

# **Review of biodiversity research results from Hungary that directly contribute to the sustainable use of biodiversity in Europe**

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# Introduction

Katalin Török

Ecological science has achieved remarkable results in studying the processes of the few and rapidly shrinking natural or semi-natural ecosystems. Even this kind of knowledge does contribute to the advancement of understanding for solving future ecological challenges. However, maintenance of ecosystem services will require a considerably better understanding of the natural patterns and processes that sustain them (Daily 1997). Interdisciplinary frameworks are necessary to understand how the health of our environment and its species, including humans, depend on key ecological processes (Palmer et al. 2004). The new approach in research that is critical for future and present decision-making is to explicitly incorporate humans and their activities in ecosystems. At present, only a relatively small group of ecologists take the challenge to leave their narrow sub-discipline in order to deal with global issues (Vida 2005). However, the role of ecologists in changing the general dominance of the paradigm of the competitive and developing society is unquestionable (Vida 2001).

The Millennium Ecosystem Assessment (MEA 2005) was the first remarkable global effort to address the sustainability and resilience of socio-ecological systems and their future prospects. This report had a great influence on European legislation and resulted in the Action Plan for Biodiversity to 2010 and beyond (COM 2006). The Action Plan will probably influence research strategy in the coming years. In order to incorporate the new interdisciplinary approach, the gathering and review of biodiversity research that contributes directly to the sustainable use of biodiversity in Europe has a great importance.

What kind of research contributes directly to the sustainable use of biodiversity? We think that basic knowledge on ecological patterns and processes of natural ecosystems can only indirectly support the sustainable use. Focus on systems used by humans and the interaction of the natural systems and human management is required. Therefore, studies on farmlands/forests or their management, on agro-biodiversity, on ecosystem services, on survey and monitoring of the state of biodiversity, on the impact of alien genotypes, and on restoration, mitigation measures are incorporated in this review. A single policy issue, namely the introduction of the reformed Common Agricultural Policy (CAP) was surveyed. Selection criteria of publications and main topics were developed by a broader scientific community, based on the Hungarian Biodiversity Platform. Articles in Hungarian and other languages, reports, dissertations were used, but no conference abstracts accepted (except for genetically modified organisms). This is not an exhaustive selection of research results, but the first endeavor to provide an overview of studies executed in Hungary that might contribute to the sustainable use of biodiversity.

The structure of the review follows that of the Communication (COM 2006). Researches supporting the conservation and the restoration of biodiversity and ecosystem services (Priority Objective 2) are discussed under three headings. Identification of high value farmland and forest areas concerns research on grasslands and management intensity, the role of seed banks, and of forest genetic diversity, the importance of cultivated plant races and the survey and mapping of all habitats and their naturalness. The second part deals with research on conservation measures and restoration techniques, and the third gives an overview of the implementation of the CAP

and its effect on the sustainable use of biodiversity. The inclusion of ecological coherence and functioning into territorial development (Objective 4) is discussed in relation to linear infrastructures and mitigation measures. A short summary on the operation of eco-villages is also provided. Efforts to substantially reduce the impact of invasive alien genotypes are discussed for GMOs and invasive plants (Objective 5). Finally an introduction to monitoring schemes in Hungary is provided (Target action C.1.3.).

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## Description of main findings of the selected studies

### ***Objective 2: To conserve and restore biodiversity and ecosystem services in the wider EU countryside***

#### **Identifying high value farmland and forest areas (including Natura 2000 areas) A2.1.3 (reference to climate change)**

##### ***1. Management intensity and biodiversity***

András Báldi

##### **Introduction**

Farmlands in Central and Eastern Europe are richer in terms of biodiversity than in Western Europe (Donald et al. 2002, Gregory et al. 2005). Farmlands cover cca. 70% of Hungary, harboring more than one third of the protected species. For this review we conducted:

1. a literature search based on the largest Hungarian database,
2. a literature search in one of the largest English databases,
3. an evaluation of the main findings for grassland research results,
4. an evaluation of the main findings are presented for arable research results.

It must be noted, however, that not all papers were included into the presentation of the main findings.

It is worth to mention that the same search in Web of Science resulted in much higher values for England than in Hungary, where farmland biodiversity is much smaller (search for "grassland AND England" had 547 hits, versus 48 for Hungary, search for "arable AND England" had 372 hits, versus 44 for Hungary).

### **Effects of grazing intensity on biodiversity**

András Báldi and co-workers

Agricultural intensification is responsible for the dramatic decline of farmland biodiversity in the European Union (EU). The joining of the Central and Eastern European (CEE) countries to the EU will re-structure agriculture there. One of the main threats is the intensification of farmland management. (It has to be mentioned that another threat is the abandonment of arable fields in central Hungary on low productive soils, see section 4. on ecosystem services.) Can agri-environmental programs balance the expected decline in biodiversity of the CEE countries if farming will be intensified? We studied this question on grassland, which is the most important farmland habitat in Hungary, covering 12% of the country, and harboring diverse wildlife with endangered species like the Great Bustard. Aims of these investigations were to test the influence of grazing intensity and effects of local and landscape metrics and regional effects on various taxa, including different functional groups. We made our investigations on extensively and intensively grazed cattle pastures in three regions of the Hungarian Great Plain (alkali steppe of the Kiskunság, wet meadows of the Kiskunság, steppe of the Heves). The regions differed in landscape complexity; one region was situated in a structurally simple landscape with large landscape units, one in structurally complex landscape with marshy patches and trees in the grasslands and one in a landscape with intermediate structural complexity. In every region we had seven pairs of differently managed grasslands, which differed in the grazing intensity. Extensive fields had a cattle density of cca. 0.5 ind/ha, intensive had > 1.0 ind/ha. None of the fields were fertilized or managed by chemicals.

**Birds.** Bird assemblages varied significantly across regions and grazing intensity. Intensively grazed sites showed a higher species number and diversity, but lower densities than the extensive sites. This is probably the consequence of higher landscape diversity of intensive sites, which included farm buildings, shelters, wells and other structures. Several bird species, mainly with European conservation concern, showed contrasting responses to grazing intensity in the three regions, including key grassland species (black-tailed godwit *Limosa limosa*, redshank *Tringa totanus*, skylark *Alauda arvensis* and corn bunting *Emberiza calandra*). Therefore, threat and sensitivity to grassland characteristics are correlating. Although many of the declining species of western Europe are still abundant in Hungarian grasslands, our results project the threat of the expected intensification. This study showed that it is not possible to provide a general grassland management scheme that will favor all bird species in all regions of Hungary. In the process of integrating to the EU and re-structuring agriculture, the establishment of scientifically sound schemes is urgent.

**Bees.** Bees are the most specialized pollinators in Europe with an important function in ecosystems. Bees were collected using sweep net surveys and 1 m wide transect surveys three times during the late spring and early summer of 2003. To gain landscape parameters of each study field we mapped land-use types (grasslands; arable fields; forests; built-up areas; marshy habitat and open water) based on aerial photographs within a 500 m radius. We captured 483 individuals of 124 species in total. This shows very diverse and species rich bee assemblages in

these grassland areas. Both the diversity and the percentage of the rare species were highest on the Kiskunság alkali area. The dominance of the honeybee (*Apis mellifera*) was very low at each site. Neither species nor individual numbers differed between extensively and intensively grazed sampling sites, among regions, and between edge and interior of sites. However, both species richness and abundance of bees positively correlated with species richness and cover of flowering plants, indicating the important role of food sources. From the landscape parameters the extent marshes and the built-up areas seems to have effect on bees; small species preferred wet areas, while large species seem to avoid build-up areas. The fact that the diversity and species richness of the bee assemblages are high on intensively and extensively grazed Hungarian grasslands as well, indicates that both management intensity should be maintained, because even the studied higher grazing pressure seems to promote sufficient floral resources.

**Orthoptera.** We made sweep netting and visual and acoustic search in two 95 m long transects in each site (altogether 84 transects) once in July 2003. Additionally we made botanical surveys and we also measured other local factors on every transect. After samplings we digitized the most important land-use types using aerial photographs to get landscape scale metrics within 100 m and 500 m circles around every site. Analyzing the management, regional, landscape and local effects on species richness with linear mixed model, strong significant regional differences were found. Linear mixed model for Orthoptera abundance gave significant regional effect and marginal management effect. However, after including local and landscape metrics in a separated model beside the significant regional effect, a marginal local effect was found instead of management effect. Logistic regression models of 15 species also revealed the importance of local factors, first of all the importance of grass height, which depends highly on grazing intensity. Therefore, management intensity seems to have indirect effects on Orthoptera species richness and abundance. Landscape scale metrics could also be important, at least for some species.

