

Distinct response of two wet grassland communities to different management regimes

Jure Čop, Klemen Eler, Vidrih Matej

University of Ljubljana, Biotechnical Faculty

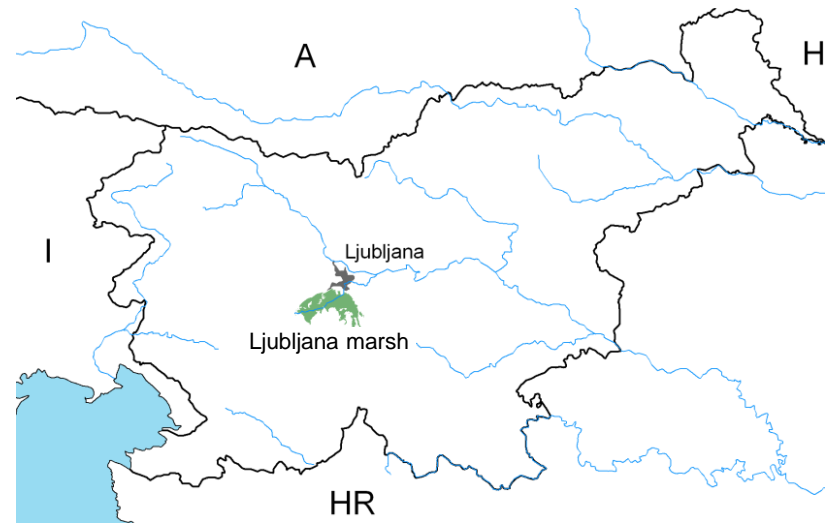


Wet grasslands

- 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

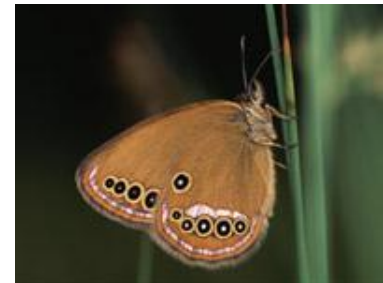
Agricultural aspects

- 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 crane, curlew, woodcock, lapwing, etc.)

