Distinct response of two wet grassland communities to different management regimes

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Wet grasslands

• Host numerous rare plant and animal species

• Significant ecosystem functions – carbon sequestration, water reserves, etc.

• Recognized in CBD (Rio), Ramsar, etc.

• Easily intensified, potentially highly productive (flat terrain, soil quality, water availability)

• Conflicts in land use
Study area – Ljubljana marsh

- Mostly uninhabited area just outside the capital Ljubljana
- Transitional oceanic-continental climate, 290 masl.
- Ex-lake, ex-bog area
- Large vegetation changes due to drainage work since roman period
- Soils also depend on past land use: histosols (fibric or terric), mollic gleysols
- Regular spring/autumn floods still present
Grasslands of the area

Agricultural aspects

- Traditionally hay production
- Low nutritional value of oligotrophic grasslands (horse feed, litter)
- Increase of arable land in last decades (maize)
- Lately: grazing is increasing
- Abandonment – fast invasive species and shrub encroachment

Natural values

- Natura 2000 site
- Oligotrophic and mesotrophic wet meadows with threatened plant species
- 89 daily butterfly species!
- 100 bird species; some of them globally endangered (corn crake, curlew, woodcock, lapwing, etc.)
Objectives

• The effect of fertilizers and cutting frequency on two types of wet grasslands

• Compare the response of diversity, species composition and functional composition

• Inferences on proper management to meet nature conservation and agricultural goals
Experimental design and analysis

• Two grasslands: wet *Arrhenatherion*, *Molinion*
• For each: split-plot design in four blocks
• Two factors:
  – fertilization (no fert., PK, NPK, N_cPK)
  – cutting (extensive use, intermediate, intensive)
• Started in spring 1999
• 11 year-effects on sward composition evaluated using Braun-Blanquet method
• Split-plot ANOVA, correspondence analysis, compositional data approach
Interlude – compositional data

- **Closed data** (summing to fixed total or total irrelevant) can only bear relative information

- E.g. - sand, silt, clay in soil samples;
  - proteins, lipids, fibres in feed samples,
  - beech, spruce, fir in a forest

- Difficulties using classical statistics

- Inherently **multivariate** data

- Means, variances, scatterplots, correlations invalid when calculated componentwise
Interlude – compositional data

• Solution: special transformation which opens up the vector space (Aitchinson, 1986, Egozcue et al. 2003) -

**isometric logratio transformation (ilr)**

\[ u_i = C \left[ \exp \frac{1}{\sqrt{(D - i + 1)(D - i)}}, \ldots, \exp \frac{1}{\sqrt{(D - i + 1)(D - i)}}, \exp \sqrt{\frac{D - i + 1}{D - i}}, 1, \ldots, 1 \right] \]

For 3-part composition:

\[ u_1 = C \left[ \exp \sqrt{\frac{3}{2}}, 1, 1 \right], \quad u_2 = C \left[ \exp \frac{1}{\sqrt{2}}, \exp \sqrt{2}, 1 \right] \]
Results - diversity parameters

• Cutting frequency of secondary importance for the diversity (in T1 not significant)

• Delayed cut in T2 additionally decrease diversity of unfertilized treatments
Results - diversity parameters

- Fertilization decreased species richness (also true for PK treatment !)
- Both grasslands similar in response of SR
- Shannon index decreased only in T1 experiment
- Dominance of certain species in T1 expressed when N was added
Results – species composition

- Correspondence analysis
Results – species composition

- T1 – with fertilizers loss of species and change in abundance of existent species
- T2 - with fertilizers large transformation of community composition
- PK treatment more pronounced in T1
- Minor effect of cutting frequency
- Some effect of delayed first cut in T2 (competitive exclusion)
Results – species composition

• T2 trajectory when fertilized

- Molinia dominated sward
  - Fertilization effect
  - Filipendula ulmaria dominated sward
  - Normal cut
  - ~ Arrhenatherion community (Holcus / Arrhenatherum dominated)
  - Delayed first cut

- High-forb community (Filipendula ulmaria, Lysimachia vulgaris, Lythrum salicaria)

- Normal cut
Results – functional composition

- Ternary diagram of 3-part composition

![Ternary diagram of 3-part composition](image)
Results – functional composition

T1

Fertilization

Cutting: p=0.786; Fert.: p=0.000; interaction: p=0.139

T2

Fertilization

Cutting: p=0.181 Fert.: p=0.002; interaction: p=0.380
Results – response of some dominant species

T1
Arrhenatherum elatius,
Lathyrus pratensis,
Equisetum palustre

Cutting
2 cuts
3 cuts
4 cuts
-3.8
-1.8
0.2
2.2
4.2

Fertilization
V2
NPK
NcPK
PK
no fert.

T2
Holcus lanatus,
Anthoxanthum odoratum,
Filippulina ulmaria,

Cutting
2 cuts
3 cuts
4 cuts
-4.3
-3.3
-2.3
-1.3
-0.3

Fertilization
V1
NPK
NcPK
PK
no fert.

Ilr 1 (Lathyrus / Arrhenatherum)
Ilr 1 (Holcus / Anthoxanthum)
Ilr 1 (Lathyrus + Arr. / Equisetum)
Ilr 2 (Holcus + Anth. / Filipendula)
Conclusions

• Fertilization showed larger effect than disturbance regime in both grasslands

• Oligotrophic grassland (T2) larger response in terms of diversity and species composition

• T1 larger response in functional composition (legumes) showing the importance of species pool

• Difficult to reconcile nature conservation and production aims in T2
Thank you for your attention!