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Sustainable Management Recommendations to Reduce the Loss of Agricultural Biodiversity in the Mountain Regions of NE Slovakia

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With well-preserved nature and a geographical location at the border of the West Carpathian and the East Carpathian biogeographical regions, the Poloniny National Park (NP) ranks among the most valuable areas for biodiversity in Slovakia. The territory is a typical region with mountain agriculture (12% of the study area), where grasslands dominate in an agricultural landscape. Grasslands became the basis of traditional farming many years ago, when extensive agriculture was mainly focused on hay production and grazing, representing the lifestyle of the local people. This kind of sensitive human management contributed to the maintenance of valuable grassland communities and their rich biodiversity. In particular, the mountain poloniny *meadows are characterized by large numbers of rare and threatened East Carpathian species. Intensification of agriculture from the 1970s and its decline after the massive political and socioeconomic changes of 1989 have caused substantial damage to species-rich grasslands in the region. Implementation of the Common Agricultural Policy (CAP) is now providing greater financial support to restart agricultural activities in the Poloniny National Park. Nonetheless, there is still concern about maintenance of the biodiversity of mountain grassland communities, where access is limited, and which require specific extensive management. This paper aims to identify the driving forces of agrobiodiversity change and the implications for habitats and species, and to predict possible future trends in the region. Emerging from the assessment of these trends, several recommendations are made regarding appropriate management measures for the maintenance of agrobiodiversity together with sustainable development in Poloniny National Park.*

Keywords: *Agricultural decline; biodiversity; mountain meadows; sustainable development; future trends; Carpathians; Common Agricultural Policy (CAP); Slovakia.*

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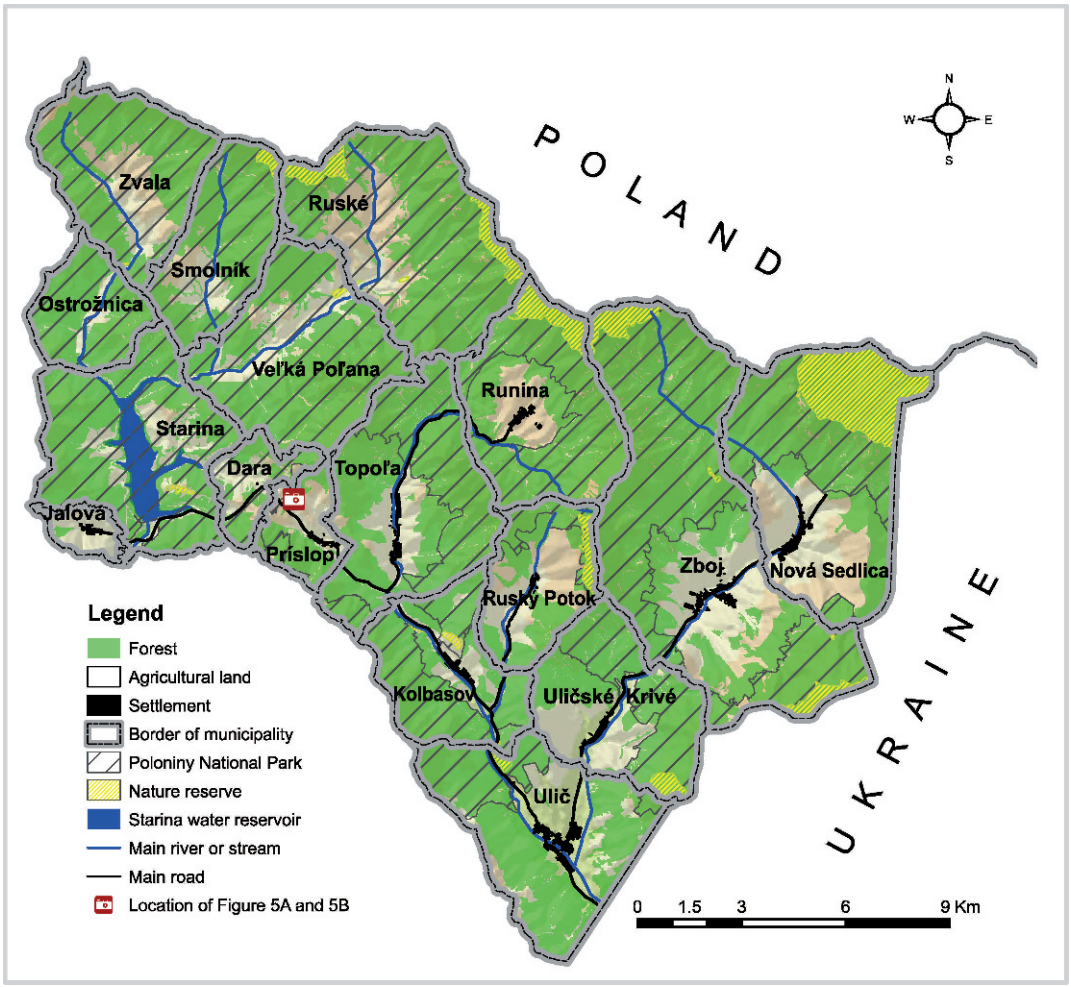
Introduction

The mountain regions of Europe have a high proportion of natural or seminatural areas, in which extensive agricultural landscapes are significant. However, socioeconomic development and, in particular, recent changes in traditional land use, such as abandonment of extensive farming and livestock grazing, are significantly influencing agrobiodiversity (variety and variability of animals, plants, and microorganisms that are important to food and agriculture, which result from the interaction among the environment, genetic resources, and the management systems and practices used by people; FAO 1999). Land abandonment, marginalization, and the collapse of traditional farming systems in the uplands have been going on for decades in many European countries (eg Garcia-Ruiz et al 1996; Caraveli 2000; MacDonald 2000). The consequent effects are seen in changes in land-use patterns and decreased landscape diversity, in particular, due to spontaneous forest regeneration of formerly open-land habitats and transformation of seminatural grasslands into woodlands. The serious implications of such changes in biodiversity are widely recognized in mountain areas of Europe (Olsson et al 2000; Dirnböck et al 2003; Bolliger et al 2007).