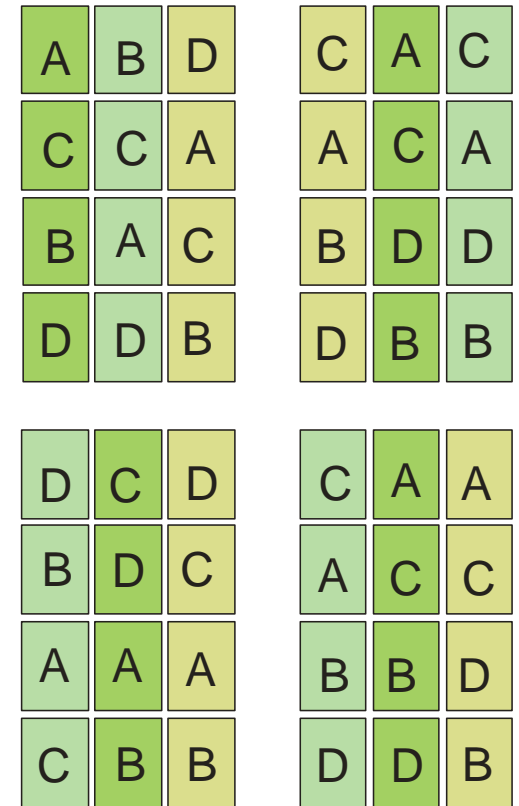


Objectives

- 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

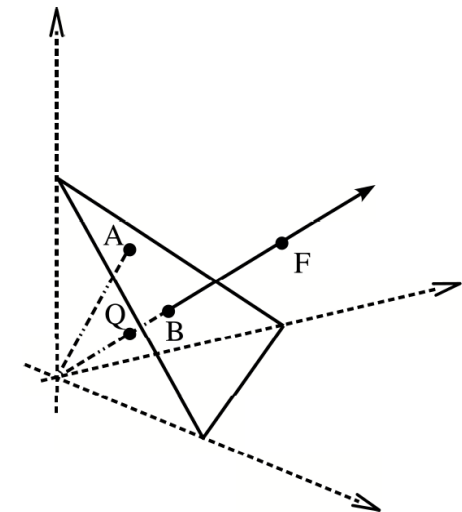
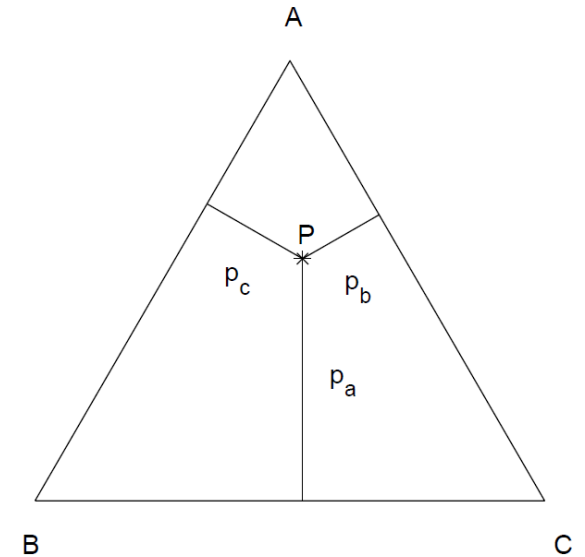
- Two grasslands: wet *Arrhenatherion*, *Molinion*
- For each: split-plot design in four blocks
- Two factors:
 - fertilization (no fert., PK, NPK, N_cPK)
 - cutting (extensive use, intermediate, intensive)
- Started in spring 1999
- 11 year-effects on sward composition evaluated using Braun-Blanquet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



- 2 cuts (delayed) A - no fertilizer
- 3 cuts (2 cuts) B - PK
- 4 cuts (3 cuts) C - N₁PK
- D - N_cPK

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



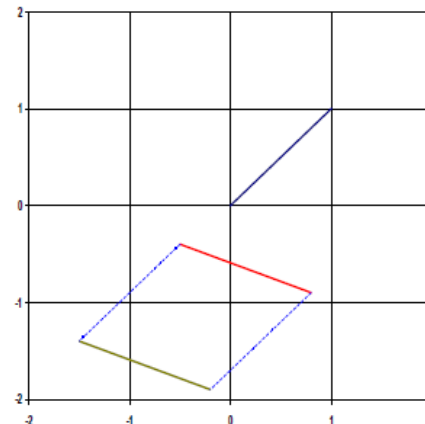
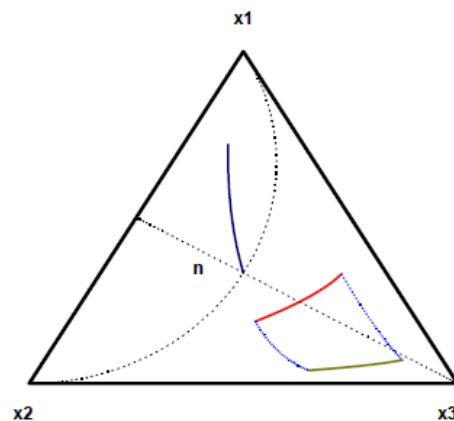
Interlude – compositional data

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

isometric logratio transformation (ilr)

