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CHANGES IN SEMI-NATURAL GRASSLAND DISTRIBUTION IN RELATION TO COMMON AGRICULTURAL POLICY 2014–2020 AREA-BASED PAYMENTS IN LATVIA

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Abstract
Semi-natural grasslands (SNG) are essential in the context of farmland biodiversity. The Common Agricultural Policy (CAP), on the other hand, is an important tool for the continuation of the management of semi-natural grasslands. Explicit knowledge on the pattern of grassland area changes is important to foster a more effective use of CAP for grassland biodiversity conservation. Our aim was to determine the habitat-specific changes in the distribution of Latvian SNG across different management regimes. Based on state-owned geospatial data of SNG distribution in 2014 and 2022, we assessed changes in semi-natural grassland areas over nearly ten years by analyzing grassland management and spatial distribution including areas inside and outside the Natura 2000 network. The spatial distribution of SNG remained similar in both periods. Eastern Latvia retained the highest share of SNG while the central part showed the most pronounced increase in new localities of SNG due to extensive habitat mapping carried out in recent years. Abandonment appeared as a more important threat to SNG in the Natura 2000 network and more profoundly to unproductive habitat types while transformation into arable land and grassland intensification was a considerable threat to SNG outside the network and to more productive habitat types. We suggest that agri-environment schemes should address the different needs of SNG in the Natura 2000 network and outside it.
Key words: grassland management, agri-environment, Natura 2000, abandonment farmland.

Introduction

Among the high nature value farmland (HNV), natural and semi-natural permanent grasslands (SNG) are the most valuable for biodiversity conservation in agricultural landscapes, and most of them are habitats listed in the Annex I of Habitats Directive 92/43/EEC (European Commission, 1992). Among the other permanent grasslands, SNG have considerably higher species richness and dependence on low-intensity farming that includes grazing and mowing with no ploughing, fertilization, drainage, herbicide use or reseeding (Herzon *et al*., 2021).

A significant decrease has taken place in the cover of SNG across Europe and the Baltic States show the highest reduction in HNV in the last decades (Anderson & Mammides, 2020). The importance of semi-natural grasslands has declined due to the intensification of management in parts of agricultural land (including conversion of semi-natural land to arable crops) and abandoning in other areas (Rounsevell *et al*., 2003; Vinogradovs *et al*., 2018).

To support HNV farmers by making a more effective use of the Common Agricultural Policy (CAP) and prioritizing the protection of HNV farmlands, explicit knowledge of the pattern of grassland area changes is important. In addition, there is surprisingly little scientific information on the habitat-specific effects of agri-environment schemes (AES) on distribution patterns. Although all semi-natural grassland habitats of the Habitats Directive fully depend on low-intensity agriculture (Halada *et al*., 2011), threats and pressures differ considerably among habitat types. For instance, more productive mesic and some wet grassland types in central Europe are more threatened by intensification (fertilization, improvement of sward by reseeding or even plowing), while most unproductive wet and dry grasslands are prone to abandonment (Ridding, Redhead, & Pywell, 2011; Dengler & Tischew, 2018; Janssen *et al*., 2021).

Whether this finding is true for Eastern-Baltic countries like Latvia and how it manifests at the landscape scale remains unclear. Our study addressed this knowledge gap by focusing on the changes in the distribution of productive and unproductive SNG in Latvia. The aim of this article was to determine the habitat-specific changes in the distribution of Latvian SNG across different management regimes.

Materials and Methods

Our data represented the implementation period of the Rural Development Programme 2007–2013 and 2014–2020. During the first period, SNG conservation management was addressed by the action-oriented agri-environment scheme 'Maintenance of Biodiversity in Grasslands' (MGB) aimed at fostering biodiversity-friendly management of permanent grasslands across the country. Eligible areas included all SNG habitats and cultivated permanent grasslands that are important habitats for bird species. The management requirements were common for all eligible habitat types and included mowing with or without hay removal once per season from 1 August

until 15 September or grazing (0.4–0.9 animal units), and any improvement of grassland was forbidden. There was a flat payment rate of 123 EUR ha^{-1}. During the Rural Development Programme period from 2014 to 2020, the same AES continued with the same management prescriptions. Yet, the approach to the payment calculation changed. Starting from 2015, differentiation of the payment into four classes based on grassland productivity was introduced ranging from 55 EUR ha^{-1} to 206 EUR ha^{-1} (less productive grasslands received higher payment); thus, the drivers of the uptake of SNG habitats changed.

