

ASSESSMENT OF INTERREGIONAL GENERALISABILITY OF CONSERVATION MANAGEMENT EXPERIMENTS ON *MOLINIA* MEADOWS

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Abstract

The economic importance of grasslands has reduced to a fraction of its former importance due to the decline of extensive livestock farming and other social and economic changes, in many cases these habitats are now maintained through conservation interventions, which, due to their low economic potential, are always dependent on the availability or lack of human and economic resources. For this reason, the maintenance of these semi-natural habitats is one of the greatest challenges for conservationists. We have selected sample areas (Nyirád and Batyk) in two different regions, where we wanted to check the impact of three management methods (mowing, mulching, burning) on the vegetation and its forage value by annual surveying of

permanent quadrats. Our aim is to investigate the relationship between the trends observed at the two different sites in order to provide an indirect picture of the broader generalisability of the results. There was similar scale variability in species composition within each sample site as between the two sample sites. However, there was a very significant difference in forage value between the two *Molinia* meadows. The effect of one treatment applied on forage quality did not prove statistically valid, although burning, which was considered the most drastic, caused the largest change in Nyirád, and the untreated control plots had the largest change in Batyk, illustrating the importance of seasonality. In order to provide generalisable findings which could be considered optimal from a conservation point of view, the experiment should be continued in the following years.

Keywords: semi-natural grasslands, mowing, mulching, burning, species composition, forage value

Összefoglalás

Az extenzív állattartás háttérbe szorulása és az egyéb társadalmi és gazdasági fordulatok miatt a gyepek gazdasági jelentősége a korábbi töredékére esett vissza. Napjainkban számos esetben inkább természetvédelmi célú beavatkozásokkal tartják fent ezeket az élőhelyeket, melyek elvégzése csekély gazdasági potenciáljuk miatt mindig az aktuálisan elérhető források és munkaerő meglététől vagy hiányától függ. A természetvédelmi szakemberek számára éppen emiatt a féltermészetes élőhelyek fenntartása jelenti az egyik legnagyobb kihívást, ez pedig témaválasztásunkat is nagyban motiválta. Két helyen, két különböző kistájban, a Nyirádi Sárallón és a Batyki-lápréten jelöltük ki mintaterületeinket, ahol állandó kvadrátok évenkénti cönológiai felvételezésével szeretnénk vizsgálni három kezelési mód (kaszálás, szárzúzás, égetés) növényzetre és annak takarmányértékére kifejtett hatását. Célunk, hogy megvizsgáljuk

a két különböző helyszínen tapasztalt trendek egymáshoz való viszonyát, így közvetett módon képet kaphassunk eredményeink szélesebb körű általánosíthatóságáról. Azt tapasztaltuk, hogy az egyes mintaterületeken belül nagyobb változékonyság volt a fajösszetételben, mint a két mintaterület között. Takarmányértékben viszont igen jelentősen elért a két kékperjés rét. Az alkalmazott kezelések hatása egy év után nem bizonyult statisztikailag igazolhatónak. Nyirádon a legdrasztikusabbnak tekinthető égetés okozta a legnagyobb mértékű változást, míg Batykon a kezelésmentes kontrollterületeken volt a legnagyobb változás, amely jól szemlélteti az évjáráthatás jelentőségét. Ahhoz, hogy a kékperjés rétek természetvédelmi szempontú kezeléséről optimálisnak tekinthető, általános érvényű megállapításokat tehesünk, a következő években szükséges a kísérlet folytatása.

Kulcsszavak: másodlagos gyeppek, kaszálás, száruzás, égetés, fajösszetétel, takarmányérték

