

The rearrangement of protected plant species in the Batyk fen meadow warns of drying out

Kiszáradásra figyelmeztet a védett növényfajok átrendeződése a Batyki-lápréten

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Abstract: Previous drainage and current climate change are drying out native grasslands at wetland areas, with the result that sensitive wetland species are gradually disappearing. The success of conservation interventions to prevent this – which are designed to retain water –, will be measured by the ability of the managed meadow to retain its water-demanding species. The Batyk fen meadow is one of the most valuable wet grasslands along the valley of the river Zala. Water retention interventions were also needed and carried out here in the year of 2012. Our work assessed the success of the intervention in conserving the meadow's protected plant species. Between 2019 and 2021, we assessed the protected species of the site and compared them with the values of protected plant species previously reported from the site according to ecological indicator indicators (relative soil moisture and relative temperature) and Borhidi's Social Behaviour Types (SBT). We found that 40 protected plant species are currently present on the site, which is a high number compared to previous data, the number of protected species has increased in the fen meadow. However, this increase is partly due to the intensity of the survey focused on such species between 2019 and 2021, partly because the appearance of species that are indicative of drier habitats, whereas many of the valuable fen species were no longer present. Ecological indicator numbers show that the most moisture-demanding species have disappeared from the site, with a concomitant predominance of species with better competitive ability over specialists. This suggests that further water retention in the Batyk fen meadow is urgently needed to conserve water-demanding fen species on the long term.

Keywords: *fen meadow, ecological indicator values, climate change*

Összefoglalás: A korábbi vízelvezetések és a napjainkban zajló klímaváltozás a hazai láprétek kiszáradását vonja maga után, ami azzal jár, hogy az érzékeny lápi fajok eltűnnek. Az ennek megakadályozására végzett, vízvisszatartást szolgáló természetvédelmi beavatkozások sikerességét az mutatja meg, ha a kezelt rét meg tudja őrizni vízigényes fajait. A Batyki-láprét a Zala-völgy egyik legértékesebb lápréte, ahol szintén vízvisszatartó beavatkozásokra volt szükség, amit 2012-ben végeztek el. Munkánk során azt vizsgáltuk, hogy a rét védett növényfajainak megőrzésében mekkora sikerrel járt a beavatkozás. 2019 és 2021 között felmértük a terület védett fajait majd összehasonlítottuk ökológiai indikátorszámok (relatív talajnedvesség és relatív hőigény) és Borhidi Szociális Magatartás Típusai (SzMT) szerint a területről korábban közölt védett növényfajok értékeivel. Megállapítottuk, hogy a területen jelenleg 40 védett növényfaj fordul elő, ami a korábbi évekhez képest magas szám, azaz a védett fajok száma nőtt a réten. Ugyanakkor ezt a növekedést a szárazabb élőhelyekre utaló fajok

adják, az értékes lápi fajokból sok nincs már jelen. Az ökológiai indikátorszámok alapján a leginkább nedvességtűrő fajok eltűntek a területről, ezzel egyidőben a specialistákkal szemben a jobb kompetíciós képességű fajok kerültek túlsúlyba. Mindezek alapján a Batyki-lápréten sürgető feladat lenne további vízvisszatartás elvégzése a vízigényes lápi fajok megőrzése érdekében.

Kulcsszavak: *láprét, ökológiai indikátorszámok, klímaváltozás*

1. Introduction

Human activity plays an important indirect role in the conservation of natural values in many cases. In Hungary, in areas with good water supply, treeless grassland habitats were almost without exception created through human mediation of traditional land use. These grasslands were used for extensive livestock production, as pastures or as mowing areas to provide biomass for supplementary winter feeding. These habitats can be associated with a number of rare, protected and community-associated species whose survival can only be ensured if the grassland character is maintained.

The conservation status of grasslands is threatened by a number of factors, including the fact that their economic value has declined to a fraction of its former value due to the decline of extensive livestock farming, leading to their abandonment and, in the long term, to scrub encroachment and the spread of competitive species (Valkó et al., 2018, 2021, Bódis et al., 2021). In addition, abiotic environmental factors are also undergoing significant changes, with climate change threatening the value of grasslands in several respects, with prolonged hot periods and extreme rainfall patterns becoming more common, posing a particular threat to the water supply of wetland and well-watered habitats (IPCC 1998, Burrkett & Kusler 2000).