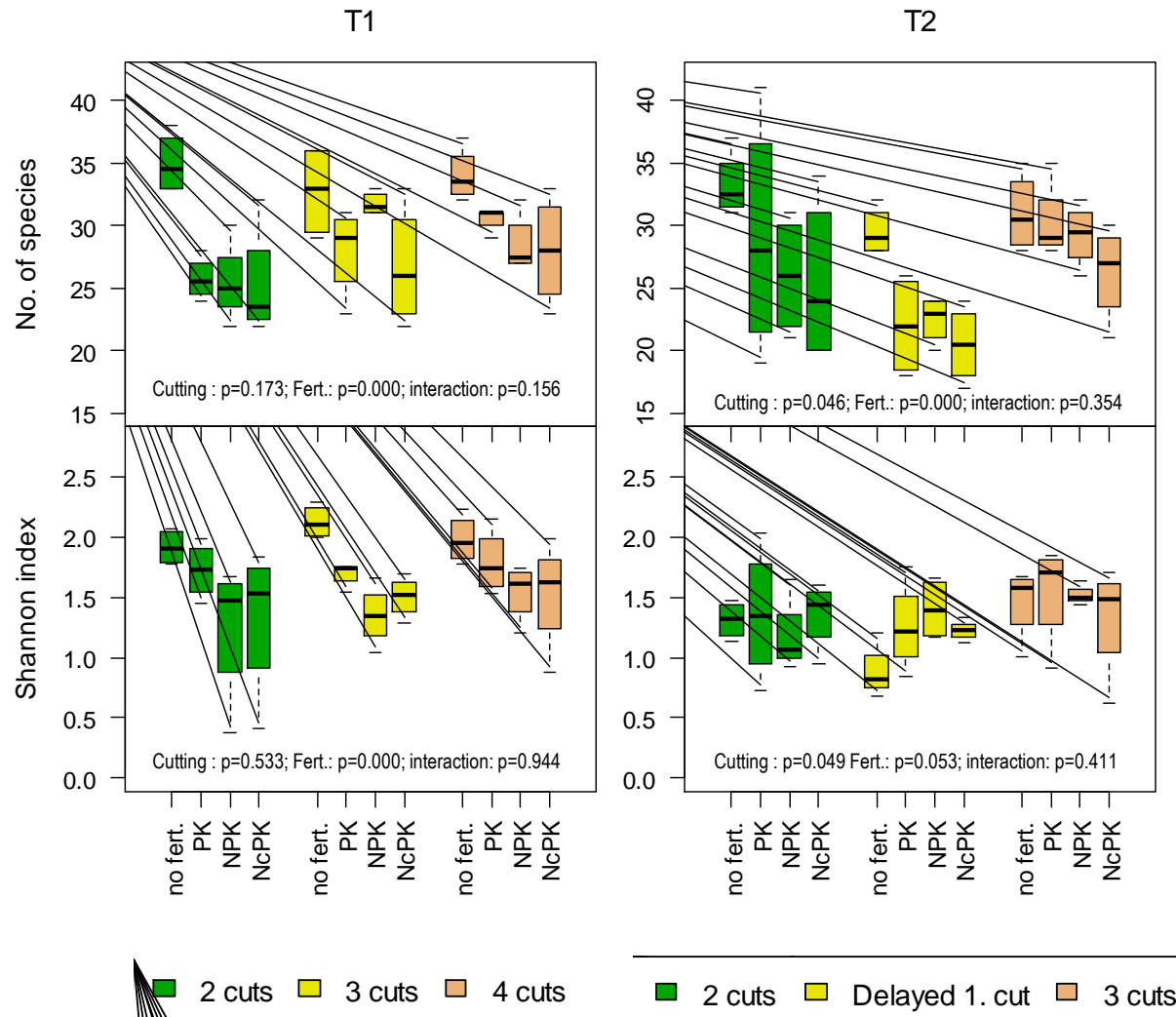
$$\mathbf{u}_i = \mathcal{C} \left[\exp \frac{1}{\sqrt{(D-i+1)(D-i)}}, \dots, \exp \frac{1}{\sqrt{(D-i+1)(D-i)}}, \exp \sqrt{\frac{D-i+1}{D-i}}, 1, \dots, 1 \right]$$

For 3-part composition: $\mathbf{u}_1 = \mathcal{C} \left[\exp \sqrt{\frac{3}{2}}, 1, 1 \right], \quad \mathbf{u}_2 = \mathcal{C} \left[\exp \frac{1}{\sqrt{2}}, \exp \sqrt{2}, 1 \right]$



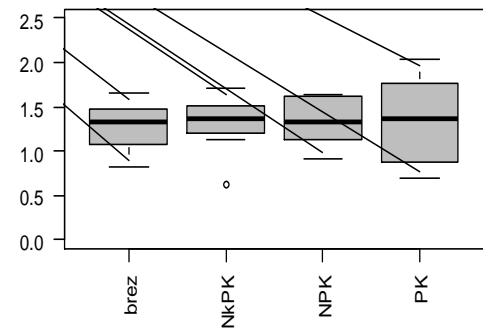
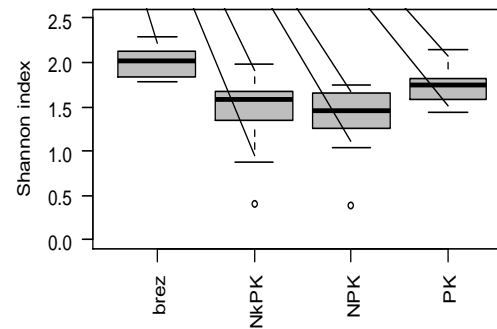
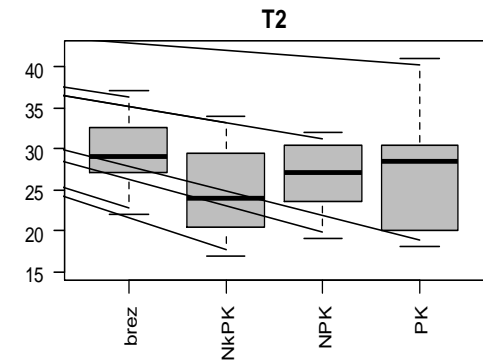
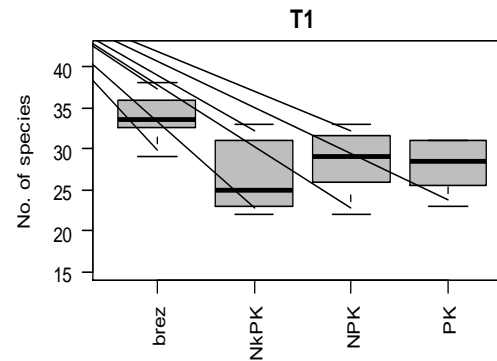
Results - diversity parameters

