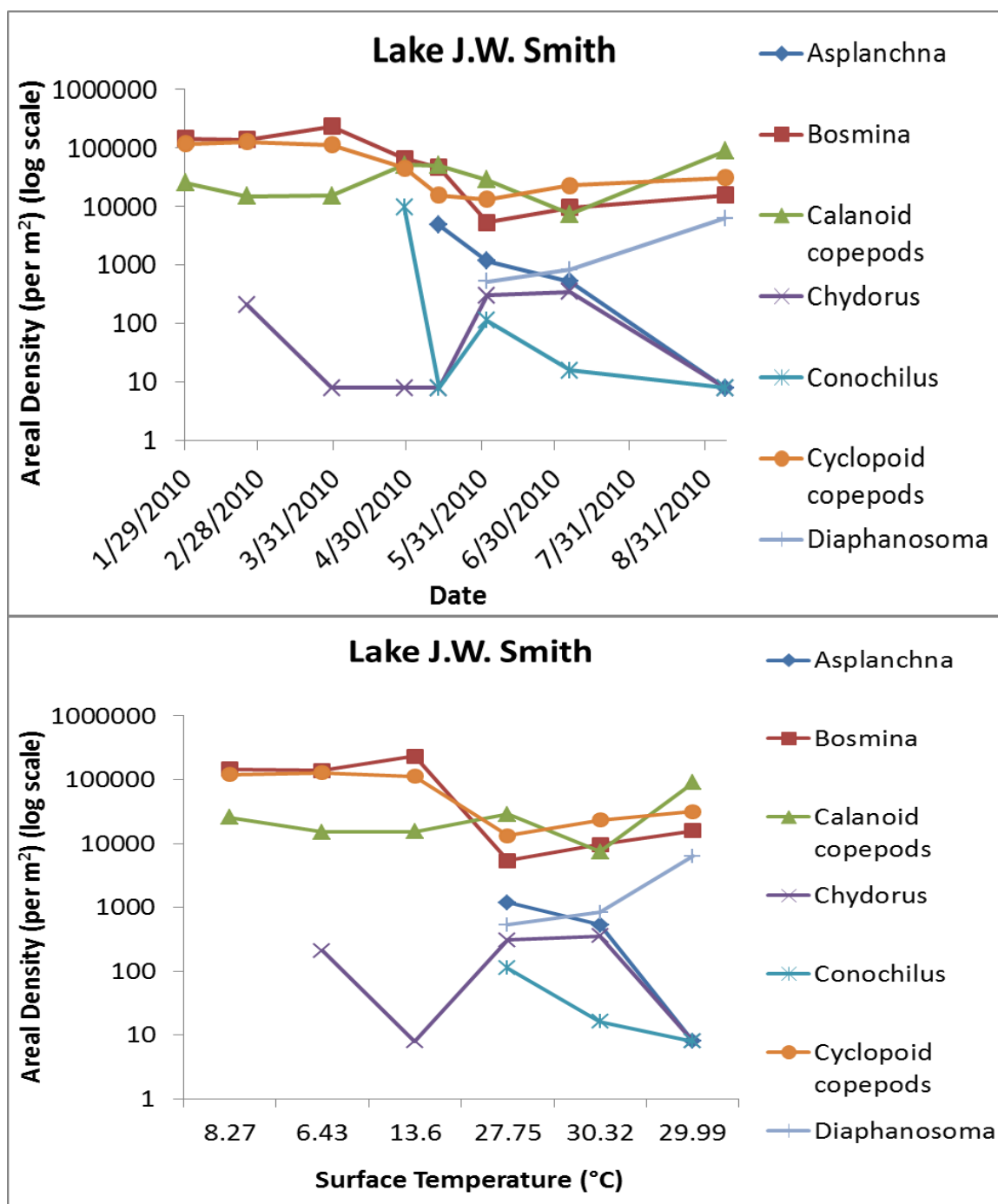


Figure 3: A) Average areal zooplankton densities in Lake J.W. Smith from January to September 2010. (Sampling dates: 1/29; 2/23; 3/30; 4/29; 5/13; 6/2; 7/6; 9/8) B) Average areal zooplankton densities plotted against temperature at 0 meters of depth. (Excludes 4/29 and 5/13)