Among the most threatened wetlands are fens and fen meadows, which are difficult or impossible to restore once they have dried out. These meadows have been drained for centuries, and many drainage ditches have been created on them in order to create arable land. In many places, conservation efforts have sought to mitigate the impact of drainage by blocking ditches or creating water retention sluices. This was the case in the Batyk fen meadow, where interventions to retain water were carried out in 2012 (Futó et al. 2013).

In our study, by reviewing the literature on the flora of the wetland and comparing them with the results of our botanical inventory carried out between 2019 and 2021, we aimed to investigate how the protected plant species assemblage of the Batyk fen meadow has been transformed over the last almost 7 decades as a consequence of the external environmental and anthropogenic impacts on the fen meadow, with a particular focus on the wetland species.

2. Material and methods

2.1. Study site

The sampling area of our research is in the northern part of Zala county, on the borders of Batyk, Zalabér and Túrje. The Batyk fen meadow is one of the most valuable wetland meadow habitat complexes near the Zala river, which preserves many protected species and even fen meadow specialists (Fülöp et al. 2022). The area is part of the Alsó-Zala-völgy (HUBF20037) Natura 2000 site.

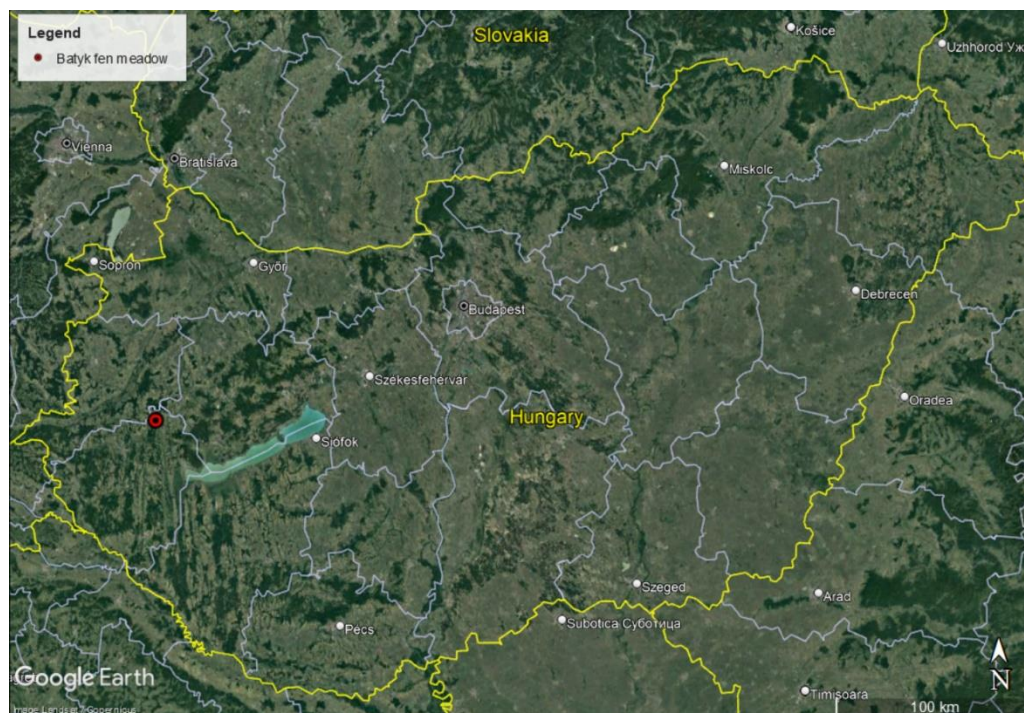


Figure 1. Location of the sampling area (marked with a red dot)

2.2. Methods

Literature review

We searched the literature for references to the Batyk fen meadow and organised the localities that relate to the occurrence of currently protected or highly protected plant species into a database. On this basis, two earlier periods were separated: 1938–1955 and 1990–2019. The sources used for the 1938–1955 period are Jávorka, Zólyomi, Boros ined., Boros (1953), Domokosné Nagy (1955); for the 1990–2019 period Palkó (1992), Lájér (1999), Kovács (2005), Óvári (2014, 2019), Vikár (2016).