- Cutting frequency of secondary importance for the diversity (in T1 not significant)
- Delayed cut in T2 additionally decrease diversity of unfertilized treatments



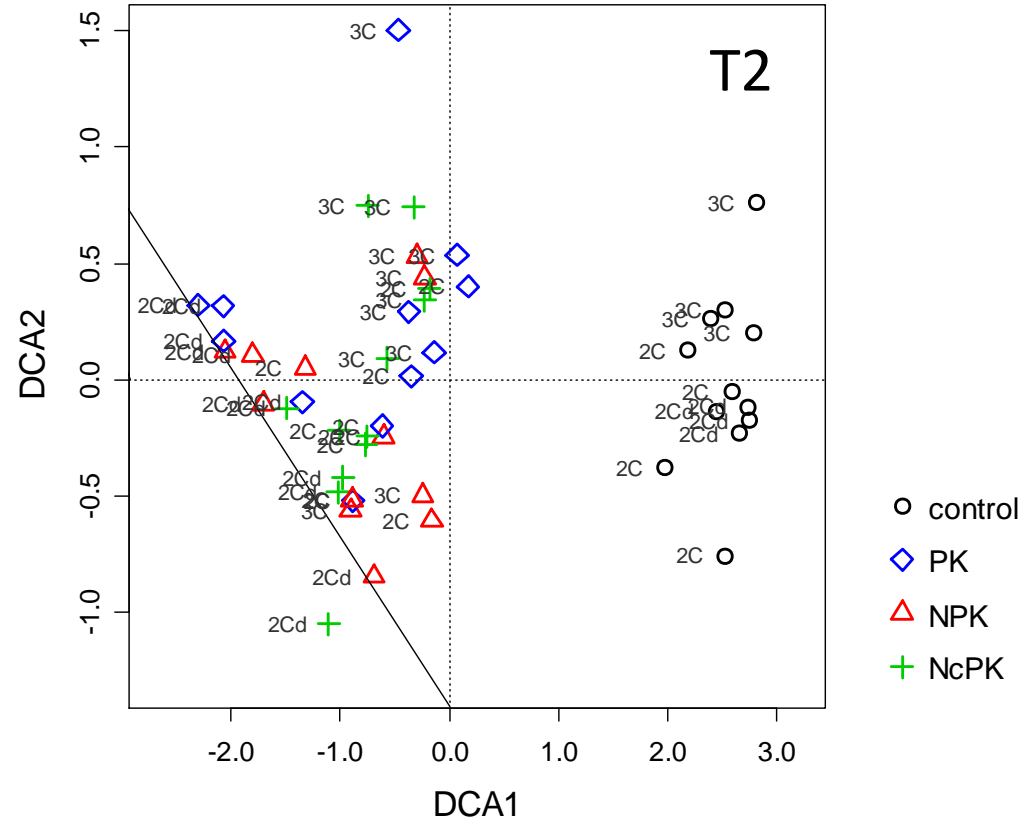
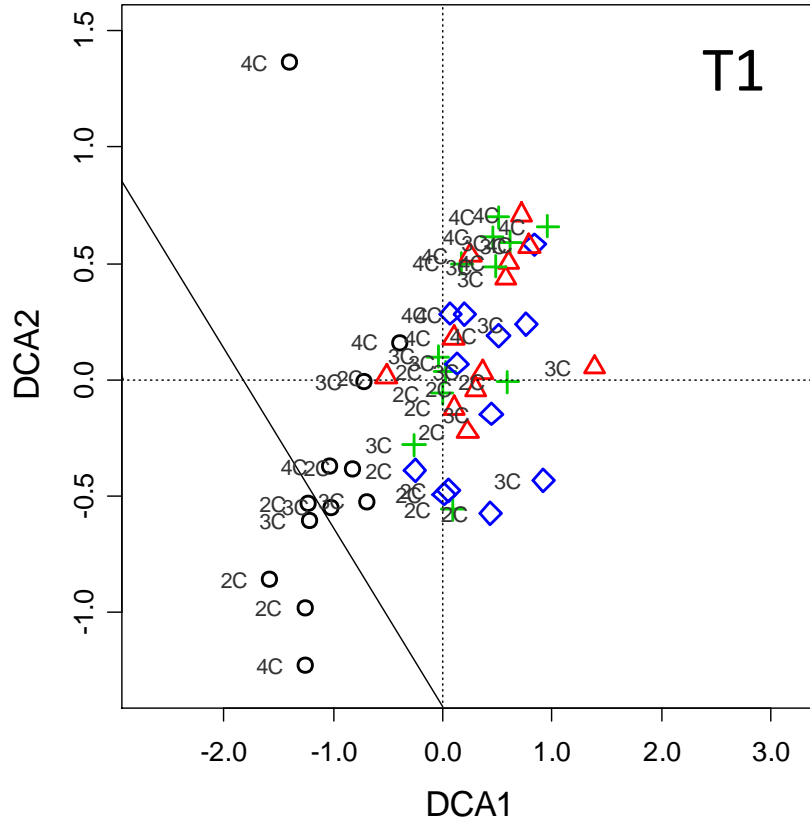
Results - diversity parameters

