Zooplankton Biodiversity, Lake Size, Isolation and Productivity in the Boundary Waters Canoe Area Wilderness

Stephen Nikolai, Matthew Faust, Matthew Troia and Stephanie Zinken,
Todd Wellnitz, Faculty mentor

Background

This study was conducted in September of 2007 in the Boundary Waters Canoe Area Wilderness to study lake ecology and biodiversity. According to the island biogeography theory, biodiversity will increase with island size and proximity to other land masses. This trend is expected because the ratio of colonization to extinction will be greater on larger, less isolated islands. Random colonization events are more likely to occur on islands that are large and near a colonizing source. Moreover, larger islands will support a larger population, which will decrease the likelihood of a species going extinct on that island. Applying the island biogeography theory to lakes would involve a shift in perspective; viewing lakes as islands in terrestrial oceans with these lakes varying in both productivity and size. Biodiversity is also known to be dependent upon primary productivity. Dodson *et al.* (2000) demonstrated that zooplankton diversity was greatest at intermediate levels of primary productivity. Intermediate productivity will provide tolerable environmental conditions for more species, while in extreme conditions only certain zooplankton species that occupy extreme niches will be able to exist. This study was undertaken to determine whether lake size or productivity best predicts zooplankton biodiversity.

Hypotheses

1. As lake size increases, zooplankton diversity will increase.

2. Isolated lakes will have less diverse zooplankton assemblages.

3. Zooplankton diversity will be greatest in lakes with intermediate productivity

Methods

- Four zooplankton samples were taken near the deepest basin of fifteen lakes in the BWCAW using a 75µm plankton net. In the lab 100 individual zooplankton from each sample were identified to species.
- Four Secchi disk readings were taken as a measure of productivity at the same locations
- Inlets, outlets and depth of each lake were found using maps from the Minnesota DNR and totaled used to measure lake isolation and connectivity.
- Data analysis included linear regression and factor analysis performed in "R".

Matthew Troia using a Secchi disk to measure lake productivity.

Stephen Nikolai taking a depth prior to gathering zooplankton.

Results

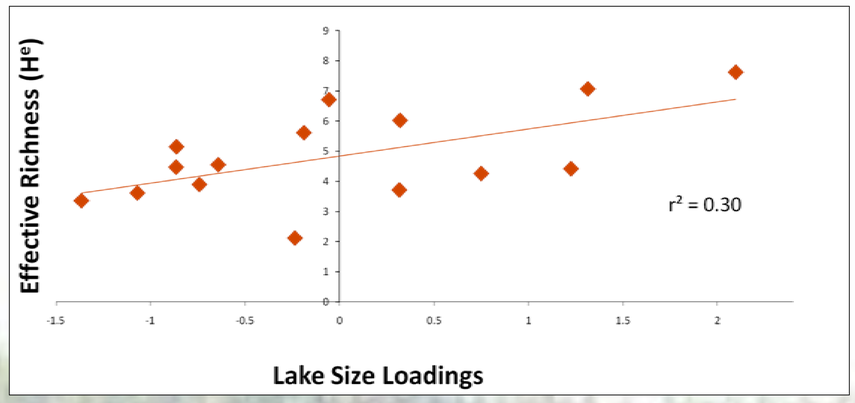


Figure 1. The relationship between zooplankton effective richness (H^e) as a function of lake size loadings, which includes the log of total lake area, littoral area, and maximum depth. (p=0.02).

