

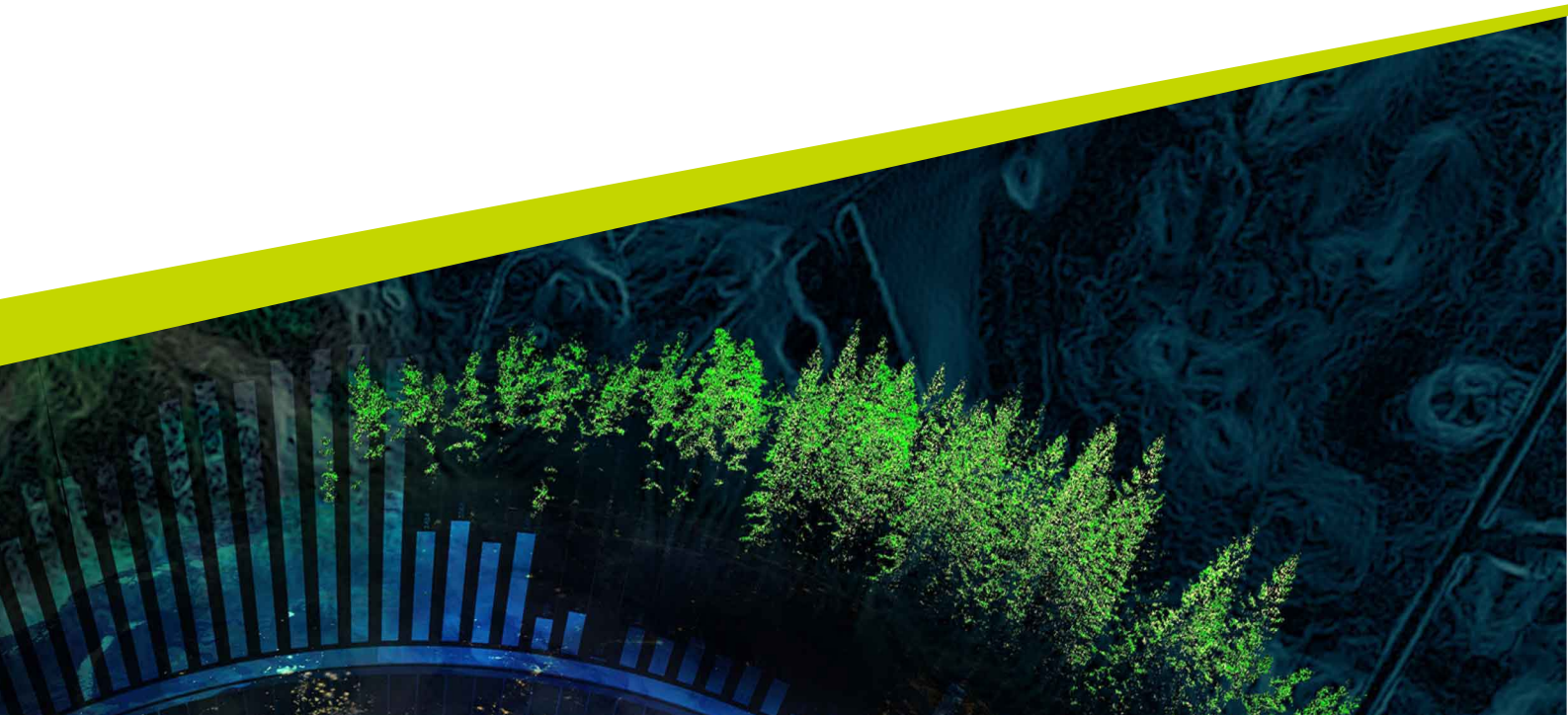


Small changes in restored, semi-natural grasslands

The effects of restoration over a 14-year time period

Signe Björk

Master's thesis • Independent project • 60 credits
Swedish University of Agricultural Sciences, SLU
Uppsala 2026



Small changes in restored, semi-natural grasslands. The effects of restoration over a 14-year time period

Signe Björk

Supervisor:	Erik Öckinger, SLU, Department of Ecology
Examiner:	Joachim Strengbom, SLU, Department of Ecology

Credits:	60 credits
Level:	A2E
Course title:	Independent project in biology
Course code:	EX0900
Course coordinating dept:	Department of Aquatic Sciences and Assessment
Place of publication:	Uppsala
Year of publication:	2026
Copyright:	All featured images are used with permission from the copyright owner.
Keywords:	Grasslands, Restoration, Diversity, Grazing, Revisited

Swedish University of Agricultural Sciences

Faculty of Natural Resources and Agricultural Sciences

Department of Ecology

Abstract

Semi-natural grasslands in Sweden are disappearing due to changes in land use and agricultural practices. With this there is also a loss of species that are dependent on these habitats for their survival. One way to try to combat this decline is through the restoration of grasslands that have been abandoned. In this paper 37 different semi-natural grasslands and the vascular plant within them were revisited and surveyed, and compared with the diversity and species composition 14 years earlier. The survey was done in 10 randomized spots in each grassland, and a 1 by 1 meter square was surveyed at each point. Analysis was run on the resulting species richness, frequency, Shannon diversity. Values similar to Ellenberg values for Swedish species calculated by Tyler et al. (2021) was used for the species temperature niches, grazing needs and light needs. Classification of generalist, narrow and broad specialists came from Öckinger et al. (2012) to analyses the change of these over time. Majority of analysis consisted of GLMM analysis using the grasslands as a grouped value to decrease the risk of false significances. The analyses made in this survey yielded differing results where most of them were non-significant, such as most of the analyzed Ellenberg equivalent values and the cover of both generalists and specialists. This can be seen in the GLMM analyses. This can have a variety of reasons which are discussed later in this paper. The significant results on the other hand were a decline in species abundance for both restored, continuously grazed and abandoned grasslands, and an increase in narrow specialist species in continuous and restored grasslands. It is likely that the lack of significant results is partly because of the timing of this survey. The time since restoration might fall outside of the optimal frame for restoration and it had been restored for a while even before the first survey in 2011. The restored grasslands show some more similarities with continuous grasslands which might mean that they are improving. Restored and abandoned grasslands on the other hand had also become more similar in some analysed categories such as grazing optimal values and light optimal values. Indications for an increase in narrow specialist species with time since restoration can be found when analysing both the 2011 and 2025 survey points using time since restoration for all points. Results indicate that improvement might be happening, but many results are insignificant and more survey of the grasslands might be needed for a better analysis of the change over time.

Keywords: Grasslands, Restoration, Diversity, Grazing, Revisited

Populärvetenskaplig sammanfattning

Naturbetesmarker i Sverige blir färre och färre på grund av förändringar i markanvändning och hur jordbruk genomförs. På grund av detta har vi en minskning av arter som är beroende av dessa habitat för sin överlevnad. Ett sätt att bromsa den här minskningen är genom restaurering av redan övergivna betesmarker. I det här arbetet återbesöks 37 tidigare inventerade betesmarker och inventeras för diversitet och artsammansättning av kärlväxter efter 14 år. 10 slumpmässigt placerade rutor om en kvadratmeter inventerades i varje betesmark. Artrikedom, förekomst och Shannon diversitet analyserades. Även värden ekvivalenta till Ellenberg värden för svenska växter användes för att analysera arternas temperaturnicher, betestrycksbehov och ljusbehov. Dessa värden kommer från en beräkning av Tyler et al. (2021). Klassifikation av generalister, smala och breda specialister användes även från Öckinger et al. (2012) för att analysera förändring över tid. Majoriteten av analyser bestod av GLMM analyser där betesmarkerna användes som ett grupperat värde för att minska risken för falska signifikanta resultat i analyserna. Analyserna gav varierande resultat och de flesta var icke signifikanta så som Ellenberg ekvivalenterna och täcket av både generalister och specialister. Det kan finnas flera anledningar till att resultaten inte var signifikanta och de diskuteras i texten. De resultat som visade sig signifikanta var en minskning av artantal för alla typer av betesmarker och en ökning av smala specialister i kontinuerligt betade och restaurerade betesmarker. Bristen på signifikanta resultat kan bero på tiden återbesöken gjordes. Tiden sedan restaurering är möjligen utanför den optimala tiden för att se effekterna av en restaurering och de flesta restaurerade betesmarker hade varit restaurerade ett tag redan vid den första inventeringen 2011. Över tid har de restaurerade betesmarkerna blivit mer lika de kontinuerligt betade vilket kan innebära att de restaurerade betesmarkerna förbättrats. Indikationer fanns också för att smala specialister har ökat med tiden när datan från 2011 och 2025 analyserades tillsammans och tid sen restaurering undersöktes. Resultaten i detta arbete indikerar en förbättring av de restaurerade kan ha skett men många resultat är insignifikanta och mer studier kan behövas för att få en bättre förståelse för förändringen över tid.

