INTEGRATED BOTANICAL AND ZOOLOGICAL RESEARCH IN CONSERVATION ECOLOGY TO RESTORE, CONSERVE AND INCREASE GRASSLAND BIODIVERSITY

FINAL TECHNICAL REPORT OF OTKA NNF GRANT NO. 78887 (March 31, 2011)

1. PROJECT RESULTS (PUBLICATIONS RELATED TO THE PROJECT)

1.1. PROJECT DESCRIPTION AND STATUS

We planned eight tasks in three workpackages (WP) in the original proposal. The current status of these tasks as well as related publications is shown in **Table 1**. A summary of results is given in Chapter 2.

Table 1. An overview of project completion until the end of reporting period 4 (March 31, 2011).

WP	Task	Short description	Activity status	Related publications *
WP1	Task 1	Continued monitoring of grassland restoration and synthesis of early results	Field surveys and lab studies completed in Periods 1-3 as planned, all data from 2009 and 2010 available. Some zoological samples are being sorted/identified in the lab.	(**Déri et al. in press**), (**Török et al. 2010**), **(Vida et al. 2010**), (Kelemen et al. 2010), (Kelemen 2010), (Valkó et al. 2010), (Deák et al. in revision), (Lengyel et al. in review-b) (Török et al. in review), (*Török et al. 2009, 2010*), (*Vida et al. 2009*)
	Task 2	Development of long-term database	Database is operational and complete for 2004-2009. Data from 2010 are prepared for upload in database.	(**Lengyel et al. 2009**), (**Rocchini et al. in press**), (*Lengyel et al. 2009a,b, 2010*)
	Task 3	Testing hypotheses on community assembly	Testing is currently ongoing.	(**Rocchini et al. in press**), (*Szabó et al. 2010*)
WP2	Task 1	Extending and repeating habitat monitoring	Field surveys completed in Period 3, data for 2010 are prepared for upload in database.	(Lengyel et al. in review-a), (*Lengyel & Seliskar 2009*)
	Task 2	Study of changes in landscapes	Habitat maps completed in Period 2, data analysis ongoing.	(**Török et al. 2011**), (*Varga et al. 2010*), (*Lengyel et al. 2009a*)
	Task 3	Relationship between habitat diversity and species diversity	Study completed, one manuscript submitted, further time-series comparisons underway.	(Lengyel et al. in review-b), (Déri et al. in review)
WP3	Task 1	Grazing experiment	Plots constructed, experiments carried out as planned, data from 2009 in database, data from 2010 are ready for upload.	(**Török et al. in press**), , (Ölvedi 2010), (*Tóthmérész et al. 2010*), (*Lengyel et al. 2010*)
	Task 2	Mowing experiment		

* Articles published or accepted for publication in ISI-journals are highlighted in **Bold** and presentations at international conferences are given in *Italics* (full references are given in References Cited).

1.2. PUBLICATIONS REFERRED TO IN TABLE 1

Since the start of the project, **9 papers** in ISI-listed journals (total IF: **24.784**) and 7 papers in Hungarian journals have been published or accepted for publication. One of these papers (Málnás et al. in press) is not related to the topic of the proposal and the OTKA-NNF funding was not acknowledged in another (Török et al. 2011) (without these, **7 papers**, total IF: **18.745**). Two papers are currently under minor revision and three other papers are under evaluation in ISI-journals. We gave 8 talks (two of them invited) and 4 posters at international scientific conferences and three talks (one invited) at Hungarian conferences with acknowledging the OTKA-NNF funding. Finally, one PhD dissertation and three MSc theses were published related to the research carried out and one student paper partly funded by the grant reached first place at the national competition for undergraduate students (OFKDK).

