EFFECTS OF DIFFERENT LAND-USES ON ALKALINE GRASSLANDS – IMPLICATIONS FOR CONSERVATION

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Introduction

The basic purpose of conservation biology is to provide practical information useful in conservation management (Margóczi *et al.* 1997, Aradi *et al.* 2004). Due to the changes in farming methods in agriculture, semi-natural grazed grasslands are threatened throughout Europe (van Wieren 1995). Alkaline grasslands belong to the most typical communities in the Carpathian basin (Illyés *et al.* 2007), covering considerable areas, a great proportion of which is natural or near-natural (cf. Kun 1998, Kelemen 1997, Molnár and Borhidi 2003). If we are to maintain the natural values of these alkaline communities, we have to gather data on which measures to made.

In this study, we chose two neighbouring alkaline grasslands, which belong to different countries, thus their land-use is assumed to be different. Our aim was to determine the present land-use types and their effects on conservation values. Moreover, we wanted to give specific proposals on the management of the areas under study.

Material and methods

Two neighbouring near-natural alkaline grasslands were chosen for our investigations. They are separated by the Hungarian-Romanian state border. The grasslands are located between Gyula and Elek on the Hungarian side and southwest of Vărşand (Gyulavarsánd) on the Romanian side. Distance between the two grasslands is approximately 1.5 km, and abiotic parameters are nearly identical. Mean annual temperature in Gyula is 10.2 °C, mean annual precipitation is 581.3 mm (Hubai 1934, also see Ambrózy and Kozma 1990). History of land-use on both sides of the border are basically identical. A detailed analysis of the land-use history of the area is given by Cseh *et al.* (2011).

A habitat map was prepared based on field studies carried out during the summer 2010. Habitats were identified using the habitat guide (Bölöni *et al.* 2007a, 2007b). Naturalness of every patch was recorded according to the modified Németh-Seregélyes scale (Bölöni *et al.* 2007b). In addition, a land-use map was prepared. Habitat and land-use maps were made with the program ArcView GIS 3.2 (ESRI).

Coenological relevés were made in June 2010 in 4 m² plots. Percentage cover of all vascular plant species was estimated. We made relevés in every community types; the number of relevés made in every particular community type is proportional to the area covered by that community.

Species numbers of the plots were calculated and the two grasslands were compared with the Wilcoxon-Mann-Whitney test, using Past 1.99 (Hammer *et al.* 2001).

Diversity ordering was applied in order to analyse the diversity of the two most typical habitats, *Artemisia* salt steppes and salt meadows. In the case of both habitats, comparisons were made between the Hungarian and the Romanian sides. We used Rényi's diversity function, since it is one of the most useful diversity ordering methods (Tóthmérész 1995). Rényi's function is given by equation (1). MS Excel was used for these computations and for the graphical representation of the diversity profiles.

$$H(R) = \left(\log \sum_{i=1}^{S} p_i^{\alpha} \right) \Big/ 1-\alpha \qquad (1)$$

We characterized the naturalness of the *Artemisia* salt steppes and salt meadows by calculating the spectra of the social behaviour types (SBT) and the ecological indicator value N of Borhidi (1993, 1995), based on frequency data. Differences between the Hungarian and Romanian sides were searched for with the Wilcoxon-Mann-Whitney test, using Past 1.99 (Hammer *et al.* 2001).

We also calculated the proportion of the plants belonging to different phytosociological groups within each plot. Again, differences between the Hungarian and Romanian sides were identified with the Wilcoxon-Mann-Whitney test, using Past 1.99 (Hammer *et al.* 2001).

During field studies, we recorded all information possibly important from a nature conservation perspective (dumping grounds, waste thrown away, damage to soil, artificial landscape elements).

Plant species names are used according to Simon (2000).

Results

Habitat maps of the grasslands are shown on Figs. 1-2 (Erdős *et al.* 2011). For the sake of simplicity, some categories were merged on the maps. We found a total of 25 habitat types. Below we give a brief description of the near-natural types.

Figure 1. Habitat map of the Hungarian grassland. 1=waste dump, 2=artificial pond.

Salt marshes (B6) have generally been preserved in a good condition. All of the stands on the Hungarian (mown) side belong to the naturalness category 5, while there are stands on the Romanian (grazed) side belonging to the naturalness category 4, 4r3 or 3. It is worth mentioning that we found a small isolated salt marsh stand on the Hungarian side. Although it is surrounded by arable fields, it is in a relatively good condition (category 5r3). Proportion of *Artemisia* salt steppes (F1a) is much greater on the Romanian side, but their naturalness values are usually lower than on the Hungarian side. Salt meadows (F2) dominate both grasslands. Their condition is generally good, but stands near agricultural fields are degraded. Dense and tall *Puccinellia* swards (F4) cover extensive areas on the Hungarian side, while their extension is much lower on the Romanian side, where their naturalness values are usually lower. Annual salt pioneer swards of steppes and lakes (F5) belong to high naturalness categories. Closed loess steppes (H5a) are degraded on both sides, the naturalness values never exceeding 3. Proportion of degraded dry habitats (*Achillea* salt steppes – F1b and uncharacteristic dry and semi-dry grasslands – OC) is also important on both sides. On both sides, we found one waste dump, the location of which is indicated on Figs.1-2. The waste dump on the Romanian side is much bigger. In addition, artificial ponds were created on both sides (Figs.1-2).