Nyckelord: Naturbetesmarker, Restaurering, Diversitet, Bete, Återbesök

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1. Introduction

1.1 Species decrease and causes

Biodiversity loss is currently one of the largest threats to our ecosystems (Montras-Janer et al. 2024). In Sweden a large amount of biodiversity loss is seen in grazed grasslands and is caused by changes in land use (Swedish Species Information Centre, Swedish University of Agricultural Sciences 2026). Many species of plants and associated pollinators are at risk because of this changed land use as well as abandonment of semi-natural grasslands historically grazed by cattle and other domesticated animals. This land use change has also been caused by increased forest and agricultural production (Auffret et al. 2018).

The number of red listed species in Sweden has increased 10% between 2020 and 2025: 2 373 species are classified as threatened in the latest version of the Red list. (Swedish Species Information Centre, Swedish University of Agricultural Sciences 2026), and loss of open semi-natural grassland is one of multiple factors contributing to this.

One contributing factor to the decline even in managed habitats can be attributed to loss of connectivity between habitats as the decline of grasslands generally across Sweden leads to fewer vectors for native vascular plants to spread (Kimberley et al. 2021). Trees and shrubs have increased in the landscape and, in contrast to grassland species, forest species show a bit of increase the last 200 years (Hallman et al. 2022). Correlation between different groups in grasslands exists to some extent but the direction and full relationship between taxa can be somewhat disputed. Some papers such as (Vessby et al. 2002) show low covariation between taxa and conclude that using one taxa as an indicator for general biodiversity does not work. Other papers also find that the correlation between diversity of vascular plants and insects in restored versus continuously grazed habitats is not a direct equivalent. Vascular plants show a larger similarity between continuously grazed grasslands and restored habitats while pollinators and other insects show a larger discrepancy when assessing diversity (Maccherini et al. 2009; Helbing et al. 2023).

Qualities of a habitat can also change as the intensity of grazing impacts the plant species present. The species of grazer in a grassland will also cause changes in plant composition (Toth et al. 2018). Characteristic of the habitat is more affected by species of grazer than by the intensity of the grazing. Cattle grazing can lead to a higher number of species compared to other types of grazers and fuller vegetation cover while sheep have a better ability to keep bushes and woody plants at bay (Toth et al. 2018). Horses impact in grazed habitats differ from other cattle as they have a tendency for grazing in specific patches which in turn create

bigger discrepancies within paddocks than other animals commonly seen in grazed grasslands (Schmitz & Isselstein 2020)

1.2 Historical land use and grasslands in Sweden

When studying grasslands, we need long timescales to understand the correlation between use and biodiversity because the impact of changes in the habitat will take time to develop. Time lags between intervention and changes in the habitat have been noted in many different studies. For example, Gustavsson et al. (2007) found that the land use of a grassland around 200 years ago had a greater impact on the biodiversity than contemporary land use in the habitat. This is one example of the long timescales involved in the processes shaping the development of these habitats. Other studies show similar results like Lindborg & Eriksson (2004) that found lag-time for plant species in the range of 50 to 100 years. These timescales are relatively short compared to other types of habitats but are still quite long in comparison with human lifetimes and are very important to consider in these situations. While acknowledging this, it is still important to look at the shorter timescales to understand what type of changes that can be observed and what these changes indicate for changes over larger time scales. Results and changes within a shorter time are important for us to coordinate current interventions in habitats and how these can come to affect the biodiversity in the longer time perspective.

The longevity and resistance of grassland species have been noted in many cases, for example clear-cuts in forestry where grasslands used to preside have a higher diversity than those with a history of forestation (Milberg et al. 2019). The longevity of grassland species and their ability to emerge and impact diversity in areas that become open is important when considering the possibility of restoring grasslands (Milberg et al. 2019).

1.3 Restoration

Restored grasslands, here defined as grasslands that have a history of longer continuous grazing followed by a period of abandonment with no grazing or other management, and in which the management or grazing has recently been reintroduced. Continuity here simply means a long history of regular grazing and/or management. Long continuity in Sweden can mean recorded use of the habitat for domesticated grazers for 200-300 years (Eriksson & Cousins 2014).

The number of continuous habitats that exist today may be too few to maintain the landscape biodiversity of grassland species, especially when there is a general decrease in species and the risks species are facing with climate change and

increased temperatures. Because of this, there is a need for restoration of abandoned grasslands to create better habitats where these species can exist and counter biodiversity loss. (Cousins 2009). Restoration is most effective if the habitat was abandoned within the last five to ten years as this is the time many grassland species can persist in abandoned grasslands (Öckinger et al. 2006).

Restoring grasslands will increase the number of semi-natural grasslands and could help mitigate the loss and fragmentation and the issues this causes for the dispersal of grassland specialists. Grassland species can disperse from more species-rich habitats to less diverse grazing areas within a relatively short time (around 10 years), but this requires the presence of species-rich grasslands in close proximity to the restored grazed land but this is only applicable to grasslands in the immediate vicinity of the grazed land (Cousins & Lindborg 2008). Due to long-term loss of habitats many semi-natural grasslands are today fragmented with sometimes large distances between species rich grasslands, which may reduce the restoration potential or that the time needed for restoring long (Ihse 1995). Some studies find timescales around 50 to 100 years for restoration to reach similar diversity as continuously grazed grasslands (Lindborg & Eriksson 2004; Gustavsson et al. 2007; Redhead et al. 2014). Redhead et al. (2014) also found that around 50 years since restoration grasslands varied a lot between different grasslands of the same age.

1.4 Aims and research questions

This study aims at investigating the change in plant species diversity and composition in 37 different current or former semi-natural grasslands over 14 years and try to understand the mechanisms that drive the change in these habitats during this period, as well as what effects restoration has over a long period of time. In my study I repeated a survey done 14 years ago (Winsa et al. 2017).

Research questions:

- How has restoration by reintroduction of grazing changed species diversity of vascular plants? Such as species numbers and Shannon diversity.
- How have the restored grasslands changed in comparison to still abandoned and continuously grazed grasslands?

Based on these research questions I have created tables with the values that will be explored and the hypothetical change that is expected has been added to these tables.

Table 1- Factors analysed in this paper. The hypothesis column indicates the hypothesized change in restored grasslands between the two rounds of surveys. This change will also be compared to abandoned and continuous grasslands. Factors analysed here using data from multiple sources to expand on the analysis. The source column notes what source was used for the data used in the analysis of each point.