**Beetles.** We tested the influence of grazing intensity and effect of landscape complexity on grassland specialist and generalist beetles of three beetle families, i.e. Carabidae, Chrysomelidae and Curculionidae. Samples were taken along two 95 m long transects; one transect at the edge and the other one 50 m away from the edge in the grassland interior (altogether 84 transects). Carabids (Carabidae) were sampled using funnel traps for three 2-week sampling periods during spring and early summer. Leaf-beetles (Chrysomelidae) and Weevils (Curculionidae) were surveyed by sweep-netting in May and June 2003. Analyzing the grazing intensity and landscape complexity effects on generalist and specialist beetles with linear mixed models, grazing effect was detected only on specialist leaf-beetle species richness with more species in the extensively grazed sites. Landscape complexity had contrasting effects on specialist and generalist species. Habitat generalists were more and negatively affected by increasing grassland coverage (reduced heterogeneity) than specialists. At species level analyses on four species out of 21, landscape effects were shown, which suggested that landscape composition might have strong effects on the species composition of the beetle assemblages. Our results suggest that conservation of biodiversity in agricultural systems (such as in managed Central-European grasslands) requires a landscape perspective besides investigating management effects.

This section was based on the following publications:

Batáry, P., Orci, K.M., Báldi, A., Kleijn, D., Kisbenedek, T. and Erdős, S. Effects of local and landscape scale and cattle grazing intensity on Orthoptera assemblages of Hungarian Great Plain. *Basic and Applied Ecology*, in press.

Batáry, P., Báldi, A., Szél, G., Podlussany, A., Rozner, I. and Erdős, S. Responses of grassland specialist and generalist beetles to management and landscape complexity. *Diversity and Distributions*, in press.

Batáry, P., Báldi, A. and Erdős, S. Grassland versus non-grassland bird abundance and diversity in managed grasslands: local, landscape and regional scale effects. *Biodiversity and Conservation*, in press.

Sárospataki, M., Báldi, A., Batáry, P., Józán, Zs., Erdős, S. and Rédei, T. Factors affecting the structure of bee assemblages in extensively and intensively grazed grasslands in Hungary. Submitted.

### **Effects of arable farming practices on biodiversity**

The effects of cultivation and landscape were studied on biodiversity of winter cereal fields in the Kiskunság National Park and surroundings in Central-Hungary in 2005. Bird census and botanical survey was conducted; spiders, ground-active beetles and bees were sampled with pitfall-traps and yellow water pans in fields with different management intensity. Intensity was measured according to fertilizer, fungicide, herbicide and insecticide use. To study the effects of landscape we determined the landscape diversity in 500-meter radius zone of the sampling points using 5 land use types (artificial surface, arable field, grassland, forest, water/wetland).

28 bird species were censused, of which the skylark (37 %, *Alauda arvensis*), yellow wagtail (27 %, *Motacilla flava*) and quail (9 %, *Coturnix coturnix*) were the most abundant. A total of 158 plant species were recorded. Total bird abundance and plant species richness decreased with increasing intensity of cultivation. There is a high edge effect by plants, there was significantly higher richness and abundance in the arable field edge, than in the interior of the field (no such data were available for the birds). The diversity of surrounding landscape had positive impact on plants and negative impact on arthropods.

This section was based on the following publication:

Kovács, A., Batáry, P. and Báldi, A. 2007. Comparison of bird and plant species richness and abundance of croplands cultivated with different methods. *Természetvédelmi Közlemények* 13: in press. (In Hungarian with English summary.)

### **Message**

Management intensity of arable fields has significant impact on biological diversity. The reducing the use of fertilizers and chemicals probably increases richness and abundance of native species.

### **Future and knowledge gaps**

There is a large gap in knowledge on the relationship of arable field management and biodiversity. Future important research areas are e.g., the effect of organic farming on biodiversity; the effect of biodiversity on biological control.

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Gregory, R.D., van Strien, A., Vorisek, P., Meyling, A.W.G., Noble, D.G., Foppen, P.B. and Gibbons, D.W. 2005. Developing indicators for European birds. *Philosophical Transactions of the Royal Society B-Biological Sciences*, 360, 269-288.

## **2. Effect of seed bank on regeneration potential of grasslands**

Béla Tóthmérész

The persistent seed bank may guarantee the success of rehabilitation of the natural vegetation after the abandonment of agricultural management as it was demonstrated by Matus et al. (2003, 2005) in the case of dry grassland areas. However, in a study on the species composition of the seed bank of an old field, Halassy (2001) found that recruitment is not the limiting factor for grassland regeneration, which suggests that restoration efforts cannot rely on soil seed bank in the case of grasslands. The vicinity of a target vegetation type has greater influence and can support the success of restoration efforts if dispersal is possible. Thus, the characteristic species of open sand grasslands are expected to extend their abundance rapidly (Csecserits 1999, Csecserits and Rédei 2001), while more time is needed for the re-establishment of rare species.

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## **3. Agro-biodiversity**

István Szabó

The Carpathian Basin is one of the oldest cultural regions of Europe where crop production goes back 8000 years, vegetable growing 5000 and fruit-growing 2000 years (Gyulai 1999). Beginning with the Neolithic Revolution, a very effective co-evolutionary process started between groups of "domesticators" and domesticated organisms, which peaked in the 17th and 19th centuries in Central Europe (Szabó 1999).

By the early 19th century a remarkable richness of genetic diversity has been developed under the pressure of characteristic agro-ecological properties and traditional selection practice (Surányi 2002). In a short time, increasing propagation of „new” plants meeting the demands of a developing market has been reported by contemporary authors. Foreign products and foreign-born varieties became more desirable and tempting than the native, ancient land-races and traditional varieties. The ratio of newer foreign cultivars was less than 50% in relation to the Hungarian cultivars until 1992, later it became more (Heszky et al. 2000).

Historical biodiversity patterns of grains, vegetables, fruits and weeds is given by Gyulai (1999) in a comprehensive study of the Hungarian Sustainable Development Committee. The National Institute of Agrobotany is the largest Hungarian gene-bank of about 80.000 specimens of domestic agricultural, horticultural crops, and distributes germ-plasma samples of traditional varieties to producers for *in situ* field conservation. Ancestors of the species were introduced to

the gene-bank as land-races, pre-bred materials and traditional varieties. The conservation of vegetable, fruit, ornamental and grass varieties belongs to other gene-banking research institutes, universities, botanical gardens and private enterprises. The nature of the work and extent of collections is reviewed by several authors e.g. Heszky et al. 2002a,b,c, Surányi 2000, Csoma 2000, Horváth et al. 2000, Kószegi et al. 2000, Facsar 2000, Terpó et al. 2000a,b. There are reports on the introduction of ancient varieties in molecular genetics and modern gene-technological breeding (Hajósné et al. 2000, Juhász et al.2000).

The actual economic situation, administration and policy is found disadvantageous for genetic diversity of crops, and a major share of genetic resources seems to disappear irreversibly (Balázs et al. 2004).

Szabó and Nyéki (2006) found that small-scale farming and diversity of cultivated species and varieties have been decreasing parallel to the increase of the role of trading companies in the food-supply of human population according to an interview and questionnaire-based study in Keszthely (Zala County). Domestic farms and small enterprises can not be competitive with large trading companies because of the shortage of investments and subsidies.

Possibilities for motivating the increase of agro-biodiversity were addressed in the study of Csanády and Kovács (2003) and Szabó (2004) by explaining its intrinsic and economic values.

The role of ethno-botany in the discovery of Hungarian agricultural biodiversity and its contribution to germ-plasma preservation was summarized by Szabó et al. (2000). Research results are at three levels: country-wide investigations (Kóczián et al. 1979), regional studies (Kószegi et al. 2000), and local investigations in villages (Kóczián and Szabó 1990).

The link between agricultural genetic resources and social sciences, including the valuation of diversity and stakeholder management practices, emerged recently as a new area of research (Balázs et al. 2004, 2005, Bela et al. 2005, Birol et al. 2005). Studies involve sociological, economic, historical and environmental sciences, including the conservation of biodiversity.

## **Conclusions**

Landrace conservation in the present and in the future is influenced by the loss of traditions, ethn(ograph)ic identity, as well as by drastic economic and political globalization. There are "ethnically sensitive" and "ethnically non-sensitive" landraces in almost every taxonomical and geographical situation.

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#### **4. Ecosystem services**

György Kröel-Dulay

A group of scientists at the Institute of Ecology and Botany are currently working within a research project on the effects of changing land-use on terrestrial biodiversity at the Kiskun LTER site (Long Term Ecological Research network), which is part of the Great Hungarian Plain. Due to environmental (drop in the water table) and socio-economic changes, an overall agricultural des-intensification is taking place in central Hungary, with a decrease in croplands and vineyards and increase in tree plantations and old-fields (Csecserits and Rédei 2001, Török 2006). In addition to assessing the effects of these changes on biodiversity by methods traditionally used in ecology, the project compares alternative land-use options in their ability to provide various ecosystem services. First, the profitability of different land-use types and associated ecosystems are compared by classical economic means (Podmaniczky et al. 2002). This method evaluates certain provisioning services (food, fiber). Second, some key regulating services (e.g. carbon sequestration, water regulation, pollination) are assessed in the region for the most widespread ecosystems by either specific studies or literature review. Third, we assess some cultural services by interviewing local inhabitants on their perception of the values of different biodiversity and landscape elements (Bela et al. 2005). Our overall objective is to evaluate options in land-use policy in central Hungary by considering environmental, economic and social issues, and thus contribute to decision-making.

