

## Diversity index lab

BIOL 484L

40 pts

Several mathematical indices have been created to quantify and describe various aspects of species diversity. We'll use several indices to examine the diversity of stream insects in 36 streams in southeastern Minnesota. Your goals will be to 1) decide which streams should have the highest conservation value based on their diversity, and 2) evaluate patterns in diversity indices among the streams.

I'll provide a spreadsheet containing the stream insect species data in one worksheet, which is in a typical species-matrix format. The columns refer to the different species while the rows refer to the 36 different streams. The species data represent habitat-weighted abundances. Using these data, I calculated several diversity indices with the program, BioTools, an old Add-In to Microsoft Excel. These indices are in a second worksheet.

**First**, you'll need to rank the streams based on the diversity indices. You'll get different rankings for different indices as they emphasize different aspects of the abundance of individual species and/or species richness. Furthermore, high values of some indices mean more diversity whereas the reverse is true for other indices. You'll need to decide on a way to take all of these index scores to produce a single conservation ranking of the streams. One or two of the indices do *not* even help very much or may be redundant with another so you should consider omitting an index or two for your final ranking. All of these considerations mean you will need to do some research about these specific diversity indices to support your ranking system; be sure to cite whatever sources you use (appropriate web sources are fine).

To simplify things, **group the streams into three categories, each with 12 streams: high priority, medium priority, and low priority**. High priority streams should receive the most protection because they are the most speciose and we want to maintain them in that state. Then, **produce a top 5 ranking for only the high priority category**. You are to present all of your rankings in a table or two. Then, you'll present and defend the reasoning behind your rankings in a brief typed report. Make sure you explain why you used certain indices and why you may have omitted some indices (with citations).

**Second**, you'll evaluate a few patterns of diversity by answering two questions about how the diversity is expressed among these streams.

- Does mean species diversity (represented by only two indices: Shannon-Wiener index and Richness) significantly differ in streams with different numbers of habitats?
- Does mean species diversity (represented by only two indices: Shannon-Wiener index and Richness) significantly differ between stream channels that are natural vs. those that have been channelized by humans?

I have provided information showing the number of habitats and channelization history of each of the streams in a separate worksheet in the Excel file. You'll then answer the two questions above using appropriate statistical tests (think two-sample t-test assuming equal variance or single-factor ANOVA) and graphs to support your answers. By the way, you'll need to run each statistical test separately for each diversity index in each question and do some sorting of the data to make Excel "Data analysis happy". Besides providing the appropriate statistical results (means, *df*, *p*-value, calculated *t*-value or calculated *F*-value) and graphics, you need to write some text explaining what these results mean and why they may differ between endpoints (e.g., does richness give you the same statistical answer as Shannon diversity for each question? Why does this difference occur?).

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*All information in the next two pages is from BioTools. The indices:*

### **Shannon-Wiener**

$$H = - \sum_{i=1}^S (p_i)(\log_2 p_i)$$

Where:      H = Shannon-Wiener Diversity  
              SUM represents a capital epsilon  
              S = number of species  
               $p_i$  = proportion of individuals of the total sample belonging to the  $i$ th species  
              calculated as  $n_i / N$  for each  $i$ th species with  $n_i$  being the number in species  $i$  and  $N$  being the total number of individuals in the sample

### **Evenness**

$$J = H / H_{\max}$$

Where:      H = Shannon-Weiner Diversity  
               $H_{\max} = H_{\text{maximum}}$ , what H would be if all species had the same number of individuals  
              calculated as  $H_{\max} = \ln S$   
              (natural log of the number of species.)

### **Total\_Individuals**

Simply a count of the total number of individuals in the sample.

### **Richness**

A count of the number of taxa represented in the sample. This is equivalent to a count of cells in the range that have values  $> 0$ .

### **Margalef**

$$\text{Diversity} = (S - 1) / \ln N$$

Where Diversity = Margalef's Diversity  
              S = Total number of taxa represented in sample  
              N = Total number of individuals in sample

\*\*\* Neither text I am using as reference gave a base for the log in this formula. I arbitrarily chose to use the natural log because I think it looks better.

### **Simpsons\_Dominance**

$$\text{Dominance} = \sum_{i=1}^S (p_i)^2 \quad (\text{read as Sum from } i=1 \text{ to } S \text{ of } p \text{ sub } i \text{ squared})$$

Where Dominance = Simpsons Dominance

$s$  = number of species (or taxa)

$p_i$  = proportion of individuals in sample that belong to the  $i$ th species  
calculated as  $n_i / N$

Where  $n_i$  = number individuals in species  $i$

$N$  = total number of individuals

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\*\*\* NOTE: There are two versions of Simpson's Diversity; each are described below.  
Make sure you use the one you want.

### **Simpsons\_Diversity\_A**

$$\text{Diversity} = 1 / C$$

Where Diversity = Simpsons\_Diversity\_A

$C$  = Simpson's Dominance

### **Simpsons\_Diversity\_B**

$$\text{Diversity} = 1 - C$$

Where Diversity = Simpsons\_Diversity\_B

$C$  = Simpson's Dominance