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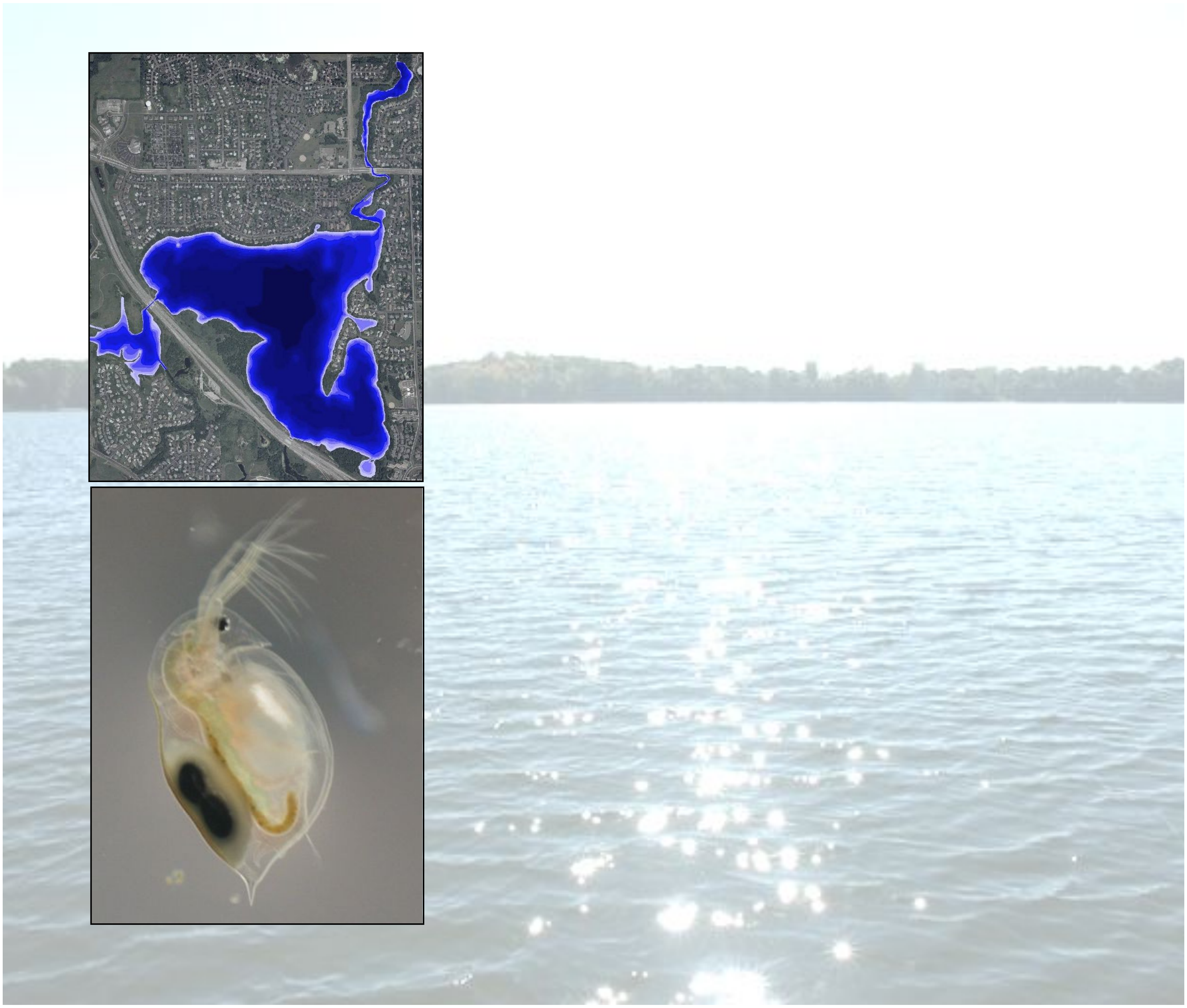
Census of Zooplankton in Rice Lake: 2010 *(DOW# 27-0116)*



Prepared for the Rice Lake Area Association – December 2010
by James A. Johnson – Freshwater Scientific Services, LLC

Census of Zooplankton in Rice Lake: 2010

(DOW# 27-0116)

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Introduction

Zooplankton are small organisms that live in water (Figure 1). Although microscopic in size, they can play a major role in maintaining good water clarity and a healthy fishery in lakes (Carpenter et al. 1985, Scheffer 2008). Large zooplankton (particularly *Daphnia,* or "water fleas") often play an important role in shallow waters like Rice Lake. These tiny animals can dramatically increase water clarity by grazing on algae and also serve as a source of food for young fish. However, both of these functions are highly dependent upon the type, size, and abundance of the zooplankton present in a lake.

