"Beyond The Null Hypothesis: Detecting Biologically Important Patterns Ignored By Traditional Statistics."

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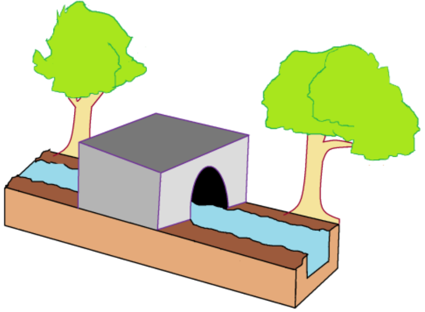
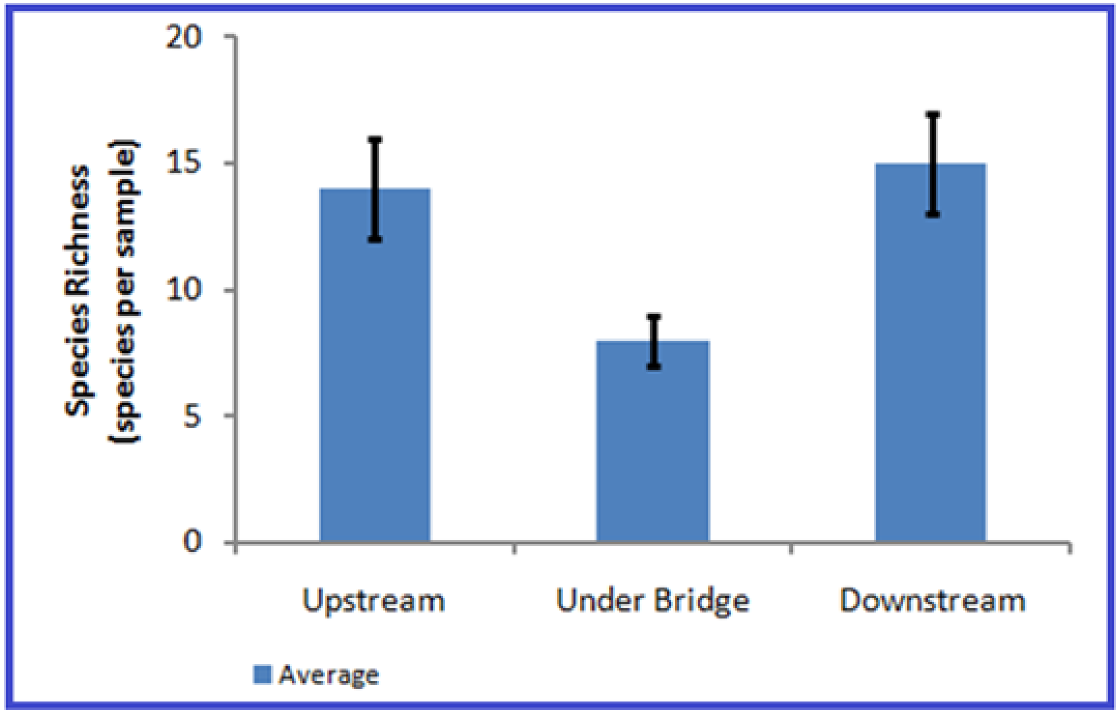
Introduction/Background



In our 2011 study:

