Wetland Lab Report Guidelines

Introduction

The Beaumont Cattails Wetland is used to remove ammonia, chlorine, and excess nutrients from effluent wastewater after it has been treated. We sampled 2 sites, an inlet site, where the treated water enters the wetland, and an outlet site, where water leaves the wetland and enters the local bayou.

The objective of this project to determine if the wetland was effective at improving the water quality as the water moved from the inlet to the outlet. Two ways to measure water quality are:

1. Chemistry measurements. We can analyze the chemistry and determine if the water chemistry changed as the water moved through the wetland. This gives as straightforward answer but is merely a snapshot of the conditions of the water when the measurements were taken. Water chemistry may not stay the same over time.
2. Bioassessment: the use of organisms to assess the impact of pollution on the environment. Some organisms are very tolerant of pollution while others are very sensitive. By looking at which organisms occur in different parts of the wetland, we can see the long-term effects of the water quality, since organisms are being influenced by water pollution over long periods of time. We will explore two different types of bioassessments metrics:
    a. Structure metrics: these metrics describe the structure of the community. They include metrics like macroinvertebrate richness, diversity, and evenness.
    b. Functional metrics: these metrics describe how well the aquatic community is adapted to pollution. The two types of functional metrics we will use are traits (e.g., morphological, physiological, behavioral, or life history characteristics of an organism) and a tolerance score (a measure of how tolerant an taxa is to pollution).

Data Analysis

<u>Hypothesis</u>

Come up with a hypothesis concerning water chemistry and the biological community along the four sites in the wetland. You will also be required to find 4 peer-reviewed papers that directly relate to your hypothesis and integrate them into your paper.

1. Think about the nature of the two sites along the wetland.
2. Think about how the chemistry may respond as water moves through the wetland.
3. Think about how our organisms may respond to the changes in nutrients and chemistry as water moves through the wetland.
    a. Think about how the structure of the community would change.
    b. Think about how the traits of the community would change.

4. Come up with your hypothesis before your analysis. It is OK to for your hypothesis to not be supported by your analysis if the hypothesis makes ecological sense.

Chemistry Analysis

Statistically analyze (using ANOVA analysis) the chemistry data to determine if it is different between the 2 sites. You will perform 9 ANOVA analyses, comparing the 2 sites (inlet and outlet) as the independent categorial variables (x-variable) and one 9 chemistry measures as the dependent variable (y-variable).

Bioassessment

Structure metrics

1. Calculate macroinvertebrate richness, diversity, and evenness between the four sites
    a. Richness: S = number of taxa.
    b. Diversity: $H' = -\sum_{j=1}^{S} p_j \times ln(p_j)$.
        i. p_j is the proportion of taxon *j* relative to the abundance of the entire sample.
    c. Evenness: $E = \frac{H\prime}{ln(S)}$.

Functional metrics

1. Calculate an average tolerance score for each site.
    a. Tolerance scores are values assigned to each taxon based on how tolerant they are to disturbance and pollution. These scores are based on known distribution of these organisms and on the opinion of experts.
    b. A tolerance score of 0 means that the taxon can not tolerate any pollution or disturbance. A tolerance score of 10 means that the taxon is extremely tolerant of most pollutants or disturbances.
    c. Weighted Average Tolerance: $T = \sum_{j=1}^{S} p_j \times t_j$.
        i. p_j is the proportion of taxon *j* relative to the abundance of the entire sample.
        ii. t_j is the tolerance score for taxon *j*.
2. Calculate the proportion of each macroinvertebrate community with each trait.
    a. Functional Feeding Group (FFG) is how a taxon is adapted to collect its food.
        i. Collector-filterers (CF) are organisms that collect and consume fine particulate organic matter (FPOM) that is suspended in the water column.
        ii. Collector-gatherers (CG) are organisms that collect and consume fine particulate organic matter (FPOM) that has settled in the benthic zone.
        iii. Shredders are organisms that break down coarse particulate organic matter (CPOM) like fallen leaves.

iv. Grazers are organisms that consume living, attached plant matter. They could scrape attached algae off a surface or consume macrophytes.
v. Predators consume other animals.

b. Respiration is the technique each taxon uses to obtain oxygen.
    i. Air breathers obtain oxygen from the atmosphere. They may reside on the water surface, trap an air bubble while they swim underwater, or have a tube that reaches the water surface.
    ii. Gills are extensions of the body wall that increase the surface area of the organism and helps it better extract oxygen form the water.
    iii. Tegument breathers have no special respiratory adaptations and absorb oxygen from the water directly through their skin.
c. To calculate the proportion of the community with each trait, sum up the proportions of all taxa in your dataset that have that trait.

Statistically analyze these measurements (using ANOVA) to test your hypothesis. You will perform 12 ANOVA analyses, comparing the 2 sites (inlet and outlet) as the independent categorial variables (x-variable) and one of your structural or functional metrics as the dependent variable (y-variable).