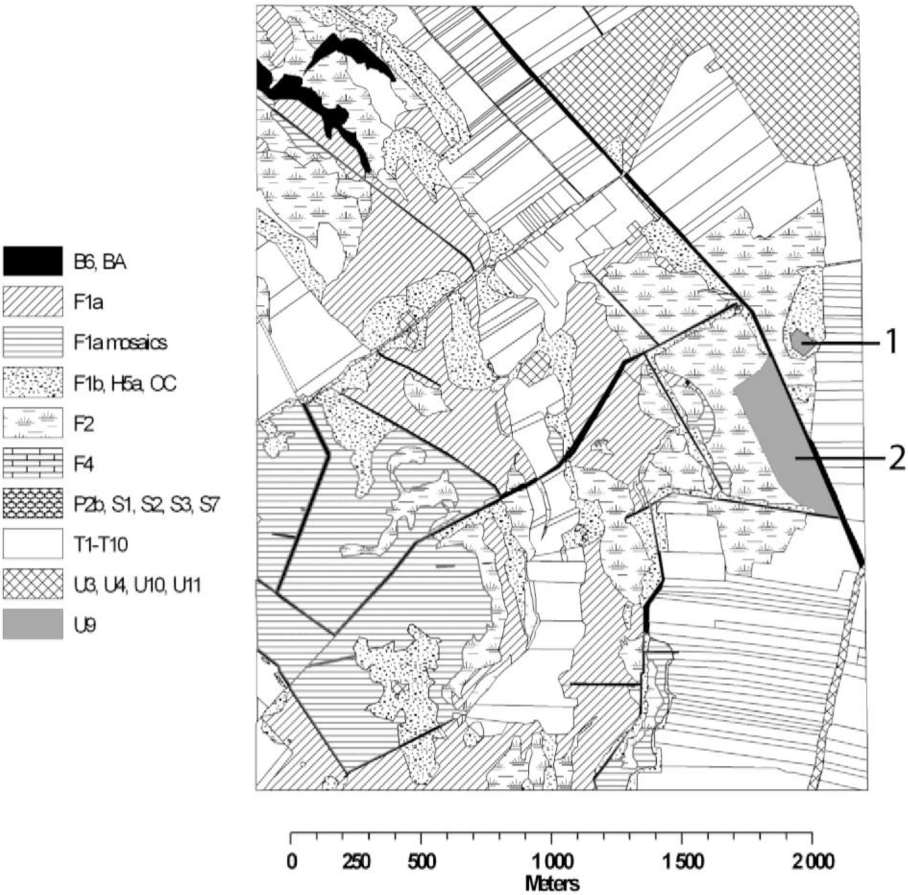

Figure 2. Habitat map of the Romanian grassland. 1=waste dump, 2=artificial pond.