1.2.1. Papers in ISI-listed journals

1. Lengyel, S., A. D. Gove, A. M. Latimer, J. D. Majer, and R. R. Dunn. 2009. Ants sow the seeds of global diversification in flowering plants. ***PLoS ONE*** 4:e5480. [**IF: 4.351**]
2. Lengyel, S., A. D. Gove, A. M. Latimer, J. D. Majer, and R. R. Dunn. 2010. Convergent evolution of seed dispersal by ants, and phylogeny and biogeography in flowering plants: a global survey. ***Perspectives in Plant Ecology, Evolution and Systematics*** 12:43-55. [**IF: 4.684**]
3. Török, P., B. Deák, E. Vida, O. Valkó, S. Lengyel, and B. Tóthmérész. 2010. Restoring grassland biodiversity: sowing low-diversity seed mixtures can lead to rapid favourable changes. ***Biological Conservation*** 143:806-812. [**IF: 3.167**]
4. Vida, E., O. Valkó, A. Kelemen, P. Török, B. Deák, T. Miglécz, S. Lengyel, and B. Tóthmérész. 2010. Early vegetation development after grassland restoration by sowing low-diversity seed mixtures in former sunflower and cereal fields. ***Acta Biologica Hungarica*** 61:246-255. [**IF: 0.551**]
5. Rocchini, D., J. Hortal, S. Lengyel, J. M. Lobo, A. Jimenez-Valverde, C. Ricotta, G. Bacaro, and A. Chiarucci. 2011. Accounting for uncertainty when mapping species distributions: the need for maps of ignorance. ***Progress in Physical Geography*** 35: 211-226. [**IF: 2.261**]
6. Török, P., A. Kelemen, O. Valkó, B. Deák, B. Lukács, and B. Tóthmérész. 2011. Lucerne-dominated fields recover native grass diversity without intensive management actions. ***Journal of Applied Ecology*** 48: 257-264. [**IF: 4.197**]
7. Déri, E., T. Magura, R. Horváth, M. Kisfali, G. Ruff, S. Lengyel, and B. Tóthmérész. *in press*. Measuring the short-term success of grassland restoration: the use of habitat affinity indices in ecological restoration. ***Restoration Ecology***. [**IF: 1.665**]
8. Török, P., E. Vida, B. Deák, S. Lengyel, and B. Tóthmérész. *in press*. Grassland restoration in former croplands in Europe: an assessment of applicability of techniques and costs. ***Biodiversity and Conservation***. [**IF: 2.066**]
9. Málnás, K., L. Polyák, É. Prill, G. Kriska, R. Hegedüs, G. Dévai, G. Horváth, and S. Lengyel. *in press*. Bridges as optical barriers and population disruptors in the mayfly *Palingenia longicauda*: an overlooked threat to freshwater biodiversity? ***Journal of Insect Conservation***. [**IF: 1.842**]

1.2.2. Manuscripts submitted or under revision in ISI-listed journals

1. Deák B, Valkó O, Kelemen A, Török P, Miglécz T, Ölvedi T, Lengyel S, Tóthmérész B. *In revision*. Litter and graminoid biomass accummulation suppresses weedy forbs in grassland restoration. Under minor revision in *Plant Biosystems*.
2. Lengyel S, Tar J & Rózsa L. *In revision*. Flock size measures in migrating Lesser White-fronted Geese (*Anser erythropus*): similar crowding in flocks of varying size. Under minor revision in *Ornis Fennica*.
3. Lengyel S, Lontay B, Stewart IRK, Küpper C, Burke T & Székely T. *In review-a*. Chick adoption in relation to brood sex ratio in pied avocets: a test of four hypotheses. Submitted to *Behavioral Ecology and Sociobiology* in Jan 2011.
4. Török P, Miglécz T, Valkó O, Kelemen A, Deák B, Lengyel S, Tóthmérész B. *In review.* Weed suppression and seed bank in early grassland restoration: understanding ecological processes for weed control. Submitted to *Ecological Engineering* in Jan 2011.
5. Lengyel S, Varga K, Lontay L, Déri E, Török P, Tóthmérész B. *In review-b*. Grassland restoration to conserve landscape-level biodiversity: a synthesis of early results and experiences from a large-scale project. Submitted to *Applied Vegetation Science* in Feb 2011.

1.2.3. Papers in Hungarian journals

1. Déri E, Lengyel Sz, Lontay L, Deák B, Török P, Magura T, Horváth R, Kisfali M, Ruff G & Tóthmérész B. 2009. Természetvédelmi stratégiák alkalmazása a Hortobágyon: az egyek-pusztakócsi LIFE-Nature program eredményei. ***Természetvédelmi Közlemények*** 15: 89-102.
2. Déri E, Horváth R, Magura T, Ködöböcz V, Kisfali M, Ruff G, Lengyel Sz & Tóthmérész B. 2009. A földhasználat-változás hatásai az ízeltlábú együttesekre Egyek-Pusztakócson. ***Természetvédelmi Közlemények*** 15: 246-256.
3. Török P, Kelemen A, Valkó O, Miglécz T, Vida E, Deák B, Lengyel Sz & Tóthmérész B. 2009. Avar-felhalmozódás szerepe a gyepesítést követő vegetáció-dinamikában. ***Természetvédelmi Közlemények*** 15: 160-170.
4. Ölvedi T. 2010. A kaszálás vegetációra és magkészletre gyakorolt hatásai. ***Botanikai Közlemények*** 97: 159-169.
5. Kelemen A, Török P, Deák B, Valkó O, Lukács B, Lengyel Sz & Tóthmérész B. 2010. Spontán gyepregeneráció extenzíven kezelt lucernásokban. ***Tájökológiai Lapok*** 8: 57-68.
6. Valkó O, Vida E, Kelemen A, Török P, Deák B, Miglécz T, Lengyel Sz & Tóthmérész B. 2010. Gyeprekonstrukció napraforgó- és gabonatáblák helyén alacsony diverzitású magkeverékek vetésével. ***Tájökológiai Lapok*** 8: 77-88.
7. Kelemen A. 2010. Szántóföldi kultúrák helyén végzett gyepvetés korai szakaszában megjelenő gyomközösségek vizsgálata a Hortobágyi Nemzeti Parkban. ***Tájökológiai Lapok*** 8: 497-506.