The Rice Lake Area Association (RLAA) contracted with Freshwater Scientific Services, LLC in 2010 to monitor zooplankton in Rice Lake (Maple Grove, MN) during the spring and summer of 2010. The purpose of this monitoring was to determine (1) which species of zooplankton were present, (2) how abundant each species was, (3) the average size of each type of zooplankton, and (4) to track any seasonal changes in the zooplankton community.

Figure 1. Large zooplankton: *Daphnia* or "water flea" (left), typical length 0.5 to 2.0 mm; copepod (right), typical length 0.5 to 1.5 mm

Study Lake

Rice Lake (45°06′54″N, 93°27″58″W; DOW# 27-0116) is a 315-acre shallow (12 ft max depth), eutrophic, drainage lake in Hennepin County, MN (Figures 2 and 3). The lake's hydrology is largely driven by Elm Creek, which drains an area of approximately 20 square miles upstream of the lake. Rice Lake typically has low water clarity (2 to 3 ft), high total phosphorus (200 to 300 µg/L), and high chlorophyll-a (50 to 100 µg/L) during the summer months (Figure 3). The lake also experiences frequent, severe blue-green algae blooms. These blooms are most prevalent in mid to late summer, with less severe blooms in the early summer.

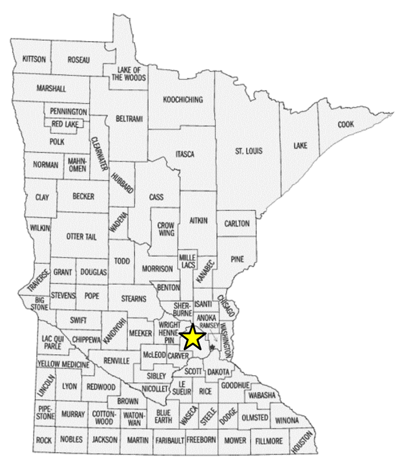


Figure 2. Location of Rice Lake

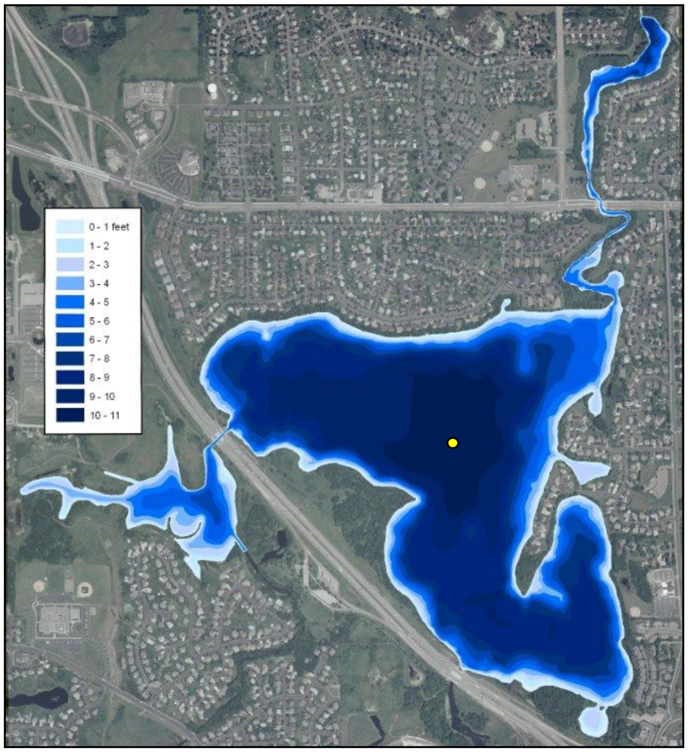
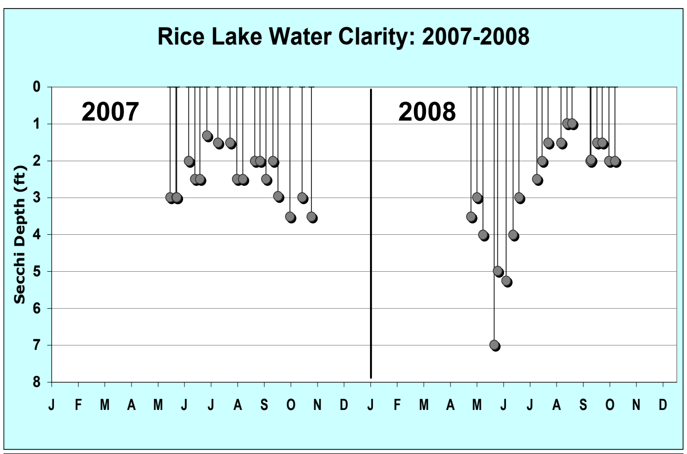


Figure 3. Depth-contour map showing the main basin of Rice Lake and the location used for sampling.



