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Changing year-round habitat use of extensively grazing cattle, sheep and pigs in East-Central Europe between 1940 and 2014: Consequences for conservation and policy

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ABSTRACT

Many habitats in Europe have been managed by grazing for thousands of years. However, extensive grazing systems are becoming increasingly rare in the region, and there is a lack of understanding of the functioning of these systems.

We carried out 147 structured interviews in 38 landscapes throughout the Carpathian Basin, with 3–5 informants/landscape. The number of actively grazing cattle, sheep and pigs, their year-round habitat use and the proportion of herds actively tended were documented for four characteristic historical periods (before, during and after socialist cooperatives and after EU Accession).

The numbers of grazing cattle and sheep had decreased substantially by 2010 (by 71% and 49%, respectively), while pig grazing almost disappeared by the 1970s. Cattle primarily grazed habitats with taller vegetation. Sheep grazed dry pastures and stubbles, while pigs were driven into marshes and forests. In general, the importance of dry and wet grasslands increased, while the significance of marshes, stubble fields, vegetation along linear elements, second growth on hay meadows, wood-pastures and forests decreased over time. Approximately half of the grazed habitats were not typical pasture grasslands, and functioned as supplementary pastures during droughts, autumn and winter. The number of habitat types grazed per month per site dropped, and herding decreased substantially, in particular in the case of cattle and pigs.

Contributing factors of the economic and social changes of the examined period included the collapse of the communist-era legal framework, the intensification of livestock husbandry, EU Common Agricultural Policy (CAP) regulations, and the rise of a nature conservation ethic.

We conclude that agricultural policies should take into account the full spectrum of habitat types necessary for the effective operation of extensive grazing systems. We argue that conservation-oriented extensive grazing should use the traditional wisdom of herders but adapted to the present situations.

1. Introduction

Extensive grazing systems (also called large-scale grazing, Plachter and Hampicke, 2010) are predominantly based on natural and semi-natural habitat types and non-intensively managed livestock breeds, kept usually at relatively low stocking densities. The system is often fine-tuned to local environmental and socio-economic conditions (Meuret and Provenza, 2014; Molnár, 2014; Reid et al., 2008). Extensive grazing systems have played and still play an important role in maintaining biological, and also cultural diversity (Halada et al., 2011; Oppermann, 2014; Plachter and Hampicke, 2010; Rodríguez-Ortega et al., 2014; Vera, 2000). Additionally, extensive grazing systems are important tools for

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resilient and sustainable agroecosystem management, and for ensuring food security. In addition, they contribute to the maintenance of several ecosystem services of biodiversity such as biomass production, control of pests and disease, and pollination (Baumgärtner, 2007; Bruun and Fritzbøger, 2002; Frison et al., 2011; Heikkinen et al., 2012; Poschlod et al., 2002; Rodríguez-Ortega et al., 2014). Extensive grazing is often beneficial for conservation purposes as well (Báldi et al., 2013; Plachter and Hampicke, 2010; Török et al., 2014; WallisDe Vries et al., 2004). A high number of high nature-value habitats require extensive or transhumant grazing management in Europe (Bunce et al., 2004; Halada et al., 2011; Hartel et al., 2013; Poschlod and WallisDe Vries, 2002; van Uytvanck and Verheyen, 2014; Vera, 2000).

In connection with the resilient maintenance of extensive land-use systems, several authors emphasize the importance of landscape scale and historical time scale (Agnoletti, 2014; Fischer et al., 2012; Loos et al., 2015; Plachter and Hampicke, 2010; Vera, 2000), as well as of traditional ecological knowledge (Agnoletti, 2014; Berkes et al., 2000; Cevasco et al., 2015; Molnár et al., 2008; Plieninger and Bieling, 2013).

Extensive grazing in Europe is decreasing in many places; the associated traditional ecological knowledge also is disappearing (Hernández-Morcillo et al., 2014; Oteros-Rozas et al., 2013; Varga and Molnár, 2014). The main role of traditional ecological knowledge in the case of extensive grazing is to optimise extensive exploitation of the biomass produced in the landscape. This is a kind of workmanship in landscape ecology (cf. Johnson and Hunn, 2010). It comprises knowledge of which biomass in the landscape is best for grazing, where, when, how and by which livestock (Molnár, 2012; Molnár et al., 2015; Vera et al., 2007). In landscapes where biomass production has a high inter- and intra-annual variability, e.g. steppe and alpine areas, extensive grazing systems must adapt to these heterogeneities (Gugič, 2009; Meuret and Provenza, 2014; Molnár, 2012; Plieninger et al., 2015). Beside typical pasture grassland habitat types (dry and wet grasslands, wood-pastures) a number of different other habitat types (such as stubble fields, second growth hay, marshlands, forests, and vegetation along linear elements) were and are still also taken advantage of (Barrantes et al., 2009; Vera, 2000).

Much agricultural, ecological and conservation biological work has focused on the role of grazing on dedicated pasture grasslands, but less research is available on grazing other habitats (e.g., marshes, forests, and stubbles) (but see e.g. Andresen et al., 1990; Middleton et al., 2006; Plachter and Hampicke, 2010; Poschlod et al., 2002; Roturier and Roué, 2009; Vera, 2000). Very little is known about the role of reserve pastures (e.g. grazing on arable lands) in extensive grazing systems based predominantly on (semi-)natural habitats (but see, e.g., Barrantes et al., 2009; Molnár et al., 2015; Toro-Mujica et al., 2015; Vera et al., 2007). Current European agricultural policy also exacerbates this divide by separating subsidies to grasslands, forests and croplands (Olmeda et al., 2014).

The continuously present herder managed herd behaviour and daily grazing circuits, often ensuring grazing optimised to the forage offered by the landscape (Meuret and Provenza, 2014; Molnár, 2014; Oteros-Rozas et al., 2013). However, as a result of the socio-economic changes of the past decades, the number of knowledgeable herders declined, throughout Europe and in the post-Soviet countries alike (Varga and Molnár, 2014). Though pastoral grazing declined, it is still a living practice in many marginal regions (Molnár, 2014; Roturier and Roué, 2009; Oteros-Rozas et al., 2013).

In most European countries a rich historical and ethnographic literature is available on extensive grazing systems (see e.g. Bellon, 1996; Gunda, 1940; Jacobeit, 1961; Wealleans, 2013). These, however, rarely document landscape ecological and habitat aspects of extensive grazing systems (but see in Hungary, e.g., Andrásfalvy, 2007; Gunda, 1968; Tálasi, 1936). Missing landscape ecological research is sometimes impeded by the explicit partial or total prohibition of grazing on certain habitats by some national or European Community rules and legislation (for instance the forest law, occasionally EU CAP; Barrantes et al., 2009; Haraszthy, 2014; Varga and Molnár, 2014).