▪ **Objective: Compare upstream, in-bridge and downstream areas of 4 streams.**

▪**Differences in macroinvertebrate metrics were measured.**

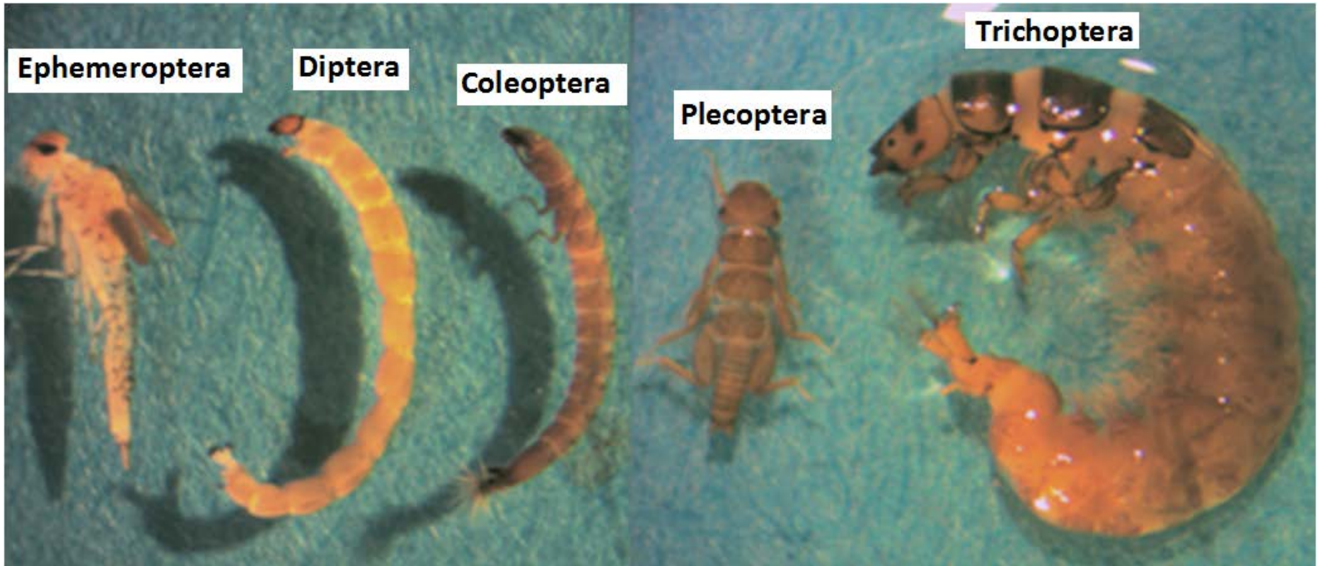


▪**Traditional statistical analysis was performed.**

Objectives

Compare the three stream areas by:

- ❑ Testing Null hypotheses using two sample *t*-tests to *if* metrics differ between treatment areas
- ❑ Go beyond and apply Cohen's *d*
- ❑ Determine *by how much* species richness, EPT, Ephemeroptera richness and % of ephemeroptera differed between treatment areas.



Materials and Methods

Testing null hypotheses in Excel

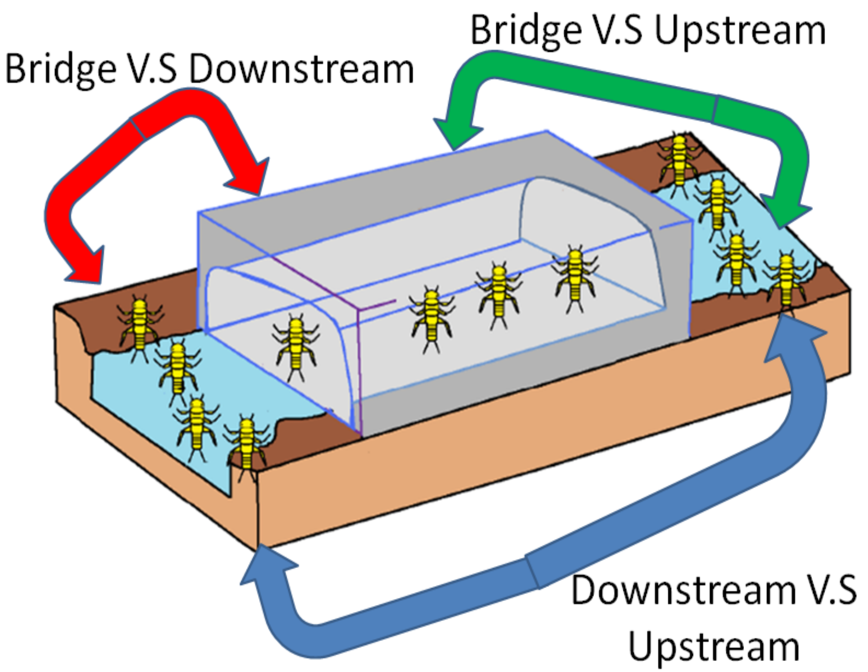
Structure:

Hypothesis: Aquatic macroinvertebrates differ among treatment areas .

$$t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\left(\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}\right)}}$$

Statistical analysis: twelve two sample *t*-tests:

3 comparisons times 4 response variables



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Using *t* test results we reject or accept the Null hypothesis; there are just 2 possible outcomes

T-test results are:

- **t-value=**size of difference between the means.
- **P-value=**probability of getting a similar t-value.
- **Degrees of freedom=**sample number.