1.2.4. Presentations at scientific conferences (presenter underlined)

1. Lengyel Sz & Seliskar A. 2009. Habitat monitoring in Europe: current situation and future perspectives. **Invited talk**, ***2nd European Congress of Conservation Biology***, Prague, Czech Republic.
2. Török P, Vida E, Valkó O, Deák B, Lengyel Sz, Tóthmérész B. 2009. Conserving grassland biodiversity by restoration: low-diversity seed mixtures, weed control, rapid changes and landscape effects. Talk, ***2nd European Congress of Conservation Biology***, Prague, Czech Republic.

3. Vida E, Deák B, Kapocsi I, Török P, Lengyel Sz, Tóthmérész B. 2009. Restoration of alkali and steppe grasslands in arable fields with low-diversity seed mixtures. Poster, ***2nd European Congress of Conservation Biology***, Prague, Czech Republic.
4. Lengyel Sz, Török P, Déri E & Tóthmérész B. 2009a. Large-scale grassland restoration to increase habitat diversity at the landscape scale. Talk, ***19th Conference of the Society for Ecological Restoration International***, Perth, Australia.
5. Lengyel Sz, Gove AD, Latimer AM, Majer JD & Dunn RR. 2009. Seed dispersal mutualisms, diversification and global climate change. Talk, ***10th International Congress of Ecology***, Brisbane, Australia.
6. Deák B, Valkó O, Vida E, Kelemen A, Miglécz T, Török P, Lengyel Sz, Tóthmérész B. 2009. Gyepesítés alacsony diverzitású magkeverékek vetésével korábbi lucernások helyén. ***8th Hungarian Ecology Congress***, Szeged, Hungary.
7. Lengyel Sz, Varga K, Déri E, Lontay L, Török P, Tóthmérész B. 2010. Grassland restoration and management to conserve biodiversity at the landscape scale. **Invited talk**, ***7th European Conference on Ecological Restoration***, Avignon, France.
8. Török P, Vida E, Valkó O, Deák B, Miglécz T, Lengyel Sz, Tóthmérész B. 2010. Grassland restoration with sowing of low-diversity seed mixtures in former sunflower and cereal fields. Talk, ***7th European Dry Grassland Meeting***, Smolenice, Slovakia.
9. Tóthmérész B, Kelemen A, Valkó O, Vida E, Lengyel Sz, Török P. 2010. Accumulated litter suppresses weeds in grassland restoration. Talk, ***7th European Dry Grassland Meeting***, Smolenice, Slovakia.
10. Lengyel Sz. 2010. Adoption of chicks as a selfish behaviour in the Pied Avocet. Talk, ***95th Annual Meeting of the Ecological Society of America***, Pittsburgh, USA.
11. Szabó Gy, Horváth R, Zakar E, Kozák L, Lengyel Sz. 2010. The effect of grassland restoration on bee communities – a preliminary study in Hortobágy National Park. Poster, ***7th International Congress of Hymenopterists***, Kőszeg, Hungary.
12. Varga K, Crisan A, Lengyel Sz. 2010. Short-term, weather-related changes in landscape structure and complexity in grasslands and marshes. Poster, ***International Conference in Landscape Ecology***, Brno, Czech Republic.
13. Polyák L, Lengyel Sz, Málnás K, Prill É, Kriska Gy, Horváth G. 2010. Emberi létesítmények hatása a tiszavirág [*Palingenia longicauda* (Olivier, 1791)] állománynagyságára és ivararányára. Talk, ***7. Conference on Research of Aquatic Macroscopic Invertebrates***, Sümeg, Hungary.
14. Lengyel Sz. 2011. Design of conservation research projects. **Invited talk**, ***Final Conference of project "Research on natural values of Bükk National Park I. Complex assessment of the Ipoly catchment"***, Eger-Felsőtárkány, Hungary.
15. Keil P, Kunin W, Schweiger O, Settele J, Kühn I, Henle K, Steinecke H, Brotons L, Kuussaari M, Pe'er G, Lengyel S, Moustakas A, Storch D. 2011. Patterns of beta diversity in Europe: what drives species turnover and how unique are the species-rich areas in the south? Poster, ***5. International Conference of the International Biogeography Society***, Crete, Greece.