The main objective of this article is to document landscape ecological features of extensive grazing and their respective changes over the past few decades in the post-communist countries of the Carpathian Basin. The actual research questions were raised as follows:

1. How many total head of cattle, sheep or pigs were and are grazed extensively in the areas of the communities under investigation?
2. In which month on which habitat types did/does the livestock graze throughout the year and how has the importance and number of habitat types grazed varied over the past 60–70 years?
3. How has the use of non-typical pasture habitat types (e.g. stubbles, marshes, forests) varied across the year and over the past 60–70 years?
4. How was and is grazing accomplished (via herding or fencing)?

Research was carried out at 38 locations across the Carpathian Basin, studying four historical periods between 1940 and 2014.

2. Study area and methods

2.1. Study area

Changes in the grazing system were studied in 38 landscapes of the Carpathian Basin in Central Europe. Research was conducted in six post-communist countries, predominantly in Hungary, and in Croatia, Serbia, Romania, Ukraine and Slovakia (Fig. 1, for name, total area of municipalities and the cover and change of grasslands see Appendix 1).

The climate of the study areas is typically continental with Atlantic, sub-Mediterranean and, to a lesser extent, alpine influences. Annual average temperature varies around 11 °C; annual average precipitation ranges up to 500–1200 mm (Condé et al., 2002). Study sites were selected to represent the most typical vegetation zones and thus grazing systems in the Carpathian Basin (the zone of *Picea abies* forests in the higher mountains (800–1200 m a.s.l.), *Fagus sylvatica* and *Quercus petraea*, *Q. cerris* forest regions in the mountain and hill ranges (200–800 m a.s.l.), and loess, sand and salty forest steppe landscapes in the lowlands (50–200 m a.s.l.)).

Over the past several centuries, small-scale peasant and allodial land-use systems typically shaped wildlife and landscape in the Carpathian Basin. Extensive livestock management played a primary role in transforming the vegetation, for instance by creating wood-pastures and pastures in the place of former forests, changing the species composition of primary steppes, and developing hay meadows (Andrásfalvy, 2007; Babai and Molnár, 2014; Bellon, 1996; Varga et al., 2015).

Social and economic changes in the 20th century (for instance, socialist transformation of agriculture, post-communist transformations after 1989, and then the accession to the EU) brought about significant changes in the rules of grazing, number of grazing livestock and breed composition (Beaufoy and Marsden, 2010; Bodó, 2001). Correspondingly, the number of jobs in agriculture diminished gradually, and barely reaches 4.9% in Hungary at present (Hungarian Central Statistical Office, 2014).

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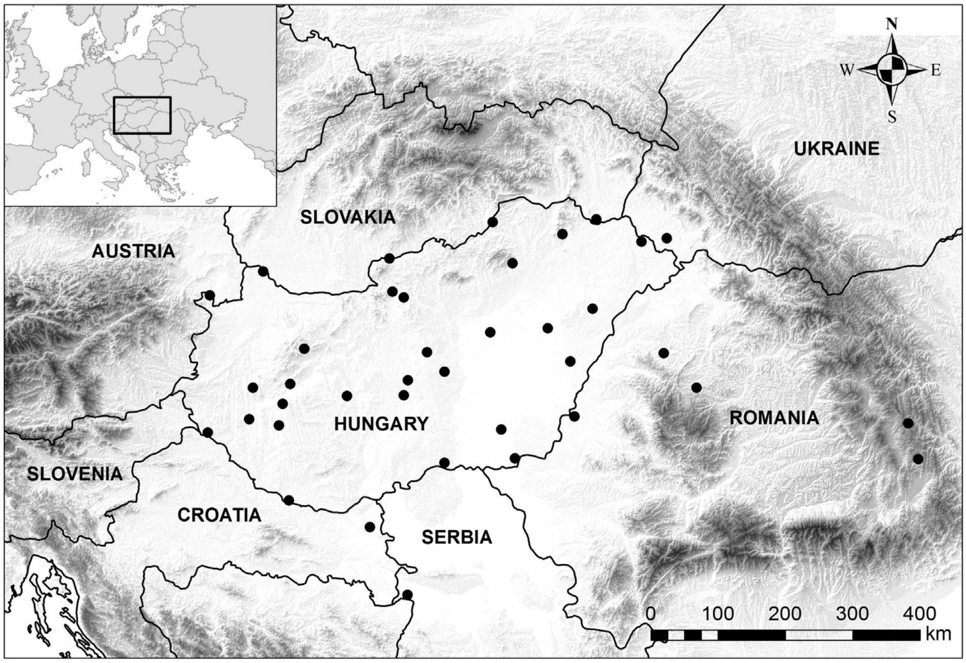

Fig. 1. Map of the 38 study sites (black dots on the map) in the Carpathian Basin, Central Europe.
Map source: ASTER-DEM, USGS, 2009.

2.2. Materials and methods

We studied the most common livestock species: cattle, sheep and pig. We included pigs in the study because this species grazed on special habitats and in a distinct way. Correspondingly, a large quantity of historical data is available about extensive porcine grazing (e.g. Szabadfalvi, 1991). Also, documentation of now-vanished pig pasturing practices was seen as important for conservation management (cf. Beinlich and Poschlod, 2002). Since horses and water buffalos were mainly used as draught animals and, as a consequence, grazed on pastures only occasionally, therefore these species were not studied. Grazing of goats, geese or ducks affected a relatively small area only (cf. Andrásfalvy, 2007).

Breeds of cattle and pigs changed significantly during the study period. The percentage dominance of Hungarian Simmental cattle ranged up to 83% in 1942, but now stands at only 14% (Holló and Szabó, 2011). Its importance was overtaken by the Holstein-Friesian from 1972 onwards, and in the last few decades in growing number by beef cattle breeds (such as Charolais, Aberdeen Angus, Limousine and Hereford) (OECD-FAO, 2012). White intensive pig breeds replaced the traditional Mangalitza breed during the years between the 1960s and the 1970s, and as a consequence, pasturing of pigs was abandoned (Bodó, 2001). Among sheep, Merino types are predominant throughout the study period (Racka, and Tsigai were significant up until the 1930s). The meat production (total of cattle, pigs and sheep in Hungary) was 1249, 460 and 697 thousand tons in 1971, 2000 and 2010, respectively. Production of milk was 4.2, 1.7, 2.1, 1.6 million liters in 1935, 1971, 2000, and 2010, respectively.

Four historical periods with typical social-economic conditions affecting the post-communist countries in the Carpathian Basin as a whole – irrespective of country – were studied (Table 1).

For each site, structured indoor interviews were made with 3–5 respondents (147 in total, 112 men and 35 women; mean age of interviewees: 70.1; the youngest were 29, the oldest 96 years old; the proportion of non-academic informants is 89%). Interviews were conducted in Hungarian and recorded digitally or notes were taken.

The first questions of the interviews concerned the number of livestock on pastures in the case of the three species studied. Our questions were (3×4 questions per interview): "*How many head of cattle/sheep/pigs were present on the pasture before/during/after the*

Table 1
The periods investigated and their major features.