Extensive grasslands belong to the most threatened habitat types in Slovakia, especially as a result of abandonment; many habitats of European importance are also seriously threatened (habitat types listed in the Habitat Directive Annex I). According to recent research, only 300,000 ha of 845,600 ha of grasslands in Slovakia are now considered to be of nature conservation value (EEA 2004).

The present paper reports results of recent interdisciplinary projects dealing with changes in agricultural biodiversity in Slovakia, and especially the Fifth European Union Framework Programme (EU FP5) BioScene project, which investigated agriculture as a main driver of change in Europe's mountain areas and evaluated its past, current, and future status and impacts on biodiversity (Mitchley 2005; Mitchley et al 2006). The

FIGURE 1 Location and demarcation of the study area by administrative units (municipalities). Latitude and longitude coordinates: 49°04′22″N, 22°24′15″E (approximate middle point of the study area). (Map by Peter Bezák)



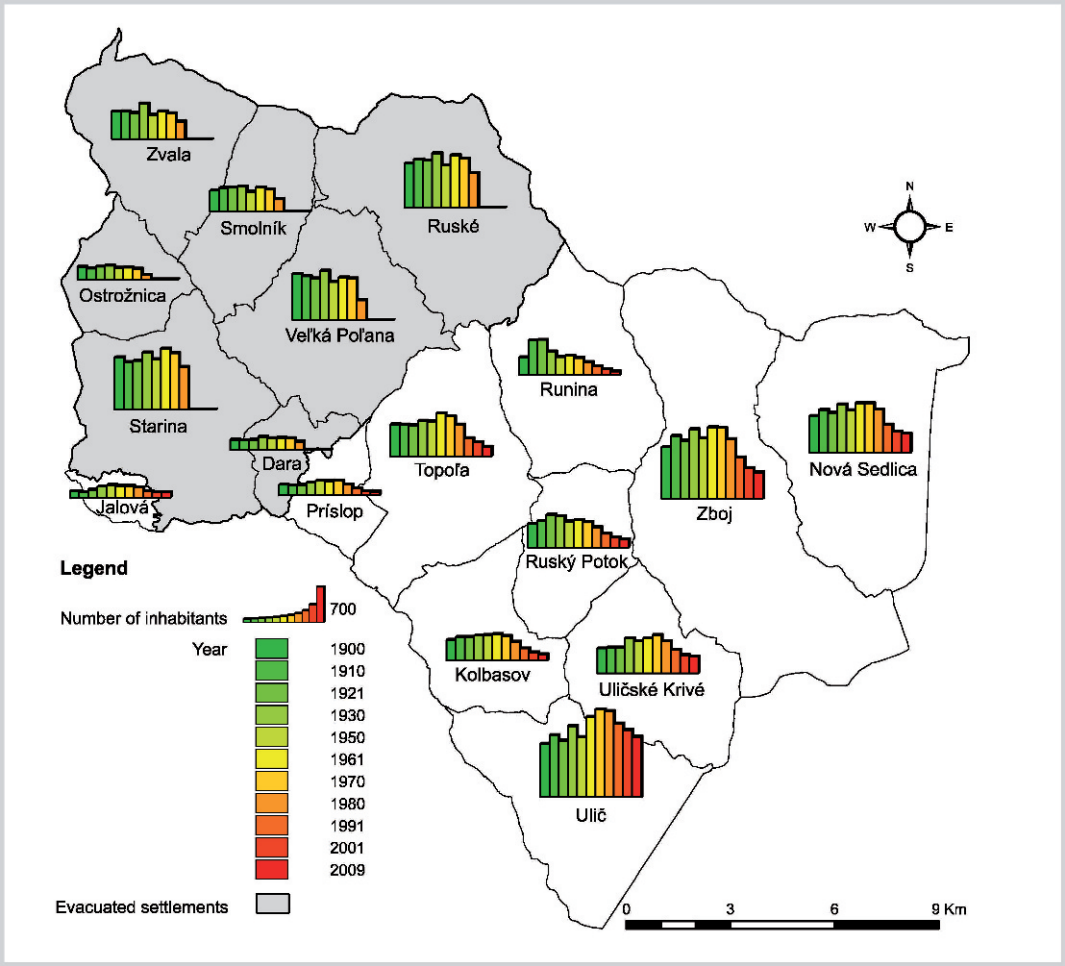
overall aim is to provide recommendations for appropriate management measures for the maintenance of biodiversity, together with sustainable development of the mountain region in Slovakia. The interdisciplinary approach includes identification of driving forces of agrobiodiversity change over the last 60 years, the implications for habitats and species, and the prediction of possible future trends. Finally, the paper points out some of the growing conflicts of interest between implementation of the Common Agricultural Policy (CAP) and biodiversity targets.

