Trophic Cascades in Artificial Ponds

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Abstract

We hypothesized that ponds treated with *Lemna minor* (duckweed) would have reduced primary productivity, and similarly affected zooplankton and macroinvertebrate abundances. We observed an accumulation of Chlorophyll *a* in the benthos of ponds treated with duckweed, indicating that duckweed feeds the system through detritus. This finding was supported by higher abundances of *Daphniidae and Centropagidae* in duckweed ponds. This information lead us to reject our hypothesis. This study has important implications for aquatic systems given the widespread nature of *L. minor*.

Introduction

- The trophic cascade hypothesis suggests that alterations at the top of the food web can cascade to lower trophic levels, as observed in many aquatic systems (Jakobsen *et al.* 2004).
- Primary productivity is the rate of O_2 that is generated by photochemical oxidation of water, which is associated with the fixation of carbon and energy into plant biomass (Falkowski and Raven 1997).
- Regions of lakes where light cannot penetrate have been seen to have lower levels of primary productivity.
- We hypothesized that blocking light from the system using *Lemna minor* (duckweed) would reduce primary productivity of the system, resulting in lower concentrations of chlorophyll as well as less zooplankton and macroinvertebrates in duckweed treated ponds.

Methods

- Five 350 L ponds, Three 90 L ponds
- Four ponds randomly assigned to treatment; presence or absence of *Lemna* minor (duckweed)
- All ponds were fertilized at beginning of project; phosphorus levels monitored
- Ponds were monitored to maintain their treatment assignment
- 5 tiles placed in bottom of each pond for 7 weeks
- Zooplankton samples collected from 4 L pond water through collection net
- Water column and tiles samples were analyzed for Chlorophyll *a* concentration according to protocol set forth by Hauer and Lamberti (1998)

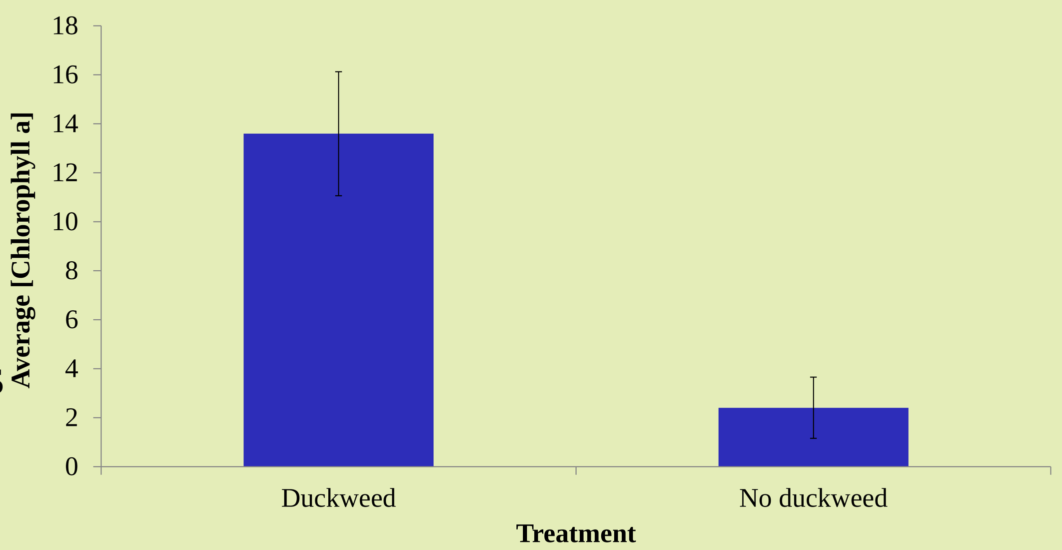

Figure 1. Average benthic Chlorophyll *a* concentration by treatment; p<0.01.