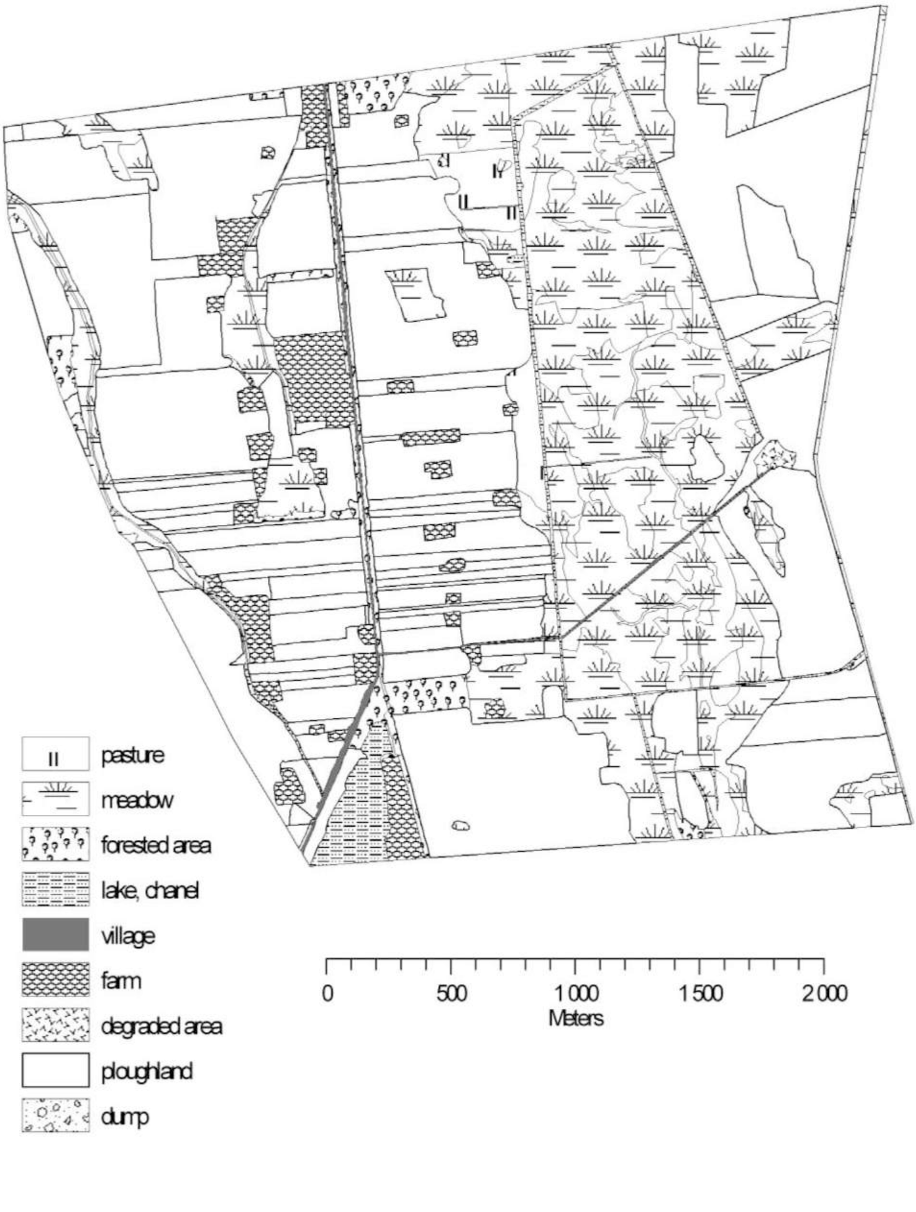

Figure 3. Land-use map of the Hungarian grassland.