$P<0.05$ = Lower = Samples are different

$P>0.05$ =Higher= Samples are not different

Null hypotheses was accepted= no difference found between treatment.

Materials and Methods

Using an statistic beyond null hypothesis

Standardized Effect Size: Cohen's *d*

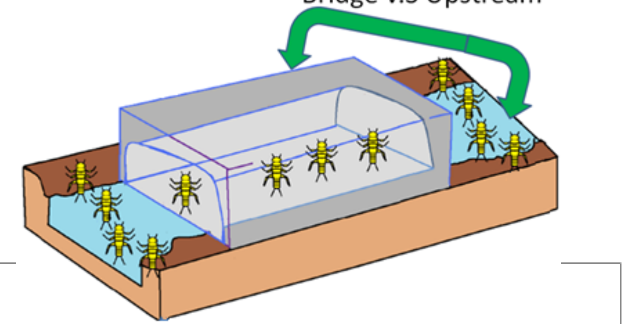
$$d = \frac{\overline{x_1} - \overline{x_2}}{s}$$

$$s^2 = \frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2}$$

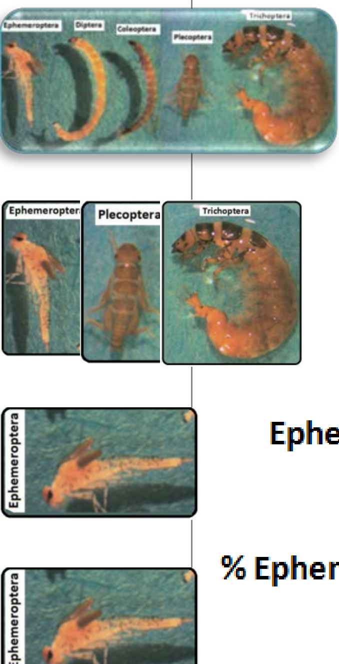
d expresses difference between treatments in terms of standard deviations

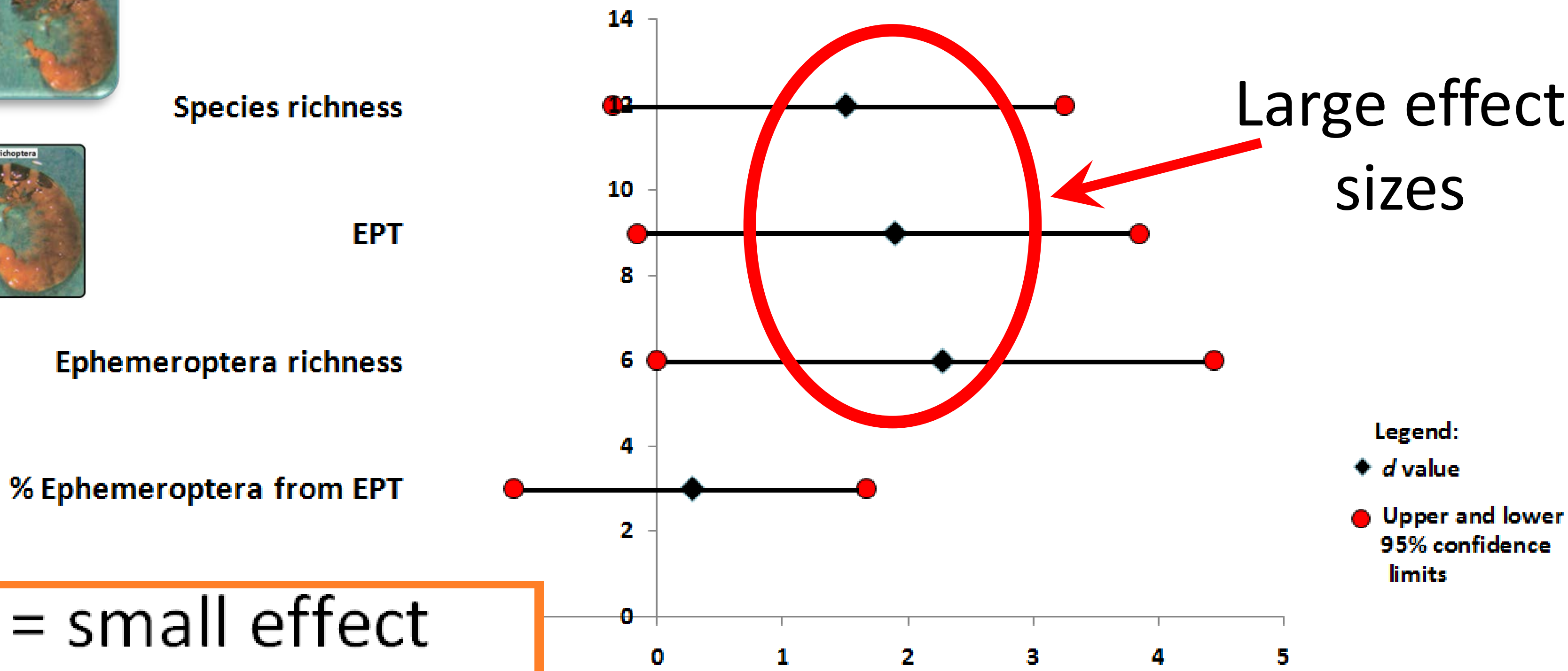
Confidence intervals for Cohen`s *d* calculated in Statistical Package for Social Sciences software (SPSS) using Wuensch`s scripts.