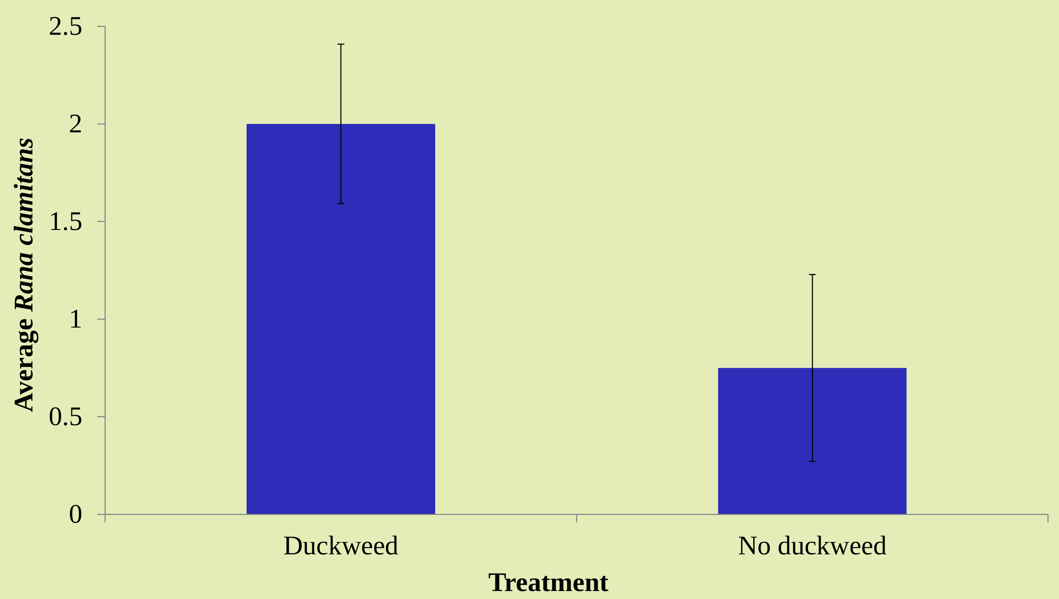

Figure. 2 Average number *Rana clamitans* per treatment; p=0.09.

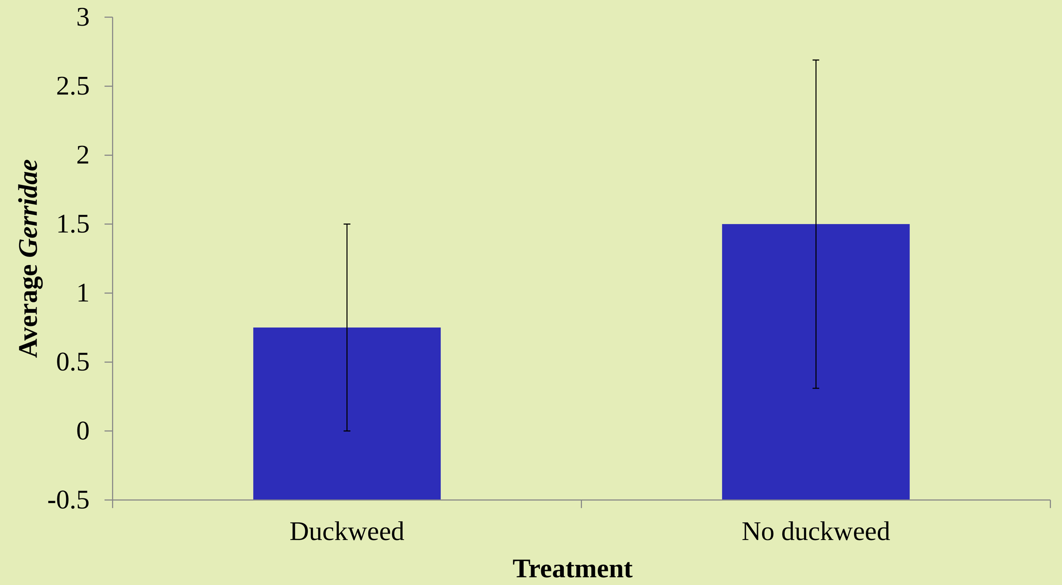

Figure 3. Average number of *Gerridae* per treatment; p=0.61.