To analyze the spatial pattern of SNG distribution, the country was divided into 2,778 grid cells of 25 km^2 each quadrant. All data were collected for each grid cell. We analyzed seven out of the ten grassland habitat types occurring in Latvia. Habitat type 6110* (asterix stands for priority habitats) *Rupicolous calcareous grasslands of the Alysso-Sedion albi,* and 6430 *Hydrophilous tall herb fringe communities* were omitted because they do not depend on agricultural activity, and 1630* *Coastal meadows* were not included because this is a landscape-level habitat type that can overlap spatially with other grassland habitat types. SNG were split into two groups of productivity according to the habitat-specific national data on productivity (Table 1).

Data on SNG area and distribution in 2014 and in 2022 were obtained from national-level georeferenced EU grassland habitat maps owned by the Nature Conservation Agency for both study periods. We used all SNG polygons irrespective of their management or abandonment at the time of mapping. Distribution data for 2014 contained all SNG mapped from 2001 until 2014. The dataset for 2022 included only those SNG that were mapped as such in the period from 2014 to 2022. Importantly, some portion of SNG that were part of the 2014 database but were documented as afforested or converted to arable land during the repeated inventories in later years have been discarded from the database in the frame of the database maintenance by Nature Conservation Agency. Productive habitat polygons accounted for 82% of the total area, and unproductive habitats accounted for 13% of the total area. The remaining 5% were polygons that included several habitat types with a mosaic structure and therefore could not be explicitly related to one of the habitat groups; consequently, they were omitted from further analysis.

To analyze the state of SNG management, we defined the following management statuses: (1) abandoned – SNG polygons that were mapped as such but not included in the agricultural parcel register of the Rural Support Centre and did not receive any payments from CAP instruments; (2) managed in AES – grasslands that received subsidies under the action-oriented AES 'Maintenance of Biodiversity in Grasslands' (the only grassland-related AES in Latvia); (3) converted to arable land – SNG polygons that were mapped as such but that were registered in the agricultural parcel register of the Rural Support Centre as arable land; and (4) managed as permanent grassland with no restrictions to biodiversity conservation (registered in the agricultural parcel register and receiving one or several of the following subsidies – direct payment, payment for organic

Table 1

HD grassland habitats analysed in the present study grouped into two productivity groups

Habitat group	HD habitat code and name (European Commission, 2013)	Phytosociological alliances (Auniņš, 2013; Mucina *et al.,* 2016)	Productivity, dry hay t ha^{-1} yr^{-1} (Rūsiņa, 2017a)
Productive habitats (dry hay more than 1 t ha^{-1} yr^{-1})	6270* (asterix stands for priority habitats) *Fennoscandian lowland species-rich dry to mesic grasslands*	*Cynosurion cristati, Calthion palustris*	1.0–2.0
	6450 *Northern boreal alluvial meadows*	*Deschampsion cespitosae, Magnocaricion gracilis, Magnocaricion elatae*	1.5–4.0
	6510 *Lowland hay meadows*	*Arrhenatherion elatioris*	1.5–4.0
Unproductive habitats (dry hay less than 1 t ha^{-1} yr^{-1})	6120* *Xeric sand calcareous grasslands*	*Armerion elongatae, Koelerion glaucae*	<0.5
	6210* *Seminatural dry grasslands on calcareous substrates*	*Filipendulo vulgaris-Helictotrichion pratensis*	0.5
	6230* *Species-rich Nardus grasslands*	*Violion caninae*	<0.5
	6410 Molinia meadows	*Molinion caeruleae*	0.5–1.5

farming, and payment for less favorable areas).

The comparative method was used, which determined the change of SNG areas in Latvia from 2014 to 2022. The results were presented in hectares and percentages. The method of analytical and logical analysis was used to determine the reasons for the changes in the area over the studied period.

