Grasslands in the UNESCO-MAB Biosphere Reserve East Carpathians (Poland, Slovakia,and Ukraine): Influences of Land Use and Management Changes

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Abstract

Grasslands in the Biosphere Reserve East Carpathians are of cultural-historical as well as of scientific and nature conservation importance. They have a high biodiversity, are rich on endangered and rare species as well as east-carpathian species with occurrence on the west boundary of their area of distribution. During the last 25 years large changes occurred in the mode of grassland management in the Biosphere Reserve. Grasslands are endangered by degradation and retreat, and extinction, respectively. Permanent monitoring plots were established, covering all endangered meadow com-munities and 75 per cent of grassland and wetland plant species, known from the Slovak part of the Biosphere Reserve. Species composition and abundance in relationship with mode of management is recorded each year. First results show significant changes in species abundance as a result of different types of management.

Construction of the water reservoir "Starina" in 1987 represented important impulse for starting of the large-scale changes of land-use in part of the BR East Carpathians. All villages in the reservoir watershed were evacuated, grassland, fields, orchards, and gardens were abandoned. Data on vegetation structure, soils and geomorphology in the upper part of the Cirocha river watershed were collected in 1999. After their completion by further data, especially concerning land-use history, they can serve as a basic material for monitoring of non-forest vegetation changes and for identification of the most important sites for grasslands biodiversity protection.

1. Introduction

The Biosphere Reserve East Carpathians is the first trilateral Biosphere Reserve in the World - it lies on the territory of Poland, Ukraine, and Slovakia. Grasslands form an important vegetation type of the Bukovské Vrchy Mts. in the Slovak part of the Biosphere Reserve (BR) East Carpathians. Grasslands in this area had overcome several hundred years long evolution and they are a valuable document of traditional methods of landscape use. They are of cultural-historical as well as of scientific importance. Many endangered and rare species are found in these communities.

In the Biosphere Reserve East Carpathians, similarly as in other mountain areas of Slovakia, during the last 25 years large changes were carried out in the way of the grassland management. These changes are often so extensive, that they lead to irreversible changes in the species composition of grasslands: species reduction or also grassland extinction by afforestation with spontaneous succession.

Two interconnected projects, performed by a team of scientists from the Institute of Landscape Ecology SAS are presented in this paper:

A. Monitoring of grasslands on permanent plots.

B. Research of vegetation succession on abandoned area in "Starina" reservoir watershed

2. Monitoring of grasslands on permanent plots

The aim of this project is to find mechanisms of conservation, respectivelly restitution the species composition of meadows and pastures of this area. We established a set of permanent plots, which cover all endangered grassland communities and more than 75 per cent of species known from the Slovak part of the BR. They can serve as a representative network for monitoring of grasslands in the BR.

A good knowledge of meadows in the whole region is necessary for right selection of monitoring plots. My colleague Dr.Ruzicková carried out a geobotanical survey of meadows in Bukovské Vrchy Mts. The results of the survey were completed by published data; more than 200 phytosociological records were obtained in that way. These data allowed us to make a synopsis of meadows communities in the area (*Table1*) and to evaluate their endangering.

The meadows of Bukovské Vrchy Mts. can be divided into two large groups having not only different vegetation but also requiring different approaches to their biodiversity protection, i.e. mountain "poloniny" grasslands and grasslands of lower positions.

Poloniny meadows occupy the ridges of the East Carpathians in altitudes of about 1,000 m and above. The traditional way of farming consisted of alternate mowing and pasturing (one year mowing, the next year pasturing). It enabled breeding of farm animals, although neither hay nor grass were of the same quality as in lower sites. They were pastured by sheep, later by oxen and horses, and at last they remain quite abandoned. "Poloniny" are important especially for the presence of the East Carpathians species, which often have their western boundary there. Some of them are bounded on ridge areas exclusively, they cannot be found on the lower situated grasslands (*Viola dacica, Campanula abietina, Melampyrum herbichii, Senecio papposus, Tithymalus sojakii, Dianthus compactus* etc.). The preserving of species diversity of mountain grasslands is methodologically and practically a complex problem. Usually it is not a question of preserving the grassland in

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their original species composition, but of their restoration.