Results and discussion



Standardized effect size (Cohen`s *d*) between bridge/upstream treatment





d>0.2 = small effect

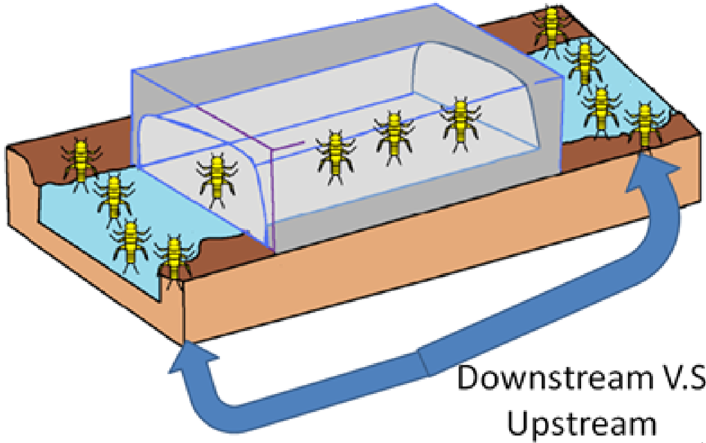
d>0.5 = medium effect

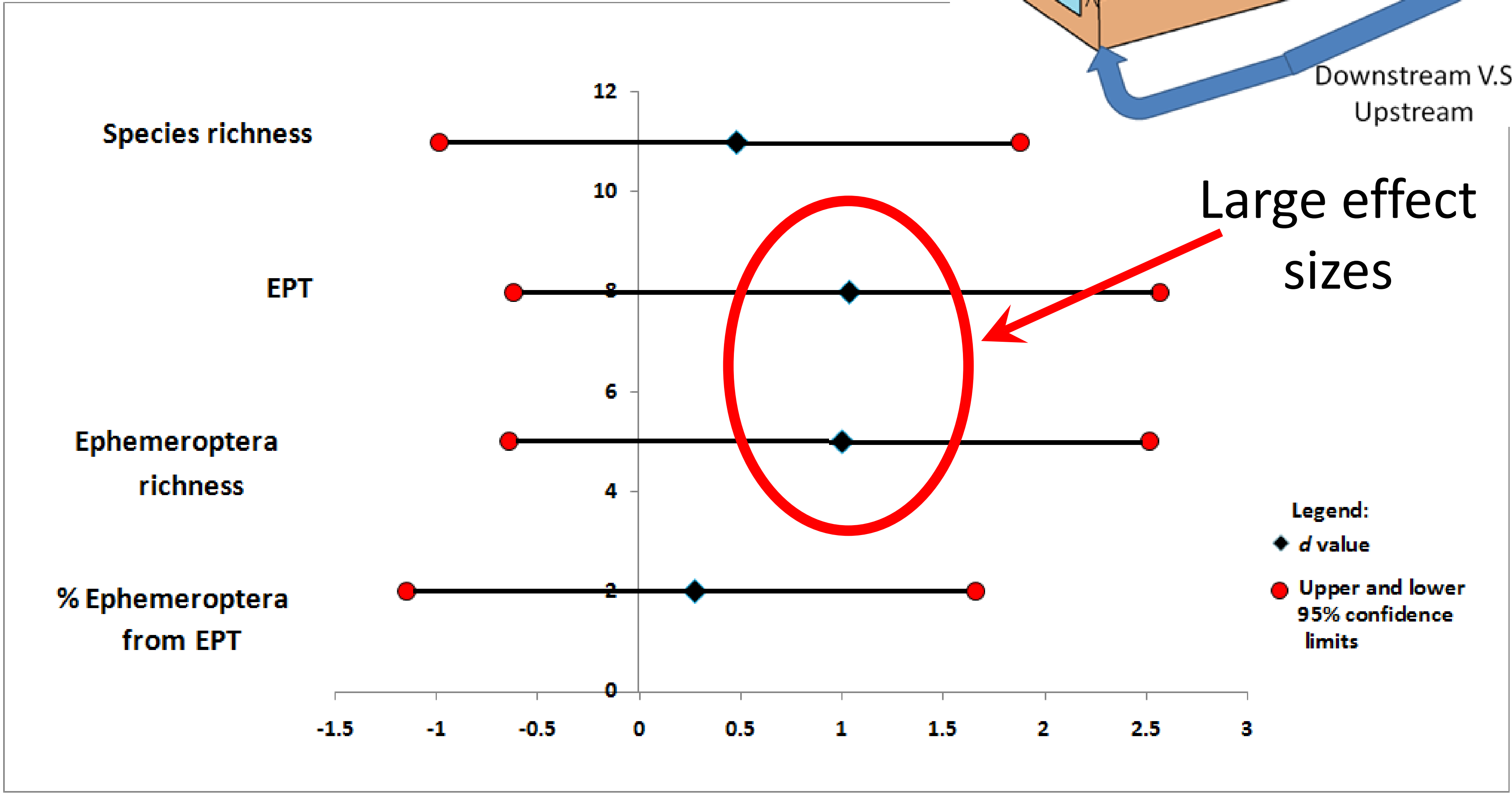
d>0.8= higher effect

upstream

Results and discussion

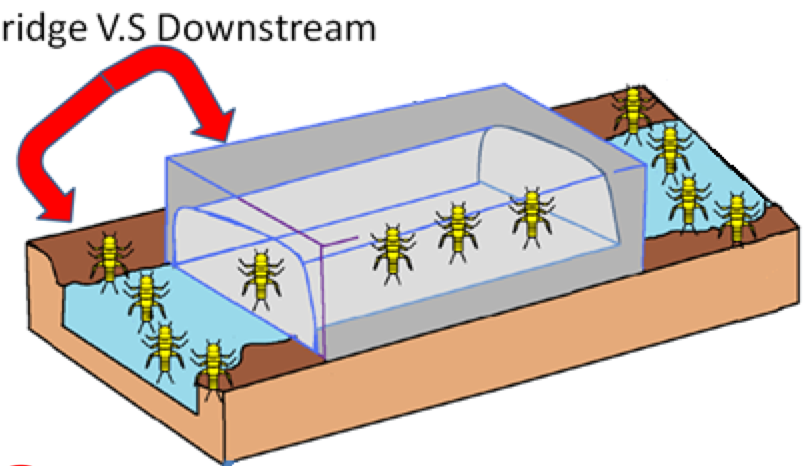
Standardized effect size (Cohen`s *d*) between downstream/upstream treatment