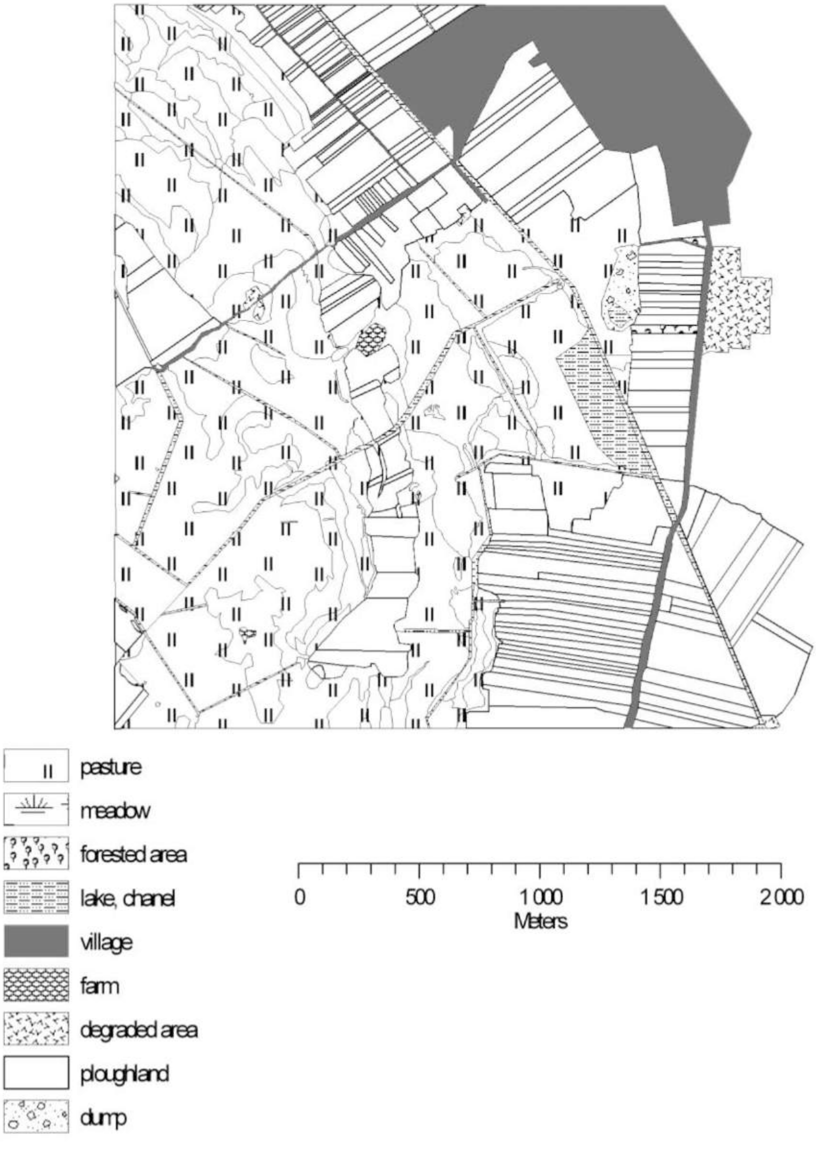

Figure 4. Land-use map of the Romanian grassland.

Land-use maps are presented on Figs. 3-4. Unfortunately, both sides are dominated by arable fields, although in Romania, greater parts of the near-natural grasslands remained unploughed. The overwhelming majority of the near-natural grasslands on the Hungarian side is hay-meadow, and only a small fraction is grazed. In contrast, nearly the whole grassland is a pasture on the Romanian side. There are several small farms scattered on the Hungarian side, but only a few farms on the Romanian side.

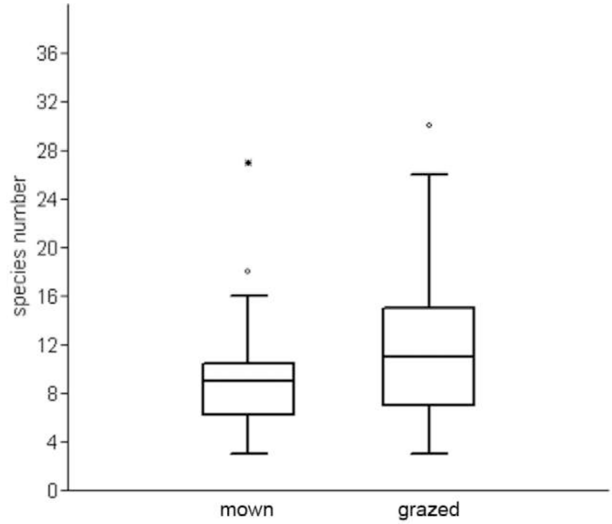

Figure 5. Species number of the two grasslands.

Species number of the plots is higher on the Romanian (grazed) side if every habitat type is considered (Fig. 5), although differences are not significant according to the Wilcoxon-Mann-Whitney tets (U=537, p=0.0805).

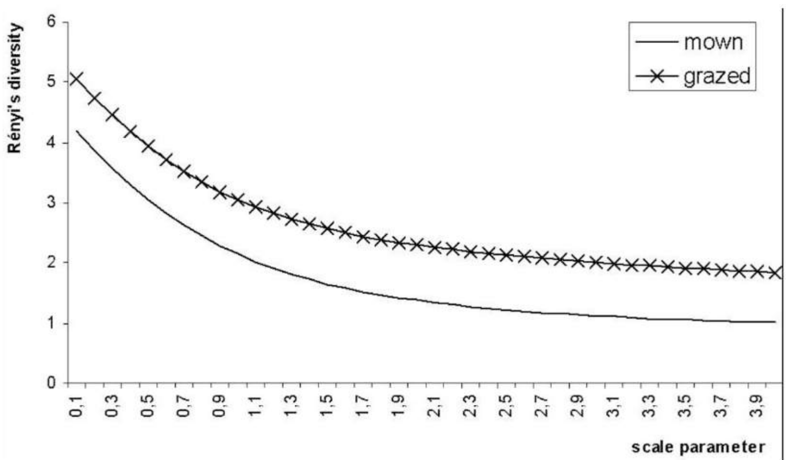

Figure 6. Diversity profiles of the *Artemisia* salt steppes.

In the followings, we analyse the Artemisia salt steppes and the salt meadows exclusively, since these are the most typical habitats on the area under scrutiny. However, our main conclusions are very similar if every habitat type is considered (cf. Erdős *et al.* 2011).

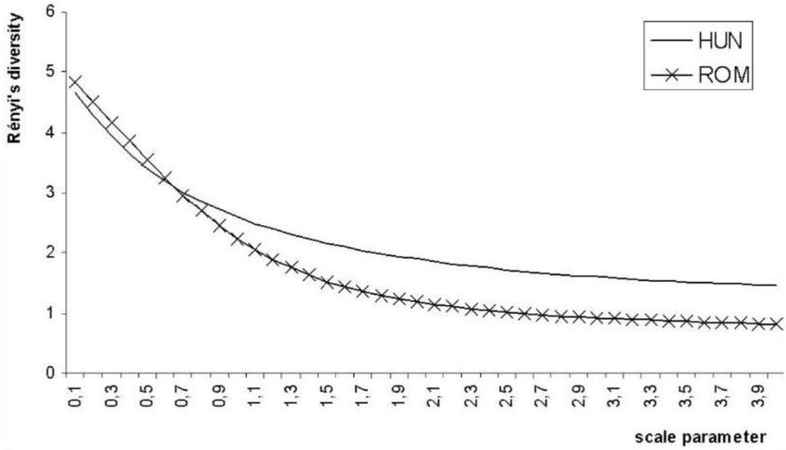

Figure 7. Diversity profiles of the salt meadows.