Factor	Description	Source	Hypothesis
Species number	Number of species per plot		↗
Shannon	Shannon diversity per plot		↗
Grazing values	Grazing or mowing optimal for the plant	Tyler et al.	↗
Temperature values	Optimal temperature for a species	Tyler et al.	↗
Light	Light conditions that favour a species	Tyler et al.	↗
Generalist cover	Frequency of generalist species	Öckinger et al.	↘
Broad specialist cover	Frequency of broad specialist species	Öckinger et al.	↗
Narrow specialist cover	Frequency of narrow specialist species	Öckinger et al.	↗
Generalist number	Number of generalist species	Öckinger et al.	-
Broad specialist number	Number of broad specilaist species	Öckinger et al.	-
Narrow specialist number	Number of Narrow specialist species	Öckinger et al.	↗
Redlisted species	Number of redlisted species	Artfakta	↗
Invasive species	Number of invasive species	Artfakta	-
Forest species	Number of forest species	Classed from Artfakta	↘
Grassland species	Number of grassland adapted species	Classed from Artfakta	↗

2. Method

2.1 Survey

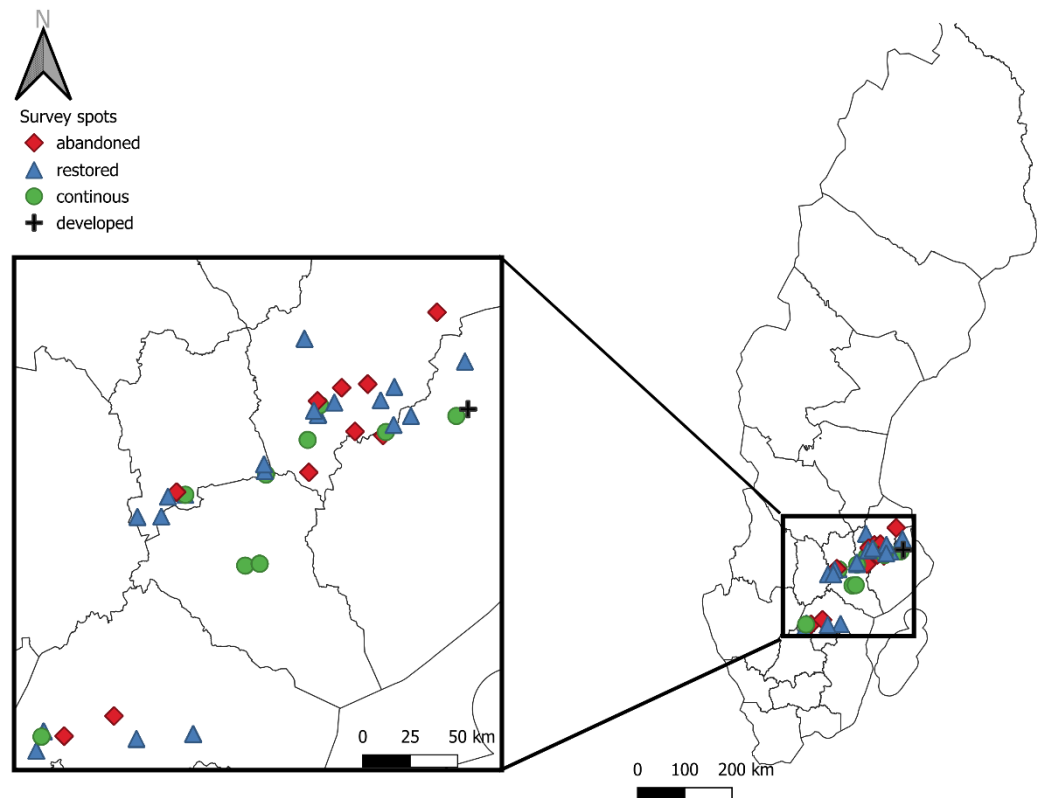


Figure 1 Map of the surveyed areas. The surveyed grasslands are located in eastern Sweden. All grasslands were chosen due to their similar composition and history by Winsa et al. (2017). Background map from Lantmäteriet

I re-surveyed plants in grassland sites that were previously surveyed in 2011 by Winsa et al. (2017). Winsa had selected 10 abandoned, 18 restored (formerly abandoned), and 10 continuously grazed (intact) semi-natural pastures of dry or mesic type. The restored sites varied in the time since restoration, such that they had been restored between 1 and 15 years prior to her surveys (Winsa et al. 2017), Grasslands were selected along a gradient of connectivity to intact pastures in the surrounding landscapes. The pastures were situated in south-central Sweden in the counties of Uppsala, Stockholm, Västmanland, Södermanland, and Östergötland

The grasslands were chosen using TUVa a geodatabase run by the Swedish Board of Agriculture (*Databasen TUVa* n.d.). All grasslands are of the type “Semi-natural dry grasslands and shrublands facies on calcareous substrates”,

”Fennoscandian lowland species-rich dry to mesic grass-lands”, “Lowland hay meadows”, “Fennoscandian wooded meadows” and “Fennoscandian wooded pastures”. This was done to control soil condition and land use history.

The survey was done using the same methods as the earlier survey conducted by (Winsa et al. 2017; Rotchés-Ribalta et al. 2018) in 2011. This means that the same grasslands were surveyed with the same method as far as possible to ensure as reliable results as possible. In 2011, there were 38 pastures surveyed but only 37 were re-surveyed in 2025. This was because one pasture (Röcksta Norrtälje) had been developed and houses have been built where the pasture earlier were located. Ten of the original pastures were abandoned, 10 continuously grazed and 18 restored. At the time for this survey 10 were continuously grazed, 11 were abandoned and 16 were restored. In the data analysis all grasslands were treated as individual grasslands with the analysis disregarding the developed grassland in the analysis of the new values. Similarly, the grasslands that were abandoned between the two surveys was treated as restored grasslands in the first analysis and abandoned in the second analysis as new and old survey values had their own classification in the data used R-studio.

Winsa et al. (2017) chose a higher number of restored grasslands to allow more variation in restoration time.

The surveys done in this study were conducted from June to August 2025 while the surveys in 2011 were conducted from June to September

In each pasture 10 points were randomised for survey. In the study by Winsa et al. (2017) the method used for randomisation is unclear as it was not recorded at the time and was not recollected at the time for the newer survey. For the new survey all points were randomised using QGIS v 3.34.4 (QGIS Development Team 2025) and the tool randomise points. The points were created within the established polygons created by Winsa et al. (2017). For navigation in the field the data points were transferred to Avenza map app, and a smartphone was used as a GPS. Due to this navigation method there is an error of 2-15 meters for each point, possibly smaller while in motion (Raufu et al. 2025). At each point a square of 1x1 meter was surveyed. A grid of 10x10 cm² squares were within the survey square equalling 100 sub-squares. In each survey point the species of vascular plants were noted. The frequency of each species was noted as presence within the sub-squares. This resulted in a value of 0-100 value for each species in each survey square. Identification was done using primarily Svensk Flora (Krok & Almquist 2013) as well as Svensk Fältflora (Mossberg & Stenberg 2021) .iNaturalist (*iNaturalist* n.d.) and Artsorakel (*Artsorakel* n.d.) were used for some initial identification and alternatives for species identification that were compared to Krok & Almquist (2013) and Mossberg & Stenberg (2021) for confirmation. A few species of grasses were collected and identified out of the field. Some of these

identifications used Nordens flora (Mossberg & Stenberg 2018) in addition to the previous literature.

Other data collected during the 2025 survey was shading over each habitat, state of the habitat and type of cattle grazing. Shading was simply estimated through assessment of pictures taken on sight, from ground level, of the tree cover. The shading was assessed as a percentage cover. The type of grazing animal was noted based on presence of the grazer, fresh signs such as prints or droppings and in a few cases verbal communication with the landowner. Some grasslands had no clear signs of specific types of grazers but were marked with unknown if there were signs of semi-recent grazing as well as other indicators such as intact fences.

The time since abandonment was recorded in Winsa et al. (2017) using orthophotos and historical data was used here as well. The time since the last survey (14 years) was added for each of the new grasslands to give their new time since restoration. This is the best estimation, but things such as intermittent abandonment or changes in grazing intensity etc. could not be quantified for a more robust data set of abandonment.

2.2 Analysis

2.2.1 Species characteristics and supplementary data

To analyse the data, I added additional information about species attributes using datasets created in other studies. Temperature and light requirements as well as values for grazing correlation and longevity of plants used data from (Tyler et al. 2021). These values are based on Ellenberg values (Ellenberg 1974). Ellenberg values categorize vascular plants with regard to their requirements and optimum values in relation to temperature, light, grazing and other environmental factors. Ellenberg values are optimized and calculated for species present in central Europe and Tyler et al. (2017) use these as a basis for establishing the same system for Swedish species classified as present or ephemeral, as well as a few species that are regarded as nationally extinct since the 1950's) I used this data to calculate community weighted averages for each of the 10 plots in each of the 38 older and 37 newer habitats. I used these values to examine if it was possible to associate changes happening in the species composition to a particular driver of change.

