

Interactive effects of local and landscape scale restoration of semi-natural grasslands and agricultural fields on species interactions and ecosystem functions in different social-ecological systems (InterRest)

ABSTRACT

Context

Calcareous grasslands were created by traditional land use in European cultural landscapes and are among the most species-rich habitat types. They host many rare and highly endangered species but are nowadays often threatened, mainly by abandonment and eutrophication. Restoration measures are therefore urgently needed. However, transnational restoration approaches are lacking, and evaluations within regional restoration schemes usually focus only on indicator species or species richness and ignore biotic interactions, ecosystem functions and the landscape context. Species interactions, in particular, are important indicators of restoration success, as they are often more sensitive to environmental changes and determine vital functions that are necessary to stabilize ecosystems. InterRest analyses and links multiple interaction networks representing different ecosystem functions (e.g. decomposition, pollination, predation) as well as social-ecological interactions.

Objectives

InterRest investigates species interactions across different trophic levels, including plant-soil, plant-pollinator, and bird-food resource interactions, in both restored and degraded calcareous grasslands that are embedded in different socio-ecological and landscape contexts in three countries (Germany, Spain and Estonia). Biodiversity and species interactions are assessed by vegetation surveys, metabarcoding of soils, bird surveys, arthropod sampling via pitfall traps and sweep netting, bird faeces sampling, transect walks for bees and pollen collection.

In addition, InterRest evaluates ecosystem functions such as soil processes, pollination and predation. To this end, we conduct decomposition experiments, measure seed set of wild plant species, and use dummy caterpillars to measure predation pressure. It is hypothesised that local restoration measures will lead to more complex and stable interactions and improved ecosystem functions compared to degraded sites. Furthermore, InterRest investigates whether landscape-scale restoration through agri-environment schemes can make local restoration efforts more effective through additive or synergistic effects.

Finally, the project investigates a range of social factors that affect the willingness and capacities of stakeholders to implement restoration at both local and landscape scales. These include farmers, nature conservation organisations, land managers and local conservation authorities. Based on stakeholder interviews and ecological data, InterRest develops social-ecological networks to better understand human-nature interdependencies. To synthesize the results of this project, meta-network and multifunctional approaches will be applied to identify conservation priorities and possible trade-offs.

Conclusions

The results obtained so far indicate that restoration through extensive management in calcareous grasslands has positive effects on biodiversity. In Estonia, plant species richness and bird abundance were higher in restored sites compared to abandoned ones, but similar effects were not observed in Germany and Spain. Long-term abandonment and intensive management both reduced wild bee species richness and abundance, either directly or indirectly through effects on floral resource availability.

The extent of calcareous grassland and AES in the surrounding landscape benefited wild bee communities, although the effectiveness of AES often depended on the amount of calcareous grasslands in the landscape. Bees collected a more diverse range of pollen in grasslands with lower shrub coverage, an indicator of sufficient management and successful restoration. Floral cover and richness were fundamental for restoring diverse interactions and supporting interaction complementarity.

Moreover, greater landscape cover of agri-environment schemes (biodiversity-friendly farming practices) promoted more redundant interactions across grasslands and buffered against grasslands becoming isolated from the regional meta-network, promoting links between regional communities. Finally, we identified five key challenges that currently hinder effective site-level management for restoration and conservation success. We provide general recommendations to strengthen management capacities and to better address these challenges locally.

Keywords

Biodiversity, calcareous grasslands, ecosystem functions, habitat restoration, interaction networks, landscape ecology