	Period	Years	Main features of the period
I.	Before cooperatives	1940–1955	The so-called traditional period of agriculture before the socialist transformation, including mainly smallholder farms and landlord estates
II.	During cooperatives	1965–1980	Heyday of socialist agriculture, including forced mechanisation, use of synthetic fertilisers and chemicals
III.	After the political transition in 1989	1992–2000	The period after the political transition (1989) with re-organised capitalist farming practices but limited financial support for farmers
IV.	The last ten years (after EU-accession)	2005–2014	The period after EU accession (2004); significant agricultural subsidies, effects of CAP

cooperatives/in the last 10 years?" Estimates from respondents were necessary because the figures of the Central Statistical Office provide only a total number of livestock for each settlement and data are not adequate to determine the actual number of grazing livestock. The two figures are close to each other only in the case of sheep. The change in the number of livestock was compared using Kruskal–Wallis H test, in the PAST 3.08 programme package (Hammer et al., 2001).

In the second part of the interviews questions on grazed habitats were posed for the three species and four periods, respectively. The aim was to document the number of habitat types grazed. The respective questions were as follows ($3 \times 12 \times 4$ questions/interview): "*Where did cattle/sheep/pigs stay/graze in January/February . . . etc. before/during/after the cooperatives/in the last 10 years?*" To make data collection uniform, 14 broad but clearly identifiable habitat categories were determined, and data collectors (11 authors of this paper and 7 additional researchers; see Acknowledgements) encoded primary interview data into those categories. Investigated habitat types included the following: (1) dry and mesophilous grasslands including loess, saline, rocky and sandy grasslands, mostly steppe grasslands dominated by *Festuca* spp.; (2) wet grasslands (such as marsh and fen meadows characterised by *Alopecurion* and *Molinion* spp.); (3) wood-pastures and shrublands (with scattered deciduous and coniferous trees and bushes); (4) vegetation along linear features (grasslands and shrub along roads, ditches, small streams etc.); (5) hay meadows (i.e. when the second growth on these meadows was grazed seasonally); (6) marshes, fens (with *Phragmites australis*, *Phalaris arundinacea*, tall sedges etc.); (7) forests and forest edges (deciduous and coniferous); (8) stubble fields (e.g. wheat, barley, corn, sugar beet stubbles); (9) fallows (temporarily abandoned fields); (10) cropland (e.g. cereals); (11) yards; (12) stables. Due to the very low number of cases, habitats No. 9, 10 and 11 were omitted from the analysis.

The questions of part three of the interviews concerned herding practices: "*Was/is there any herder with the grazing livestock?*", and "*Is/was livestock kept in permanent fencing or in portable electric fencing*?" "*Which was/is more typical*: *only herding, only fencing or both?*"

Data from the 38 study sites were arranged in tables. Each and every occurrence of a given habitat was summarised by month, livestock species and period, and the percentage ratio of how many times each habitat type was mentioned was determined. Taking the number of mentions in the first period as 100%, the changes in significance of each habitat type was calculated for Periods II, III and IV. The number of grazed habitat types (habitat-use diversity) was determined for a monthly breakdown by site and period. The *p*-value of differences between periods was assessed by a permutation test. Diversity data were displayed using the R i386 3.2.1. programme (R Core Team, 2015). In each figure presenting the annual cycle the most frequently mentioned initial month of the grazing season (April) is shown in the first column. Data of pigs in Periods III and IV are not shown on Fig. 2, because the figures would be misleading due to the small sample size of the pig grazing.

3. Results

3.1. Number of livestock on grazing land between 1940 and 2014

The number of livestock on grazing land substantially decreased for all three species from the 1940s through the mid-2000s (Appendix 2). By the end of the communist period, grazing pigs vanished from the Carpathian Basin almost entirely. The stock of sheep grew in the cooperative period, only to decline later. From Period III to Period IV, grazing cattle increased by approximately 10% as a whole but were further reduced in most sites. All in all, today about half as many sheep (51%) and a third as many cattle (approximately 29%) graze on pastures in comparison to their numbers 60–70 years ago.

3.2. Annual cycle of habitat use

Monthly changes of grazed habitats across periods are shown on Fig. 2 and in Appendix 3. Fig. 2 illustrates the ratio of grazed habitats in relation to one another (as a percentage value of frequencies of all sites in the month in question). Appendix 3 shows the percentage of sites where the habitat concerned was used for grazing in the given month in the four respective periods.

The most commonly grazed habitats were dry grasslands. Sheep grazed them throughout the year but mainly from March on, while cattle grazed such sites from April on. Cattle and sheep grazed dry grasslands up to late autumn but in a gradually diminishing ratio (30% and 20–28%, respectively). Their significance in the case of pigs was less prominent.

Grazing on wet grassland was also significant (pigs 20–24%, cattle 18–25%, sheep 10–16%). Their importance usually diminished from May through February. For pigs, wet grasslands were of greater importance than dry grasslands (18% vs. 12%, respectively).

Wood-pastures and shrublands were grazed by all three species. Their significance increased in Period IV. Grazing cattle sometimes stayed on them throughout the year. Sheep used wood-pastures and shrublands across the year in all periods, but most intensively in winter and springtime (10–14% in winter and 10–12% in April and May). Pigs also used wood pastures and shrublands through practically the whole year.

Grazing along linear structures (mainly roadside grazing, banks of ditches and canals, narrow riparian zones along streams) played important roles for all three species throughout the year. In regions where cattle were driven out in winter months (mainly in Periods I and II), roadsides, banks of ditches and canals, and riparian zones along streams represented the most important habitat (42–66%).

Hay meadows were used at the end of the summer, and during autumn. Second growth was grazed there. The ratio reached 10–12% for cattle and sheep (somewhat higher for cattle). Spring grazing on hay meadows was infrequent; it was typical only in a few locations in the Carpathian Basin (such as Gyimes in Romania), mainly in Period I only. Pigs never went to hay meadows.

Marshes and fens were once important mainly as pastures for cattle and pigs. Their significance was small and was declining in the case of sheep. The importance of marshes grew for cattle in the cooperative period. However, grazing cattle in marshes during the winter and early spring period is now being forced out. Pigs were driven to these habitats in Periods I and II throughout the year, sometimes this was the dominant type of pig pasture (and still is today wherever extensive grazing practices survive).

Forest grazing was widespread in all four periods for all the three species in most sites. Cattle grazed in the forest mainly during the summer months. Winter month figures were very low (though they showed a growing tendency recently). Forest grazing throughout the annual cycle varied between 8 and 14%, declining in period IV to some extent (10%). Sheep roam (or roamed) the woods throughout the year, including the winter months (9–12%), with a slight peak in autumn. An autumn maximum can also be observed in the case of pigs. Surviving extensive pig pasturing happens in forests, for the most part.