Grazing values from Tyler et al. (2021) are valued from 1 to 8 where 1 is a species that cannot handle grazing or mowing are given low values, while a species that are associated with grazing or mowing are given high values. Temperature values are an average of the optimal temperature for all the species in a plot, these values are taken from Tyler et al (2021) as well. Light values from Tyler et al. (2021) use a numerical value for the optimal light condition for each

species. The values range from 1 to 7 with higher numbers meaning more sunlight is optimal for the species.

Classification of species as generalist, broad specialist and narrow specialists used data also used in Öckinger et al. (2012) The strict specialist are the ones specialized in grasslands, and typical of species that will disappear with discontinued grazing. Not all species found in the survey were classified within this data set and the outliers were excluded in this analysis. The classification was used to calculate the number of species in each category for every plot per grassland. The relative cover of each category was also calculated using this data and the frequency data for each species.

Identification of species as invasive or red listed as well as classification of species as forest or grassland species used information from Artfakta (Artdatabanken n.d.). The values were collected from October to November 2025. The red list classification uses the 2020 red list from Artdatabanken (Eide 2020). At time of analysis and writing for most of the paper the 2025 red list (Swedish Species Information Centre, Swedish University of Agricultural Sciences 2026) had not yet been published.

The analysis change over time used a GLMM analysis with R-studio v. 4.3.3, (R Core Team 2024) and the packages used for the glmm was glmmTMB (Brooks et al. 2017; McGillicuddy et al. 2025) emmeans (Lenth et al. 2026) and car (Fox & Weisberg 2019; 2022). The GLMM was done using poisson distribution for all analyses except Shannon diversity. Graphs and plots were created using the package ggplot2 (Wickham 2016; Kassambara et al. 2026). The GLMM analysis used a nested structure analysis to account for false positives caused by the large number of points of analysis (750 for both old and new when looking at all plots in each grassland). The package report was used for recording the source information for each of the packages for the report (Makowski et al. 2021).

Analysis was run on the full number of species for both surveys but also run without grasses for some analysis. Doing the analysis without grasses was done to mitigate the risks of miscalculations caused by uncertainties in the identification of grass species. This is because species identification of grasses is difficult, particularly in grazed habitats where identification often has to be done without flowering individuals.

Other analyses run looked at the correlation of connectivity to species richness, generalists and specialists to understand if these things are impacting the results of the other analyses. Area was also analysed in the same way. Looking at this is to understand if these things will impact the diversity and the presence of generalists and specialists more than the grazing of the habitats. The area calculation and connectivity data comes from (Winsa et al. 2017). Area is simply the area of the grassland and connectivity was calculated using an index by Hanski et al. (2000).

The calculation uses area of near grasslands, distance to those, dispersal ability and emigration (Winsa et al. 2017).

3. Results

3.1 Results.

In total 275 species were found during the survey in 2011 (Winsa et al. 2017), while I in my survey in 2025 encountered 208 species. More species were recorded outside of the plots, but this data was not used in my analyses. The only species present within just one plot was one specimen of *Botrychium lunaria* in the 2025 survey.

A statistical difference that is found in most of the analyses is a lower number of species in all groups from the more recent survey. Analyzing all species shows decreases of -0.1835 (± 0.0478 , $p = 0.0017$) species per plot for continuous, -0.2043 (± 0.0408 , $p = 0.0001$) for restored and -0.0907 (± 0.0314 , $p = 0.0451$) for abandoned (Table 2). Looking at the species numbers while excluding the grass species, I find a similar pattern with a decrease of -0.4352 (± 0.0513 , $p < 0.0001$) for continuous, -0.291 (± 0.0439 , $p < 0.0001$) and -0.2643 (± 0.0321 , $p < 0.0001$) for abandoned between the two surveys (table 3). The Shannon diversity only has one statistically significant change over time, the one for abandoned habitats which has decreased with -0.2249 (± 0.0703 , $p = 0.0181$) (Table 2, Fig 2B).

3.2 Change over time

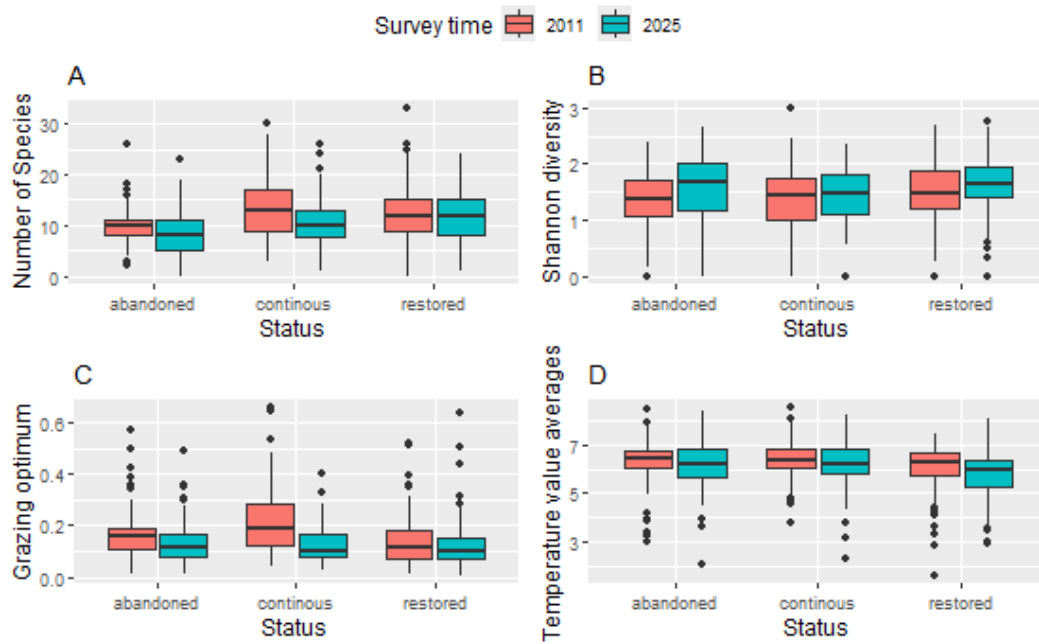


Figure 2 Boxplots picturing the GLMMs: A- the number of species in each plot for the different groups, B-the Shannon diversity of each plot for the different group C- The average grazing optimum for the species in each plot for each group, D- The average temperature optimum for the species in each plot in each of the groups.

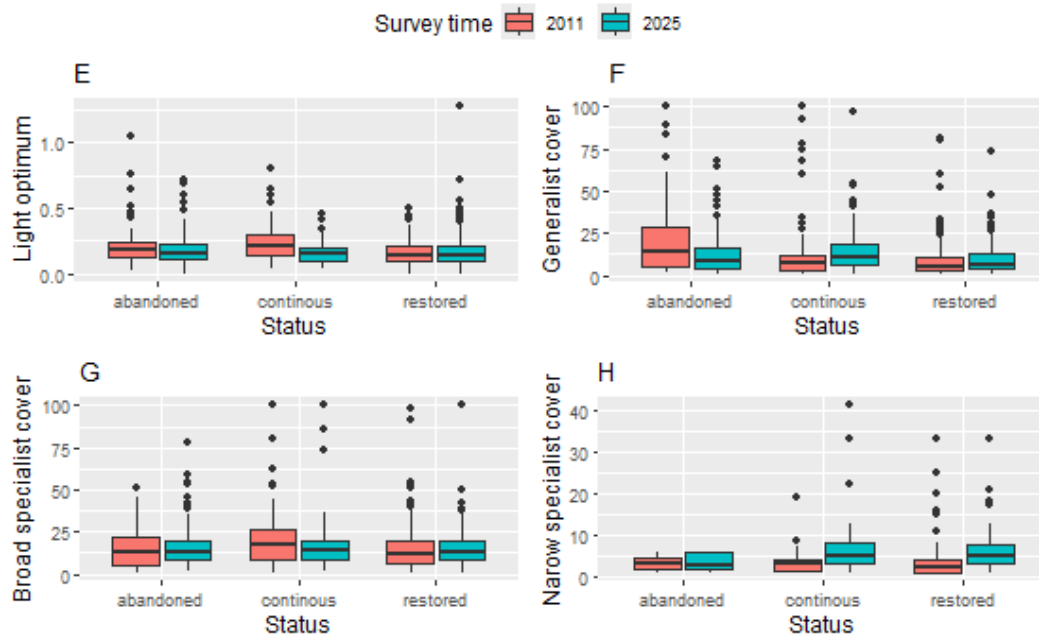


Figure 3 Boxplots picturing the GLMMs: E- The average light optimum for the species in each plot in each of the groups. F- The cover of generalist species in each plot G- The cover of broad specialist species in each plot, plot H -The cover of narrow species in each plot