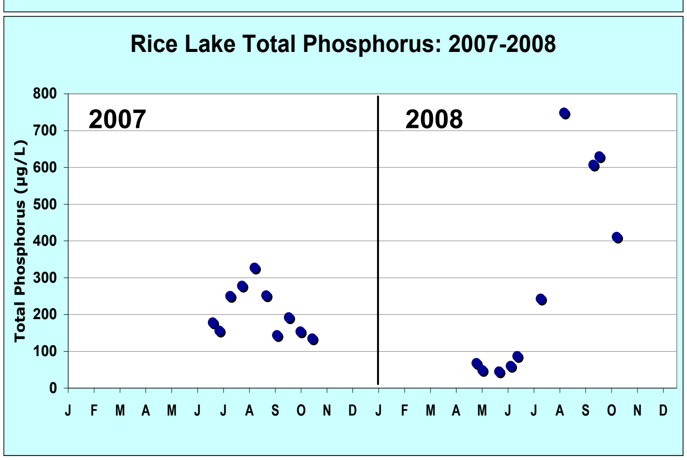


Figure 3. Water clarity (Secchi depth) and total phosphorus in Rice Lake; 2007 and 2008. Samples collected by Blue Water Science and lake volunteers (Minnesota Citizen Lake Monitoring Program)

Study Objectives

The RLAA is currently considering management options to improve the fishery of Rice Lake. Before implementing any such management options, the RLAA wanted to determine whether the zooplankton population in Rice Lake would provide an adequate source of food to support young fish. The specific objectives of the study were:

(1) Determine what types of large zooplankton were present

(2) Determine the abundance of each type of large zooplankton

(3) Determine the size and estimated biomass of each type of zooplankton

(4) Track seasonal changes in the zooplankton community in 2010

Methods

Sample Collection

We collected zooplankton samples monthly from May through August of 2010. On each sample date, we collected a full water-column sample (bottom to surface) from the deepest portion (11 ft) of the main basin of Rice Lake (Figure 2). Each sample was collected by lowering a Wisconsin plankton net (12-cm circular gape, 153-µm; Wildlife Supply Company, Yulee, FL) to the bottom of the lake, waiting for 10 seconds, and then retrieving the net vertically at a rate of approximately 1 m/sec. Immediately after collection, each sample was fixed for 15 seconds in 95% ethanol and then transferred to a storage bottle with 70% ethanol (Black and Dodson 2003).

Laboratory Analysis and Calculations

In the lab, samples were concentrated to 100 mL. A 5-mL sub-sample was taken from this concentrated sample using a 5-mL Hensen-Stempel pipette, and transferred to a Bogorov counting chamber for analysis under a microscope. All zooplankton in the analyzed sub-sample were identified, enumerated, and measured (length). Length was measured using an ocular reticle that was calibrated against a stage micrometer. If needed, additional 5-mL subsamples were analyzed until at least 60 individuals were counted (McCauley 1984). In addition, we recorded the number of Cladoceran brood eggs to estimate reproduction.

For each sample, we calculated the abundance of each type of zooplankton (Number/m^3) using the total sampled volume (0.0113 m^2 × sampled depth), concentrated volume (100 mL), counted sub-sample volume, and zooplankton counts (Equation 1).

(Eq 1) $\text{Number}/m^3 = \text{Count} \times (\text{Conc. Vol.} \div \text{Counted Vol.}) \div \text{Sampled Volume}$

Biomass (dry mg/m^3) for each type of zooplankton was estimated using Equation 2, based upon the measured body lengths and length/mass relationships reported by O'Brien and deNoylles (1974), Dumont et al. (1975), and Pace and Orcutt (1981).

(Eq 2) $\mathit{ln}\ \text{Biomass (dry µg)} = \mathit{ln}\ A + (\mathit{ln}\ B \times L)$

Where:
ln = natural logarithm
A and B = species specific constants
L = average of ln-transformed body lengths

Results

Summary of Zooplankton

Overall, large zooplankton were fairly abundant in Rice Lake during the spring and early summer (Table 1, Figure 4). However, by late summer, only small-bodied zooplankton were found (Figure 4). Although large-bodied *Daphnia pulex* decreased in abundance in August, this species was a major contributor to zooplankton biomass from May through July (Figure 5).