Field surveys

During the period 2019–2021, the entire area of the marsh was surveyed from spring to autumn, during different vegetation periods, and all protected plant species were recorded, with the aim of a complete survey. This information has been added to the literature database, with the period 2019–2021.

Ecological indicator values

We illustrate the qualitative changes in the protected species assemblage of the Batyk fen meadow using ecological values. The species can be classified according to their ecological requirements and their role in natural systems. The first such scales were developed by Ellenberg in 1950, and several domestic adaptations have been published. In our work we used the Relative soil moisture figures (WB) and Relative temperature figures (TB) from Borhidi's (1993, 1994) classification. We also used the Social behaviour type (SBT) classification from Borhidi (1995).

Relative soil moisture figures (WB):

A value between 1 (Plants of extremely dry habitats or bare rocks) and 12 (Water plants, most wholly submersed in water) where higher numbers represent higher amount of water supply in the soil of the habitat where the species are usually present (Table 1).

Table 1. Relative soil moisture figures (WB) categories based on Borhidi (1994)

Value	Category
1	Plants of extremely dry habitats or bare rocks
2	Xero-indicators on habitats with long dry period
3	Xero-tolerants, but eventually occurring on fresh soils
4	Plants of semidry habitats
5	Plants of semihumid habitats, under intermediate conditions
6	Plants of fresh soils
7	Plants of moist soils not drying out and well aerated
8	Plants of moist soils tolerating short floods
9	Plants of wet, not well aerated soils
10	Plants of frequently flooded soils
11	Water plants with floating or partly emergent leaves
12	Water plants, most wholly submersed in water

Relative temperature figures (TB):

A value between 1 (Subnival or supraboreal) and 9 (Eumediterranean evergreen belt) where higher numbers represent higher heat supply of the habitat where the species are usually present (Table 2).

Table 2. Relative temperature figures (TB) categories based on Borhidi (1994)

Value	Category
1	Subnival or supraboreal
2	Alpine, boreal or tundra
3	Subalpine of subboreal belt
4	Montane needle-leaved forest of taiga belt
5	Montane mesophilous forest belt
6	Submontane broad leaved forest belt
7	Thermophilus forest or woodland belt
8	Submediterranean woodland and grassland belt
9	Eumediterranean evergreen belt

Social behaviour type (SBT):

Values between -3 (alien competitors) and +10 (unique specialists), the higher numbers represent more valuable species (Table 3).

Table 3. Social behaviour type (SBT) categories based on Borhidi (1995)

SBT	Main traits	Value
<i>Natural habitats</i>		
Specialists (S)	Low competitiveness, sensitive indicators of certain ecological factors.	+6
Competitors (C)	Dominant species of natural communities.	+5
Generalists (G)	Species of wide ecological range or tolerance in the natural plant communities.	+4
Natural pioneers (NP)	Species of initial stages of succession series.	+3
<i>Disturbed habitats</i>		
Disturbance tolerants (DT)	Pioneer elements of secondary succession	+2
Weeds (W)	Plant species living in heavily disturbed, artificial habitats.	+1
Introduced alien species (I)	Plants alien to a region and flora intentionally introduced and acclimatized as potential useful crops.	-1

Adventives (A)	Alien species to region and flora. Not intentionally introduced.	-1
Ruderal competitors (RC)	Dominant weeds of natural flora, with the ability to transform the habitat and modify successional trends.	-2
Aggressive alien species (AC)	Alien to region or flora, invading the gaps of natural or semi-natural communities and became dominant.	-3

3. Results

A total of 40 protected plant species were recorded during our field surveys (Fülöp et al. 2022).

Changes in Relative Water Moisture figures (WB) between 1938 and 2021:

Although most protected species of Batyk fen meadow apparently preferred wet soils in all three time periods, the decrease in numbers of the water-dependable species is clear through time. In the 1938–1955 period 11 species were present with WB values between 9 („plants of wet, not well aerated soils”) and 11 („water plants with floating or partly emergent leaves”), this decreased first to only 7 species, then this number further decreased to 6, along with the complete disappearance of species with the highest WB (10: „plants of frequently flooded soils”) and 11: „water plants with floating or partly emergent leaves”) values (*Menyanthes trifoliata*, *Peucedanum palustre*, *Ranunculus lingua*). Species with WB values of 8 („plants of moist soils and tolerating short floods”) were present in largest numbers in all periods. The number of species belonging to WB categories 7 or less all increased, especially category 4 („plants of semi-dry habitats”). In the last two periods even a xero-tolerant species (WB=3), *Allium carinatum* were present in the area (Figure 1).