Semi-natural grasslands of lower position occur mainly in the areas which were not good for arable land. They were either too wet, too dry, sloppy with shallow or the soils too acid. The meadows and pastures of these sites have often very specific species composition. They are single- or double-mowing meadows or extensive pastures. Today many sites are abandoned. In the group of semi-natural meadows of lower position there are moor and peaty meadows, wet and mesophilous meadows, sub-xerophilous meadows and pastures and acid pastures.

We selected 14 plots for monitoring, using following criteria:

- first of all grassland types which are in the danger of their extinction were selected;
- plots, which were mowed in the program of care of the BR were preferred. They are mainly small scale protected areas;
- it seemed to be necessary also to investigate the influence of mowing on ruderalized areas, especially around the evacuated villages;
- for monitoring a plot was selected that is one of the foci of spreading of the dangerous neophyte *Heracleum mantegazzianum;*
- time factor of the research team that would be able to ensure the annual investigation of permanent plots was taken into consideration.

We selected and established permanent plots in these sites:

- **Stinská** ("poloniny"), altitude 1,010 m. Locality managed by organs of nature protection. Special richness of species characteristic for the East Carpathians.
- **Rovnálúka** ("poloniny"), altitude 1,130 m. For a long time uncut meadows with the dominance of *Calamagrostis arundinacea*. Examination of backwards succession after cutting renewal.
- **Durkovec** ("poloniny"), altitude 1,100 m. The mowing was recently renewed on this plot. Examination of the come back of East Carpathians species into stands.

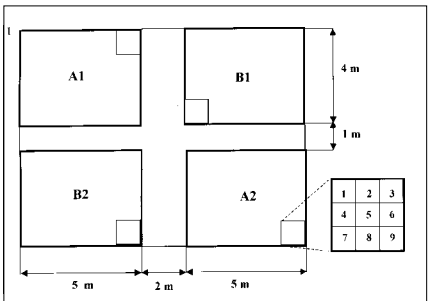
Table 1: **The list of grassland communities of the East Carpathians' Biosphere Reserve (Sources: Hadac, Andersová, Klescht, 1988; Blazková, 1991; Ruzicková 1994, 1995.)**

MOUNTAIN „POLONINY" GRASSLANDS	
Calamagrostion arundinacae (Luquet 1926) Jeník 1961	Plot No.
Achilleo strictae-Calamagrostietum arundinaceae Hadac et al. 1988	2
Acetoso carpaticae-Deschamsietum caespitosae Hadac et al. 1988	
Gentiano asclepiadee-Acetosetum carpaticae Hadac et al. 1988	
Hyperico-Luzuletum luzuloides Hadac et al. 1988	
Nardo-Agrostion tenuis Sillinger 1933	
Campanulo abietinae-Nardetum (Palczinski 1962) Hadac et al. 1988	1,3,9
Betonico-Agrostietum tenuis Blazková 1991	5
SEMI-NATURAL GRASSLANDS OF LOWER POSITION	
Caricion lasiocarpae Vanden Berghen in Lebr. 1949	
Carici flavae-Eriophoretum latifolii Soó 1944	13
Caricion fuscae Koch. em. Klika 1934	
Caricetum goodenowii Braun 1915	
Calthion Tx. 1937 em. Bal.-Tul. 1978	
Cirsietum rivularis Nowinski 1927	4, 12
Scirpetum silvatici Eggler 1933	
Lythro-Filipenduletum ulmariae Hadac mscr.	
Junco-Deschampsietum caespitosae Špániková 1982	14
Polygalo-Cynosurenion Jurko 1974	
Anthoxantho-Agrostietum tenuis Sillinger 1933 *typicum* Jurko 1969	
nardetosum Jurko 1971	
Festuco-Cynosuretum cristati R.Tx. in Bükker 1942	
Arrhenatherion W. Koch 1926	
Arrhenatheretum elatioris Braun 1915	11
Poo-Trisetetum flavescentis Knapp 1951	
Cirsio-Brachypodion pinnati Klika et Hadac 1944	
Origano-Brachypodietum pinnati Medw.-Kornas et Kornas 1962	
Prunello laciniatae-Dorycnietum herbacei Hadac mscr.	10