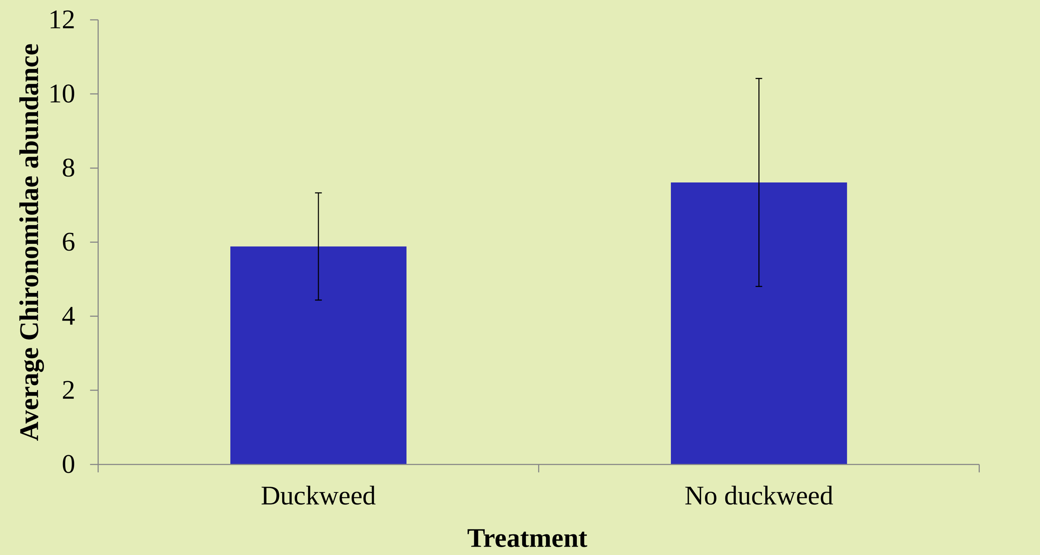

Figure 4. Average *Chironomidae* per treatment; p=0.59.

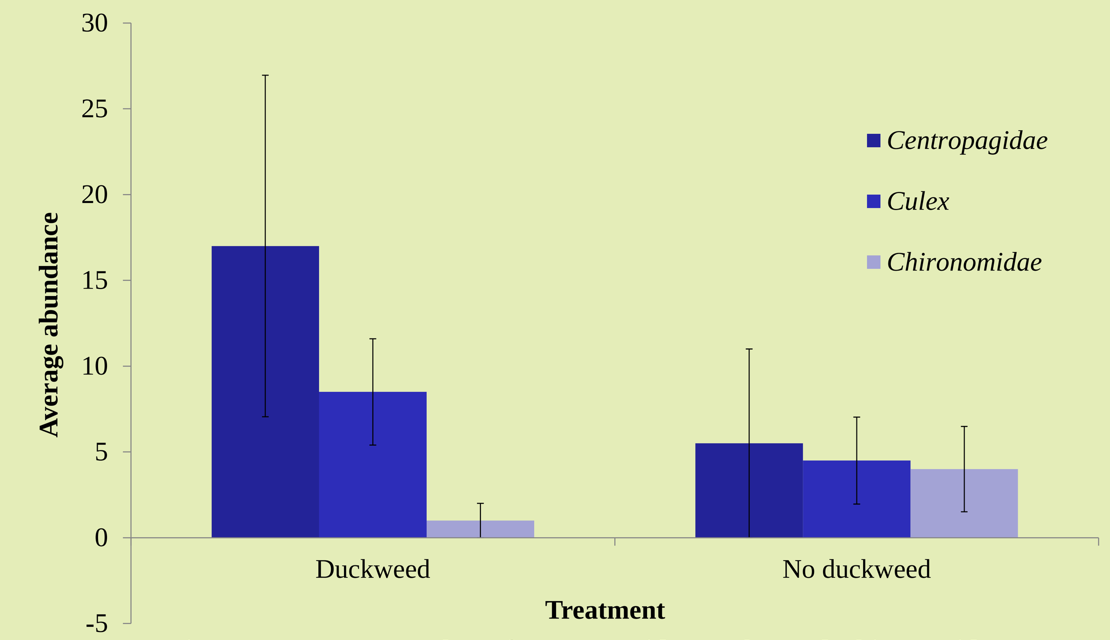

Figure 5. Average number of *Centropagidae, Culex and Chironomidae* per treatment; p=0.35, 0.36 and 0.30, respectively.