- 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



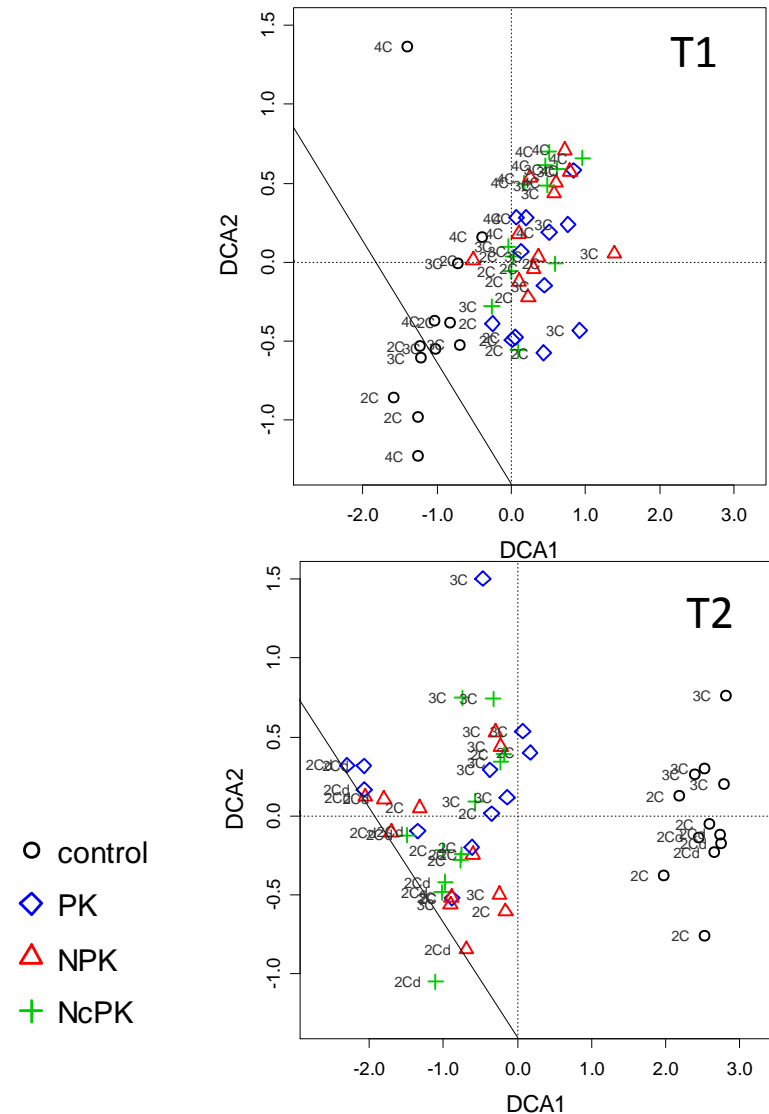
Results – species composition

- 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



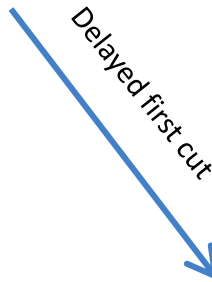
Filipendula
ulmaria
dominated
sward

Normal cut



~ Arrhenatherion
community
(Holcus / Arrhenatherum
dominated)