- **Ruskésedlo - Rypy** („poloniny"), altitude 950 m. The meadows in the monitoring plot were utilised recently. High species diversity.
- **Zvala**, altitude 458 m. The spreading of the dangerous neophyte *Heracleum mantegazzianum* and the possibilities of its blocking are monitored in the plot.
- **Velká Polana**, altitude 416 m. Ruderal stands with *Chaerophyllum aromaticum*, a spontaneous succession in the place of the extinct village. Examination of possible changes due to cutting on grass stands.
- **Brook Ulicka**, altitude 325 m. Monitoring of the changes of hygrophilous ruderal stands on meadows by regular cutting.
- **Plaša** ("poloniny"), altitude 1,010 m. Examination of backwards succession of stands in a medium advanced stage after renewal of cut.
- **Gazdorán**, altitude 380 m. Subxerophilous pastures rich in species, fallow land growing in by shrubs. On the area we investigate the influence of mowing and burning off in order to preserve the species composition.
- **Bzana**, altitude 380 m. Thermophilous tall oat-grass meadows, the richest species composition of the investigated area. They are mown only occasionally. By the monitoring the frequency of mowing necessary to preserve species diversity will be determined.
- **Kolbasov**, altitude 310 m. Wet meadows typical for the area of the Biosphere Reserve. They are mown only occasionally.
- **Ruské**, altitude 650 m. Moor meadows. There the influence of mowing frequency on spreading of tree species is investigated.
- **Starina**, altitude 320 m. Disused acid pastures with extreme dynamics of soil moisture, occurrence of endangered species.

Methodology

The basic method used for monitoring of the vegetation changes are repeated records in permanent plots. We used the combination of small squares (1 square meter, divided into 9 smaller squares) suitable for the investigation of plant populations with large squares that cor-



Legend: A - unmowed plots, B - mowed plots

Figure 1: **Typical arrangement of the permanent plot**

respond to minimal area of meadow plant association (20 sq.m). Within the frame of the permanent plot there are 4 large squares (2+2, 2 are mown and 2 unmown), the number of small squares is dependent on the needs and time factor. Typical arrangement of permanent plot shows *Figure 1*. Species composition and species cover are recorded each year. The scale used in larger squares has its origin in the Braun-Blanquet combined scale:

1 - one sample

2 - few samples, little cover

3 - few samples, cover 1%-5 %

4 - many individuals, cover 1%-5 %

5 - cover 6%-12,5 %

6 - cover 12,6%-25 %

7 - cover 26%-50 %

8 - cover 51%-75 %

9 - cover 76%-100 %

In small squares species composition and abundance is recorded, used simple scale:

+ - small number of individuals, little cover

1 - cover 0-25 %

2 - cover 26%-50 %

3 - cover 51%-100 %

Results

The project was a part of the Global Facility Programme in Slovakia in 1994-1996. Then, in 1997 and 1998 had none financial coverage and only collection of data was made. Data elaboration from whole period of monitoring will be done this autumn and winter, following results are preliminary.

We registered 304 plant taxa in monitoring plots, which represent 32 per cent of all flowering plants, known from the Slovak part of the Biosphere Reserve, and 7 per cent of grassland and wetland species of this territory.

Relatively high differences in species diversity are found among individual plots. Species numbers per site vary from 28 on poor abandoned poloniny mountain meadow (plot no.2) to 100 species on thermophilous meadows (plot no.11) and grassland, located in the former village (plot no.6).

It is interesting to note that species presence on individual plots did not significantly chang during 5 and 6 years, respectively. Changes were in quantity of individual species. We recorded relatively high decrease of density of individuals on mowing plots. Gaps in the community occurred. This is probably a result of biomass export from the community. Soils in the territory are relatively poor on nutrients and grasslands need fertilisation, which was traditionally done by grazing of domestic animals.

