Title: Analyzing Macroinvertebrate Communities and Water Quality in River Systems: Insights into Ecological Health

Abstract

This research proposal aims to investigate the relationship between macroinvertebrate species distribution and water quality parameters across three river systems at various distances from their sources. Using data on water chemistry (e.g., pH, dissolved oxygen) and macroinvertebrate populations (e.g., mayflies, stoneflies, caddisflies), the study seeks to identify patterns that reflect river health and environmental stress. Statistical analyses such as correlation, diversity indices, and multivariate techniques will be used to explore how species distribution is influenced by water quality and habitat characteristics. Results could inform conservation strategies and improve freshwater management in similar ecosystems.

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Introduction

Freshwater ecosystems are essential for biodiversity, providing habitat for numerous aquatic species, including macroinvertebrates, which serve as key indicators of water quality. Studying the distribution of macroinvertebrates alongside water quality parameters can reveal the health of river systems and identify potential stressors such as pollution or habitat degradation. This research focuses on three river systems (Silver River, Camcor River, Faurawn River) in which macroinvertebrate populations were surveyed at three distances from the river sources (1.5 km, 3 km, and 6 km). Given the environmental variability along river gradients, understanding how species distribution correlates with water chemistry is crucial for effective freshwater management.

Why It's Important

River ecosystems are under increasing pressure from human activities such as agriculture, urbanization, and industrial pollution. Understanding how environmental variables affect macroinvertebrate populations can provide insights into river health, guiding conservation efforts. Macroinvertebrates, as sensitive bioindicators, respond to changes in water quality (e.g., pH, oxygen levels), making them ideal for assessing the ecological integrity of aquatic habitats.

Hypothesis

I hypothesize that the abundance and diversity of macroinvertebrates, particularly sensitive species like mayflies and stoneflies, will decrease with deteriorating water quality (e.g., lower dissolved oxygen levels and higher conductivity) at greater distances from the river source.

Planned Analysis

To test this hypothesis, the following analyses will be conducted:

1. Descriptive Statistics: Summarize key water quality variables (pH, temperature, dissolved oxygen) and macroinvertebrate counts for each river system and sampling distance.
2. Diversity Indices: Compute the Shannon-Wiener and Simpson's indices for each sampling site to compare species richness and evenness across the three rivers and distances.
3. Correlation Analysis: Use Pearson or Spearman correlation to assess the relationship between environmental parameters (e.g., pH, dissolved oxygen) and the abundance of key macroinvertebrate species (e.g., mayflies, stoneflies).
4. ANOVA: Perform one-way and two-way ANOVA to determine if significant differences exist in water quality parameters and macroinvertebrate diversity across rivers and distances from the source.
5. Multivariate Analysis: Apply Principal Component Analysis (PCA) to identify patterns in species distribution and environmental gradients.

These analyses will help answer the research questions:

- How do water quality parameters vary across rivers and sampling distances?
- What patterns in species distribution are observed with changing water quality?
- Are there any species particularly sensitive to water quality, and how do they respond to habitat changes?

Broader Impacts

Understanding the relationship between macroinvertebrate communities and water quality can have significant implications for freshwater management and conservation. The findings of this study can help identify priority areas for conservation and inform water quality monitoring programs. Additionally, these insights are crucial for maintaining biodiversity and ecosystem services, as rivers provide vital resources for both wildlife and human communities. The broader societal impact includes improving water resource management strategies, particularly in regions where freshwater ecosystems are increasingly threatened by human activities.