Delayed first cut

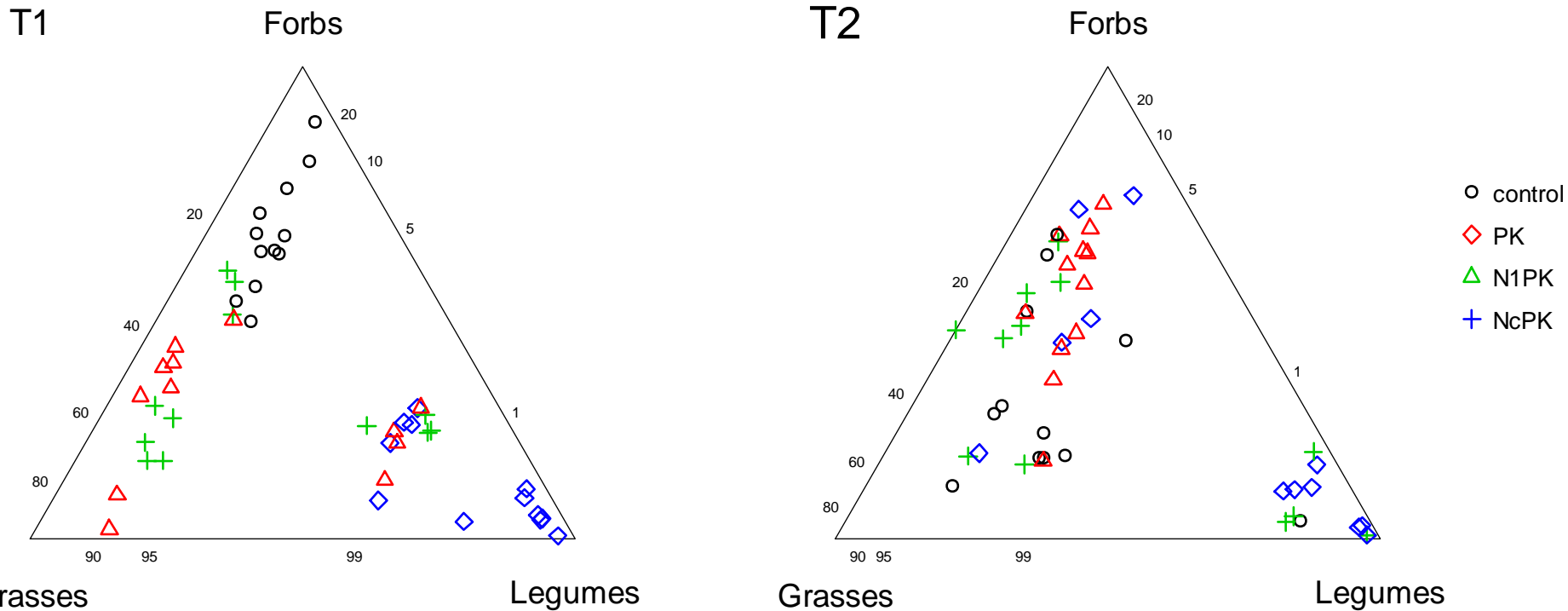


High-forb community
(Filipendula ulmaria,
Lysimachia vulgaris, Lythrum
salicaria)