One monitoring plot was chosen for trying to restore species composition on the ”poloniny” mountain meadow, overgrowing by large grass Calamagrostis arundinacea and by Vaccinium myrtillus. Six years of mowing resulted in a decrease of coverage and of vitality of these species. Relatively large gaps appeared, but they were not colonised. No new species were recorded in these gaps. The reasons could be a high amount of dead underground biomass or changes in soil conditions

On the basis of our own experience and literature data we can summarise the principles of management for individual grassland types as follows:

Poloniny mountain meadows

It is necessary to move strongly changed meadows (advanced succession) each year in first 2-3 years, followed by removing of biomass from the site. In the following years it is possible to use mowing only once in 2-3 years. Mowing time and frequency will be specified on the basis of monitoring results.

Dry and semi-dry grasslands (Cirsio-Brachypodion, Arrhenatherion)

Species composition of these communities is changing very slowly as a result of abandoning. Old fallow meadows should be mowed twice in first year, mowed matter must be removed from community. After that it is possible to mow once in 2-3 years and mowed matter can remain in the site, in the case of mowing early in the year (June). This way of management can be combined with burning.

Wet meadows (Calthion, Molinion)

It is necessary to mow old abandoned grasslands twice in a year in the first period (2-3 years) and mowed matter must be removed from the site. In the next period mowing once in 2 years is sufficient. Time of mowing is important for survival and vitality of some species. Impact of mowing time on species composition must be studied on permanent monitoring plots.

Peat-meadows (Caricion lasiocarpae, Caricion fuscae)

These communities must be mowed once in 2-3 years in winter for conserving existing species structure. Young shrubs and trees are removed by mowing too.

Poor mountain meadows, Nardus-communities of lower positions (Polygalo-Cynosurenion)

It is necessary to mow these communities minimally once in 2-3 years and matter remove from community as a prevention against accumulation of biomass and eutrophisation of stand. Pasturing is possible occasionally.

The continuously used grasslands are more effective for preserving biodiversity (and also costs are lower) than the regeneration of old fallow meadows. It is necessary to take into account this fact and to prefer management of meadows and pastures traditionally used to the present time.

3. Vegetation succession research on abandoned area in ”Starina” reservoir watershed

The water reservoir ”Starina” was constructed on the territory of the Biosphere Reserve 12 years ago. Because of utilisation of this reservoir as source of drinking water, all (7) villages in the watershed were evacuated. Management of meadows, pastures, fields, and gardens was ceased, succession changes of vegetation on abandonment plots star-

ted. These changes were not recorded and their influence on biodiversity of the Biosphere Reserve was not evaluated. This was the reason for prepearing a project, with the aim to understand changes of vegetation structure after the stopping of grassland management and to propose sites important for Biosphere Reserve biodiversity protection. This project started in 1999 and is supported by Man and Biosphere Programme through MAB 1998 Young Scientist Award.

We adopted two approaches for data sampling sites location:

- in the lower part of the area where non-forest landscape is prevailing, sampling plots were arranged in regular network every 500 m;
- at higher altitudes where forests dominate, sampling plots were located on individual, mainly isolated, grasslands.

Data were collected during summer 1999 on 113 sampling plots. The plots were marked in the field for repeating of data sampling in future. Soil and vegetation data were sampled on each plot. Soil profiles were described, using standard pedological methods. Phytosociological releveés were made on standard plots of 10 m x 10 m using methods of the Braun-Blanquet school. The geomorphology of individual plots as well as the entire watershed was recorded too. Information on selected animals groups were sampled on chosen plots. Soil traps for invertebrates were installed in 10 plots, 8 of them were arranged in the transect. Material from these traps was collected every month, starting in May. Spiders, beetles, and some other invertebrate groups are to be studied using this material. Spiders from vegetation were collected from a further 40 of the above mentioned sampling plots using entomological nets.

Field data will be completed by data from other sources. Land use history of individual plots can be important for type and rate of successional processes. Information about land use history will be gathered from historical maps (1864, 1957) and aerial photos (1949, 1982, 1987, 1998). Published thematic maps represent other types of data source. We will use geological and geomorphological maps. Some data about relief forms will be extracted from published standard topographical maps.