Grazing of stubble fields started from mid-summer, wheat stubbles from July and corn stubbles from the end of September, respectively. Stubble fields were visited by cattle on a number of sites, yet they were important grazing land mainly for sheep (5% and 9–15% during the first three periods for cattle and sheep, respectively). In winter months the ratio of stubble fields reached

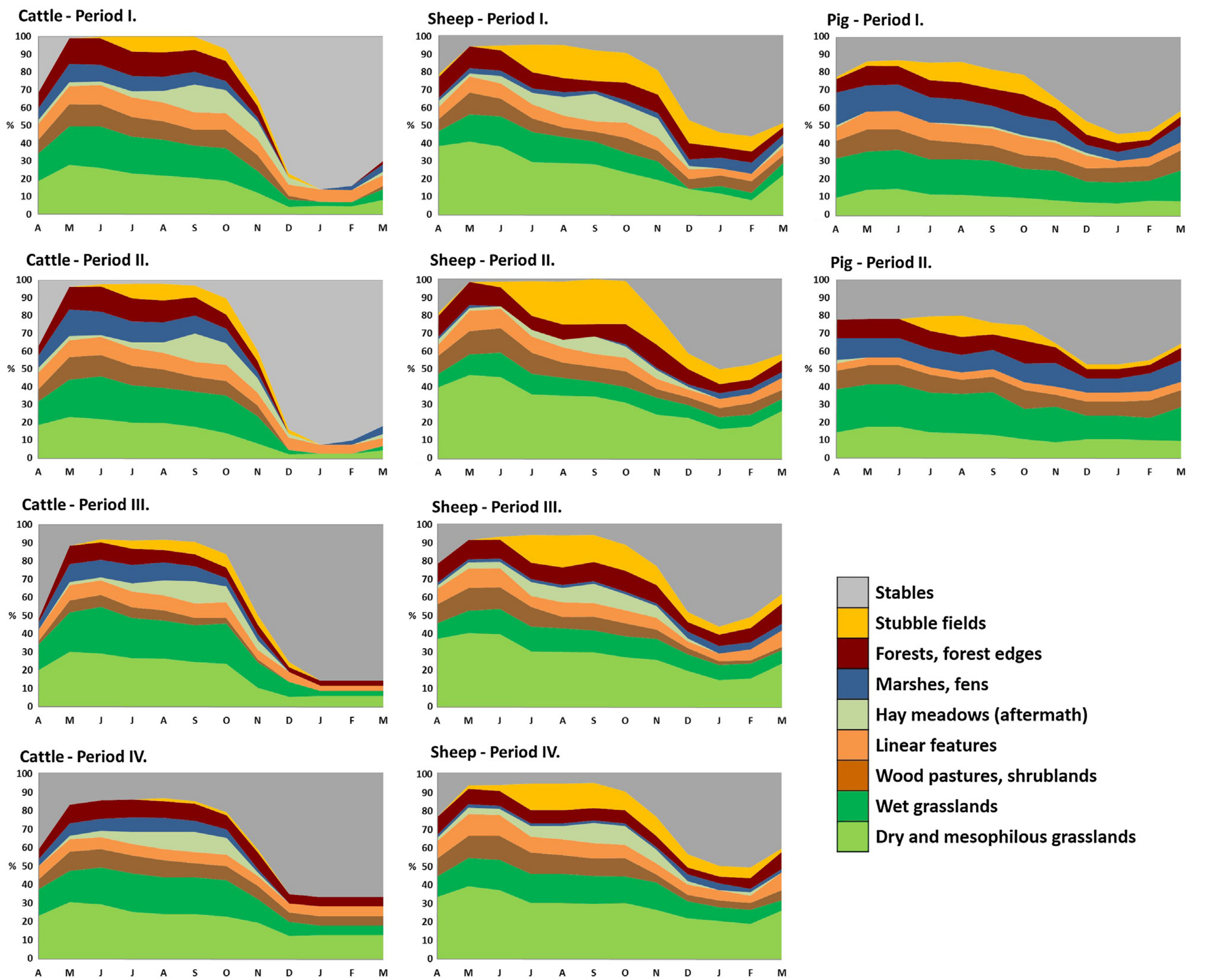

Fig. 2. The respective ratios of use for each habitat type (a percentage value of frequencies of all sites in the month in question) during the annual cycle in the four historical periods studied (1940–1955, 1965–1980, 1992–2000 and 2005–2014) in 38 study sites in the Carpathian Basin (as a ratio of all mentions). Data for pigs for Period III and IV have extremely low sample sizes, and thus are not shown.

10–12% and 16–24% for cattle and sheep, respectively. Cattle did not graze stubbles in winter, while this happened frequently for sheep (9–19%). Pigs also visited stubble fields often (9–14%), including the winter months. Now grazing of just sheep is typical on stubble fields.

The length of the grazing season was shortened by one month for cattle and did not change for sheep over the past 60–70 years. Since Period III it has become common for livestock not to spend all season on grass, but to be driven into the stables every now and then and sometimes during the summer period as well (see gray colour in Fig. 2).

3.3. Changing frequency of habitat use

Taking period I as a baseline (100%), Fig. 3 provides frequencies of mention of each habitat type in the other three periods. Grazing of cattle on most habitat types declined continuously during the past 60–70 years. Fewer and fewer animals utilised the biomass from fewer and fewer habitat types. Grazing was reduced mainly on more fragmented, non-pasture grasslands, such as along linear features, second growth, marshland, and mostly stubble fields. Wood-pastures and forests represent an exception: their proportion increased to a slight extent in the period following the political transition (Periods III and IV), after a decline during the cooperative period (Period II). Habitat use by sheep was transformed during the cooperative period to a major extent. Use of dry grasslands, stubble fields and linear features increased and that of hay meadows and marshes decreased. Period III showed signs of reset. In Period IV certain trends took another turn. Grazing with pigs decreased on all habitats during the cooperative period and vanished practically completely by Period III (not shown on Fig. 3).

3.4. Diversity of habitat use by grazing livestock during the annual cycle

Habitat-use diversity by cattle was reduced significantly in the period between April and October during the past 60–70 years, but this decline stopped in most months between Period III and IV (Fig. 4). No significant differences were found across historical periods in the months between November and March. Diversity of habitat use in the case of sheep was also reduced slightly in the

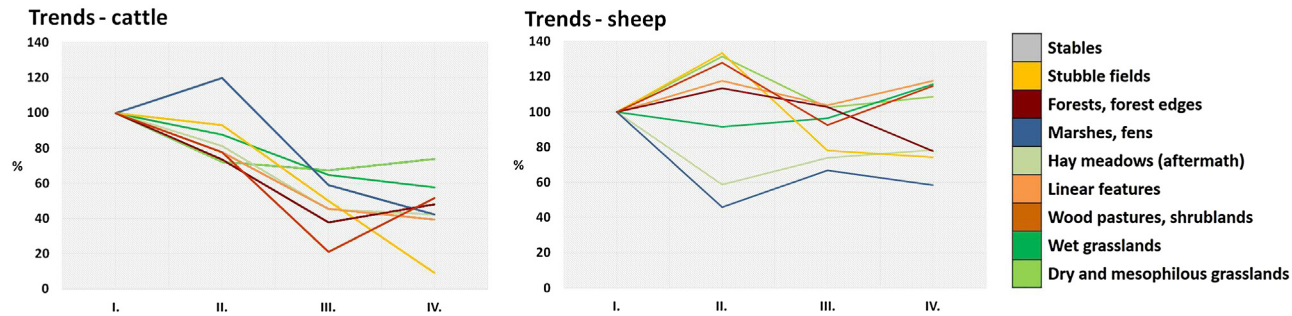

Fig. 3. Trends in changes of habitat use over the past 60–70 years, taking levels of Period I (1940–1955) as the reference (100%), Period II (1965–1980), Period III (1992–2000) and Period IV (2005–2014).

past 60–70 years between May and August, but these reductions were not statistically significant. Decline was significant in the case of pigs in each month (Apr $p < 0$, May $p < 0.00001$, Jun $p < 0.00001$, Aug $p < 0.00001$, Sep $p < 0.00001$, Oct $p < 0.00001$, Nov $p < 0.00001$, Dec $p = 0.00001$, Jan $p = 0.00004$, Feb $p = 0.00002$, Mar $p < 0.00001$. Level of significance: $P < 0.05$).