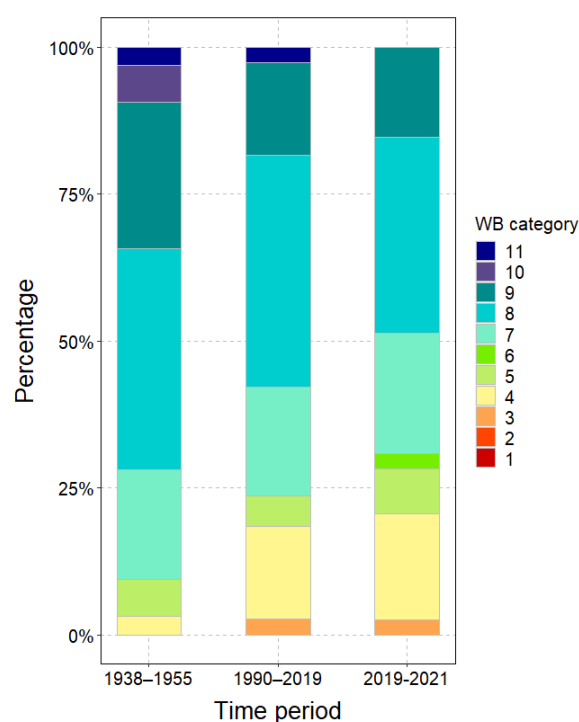


Figure 1. Composition of WB values based on the species pool

Changes in Relative temperature figures (TB) between 1938 and 2021:

During the assessed time period there was a distinct decrease in the number of species associated with the coldest climate category (TB=3, “subalpine of subboreal belt”) present in the area. The proportion of categories between 5 and 7 are increased, especially the number of species with TB=6 (“submontane broad leaved forest belt”). In this category in the first assessed time period only 3 species were recognized, after 2019 their number was 8.

The most populous category in all cases was the category 5 („montane mesophilous forest belt”), but before 1955 this only contained 46.8% of the species, in 2019–2021 it was 56.41%. The highest TB value found was TB=7 („thermophilus forest or woodland belt”), this included species *Fritillaria meleagris*, *Hemerocallis lilio-asphodelus*, *Anacamptis coriophora*, *Ornithogalum sphaerocarpum*, *Schoenus nigricans* after 2019. Before 1955 there were only 3 of these species, from 2014 there were 4. *Anacamptis coriophora* has disappeared from the area since 1955, and *Ornithogalum sphaerocarpum* and *Fritillaria meleagris* have been reported since 2014 (Figure 2).

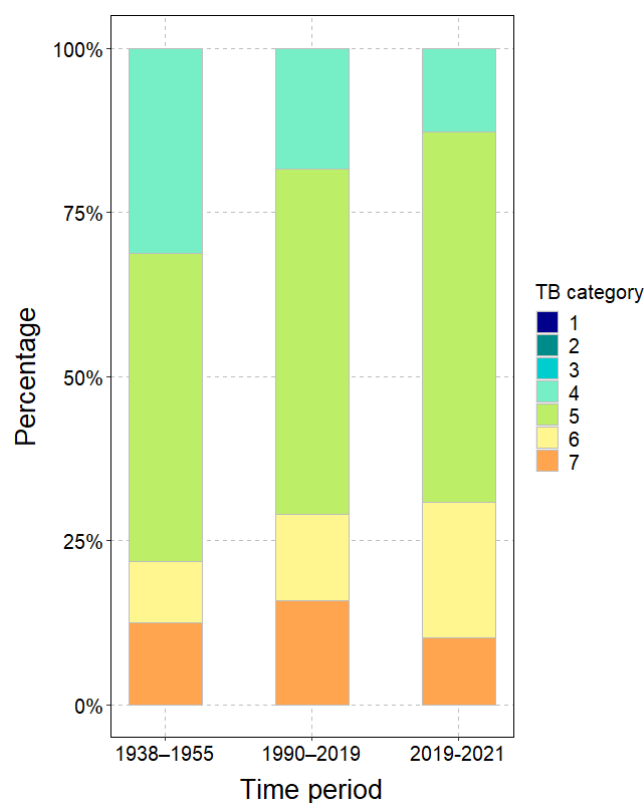


Figure 2. Composition of TB values based on the species pool

Changes in Social behaviour type (SBT) categories between 1938 and 2021:

