Variability in responses of animal groups to grassland restoration

Lengyel S.[1], Szabo G.[1], Kosztyi B.[1], Mester B.[1], Mero T. O.[1], Török P.[1], Horvath R.[1], Magura T.[2], Racz I. A.[3], Tothmeresz B.[1]

University of Debrecen, [1] Department of Ecology, [3] Department of Evolutionary Zoology, 4032 Debrecen, Egyetem tér 1., Hungary
[2] Hortobágy National Park Directorate, 4024 Debrecen, Sumen u. 2., Hungary

Abstract

Understanding the diverse responses of animal groups to grassland restoration is vital for restoration planning. Here we summarise responses of seven animal taxa (orthopterans, bees, carabid beetles, spiders, amphibians, birds, mammals) to grassland restoration in Hortobágy National Park (E-Hungary). Species richness did not vary but abundance increased with time in orthopterans. Carabid species richness and abundance, and spider and bird abundance decreased after a peak in Year 1 after restoration. Both species richness and abundance of amphibians increased after Year 2. There were no changes in species richness and abundance of bees and small mammals and in the species richness of spiders and birds. Our results show that the responses to grassland restoration can greatly vary among animal taxa. Trends in several arthropod taxa could be explained by vegetation changes, whereas vertebrates showed fluctuations due to factors other than restoration per se.

Introduction

Grassland restoration on former croplands is a frequent habitat restoration in Europe and most studies have followed vegetation development to measure restoration success (Kiehl et al. 2010; Török et al. 2011). We know much less on how grassland restoration affects animal assemblages and thus monitoring should be extended to trophic groups other than plants (Dixon 2009; Woodcock et al. 2008).

This paper describes post-restoration changes in species richness and abundance of four invertebrate and three vertebrate taxa important in grassland biodiversity and ecosystem services. We evaluated these changes in the largest grassland restoration project in Europe, conducted in the Egyek-Pusztakócs marsh and grassland complex in Hortobágy National Park (E-Hungary).

Materials and methods

760 hectares of cropland were restored by sowing two low-diversity seed mixtures (two or three grass species depending on soils) between 2005 and 2008. Grassland restoration was generally successful (Lengyel et

al. 2012), more so on former alfalfa fields (Török et al. 2010) than on former sunflower or cereal fields (Vida et al. 2010). Insect assemblages changed from generalist to more specialist between Year 1 and 2 (Déri et al. 2011). For further details, please see http://life2004.hnp.hu or Lengyel et al. (2012).

We sampled grasshoppers and crickets (Orthoptera), bees (Hymenoptera: Apoideae), ground beetles (Coleoptera: Carabidae), spiders (Araneae), and frogs and newts (Amphibia), birds (Aves) and small mammals (Mammalia: voles, mice and shrews). We used standardised sweep-netting for sampling orthopterans and vegetation-dwelling spiders and yellow plate traps for sampling bees. Pitfall traps were used to sample carabid beetles and ground-dwelling spiders, and amphibians in an exceptionally wet year. Birds were censused in standardised point counts and we sampled small mammals by live trapping. We sampled croplands (start of restoration), restorations of four different ages (2005-2008) and natural grasslands (restoration targets). Each category was replicated by at least three sites. For Orthoptera, Carabidae and Araneae, data for croplands are from 2005, for natural grasslands from 2007, for restored grasslands from 2009. In all other taxa, data are from one year (Apoidea: 2010, Amphibia: 2010, Aves: 2009, Mammalia: 2011). We analysed species richness and abundance among six habitat types by one-way ANOVAs, after log-transforming the data when necessary, and used Tukey's HSD test for post-hoc comparisons.

Results and discussion

Species richness (SR) did not change considerably for Orthoptera (Fig. 1A), although their abundance (Ab) increased greatly with time (Fig. 1B). The SR of bees decreased gradually but non-significantly with time on restorations (Fig. 1C), and bee Ab was lower in restorations and natural grasslands than in croplands (Fig. 1D). Both the SR and Ab of Carabidae beetles increased in Year 1 and then decreased afterwards to below that on croplands (Fig. 1E, F). Although SR of spiders did not vary (Fig. 1G), their Ab decreased continually from a peak in Year 1 (Fig. 1H). Amphibians were more numerous in older restored grasslands than in younger ones or natural grasslands, both in SR (Fig. 2A) and Ab (Fig. 2B), mainly because of the Danube Crested Newt (*Triturus dobrogicus*). Bird SR did not change (Fig. 2C), although their Ab showed a peak in Year 1 and decreased slightly afterwards (Fig. 2D). Both the SR and the Ab of small mammals fluctuated widely, resulting in no discernible pattern (Fig. 2E, F).