3.5. Contribution of non pasture-grassland habitats throughout the year

The ratio of non pasture-grassland habitats (e.g. second growth on hay meadows, marshes, vegetation along linear features, forests and stubble fields) was slightly reduced in the past 60–70 years, but remained significant to date (Fig. 5). Dominance of pasture-grassland habitats (dry grasslands, wet grasslands, and wood-pastures) was most typical in May–June and in April–June in the case of cattle and sheep, respectively. Use of other habitat types increased from mid-summer, most dramatically in the case of sheep. Their use reached a maximum in late autumn and during the winter in all four historical periods.

3.6. Herded vs. fenced grazing

In Period I all three species were herded almost exclusively (Fig. 6.). In the cooperative period fenced grazing emerged, mainly with cattle, but it has never become a dominant practice. In the past ten years enclosures (mostly by electric fencing) has increased, but pasturing by herders is still the dominant form of extensive grazing in the studied region.

4. Discussion

4.1. Changing number of extensively grazing livestock

At the 38 study sites investigated the number of cattle, sheep and pigs kept in extensive grazing systems has decreased from the 1940s up to date. The main cause for reduced numbers has been intensification of management, the extent of which depended on the species concerned. The swine industry could most readily be intensified, cattle to a lesser extent and sheep hardly at all (Bodó, 2001; Keszei et al., 2000). Area of grazeable land has not changed

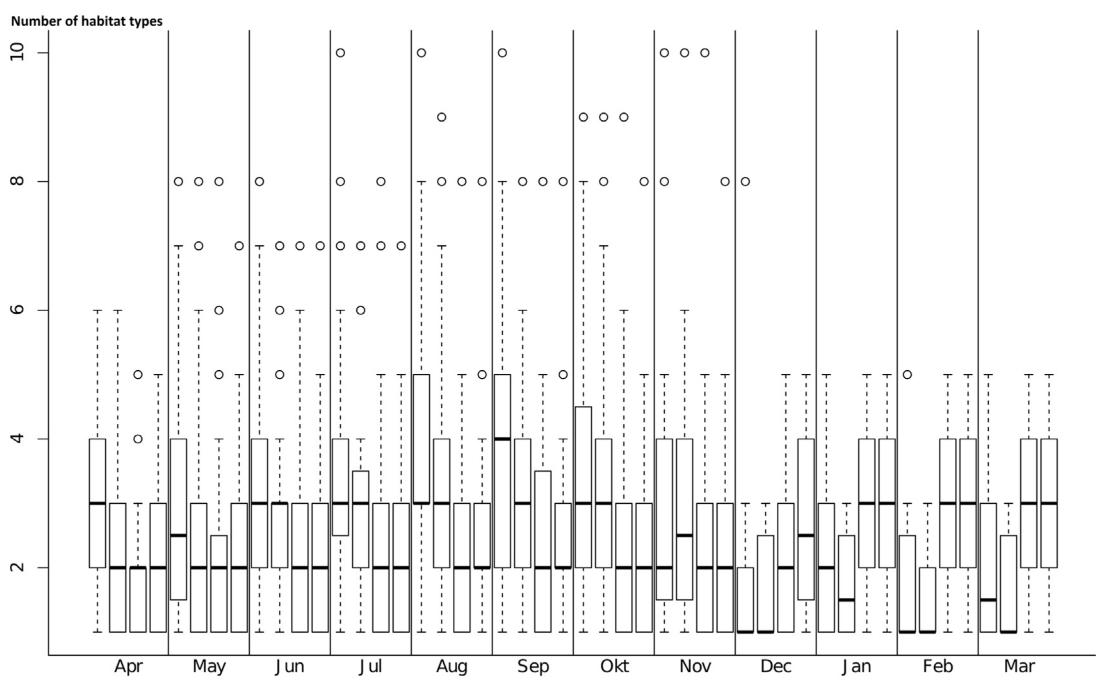

Fig. 4. Diversity in habitat use (number of different habitat types used as pastures in any given month in the 38 study sites) by cattle across the annual cycle in the Carpathian Basin. Boxes represent the four historical periods (I. 1940–1955, II. 1965–1980, III. 1992–2000 and IV. 2005–2014). Cattle: Apr $p = 0.01447$, May $p = 0.00063$, Jun $p = 0.00004$, Jul $p = 0.00001$, Aug $p = 0.00002$, Sep $p = 0.00001$, Oct $p = 0.00028$, Nov $p = 0.06601$, Dec $p = 0.59593$, Jan $p = 0.83531$, Feb $p = 0.77312$, Mar $p = 0.31694$; sheep: Apr $p = 0.51592$, May $p = 0.32481$, Jun $p = 0.25967$, Jul $p = 0.28205$, Aug $p = 0.33726$, Sep $p = 0.67905$, Oct $p = 0.59882$, Nov $p = 0.56988$, Dec $p = 0.75851$, Jan $p = 0.72672$, Feb $p = 0.67319$, Mar $p = 0.81177$.

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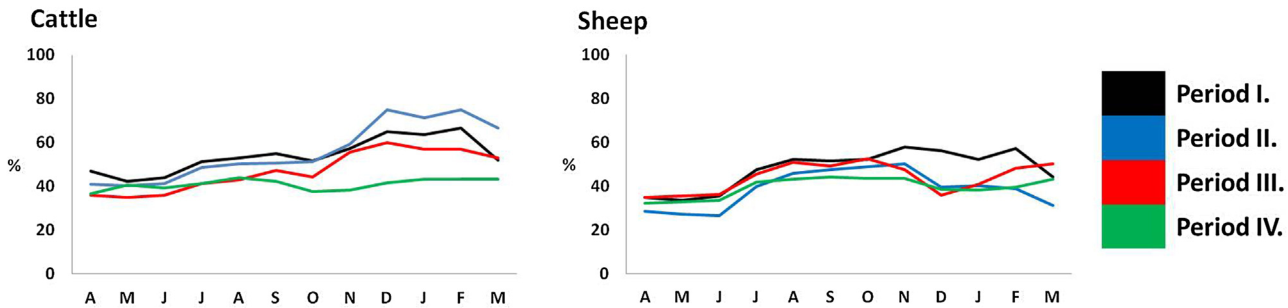

Fig. 5. Proportion of non pasture-grassland habitats (e.g. second growth on hay meadows, marshes, vegetation along linear features, forests, and stubble fields) during the year across the four periods (1940–1955, 1965–1980, 1992–2000, 2005–2014) in the 38 study sites in the Carpathian Basin.

considerably during this period (Appendix 1), so this cannot be the cause of the drastic changes in livestock numbers.