Results and Discussion

Changes in SNG area

The total area of SNG increased from 44 662 ha in 2014 to 61 232 ha in 2022. The increase is mostly explained by the improved level of knowledge due to the continuous SNG habitat mapping in the frame of conservation planning in Natura 2000 network, as well as the country-wide habitat mapping project 'Nature Census' that was launched in 2017 by the Nature Conservation Agency. Some portion of the increase could be attributable to ecological restoration of SNG habitats that started in early 21c. For instance, ca. 7200 ha were restored in the period from 2000 to 2017 (Rūsiņa, 2017b). However, there is no updated statistics available about the total area restored or recreated until now.

Although it is a very positive tendency that SNG area has increased considerably, the observed increment is still very far from the minimum favorable conservation area needed to secure favorable conservation status as defined in the Habitats Directive. In Latvia, it is estimated that the favorable protection area should be between 130 000 and 390 000 ha (Rūsiņa, 2017a).

A large proportion of all SNG was abandoned in both study periods, and it was more pronounced in grasslands located in Natura 2000 network than outside it (Figure 1).

In 2014, 38.5% of the SNG area was abandoned (did not receive any CAP payments) outside Natura 2000. In 2022, this proportion decreased to 29.9%. At the same time, 47.3% of the SNG area located in the Natura 2000 network was abandoned in 2014 while this proportion decreased to 36.6% in 2022. On contrary to abandonment, SNG outside the Natura 2000 network were more exposed to ploughing. 3.9% of the total area of SNG mapped until 2014 was ploughed up in 2014 outside Natura 2000 while only 0.3% was ploughed inside the network. A similar ratio remained in 2022 but to a lesser extent. Importantly, for management in 2022, only data on actual SNG areas in 2022 were available for analysis and they did not include areas destroyed either by ploughing for tree planting or for other reasons in the period from 2014 to 2021. Thus, comparison is valid only for ploughed area ratio between outside and inside the Natura 2000 network, but not for the absolute amount of ploughed area of SNG in the given time period.

Our results are in line with the recent European wide evaluations of HNV transformation inside and

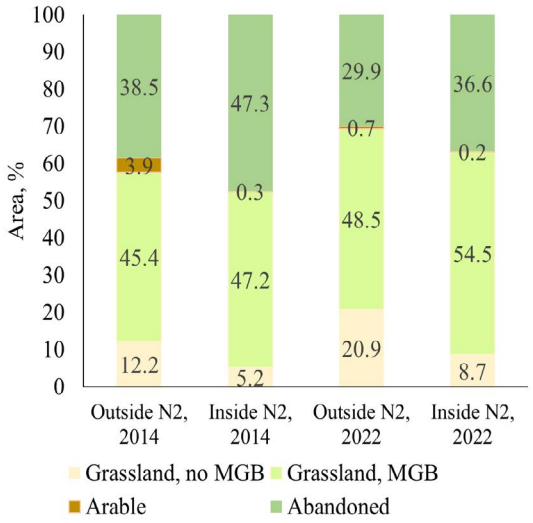

Figure 1. Management of semi-natural grasslands inside and outside Natura 2000 network in 2014 and in 2022. N2 – Natura 2000 network, MGB – agri-environment measure 'Maintenance of Biodiversity in Grasslands'.

outside the Natura 2000 network. There is evidence for an increase in arable land at the expense of grasslands in HNV farmlands in countries that joined the EU in 2004 or later (Reif & Vermouzek, 2019), and this finding has also been true for the Natura 2000 sites. However, Natura 2000 network experienced slightly lower ratio of transformation in comparison to the HNV outside the network. According to Anderson & Mammides (2020), arable land increased by 64% and transitional woodland by 9% within high nature value farmlands during the years 2012–2018 in Latvia. A similar tendency was observed in Lithuania, but Estonia experienced very little change – only a 6% increase in arable land and a 1% decrease in transitional woodlands. Our results show that abandonment is a more important threat to SNG in the Natura 2000 network while transformation into arable land is a considerable threat to SNG outside the network, and this pattern is consistent across time.