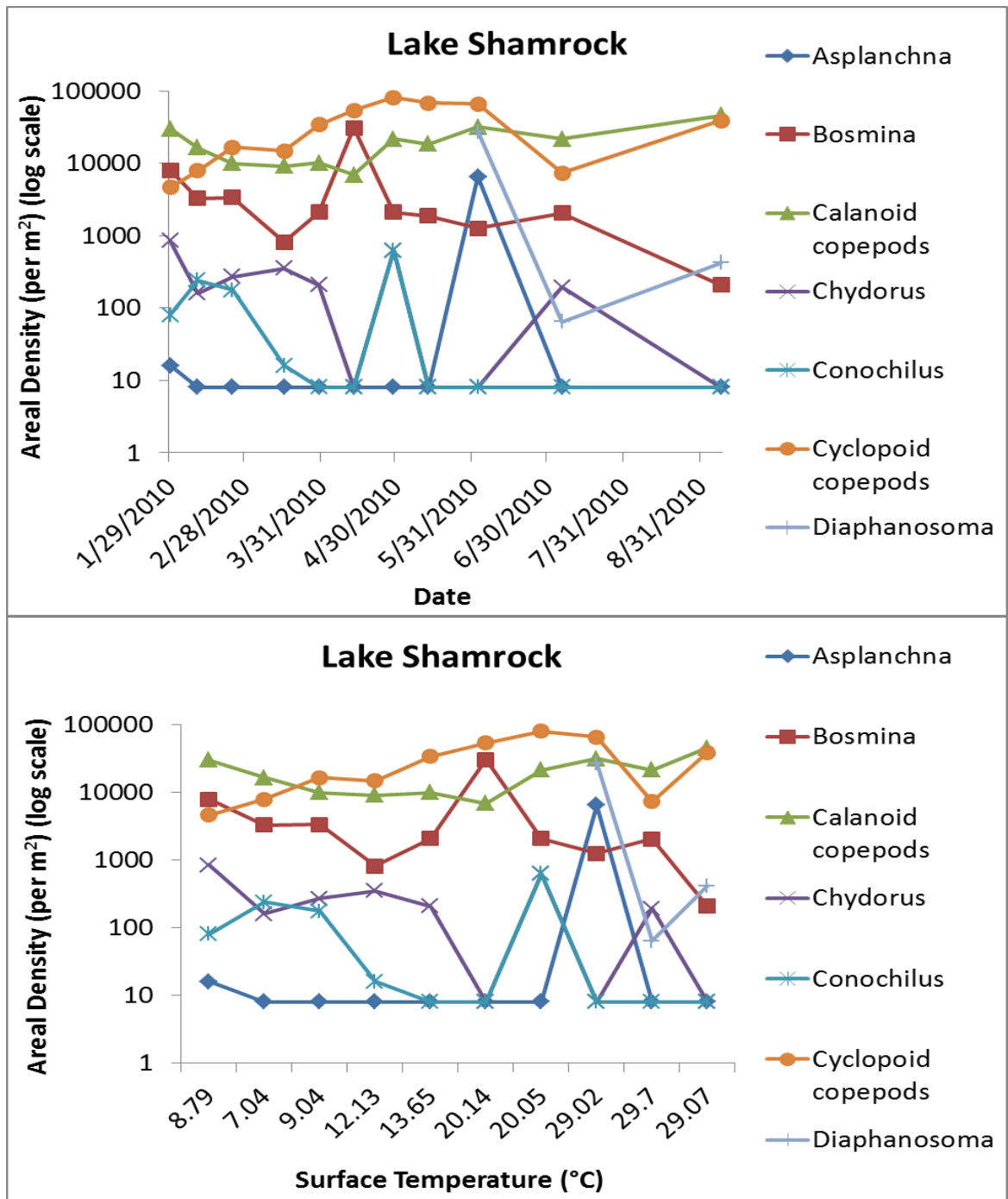


Figure 4: A) Average areal zooplankton densities in Lake Shamrock from January to September 2010. (Sampling dates: 1/29; 2/9; 2/23; 3/16; 3/30; 4/13; 4/29; 5/13; 6/2; 7/6; 9/8) B) Average areal zooplankton densities plotted against temperature at 0 meters of depth. (Excludes 5/13)