The number of cattle kept extensively declined gradually and significantly. The underlying cause might be the statutory breed change imposed on cooperatives and farmers in Period II in Hungary (Hungarian Simmental had to be replaced by Holstein Friesian, Bodó, 2001). With the spread of intensive dairy farms, village herds have disappeared in Hungary by Period IV. At the same time the number of grazing meat cattle, albeit growing, remained low. Due to a lack of studies, no information is available on which impacts various cattle breeds have on pastures of the Carpathian Basin (but cf. Rook et al., 2004). Average body weight of breeds increases, but less so of grazing cattle than of cattle kept in intensive farms. Sheep stock grew in Period II (48%), but declined again in Period III following the disintegration of cooperative farms. The declining trend slowed down in Period IV. The latter might have been caused by a growing demand for lamb from abroad and the increased rate of financial support from the state and EU (Niżnikowski et al., 2006). The avoidance of a dramatic decline might have also been caused by land managers' tendency to use this species to utilize large and extensive dry, saline, and sandy grasslands and abandoned fields, which could not be put to more intensive use.

Throughout the 1960s and 1970s, extensively grazed pigs vanished almost completely from the region studied (only surviving in Serbia; cf. Zingstra et al., 2009). Besides this, pigs are grazed at one locality in Croatia (Lonsko Polje at the Sava river—Beinlich and Poschlod, 2002; Gugič, 2009), and on an occasional basis in the mountainous areas of Romania. Outdoor pig grazing disappeared in Western Europe from the 19th century onward (Beinlich and Poschlod, 2002), except the *dehesa* and *montado* systems on the Iberian Peninsula (Toro-Mujica et al., 2015). At the same time, grazing pigs for conservation purposes is gaining ground (Beinlich and Poschlod, 2002; Putman, 2012). Extensive grazing of pigs for conservation purposes is being raised ever more often in the Carpathian Basin recently. For instance, it could be used to suppress *Bolboschoenus maritimus* in marshes, or the native breed Mangalitza could be put to masting, because of the growing market for high quality, acorn feeded Mangalitza pig (Péter Tóth, pers. comm.).

There are only limited data available in the Carpathian Basin on how Common Agricultural Policy impacted the number of livestock grazed extensively. However, CAP has been a decisive driving force behind key sectors in agriculture for the past 10 years or so, and it also has an impact on nature conservation. There are countries in Europe where CAP reduced the number and ratio of sheep, and others, where it has increased (e.g., in Spain, the number of sheep dropped to the benefit of pigs, in Greece sheep became more numerous at the cost of cattle, Toro-Mujica et al., 2015).

4.2. Changes in the annual grazing cycle of extensively grazed habitats

Cattle primarily grazed areas with longer grasses. Sheep grazed dry pastures and stubbles, and pigs were driven into marshes and forested areas. The portfolio of grazed habitats has been rearranged during the 60–70 years studied: the role of dry grasslands and wet grasslands increased somewhat, while the significance of marshes, stubble fields, vegetation along linear elements, second growth on hay meadows, wood-pastures and forests decreased. The importance of stubble fields dropped most dramatically. Several underlying causes are suspected: land owners refrain from granting permission to grazing; it has become a dangerous practice because of the use of pesticides; and also, stubble fields are usually ploughed over after harvest because the allergenic *Ambrosia artemisiifolia* must be controlled on a statutory basis. Beside industrialisation of farming practices, the reduced use of marshes may be caused by draining of wetland habitats. According to our data the role of grazing in marshes, wood-pastures and forests increased to some degree in the last decade, partly as a result of habitat reconstruction efforts for nature conservation

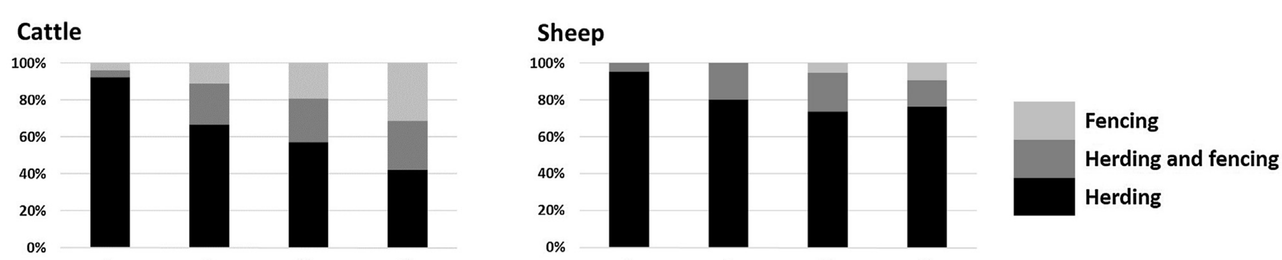

Fig. 6. The ratio of herded livestock vs. fenced livestock in the four historical periods (1940–1955, 1965–1980, 1992–2000 and 2005–2014) in the Carpathian Basin.

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purposes (Mérő et al., 2015; Mosquera-Losada et al., 2009; Putman, 2012; Varga et al., 2014).

Forests played an important role in all four periods and all three species. Grazing in forests was typical mainly in the summer (cattle) or from spring until autumn (sheep and pigs). Grazing in forests used to be an important non-timber forest product on the continent up to the period before World War II (Johann, 2007; Hartel et al., 2015). It is still an important source of biomass, even though grazing in forests is an activity which is forbidden or subject to permission throughout Europe (it is completely forbidden in Slovakia and Hungary and subject to permission in Romania, Serbia and Ukraine—(Cirelli et al., 2001).

According to our data, the frequency of grazing was reduced in the case of several habitat types over the past 60–70 years. Abandonment of grazing may be harmful from a conservation point of view in many cases, since it may result in decreasing species diversity both in pasture grasslands, and non pasture-grassland habitats, for instance due to light-demanding species being suppressed by the closing canopy (Lasanta et al., 2015; Paltto et al., 2011; Vera, 2000).