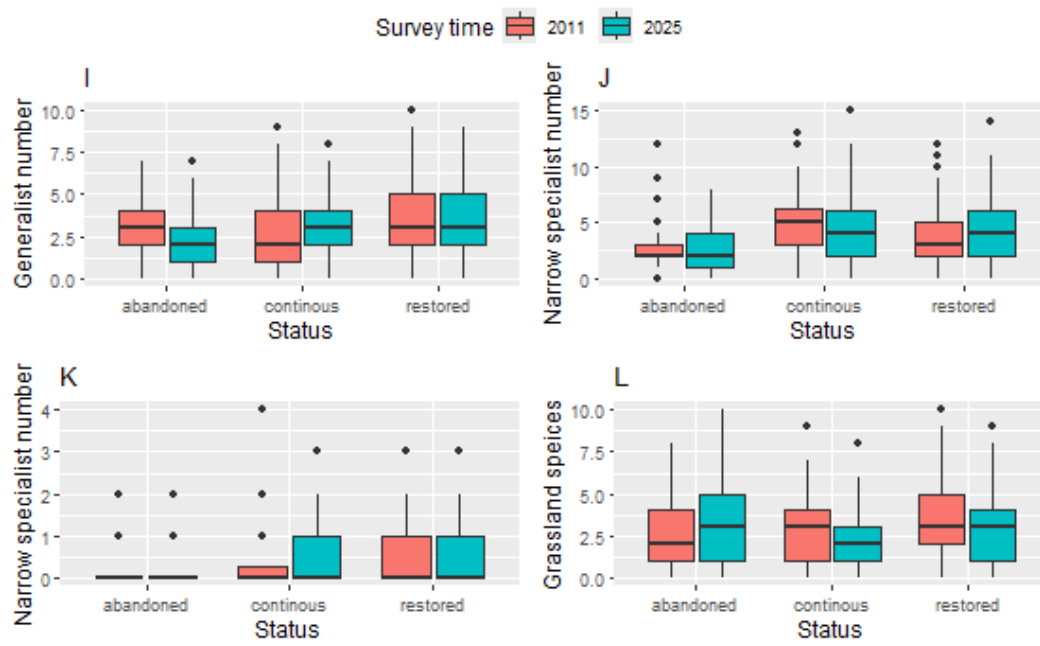


Figure 4 Boxplots picturing the GLMMs: I- The number of generalist species in each plot J- The number of broad specialist species in each plot, K- The cover of narrow species in each plot, L – The number of grassland species in each plot.

Table 2- GLMM analysis interactions of change over time in the different grassland typed for the analyzed values. Significance is indicated in the column furthest to the right. 0= insignificance i.e. a p-values over 0.05. If a change is significant decrease or increase is indicated by an arrow in the column furthest to the right

Number of species						
contrast	estimate	SE	df	t.ratio	p.value	
continous	-0.1835	0.0478	Inf	-3.841	0.0017	↘
restored	-0.2043	0.0408	Inf	-5.005	0.0001	↘
abandoned	-0.0907	0.0314	Inf	-2.886	0.0451	↘
Shannon diversity						
abandoned	-0.2249	0.0703	735	-3.197	0.0181	↘
continous	0.0414	0.0718	735	-0.577	0.9925	0
restored	0.1482	0.0543	735	-2.728	0.071	0
Grazing optimums						
abandoned	-0.20892	0.372	Inf	-0.561	0.9935	0
continous	-0.54413	0.356	Inf	-1.528	0.6464	0
restored	-0.08248	0.298	Inf	-0.276	0.9998	0
Temperature value averages						
abandoned	-0.0106	0.0565	Inf	-0.188	1	0
continous	-0.0287	0.0564	Inf	-0.509	0.9959	0
restored	-0.0503	0.0441	Inf	-1.14	0.8646	0
Light optimums						
contrast	estimate	SE	df	t.ratio	p.value	
abandoned	-0.1222	0.318	Inf	-0.384	0.9989	0
continous	-0.3535	0.32	Inf	-1.104	0.8801	0
restored	0.105	0.26	Inf	0.404	0.9986	0
Generalist cover						
abandoned	-0.48316	0.0361	Inf	-13.37	<0.0001	↗
continous	0.07986	0.0396	Inf	2.018	0.3318	0
restored	0.05243	0.0361	Inf	1.452	0.6947	0
Broad specialist cover						
abandoned	0.0702	0.0385	Inf	1.825	0.4492	0
continous	-0.0836	0.0333	Inf	-2.513	0.1203	0
restored	0.0632	0.0286	Inf	2.214	0.2312	0
Narrow specialist cover						
abandoned	0.2549	0.269	Inf	0.947	0.9341	0
continous	0.8371	0.143	Inf	5.846	<0.0001	↗
restored	0.0333	0.0873	Inf	0.381	0.999	0
Generalist number						
contrast	estimate	SE	df	t.ratio	p.value	
abandoned	-0.2182	0.0875	Inf	-2.494	0.1258	0
continous	0.1339	0.0853	Inf	1.569	0.619	0
restored	0.048	0.0609	Inf	0.789	0.9695	0
Broad specialist number						
abandoned	-0.0084	0.0928	Inf	-0.091	1	0
continous	-0.1037	0.0661	Inf	-1.569	0.6192	0
restored	0.0925	0.0572	Inf	1.618	0.5866	0
Narrow specialist number						
abandoned	-0.79675	0.406	Inf	-1.961	0.3647	0
continous	0.2611	0.247	Inf	1.055	0.8989	0
restored	0.22593	0.169	Inf	1.34	0.7626	0
Redlist						
abandoned	-0.223	0.7	Inf	-0.333	0.9995	↘
continous	-28.717	429000	Inf	0	1	↘
restored	-3.357	1	Inf	-3.301	0.0124	↘
Invasive						
contrast	estimate	SE	df	t.ratio	p.value	
abandoned	-2.416	0.467	Inf	-5.176	<0.0001	↘
continous	-1.907	0.357	Inf	-5.333	<0.0001	↘
restored	-2.352	0.315	Inf	-7.469	<0.0001	↘
Forest						
abandoned	-0.277075	0.186	Inf	-1.488	0.6717	0
continous	-0.469655	0.18	Inf	-2.61	0.0947	0
restored	0.078456	0.121	Inf	0.65	0.9871	0
Grassland						
abandoned	0.2561	0.0886	Inf	2.892	0.0444	↘
continous	-0.2797	0.0937	Inf	-2.986	0.0336	0
restored	-0.1761	0.0631	Inf	-2.79	0.0591	0

Table 3 - Table of changes over time discounting species of grass. Significance is indicated in the column furthest to the right. 0= insignificance i.e. a p-values over 0.05. If a change is significant decrease or increase is indicated by an arrow in the column furthest to the right