Management of SNG and CAP area-based payments

A comparatively small proportion of managed SNG was not supported by the agri-environment measure MGB. However, this area was two times larger outside the Natura 2000 network than inside it (12.2% versus 5.2% in 2014, and 20.9% versus 8.7% in 2022). Although this area is maintained as permanent grassland, there is no guarantee that biodiversity is intact because all other CAP payments for permanent grasslands do not prohibit intensive mowing or grazing combined with substantial fertilizing.

Two productivity groups of habitats – productive and unproductive (Table 1), showed a differing pattern of distribution and changes in

area in relation to management type (Figure 2). Unproductive habitats experienced a much higher abandonment rate than productive habitats in both periods. However, the proportion of abandoned areas decreased considerably in the second period. Productive habitats had a higher share of areas managed as permanent grasslands outside the agri-environment commitment of the MGB measure, and this tendency increased in the second period. At the same time, the ploughing pattern differed among periods. A considerably higher proportion of productive habitats was ploughed in 2014 than in 2022 (Figure 2).

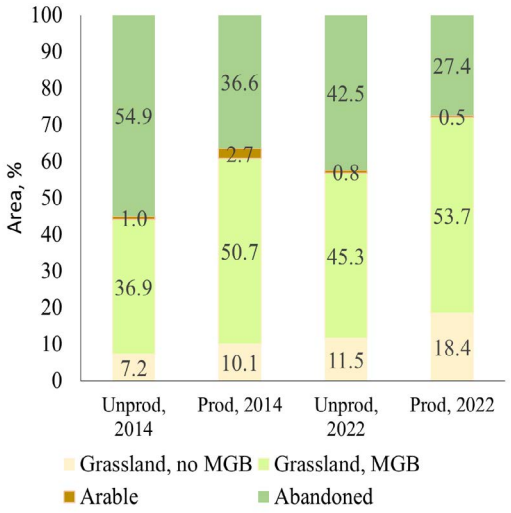

Figure 2. Management of productive and unproductive semi-natural grassland habitats in 2014 and in 2022. MGB – agri-environment measure 'Maintenance of Biodiversity in Grasslands'; Unprod – unproductive habitats, Prod – productive habitats.

Our results confirm findings of other studies that threats to SNG are habitat-specific (Ridding, Redhead, & Pywell, 2015; Dengler & Tischew, 2018). Productive habitat types are more threatened by intensification. In our case, it was either ploughing or avoiding to apply for grassland biodiversity related agri-environmental support that requires less intensive management regime. On contrary, unproductive habitats were threatened by abandonment. Similarly, unproductive dry semi-grasslands are highly threatened by abandonment also in neighboring countries. In Lithuania, over 72% of these grasslands are unmanaged (Uogintas & Rašomavičius, 2020). Abandonment of these habitats leads to considerable loss in the provision of ecosystem services and multifunctionality of landscapes (Prangel *et al.,* 2023).

The spatial pattern of grassland distribution changed slightly between the two periods. More grasslands were located in Eastern Latvia, less – in the central part of the country (Figure 3). The coverage of SNG across the whole country was higher in 2022 than in 2014. The largest difference was observed in the central part of Latvia, where in 2014 there was a much higher number of empty grid cells than in 2022.