Timeline

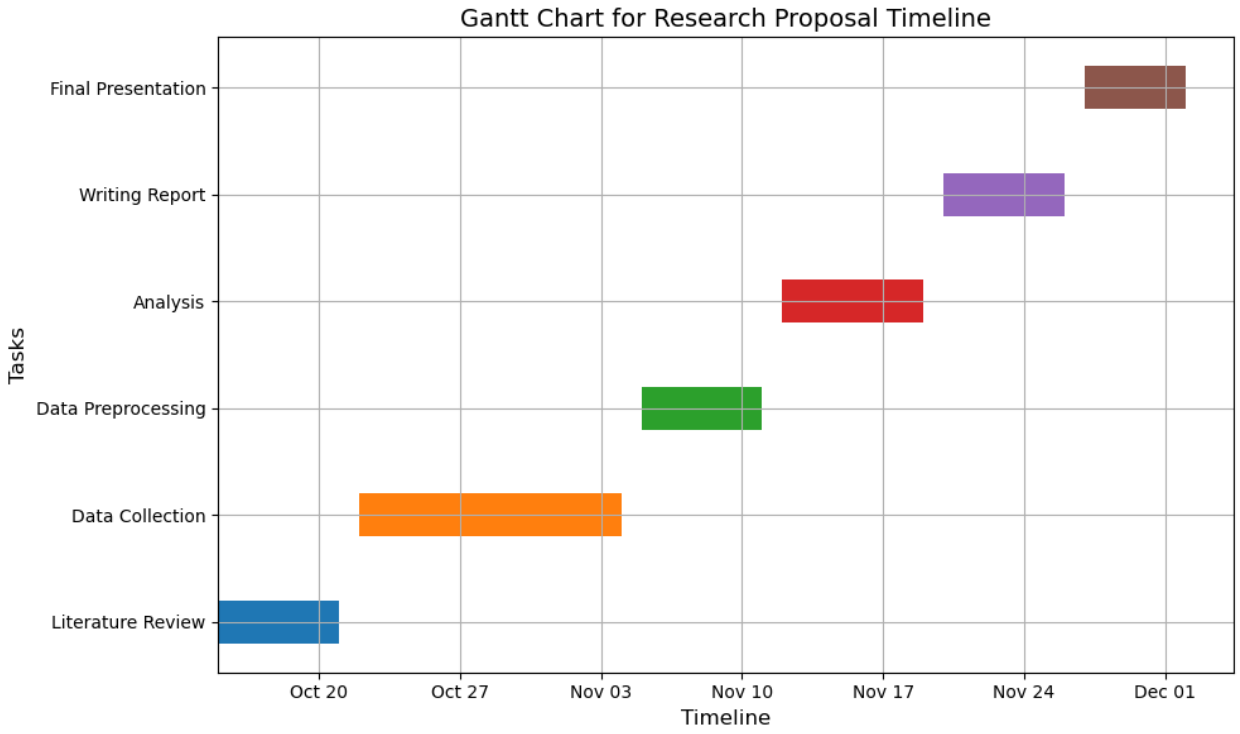

Figure 1: Ghant chart for the final project

Preliomnary data analysis

Figure 2 presents a boxplot comparing the dissolved oxygen (DO) levels at three sampling points (1.5 km, 3 km, and 6 km from the source) for the Siler, Camcor, and Faurawn rivers. Each boxplot summarizes the range, median, and quartiles of DO levels observed at the different distances for each river. The boxplot allows us to easily compare the distribution of dissolved oxygen levels between rivers and identify any significant variations.

- The Siler river shows a narrower range of DO values, with slightly higher levels at downstream points (3 km and 6 km).

- The Camcor river displays a wider spread of DO levels, indicating more variation at different sampling points.
- The Faurawn river exhibits relatively high DO levels at the headwater (1.5 km), with a slight decrease further downstream.
- The Camcor river's 3 km point shows lower median DO compared to other rivers, while the Faurawn river has higher levels near the source.