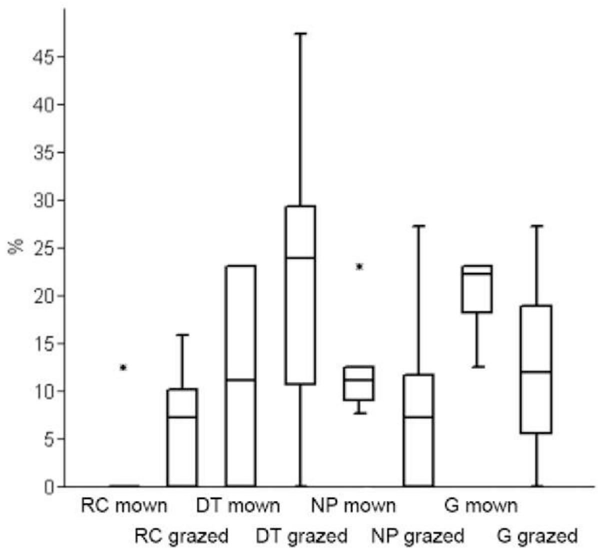

Figure 8. Group participation of the social behaviour types in the case of *Artemisia* salt steppes.

In the case of *Artemisia* salt steppes, results of the diversity ordering are clear, indicating higher diversity on the Romanian (grazed) side (Fig. 6). In contrast, in the case of the salt meadows, the two grasslands (mown vs. grazed) can not be ordered (Fig. 7).

If we look at the spectra of the social behaviour types, differences between the grazed and mown grasslands are not significant if *Artemisia* salt steppes are considered. However, differences are quite close to the significance level in the case of ruderal competitors (U=22, p=0.0689), disturbance tolerants (U=19.5, p=0.0567), natural pioneers (U=21, p=0.0764) and generalists (U=19, p=0.0506), indicating that the Romanian side is more disturbed (Fig. 8.).

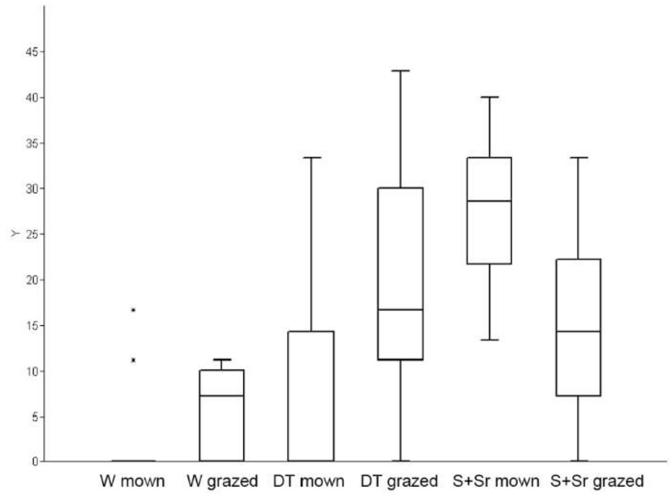

Figure 9. Group participation of the social behaviour types in the case of salt meadows.

If salt meadows are considered, weeds and disturbance tolerants are more typical of the grazed grassland (U=61, p=0.0282 and U=48, p=0.0141, respectively), whereas specialists are more typical of the mown grassland (U=46.5, p=0.0143) (Fig. 9).

No considerable differences were found in the group participation of the N indicator values between the grazed and mown grasslands.

In the case of *Artemisia* salt steppes, proportion of plants belonging to the phytosociological group *Festuco-Puccinellietea* is higher on the Hungarian side (U=18.5, p=0.0457), while proportion of indifferent species is higher on the Romanian side (U=15, p=0.0211) (Fig. 10). Similarly, salt meadows of the Hungarian side possess more *Festuco-Puccinellietea* (U=47, p=0.0171) and less indifferent plants (U=50.5, p=0.0285) than salt meadows of the Romanian side (Fig 11).

On the Romanian side, litter was found everywhere scattered on the pastures, the landscape has been destroyed due to power lines and abandoned buildings, and soil surface is damaged because of tractors. In contrast, on the Hungarian side there is only limited litter, landscape is nearly intact and soil surface is only rarely damaged (Erdős *et al.* 2011).