Table 1. Large zooplankton (>0.1 mm) in Rice Lake (Maple Grove, MN) in 2010; See Figure 7 for images.

Zooplankton Taxa	*Maximum Abundance (1000/m^3)*	*Month of Maximum Abundance*	*Length Range (mm)*	*Maximum Biomass (dry mg/m^3)*	*Food*
Cladocerans					
Daphnia pulex	84	May	0.6–2.2	897	Algae
Daphnia galeata	3	Jun	0.5–1.1	6	Algae
Ceriodaphnia sp.	189	Jul	0.2–0.8	353	Algae
Chydorus sphaericus	32	Jun	0.1–0.3	10	Algae
Bosmina longirostris	1	Jun	0.2–0.3	1	Algae
Copepods					
Calanoid	30	May	0.7–1.5	108	Algae
Cyclopoid	13	Jun	0.5–1.2	39	Zooplankton

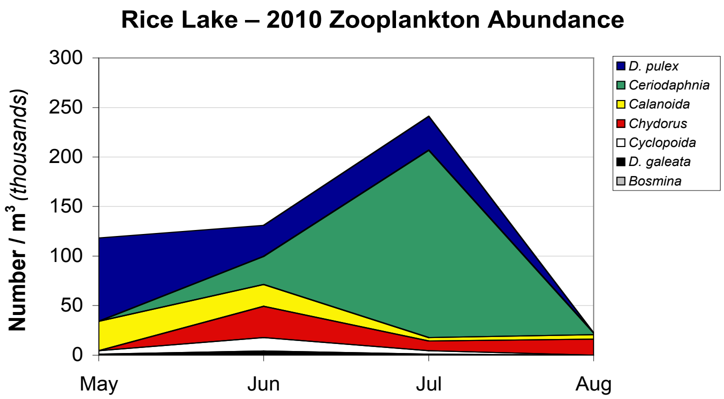


Figure 4. Zooplankton abundance (Number/m^3) in Rice Lake; May–August 2010.

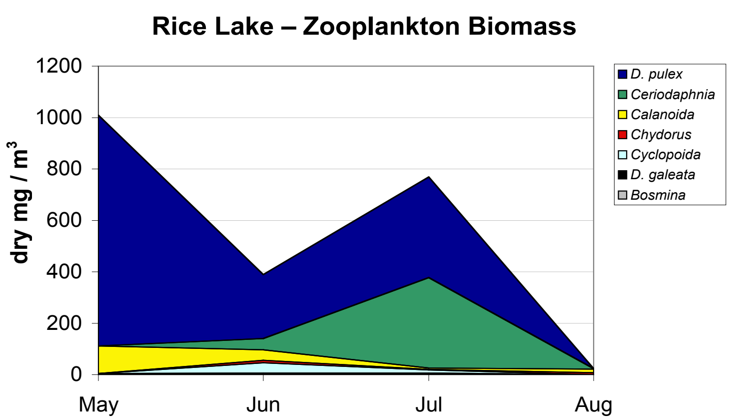


Figure 5. Zooplankton biomass (mg/m^3) in Rice Lake; May–August 2010. Biomass estimated using species-specific length:weight relationships.

Estimates of reproduction (brood eggs per female) by *Daphnia pulex* showed that this large-bodied species was actively producing large numbers of eggs through the early summer, with a subsequent rapid decrease in egg production in August (Figure 6). This suggests that *D. pulex* had access to abundant food (edible algae) until the late summer. Furthermore, the dramatic decrease in abundance of this species in August appeared to be attributable to starvation (lack of edible algae) rather than to fish predation. Similarly, *Ceriodaphnia* sp. was actively producing many eggs in June but showed lower reproduction in July and August, suggesting that they too ran out of edible algae later in the year. By contrast, if fish predation had been responsible for the decrease in the abundance of these zooplankton species, we would have expected to see decreases in abundance without a coincident decrease in egg production.