We found that responses to grassland restoration can greatly vary among animal taxa. No change in total SR was most frequent (orthopterans, bees, spiders, birds, mammals) followed by increasing (amphibians) or decreasing (carabids) trends. Decreasing trends in Ab were the most frequent (bees, carabids, spiders, birds), followed by increasing trends (orthopterans and amphibians) and no trend (small mammals). The trends found may be related to vegetation changes. Litter accumulation and lack of propagula of dicotyledonous plants can lead to a low diversity of vegetation, which is typical in target grasslands and may influence arthropod assemblages. In bees, for example, transient species abundant in the weedy, flower-rich early stages decreased and the few species characteristic to the target natural grasslands increased in Ab. Alternatively, it is also possible that total SR and Ab are not the best indicators of post-restoration trends in animal diversity. First, species are likely to differ in their response to restoration, e.g. restoration may favour specialists over generalists, which can go unnoticed when total SR and Ab are considered. Second, changes in trends of a few rare species may be more important for conservation. Our previous findings, for example, showed that although combined SR did not change, species composition became more similar to that of natural grasslands, resulting in increasing naturalness of arthropod assemblages (Déri et al. 2011). Finally, it is also possible that post-restoration changes occur at longer time scales and that the short time since restoration (5-6 years at maximum) may not reliably detect changes on longer time scales.

Acknowledgments

We thank Hortobágy National Park for permits and logistic help, and four grants from the Hungarian Scientific Research Fund (OTKA - Norway Financing Mechanism NNF 78887, 85562, K 106133 to SL and OTKA PD 100192 to TP) and three Bolyai Research Fellowships to RH, SL and PT for financial support.

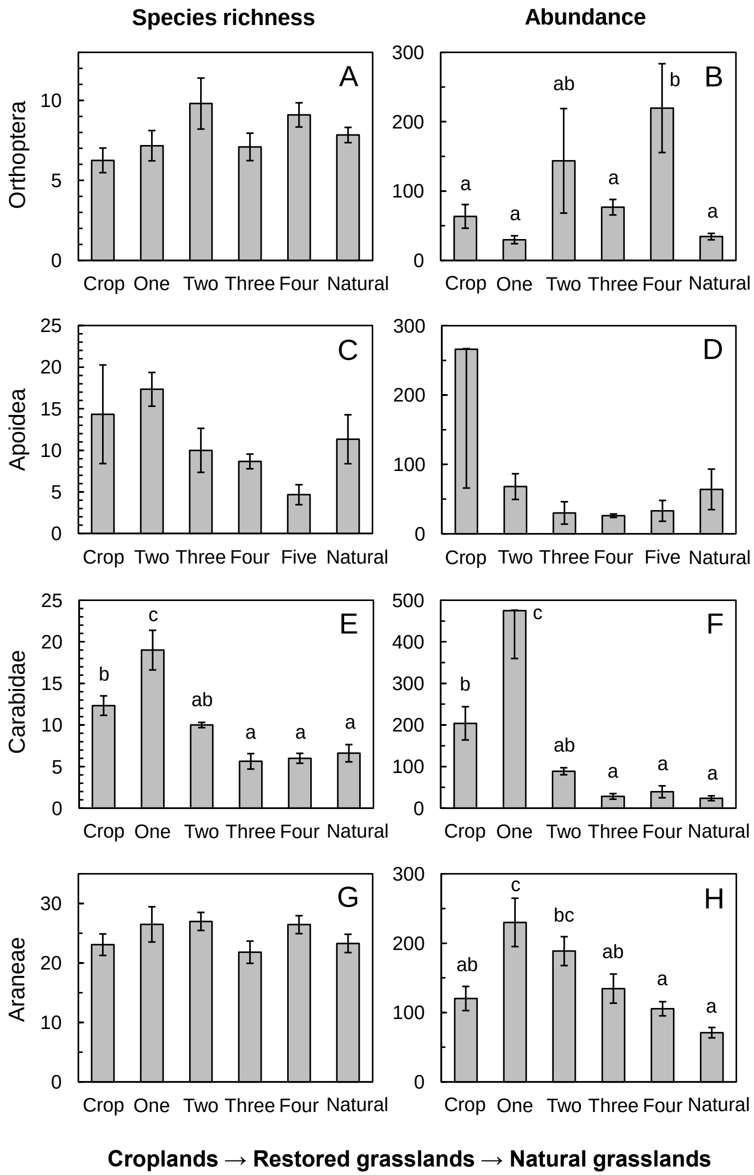

Figure 1. Mean ± S.E. of total species richness (left) and abundance (right) of four invertebrate groups in croplands, grassland restorations of four different ages and natural grasslands. Different lowercase letters indicate statistical significance between groups (Tukey's HSD, $p < 0.05$).