Results of field research and data collected from other sources will be analyzed using multivariate methods as well as GIS techniques. We will look for regularities in the rate and direction of successional changes and their connections with other attributes of the landscape. Identification of sites important for biodiversity of the Biosphere Reserve represents a first output of the project. Sites will be recommended for special attention by the Biosphere Reserve Authorities and the realisation of necessary management measures will be proposed.

4. Conclusion

Grassland research in the East Carpathians' Biosphere Reserve is important from several points of view. Firstly, it documents the structure and biodiversity of seminatural meadows of the area which are managed in the traditional way. Secondly, it can help to find a way for their management in the near future that will maintain their structure with acceptable financial costs. Thirdly, it helps to identify sites which need special attention and management because of their importance for Biosphere Reserve biodiversity.

Grassland research in BR East Carpathians is in harmony with some current international activities. Set of grassland monitoring plots fulfil requirements for their inclusion into the international network of monitoring plots NoLIMITS. During the workshop on International Long-Term Ecological Research, held in July 1999 in Budapest, the Biosphere Reserve East Carpathian was recognised as a candidate for ILTER. Both projects presented here can in future form a part of integrated research in the East Carpathians' Biosphere Reserve.

References

Blazková, D., 1988: The succession of the *Nardus*-communities during overgrowing by shrubs and trees (in Czech). *Preslia*, Praha, *60*, p. 127-132.

Blazková, D., 1991: Succession on the unmowed meadows in the Nature Reserve Stuzica (Bukovské vrchy Mts.) (in Czech). *Preslia*, Praha, *63*, p. 177-188.

Borgfräfe, K., 1995: Restitution von Grünland-Gesellschaften. *Naturschutz und Landschaftsplanung*, *27*, p. 19-24.

Dykijová, D. et al., 1989: *Methods of ecosystems studies* (in Czech). Academia, Praha.

Goldsmith, B., 1991: *Monitoring for conservation and ecology*. Chapman and Hall, London.

Hadac, E., Andersová, J., Klescht, V., 1988: Vegetation of the "poloniny" in the Bukovské vrchy Mts. (NE Slovakia) (in Czech). *Preslia*, Praha, *60*, p. 321-338.

Hadac, E., Terray, J. et al., 1991: *Flora of the Bukovské vrchy Mts*. (in Slovak). Príroda, Bratislava, 182 pp.

Herben, T., Krahulec, F., Hadincová, V., Kovárová, M., 1993: Smallscale spatial dynamics of plant species in a grassland community over six years. *Journal of Vegetation Science*, Uppsala, *4*, p. 171-178.

Maglocký, Š., Feráková, V., 1993: Red list of ferns and flowering plants (*Pteridophyta* and *Spermatophyta*) of the flora of Slovakia. *Biológia* (Bratislava), *48*, 4, p. 361-385.

Mucina, L., Maglocký, Š., 1985: A list of vegetation units of Slovakia. Doc. phytosoc. N.S., *Camerino*, *9*, p. 175-220.

Prach, K., 1994: Monitoring of the vegetation changes. Methods and principles (in Czech). Ceský ústav ochrany prírody, Praha, 69 pp.

Quinger, B., 1994: Methoden und Erfarungen bei Dauerflächenbeobachtung von Magerrasen-Renaturierungsflächen in bayerischen Alpenvorland. *Schriftenreihe für Landschaftspflege und Naturschutz*, *40*, p. 113-123.

Ruzicková, H. et al., 1995: Management of the meadows of the Biosphere reserve Východné Karpaty (in Slovak). Report of the GEF biodiversity protection project. Ministry of Environment SR, Bratislava.

Weber, D., Hintermann, S., Fiechter, S., Bühler, Ch., 1995: Optimieren der Vegetationsbeobachtung für die Erfolgskontrolle in Naturschutzgebieten. *Naturschutz und Landschaftsplanung*, *27*, p. 45-51.