The study area

The study area is located in the northeast corner of Slovakia on the border with Poland and the Ukraine, in the Bukovské vrchy Mountains, which are part of the Carpathian mountain range. The area has a hilly to upland character, with an altitudinal range of 240–1221 m. The landscape is dominated by forests with (predominantly grassland) agriculture taking place in a mountainous setting (Figure 1). The area was designated as the Poloniny National Park (NP) in 1997, in recognition of the high nature conservation value of the region as a whole. The whole study area lies in the East Carpathians Biosphere Reserve designated by the United Nations Educational, Scientific and Cultural Organization (UNESCO) Man and Biosphere (MAB) program. It has great taxonomic diversity: 2769 plant species (1010 of which are vascular plants), 4488 invertebrate species, and 314 vertebrate species, including a high proportion of threatened and rare species (including large carnivores; data from 2004).

The study area belongs to Snina district within the Prešov region and is demarcated by a number of administrative boundaries (Figure 1). The size of the study

FIGURE 2 Population change in the study area, 1900–2009. (Map by Peter Bezák)



area is 34,191 ha, with a population of 2536 people in 2009. The population showed the highest increase in the 1930s and 1960s, reaching almost 10,000 inhabitants. Since then, the population has continued to decline rapidly (Figure 2). The establishment of a water reservoir in the area, Starina, was a significant factor contributing to population decline, due to the complete removal of settlements of seven municipalities in the 1980s from the higher part of the catchment. The population density of the populated territory ranges from 4.1 to 43.2 inhabitants per square kilometer, which is far below the Slovak average (110 per km^2).

Methods

Due to the interdisciplinary focus of the research, several methods of ecological, socioeconomic, and geographic information systems (GIS) analysis were employed to produce integrated results. Aerial photographs from 1949, 1987 (both panchromatic), and 2003 (true colors) were analyzed to reveal changes in land cover, and, after orthorectification, the data were subject to manual interpretation using 25 categories of land cover. Further data processing and statistics were completed using GIS ArcView software.

Data on socioeconomic trends were collected from local censuses, statistics, historical photographs and books, brochures, maps, and legislative tools. In addition, qualitative research methods, including semistructured interviews, questionnaires, rating exercises, and focus groups with stakeholders, were deployed to investigate local understanding of past and future trajectories of landscape change. Semistructured interviews with more than 30 local stakeholders were carried out as a first step, focusing on people's perceptions of landscape and biodiversity changes due to agricultural decline in recent decades, and their expectations and wishes regarding future landscape development. Subsequently, 12 stakeholders were selected as members of the Stakeholder Panel for subsequent discussions, which focused on the

exploration of narratives of landscape change, assessments of predicted livelihood and biodiversity impacts of future scenarios (presented later herein), and feedback on proposed sustainability objectives (ecological, social, and economic) in the study area. The purpose of involving stakeholders in the research was to make sure that the views of the experts doing research are complemented by the opinions and values of members of the stakeholder panel and the wider public, and to raise awareness of issues relating to conservation and biodiversity.

For the biodiversity study, we selected priority species based on 3 criteria: (1) species positively or negatively reacting to intensification and abandonment; (2) indicator species of threatened plant communities; and (3) threatened and rare species. We used data and experience obtained in previous research in the region using both phytosociological and permanent plot approaches (Ružičková et al 2001), as well as data collected by the Poloniny NP administration.

Finally, the interdisciplinary research included a scenario approach wherein three contrasting BioScene scenarios were evaluated: Business As Usual (BAU: assumes that current trends continue with support payments for agriculture), Agricultural Liberalization (LIB: assumes withdrawal of all support to the agriculture sector and removal of export aids), and Managed Change for Biodiversity (MCB: assumes withdrawal of agricultural support as in LIB, but here these funds are diverted to public and private nature conservation programs designed to halt biodiversity loss and to encourage landscape management to meet biodiversity objectives) (Mitchley 2005). The scenario approach used a range of techniques to examine the implications for biodiversity, landscape, and livelihoods, including results of partial single-discipline analysis, expert judgments of multidisciplinary country teams, and stakeholder input in the form of feedback. In particular, an integrated sustainability assessment included:

- sustainability assessment matrix-based evaluation (Sheate et al 2008);
- assessment of the impacts on priority habitats and species (Bolliger at al 2007; Haddock et al 2007);
- stakeholders' perceptions and assessments of landscape changes (Soliva et al 2008); and
- cost estimates: the amount of agricultural support to the study area.