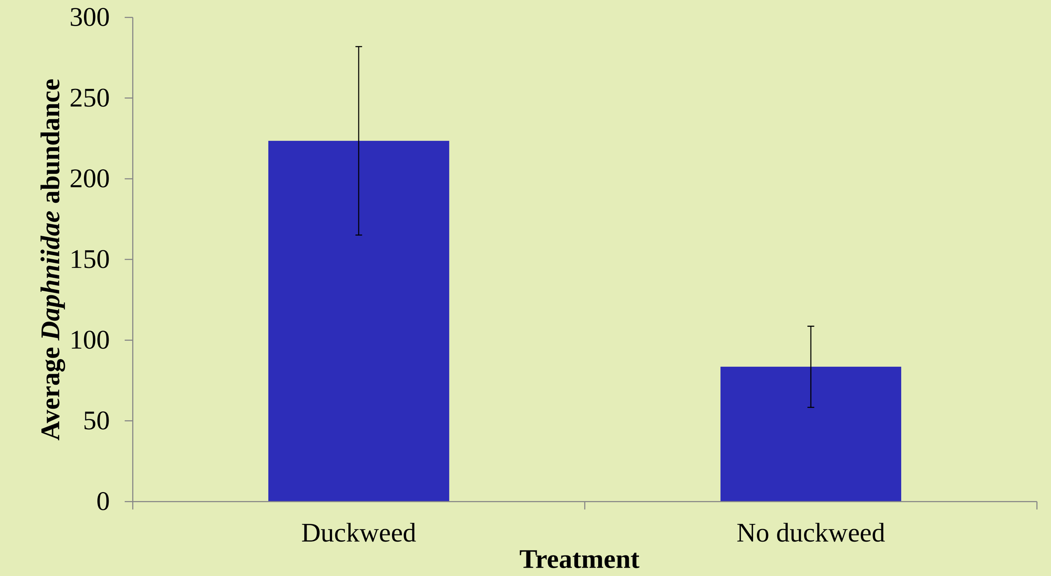

Figure 6. Average *Daphniidae* per treatment; p=0.06.

Results

- Significant difference in concentration of Chlorophyll *a* in the benthos between treatments; higher average concentration observed in ponds with duckweed; p<0.01 (Figure 1).
- Higher average number of *Rana clamitans* found in ponds with duckweed (p=0.09) (Figure 2).
- Higher average number of *Gerridae* and *Chironomidae* found in ponds without duckweed, although the difference was not significant (p=0.61, 0.59) (Figure 3, Figure 4).
- No significant difference in the abundances of *Centropagidae, Culex and Chironomidae* between treatments (Figure 5).
- Higher *Daphniidae* abundances in ponds treated with duckweed (p=0.06) (Figure 6).

Discussion

- We observed an accumulation of chlorophyll in the benthos of ponds treated with duckweed (Figure 1). Leads us to reject our hypothesis.
- Higher abundance of *Daphniidae* and *Centropagidae* observed in ponds with duckweed (Figure 5, Figure 6).
  - Have been seen to thrive in nutrient rich systems (Jakobson *et al.* 2004).
  - Difference in *Daphniidae* abundances approach significance (p=0.06).
- *R. clamitans* observed more often in ponds treated with duckweed; potential protection from predators (Figure 2).
- Higher number of observation of *Gerridae* (water striders) found in ponds that also had higher abundances of *Chironomidae* in both the water column and the detritus (Figure 3, Figure 4, Figure 5).
  - Water striders have been observed feeding on emerging *Chironomidae.*
- Additional replication could reveal significant differences between treatments.
- Future studies could further replicate the two treatments, examine further the zooplankton community composition.

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