The Report: Once you have computed metrics, performed statistical analyses, and built your graph and tables, you will present your ideas in a lab report, which should consist of 4 sections:

1) The introduction presents previous research on the topic and gives your hypothesis (including how your analysis will add to the current understanding). You need to explain the ecological theory supporting your hypothesis. You need to review 4 peer-reviewed publications and state how they relate to your hypothesis. You should find some publications describe how wetlands can be used to filter nutrient and/or pollutants from water and how organisms respond to those changes.

2) The methods section has a description of the wetland, how the data was collected, and describes how the analysis was performed. Include equations and statistics used.

3) The results section tells the reader what the important results are. Simply placing tables and graphs is not enough. You need to explain the results to your reader, leading your reader to the most important points you want to make. You do this by writing about the most important results and backing up your text with the tables and graphs. To properly do this, you need to understand each table and graph and describe in the text the most relevant results from each. You must also refer to each table and graph in the text. You should include the following tables and graphs:

- 5 bar graphs showing the relationship between the sites (x variable) and 5 chemistry metrics: dissolved oxygen, nitrate, phosphate, and ammonia, and free chlorine.
- A table showing the results of the ANOVA analysis for the 9 chemistry variables. The table needs to include: 1) average for each site, 2) variance for each site, 3) F-ratio, 4) P-value. The F-ratio is just listed as "*F*" in the Excel ANOVA analysis.
- A table showing the results of the ANOVA analysis for the structural metrics: richness, diversity and evenness. The table needs to include: 1) average for each site, 2) variance for each site, 3) F-ratio, 4) P-value. The F-ratio is just listed as "*F*" in the Excel ANOVA analysis.
- A table showing the results of the ANOVA analysis for the functional metrics: weighted average tolerance, the 5 functional feeding groups, and 3 respiration traits. The table needs to include: 1) average for each site, 2) variance for each site, 3) F-ratio, 4) P-value. The F-ratio is just listed as "*F*" in the Excel ANOVA analysis.

Remember, you need to refer to and explain the results from all the tables and graphs in the text. That means that you need to understand what P-values mean and interpret them for each table.

4) The discussion section interprets your results. You want to describe how this analysis has contributed to our general understanding. Was your hypothesis upheld or not? Why? Why is this important? You need to also compare your results to the 4 publications you reviewed in the introduction. How did they compare? What ecological principles and theory support these results? What conclusions can you make from this study?

5) Literature cited section lists the papers used in your introduction and discussion

Remember all of this must be **written in your own words**!

Appendix A: Excel formulas you can use in this analysis

1. Average() - averages all the numbers in the cells you have selected
2. sum() – adds up all the numbers in the cells you have selected
3. if() – checks a cell to see if it meets a criterion and returns two possible outcomes. There are three parts to this function: 1) the criterion (e.g., C3=D4), 2) the result if the criterion is true, and 3) the result if the criterion is false
4. countif() – adds up all the cells that match a criteria you set. The function has two parts. One is the range of cells you want to count. The second is the criteria. The criteria must be in quotation marks (e.g., ">0", "=2")
5. iferror() – If you get an error due to a calculation, you can use this function to convert the error to a value. This can be used for legitimate errors, such as taking the natural log of 0 or dividing by zero, but if you make a mistake in your calculations, this function may also hide it and give you a value. This function has two parts: the first is the calculation or function you want to use (e.g., Ln(0)). The second is the value you want to return if an error occurs.
6. ln() – takes the natural log of the cell you have selected
7. abs() – takes the absolute value of the cell you have selected

Appendix B: The grading rubic I will use

Wetland Report

Criteria	Points Possible	Points Earned
Paper in proper scientific format (Intro, methods, etc.)	1	
Spelling and grammar correct	1	
Introduction		
Introduction describes the paper objective and its importance to science	2	
Introduction contains ecological reasoning that supports the hypothesis	2	
At least 4 articles are reviewed that justify the hypothesis	4	
Hypothesis clearly stated in the introduction	1	
Methods		
Study location described with enough information to find it	1	
Collection procedures with enough detail to reproduce	3	
Metric equations included	1	
Statistical methods described	1	
Results		
Metrics were properly calculated	1	
Statistically compare metrics	2	
Bar graphs	2	
The most important and relevant results described in text	5	
Tables produced according to instructions and referenced in text	2	
Discussion		
Stated that the hypothesis is supported or not by the statistics	2	
Discussion of possible explanations for getting the results, specifically what it means when some analyses are significant and some aren't	5	
Comparison of results to 4 articles	4	
Explanation of the importance of the results	2	
Possible flaws with study	1	
References		
References cited in text	1	
References listed in back	1	
Total	**45**	