5. DISCUSSION

There was no consistent statistical correlation between temperature and the different zooplankton taxa in these reservoirs, with the exception of *Diaphanosoma*, signifying that there may be other factors that control the population dynamics of these zooplankton species. The population analysis revealed that in addition to temperature, the varying distributions of the different taxa influenced the population dynamics.

Although southern, subtropical and tropical lakes may have similarities to the seasonal patterns of northern lakes, there are several characteristics specific to the zooplankton found in subtropical and tropical environments. The characteristics include: a maximal biomass during the spring and/or fall seasons, a mid-summer minimum and declines, an abundance of copepods during the summer when cladocerans are rare or absent, and the absence of large cladocerans (Havens et al. 2000). These generalities were also seen in the studied reservoirs. Such results illustrate the effects on zooplankton abundance in a climate where temperatures remain warmer for a greater period of time.

A reason for the general trend of zooplankton decline in late spring and mid-summer may be due to predation as predators are more abundant with increased food and nutrient availability (Havens et al. 2009). In a study of Florida lakes, zooplankton biomass was shown to decline with spring increases of juvenile fish (Havens et al. 2009). Additionally, zooplankton experienced one or two maxima, though short-lived, in winter or spring and had low densities in the other seasons as predators increased with greater food availability (Havens et al. 2000). Also, consistent with this study, Sommer et al.

(1986) have shown that higher species diversity can be present in the summer with more feeding mechanisms represented due to food partitioning and predation.

Food limitation due to the abundance of inedible phytoplankton during the summer period could also be a contributing factor in the decline of zooplankton density (Sommer et al. 1986). A previous study in Florida lakes suggested that some species affect the grazing rates of zooplankton and are not consumed perhaps due to the production of toxins (Havens et al. 2009). Cyanobacteria are present year-round in Florida lakes and have generally been found in the guts of crustacean zooplankton, but this may result from the high abundances of cyanobacteria and not as an indication of food preferences (Havens et al. 2009).

Another reason for the seasonal declines could be due to thermal stress (Havens et al. 2000). When studying temperature-biomass relationships, Havens et al. (2000) found the spring declines in the biomass of cladoceran species generally occur when water temperatures near 30 °C; however, a temperature of 24 °C was considered optimal for growth, supporting that temperature may be a main controlling variable (Havens et al. 2000). In this study, *Bosmina*, a cladoceran species, and cyclopoid copepods generally declined with temperatures nearing 30 °C. Therefore, high water temperatures may prevent cladocerans from occurring during the summer and restrict growth periods to late winter and early spring. However, the marginally significant, negative correlation between temperature and densities of both *Conochilus* and *Chydorus* in Lake Shamrock, though not in Lake Blalock, may require additional data to explain the correlation.

The inconsistent correlations between densities of different zooplankton taxa remain unexplained. Despite an insignificant correlation between densities of cyclopoid copepods and calanoid copepods, these species had comparable seasonal dynamics. In a study conducted in Union Bay, Washington, predatory cyclopoid copepods and large calanoid copepods were present in similar abundances throughout the year (Kerfoot and Peterson 1980). Furthermore, *Bosmina* were found extensively with moderate-sized predatory copepods (Kerfoot and Peterson 1980); however, this correlation was not significant in Lake Blalock and Lake Shamrock. Further study is required to clarify the fluctuations in the densities of the zooplankton.

While temperature can shape seasonal densities, species may have variable dynamics. Further sampling should be carried out in the Clayton County reservoirs to determine changes in the overall zooplankton density and their relative abundances in comparison to seasonal changes. Analysis of additional factors, such as food availability, predation, and competition, could demonstrate distinct interactions of the different taxa of zooplankton.

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