#### **Message**

First steps to apply multidisciplinary research to evaluate ecosystem services at landscape level have been made at the Kiskun LTER site, Hungary. Economists, agro-environmental experts, sociologists and ecologists currently work together to estimate different aspects of services in relation to the conservation value of habitats.

## Gaps

Further research on the value estimation of biodiversity to humans and their livelihoods is required. Lack of knowledge of the interactions of the natural environment and human well-being hinders the more sustainable use of biodiversity.

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## 5. Forest genetic conservation

Attila Borovics and László Nagy

Forest genetic diversity is usually understood as the genetic variability within tree populations and species. Forest tree species are typically long-lived and have developed natural mechanisms to maintain high levels of genetic variation within species. These include high rates of outcrossing and the dispersal of pollen and seeds over wide areas. These mechanisms, combined with native environments that are often variable have contributed to the evolution of forest tree species into some of the most genetically diverse organisms (Mátyás 2002).

The high levels of genetic variation that are present within native (*Fagus*, *Quercus*), or even domesticated tree species (*Robinia*, *Pinus*) can be beneficially used by foresters. Whereas farmers often modify the growing environment to suit a specific crop variety, tree growers commonly identify species and provenance which can provide goods even without intensive selection, or intense management requirements, or major modification of the growing environment. Such diverse tree genetic materials are well adapted against variations in soil and microclimates.

Accordingly, forestry production depends considerably on the availability of these diverse genetic resources at both the species and population levels. Intraspecific genetic variation is needed to ensure the future adaptability of the species, as well as to allow breeding programmes (Borovics 2001).

Knowledge regarding the conservation of forest genetic resources is usually limited and often not adequate concerning the distribution, frequency of genetic variation and threats to native tree species (Borovics et al 1998). Many factors threaten our forest genetic resources, including deforestation and changes in land use in the past (Borovics et al. 1999; Bordács and Borovics 2004), inappropriate management practices including coppicing, thinning (Mátyás et al. 2005a) and over-harvesting of *Acer*, *Fraxinus*, *Tilia*, *Sorbus*, *Cerasus* (Mátyás and Bach 1998; Nagy

2002). We have limited knowledge about the consequences of climate change, and the movement of reproductive material (Mátyás et al. 2005b).

Sustainable use of forest genetic resources may be considered as the actions that assure the continued availability of these resources for present and future generations. The aim of genetic resource management is to maintain conditions in which the genetic structure of species can continue to evolve in response to changes in its environment. Accordingly, the conservation of these resources should not be seen as an attempt to preserve a particular group of genotypes or populations, and their various combinations of genes. The practice of genetic resources conservation is essentially a dynamic process (Borovics 2001).

The Ministry of Agriculture established the Plant Gene Bank Council (PGBC) to organize and coordinate the activity of gene conservation according to international standards, to develop the management of domestic gene reserves and provide effective allocation of state funds supporting gene conservation. The Forestry Committee of PGBC (founded in Sárvár on the 20<sup>th</sup> September 1996) included representatives of forest research, education, management, administration, as well as nature conservation. During the last ten years, the committee

- compiled the list of woody species that are relevant to gene conservation, set up priorities for future activities;
- developed the national strategy of forest gene conservation (Mátyás et al. 1998);
- published guidelines for gene conservation of rare and endangered species (Mátyás 1999);
- provided background studies, expert opinions on legislation and funding aspects of gene conservation,
- coordinated the establishment of the national in situ gene conservation network for oaks and beech;
- delegated experts as national representatives for the EUFORGEN networks.

In accordance with the Strasbourg Resolution S2, our national forest gene conservation strategy gives high priority to **in situ conservation measures**. In 2004, summarizing the efforts of its members for the previous three years, the Forestry Committee of PGBC proposed candidate stands for conservation units of the national beech and oak in situ conservation networks. The 99 candidate stands, totaling 2288 hectares, cover the local distribution of the target species, as well as geographic, ecological, structural and presumably, genetic variation. The proposal includes detailed description and management plan of each stand.

Due to the inconsistent and incomplete legal background and the complete lack of dedicated state funding, further activities regarding in situ conservation were postponed.

EUFORGEN scheduled to set up the pan-European network of conservation units in 2007, therefore member countries have been asked to specify the eligible stands of national conservation networks.

**Ex situ conservation measures** complement in situ gene reserves when a rare or valuable resource is endangered in its original site. Basically, existing ex situ collections (clonal banks, family/provenance collections, etc.) originate from previous research or breeding activities

(Table 1). The financial background provided by regular and dedicated state funding was suspended in 2004. Since then, maintenance of the collections has been ceased, postponed or only partially financed through occasional research projects.

Type of maintenance	Target species groups	Registered genotypes by specimen
Juvenile forms (stoolbed)	Poplars, Willows	3800
Tree shaped forms	Poplars, Willows	2000
Graftings	Pines, Noble hardwoods, Oaks	3000
Progenies, provenances	Elms, Oaks, Beech, Pines, Black poplar	1500

Table 1. Number of genotypes and families conserved in gene collections in Hungary (source: OMMI, István Bach)

To conclude, recommendations accepted in Strasbourg Resolution S2 seem to fail, especially because of

- the lack of consistent legislation on in situ gene reserves,
- the lack of secure state funding of gene conservation activities,
- the mandate of the Forestry Committee of PGBC expired and current activities lack co-ordination.

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## ***6. The importance of forest borders in the maintenance of diversity***

Béla Tóthmérész

The importance of forest edges was underpinned in a series of studies in the case of oak, oak-hornbeam and beech forests. The studies mainly focused on carabids, but spiders, weevils and isopods were also studied (Horváth et al. 2002). The high diversity of the forest edge resulted from the presence of edge-associated species and of species characteristic of adjacent habitats (Magura and Tóthmérész 1997, Bokor and Tóthmérész 1998, Magura and Tóthmérész 1998, Magura et al. 2000, Molnár et al. 2001, Magura et al. 2001a,b). Leaf litter, herb, canopy cover, and prey abundance proved to be the most important factors influencing carabid diversity (Magura et al. 2002). Forest edges seem to play an important role in maintaining diversity. Serving as source habitats, edges also contribute to the recolonization by ground beetles after habitat destruction or other disturbance in the adjacent habitats. The significance of forest edges in nature conservation, serving as a source habitat for dispersal processes, contributing to the recolonization of carabids after habitat destruction or other disturbance is emphasized. Even non-native tree plantations can provide opportunity for soil fauna survival (Elek et al. 2001).

### **Message**

Forest edges and even non-native tree plantations are important habitats for soil fauna that have to be taken into consideration in spatial planning by aiming to increase habitat diversity and directing habitat pattern.

### **Gaps in knowledge**

Little is known on the relationship of the vegetation composition and soil fauna at forest edges.

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## ***7. Evaluation of Hungarian Habitats (MÉTA)***

Zsolt Molnár

Actual knowledge is needed on the geographical pattern, quality and threats of the natural habitat types in order to be able to conserve our natural vegetation heritage. In the last few years a grid based, landscape scale, standardized field vegetation mapping project, called MÉTA was executed in Hungary (MÉTA stands for Magyarországi Élőhelyek Térképi Adatbázisa: GIS Database of the Hungarian Habitats) (Molnár et al. 2007). The system is supported by satellite images. The goals of the MÉTA project were: (1) to map the actual (semi-)natural vegetation of Hungary; (2) to evaluate our (semi-)natural vegetation heritage for conservation purposes; (3) to evaluate the present status of our landscapes from an ecological point of view; (4) to collect vegetation data and other background variables on landscape scale for the prognosis of future changes of vegetation and the landscape.

The MÉTA-survey used a hexagon grid with cells of 35 hectares (267 813 hexagons cover the country). In the hexagons, habitat types were listed (86 types). The area, the habitat quality (based on naturalness), effect of the neighborhood, connectedness and threatening factors were recorded for each habitat type. Other attributes estimated in the hexagons are: potential natural vegetation, area of invasive plant species, area of abandoned arable fields, land use of grasslands, and landscape health status.

By January 2007, 94 % of the country was mapped (cca. 200 mappers, 7000 field-days), 91 % being already digitized in the database. In the coming years, several new evaluations are foreseen based on the MÉTA-database regarding the status of our natural vegetation heritage. The following figures show some of the preliminary results (Figures 1, 2 and 3.).

### **Message**

The building of the MÉTA-database is an exceptional initiative in Europe, supported by remote sensing and field survey, covering the whole territory of the country. A broad application of the database is foreseen for the near future for conservation, monitoring and land use planning purposes, including ecological studies. First analyses show that invasion of alien plants threaten natural habitats in Hungary more than in other European countries.