Number of species						
contrast	estimate	SE	df	t.ratio	p.value	
continous	-0.4352	0.0513	Inf	-8.487	<0.0001	↘
restored	-0.291	0.0439	Inf	-6.626	<0.0001	↘
abandoned	-0.2643	0.0321	Inf	-8.231	<0.0001	↘
Shannon diversity						
abandoned	-0.3418	0.368	Inf	-0.928	0.9394	0
continous	-0.4017	0.415	Inf	-0.968	0.9282	0
restored	-0.1715	0.295	Inf	-0.581	0.9923	0
Grazing optimums						
abandoned	-0.3418	0.368	Inf	-0.928	0.9394	0
continous	-0.4017	0.415	Inf	-0.968	0.9282	0
restored	-0.1715	0.295	Inf	-0.581	0.9923	0
Temperature value averages						
abandoned	-0.01063	0.0565	Inf	-0.188	1	0
continous	-0.03296	0.0595	Inf	-0.554	0.9938	0
restored	-0.04673	0.0428	Inf	-1.091	0.8852	0
Light optimums						
contrast						
abandoned	-0.0375	0.315	Inf	-0.119	1	0
continous	-0.3233	0.348	Inf	-0.93	0.9389	0
restored	0.0352	0.256	Inf	0.137	1	0
Generalist cover						
abandoned	0.04097	0.0378	Inf	1.083	0.8882	0
continous	-0.00304	0.0395	Inf	-0.077	1	0
restored	0.01624	0.0263	Inf	0.618	0.9898	0
Broad specialist cover						
abandoned	-0.5867	0.251	Inf	-2.335	0.1799	0
continous	0.7147	0.127	Inf	5.614	<0.0001	↗
restored	0.7103	0.0944	Inf	7.524	<0.0001	↗
Narrow specialist cover						
abandoned	-0.13254	0.0848	Inf	-1.562	0.6235	0
continous	0.06987	0.0923	Inf	0.757	0.9745	0
restored	0.02774	0.0607	Inf	0.457	0.9975	0
Generalist number						
contrast						
abandoned	-0.4841	0.0951	Inf	-5.091	<0.0001	0
continous	0.0515	0.0753	Inf	0.684	0.9837	0
restored	0.0967	0.0541	Inf	1.788	0.4733	0
Broad specialist number						
abandoned	-1.433	0.46	Inf	-3.116	0.0226	↘
continous	0.889	0.238	Inf	3.744	0.0025	↗
restored	0.32	0.17	Inf	1.88	0.4143	0
Narrow specialist number						
abandoned	-1.4294	0.457	Inf	-3.125	0.022	↘
continous	0.2614	0.248	Inf	1.052	0.9	0
restored	0.3236	0.167	Inf	1.941	0.3767	0
Redlisted species						
abandoned	-2.9832	0.513	Inf	-5.821	<0.0001	↘
continous	-1.8326	0.381	Inf	-4.813	<0.0001	↘
restored	-2.1611	0.304	Inf	-7.108	<0.0001	↘
Invasive species						
contrast						
abandoned	-21.157	1.18E+04	Inf	-0.002	1	0
continous	-1.253	8.02E-01	Inf	-1.562	0.6234	0
restored	-2.389	6.03E-01	Inf	-3.964	0.001	↘
Forest species						
abandoned	0.4474	0.173	Inf	2.586	0.1007	0
continous	-1.0168	0.226	Inf	-4.509	<0.0001	↘
restored	-0.1602	0.118	Inf	-1.353	0.7549	0
Grassland species						
abandoned	-0.89899	0.0993	Inf	-9.05	<0.0001	0
continous	0.44426	0.0881	Inf	5.045	<0.0001	0
restored	-0.00172	0.0634	Inf	-0.027	1	0

Generally, few of the analysed values showed significant changes between the two surveys (Table1, Figure 2, Figure 3). The results with significance show no clear pattern between the different the type of grassland. Generally, the changes were decreases in values and a general trend of decreases can be observed even in the non-significant values (Table 1). Highly significant changes can be seen for the number of invasive and red listed species observed in the habitats.

3.3 Changes in contrast between grasslands that are continuous, abandoned or restored

Table 4 - Changes in contrast between continuous and restored grasslands over time

Continuous-restored					
Species number	estimate	SE	df	t.ratio	p.value
2025	-0.0581	0.0726	Inf	-0.8	0.9675
2011	0.0554	0.0708	Inf	0.783	0.9705
Shannon diversity					
2025	-0.22	0.10	735.00	-2.17	0.25
2011	-0.11	0.10	735.00	-1.11	0.88
Grazing optimum					
2025	-0.00744	0.357	Inf	-0.021	1
2011	0.45422	0.298	Inf	1.527	0.647
Temperature values	estimate	SE	df	t.ratio	p.value
2025	0.0635	0.0513	Inf	1.237	0.8187
2011	0.0419	0.05	Inf	0.837	0.9606
Light optimum					
2025	-0.0753	0.305	Inf	-0.247	0.9999
2011	0.3832	0.277	Inf	1.382	0.7377
Generalist cover					
2025	0.336	0.157	Inf	2.145	0.2643
2011	0.30857	0.157	Inf	1.967	0.3617
Broad specialist cover					
2025	0.1267	0.116	Inf	1.095	0.8838
2011	0.2735	0.115	Inf	2.373	0.1658
Narrow specialist cover	estimate	SE	df	t.ratio	p.value
2025	0.5441	0.217	Inf	2.508	0.1216
2011	-0.2597	0.231	Inf	-1.124	0.8717
Generalist number					
2025	-0.0969	0.114	Inf	-0.848	0.9583
2011	-0.1827	0.116	Inf	-1.574	0.6159
Broad specialist number					
2025	0.1282	0.14	Inf	0.913	0.9433
2011	0.3245	0.139	Inf	2.337	0.1791
Narrow specialist number					
2025	-0.22506	0.227	Inf	-0.99	0.9212
2011	-0.26023	0.247	Inf	-1.055	0.8988
Redlisted species	estimate	SE	df	t.ratio	p.value
2025	-25.484	429000	Inf	0	1
2011	-0.125	0.5	Inf	-0.275	0.9998
Invasive species					
2025	0.326	0.455	Inf	0.715	0.9802
2011	-0.12	0.173	Inf	-0.693	0.9828
Forest species					
2025	-0.54905	0.256	Inf	-2.141	0.2661
2011	-0.00094	0.241	Inf	-0.004	1
Grassland species					
2025	-0.2158	0.132	Inf	-1.633	0.5763
2011	-0.1122	0.125	Inf	-0.9	0.9466

Table 5- Changes in contrast between abandoned and restored grasslands over time

Abandoned - restored					
Species number	estimate	SE	df	t.ratio	p.value
2025	-0.3411	0.0749	Inf	-4.556	<0.0001
2011	-0.2483	0.0727	Inf	-3.416	0.0084
Shannon diversity					
2025	0.0981	0.0999	735	0.982	0.9237
2011	-0.1268	0.0997	735	-1.272	0.8004
Grazing optimum					
2025	0.04561	0.352	Inf	0.129	1
2011	0.17205	0.322	Inf	0.534	0.9948
Temperature values					
2025	0.0739	0.0513	Inf	1.441	0.7018
2011	0.0343	0.0501	Inf	0.684	0.9838
Light optimum	estimate	SE	df	t.ratio	p.value
2025	0.0387	0.294	Inf	0.132	1
2011	0.2659	0.287	Inf	0.928	0.9395
Generalist cover					
2025	0.34452	0.157	Inf	2.197	0.239
2011	0.88011	0.156	Inf	5.656	<0.0001
Broad specialist cover					
2025	0.037	0.116	Inf	0.318	0.9996
2011	0.03	0.116	Inf	0.258	0.9998
Narrow specialist cover					
2025	-0.2078	0.306	Inf	-0.679	0.9843
2011	-0.4294	0.248	Inf	-1.734	0.509
Generalist number	estimate	SE	df	t.ratio	p.value
2025	-0.3386	0.118	Inf	-2.863	0.0482
2011	-0.0723	0.114	Inf	-0.634	0.9885
Broad specialist number					
2025	-0.4487	0.148	Inf	-3.035	0.029
2011	-0.3477	0.147	Inf	-2.361	0.17
Narrow specialist number					
2025	-1.70873	0.371	Inf	-4.61	<0.0001
2011	-0.68606	0.279	Inf	-2.455	0.1376
Redlisted species					
2025	1.958	1.2	Inf	1.684	0.5424
2011	-1.176	0.6	Inf	-2.036	0.322
Invasive species	estimate	SE	df	t.ratio	p.value
2025	-0.266	0.544	Inf	-0.488	0.9966
2011	-0.202	0.177	Inf	-1.143	0.8633
Forest species					
2025	-0.51588	0.256	Inf	-2.018	0.3317
2011	-0.16035	0.245	Inf	-0.654	0.9868
Grassland species					
2025	0.0847	0.128	Inf	0.664	0.9858
2011	-0.3475	0.127	Inf	-2.74	0.0676

The difference between restored and continuous grasslands was less obvious for data from the 2025 survey. Looking at abandoned and restored grasslands as they seem to in a few cases also become more similar, for example in terms of species numbers (Table 2), where data from the 2011 survey showed an average difference of -3.48 (± 0.86) while the average difference based on data from the 2025 survey was -2.75 (± 0.85).

