Detecting Duckweed Mediated Trophic Cascades Using Standardized Effect Size

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Abstract

In the biological sciences, it is often difficult to have large replicate sizes for a variety of reasons. In many statistical tests, replicate number can affect if there are detectable differences between treatment groups. Measuring standardized effect size in addition to traditional metrics can aid in revealing trends in data sets that traditional null hypothesis models alone would not reveal. In aiming to demonstrate the usefulness of Cohen's *d* in small sample studies, we were able to support the existence of a duckweed mediated trophic cascade when traditional metrics revealed no difference between treatments. This study has important implications for many of the biological sciences.

Introduction

- •Traditionally, p-values are the standard by which scientists analyze whether or not a statistical difference exists between treatments.
- •Statistical significance influenced by sample size (n), magnitude of difference, and variance (McCabe *et al.* 2012).
- •Cohen's *d* is an alternative effect size measure that demonstrates the size of the difference as well as the direction of effect between two variables (Nakagawa 2004).
- •We conducted a trophic cascade experiment, using eight small artificial ponds, from which very little significant statistical evidence resulted.
- •Objective was to demonstrate the usefulness of Cohen's *d* in small sample studies where traditional analysis using p-value does not reveal significance of trends in the data.

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.
- •Analysis for SES conducted using SPSS software, using the protocols set forth by Wuench (2009).

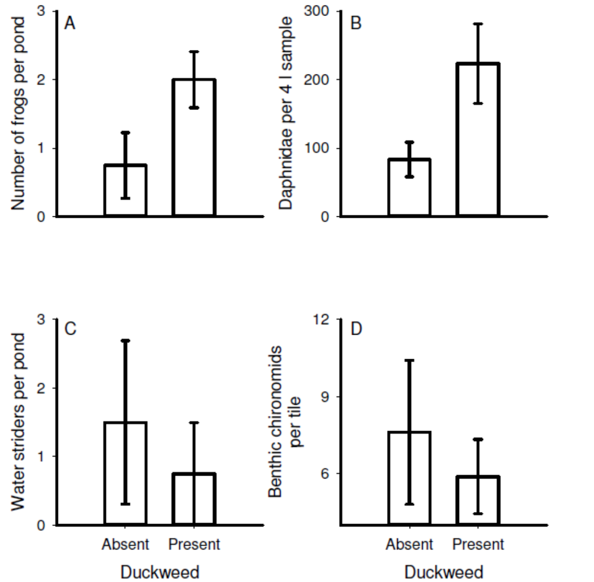

Figure 1. Average number of *Lithobates clamiitans* (p=0.09), *Gerridae* (p=0.61), *Daphniddae* (p=0.06) and *Chironomidae* (p=0.59) per treatment.

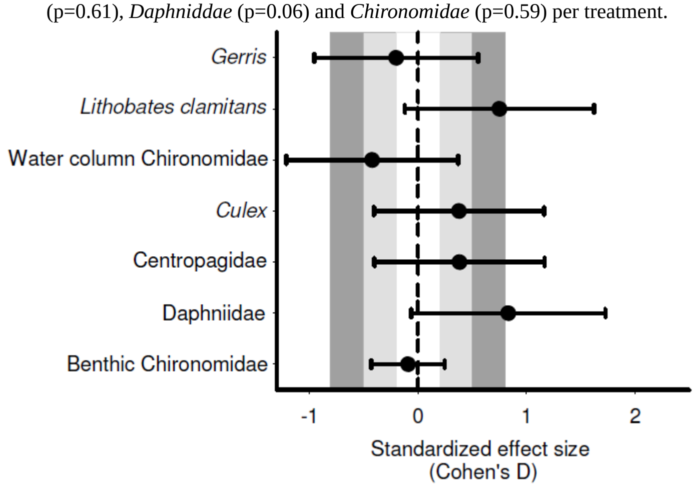

Figure 2. Standardized effect sizes (Cohen's *d*) with 95% confidence intervals of differences in ponds with the presence or absence of duckweed when n=4 per treatment. The vertical dotted line in representative of no difference. Shading is representative of small, medium, and large effect sizes, where *d*=..20, .50, and .80, respectively.

Results

- •Higher average number of *L. clamiitans* found in ponds with duckweed (p=0.09) (Figure 1).
- •Higher average number of *Gerridae* and *Chironomidae* found in ponds without duckweed, although the difference was not significant (p=0.61, 0.59) (Figure 1).
- •Higher *Daphniidae* abundances in ponds treated with duckweed (p=0.06) (Figure 1).
- •The highest effect sizes were found in *Daphniidae* (*d*= 0.83) and *L. clamiitans* (*d*= 0.75).
- • The effect sizes for *Centropagidae* (d= 0.38) and *Culex* (d=0.37) were lesser, but did result in medium effect size.

Discussion

- •Comparing the traditional metrics with standardized effect sizes indicates the utility of using multiple metrics
- •Where traditional ANOVA revealed borderline significance, Cohen's *d* illustrates that duckweed had large and medium effects on *Daphniidae* and *L. clamiitans* (Figure 1, Figure 2).
- •*Centropagidae* as well as *Culex* also increased in the presence of duckweed, confirming the findings of Jackobsen *et al.*2004 (Figure 2); the effect sizes were small in these cases.
- •Supported the predicted trend the dominant macrophyte in the system leads to a trophic cascade through the food chain.
- •Standardized effect size allowed us to reveal trends that traditional analysis would not.

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Work Cited

Jakobsen, T.S., Hansen, P.B., Jeppesen, E., and Sondergaard, M. 2004. Cascading effect of three-spined stickleback *Gasterosteus aculeatus* on community composition, size, biomass and diversity of phytoplankton in shallow, eutrophic brackish lagoons. *Marine Ecology Progress Series* 279: 305-309.

McCabe, D.J., Hayes-Pontius, E.M., Canepa, A., Berry, K.S., and Levine, B.C. 2012. Measuring standardized effect size improves interpretation of biomonitoring studies and facilitates meta-analysis. *Freshwater Science* 31: 800-812.

Nakagawa, Shinichi. 2004. A farewell to Bonferroni: the problems of low statistical power and publication bias. *Behavioral Ecology* 15: 1044-1045.

Wuensch, Karl L. 2009. Using SPSS to Obtain a Confidence Interval for Cohen's *d*. East Carolina University, Greenville, NC.