## Future and knowledge gaps

Further analyses of habitat diversity, natural capital and ecosystem service estimations are required, based on the MÉTA database. Spatially explicit modeling of habitat change (the effect of land-use and climate change) are foreseen.

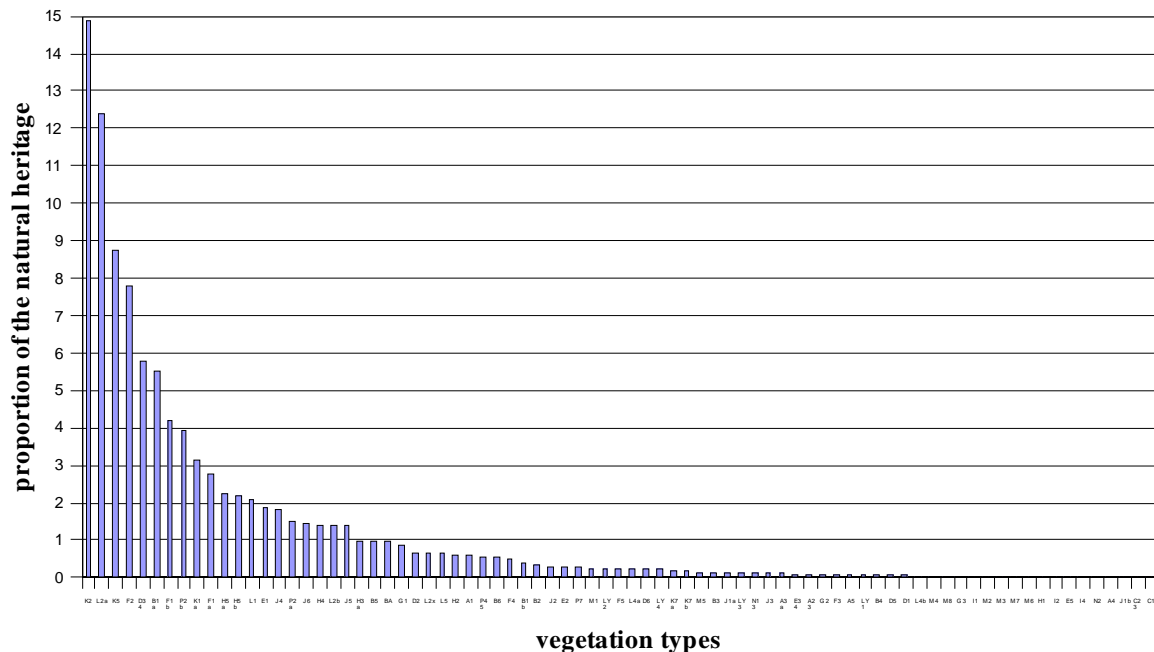


Fig. 1. Area of habitat types as a proportion of the total (semi-)natural vegetation heritage. The most common habitat types are: Oak-hornbeam woodlands, Turkey oak-sessile oak woodlands, Beech woodlands, Salt meadows, Mesotrophic meadows, Eu- and mesotrophic reed and Typha beds, Achillea salt steppes on meadow solonetz, Dry shrub vegetation with Crataegus, Prunus spinosa and Juniperus, Lowland oak-hornbeam woodlands, Artemisia salt steppes, Closed steppes on loess, clay, tufa. The rarest habitat types are: Transition mires and raised bogs, Soft and hard water flushes, Birch mire woodlands, Euhydrophyte communities of fens, Calcareous Scots pine woodlands, Open vegetation of shadowed rocks, Calluna heaths, Semi-desert vegetation on loess cliffs, Closed rock grasslands, Species-rich Bromus pannonicus grasslands, and Continental deciduous rock thickets.

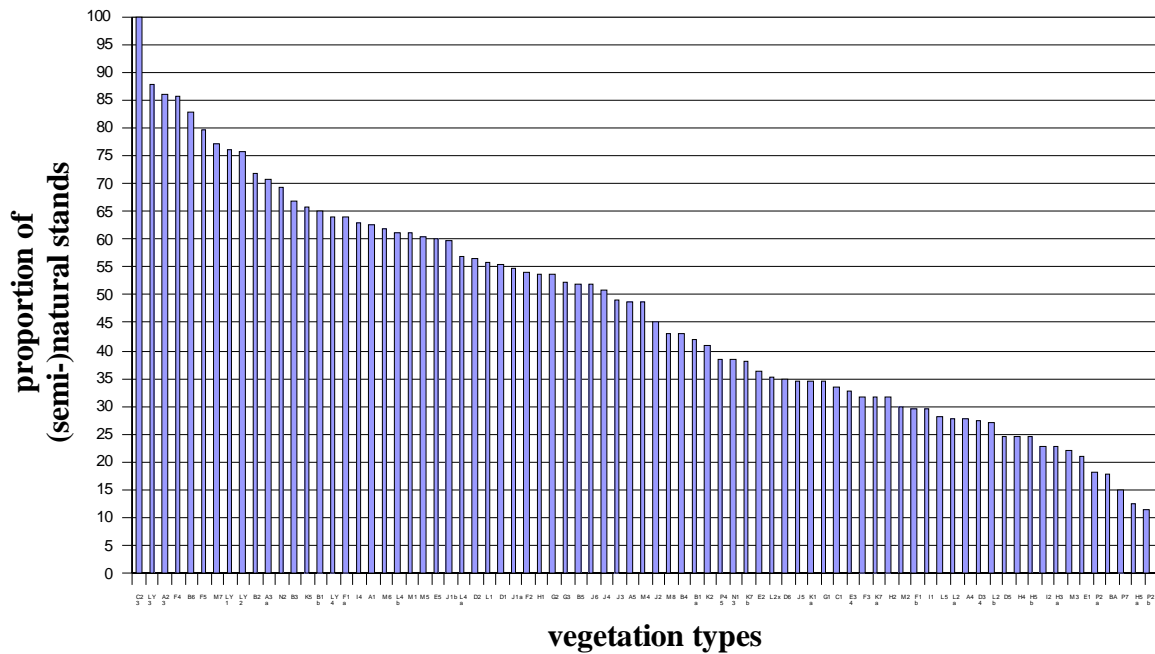


Fig. 2. Naturalness-based habitat quality of Hungarian habitats. Proportion of (semi-)natural sites as a percentage of the total area of the habitat. The most natural habitats are: Transition mires and raised bogs, Limestone beech woodlands, Euhydrophyte communities with *Nymphaea*, *Nuphar*, *Utricularia* and *Stratiotes*, Dense and tall *Puccinellia* swards, Salt marshes, Annual salt pioneer swards of steppes and lakes, Continental deciduous steppe thickets, Ravine woodlands (mesic rock woodlands rich in *Acer pseudoplatanus*), Slope woodlands, *Glyceria*, *Sparganium* and *Schoenoplectus* beds. The most degraded habitat types are: Dry shrub vegetation with *Crataegus*, *Prunus spinosa* and *Juniperus*, Closed steppes on loess, clay, tufa, Mesic shrub vegetation, *Arrhenatherum* hay meadows, Open salt steppe oak woodlands with openings, Slope steppes on stony ground, Semi-desert vegetation on loess cliffs, Closed sand steppes, *Bromus erectus*-*Brachypodium pinnatum* xero-mesophilous grasslands, and Water-fringing and fen tall herb communities.

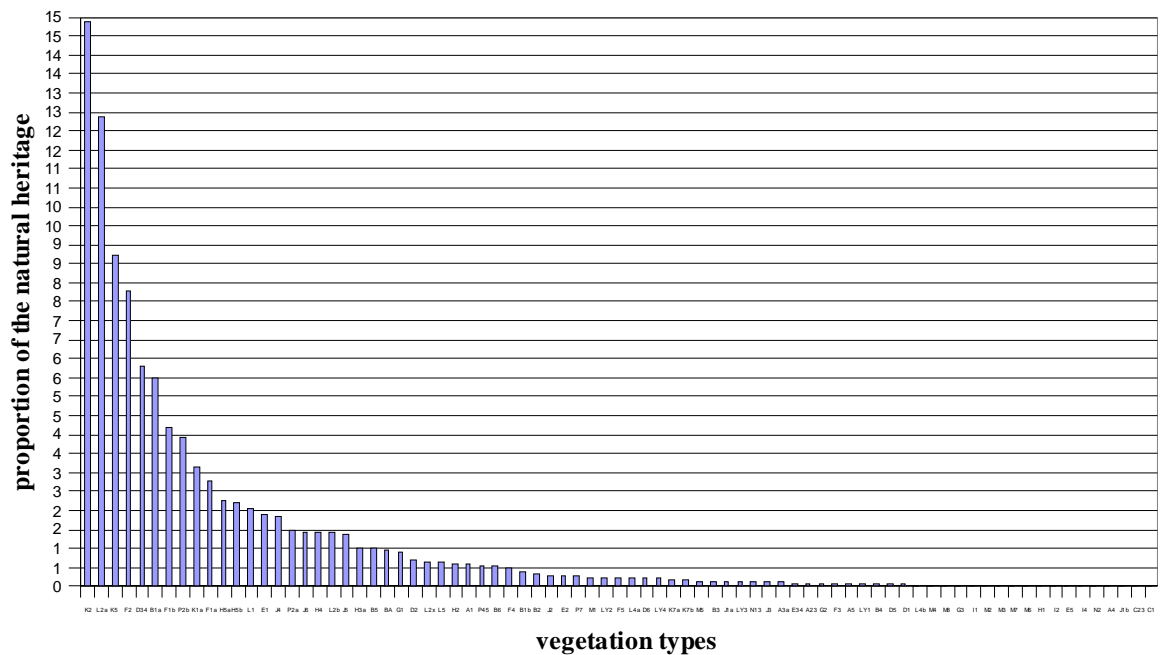


Fig. 3. The importance of impacts threatening Hungarian habitats. 28 potential threat types were documented in each hexagon for each habitat type. The ten most common threatening factors are: colonization of invasive species, overgrazing by game, drainage, encroachment of shrubs and trees, trampling, homogenized woodland structure, logging trees at low age, improper tree species planted, abandonment of grazing and mowing and ploughing of grasslands.

