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## Semi-natural grasslands in boreal Europe: a rise of a socioecological research agenda

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### Abstract

The European continent holds substantial areas of semi-natural grasslands, which are among the most endangered and species-rich habitats in Europe. Their continuation is dependent on some form of human activity, for either production or conservation purposes, or both. We examined the relationship of semi-natural grasslands within the general grassland use in boreal Europe. We reviewed literature across the region to compile evidence on their importance for conservation by such aspects as ecology, land use change, socioeconomics and others, explored drivers of the research agenda, and outlined future research needs. There are challenges in defining and quantifying semi-natural grassland habitats even across a restricted region. Agricultural development and other policies had a clear impact on the research agenda in different countries. There are recent signs of a shift from classical ecological studies towards more multidisciplinary and integrated research. In order to sufficiently address the threats faced by semi-natural grasslands, political and research frameworks in the European Union should pay more attention to the socioecological complexity inherent of their management. When aiming at meeting future demands for grassland production, the many facets of grassland values to humanity and biodiversity should be incorporated.

Keywords: conservation, land-use statistics, literature review, low-input production

### Introduction

The European continent holds substantial areas of semi-natural grasslands (SNG), defined as “habitats inhabited by native and spontaneously colonizing species that are dependent on traditional management... to prevent invasion of woody species” (Westhoff, 1983). This management includes grazing, mowing, and the removal of trees and shrubs, but precludes ploughing, substantial fertilizing, drainage or herbicide use. The SNG are increasingly valued for such public goods as unique biodiversity, carbon sequestration, water retention, heritage, and reduced fire risks (Bengtsson *et al.*, 2019). Despite their relatively low productivity, they remain a key source of forage in High Nature Value farming systems in Europe. Here we focus on European Union (EU) countries within the boreal region, i.e. Sweden, Finland, Estonia, Latvia, and Lithuania, as well as Norway. The aims were: examining current status of SNG within the managed grassland cover of the region, and exploring development of research agenda in time and across the region.

## Materials and methods

We retrieved data from national land-use registers and evaluations, and Eurostat on covers of grassland types. Permanent grasslands are defined as remaining in one place for a minimum of five consecutive years. We further conducted a literature review based on searches in Scopus and Web of Science. We categorized the papers by relevant research aspects: 1. Ecological, 2. Agronomic (e.g., biomass quantity and quality, animal welfare and growth), 3. Cultural (cultural values, traditional land use, heritage, artisanal products), 4. Socioeconomic (profitability, motivations, challenges, opportunities, solutions), 5. Political (subsidies, regulations), 6. Functioning and regulating ecosystem services (pollination, flood management, soil etc.), 7. Land-use change, 8. Techniques (for management or detection), 9. Innovative land-use solutions (bioenergy, education, tourism etc.), and 10. Restoration. In the review, we included all types of semi-natural habitats, also not grassland in *sensu stricto*. These have a high share of shrubs and trees, predominant cover of non-gramineous species, and include silvo- or ligneous pastures, burned and/or grazed heaths, mowed mires and fens.

## Results and discussion

There are challenges in defining and quantifying SNG even across a restricted region (e.g., including or excluding old arable fields). Comparable data on semi-natural habitats other than grasslands are particularly scarce because these are not always included in agricultural land use or receive agricultural subsidies. Bearing in mind somewhat different definitions, their coverages vary dramatically, from 4000 hectares for all types in Lithuania to 60 000 ha of coastal heath and 4 million ha of grazed forest in Norway. Common definitions and periodic inventories, also using modern technology, are necessary in light of critical importance of semi-natural habitats for conservation and their role in low-input livestock production.

Estonia and Sweden have the highest proportion of SNG in relation to total grassland cover (over 10%), while Finland has the lowest (ca 3%). Finland and Sweden contrast in the temporary grassland share compared to the other countries (Figure 1). Strong national public policies (also before the EU) heavily subsidized the process of intensification of grassland-based production at expense of their ecological values.

Of 1,009 papers identified in the literature search, 561 were relevant to our research topic. Of these, 43% were from Sweden, 18% Norway, 17% Finland, 15% Estonia, 3% Lithuania, and 1% Latvia. The research most frequently focused on ecological aspects (51 %), followed by management techniques or detection (15%) and land-use change (14%). Ecology and land-use

change were nearly the only focus areas prior to 1996 (Figure 1). Since 1996, management and restoration became common. After 2000, the number of publications doubled and the research focus diversified into aspects pertaining to socioeconomic dimensions (e.g., policy and cultural ecosystem services) and other ecosystem services. The innovative ways of using semi-natural habitats is the most recent line of research. Especially focus on socioeconomics expanded from a few studies per year in early 2000s to nearly 20 in 2016.

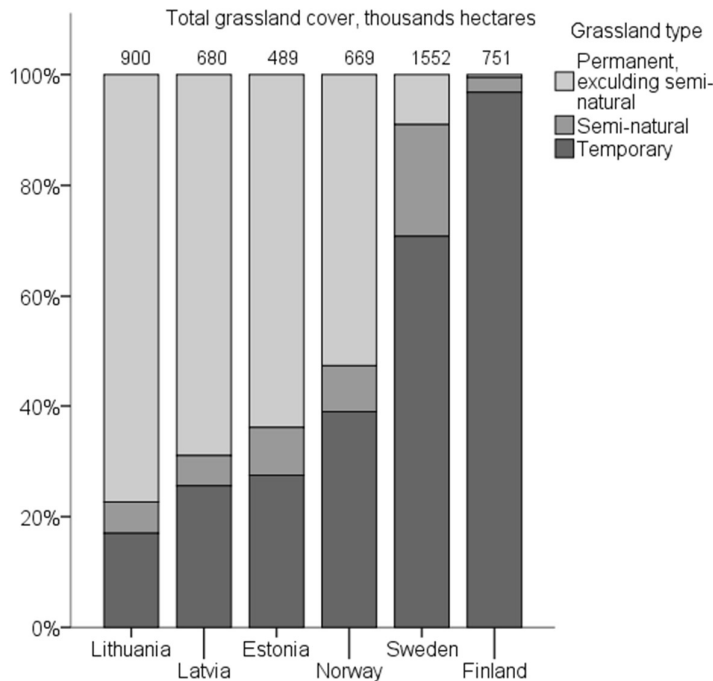


Figure 1. Relative areas for permanent (excluding semi-natural grassland), semi-natural, and temporary (rotational, five or less years on one field parcel) grasslands in the boreal countries of northern Europe. Only areas that are managed, either for production or as part of agricultural policy requirements, are included.

Only ecology and land-use change are represented in all countries. Of production-focused papers, ca. 60% are from Norway, followed by Sweden (15%). In Norway, strong national policies focusing on maintaining rural viability, with an emphasis on the positive links between food production and other public goods (biodiversity and food quality) stimulate this. The rise in research can be attributed to the Convention on Biological Diversity in 1993, integration of biodiversity objectives into national and EU legislation and agricultural subsidies, as well as the EU accession. Under policies influences research expanded into the socioeconomic aspects of management and restoration due to public payments for SNG, and a political focus on the ecosystem services. Research into farmers' acceptance of the payments, their role in the farm economy, and targeting the payments by multiple benefits proliferated.

## Conclusion

The national political framing seems to determine how common SNG remain within the grassland area of a country while international policies influence research directions. In order to sufficiently address the threats faced by SNG, research should focus at the socioecological complexity inherent to the SNG management. When aiming at meeting future demands for grassland production, the many facets of grassland values to humanity should be incorporated.

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