Introduction

Due to the climatic conditions, the potential natural vegetation are typically forests on the mesic habitats across Hungary. Extensive livestock farming in the past centuries has resulted the development of relatively large areas of grass-dominated habitats, which were either pastures or hay meadows for the production of supplementary winter feeding. In many cases, the species richness of anthropogenic grasslands significantly exceeds the diversity of the potential climax communities, and they are associated with a number of specialist plant and animal species, including protected and even species of Community interest, which have led to the designation of the Natura 2000 network (Valkó et al. 2018). Unfortunately, their economic importance has declined in recent decades (Joyce 2014) to the point where their long-term survival is not assured. Sustaining the regularity of habitat maintenance treatments is one of the greatest challenges facing conservationists today, as the failure to do so will lead to the spread of

competitor species, accumulation of litter, leading to species degradation and, ultimately, habitat loss (Csergő et al. 2013; Valkó et al. 2018; Kuhn et al. 2021). Cost-effective management is essential for practical nature conservation, so the key issue is to choose cost-effective management methods that preserve natural values, as the reintroduction of management can help to offset negative trends (Valkó et al. 2011, Fülöp et al. 2021), although continuity is also very important (Bódis et al. 2021).

The most commonly used conservation management methods are: mowing, mulching and, more recently, burning every few years as a cost-effective solution (Valkó & Deák 2021). *Molinia* grasslands are particularly in need of conservation treatment as they are extremely rich in protected species, but less cultivated by farmers due to their relatively low forage value.

Our goal was to determine whether the results of a treatment experiment on *Molinia* meadows could be generalised, at least on a small-scale geographical range. To answer this question, we conducted treatment experiments on *Molinia* meadows in two neighbouring regions in Hungary and investigated the dynamics in species composition and change of forage values induced by the conservation management.

Material and methods

Study site

Our sample sites are located in the Sáralló of Nyirád and Batyk fen meadow, both are parts of the Natura 2000 network (Figure 1). The Sáralló of Nyirád is part of the Felső-Nyirádi-erdő és Meggyes-erdő (HUBF20011) site, which can be described as a mixture of forest and grassland habitats of high importance, the most characteristic of them are Pannonian-Balkan turkey oak-sessile oak forests, while the most characteristic grassland habitats are European dry heaths and

alkaline fens. The Batyk fen meadow is part of the Alsó-Zala-völgy (HUBF20037) site, which is a site largely composed of grassland habitats, with lowland hay meadows and alkaline fens covering the largest proportion among the habitats of community importance.

The Sárálló of Nyirád provides habitat for several strictly protected species, e.g., the marsh gladiolus (*Gladiolus palustris*) is present in large numbers, while the Batyk fen meadow is the most prominent representative of the meadows surrounding the river Zala.

A total of seven (three on Nyirád and four on Batyk) 10x10 m treatment units were established in the study areas in *Molinia* meadows habitats.



Figure 1 Location of the Alsó-Zala-völgy and Felső-Nyirádi-erdő és Meggyes-erdő Natura 2000 sites

Methods

Four different management treatments are applied: mowing, mulching, burning, control (no intervention). Within the 10x10 m sampling units, we monitored the changes of the vegetation composition using of 2x2 m permanent quadrats, with annual surveying.

The first conservation management treatments were carried out after the baseline survey in 2019 at the Sáralló of Nyirád and in 2020 at Batyk fen meadow. Field surveys were repeated in the year following treatment interventions.

Forage value as a value index was introduced in the 1960s, classifying grassland species according to their utility for livestock, with values ranging from -3 to +7, the higher the value of a species, the higher its forage value (Balázs, 1960).

To determine the forage value of each 2x2 m quadrat, the values for each species were summed by weighting the species by their percentage cover.

Linear mixed models and NMDS were used to evaluate the results, using IBM SPSS Statistics software version 23.0. (IBM Corp. 2015) and R software version 4.1.3 (R Core Team 2022) with vegan package (version 2.6-2), Figureures were produced using the package ggplot2 (version 3.3.6).

Results

In Nyirád, a total of 143 species, 8 of which are protected by law (*Carex fritschii*, *Sesleria caerulea*, *Dianthus deltoides*, *Iris sibirica*, *Platanthera bifolia*, *Polygala amarella*, *Potentilla rupestris*, *Scorzonera purpurea*) were recorded during the baseline survey, while in Batyk only a total of 70 species, 8 of which are protected (*Iris sibirica*, *Gymnadenia conopsea*, *Schoenus*

nigricans, *Scorzonera humilis*, *Orchis militaris*, *Epipactis palustris*, *Allium carinatum*, *Gentiana pneumonanthe*) were found, *Iris sibirica* was present in both study sites.