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## **Design and implement measures to maintain and/or restore conservation status A2.1.3**

### ***1. Towards a sustainable forest management scheme***

Ferenc Horváth

Information on forests was collected at national scale within a Phare project in relation to the Birds and Habitats Directives. The actual distribution and conservation status of forest habitats and forest species were reviewed (Horváth et al. 2003, Lovászi 2002), and a biodiversity map of the country was generated.

Our scientific knowledge on the distribution and status of natural flora and fauna elements in the country is incomplete and soon becomes obsolete. The “Survey and Assessment of the Natural Vegetation Heritage of Hungary” project was one of the initiatives to reduce this gap of knowledge (Bartha et al. 2005). Studies were carried out in the frame of this project, to determine the naturalness of Hungarian forests (Bartha et al. 2003) and to implement a complete survey to draw the distribution map of all habitats in Hungary (see previous section on MÉTA project, Molnár et al. 2007).

The national forest inventory database unfortunately does not distinguish forest plantations from semi-natural forests. Bölöni (2001) found that within the “forest” land-use category, the estimated proportion of semi-natural forests (mainly native tree species, characterized by high biodiversity) was only one third of the forest areas (6.2% of the country’s territory). Within the MÉTA project, the detailed and actual map of semi-natural forest stands is under development.

Correspondence between the heterogeneity of forest stand structure and naturalness was revealed by Bartha et al. (2006). Other studies pointed out a marked difference in biodiversity of the herb-layer of beech forests with and without forest management (Standovár et al. 2006, Kenderes és Standovár 2003, Standovár 1998). Csontos (1996) listed the possible causes of vegetation impoverishment through a study on clear-cutting system and herb-layer regeneration of turkey-sessile oak forests.

Dead wood is scarcely left in production-oriented managed forests, which results in ecosystem dysfunctions and in local extinction of several specialized species. The volume of dead wood in beech forest reserves was analyzed in the NAT-MAN project (Christensen et al. 2005), covering most of the range of European beech forests. The quantity, decay class and bryophyte vegetation of dead wood, and the preference of bryophyte species were studied in beech forests under different management regimes as part of the project in Hungary (Ódor and Standovár 2001, Ódor and van Hees 2004, Ódor et al. 2006). Siller studied the fungi communities of beech forest reserves, demonstrating the significant role of dead wood in nature conservation (Siller et al. 2002, Siller 2004). Czajlik et al. (2003a, 2003b), Standovár and Kenderes (2003) analysed the natural forest structure and dynamical processes of beech forest reserves.

Unmanaged forest reserves, left for natural development, play a principal role as reference-points for scientific research on forests. The National Forest Reserve Program of the Ministry of Environment and Water (Temesi et al. 2002) established the stand dynamic and ecological observation network of natural forests (Horváth et al. 2006). The aim of the network is to track changes in forest structure, vegetation and pattern in the long term and in broad spatial scales. It also provides a field-laboratory facility for landscape ecological studies (Manninger and Mázsa

2005). The forest reserve protocol of the National Biodiversity Monitoring System applies a monitoring protocol to compare reserves with managed forests.

Formerly, locally extinct large carnivores (lynx and wolf) are now occasionally present in extended forests and woodlands in Hungary. Several projects aimed at analyzing the possibilities for resettlement of these species and at identifying related risk factors (Gadó and Pačenovský 2003, Szemethy et al. 2004a, 2004b).

Pannonian forest-steppe is the most fragmented, scarce and endangered forest habitat in Hungary. A survey of its actual state was carried out by Molnár and Kun (2000), which forms the basis for planning urgent conservation measures.

Recognition of the disadvantageous consequences of silviculture exclusively for wood production has led to the reform of current forestry practices, with considerations of ecological, sustainability and nature protection aspects (Frank 2000, Bartha 2001). The Pro Silva Hungaria Association works towards achieving such reforms and promote close-to-nature, ecologically and economically sustainable forest management approach (Besze et al. 1999, Csépanyi et al. 2003, Csóka 2005, Madas 1998, Madas et al. 2005).

A main problem is that in recent decades Hungarian forests have suffered an increasing pressure from the overpopulated wild stock. The strong hunting lobby has achieved that the related legal regulations benefit their expectations against the natural regeneration and biological richness of forests. Biological invasions also pose increasing threats. The most dangerous invasive species are discussed by Mihály and Botta-Dukát (2004), Botta-Dukát and Mihály (2006) and Török et al. (2003).

Mátyás and Czimber (2004), as well as Gálhidy et al. (2006) constructed environmental envelop models to predict ecological consequences of climate change and expected anomalies in macroclimatic conditions on the main tree species. The warmer, more arid climate with more extreme events, expected within 50-100 years locally, will lead to significant shift in the forest-steppe border and in the zones of the main tree species. Risk of damage will increase in tree stands with suboptimal ecological status. Essential guidelines for conservation concerning climate change are discussed by Aradi (2006) and Láng et al. (2007).

### **Message**

Favorable changes are seen in forest management due to the activity of Pro Silva Hungaria, NGOs, and governmental nature conservation. Results of studies on conservation and ecology of forests back up these changes. At the same time, wood production oriented silviculture, biological invasions, strong pressures from the overpopulated wild stock, and increasing risk of climate change pose danger for forest biodiversity and ecosystem functioning, their cumulative effect might result in extreme threats.

### **Gaps**

Forest management monitoring schemes do not include aspects of biodiversity, ecosystem services and naturalness. The lack of relevant actual countrywide information to support sustainable forest management and the use of its natural services hinders appropriate feedback to the society. Upscaling of local results and further long term, large scale, field based biodiversity research and monitoring programs are necessary. Main focus should be on light-rich, oak-

dominated, mesic or dry zonal forests and open forest-steppes of Hungary that are biodiversity rich, but threatened increasingly.

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## ***2. Effect of mowing techniques on grassland species***

Levente Viszló

The Pro Vértes Fund, manager of the 2000 hectare Zámoly basin, a species rich wet grassland area in Western Hungary (Important Bird Area and Natura 2000 site) collected information on best practice for grassland management (Viszló and Karsa 2005). According to their findings, human factor is the most important for the conservation of biodiversity on a managed site, i.e. staff working in nature conservation should be well educated and dedicated.

Regarding the timing of the mowing, late June - early July was found to be the best season to ensure the protection of most animal species, the only exceptions being the second brood of the quail, or replacement broods of other species (Szabó and Viszló 2001). Late mowing may result in that the cut grass fails to sprout during the dry late summer season, which can lead to the loss of appropriate hiding and breeding microhabitats.

Chain-curtain was found to be an adequate tool to flush wild animals: out of 2565 observed vertebrate individuals 2354 escaped by themselves, while 182 were rescued by humans, and only 29 were killed in a mowing trial. The optimal spatial pattern of mowing was found to be from the inside to the outside, and by leaving a network of unmowed vegetation for hiding.

### **Message**

Nature friendly grassland management, or the maintenance of traditional, extensive use of pastures have the potential to conserve the rich and unique wildlife of the Hungarian grasslands.

### **Future and knowledge gaps**

Several valuable grassland types are still not studied. The studies should also include a wider range of management activities, including chemical use and abandonment as well.

