MSc ENR ISM: Exercise B

Biodiversity analysis (alpha, beta, gamma)

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Methods

The vegetation data and associated header information were imported and preprocessed. Missing values (NAs) were replaced with zeros to indicate species absence. From the header data, only the assignment of plots to management types was used.

Alpha diversity was assessed using species richness (S), the Shannon index (H') (Shannon and Weaver 1949), and Pielou's evenness (E) (Pielou 1966). All calculations were performed with the vegan package (Oksanen et al. 2025). Species richness was calculated using the `specnumber()` function, while the Shannon index and Pielou's evenness were computed using the `diversity()` function, based on relative species abundances per plot.

Statistical tests (e.g., ANOVA) were conducted to assess differences in species richness, Shannon index, and Pielou's evenness between the two management types (grazed vs. mowed).

Overall gamma diversity was calculated as the total number of unique species recorded across all plots, irrespective of management type. Habitat-specific gamma diversity was determined separately for each management type (grazed and mowed fens) by counting the number of unique species recorded within each group.

Mean beta diversity was calculated according to the formula $\beta = \gamma/\overline{\alpha}$, where γ represents the habitat-specific gamma diversity, and $\overline{\alpha}$ denotes the mean species richness across plots within each management type. Plot-wise beta diversity was calculated using the formula $\beta = \gamma/\alpha$.

All analyses were conducted using R version 4.5.0 (R Core Team 2025).

Results

Gamma diversity across all fens in the study region was 110 species. Habitat-specific gamma diversity was slightly lower, with 96 species recorded in mowed fens and 86 species in grazed fens. In mowed fens, the mean species richness per plot was 30.4, ranging from 19 to 41 species. In grazed fens, the mean was 30.3 species per plot, with a range from 18 to 40 species. ANOVA results indicated no significant differences between the two management types for any of the calculated alpha diversity metrics, including species richness, Shannon diversity, and Pielou's evenness (Figure 1).

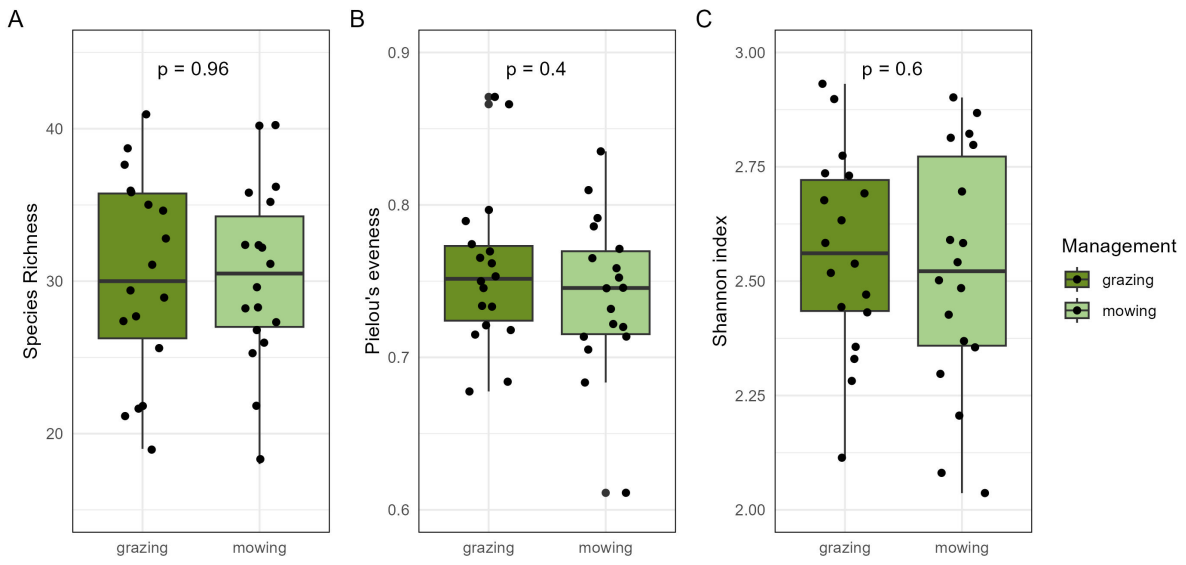

Figure 1: Boxplots showing differences in vegetation diversity metrics between grazed and mowed plots. (A) Species richness (number of species), (B) Shannon evenness, and (C) Shannon diversity index. Each point represents an individual plot. p-values from ANOVA tests indicate no significant differences between the two management types.

Mean beta diversity differed slightly between the two management types. In mowed fens, mean beta diversity was 2.84, whereas in grazed fens it was slightly higher at 3.16. When calculating plot-wise beta diversity, the mean value across plots was 2.95 for mowed fens and 3.32 for grazed fens. The minimum plot-wise beta diversity was 2.15 in mowed and 2.34 in grazed fens, while maximum values reached 4.78 and 5.05, respectively.

References

Oksanen, Jari, Gavin L. Simpson, F. Guillaume Blanchet, Roeland Kindt, Pierre Legendre, Peter R. Minchin, R. B. O'Hara, et al. 2025. *Vegan: Community Ecology Package*. https://CRAN.R-project.org/package=vegan.

Pielou, E. C. 1966. "The Measurement of Diversity in Different Types of Biological Collections." *Journal of Theoretical Biology* 13 (December): 131–44. https://doi.org/10.1016/0022-5193(66)90013-0.

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