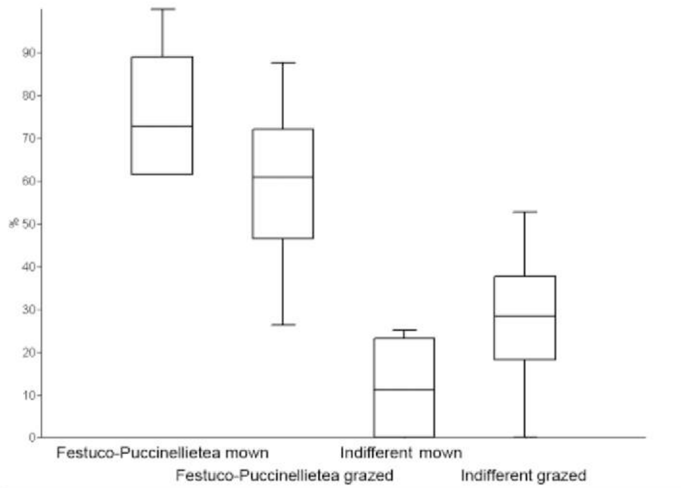

Figure 10. Group participation of the *Festuco-Puccinellietea* and indifferent species in the case of *Artemisia* salt steppes.

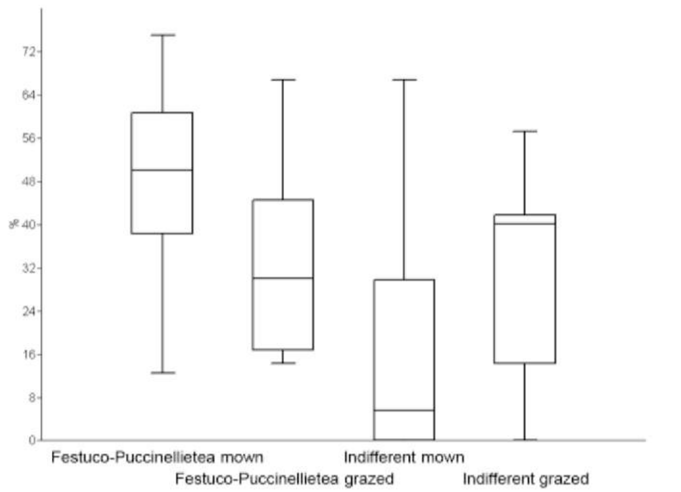

Figure 11. Group participation of the *Festuco-Puccinellietea* and indifferent species in the case of salt meadows.

We found that *Plantago schwarzenbergiana*, an endemic species occurs in great numbers on both sides of the border. Also, the endemic plant *Limonium gmelinii* ssp. *hungaricum* is common everywhere on the near-natural grasslands under study.

Discussion

We found a mosaic pattern of various habitats. The near-natural areas are dominated by salt meadows, *Artemisia* salt steppes and dense and tall *Puccinellia* swards. At higher elevations, small loess steppe fragments are scattered in the alkaline matrix. These are usually degraded, in spite of the fact that the surrounding alkaline vegetation is natural. Loes steppe fragments are common within alkaline areas throughout the Carpathian basin (Kelemen 1997), and they were known near Gyula as well (Tóth 2003). Their naturalness values are lower probably because both resistance and resilience of alkaline communities is pretty high (cf. Kelemen 1997, Kun 1998, Molnár and Borhidi 2003). Thus, a certain disturbance event may result in a considerable degradation within loess steppes, while the very same disturbance has much less effect on the alkaline communities.

Our investigations showed that differences in the land-use (hay-meadows on the Hungarian side, pastures on the Romanaian side) result in marked differences in the vegetation. Species richness of the grazed grasslands seemed to be higher, although differences were not significant. Diversity of the *Artemisia* salt steppes proved to be higher on the grazed side, whilst diversities of the salt meadows could not be ordered. Thus grazing may have a greater effect on *Artemisia* salt steppes.

We found that naturalness values of habitats on the Romanian side were often lower. In addition, proportion of plants typical of disturbed, degraded habitats is also somewhat higher on the Romanian side. We conclude that grasslands of the Romanian side may be overgrazed.

We found high numbers of the species *Plantago schwarzenbergiana*. This species was known from the area (Kertész 2000, Tóth 2003). Also, other valuable species which are legally protected in Hungary occur on the grassland studied and the immediate surrounding, such as *Aster sedifolius* ssp. *sedifolius*, *Bassia sedoides*, *Orchis laxiflora* (Kertész 2000, Tóth 2003). Moreover, these grasslands provide habitats for some protected animal species (Lőrinczi *et al.* 2011), thus we conclude that the area should be protected.

Proposals for conservation management

In the followings we give specific proposals to the management of the studied grasslands, based on the statements of Erdős *et al.* (2011).