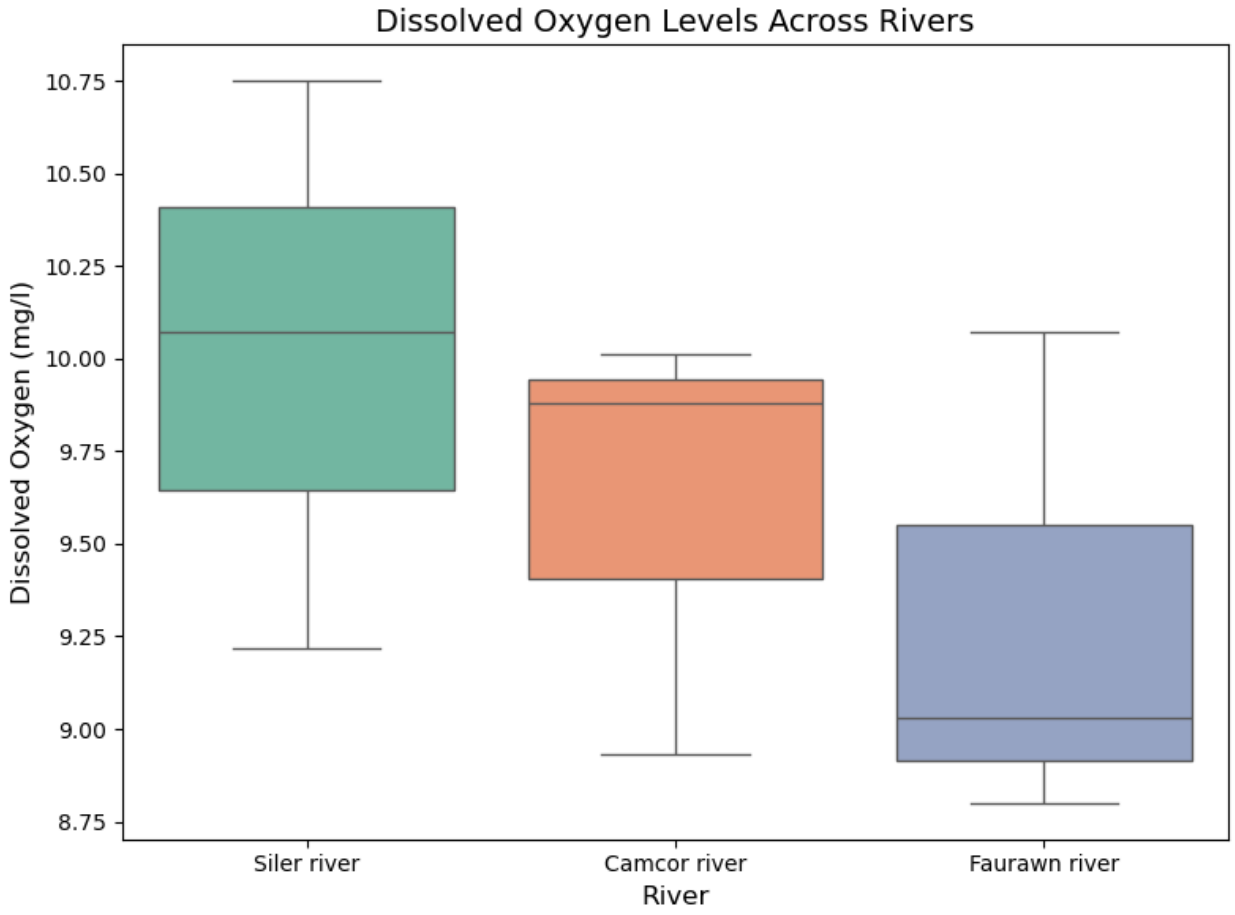

Figure 2: A preliminary boxplot comparing dissolved oxygen levels across the three rivers (6).

Figure 3 presents a scatter plot showing the relationship between species abundance and dissolved oxygen (DO) levels across different sampling points in the three rivers. The color of each point represents the distance (in kilometers) from the source of the river, as indicated by the color bar. Each point is also annotated with the river name and distance for clarity.

- There appears to be a general trend where species abundance increases at moderate DO levels, particularly in the Faurawn and Camcor rivers.
- The Faurawn river (shown in green/yellow hues) exhibits higher species abundance at a distance of 3 km from the source, which coincides with moderate DO levels.
- The Siler river (shown in dark purple) has a consistent species abundance but lower overall values compared to the other rivers.
- The Camcor river shows lower species abundance at 3 km, despite relatively high DO levels at the same point.
- This figure highlights the interplay between dissolved oxygen and species diversity while also showing how distance from the source can influence both parameters.