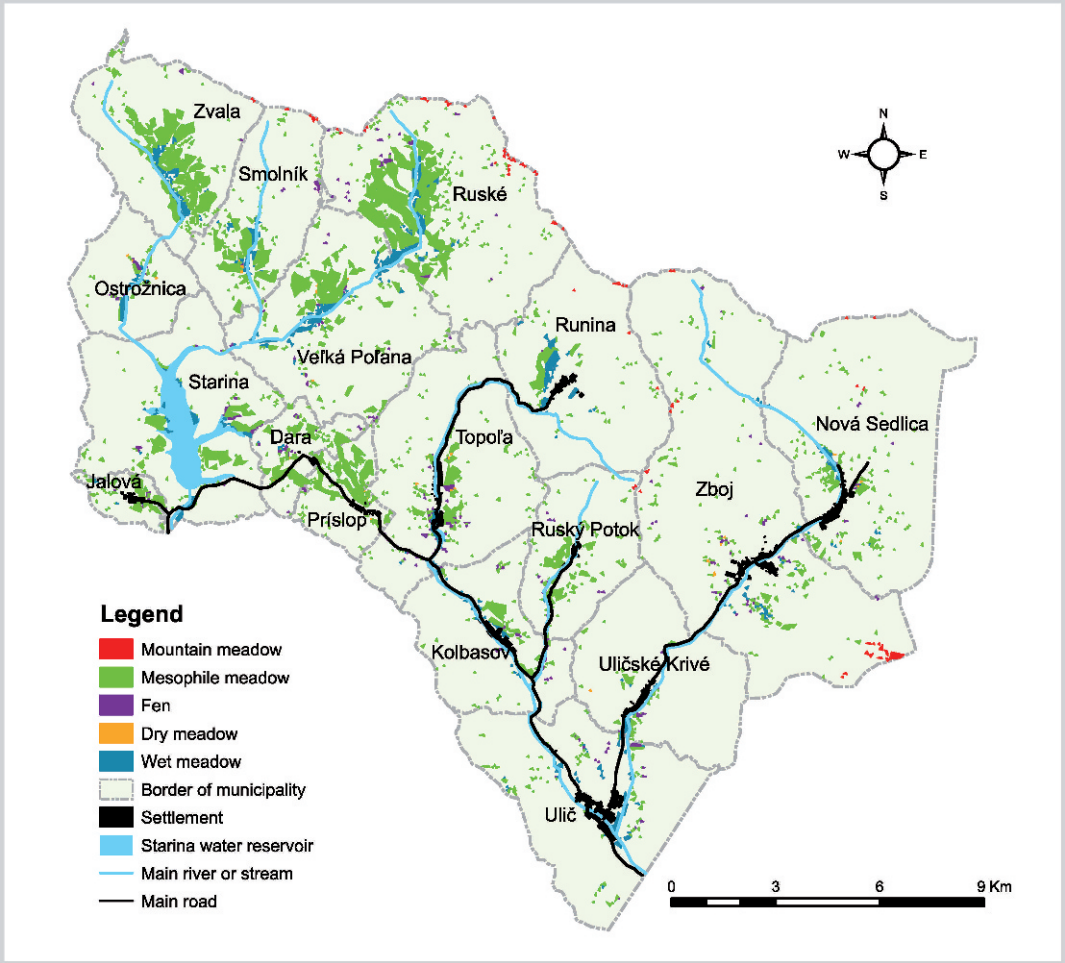
Key driving forces of change in agriculture during the last 60 years

Agricultural activities in the area of Poloniny NP are influenced by unfavorable local climatic conditions, less productive soils, and dissected relief. Therefore, extensive agriculture mainly consisted of hay production and grazing as the main activities until agriculture was collectivized. In the beginning of the 1970s, two large state farms were established: a forest-agricultural enterprise in Ulič (LPM Ulič) and a state agricultural farm in Stakčín (privatized in 1995, with the later name Agrifop). Agricultural management experienced rapid change as the small strips of fields around the villages were amalgamated into large blocks of intensive arable land, and similarly large areas of intensive hay meadows were established in the valley basins, where most of the agricultural production was concentrated. On the other hand, remote patches of seminatural grasslands were no longer farmed due to difficult access to remote localities and the fact that agriculture was primarily focused on intensification and productivity increase (eg less diverse farming oriented toward increasing yields of specific monoculture crops, applying fertilizers and pesticides, intensifying grasslands, using concentrated grazing, and converting grasslands to arable land; Orsillo 2008).

Notwithstanding the intensification of agriculture in the region, there were a few other driving forces that retarded negative impacts on the environment (Bezák and Petrovič 2006). A long tradition of nature conservation in the study area, the construction of the Starina water reservoir in the western part of the study area, and the region's marginal location did not allow implementation of the full range of radical agricultural measures seen in other regions in Slovakia. However, the first nature protection actions were focused on primeval forests (Vološčuk 1988). The more complete protection of the landscape dates from 1977, when the Eastern Carpathians Landscape Protected Area was established, and a bit later the Poloniny NP was designated. Seven villages were evacuated in the period 1980–1986 because of the need to protect the hygienic quality of water in the Starina reservoir, and the consequent elimination of agricultural activities has led to conversion of arable land close to the water reservoir into grasslands, but also to abandonment of larger areas of agricultural land and overgrowth of scrub (Halada et al 2002).

Steps toward environmentally friendly farming have been taken since the socioeconomic and political changes in Slovakia in the 1990s, when the system of agriculture was changed. A decline in intensive agricultural production in the first years of the new era was primarily a result of the economic crisis in Slovakia and the withdrawal of support for the farming sector. In addition, free market and new job possibilities elsewhere in the country contributed to a loss of interest in agriculture among local inhabitants, especially younger generations, and the migration of labor to other regions. As in the extensive agricultural landscapes of the uplands and highlands of other postcommunist countries (Kuemmerle et al 2008), the process of land abandonment increased and led to successional changes in vegetation and conversion of grassland to scrub and woodland.

