Comparing Diversity Indices using Field Data from a Riparian New Hampshire Forest Community

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Background and Objectives

Riparian communities are unique in that they encompass both terrestrial and aquatic ecosystems. This diverse landscape can serve as an interesting framework for understanding the organization, dynamics, and diversity of ecological communities (Naiman *et. al.* 1993). In this study we focused on biodiversity, which consists of two components: species richness (number of species) and species evenness (relative abundance of each species; Magurran 2004).

Specifically, we analyzed the diversity of a riparian forest community at the Amherst Country Club (Amherst, NH), which is also the site of a Certified Audubon Cooperative Sanctuary. We did this by calculating two of the most widely used diversity indices, the Shannon-Weiner's Index and the Simpson's Diversity Index, using three different statistical approaches.

Our objectives in this study were to:

1. Describe species diversity through species richness, Shannon-Weiner and Simpson's Diversity
2. Compare the method of estimating each index between an empirical approach and resampling approaches using field data

Methods

Field Sampling

- Site: Amherst Country Club, Amherst, NH (N42° 49.6765', W071° 36.5054')
- Dates: October 3 and 10, 2010
- Method: sampled 173 trees with point-centered quarter method using 50 m transect and sampling 10m, 20m , 30m, 40m , and 50m marks

Statistical Testing

- Nonparametric measures of diversity:
  1. Species Richness
  2. Shannon-Weiner
  3. Simpson's Diversity (Gini Coefficient)
- Calculations:
  1. Empirical calculations using equations from Lande (1996; table 1)
  2. Bootstrapping of field data using Matlab software (ver. 7.11.0584)
  3. Bootstrapping of field data using EstimateS software (ver. 8.2.0)

Table 1. Equations used from Lande (1996) in order to calculate each of the three diversity indices and their respective variation. Note: calculations from these equations produce theoretical estimates of diversity based on our field sampling results of S = 16 and N = 173.

Diversity Index	Equation	Estimated Statistical Mean	Estimated Statistical Variation
Species Richness	S = number of species	$\mathrm{E}[\hat{S}] = S - \sum_{i=1}^{S}(1-p_i)^N$	$\mathrm{Var}[\hat{S}] = \sum_{i=1}^{S}(1-p_i)^N[1-(1-pi)^N] + 2\sum_{i>}\sum_{j}[(1-pi-pj)^N-(1-pi)^N(1-pj)^N]$
Shannon Information	$H = -\sum_{i=1}^{S} p_i \ln p_i$	$\mathrm{E}[\hat{H}] \cong H - \frac{S-1}{2N}$	$\mathrm{Var}[\hat{H}] \cong \left[\sum_{i=1}^{S} p_i(\ln p_i)^2 - H^2\right]/N$
Simpson Concentration	$\lambda = \sum_{i=1}^{S} P^2{}_i$	$\mathrm{E}[1-\hat{\lambda}] = \left(\frac{N}{N-1}\right)(1-\lambda)$ $1-\hat{\lambda} = \left(\frac{N}{N-1}\right)(1-\hat{\lambda})$	$\mathrm{Var}[1-\hat{\lambda}] \cong \frac{4}{N}\left[\sum_{i=1}^{S} p^3{}_i - \lambda^2\right]$

Results and Conclusions

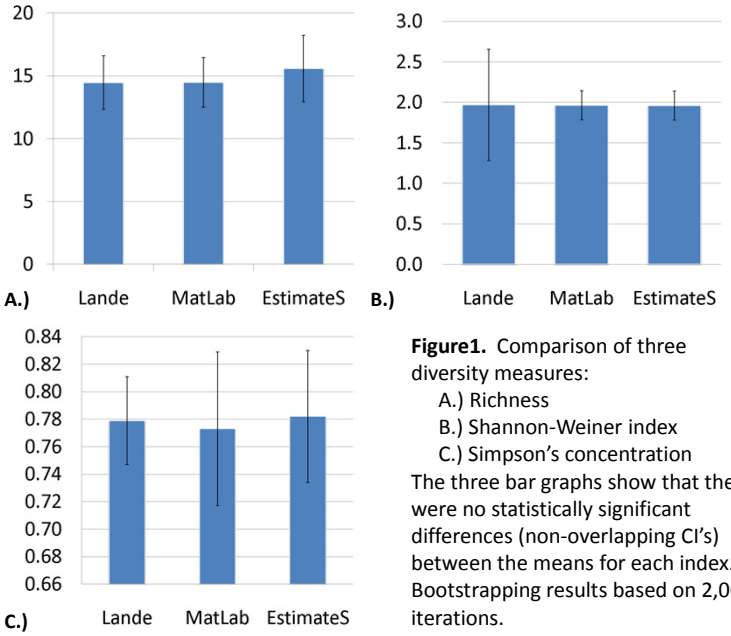

Figure1. Comparison of three diversity measures:
A.) Richness
B.) Shannon-Weiner index
C.) Simpson's concentration
The three bar graphs show that there were no statistically significant differences (non-overlapping CI's) between the means for each index. Bootstrapping results based on 2,000 iterations.

- Estimation of diversity parameters (figure 1)
  - Richness averaged 14.9 sp. (16 sp. encountered during sampling)
  - Shannon-Weiner's index averaged 1.96 (scale = 0 – 2.77)
  - Simpson's concentration averaged 0.77 (scale = 0 – 1)
- Simpson's concentration, which emphasizes common species, indicated higher species diversity than Shannon-Weiner, which emphasizes rare species.
- The discrepancy between diversity measures reinforces value of using multiple indices to accurately describe community diversity.
- Lack of statistical difference between empirical approach (Lande 1996) and resampling approaches (Matlab and EstimateS) suggest that any of the three statistical approaches is effective.

References

- Lande R. Statistics and partitioning of species diversity and similarity among multiple communities, Oikos 1996; 76: 5-13.
- Magurran A E. Measuring Biological Diversity. Malden (Ma): Blackwell Publishing; 2004. 256 p.
- Naiman R J, Decamps H, Pollock M. The Role of Riparian Corridors in Maintaining Regional Biodiversity, Ecological Applications 1993; 3 (2): 209-212.

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