We showed that approximately half of the grazed habitats in these extensive grazing systems were not typical pasture grasslands, but some other type of habitat. A number of situations were documented as extremes (e.g. in sand regions), where grazing was restricted almost exclusively to non pasture-grassland habitats, being based mainly on stubble fields, fallow land, vegetation along linear elements and forest plantations. Grazing on these 'other' types of habitats has become more frequent mainly after July (cf. Etienne, 2005; Kerven et al., 2006), when they functioned as supplementary pastures during the late summer and early autumn drought periods. The particularities of the continental climate (such as the low precipitation in the July-August period) cause systematic shortages in forage biomass on classical pasture grasslands between July and September (Molnár, 2014). Thus, in spite of a decline in livestock the biomass of these other habitats is required. Their grazing has conservation benefits as well, because grazing may – among other effects – suppress invasive species, increase dispersal of propagules or regeneration of secondary habitats, such as old-fields (Bruun and Fritzbøger, 2002; Haraszthy, 2014; Mosquera-Losada et al., 2009; van Uytvanck and Verheyen, 2014).

4.3. Decreasing diversity of grazed habitats

Extensive grazing is a culturally and ecologically relatively conservative land-use system adapted to the needs of the animals and the conditions of the landscape (Meuret and Provenza, 2014). This might be the main reason why – in spite of dramatic social and economic changes—the number of habitat types grazed per month per site often did not drop drastically over the four periods investigated. In the case of cattle and the pigs the reduction was significant from April to October and during the first two periods, respectively, while number of habitats and sites used by grazing sheep did not change as much, and the decline was not significant. In other words, grazing of sheep was found to have the most conservative attitude, hardly changing activity.

The reduction in the numbers of habitat types grazed can be explained by reduced micromobility in the landscape. That is, livestock stays on any given pastureland longer. The underlying causes may include the ongoing slow intensification of management practices on the one hand and the busy road network on the other, which makes mobilisation of animals increasingly difficult (cf. Luick, 2008; Oteros-Rozas et al., 2013). One of the most important ecological consequences of reduced mobility is that a key vector of seed dispersal is lost, which may have serious economic, ecological and conservation implications (cf. Agnoletti, 2014; Bruun and Fritzbøger, 2002; Poschlod et al., 2002).

Unfortunately, no similar data are available on the diversity of habitat use within extensive grazing systems of other European countries, although they would be essential for the maintenance, set-up and support of sustainable grazing systems. CAP does not directly affect the diversity of grazed habitats. However, if farmers use reed beds for grazing, they do not get the same payment for these areas as for grasslands. Arable land is not allowed to be grazed in areas under agri-environmental schemes. Forest grazing – subject to national regulation – is not affected by the CAP.

4.4. Decrease of herding

Herding decreased substantially over the past 60–70 years, in particular that of cattle and pigs. Nonetheless, herding is still quite common in these post-communist East-Central European countries, especially the herding of sheep. The average age of herders, however, is increasing, while their number declines as in other European regions (Bernués et al., 2011). One consequence is that there are not enough people with the appropriate skills and competence to herd the livestock (Oteros-Rozas et al., 2013; Molnár et al., 2016). In fact, the knowledge of herding is being lost at an even more rapid rate than the number of herders, because there are many 'compelled' herders who are not qualified for the job. However, preservation of herding is an important social and conservation value because conscious herding of grazing animals contributes to the maintenance of many ecosystem services (e.g. plant diversity, agricultural productivity, mitigate climate change impacts) and to the implementation of a number of conservation measures (cf. Heikkinen et al., 2012; Meuret and Provenza, 2014; Molnár, 2014; Rodríguez-Ortega et al., 2014). CAP should motivate farmers to maintain herding by providing them financial reward and recognition for their work.

5. Conclusions

Extensive grazing systems based on traditional (landscape-) ecological knowledge are culturally and ecologically relatively conservative land-use systems. Ratios of utilization among various habitats are set by harmonising the interests of livestock and the biophysical conditions of the landscape. As a consequence the impacts of socio-economic and political changes are sometimes less explicit than in the case of intensive systems.

Due to the prevailing continental climate in the Carpathian Basin, the quantity and quality of biomass fit for grazing is subject to substantial intra- and interannual variability. Adapted to these conditions, extensive grazing systems utilised and are utilising still a number of non pasture-grassland habitat types even at the cost of violating laws and regulations presently in effect. As opposed to this, the majority of agricultural and conservation research and policies concerning the support of farming on high nature-value habitats focus on classical pasture grasslands (Chang et al., 2015; Haraszthy, 2014; Olmeda et al., 2014). EU-level (CAP) and national agricultural policies should take into account not only pasture grasslands but also the full spectrum of habitat types (e.g. forests, marshes) necessary for the effective operation of extensive grazing systems. CAP should promote grazing in forests and marshes, on stubble fields, the second growth on hay meadows and vegetation alongside linear landscape features, ensuring the necessary legislative and financial framework. These habitats are all required in order to successfully maintain sustainable extensive grazing systems (cf. Meuret and Provenza, 2014).

We argue however that conservation-oriented extensive grazing cannot be built only on traditional herder wisdom; it also needs to be adapted to the current socio-ecological environment.

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To do so we need new mechanisms to generate and transfer knowledge and experiences and an efficient cooperation between various knowledge systems–science, traditional knowledge, and conservation practice (Molnár et al., 2008; Tengö et al., 2014). The biggest opportunity may lie with cooperation among local farmers, herders and conservation rangers (Erny and Salmon, 2014; Varga et al., 2014).

Traditional extensive grazing systems have generally been operated by village communities, which organised the utilization of ecosystem services, usually within the community boundaries. For these purposes, livestock was grazed in a number of different habitats with strictly regulated but annually adapted spatial and temporal patterns (Molnár et al., 2015; Vera, 2000). Unfortunately, little is known currently about the ecological aspects of former extensive grazing systems: for instance, the spatiotemporal pattern of grazing intensity, the impact of extensive grazing on various vegetation types if grazed in a network, and the herder knowledge used in various habitats and various seasons. All these would be highly necessary in order to make extensive grazing systems built on the mosaics and networks of semi-natural habitats truly sustainable.

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Appendix 1.

Basic data of the 38 study sites: Name, total area of municipalities, proportional cover of grasslands in the 1970s, and change of the area of grasslands between 1935 and 2010. Official statistical (KSH) data were used. Legend: ≈ did not change significantly (+/− max. 20%); ↓↓ proportion of grasslands decreased significantly (by more than 50%); ↓ decreased moderately (21–49%); ↑ increased moderately (21–49%); ↑↑ increased significantly (by more than 50%).