1.2.5. PhD-dissertations and MS-theses

1. Fekete O. 2009. Az Egyek-Pusztakócsi tájrehabilitáció második ütemének a madárvilágra gyakorolt hatásai. ***MS thesis***, Department of Ecology, University of Debrecen.
2. Szabó Gy. 2009. Az élőhelyszerkezet és élőhelyhasználat összefüggéseinek vizsgálata a telepesen fészkelő kék vércsék példáján keresztül. ***MS thesis***, Department of Ecology, University of Debrecen.
3. Polyák L. 2010. Emberi létesítmények hatása a tiszavirág [*Palingenia longicauda* (Olivier, 1791)] állománynagyságára és ivararányára. ***Student paper*** [**1st prize**, National Scientific Conference for Undergraduate Students]
4. Polyák L. 2010. Műtárgyak hatása a tiszavirág [*Palingenia longicauda* (Olivier, 1791)] állománynagyságára és összetételére egy felső-tiszai telepen. ***MS thesis***, Department of Ecology, University of Debrecen.
5. Déri E. 2011. Habitat-scale biodiversity: changes, influencing factors, monitoring and restoration. ***PhD-dissertation***, Department of Ecology, University of Debrecen.

2. SUMMARY OF RESULTS

2.1. Early results of grassland restoration: synthesis

An overview of the strategic planning process of the habitat restoration and management programme has been prepared for intended use by practitioners (Déri et al. 2009). Our experience at international conferences suggested that the grassland restoration, which was carried out at a scale (760 hectares in 4 years) unprecedented in Europe and rarely matched in North America and Australia, draws a lot of interest from both scientists and practitioners. Therefore, we have compiled a manuscript on the technical design and implementation of grassland restoration, based on an invited conference presentation (Lengyel et al. 2010), and the manuscript is currently under review in *Applied Vegetation Science*. We have also summarised our experience in carrying out grassland restoration, primarily aimed to practitioners, in two reviews of the major techniques and the costs of grassland restoration (Vida et al. 2008, Török et al. in press).

2.2. Short-term changes in flora and fauna after grassland restoration

Grassland restoration on arable lands was generally successful. The sown grass species became dominant and grass cover established as early as in Year 2 after restoration (Török et al. 2010). The plant species composition of alkali restorations approached that of target grasslands as early as Year 3 after restoration, whereas loess restorations progressed slower towards the target grasslands. Although natural revegetation on former alfalfa fields can lead to grasslands with high floristic diversity in 10 years (Kelemen et al. 2010, Török et al. 2011), restoration appeared to greatly accelerate the natural (unassisted) revegetation of abandoned alfalfa fields (Lengyel et al. in review-b). For insects, there was a marked difference between Year 1 and 2 because the turnover of generalist species to more specialists has resulted in greatly increased naturalness of insects assemblages (Déri et al. in press). For birds, we found that species diversity increased greatly on restored grasslands compared to arable lands (Mérő et al. in preparation). This increase was mostly due to the increasing abundance of common rather than rare species. Many of the common birds are farmland birds that are seriously declining elsewhere in Europe.

Data from our experimental control plots showed that succession in the absence of removal of dead plant material (lack of grazing or mowing) leads to increasing amounts of litter. Litter accummulation has both beneficial and detrimental effects. Litter accummulation effectively suppressed the establishment of early colonizing weeds (Török et al. in review, Deák et al. in revision), although it may also hamper the colonization of dicotyledonous plants typical of target grasslands (Valkó et al. 2010, Vida et al. 2010, Török et al. in review). The differences in successional pathways could be well related to the previous history (last crop type) of restored lands. This was because post-restoration succession was relatively fast in former alfalfa fields (Török et al. 2010) and much slower in sunflower or cereal fields (Valkó et al. 2010). In all, several different successional pathways were observed, which may, with time, lead to high diversity of habitats and higher levels of landscape-level biodiversity (Lengyel et al. in review-b).

2.3. Changes in habitat patches and in landscape structure

We have digitized orthophotographs from three years of very different weather patterns to analyze changes in habitat patches and landscape structure. Year 2000 had higher-than-average precipitation (wet year), 2005 was an average year and 2007 had very low precipitation (extreme

dry year). A comparison of these three years showed that weather largely influences habitat patches and landscape structure (Varga et al. 2010), as detailed below.