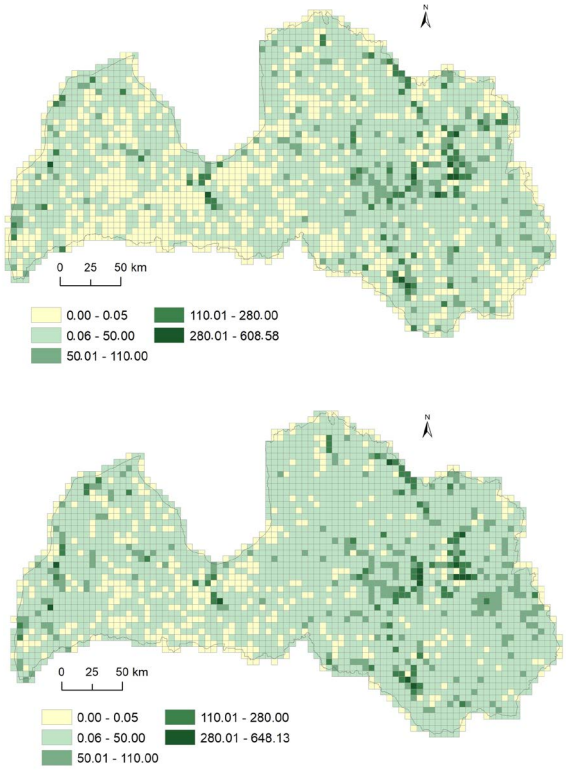

Figure 3. Distribution of SNG in Latvia. The legend shows grassland cover in hectares per 5×5 km cell. Upper figure 2014, lower – 2022.

The spatial structure of the intensity of the agri-environment support measure 'Maintenance of Biodiversity in Grasslands' showed overall high intensity in both periods (Figure 4).

The positive trend observed is that as the overall area under SNG increased, the supported area also increased, indicating that grassland owners were interested in applying for support and meeting the necessary conditions.

Despite the changes in CAP, Latvia still has a high proportion of unmanaged SNG (Figure 5). From 2014 to 2022, the abandoned areas have decreased from 20 336 ha to 17 761 ha. Some of this decrease can be attributed to the restoration of abandoned SNG (reversion of abandoned areas to managed SNG). However, some of it is due to the deletion of such areas from the database – those abandoned SNG areas that were still considered as SNG in 2014 but completely overgrown by 2022 have been omitted from the SNG spatial geodatabase of Nature Conservation Agency (permanent loss of area of

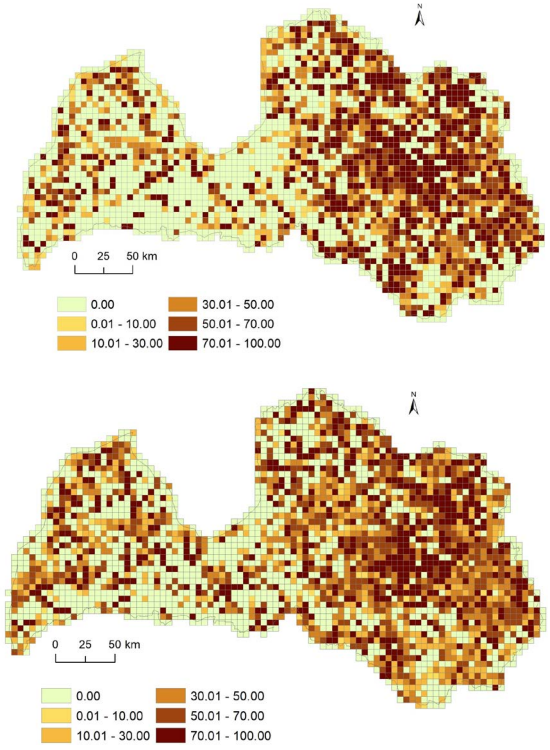

Figure 4. Spatial pattern of the intensity of agri-environmental support measure 'Maintenance of Biodiversity in Grasslands' shown as the percentage of supported area out of the total area per 5*5 km cell in both study periods. Upper figure 2014, lower – 2022.

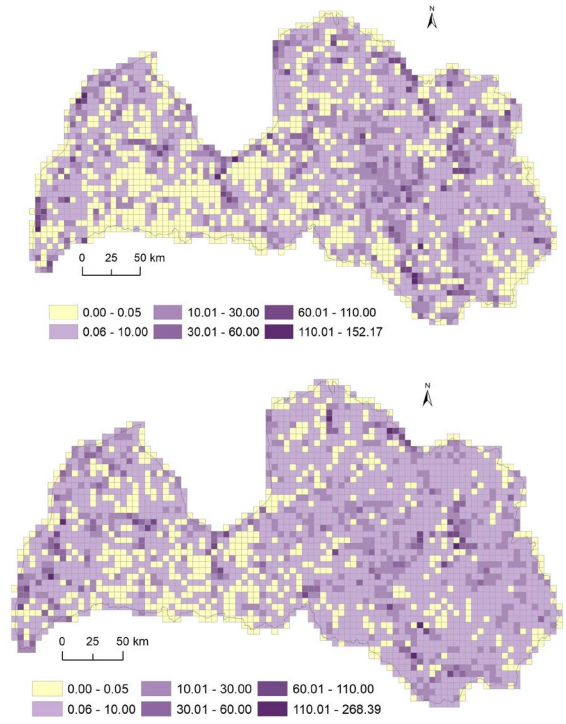

Figure 5. Distribution of abandoned SNG in 2014 (upper figure) and 2022 (lower figure) in hectares.