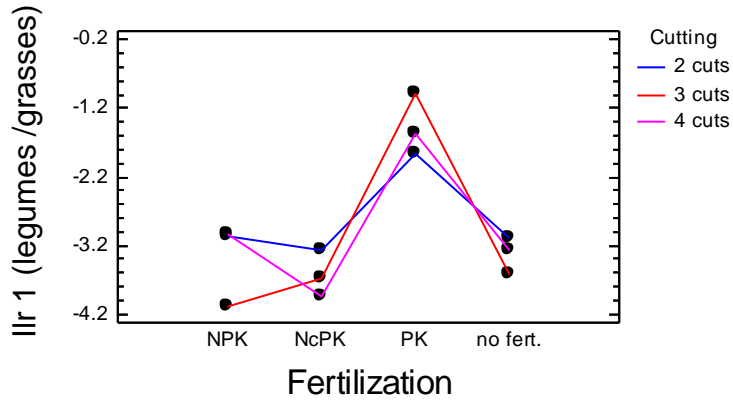
Results – functional composition

- Ternary diagram of 3-part composition



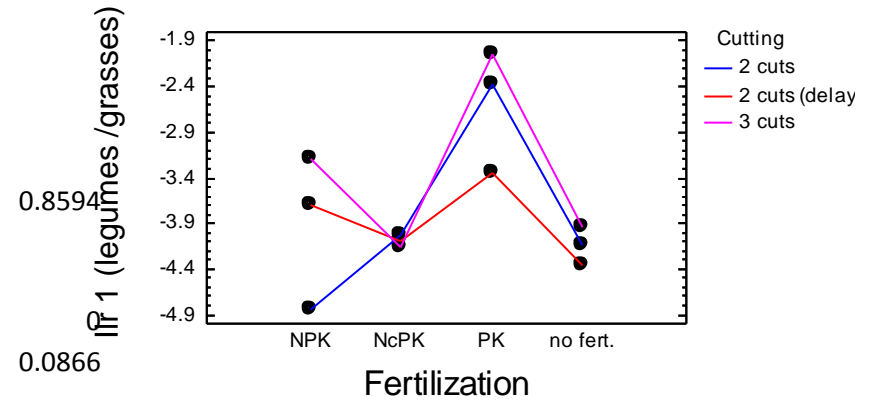
Results – functional composition

T1



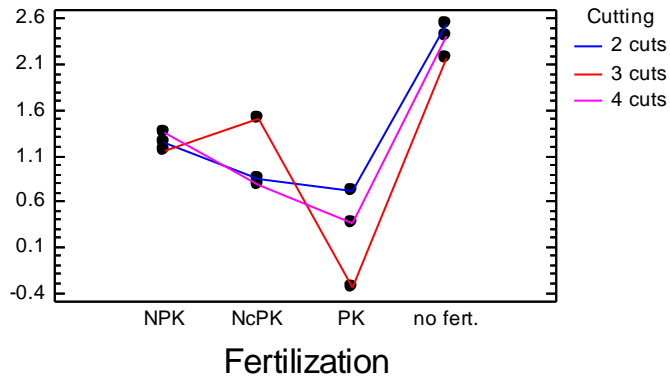
Cutting : $p=0.786$; Fert.: $p=0.000$; interaction: $p=0.139$

T2



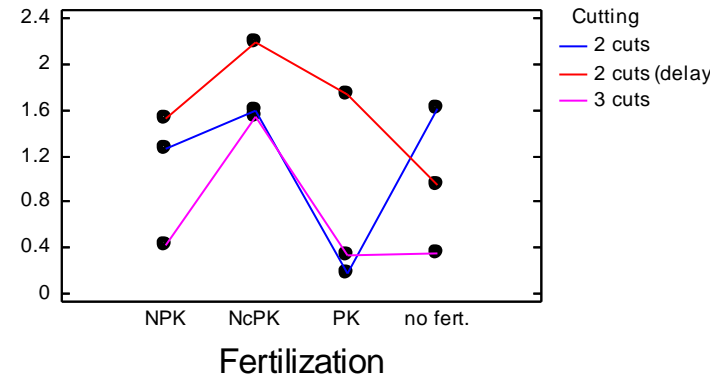
Cutting : $p=0.181$ Fert.: $p=0.002$; interaction: $p=0.380$

Ilr 2 (legumes + grasses / forbs)



Cutting : $p=0.859$; Fert.: $p=0.000$; interaction: $p=0.067$

Ilr 2 (legumes + grasses / forbs)