The Romanian side seems to be overgrazed, which is one severe threatening factor to alkaline communities, resulting in degradation (Kelemen 1997, Kun 1998, Molnár and Csízi unpublished data, Molnár and Borhidi 2003). With careful grazing techniques and traditional methods such as "acatolás" or "töviskelés", adverse effects of overgrazing could be minimized even if the grazing pressure remained the same as it is currently (cf. Kelemen 1997, Molnár and Csízi unpublished data).

The illegal waste dump should be eliminated as soon as possible. Invasive species (mostly *Xanthium italicum* and *X. spinosum*) should be eradicated from their potential centres of infection (near roads and small farms). Pastures possess considerable aesthetic values (Sanderson *et al.* 2004). Littering on the Romanian side greatly reduces this value. Therefore, attitude of local inhabitants to natural values should be changed. If people of the nearby settlements valued their grasslands more, protection from waste and undesirable landscape elements would be easier.

According to the land-use historical analyses (Cseh *et. al.* 2011), the grasslands on the Romanian side have undergone a radical drying tendency. This is undoubtedly an undesirable process, diminishing the alkaline character (Kelemen 1997). Therefore, efforts should be made to halt further drying.

As indicated earlier, the pasture is valuable from a nature conservation perspective, therefore, the whole grassland should be legally protected, which is currently lacking on the Romanian side.

The grassland on the Hungarian side is mown, and only a small fraction is grazed. Since the second half of the 19th century, livestock grazing has decreased around Gyula (Cseh *et al.* 2011). Although undergrazing does not belong to the most threatening factors in the case of primary alkaline communities (Molnár and Borhidi 2003), it could be harmful in some cases (Molnár and Csízi unpublished data, Kelemen 1997, Kun 1998). Molnár and Borhidi (2003) suggest that alkaline steppes were grazed by native ungulates long before human history, which is in good accordance with the megaherbivore hypothesis (Vera 2000). Moreover, traditional grazing is culturally more valuable (cf. Molnár and Borhidi 2003, Molnár and Csízi unpublished data) than mowing. It is likely that grasslands in the proximity of Gyula were grazed for centuries (Cseh *et al.* 2011). Therefore, grazing of the studied grassland, as the traditional land-use method, should be re-established, preferably with traditional Hungarian varieties (Hungarian grey cattle, Racka sheep). However, adverse effects of the grazing should be minimized.

Mosaic grazing would also be possible, where undergrazed and overgrazed patches alternate (Molnár and Csízi unpublished data). Also, mown and grazed patches could alternate (cf. Ölvedi 2010).

The illegal waste dump should be eliminated on the Hungarian side, too. The interviews with the inhabitants of Gyula pointed out that local people are not really aware of the natual values of their immediate surrounding (Málovics *et al.* 2011).

Although drying tendency on the Hungarian side is not as marked as on the Romanian side, we think that further drying should be avoided. We found several very deep drainage ditches, which are especially harmful (Kelemen 1997), and we suggest that they should be filled in.

Although the grassland of the Hungarian side is a Natura 2000 area, protection of the site would be necessary at a higher level.

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References

Ambrózy, P. and Kozma, F. (1990): Éghajlat. Békési-sík (Climate. Békés-plain). In: Marosi, S. and Somogyi, S. (eds): Magyarország kistájainak katasztere I. – MTA Földrajztudományi Kutató Intézet, Budapest, p. 311.

Aradi, Cs., Gőri, Sz. and Lengyel, Sz. (2004): Természetvédelmi gyakorlat és konzervációbiológia: a kutatás szerepe a gyakorlati természetvédelemben (Conservation practice and conservation biology: the role of research in practical conservation). – Term.véd. közlem. 11. 21-30.

Borhidi, A. (1993): A magyar flóra szociális magatartás típusai, természetességi és relatív ökológiai értékszámai (Social behaviour types of the Hungarian flora, its naturalness and relativ ecological indicator values). – Környezetvédelmi és Területfejlesztési Minisztérium Természetvédelmi Hivatala és Janus Pannonius Tudományegyetem, Pécs.

Borhidi, A. (1995): Social behaviour types, the naturalness and relative ecological indicator values of the higher plants in the Hungarian Flora. – Acta Bot. Hung. 39, 97-181.

Bölöni, J., Molnár, Zs., Illyés, E. and Kun, A. (2007a): A new habitat classification and manual for standardized habitat mapping. – Ann. Bot., n. s. 7, 105-126.

Bölöni, J., Molnár, Zs. Kun, A. and Biró, M. (eds.) (2007b): Általános Nemzeti Élőhely-osztályozási Rendszer (General National Habitat Classification System). – MTA ÖBKI, Vácrátót.