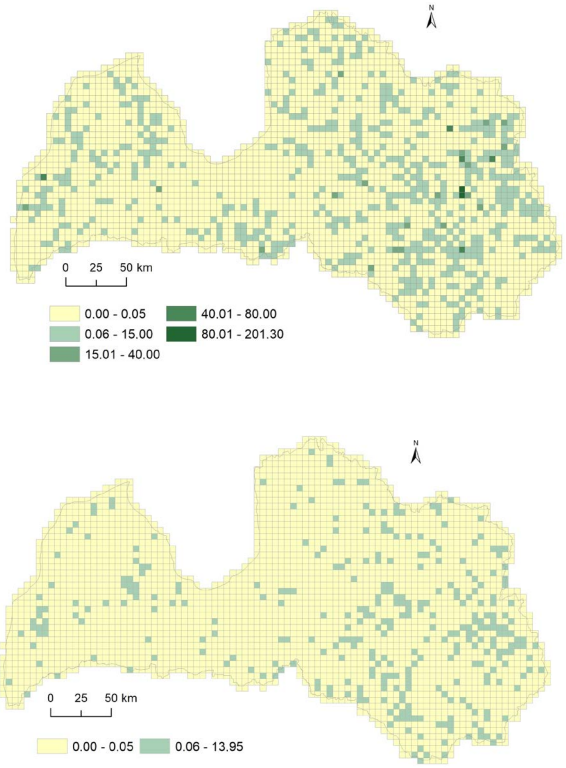

Figure 6. Distribution of ploughed SNG in 2014 (upper figure) and 2022 (lower figure) in hectares.

SNG). The loss of SNG area due to abandonment is a common problem across Europe, especially, in Eastern Europe (Török *et al*., 2018) and CAP support plays a crucial role as an effective tool for protecting grasslands from abandonment (Halada *et al*., 2017).

Still, the way how the abandoned land is reintegrated in management should be carefully considered to achieve not only production goals but also biodiversity goals (Valujeva *et al*., 2022). As our findings indicate, the conversion of SNG into arable land or other intensified agricultural land use remains a significant risk in Latvia (Figure 6). The total area of ploughed SNG reached 2 475 ha in 2014 (area of SNG mapped as such in the period from 2004 to 2014 and reported as under arable land in 2014) and 342 ha in 2022. However, the lower area in 2022 was due to a lack of data on the area ploughed between 2014 and 2022. More detailed conclusions would require accurate monitoring data on the abandonment and ploughing of SNG.

Conclusions

1. The total area of SNG experienced a significant increase from 2014 to 2022. This increase can primarily be attributed to the improved knowledge obtained through habitat mapping efforts. Ecological restoration efforts also played a role but to a lesser extent over the past decade.
2. Our findings indicate that abandonment posed a

greater threat to SNG within the Natura 2000 network, whereas transformation into arable land and intensification of grasslands were significant threats to SNG outside the network. This pattern remained consistent during both study periods.

3. The abundance of SNG habitats and their uptake in grassland biodiversity related agri-environment schemes differed between the productive and unproductive habitat groups. Productive habitats experienced higher impact of ploughing and intensification, while unproductive habitats were more prone to abandonment.
4. The spatial distribution of SNG remained relatively similar between the two periods. Eastern Latvia retained the highest share of SNG while the central part showed the most pronounced increase in new localities of SNG.
5. Considering our findings, we suggest that agri-environment schemes should address the different needs of SNG in Natura 2000 network and outside it. From one side, the support should promote introduction of extensive management of SNG in Natura 2000 sites to tackle abandonment problem, and from the other side – to prevent ploughing or intensification of SNG outside the network.

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