FIGURE 3 Distribution of extensive grasslands in the study area based on habitat suitability modeling. (Map by Andrej Halabuk)



The last historical milestone of agricultural development in the study area is connected to the accession of Slovakia to the European Union (EU) in 2004. The new system of financial support for agriculture is now being implemented in Slovakia within the framework of the CAP (Ministry of Agriculture of SR 2003). The CAP is directed more toward the environmental goods that farmers provide rather than the productive functions of agriculture; this includes the maintenance of landscape values and scenery, mostly through extensive forms of agriculture (cutting and grazing of grasslands, etc).

Implications of agricultural decline for biodiversity

Major land-cover changes recorded in the study area include increase in woodland area due to grassland abandonment and the conversion of woodland/shrubs due to forest management (Olah et al 2006). Grasslands are considered a very valuable natural resource, either economically or for nature protection. For many years, traditional farming focused mainly on hay production, and grazing contributed to the maintenance of valuable grassland communities and their rich biodiversity.

At the present time, grasslands constitute about 3500 ha of the study area (about 10%), including intensive and extensive meadows. Based on our extensive research on grassland communities in the study area (eg Ružičková et al 2001; Halada et al 2002), we distinguish the following types of extensive grasslands:

- mountain *poloniny* meadows (1.61%),
- mesophile meadows (81.55%),
- fens (2.37%),
- dry meadows (2.03%), and
- wet meadows (12.43%).

The map showing the distribution of these grassland types (Figure 3) was prepared by habitat suitability modeling using 285 phytosociological records from the

study area as a background data set (Halabuk and Halada 2006). Each grassland type contains different species and contributes to the overall diversity of the region. The mountain *poloniny* meadows are characterized by large numbers of East Carpathian rare and threatened species. Dry meadows are characterized by their high species diversity (some communities containing more than 100 species), while wet meadows and fens are rare habitats containing many threatened species.

The second half of the 20th century has seen notable changes in agricultural habitats, which have been negatively affected by agricultural decline—principally lack of management. The mountain meadows or *poloniny* were the first to be abandoned; they have become dominated by tall grasses (*Calamagrostis arundinacea*, *Deschampsia cespitosa*, *Luzula luzuloides*) or small shrubs (*Vaccinium myrtillus*, *Vaccinium vitis-idaea*). The species richness of some plant communities has declined by one half (from more than 60 to less than 30 species; Ružičková et al 2001), and unique communities with East Carpathian species are disappearing. In addition, the abandoned lower altitude meadows have become overgrown with shrubs such as *Rosa canina*, *Crataegus* spp., *Rubus idaeus*, and *Corylus avellana*, and the pastures also by *Juniperus communis*. Even here, species diversity is declining, and species with high competition ability such as *Filipendula ulmaria* have started to dominate in wet grasslands.

These changes have caused the retreat of animal species adapted to managed meadows and pastures (eg *Lanius excubitor*, *Lulula arborea*), and probably also birds of prey, due to the loss of their prey area. On the other hand, abandoned grasslands can offer good habitat conditions for ecotone and woodland birds such as *Lanius collurio*, *Sylvia nisoria*, and *Crex crex*, but also for large mammals, including herbivores (eg European bison [*Bison bonasus*]) and carnivores (eg brown bear [*Ursus arctos*]). A summary of the most important species and habitats negatively affected by the agricultural decline, as well as a review of new opportunities resulting from agricultural decline, is presented in Tables 1–3. The tables include habitat types and species, as well as conservation targets derived from the results of biodiversity research and consultation with the National Park Administration.

Predicted future trends and sustainable land management recommendations

There is general agreement in the literature that agricultural policy reform is one of the most important determinants of future land-use change in mountain areas. The scenarios approach is a tool for modeling landscape futures (eg Hawkins and Selman 2002; Shearer 2005; Mitchley et al 2006), and assumptions regarding the direction of subsidies can be clearly handled in order to illustrate differences in future land management.

Comparative results of BioScene scenarios have been discussed in the literature (Mitchley et al 2006; Soliva et al 2008; Partidário et al 2009); overall assessments in the Poloniny NP area mostly favor the BAU scenario. The reasons relate to the variety of benefits to livelihoods (rural, economic, and social objectives) and restoration of the management of agricultural land. Overall, the impacts of these activities on biodiversity are expected to be positive, but to a lesser extent than the economic benefits. In the MCB scenario, landscape management focuses on the importance of this area as a biodiversity resource, wherein the management activities are secured by conservation authorities and performed preferably on the basis of national and local biodiversity strategies, and thus the benefits for livelihood developments would be reduced. Finally, very negative impacts on biodiversity, livelihoods, and sustainability would take place in the case of the LIB scenario. Considering the current socioeconomic situation and unfavorable natural conditions for agriculture, farming activities would barely survive in the absence of support payments, and subsequent land abandonment would result in overall ecosystem diversity loss. A combination of the first 2 scenarios (BAU and MCB) was assessed as the most appropriate for the region, reflecting the integrated results of the sustainability assessment process and taking into account expert judgments and also feedback from local stakeholders (Bezák and Petrovič 2006).

An analysis based on land-cover changes, socioeconomic data, and the scenario approach results in the following socioeconomic and institutional recommendations for future management measures in the Poloniny NP:

- Implement measures of agro-environmental support (eg protection of biotopes, ecological farming, protection from erosion, measures that support water retention).
- Involve local small- and medium-sized enterprises and farmers in agricultural/environmental support schemes, with the aim of managing small and inaccessible grassland localities and realizing more environmentally friendly farming.
- Establish close and permanent contacts between nature conservation institutions, like the NP Administration, and other relevant institutions within the region to clarify their interests and competencies in the Poloniny NP.
- Establish closer cooperation between farmers and the NP administration to specify sites and detail management for biodiversity maintenance.
- Conduct public awareness activities in the region by the mentioned institutions to enhance understanding of issues of nature conservancy and biodiversity.