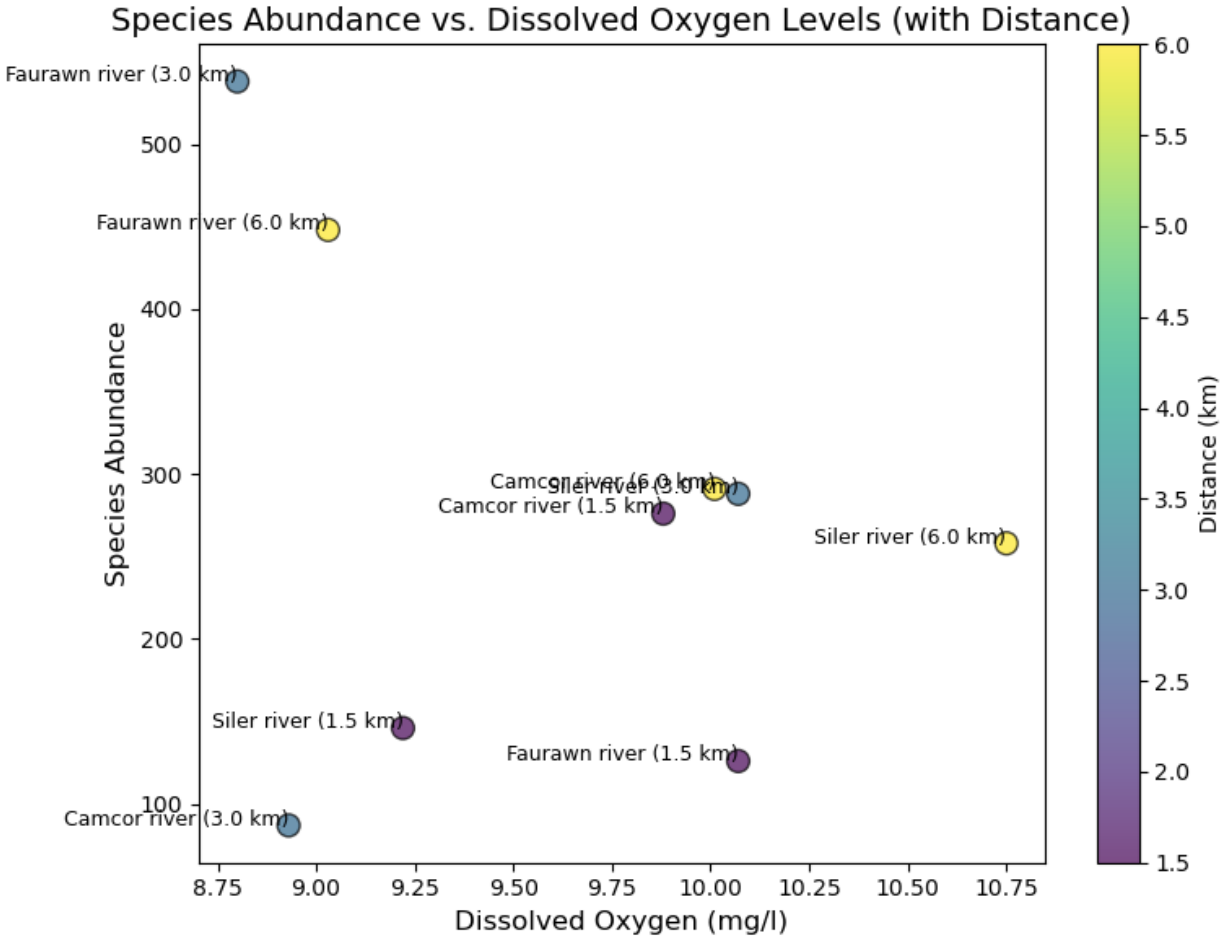

Figure 3: A scatter plot of species abundance vs. dissolved oxygen levels, highlighting key macroinvertebrate species (6).

References

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