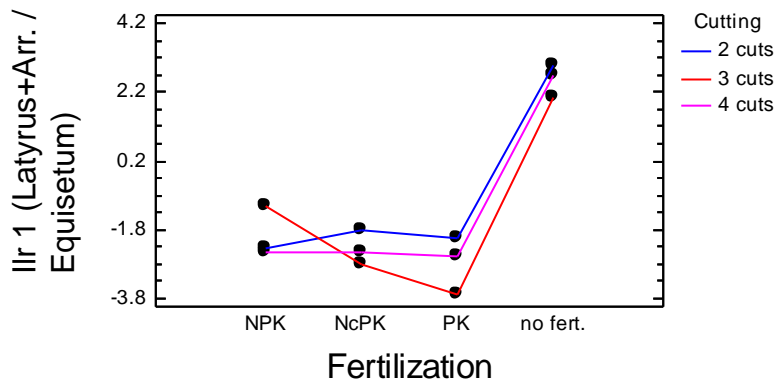
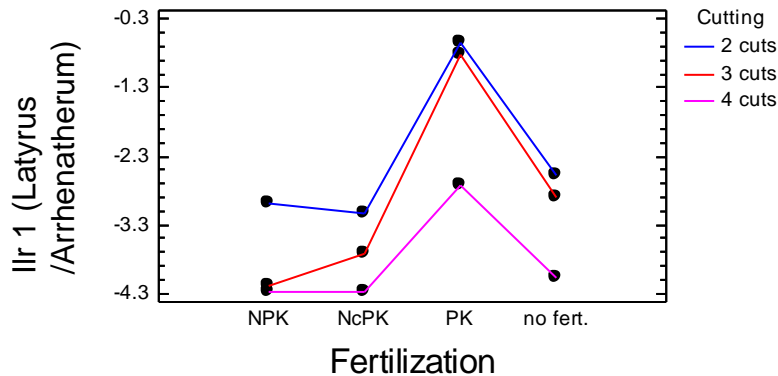


Cutting : $p=0.063$; Fert.: $p=0.022$; interaction: $p=0.208$

Results – response of some dominant species

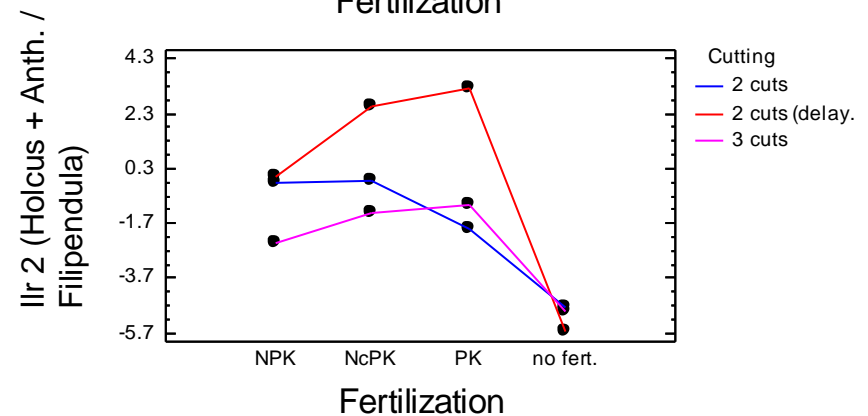
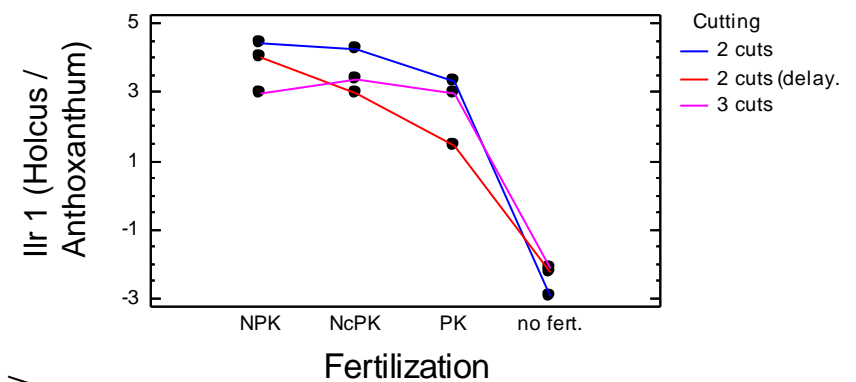
T1

Arrhenatherum elatius,
Lathyrus pratensis,
Equisetum palustre



T2

Holcus lanatus,
Anthoxanthum odoratum,
Filipendula ulmaria



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

An aerial photograph of a vast, green valley. A winding river flows through the center, surrounded by dense trees and vegetation. The valley is divided into numerous rectangular fields, some of which are a vibrant green, while others are a golden-brown, suggesting different crops or stages of harvest. In the distance, a range of blue mountains stretches across the horizon under a bright, slightly hazy sky. The overall scene is peaceful and scenic.

Thank you for your attention!