3.4 Connectivity

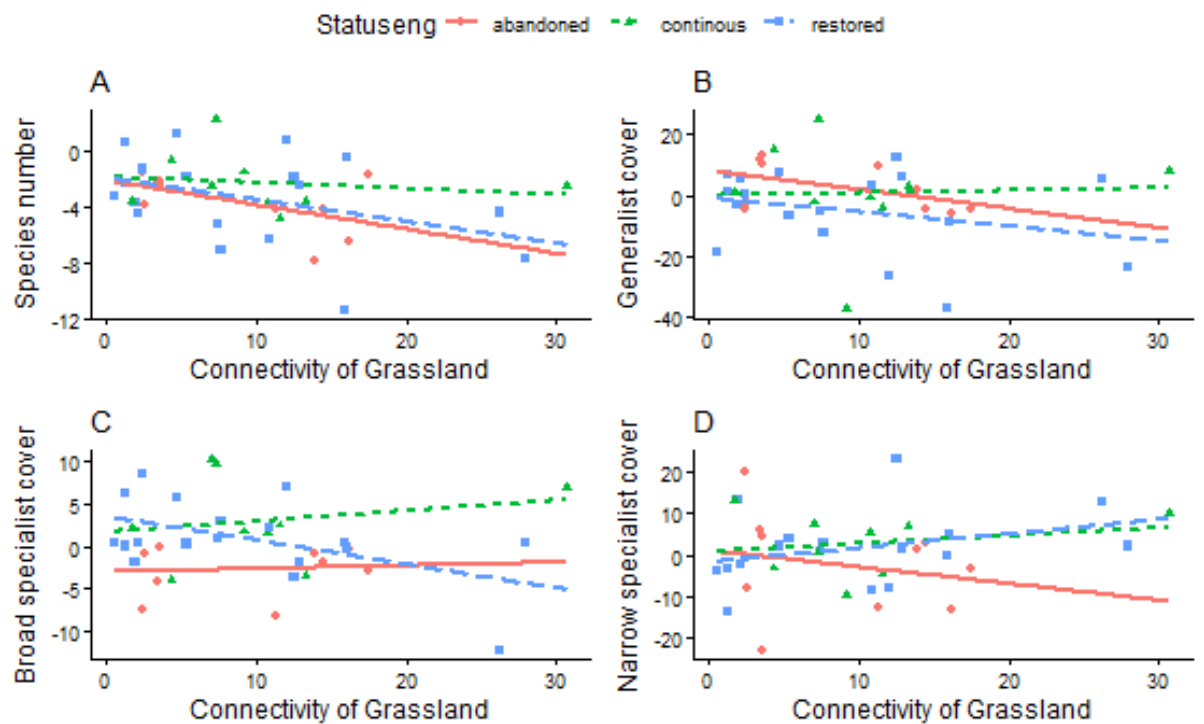


Figure 5 The change in number of species per plot and correlation to connectivity of the grasslands as calculated by Winsa et al. (2017). A- Change in species number between the two surveys correlated to the connectivity of the grassland. B- Change in generalist species between the two surveys correlated to the connectivity of the grasslands. C- Change in broad specialist species between the two surveys correlated to the connectivity of the grasslands. D- Change in narrow specialist species between the two surveys correlated to the connectivity of the grasslands.

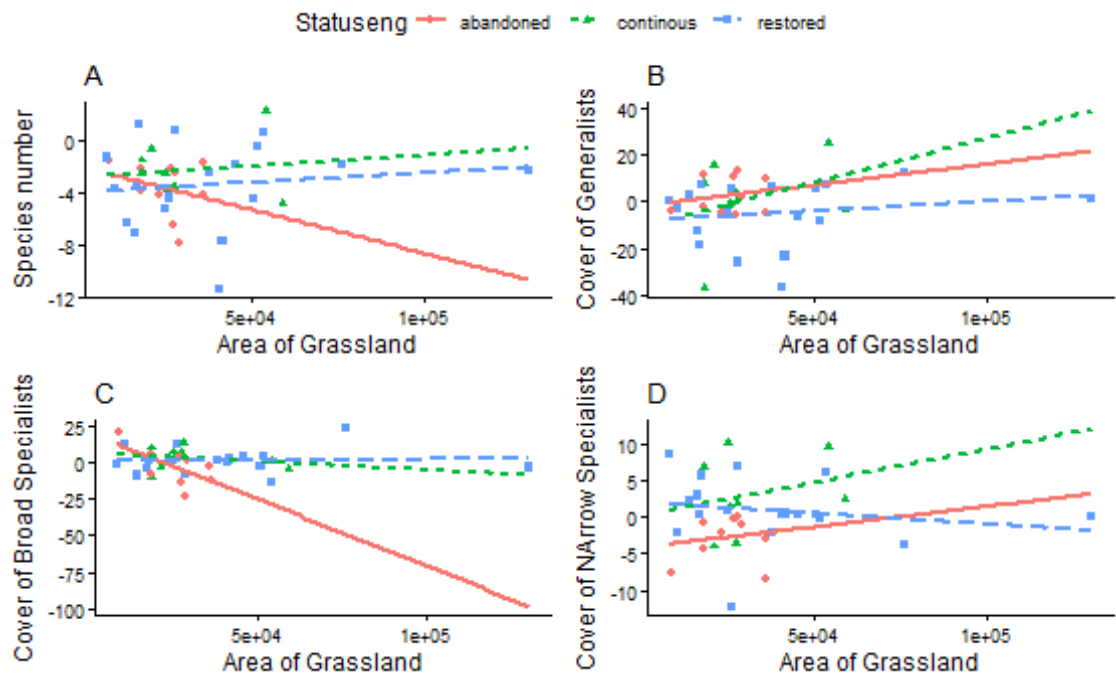


Figure 6 The correlations of Area of the grassland, Area of grassland was calculated through maps and ortho-photos by Winsa et al. (2017), (Rotchés-Ribalta et al. 2018) A- Number of species per plot and correlation to area of the Grassland. B-The cover of generalist species per plot and correlation to area of the Grassland. C-The cover of broad specialist species per plot and correlation to area of the Grassland. D-The cover of narrow species per plot and correlation to area of the Grassland.

Connectivity of grassland in the landscape does not show correlation with different species values and all types of grasslands show a negative correlation with connectivity which is a bit unexpected since connection and the ability for species to disperse to the grassland could be a way for grassland species to establish themselves. It might simply be the case that there is no correlation there caused by connectivity for these grasslands.

Some correlations can be seen with the grassland area in the landscape and species cover and numbers. Restored and continuous grasslands show some positive correlation between the number of species and area, while abandoned show a negative trend, but it is not quite consistent. For species richness this holds true (figure 5A) but for specialists the results are a little more unclear as both continuously grazed and abandoned grassland have a positive correlation while restored grasslands show a negative correlation between area and narrow specialist species (figure 5D).

3.5 Grazer types

Livestock types show no significant effects on the number of species in the habitat although some trends can be seen, habitats that are abandoned and

therefore are not grazed at all do in general have a much lower number of species. Comparing the habitats that are currently grazed to each other shows less difference than the difference between any grazer and the abandoned grasslands. Cattle and horses show higher numbers of plant species, and areas grazed by cattle showed the absolute highest number of species.