The NMDS-plotting of the vegetation relevés by species composition shows two distinct groups of the sample areas, however their distance is in a similar scale than the in-between differences of the relevés of Nyirád (Figure 2), where the variability is noticeably higher than in Batyk.

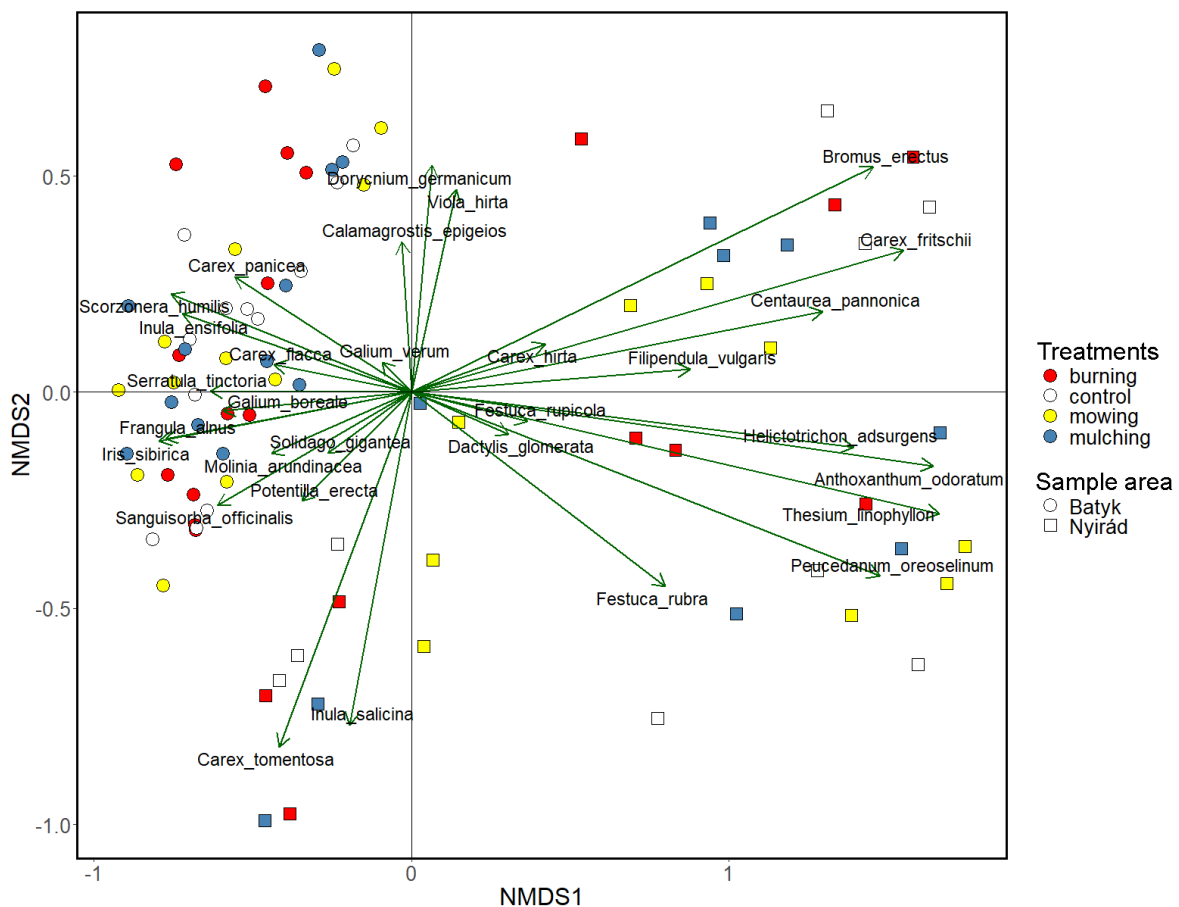


Figure 2. NMDS-plotting of the vegetation relevés after one treatment the 30 most abundant species represented as arrows

Based on the baseline assessment, the hay from Batyk fen meadow (0.76 value) was significantly lower in terms of forage value than the hay from Nyirád (3.01).