In terms of social behaviour types, protected species observed on the Batyk fen meadow before 1955 ranged from specialists to natural pioneer species, with the clear dominance of specialists (48%). After 1990 disturbance tolerant species appeared as a new category and simultaneously the proportion of the two most valuable categories decreased. This tendency continued after 2019 and the number of generalist species became almost equal to the specialists. In overall, the number of protected species (viewed by 2022 legislature) increased from 31 to 37, then 40 (Figure 3).

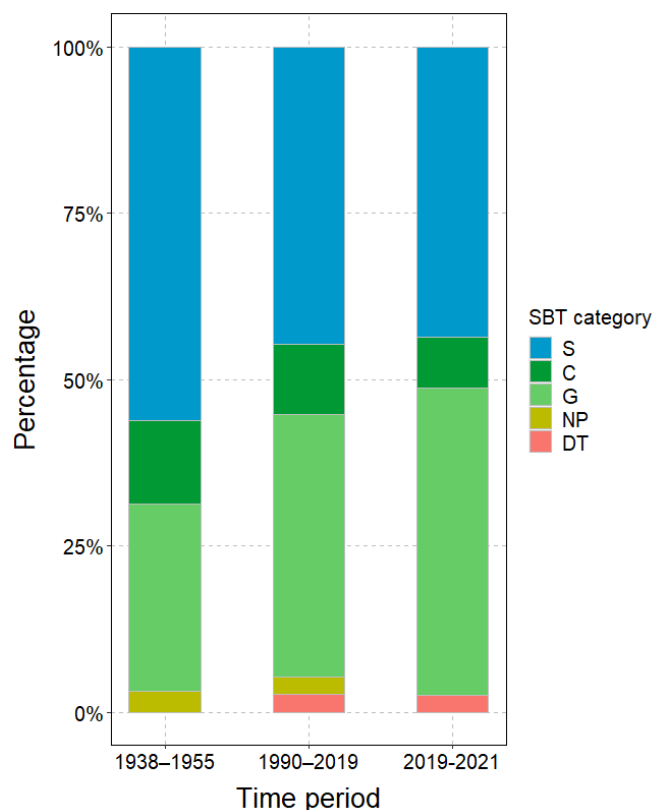


Figure 3. Composition of SBT values based on the species pool

4. Discussion

A significant proportion of the protected species associated with semi-arid or wetter habitats has disappeared from the area, while drought-tolerant species are present in significantly higher proportions.

Although the change in relative heat requirements is not as marked, the proportion of warmth-tolerant species has doubled, while the proportion of montane elements has halved.

Unique species were not previously abundant in the sample area, D. Nagy (1955) the time of the first detailed survey, fen meadow specialists made up the largest proportion of the species assemblage, but nowadays generalists have become predominant, while disturbance-tolerant species have also appeared.

Although the overall number of protected species has increased over time, specialists characteristic to the fen meadow were gradually disappearing. This tendency is linked with the decrease of number of species with the highest WB values. Among the specialists 5 species (*Dactylorhiza incarnata* subsp. *ochroleuca*, *Eriophorum latifolium*, *Menyanthes trifoliata*, *Pedicularis palustris*, *Ranunculus lingua*) became extinct in the area, which could not be counterbalanced with the appearance of 4 other specialists (*Dianthus superbus*, *Dryopteris carthusiana*, *Fritillaria meleagris*, *Leucjum vernum*), as most of them are characteristic to different habitats.

A significant change is the disappearance of species with the highest requirement for water. The rise of drought-tolerant species and the advance of heat-tolerant species is a less obvious phenomenon, while the number of species with better competitive ability are also increasing, taking the place of weaker competitors. Although these gradual changes have only a moderate effect on the overall natural value of the habitat, during this transformation we can lose species which have one of their last refuges here on a greater scale.

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