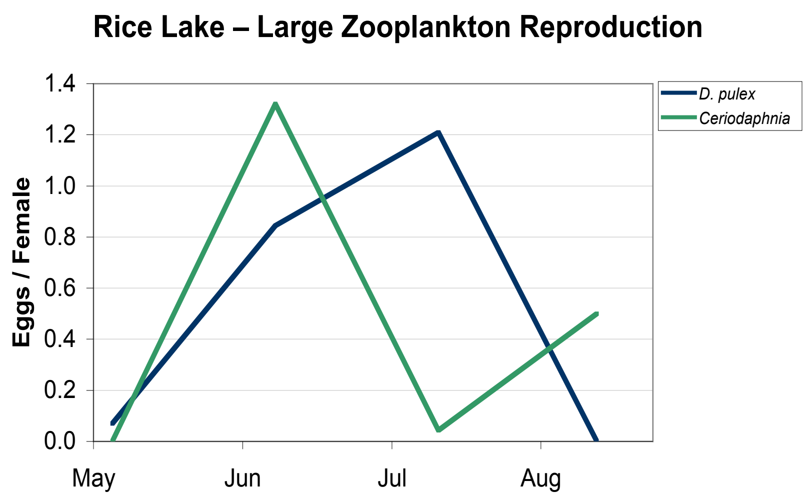
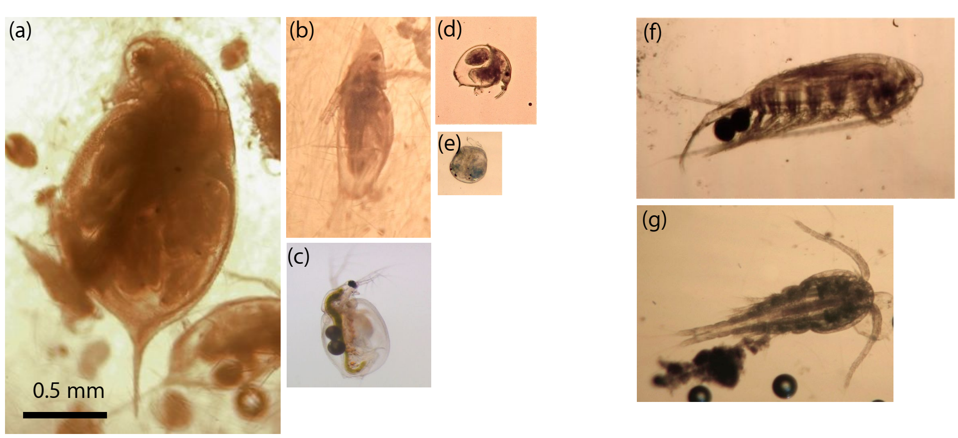


Figure 6. Reproduction (eggs/female) by *Daphnia pulex* and *Ceriodaphnia* sp. in Rice Lake; May–August 2010.

Figure 7. Images of zooplankton found in Rice Lake showing approximate relative size. (a) *Daphnia pulex*, (b) *Daphnia galeata*, (c) *Ceriodaphnia* sp., (d) *Bosmina longirostris*, (e) *Chydorus sphaericus*, (f) calanoid copepod, (g) cyclopoid copepod



Discussion

In 2010, Rice Lake supported a relatively high abundance of large-bodied *D. pulex* and smaller *Ceriodaphnia* sp. through mid summer. The persistence of *D. pulex* into July suggests that fish predation was quite low, as these large-bodied zooplankton are a favorite food of many fish. In 2008, a fish survey conducted by Blue Water Science indicated that Rice Lake supported relatively abundant bluegill and some crappies. These fish readily consume large zooplankton, and typically keep the abundance of large *Daphnia* relatively low during summer months. This suggest that poor water clarity may be impairing the ability of these fish to locate large zooplankton, resulting in lower predation than expected based upon the abundance of bluegills. This presents an interesting paradox in that if the water clarity in the lake is increased, the fish will likely eat the large zooplankton that are most effective at grazing on algae, thus potentially leading to a subsequent increase in algae and decrease in water clarity (Carpenter et al. 1985). This is a good example of one of the numerous mechanisms that keep shallow, fertile lakes in an algae-dominated state. Although we now know substantially more about the zooplankton in Rice Lake, we need to remind ourselves that zooplankton are only a small component of the lake's ecology, and that many aspects of the lake (chemistry, biology, physical conditions) can interact in complex and often unpredictable ways.

The results presented in this report will help to guide future management of fish in Rice Lake by informing managers of the food available for young fish. Given the complexity of the interactions between nutrients, water clarity, zooplankton, and fish, it is difficult to predict specific changes that may occur in Rice Lake or what role zooplankton may play in such changes. However, research has shown that as nutrients are reduced, shallow lakes become more and more likely to shift to a plant-dominated, clear-water state (Scheffer 2008). Such a shift would have dramatic implications for fisheries and recreation in Rice Lake. Until such a shift occurs, the zooplankton community in Rice Lake will likely remain relatively similar to that observed in 2010.

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