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### ***3. Restoration of abandoned fields and plantations***

Katalin Török

The objective of restoration trials was to search for methods to improve the natural state of abandoned arable fields and black locust (*Robinia pseudo-acacia*) plantations, an alien tree species that becomes invasive in lowland landscapes. In low productive areas of the Hungarian Great Plain land abandonment widely occurs and the profitability of black locust plantations can also be questioned. The native vegetation in this area is sandy grassland, an endemic community under EU protection and rich in endemic and rare animal and plant species. This community is the target for restoration experiments to create a self-sustaining, high nature value vegetation type that optimizes ecological services under the local environment (Török et al. 2000, Szili-Kovács et al. 2000b, Szabó et al. 2003, Török et al. 2003). Different treatment methods have been tested and the results monitored. Herbicide application is necessary to avoid re-sprouting of black locust. It was proved that mowing is required after clear-cutting of black locust plantations in order to avoid the encroachment of shrubs as a result of increased nitrogen supply under this species (Halassy and Török 2004). Timing and length of treatment is of major importance. Treatments had significant effect on the ground dwelling arthropod assemblages (Markó and Török 2001). Vegetation response was dependent on the drought events of the current and previous years (Török and Lohász 2004).

Experiments on abandoned fields showed that methods effective in other regions might not be useful in others. For example carbon amendment to reduce available nitrogen proved to be effective to influence the soil microbial community, but had only low effect on the composition of the vegetation (Szili-Kovács et al 2000a, Szili-Kovács et al. 2003a,b, Szili-Kovács and Török 2005, Szili-Kovács et al. 2005, Szili-Kovács et al. 2007). The initial composition of the vegetation can be crucial: clonal perennial plants can hinder the effects of practically all management types. Therefore combined trials are under testing by the use of one ploughing at the beginning of the experiment, mowing, seeding and carbon amendment. First results support the effectivity of multiple management techniques: the pre-treatment by ploughing helps to hinder the dominance of clonal species; seeding of specialist species of the target community is effective; mowing eliminates weeds at the first period of the trial.

#### **Message**

A plant community resembling the target endemic grasslands can be restored at abandoned arable fields and clear-cut plantations by the use of multiple restoration techniques. However, the state of the resulting community is far from the natural.

#### **Gaps**

Further research on treatment methodology is required to ensure the repeatability of experiments and the increase of effectivity and scale of restoration.

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## **Influence of national plans of CAP implementation on biodiversity, including aspects of cross-compliance A2.1.4**

Katalin Balázs, Márta Belényesi and László Podmaniczky

Integration of environmental and biological diversity conservation considerations into agriculture is a developing priority in European agricultural policy. Agri-environment schemes (AESs) and Natura 2000, designed to encourage farmers to protect and enhance the environment on their farmland, are the main vehicles in Hungary to deliver this integrative approach at the moment.

### **Agri-Environmental Programmes**

The National Agri-Environmental Programme (NAEP) was prepared in the pre-accession period to the European Union, according to the provisions of the Common Agriculture Policy. The programme (that was launched in 2002 and was continuing in 2003) intended to meet complex demands. The policy aimed at the structural change of agriculture, the reduction of the environmental load of agriculture origin and the preservation of biodiversity, while the farmers expected improving living conditions as well as the compensation of environmental and nature conservation restrictions from the Programme. The professional nature conservation organisations and the NGOs with good reason considered this agriculture granting system as the implementation tool of nature conservation management. By taking into account all these demands, the results of the first years confirmed the success of the programme – it was popular among farmers.

The concept of Nature Sensitive Areas (NSAs) appeared in Hungarian nature conservation policy around the end of the 1980s, based on the example of the British Environmentally Sensitive Areas. In Europe (under various names in different countries) this system exists for decades and for four years among agri-environmental schemes in Hungary (Belényesi 2006).

In the framework of the National Agri-environmental Programme the NSA scheme was launched in 11 pilot areas in 2002 and additionally in 4 areas in 2003. Apart from the operating pilot areas, there are detailed plans for future candidate areas to be introduced to the system. Presently, the total area cultivated by the 24,000 enterprises and farmers awarded agri-environmental support totaled 1.4 million hectares. The areas covered by the Programme now make up more than one-fourth of all agricultural land in active cultivation – a high rate even in EU comparison (Ministry of Agriculture and Rural Development 2004).

### **Natura 2000**

Payments of the Natura 2000 programme have not started yet in Hungary, which inhibits agricultural production from playing a potentially decisive role in the protection of the natural environment and in the preservation of rural environments.

The designated Natura 2000 sites amount to a total of 1.91 million hectares, or 21% of the country. In the Hungarian sites of this European ecological network, 467 Special Areas of Conservation were designated on a total of 1.41 million ha, as well as 55 Special Protection Areas on 1.36 million ha. The overlap between these two types of conservation areas is nearly 41%. The Natura 2000 network in Hungary relies heavily on existing areas under natural protection, (37% of the designated areas), however, it involves hitherto unprotected areas as

well. Natura 2000 areas consist of 480.000 ha pastures, 520.000 ha arable lands and a little more than 770.000 ha forests.

The unique landscape features, natural conditions, natural capital, the size of the protected areas in Hungary represent a very high rate in a European comparison. The annual compensation provided for the private farmers concerned ensures the long-term sustainability of the Natura 2000 network, it provides a farming prospect for those involved and also has a substantial educative effect (Balázs et al. 2001).

A two-level payment system is planned to be implemented that shall bring adequate results both in terms of the conservation of diversity in agriculture, in accordance with the Göteborg objectives and a social acceptance of the Natura 2000 network.

By means of compulsory regulations, the preservation of the values, that also served as a basis of the designation of the Natura 2000 areas, can be ensured.

Programmes including further voluntary commitments (these are the regulations of the agri-environmental schemes, in the case of forest areas, the regulations of the forest-environmental programmes), resulting, in addition to the preservation of the protected species and habitats, in the sustainable use of the habitats.

Because in many cases voluntary commitments can be more effective than compulsory restrictions, the so called “New Hungary Rural Development Plan (2007-2013)” aims at achieving a significant overlap between areas included in the agri-environmental farming and Natura 2000. To this end, priority is given to applicants farming on Natura 2000 areas within the evaluation the proposals for the support of agri-environmental measures. The collaboration of advisors in providing information and in the preparation of farmers is also important (Ministry of Agriculture and Rural Development 2007).

## **Gaps**

Little is known on the effects of certain management techniques, carried out in the scope of agri-environmental schemes on the biodiversity of the particular area.

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## ***Objective 4: To reinforce compatibility of regional and territorial development with biodiversity in the EU.***

### **Ecological coherence and functioning and its inclusion into spatial planning A.4.3.1.**

#### ***1. Linear infrastructure mitigation***

Miklós Puky

Transportation infrastructure is a major factor determining land use forms. Global changes in this driver are of major importance for biodiversity (Sala et al. 2001), roads and railways fundamentally influence wildlife. Their effects have been categorised in several ways resulting in five to ten categories (see e.g. Seiler 2003; Trombulak and Frissel 2000). Though other measures, such as translocating protected plants were also made at railway as well as at road constructions (Pallag 2000), we focus on sustaining mobility in this chapter, i.e. fragmentation mitigation over linear infrastructure.

This is an especially important element in biodiversity conservation as the road network of Hungary is relatively dense in comparison with most European countries (International Road Federation, 2002). The effect of roads on different animal groups, including insects, were proved. Besides direct impacts, such as road kills, bare road surfaces stretching long distances can cause the fragmentation of populations. Studies have shown that road-like objects deter some insect species from trying to fly over, e.g. ladybirds (Coccinellidae) (Sároszpataki and Markó 1995), hover-flies (Syrphidae) (Lóvei et al. 1998). This phenomenon is caused by the eco-physiological influences of road properties completely different from the microclimate of the surrounding environment. Similarly, railway tracks can also act as a barrier for butterfly species. Gene-flow among these subpopulations becomes highly restricted or even ceased, which may cause their genetic impoverishment and finally extinction. As a result, in a recent scientific analysis of road planning invertebrates were also taken into consideration and conservation priority ranks were developed for Carabid beetles using fragmented landscape elements (Jordán et al. in press). The results should be considered during the construction of new freeways through sensitive areas.

Due to practical reasons, so far mitigation measures were implemented to maintain the existing corridors of vertebrates (there are no real green bridges in the country). In comparative local studies amphibians turned out to be the most frequently killed vertebrates on roads (Fenyves 1989, Onuczán 1992). Amphibian mass mortality was recognised even earlier and several toad rescue teams created temporary mitigation measures using buckets and plastic fences and suggested permanent solutions in different parts of the country from the 1980s onwards (Frank et al. 1991, Kárpáti 1988, Kelemen 2000, Puky 1989). In Central-Europe the first amphibian-related culvert modification occurred at Parassapuszta, Hungary in 1986 (Puky 2003). Since then, several dozens of amphibian-oriented mitigation infrastructure elements have been made under roads and motorways, especially after 1995.

A long-term conservation survey was launched in 1998 with a focus on existing roads near national parks to determine where amphibians are run over in large numbers and to suggest technical solutions for those sites (Puky 2001, 2006; Simonyi et al. 1999). As an integral part of

the national survey, twenty-four road sections with mitigation measures (all wildlife-oriented constructions including game passages and game bridges at that time), which help between one and five million amphibians annually to cross roads safely, were monitored in 2000. The studied mitigation measures proved to help individuals of at least thirteen species (two third of the Hungarian amphibian fauna) to cross the road (Puky and Vogel, 2004).