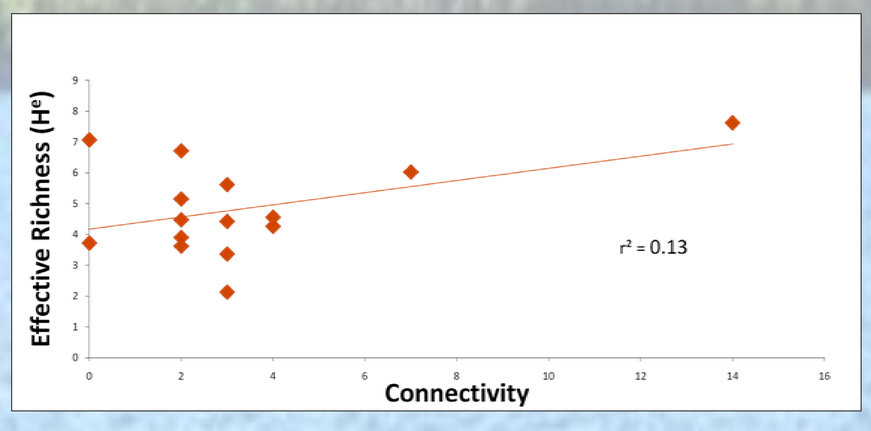


Figure 2. The relationship between zooplankton effective richness (H^e) as a function of lake connectivity, i.e., sum of lake inlets and outlets (p= 0.10).

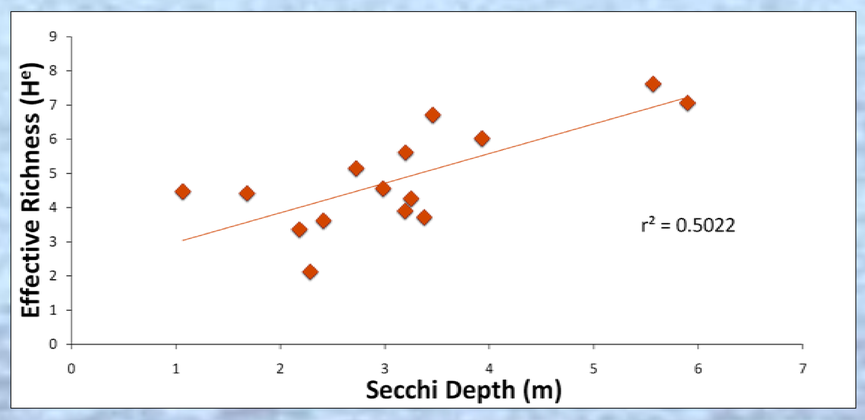


Figure 3. The relationship between zooplankton effective richness (H^e) as a function of secchi depth. (p=0.002).

References

Dodson, S.I., Arnott, S.E., Cottingham, K.L. (2000). The relationship in lake communities between primary productivity and species richness. *Ecology* 81(10): 2662-2679.

Discussion

We found a positive relationship between lake size (i.e., surface area, littoral area and maximum depth) and effective richness (Figure 1). Although there was no significant relationship between connectivity and effective richness (Figure 2.), there was a relationship between Secchi depth and effective richness (Figure 3.).

With respect to our hypotheses:

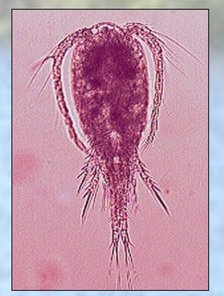
- The data support the hypothesis that as lake size increases, zooplankton diversity increases.
- No relationship was observed between lake connectivity and zooplankton diversity.
- We can accept the hypothesis that lakes with a more intermediate productivity will have higher species diversity.

Conclusion:

Lake productivity is a better predictor of zooplankton diversity.

Importance:

Most lakes and watersheds are directly affected by pollution and excess nutrient loading. By understanding the relationship between lake productivity, lake size and zooplankton diversity, ecologists and policymakers can make better informed decisions regarding lake protection and species conservation.



***Diacyclops thomasi*:** Dominant cyclopoid copepod species in most lakes sampled. Generalist feeders; eating other zooplankton, algae, and larval fish.

Skistodiaptomus oregonensis: Most common calanoid copepod species in the lake samples. This is a herbivorous species that feeds on algal particles of almost every size.

Daphnia galeata mendotae: Common Cladocera species. Equipped with helmet and spine to deter planktivorous fish. This species is herbivorous and typically feeds on small algae.

Lake Team (Left to right): Steve Nikolai, Steph Zinken, Matt Faust and Matt Troia

Acknowledgements:

Lake Team would like to thank ORSP for their funding and Evan Weiher for statistical support.