Name of village	Total area (ha) of municipality (1970s)	Proportional cover of grasslands (1970s) (%)	Trend – change of the area of grasslands between 1935 and 2010
Balatonmagyaród	3158	29	↓↓
Csanádpalota	7763	16	≈
Dánszentmiklós	3801	8	↓↓
Dörgicse	1913	17	↓
Drégelypalánk	2221	23	↓↓
Dunasziget	3589	6	↓
Erdőbénye	4579	14	≈
Felsőszentmárton	1945	22	↓↓
Fertőrákos	3969	5	↓
Furta	4285	35	↑
Fülöpszállás	9127	39	↑↑
Gömörszőlős	855	32	↑
Hajdúsámson	6952	7	≈
Kisgyőr	7116	16	≈
Kopačevo (HR)	450	50	↓
Kunadacs	8997	30	≈
Lunca de Jos (RO)	5906	60	≈
Mezőszilas	6497	4	↓↓
Mórahalom	8314	21	≈
Muraszemenye	1550	14	↓
Nádudvar	22591	40	↓
Nagykőrös	22786	12	↓
Nuşfalău (RO)	5131	8	↑
Olaszfalu	2184	16	↑
Ordacsehi	2262	30	↓↓
Plăieşii de Jos, P. Sus, Imper (RO)	30250	35	↑↑
Pusztakovácsi	4339	11	↓
Somotor (SK)	1631	10	↑
Stana (RO)	1400	15	↑↑
Székkutas	12400	21	≈
Tahitótfalu	3921	11	↓
Tiszasüly	9182	5	↓
Vácrátót	1815	11	↓↓
Vámosatya	2429	26	≈
Višnjićevo (SRB)	6800	7	≈
Zalaszántó	3773	20	↓
Zerind (RO)	5088	23	↓
Великі Береги—Veliki Berehi (UKR)	550	25	↑

Appendix 2.

See Fig. A2.

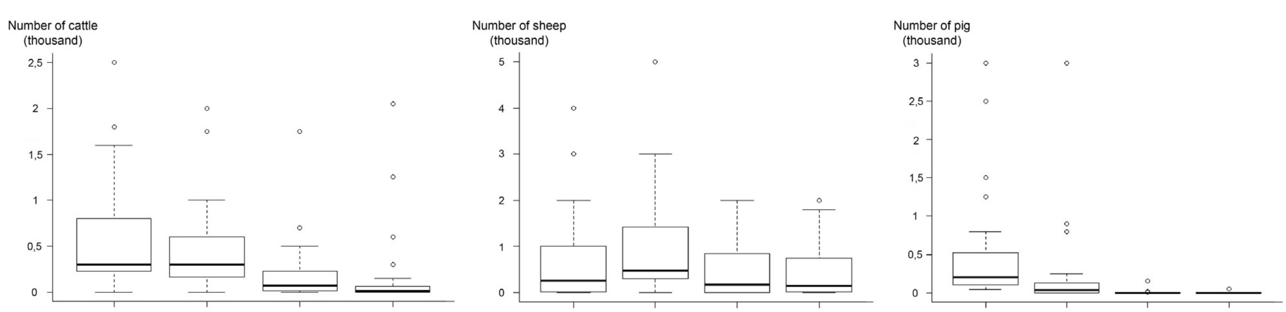

Fig. A2. Number of livestock turned out to pasture in the 38 study sites investigated during the four periods (1940–1955, 1965–1980, 1992–2000, and 2005–2014). Cattle p = 0.000000109, H: 35.11; sheep p = 0.07851, H: 6.744; pigs p = 2,07E−17, H: 64.3.

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Appendix 3.

See Fig. A3.

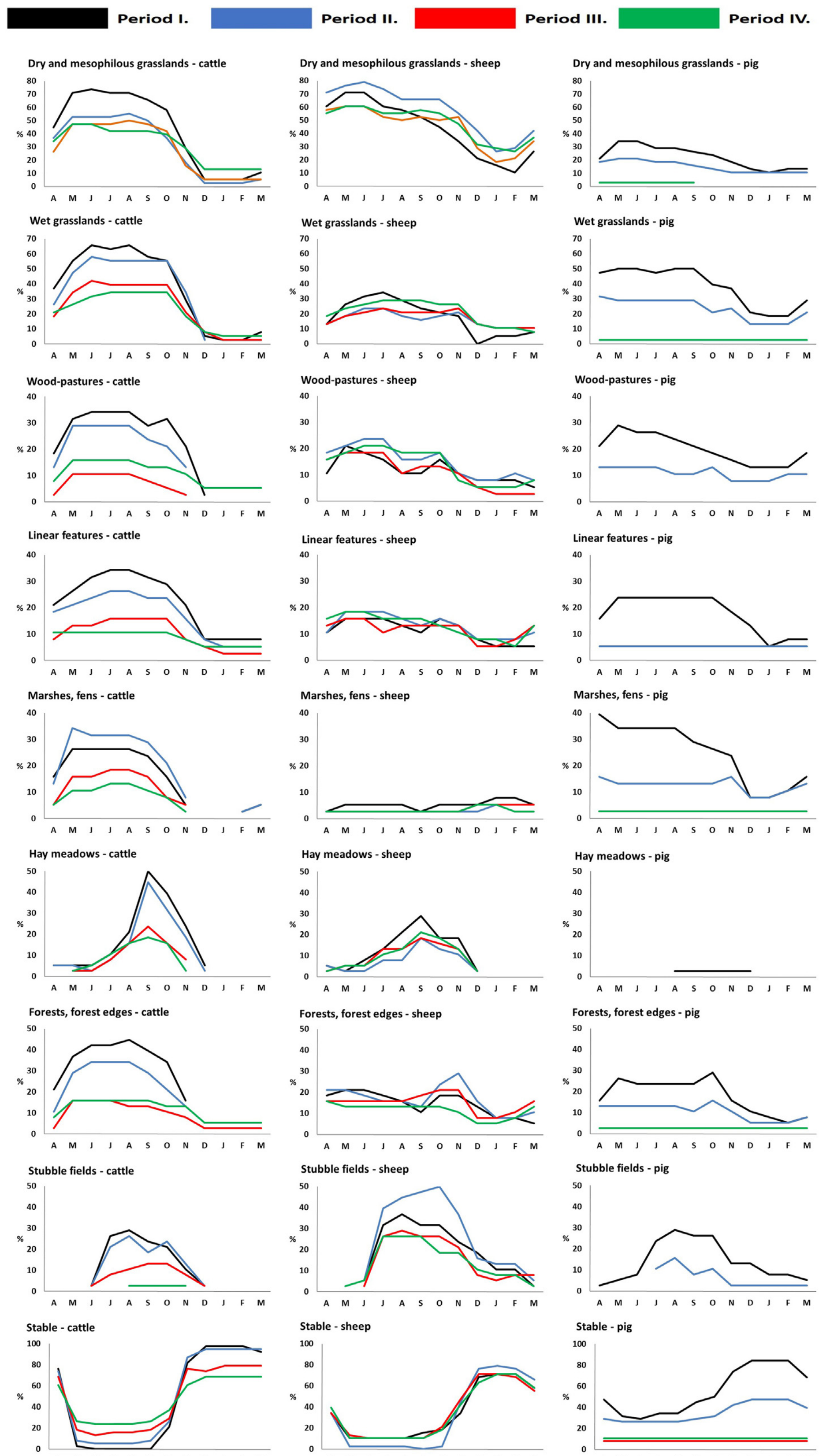

Fig. A3. The percentage of different habitat types mentioned in the 38 study sites in the Carpathian Basin, during the annual cycle in the four historical periods studied (1940–1955, 1965–1980, 1992–2000 and 2005–2014). For the annual cycle the most frequently mentioned initial month of the grazing season (April) was included in the first column.

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