The tunnel systems showed a great diversity e.g. in tunnel and fence material, their position in relation to the road and connections between them. Because of economical reasons, concrete tunnels are the most common. The accessibility of the entrance was a frequent problem, especially in areas where erosion was considerable. Some systems did not work because certain elements (usually fences) were in bad condition. Elsewhere, lack of maintenance reduced the efficiency of mitigation measures (Puky 2003, Puky and Vogel 2004). In case of adequate fencing, game passages and game bridges would also be adequate for the crossing of smaller size animals, amphibians as well as reptiles and small mammals similarly to slightly modified existing culverts under high road mortality sections. Such improvements would be required at several sites.

Roads are known to have a barrier effect on game species such as red deer in Hungary (Szemethy et al. 1994), which has a 200-800 hectare home range (Szemethy et al. 1999) with an extreme of 17,000 hectares (Szemethy pers. comm.). According to the current statistics, 0.1-1% of the Hungarian fallow deer, wild boar, moufflon, red deer and roe deer population dies in accidents annually (Bidló et al. in Pallag 2000). Game bridges and game passages only exist along motorways in Hungary, which are protected from game species by fencing along their entire lengths.

Besides improving the existing mitigation measures and creating new ones, environmental education should be a key element of future projects, with special focus on decision-makers, local residents and the general public (Puky and Vogel 2004).

### **Message**

The implementation of wildlife mitigation measures on roads is becoming a routine task in Hungary. As a result, different mitigation measure types exist in the country, mostly along motorways, but also on lower roads.

### **Future and knowledge gaps**

The regular monitoring and feed-back, the maintenance and, where necessary, improvement of mitigation measures are still missing elements of a well-functioning linear infrastructure mitigation system. The improvement of public relation activities on fauna passages is necessary for the effective protection of wildlife on roads.

## ***2. Ecovillage***

István Gyulai

The first initiatives to build ecovillages were launched in the early 1990s in Hungary, however, these can hardly be regarded as typical ecovillages. Despite many similarities, like the use of renewable energy sources, natural building materials, organic farming and conservation of the rural traditions, the initiatives selected different ways of implementation. At Visnyeszéplak

(founded in 1991) the settlers harmonize the ecologically sound lifestyle with community development and the revival of traditions. At the previously deserted Gyűrűfű inhabitants are partly dealing with farming and partly with intellectual activities by using the Internet (Borsos, 1998).

In 1993 the Ecological Institute for Sustainable Development was invited by the local government of Gömörszőlős to make a relevant development scenario to mobilize the intellectual investments and common will of the community, that suffered from different challenges, like decreasing population, as a result of migration of the young to larger towns, unbalanced age structure, relative poverty, poor employment opportunities and high unemployment level, lack of social facilities, restricted opportunities for cultural events and poor educational facilities. To promote local production for the local market, a wool processing plant was constructed, an organic farm was created, extensive orchards were revitalised, and different handicrafts were designed and manufactured. They resulted around 40 different local products, all meeting the criteria of sustainable resource use. The project has received national and international awards (Gyulai, 1998).

A new wave of ecovillage initiatives is arising recently. Galgahévíz is a prominent example, where 30-40 families cultivate several hundred hectares according to the principles of ecological farming. Certified bio-products, the folk high-school, the education centre and the foundation working for rural development now provide a long-term basis for the establishment of a new ecovillage situated in the border-land of the settlement.

Several other initiatives try to generate broader impact through ecological landscape management. They brought new concepts to alternative rural development initiatives with focus on community relations (Lantos, 1998). Environmental education also contributed significantly to the conservation of natural habitats and associations e.g. along the River Dráva or in Somogy county (Hivatal et al., 1998). They help the survival of ecological values existing for centuries e.g. by using traditional methods of fish farming and animal husbandry, conserving the natural and cultural diversity for future generations. It is important to present these activities and values to the public, and some also have visitors programs, such as riding holidays, which are now well-known.

### **Message**

Ecovillages with different awards have developed on diverse theoretical and religious bases and approaches in Hungary as an alternative for modern city life. Willingness of living in a sustainable way and the use of the agricultural potential of the country are the major driving forces. By 2007 ecovillages have tried to find their ways into the society by participating in organic food production, education and the tourism industry.

### **Future and knowledge gaps**

The economic environment is not as favourable towards sustainable living initiatives as it should be, however, different communities running ecovillages utilised well their natural and intellectual resources to survive long-term in their past 15 years of existence. As a consequence, different means, e.g. internalisation of negative external costs, should promote their development together with a national analysis of where further settlements should be initiated.

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## **Objective 5: To substantially reduce the impact on EU biodiversity of invasive alien species (IAS) and alien genotypes.**

### **Impact of alien genotypes on biodiversity A5.2.**

#### ***1. Genetically modified organisms***

András Horváth and Gábor Bakonyi

Despite that the global biotech crop area exceeds 100 million hectares in 2006 (Clive J. 2006), only relatively limited number of research works has assessed the impact of genetically modified organisms (GMO) on environment, ecosystem services and human health (Lövei 2006). Results of these studies draw our attention to that advantages of GM crops compared with those of conventional crops are not unambiguous. Actually, the cultivation of GM organisms involves serious environmental risks, and the consumption of food products containing GM crops can affect human and animal health adversely (Pusztai and Bardócz 2004, Bardócz and Pusztai 2006). Hungarian studies, which are summarized below, made a great step forward to reveal these hazards.

Currently, the production of GM crops is not authorized in Hungary. Besides, EU ministers of environment rejected a proposal from the EU Commission obliging Hungary to repeal its ban on MON 810 maize on 20. February 2007. Different varieties of Bt-maize producing *Bacillus thuringiensis* (Bt) Cry1-toxin are proposed by several agro-biotech companies to plant (Füsti 2006). Hungarian researchers therefore examined the impact of the genetically modified Bt-maize (e.g. DK-440 BTY, DKC 4442YG, PR37R71 containing event MON810) on crop production, toxin remnants, biological activities in soil, gene-flow to izogenic plants, risk for pollinators, including bees and protected butterflies, resistance of parasites, etc.

The crop production of the Cry1-toxin containing Bt-maize is practically the same as that of the conventional izogenic maize; there was only 0-5% excess production when relatively strong *Ostrinia nubilalis* invasion appeared (Füsti 2006). However, *Ostrinia nubilalis* does not cause considerable loss on maize production in Hungary.

Because every cell of Bt-maize produces Cry1-toxin, the quantity of toxin per hectare in Bt-maize fields is 1.5-2 thousand times larger than in izogenic ones treated by commercial Bt-insecticide (DIPPEL). Therefore the loading of environment induced by the Cry1-toxin containing Bt-maize is larger than in case of the equivalent Bt-insecticide (DIPPEL) (Székács and Darvas 2006). Largest quantities of toxins occur in the leaf and stem. The residual of toxin produced by Bt-maize is about 4% one year later, which accumulated in the soil as stubble-rest (Székács and Darvas 2006).

The C:N ratio is significantly larger in the remains of izogenic maize compared to those of Bt-maize, therefore deficiency of nitrogen causes the decomposition to be less intensive, independently of toxin-content (Villányi et al. 2003, Biró and Villányi 2006). The microbial activity was significantly higher in the Cry1-toxin producing Bt-maize rhizosphere compared to that of the isogenic (Biró et al. 2005). At the same time, a field study on the same site showed that the biological activity (measured as soil CO<sub>2</sub>-production) was smaller in the soil of the Bt-maize (Bakonyi et al. 2006a). Relying on feeding preference experiments with three Collembola-

species (*Folsomia candida*, *Heteromurus nitidus*, *Sinella coeca*) it can be stated that *F. candida* prefers less the Bt-maize as food source, while the other two species do not distinguish the isogenic and Cry1-toxin producing maize (Bakonyi et al. 2006b).

If an isogenic maize plant is pollinated by a Cry1-toxin producing Bt variety, the new seeds of isogenic maize will produce 1/3 quantity of Cry1-toxin (Székács and Darvas 2006). So, the GM-free bio-production is threatened by spontaneous drift of GM maize pollens. Cry1-toxin content of pollens is non-toxic directly for honey-bee adults or larvae, but it reduces both the weight gain of larvae and resistance of adults against *Nosema* infestation (Békési 2006, Békési et al. 2006). In a laboratory study, 1/5 of the larvae-population of the protected butterfly species *Inachis io* died, when the pollen concentration on the leaves of food-plants (*Urtica dioica*) was set to the same level as at the borders of Bt-maize fields (Lang et al. 2007, Lauber et al. 2006).

It is verified that nearly complete resistance has been developed against the Cry1-toxin produced by Bt-maize in the tenth generation of *Plodia interpunctella* (Darvas et al. 2005, Darvas and Lauber 2006). In the thirtieth generation the resistance of the pestiferous moth species was four times larger against insecticide containing Cry1-toxin (Darvas et al. 2006).