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TABLE 1 Habitats negatively and positively affected by agricultural decline.

Habitat type	Status	Significance	Important species	Targets
Habitats negatively affected				
Mountain meadows	Not managed, increasingly overgrown by tall grasses and small shrubs (*Vaccinium*)	Unique community composition with East and West Carpathian species	*Dianthus barbatus*, *Viola dacica*, *Campanula abietina*, *Melampyrum herbichii*, *Tephroseris papposa*	Conservation of representative parts, in situ protection
Wet meadows	Only some managed, in others: secondary succession and afforestation in progress	Well-preserved types, representative on national scale	*Oenanthe banatica*, *Achillea ptarmica*, *Orchis elegans*, *Thalictrum flavum*, *T. lucidum*, *Epipactis palustris*	Protection of most valuable locations of nationally important species
Extensively grazed pastures	The majority not managed, getting overgrown by shrubs	For listed species otherwise not high	*Spiranthes spiralis*, *Orchis morio*	Maintain at least a sample of these habitats
Fens	Limited mowing, majority of fens not managed, threatened by extinction if scrub invades	Higher density of fens than in other regions, well-preserved community structure	*Orchis maculata*, *Triglochin palustre*, *Valeriana simplicifolia*, *Dactylorhiza majalis*, *Epipactis palustris*	Protection of the most valuable fens
Habitats positively affected				
Scrubland	Area increased through secondary succession on abandoned sites	High abundance of this habitat type	*Helleborus purpurascens*, *Crataegus lindmanii*, *Knautia drymeia*, *Lilium martagon*, *Elaphe longissima*	Allow to develop freely where suitable, keeping the status of agricultural land
Forests	Area has increased, its status is under the influence of forest management	Region with the highest number and area of primeval and natural forests in Slovakia	*Ranunculus carpaticus*, *Scopolia carniolica*, *Ursus arctos*, *Lynx lynx*, *Ciconia nigra*, *Canis lupus*, birds of prey, owls, birds nesting in hollows	Protect primeval forests, maintain the high proportion of native forests in good condition

- Apply for grants and thus support local employment and achieve maintenance of the management in localities where biodiversity is important.
- Support cross-border cooperation to facilitate rural development of the region.
- Support the formation of local information centers as well as accommodation facilities and services for tourists.
- Inform local people via the local government about possible support for tourism, which has great potential to make the region accessible for more visitors/tourists.

The need for the maintenance of open and nonintensive farmland to benefit agricultural biodiversity has been recognized in other mountain regions as well. The recommendations from the BioScene project suggested that agricultural subsidies should be directed to promote, for example, alternative types of landscape management within business development (Norway), farming models using rangeland resources (France), local biodiversity enhancement measures under Ecological Quality Ordinance, and development of regional landscape concepts (Switzerland) (Mitchley 2005).

Furthermore, long-term biodiversity research findings, ecological modeling, and biodiversity implications of the scenarios specify detailed management recommendations for the maintenance of biodiversity in agricultural landscapes.

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TABLE 2 Species negatively affected by agricultural decline.

Species	Current status	Importance	Habitat	Targets
***Bison bonasus* (European bison)**	Small reintroduced population	Only population in Slovakia (SK)	Nonforest and forest landscape	Protection of the micropopulation, study of behavior
***Lutreola lutreola* (European mink)**	Extinct (very rare in Ukraine near study area)	Type of territory closest to actual distribution of species	Streams, waterside vegetation	Reintroduction of indigenous species
***Milvus milvus* (red kite), *Milvus migrans* (black kite)**	Disappeared during last years, reason unknown	Recent extinction, thus chance for reintroduction	Forests, old woods	Protection of woodlands with trees suitable for nesting
***Lanius excubitor* (great grey shrike)**	Significant decrease, currently about 20 pairs	Significant part of Slovak population	Managed meadows and field borders	Preservation of the vital population and its habitat
***Spiranthes spiralis* (autumn lady's tresses)**	Extinct (8 pasture sites in the past)	Very rare in SK, occurred in last decades	Pastures	Protection in case of rediscovery
***Orchis coriophora* (bug orchid)**	Extinct (1 site in the past)	Very rare in SK, occurred in last decades	Meadows	Monitoring of site, maintenance of suitable habitat
***Bistorta major* (common bistort)**	1 site (low population)	Significance not high	Wet grasslands	Conservation, ie strengthening of existing population
***Agrostemma githago* (common corncockle)**	Extinct	Very rare in SK, occurred in last decades	Fields (weed)	Protecton of the species population if refound
***Achillea ptarmica* (sneezewort)**	2 localities, quite numerous populations	Nationally rare species	Wet meadows	Protection of the existing populations
Oenanthe banatica	1 site, fluctuating number of individuals	Very rare in SK	Wet meadows	Reestablishment of site management, maintenance of vital population