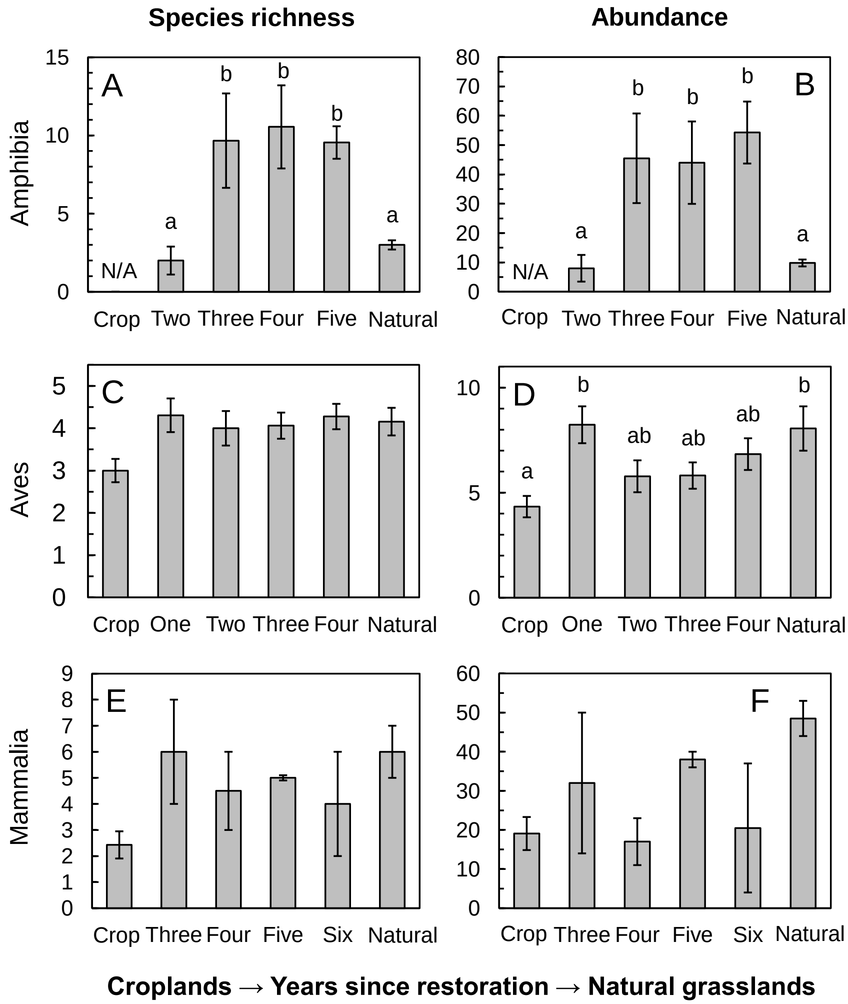

Figure 2. Mean ± S.E. of total species richness (left) and abundance (right) of three vertebrate groups in croplands, grassland restorations of four different ages and natural grasslands. Different lowercase letters indicate statistical significance between groups (Tukey's HSD, $p < 0.05$).

References

Déri, E., T. Magura, R. Horváth, M. Kisfali, G. Ruff, S. Lengyel, and B. Tóthmérész. 2011. Measuring the short-term success of grassland restoration: the use of habitat affinity indices in ecological restoration. *Restoration Ecology* 19:520-528.

Dixon, K. W. 2009. Pollination and restoration. *Science* 325:571-573.

Kiehl, K., A. Kirmer, T. W. Donath, L. Rasran, and N. Hölzel. 2010. Species introduction in restoration projects - Evaluation of different techniques for the establishment of semi-natural grasslands in Central and Northwestern Europe. *Basic and Applied Ecology* 11:285-299.

Lengyel, S., K. Varga, B. Kosztyi, L. Lontay, E. Déri, P. Török, and B. Tóthmérész. 2012. Grassland restoration to conserve landscape-level biodiversity: a synthesis of early results from a large-scale project. *Applied Vegetation Science* 15:264-276.

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.

Török, P., E. Vida, B. Deák, S. Lengyel, and B. Tóthmérész. 2011. Grassland restoration on former croplands in Europe: an assessment of applicability of techniques and costs. *Biodiversity and Conservation* 20:2311-2332.

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 (Suppl):246-255.

Woodcock, B. A., A. R. Edwards, C. S. Lawson, D. B. Westbury, A. J. Brook, S. J. Harris, V. K. Brown, and S. R. Mortimer. 2008. Contrasting success in the restoration of plant and phytophagous beetle assemblages of species-rich mesotrophic grasslands. *Oecologia* 154:773-783.