### Message

The cultivation of the genetically modified MON 810 maize involves serious environmental risks, which have been revealed by Hungarian researchers. These hazards appear in relation to quantity of toxin produced by MON 810 maize in the fields, toxin remnants, less intensive biological activities in soil, gene-flow to isogenic plants, risk for bees and protected butterflies, rapidly developing resistance of parasites.

### Future and knowledge gaps

Further comprehensive studies are necessary to assess environmental impacts of other genetically modified crops proposed to grow as food, feed, bio-fuel or other energy-plants.

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(Note: Regarding the scarce literature on the impacts of GM plants, Abstracts from conferences are also involved in the list of this section)

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## ***2. Alien invasive species***

Identification of alien species that have the potential to become invasive would be the best method to avoid their harmful effect in the future. Despite efforts to describe the general characteristics of species that become invasive, prevention of invasion events is rare. The list of invasive species is under continuous revision (Bartha 2000, Török et al. 2003). There are debates on certain species, but there is a general agreement on others.

Knowledge on the behavior of invasive species and their distribution provide the basis for the fight against them. Studies so far on biological invasions revealed that the Carpathian basin is highly infected as a result of biogeographical characteristics in comparison with several other European countries. The transitional nature of climate (sub-Mediterranean, continental, less

atlantic and alpine) makes this territory particular susceptible to invasions (Török et al. 2003), the Carpathian basin may have a role as ‘invasion gate’ to Europe.

The impacts of invasive species include threat to natural communities, weeding of crops, pollen supply to induce allergy in humans. An exhaustive list of invasive plant and animal species with the identification of habitat types most affected was published by Török et al. in 2003. Different habitat types have different species of alien invasions. Habitat types can be ranked according to their sensitivity to invasion on the basis of the number, frequency and abundance of invasive species present. An approximate rating of the sensitivity of habitat types to invasion was produced for plants based on field experiences (Török et al. 2003). Most threatened habitats in Hungary are sandy grasslands, flood plains, gallery forests, forest plantations and ruderal areas. Submersed vegetation and rock grasslands are the least sensitive to invasion.

The two volumes with the description of invasive plant species in Hungary has become a handbook used in nature conservation (Mihály and Botta-Dukát 2004, Botta-Dukát and Mihály 2006). Beside a detailed description of the biology, distribution and behavior of the species, the books provide suggestions and tested methodologies for the eradication or the containment of the invasive species.

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## ***Develop indicators and monitoring schemes (C.1.3)***

### **The Hungarian Biodiversity Monitoring System (HBMS)**

Katalin Török

The need for the establishment of monitoring schemes for biodiversity was first expressed in Rio, in 1992, when the Convention on Biological Diversity was launched. Since then, national and international institutions and organisations call for biodiversity monitoring activities. At the European level, a great number of documents and statements on the need of monitoring (e.g. Göteborg strategy), but the lack of organised international activity characterised the last decade, up to the recent past. Important steps forward are the activity of the European Environmental Agency to streamline biodiversity indicators (SEBI), the drafting of the European Action Plan to halt biodiversity loss (COM 2006) and the reporting on the NATURA 2000 species and habitats, first due in 2007. As a result, the state of biodiversity at EU and national level will be better documented.

Regarding this state of art, the early development of the Hungarian Biodiversity Monitoring System (HBMS) is exceptional at European level. The HBMS is a national programme for observing the state of biological diversity in Hungary. The programme started with the elaboration of the concept and sampling methodologies under a PHARE project between 1995-1997. The results were edited in a series of 10 volumes in 1997, the handbook on habitat mapping appeared latter (1999). The concept was developed along the guidelines of the Convention on Biological Diversity, that is, beside populations of species, the diversity of communities, habitats and landscapes is taken into consideration. The development of protocols to carry out field sampling was based on a wide expert community, including botanists, zoologists, mapping experts and ecologists and resulted in a great number of tested guidelines for different components of the living world. Field sampling was made possible in 1998, when monitoring coordinators were employed at the national park directorates that carry out the work regionally. Data are gathered ever since in an increasing volume with the help of researchers and different universities and institutes (Török and Fodor 2001, Demeter et al. 2002). The Authority for Nature Conservation of the Ministry for Environment and Water is supervising the monitoring activities.

A review was started in 2003 to summarise the results and to test the value of data gathered during 5 years. The main finding of the process was that the sampling methods are relevant to the task, only minor changes in a few protocols have been suggested. It was concluded, that the HBMS was an important source of information during the every day operation of the national parks. However, the development of the system experienced difficulties as not all the planned activities could be carried out. Even presently, an important drawback is the lack of sufficient staff to coordinate the programme and to handle the data.

The first volume of the planned series to demonstrate the results of HBMS in form of scientific papers appeared in 2006 (Török and Fodor 2006). This volume contains three papers. The first one is on habitat mapping results, with a novel methodology. It demonstrates the possible use of habitat maps to compare areas and to analyse map series in time. The results of bryophyte monitoring is the topic of the second paper, while the third is dealing with macrofungi, another field of biodiversity without sufficient sampling experience and with methodological difficulties.

The titles and legends of figures and tables and the summaries enable the understanding of the main findings for English speaking scientists.

The data gathering of the HBMS has contributed to research on biodiversity and resulted in several other publications and presentations at conferences.

Regional subprogrammes, focusing on local environmental problems are also part of the HBMS. These include the monitoring of the Tisza river valley, the Dráva river, the Szigetköz area of the Danube and the Kis-Balaton water reservoir. Currently the harmonisation of HBMS and NATURA 2000 monitoring schemes is under way.

## **Common Breeding Birds Monitoring**

Common birds, as environmental indicators, are used by the Common Breeding Birds Monitoring Program of BirdLife Hungary (Szép and Gibbons 1999, Szép and Nagy 2002) since 1998. The monitoring scheme based on this indicator group aims at tracking changes in various habitat types, and was designed by BirdLife Hungary for the call of the European Bird Census Committee (EBCC) in a way that the largest possible study area can be sampled (the territory of Hungary) by using easily identifiable indicator species in order to involve multitudinous non-professional volunteers.

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## **Conclusions**

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A great variety of research results have been published or are in a preparatory phase that may support the sustainable use of biodiversity in Hungary, based on surveys, experiments or analyses. Results are summarised along the actions and objectives proposed by the European Commission (COM 2006) to halt the loss of biodiversity by 2010 and beyond. Studies reviewed focus on the wider countryside, areas with human impact or direct use by agriculture. The review exercise itself has revealed unknown research results of other authors and helped to have a broader view at national level as well. Several research projects are carried out on the possible future effects of climate change, however, this was not the topic of this review, so such results are only mentioned in a few parts, linked to other issues.

The main results that could be applied to use biodiversity and ecosystem services in a more sustainable way are as follows:

- grazing and mowing regime and intensity influences biodiversity according to taxonomic groups: best practice can be suggested to favour different species groups;
- in most cases regeneration of perennial grasslands at abandoned arable fields cannot rely merely on seed bank, manipulation is required;
- socio-economic issues largely determine land race diversity of crops;
- first attempts to evaluate ecosystem services help to develop methodology and provide basis for further analyses;
- important steps to describe and conserve forest genetic resources have been made;
- forest edges conserve remarkable soil fauna diversity;
- map of the natural vegetation heritage has been produced over the whole territory of Hungary (MÉTA database);
- the Pro Silva programme has achieved good results in developing ecologically and economically sustainable forest management practices;
- a plant community resembling the target perennial protected grassland can be restored at arable fields and clear-cut tree plantations by the use of combined treatments;
- surveys on the effectivity of wildlife mitigation measures on roads to increase ecological coherence contributed better technical solutions;
- experiences gained through the building and operation of ecovillages help to popularize more sustainable lifestyles and different use of livelihoods;
- experiments revealed that genetically modified organisms (maize) may cause serious risks for biodiversity and the environment;
- the Carpathian basin is an invasion gateway to Europe and is highly infected, alien invasive plant species have been identified and described;
- the Hungarian Biodiversity Monitoring System is a remarkable programme to collect data on species, community and landscape diversity and trends, completed by the Common Breeding Birds Monitoring for bird data.

The following lack of knowledge hinders most the understanding of processes and the sustainable use of biological resources:

- estimation of ecosystem services over large areas;
- habitat change modelling at large scale;
- the link between land management and biodiversity for other habitat types and communities;
- influence of organic farming on biodiversity;
- the relation between arable field management type and biodiversity;
- the role of public perceptions and activities in attaining sustainable use of biodiversity;
- and many others.

There are certain negative trends in governance and policy orientation that seem not to support sustainability and the biodiversity action plan (COM 2006). It is important to motivate further

- measures to help conserve agro-biodiversity (crop varieties, breeds and races);
- institutional support and state funding for the conservation of forest genetic resources;
- support of research on biodiversity and its links to socio-economic processes;
- commitment to continue successful biodiversity monitoring programmes.