The areal proportion of marshes decreased from 21% to 16% and that of grasslands increased from 16% to 20% between 2000 and 2007. Meadows showed smaller fluctuations (9% to 7%, then again 9%), although many of the meadow patches changed in geographical position and occupied former marsh areas. The average size of habitat patches decreased for marshes and increased for grasslands. The area-proportional changes were largest for grasslands (over +40%) and smaller for wet habitat types (6% for meadows and for marshes, respectively) between 2000 and 2005, whereas changes between 2005 and 2007 were smaller. The drying process between 2000 and 2007 could be seen because the most frequent change in the type of habitat patches was 'meadow → grassland' and 'meadow → fragmented meadow', followed by 'marsh → meadow', and because bare alkali flats ('vakszik') have appeared at 29 locations in 2007.

2.4. Grazing and mowing experiments

The early results of the experiments showed that both grazing and mowing were efficient in removing dead plant material (litter) and maintaining plant diversity. Control plots confirmed that lack of mowing leads to an increased accumulation of litter, and that there are important differences between plots mowed only once and those mowed twice within a growing season. Grazing by cattle and by sheep appeared highy beneficial in introducing plants from nearby natural grasslands into the restorations. Currently, our "best" grasslands are all in sites that are regularly grazed by livestock. Several of these grasslands are colonized by more valuable dicotyledonous species such as *Salvia nemorosa*, *Dianthus pontederae* etc. (Lengyel et al. in review-b), which provide feeding sources and attracts bees. In 2009, a significant increase in bee species was observed in three- and four-year-old restored grasslands (Szabó et al. 2010).

Experience at some mowed plots, however, showed that mowing may be less efficient than grazing in removing litter and in controlling weedy plants . Some plots that were mowed by farmers too late in the season are dominated by weeds such as *Cirsium arvense*. This may be a threat to the restoration process as *C. arvense* disperses both vegetatively and by wind-dispersed seeds, and controlling this species may present challenges in the future (Lengyel et al. in review-b, Török et al. in review). To provide a basis for further work, the potential effects of mowing on vegetation development have been reviewed in (Ölvedi 2010). This review shows that the impact of mowing are generally beneficial for the diversity of the vegetation and the seed bank in grasslands but that the realized effects depend on the intensity, timing and spatial arrangement of mowing (Ölvedi 2010).

2.5. Accessory activities

As corollary activities, we participated in three international scientific collaborations related to the topic of the original proposal. First, we participated in studying in detail the potential pitfalls of modelling species distributions (Rocchini et al. in press). Such modelling is an essential component in WP 2, Task 3 (Testing hypotheses on community assembly), which will require the use of distribution modelling based on the occurrence data we collect in the field. Second, we participated in a study in evolutionary ecology (Lengyel et al. 2009, 2010), during which we collected literature information for starting a plant trait database. An updated version of this database was used in the further development of the Egyek-Pusztakócs project database completed in this project, when we

plan to incorporate basic trait data (e.g. life form, longevity, dispersal type, habitat requirement etc.) for each species found in the study. Finally, we have evaluated the performance (scientific quality) of European habitat monitoring programs and proposed a benchmarking technique which may help monitoring coordinators to evaluate the performance of their programs relative to other programs (Lengyel et al. in review-a).

We have also started two preliminary studies to better understand ecosystem dynamics and ecosystem services of the studied habitats and to provide a foundation for future investigations. First, we carried out field surveys to test the effect of habitat management (fire management, grazing) on marsh-dwelling amphibians and birds. The southern half of Fekete-rét marsh, regularly grazed by cattle, was burned in late summer in both 2007 and 2009, which provided an excellent experimental setup to study six treatment levels with five replicates in each. We have surveyed a total of 30 transects in this study in 2010. Second, we collected preliminary data on bees (Hymenoptera: Aculeata) at 12 sites in 2010 to evaluate the colonization of restored grasslands by this animal group, which is highly important in providing ecosystem services such as pollination. We have found that both groups have colonized the restored grasslands and are present in numbers sufficient to initiate a thorough survey of them. Both of these studies will be elaborated on in the continuation of the project, financed by OTKA NNF grant no. 85562.

3. REFERENCES CITED IN THE TEXT

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Déri, E., S. Lengyel, B. Deák, R. Horváth, T. Magura, and B. Tóthmérész. in review. Similar responses to different measures mask general relationship between habitat diversity and species diversity. Biodiversity and Conservation.

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