Figure 4 shows that the extensive use of meadows represents the most suitable management type for most of the priority plant species. Also, nonintensive grazing can be applied for maintenance of biodiversity, and should be avoided only for habitats in groups 4 (nongrazed habitats) and 8 (abandoned grasslands). Because a relatively large number of priority species can live in the early stages of abandoned grasslands as well, we consider areas of extensively used grasslands with smaller areas of abandoned grasslands as the most suitable land-use arrangement. Further management recommendations (based mainly on our experimental study of grassland communities' reaction to different management measures on permanent plots; see Ružičková et al 2001) are:

- Prepare management plans for larger areas of agricultural land, aiming for rotation of management measures in time and space. Mosaic utilization of larger areas and sequence of management practices on the same plot can, to some extent, simulate traditional use, and could support species diversity.
- It is not necessary to mow each grassland patch each year: wet meadows should be mown more often (once in 1–2 years), mesic types less often (once in 2–3 years), and subxerophilous types once every 3 years.
- Use controlled grazing or soil fertilization for maintenance of grassland productivity because of naturally nutrient-poor substrate.

TABLE 3 Species positively affected by agricultural decline.

Species	Current status	Importance	Habitat	Targets
Bison bonasus **(European bison)**	Small reintroduced population	Only population in Slovakia	Nonforest and forest landscape	Protection of the micropopulation, study of behavior
Lutreola lutreola **(European mink)**	Extinct, possibility of reintroduction (very rare in Ukraine near study area)	Type of territory closest to actual distribution of species	Streams, waterside vegetation	Reintroduction of indigenous species
Lanius collurio **(red-backed shrike)**	Population increased, favored by spreading of shrubs	Region provides good habitats for the species	Open landscape with shrubs, eg *Rosa*, *Crataegus*	Monitoring of the population size
Sylvia nisoria **(barred warbler)**	Population increased, favored by spreading of shrubs	Region provides good habitats for the species	Open landscape with shrubs, eg *Rosa*, *Crataegus*	Monitoring of the population
Crex crex **(corncrake)**	Population increased, mainly at abandoned sites	Probably highest population density in Slovakia	Abandoned grasslands, scrubland	Monitoring of the population, implementation of conservation program

- To avoid any drainage measures in the study area, owing to the sensitivity of some species to drainage and the nature conservation value of wet meadows and fens.
- Include the *poloniny* mountain meadows in agricultural land eligible for support from the agri-environment program.

Our experience from grassland research in this region allows us to state that continuously used grasslands are more effective for biodiversity conservation than the regeneration of grasslands abandoned for a longer time. It is necessary to take this fact into account to give preference to the management of continuously used meadows and pastures, and to apply eventual restoration measures only to those abandoned grasslands that retain native species composition.

Reflections on recent trends and conservation of agrobiodiversity

After the crisis of agriculture during the 1990s and introduction of EU pre-accession agricultural policy programs, the CAP was implemented in the study area in 2004. Greater financial support to restart agricultural activities in the region was seen as a very positive element by local stakeholders when assessing future landscape trends. Claims of support from the CAP, however, make demands on farmers' skills in adopting this new financial instrument, demanding many administrative duties, and the abilities of inhabitants in the region in relation to the current structure are very limited. Because the area is managed by two big agricultural enterprises—since large farms mostly survived in Central and Eastern European (CEE) countries (Lerman et al 2004)—there is a risk that efforts might be directed to achieve the maximum amount of subsidies for farming, which would become a primary target, rather than to pursue sensitive agricultural management aims. Ecological modeling of grassland habitats (Halabuk and Halada 2006) predicts an increase of large wet and mesophile meadows on good, accessible sites, while small mountain meadows are predicted to decrease significantly (−80%) if recent trends continue. In addition, the risk of local soil erosion can increase because of concentrated grazing in the valleys.

An increased focus on environmental concerns and introduction of rural development funds have helped better address biodiversity conservation needs, although the success of agri-environmental schemes in terms of achieving biodiversity conservation goals has often been found wanting in Europe (eg Kleijn et al 2001; Henle et al 2008). The history of CAP implementation in Central and Eastern European (CEE) countries is relatively short compared to western European countries, but conflicts between CAP and biodiversity conservation were already predicted at the outset (Young et al 2007). Predicted obstacles to the maintenance of valuable mountain meadows in the Poloniny NP became visible after only 5 years of CAP reform. Land management of the surviving large farms is dependent on financial agricultural support, and large-scale mowing of easily accessible

FIGURE 4 Management preference and tolerance of priority plant species. (Table by Ľuboš Halada)