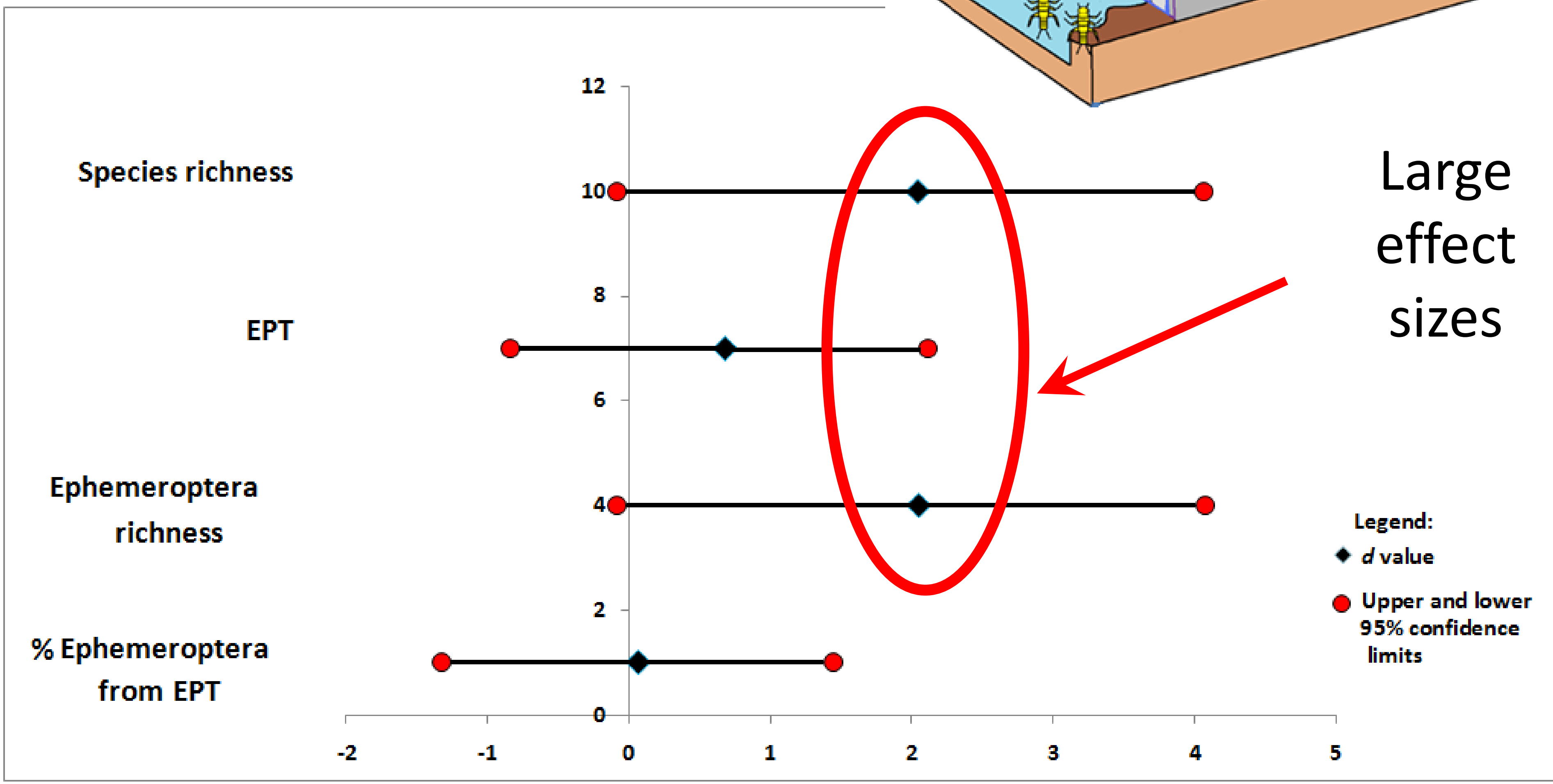


Metrics larger upstream

Results and discussion



Standardized effect size (Cohen`s *d*) between bridge/downstream treatment.



Metrics larger downstream

Conclusion

Traditional null hypothesis testing asks only if there is a difference between treatments.

Using Cohen`s *d* we focus on the size of differences between treatments

We can look at differences not even detected by traditional statistics.

Future work

In the future, I would like to monitor the most dangerous channelization structures affecting macroinvertebrate communities.

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