Cseh, V., Erdős, L. and Körmöczi, L. (2011): Landscape history of the Gyula — Vărşand region. In: Körmöczi, L. (ed.): Ecological and socio-economic relations in the valleys of river Körös/Criş and river Maros/Mureş. Szeged-Arad, pp. 7-20.

Erdős, L., Bátori, Z., Zalatnai, M., Margóczi, K., Tolnay, D., Cseh, V., Arsene, G.-G. and Körmöczi, L. (2011): Comparison of two neighbouring alkaline grasslands with different land uses: a conservation management perspective. Acta Bot. Hung. 53, 89-100.

Hammer, Ř., Harper, D. A. T. and Ryan P. D. (2001): PAST: Paleontological Statistics Software Package for Education and Data Analysis. Palaeontol. Electron., 9pp. http://palaeo-electronica.org/2001_1/past/issue1_01.htm

Hubai, I. (1934): Gyula földrajza (Geography of Gyula). Thesis. – Magyar Kir. Ferenc József Tudományegyetem, Szeged.

Illyés, E., Bölöni, J., Kovács, G. and Kállayné Szerényi, J. (2007): A száraz gyepek jelentősége, elterjedése, helyük a vegetációmozaikban és termőhelyi viszonyaik Magyarországon (Importance and distribution of xerophilous grasslands in Hungary, their state in the vegetation mosaic and their ecological conditions). In: Illyés, E. and Bölöni, J. (eds): Lejtősztyepek, löszgyepek és erdőssztyeprétek Magyarországon (Slope steppes, loess steppes and forest steppes in Hungary). Magánkiadás, Budapest, 12-19 pp.

Kelemen, J. (1997): Szikes gyepek (Alkaline grasslands). In: Kelemen, J. (ed): Irányelvek a füves területek természetvédelmi szempontú kezeléséhez (Guidelines for tconservational treatment of grasslands). TermészetBúvár Alapítvány Kiadó, Budapest, 129-165 pp.

Kertész, É. (2000): Adatok a Dél-Tiszántúl flórájához (Data to the flora of South-Tiszántúl). – A Békés Megyei Múz. Közl. 21, 5-48.

Kun, A. (1998): Száraz gyepek Magyarországon (Xerophilous grasslands in Hungary) In: Kiszel. V. (ed): Természetvédelem területhasználók számára (Nature conservation for land-users). – Göncöl Alapítvány, Vác.

Lőrinczi, G., Bozsó. M., Gallé. R., Torma, A. (2011): Preliminary results on the invertebrate fauna (Araneae. Orthoptera, Heteroptera and Hymenoptera: Formicidae) of alkaline grasslands of the Hungarian-Romanian border. In: Körmöczi. L. (ed.): Ecological and socio-economic relations in the valleys of river Körös/Criş and river Maros/Mureş. Szeged-Arad, pp. 163-175.

Málovics, Gy., Margóczi, K. and Gébert. J. (2011): Ecosystem services at Magyarcsanád site as percieved by local people. In: Körmöczi, L. (ed.): Ecological and socio-economic relations in the valleys of river Körös/Criş and river Maros/Mureş. Szeged-Arad. pp. 177-210.

Margóczi, K., Báldi, A., Dévai, Gy. and Horváth, F. (1997): A természetvédelmi ökológia kutatási prioritásai (Research priorities for conservation ecology). Term.véd. közlem. 5-6, 5-16.

Molnár, Zs. and Borhidi, A. (2003): Hungarian alkali vegetation: Origins, landscape history, syntaxonomy, conservation. – Phytocoenologia 33, 377-408.

Ölvedi, T. B. (2010): A kaszálás vegetációra és magkészletre gyakorolt hatásai (Effects of mowing on the vegetation and seed bank). – Bot. Közlem. 97, 159-169.

Sanderson, M. A., Skinner, R. H., Barker, D. J., Edwards, G. R., Tracy, B. F. and Wedin, D. A. (2004): Plant species diversity and management of temperate forage and grazing land ecosystems. – Crop Sci. 44, 1132-1144.

Simon, T. (2000): A magyarországi edényes flóra határozója (Key for the vascular flora of Hungary). – Nemzeti Tankönyvkiadó. Budapest.

Tóth, T. (2003): Újabb adatok a Dél-Tiszántúl flórájának ismeretéhez (New data to the flora of South-Tiszántúl). – A puszta 2003, 135-169.

Tóthmérész, B. (1995): Comparison of different methods for diversity ordering. – J. Veg. Sci. 6, 283-290.

Van Wieren, S. E. (1995): The potential role of large herbivores in nature conservation and extensive land use in Europe. – Biol. J. Linn. Soc. 56 (Suppl.), 11-23.

Vera, F. W. M. (2000): Grazing ecology and forest history. – CABI Publishing, Wallingford.