Habitat	Species	Intensive meadows	Semi-intensive meadows	Fertilization	Extensive meadows	Extensive pastures	Abandoned grasslands	Abandoned grasslands with trees	Drainage
1	*Trisetum flavescens*	s	s	s	t	n	n	n	
2	*Betonica officinalis*	n	s		s	t			
	Hypericum maculatum	n	s	t	s	s	s	s	
	Trifolium montanum	n	s		s	s	t	n	
3	*Crepis conyzifolia*	n	n		s	s	n	n	
	Danthonia decumbens	n	n	n	s	s	n	n	
	Dianthus barbatus	n	n		s	s	n	n	
	Viola dacica	n	n		s	s	n	n	
	Dactylorhiza sambucina	n	n	n	s	s	n		
4	*Campanula glomerata*	n	n		s	n	t	n	
	Eriophorum latifolium	n	n	n	t	n	s	n	n
	Gladiolus imbricatus	n	n	n	t	n	s	n	
	Serratula tinctoria	n	n	n	t	n	t	t	n
5	*Gymnadenia conopsea*	n	n	n	s	s	s-t	n	
	Centaurea scabiosa	n	n		s	s	t	n	
	Traunsteinera globosa	n	n	n	s	t	t	n	
	Succissa pratensis	n	n	n	s	t	t	n	n
	Cirsium rivulare	n	n		t	t	±t	n	n
	Epipactis palustris	n	n	n	t	t	s	n	n
6	*Platanthera bifolia*	n	n	n	s	s	s	s	
	Pyrethrum clusii	n	n		s	s	s	t	
	Brachypodium pinnatum	n	n		t	s	s	s	
	Agrimonia eupatoria	n	n		t	s	t	t	
	Calamagrostis arundinacea	n	n		t	t	s	s	
	Primula elatior	n	n	n	s	t	s	t	
	Gentiana asclepiadea	n	n		t	t	s	s	
	Helleborus purpurascens	n	n		t	t	s	s	
	Vaccinium myrtillus	n	n		t	t	s	s	
7	*Veronica officinalis*	n	n	n	n	s	n	n	
8	*Origanum vulgare*	n	n	n	n	n	s	t	

Habitat

1 Intensive and semi-intensive meadows
2 Semi-intensively and extensively used grasslands
3 Extensively used grasslands
4 Non-grazed habitats
5 Extensively managed and abandoned grasslands
6 Abandoned and extensively managed grasslands
7 Extensively used pastures
8 Abandoned grasslands.

Links between species and measures

s Suitable measure
t Species tolerant to measure
n Species not tolerant to measure

grasslands, using large machinery, is dominant. Apart from the positive effects of CAP support (increased managed area of mesophile meadows, renewed management of grasslands abandoned for many years), such farming also has negative consequences: large areas of uniform management have appeared and small localities of greater biodiversity importance continue to be overlooked and forgotten. Large intensive meadows become even larger as subsidies are determined by the amount of managed area (Figure 5A: before CAP; Figure 5B: after 5 years of CAP). Agri-environment support has been implemented (mostly through maintenance of grassland biotopes), but the most valuable mountain grasslands are not included in the Land Parcel Information System and thus are not eligible for financial support from the CAP. They are managed only by using the limited financial resources of the Poloniny NP administration, and the majority of them are abandoned. There is no long-term monitoring of the impact of agri-environmental measures on biodiversity. Individual farmers have not been integrated into the farming process, except for one small farm in Nová Sedlica village managing the surrounding area. The number of inhabitants continues to decline rapidly (see Figure 2), no significant livelihood benefits have emerged, and lack of management of small narrow parcels in nearby settlements has resulted in their abandonment and overgrowth or transformation to intensive meadows.

Discussion and conclusion

There have been radical changes in society and landscape in the mountain area of Poloniny NP, which are reflected in the development of agricultural land. The lack of farming management or its inappropriate implementation driven by previous agricultural policies (before the CAP) has significantly affected local biodiversity in recent decades. Recent CAP agri-environment programs have brought greater efforts to reach nature conservation goals within the sphere of rural development. However, there may be a serious increase in conflicts related to nature conservation versus economic goals, considering the divergence of recent CAP objectives and the real implications for grassland species

FIGURE 5 (A) Locality close to Príslop village in June 2004. (B) Locality close to Príslop village in July 2009. (Photos by Peter Bezák)

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in the area. Agricultural management currently practiced in an intensive manner could endanger natural sites and biodiversity. Unique species-rich seminatural grasslands require special management, with priority afforded to the maintenance of biodiversity instead of the pursuit of economic goals (Bezák et al 2007).

Financial support has resulted in a larger area of agricultural land being managed by the two postcollective farms, but stakeholders believe that local individual farmers also need to be motivated and guided to join agri-environment programs. In this case, propagation of agri-environment activities together with the offer of support for individual groups need to be launched by the local government or NP Administration. The inclusion of small farmers in agricultural programs could provide a better fit with local conditions of mountain agriculture and achieve sustainable development. Finally, it must be stressed that decision-making about agricultural biodiversity needs to follow not only financially beneficial agri-environment schemes, but also the national biodiversity strategy and local strategic aims of nature protection (Ministry of Environment of SR 1997; NP Poloniny Administration 2000).

These findings contribute to global change research in the Carpathian region, complying with an appeal for interdisciplinary and transdisciplinary approaches in complex human–environment systems (Gurung et al 2009). Drafted land management recommendations would seem to be generic enough to be implemented in neighboring Carpathian countries, although socioeconomic backgrounds are different. As Kuemmerle et al (2008) suggest, two factors—land reform and rural population development—have had different effects on farmland abandonment in Poland, Slovakia, and Ukraine. The influence of specific historical driving forces has caused disparities in the share of agricultural employment and average farm size (eg Romania and Poland versus Slovak and Czech Republics) and recent implementation of agricultural and rural programs. Private land ownership in Poland with small farms is, for instance, more favorable for tourism development than for common agreements between farmers on biodiversity preferences in the area. Access to application for financial instruments to support local biodiversity targets is very limited for farmers in Ukraine compared to EU countries. Nevertheless, there are common practices convenient for mountain farming areas in the whole Carpathian region, such as raising public awareness of agrobiodiversity issues and appropriate specific grassland management measures, cooperation of farmers with the relevant conservation authorities regarding land management favorable for biodiversity, or cross-border cooperation and exchange of information on nature conservation.

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