Table 1 Overall average forage values based on the baseline survey

	Average	Std. deviation	Minimum value	Maximum value
Batyk	0,761112	0,248678	-0,05294	1,207865
Nyirád	3,105405	0,53155	2,090909	4,75

In Batyk, one treatment seemingly did not have major effects, as we experienced the most pronounced change in the forage values at the control sites, but this could also mean that all treatments might had some stabilizing effect on hay quality.

Table 2 Overall average forage values based on the baseline survey and the year after the first treatments at the Batyk fen meadow

Treatment	Baseline survey		After 1 treatment		
	Average	Std. deviation	Average	Std. deviation	Change (%)
Mowing	0,84	0,26	0,90	0,24	6,58
Mulching	0,78	0,17	0,79	0,21	1,48
Burning	0,68	0,26	0,71	0,28	4,33
Control	0,74	0,30	0,87	0,38	18,18

Table 3 Testing the effect of management types on the forage values at the Batyk fen meadow

Treatment	Paired Differences		t-value	Sig. (2-tailed)
	Mean	Std. Deviation		
Mowing	-0,056	0,189	-1,019	0,33
Mulching	-0,012	0,239	-0,167	0,87
Burning	-0,030	-0,030	0,118	0,667
Control	-0,134	-0,134	-0,009	0,038

In Nyirád, after treatments once applied, burning increased the feed value the most, but the variance in the data is so large that it is even greater than the change itself.

Table 4 Overall average forage values based on the baseline survey and the year after the first treatments at the Sáralló of Nyirád

Treatment	Baseline survey		After 1 treatment		
	Average	Std. deviation	Average	Std. deviation	Change (%)
Mowing	3,28	0,38	3,42	0,46	4,14
Mulching	3,18	0,66	3,14	0,67	-1,38

Burning	2,74	0,37	3,11	0,55	13,36
Control	3,21	0,56	3,23	0,48	0,71

Table 5 Testing the effect of management types on the forage values at the Sáralló of Nyirád

	Paired Differences		t-value	Sig. (2-tailed)
	Mean	Std. Deviation		
Mowing	-0,136	0,278	-1,467	0,180
Mulching	0,044	0,127	1,041	0,328
Burning	-0,023	0,145	-0,465	0,654
Control	-0,023	0,145	-0,465	0,654

Discussion

Although the habitat is a *Molinia caerulea* agg. dominated wet meadow alike at both sample sites, there are marked differences in vegetation composition, as in the relevés of Nyirád, species characteristic of mesic habitats, such as *Bromus erectus* and *Festuca rubra* are also present (Figure 2). More pronounced the difference between the number of species recorded. This might affect hay quality as well, as in Batyk we found not only roughly half the number of species as in Nyirád, but the hay quality of Batyk was significantly lower than the hay produced in the plots at Nyirád.

The effect of seasonality is likely pronounced, especially in the case of Batyk, where forage quality changed the most in the control plots between two subsequent years. This also implies the stabilising effect of all used treatments on hay quality.

One set of treatments did not cause significant changes in hay quality, even in the case of such drastic methods as burning, although the trends are. It would be advisable to ensure that the meadows receive regular treatments.

Summary

There are signs of minor changes likely caused by treatments, but they were not significant after only one year and their direction is often different on the two sample areas. This indicating that although the main components of these associations and the geographic environment might be similar, still the result of a treatment could be greatly influenced by minor elements and microclimatic conditions specific to each locality.

Acknowledgement

The authors are thankful to all the surveyors and helpers: András Mészáros, Bence Pálfi, Előd Búzás, Éva Hársvölgyiné Szőnyi, Járfás Dávid, Krisztina Kórászné Markó, Piroska Tallerné Barna, Petra Svajda, Viktor Schneider, Vivien Lábadi.

The publication is supported by the EFOP-3.6.3-VEKOP-16-2017-00008 project. The project is co-financed by the European Union and the European Social Fund.

With the contribution of the LIFE Programme of the European Commission (LIFE17 IPE/HU/000018).

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