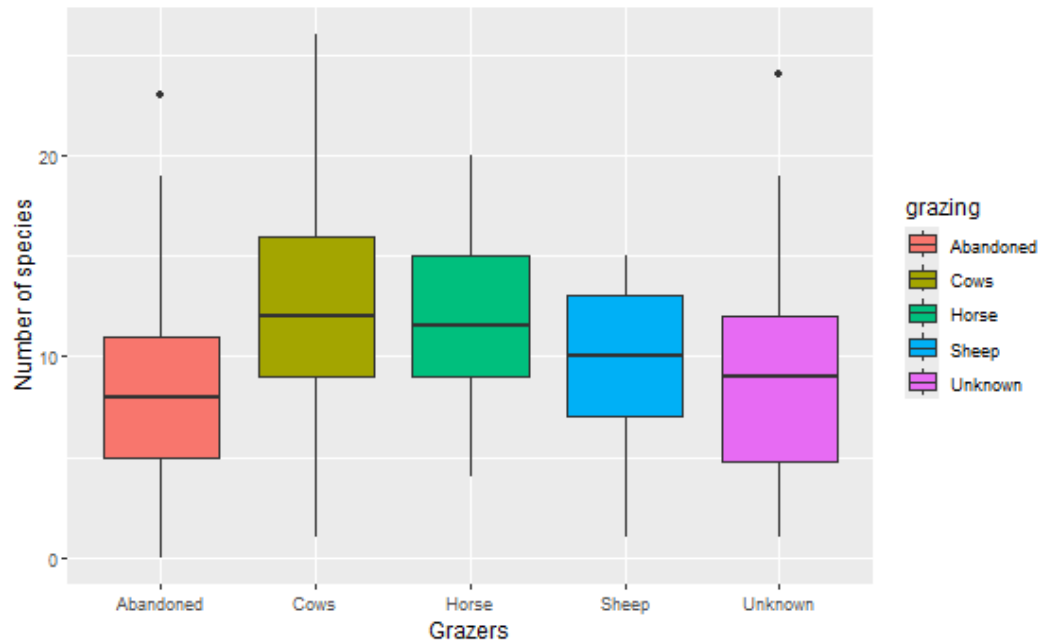


Figure 7 Plant species richness in relation to type of grazers. Note that data only presented for sites where it was possible to determine grazer type.

3.6 Time since restoration

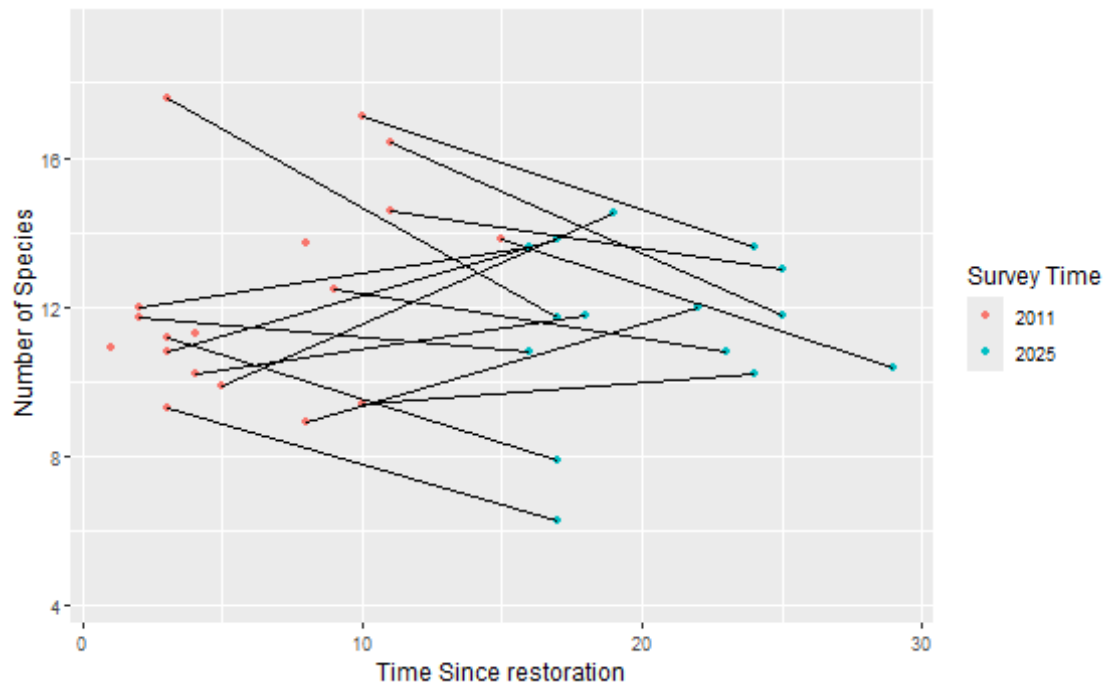


Figure 8. Change of species number and time since restoration using both old and new data result of pairwise t-test: $t = 4.3634$, $df = 369$, $p\text{-value} = 1.664e-05$ and a mean difference of 1.491892.

Analysing all of the changes correlated to time since restoration, some results with significance could be found. The species number has a significant p-value and the difference in number of species over time is clear (Fig 8) and seems to be decreasing. Looking at the correlation between the time since restoration of grassland and number of narrow specialists give some interesting results. Although there was a trend towards a decrease for narrow specialists, this trend was not significant (Fig. 9). This analysis used data for all the restored plots both 2011 and 2025 results.

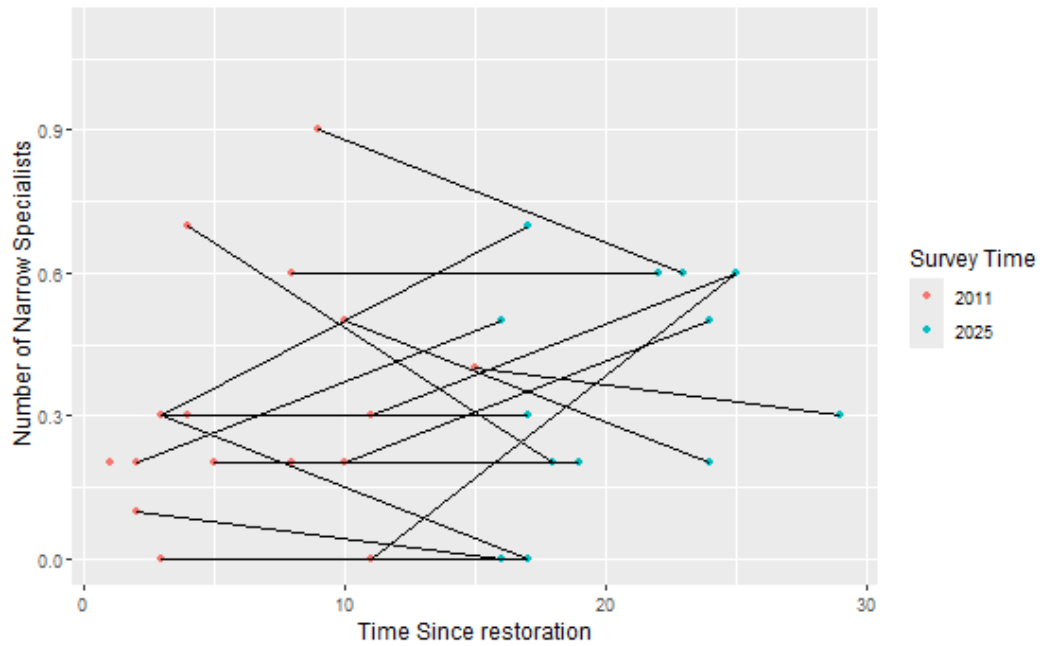


Figure 9 change of number of narrow specialists and time since restoration using both old and new data. Result of pairwise t -test: $t = -0.81694$, $df = 369$, p -value = 0.4145 and a mean difference of -0.03513514

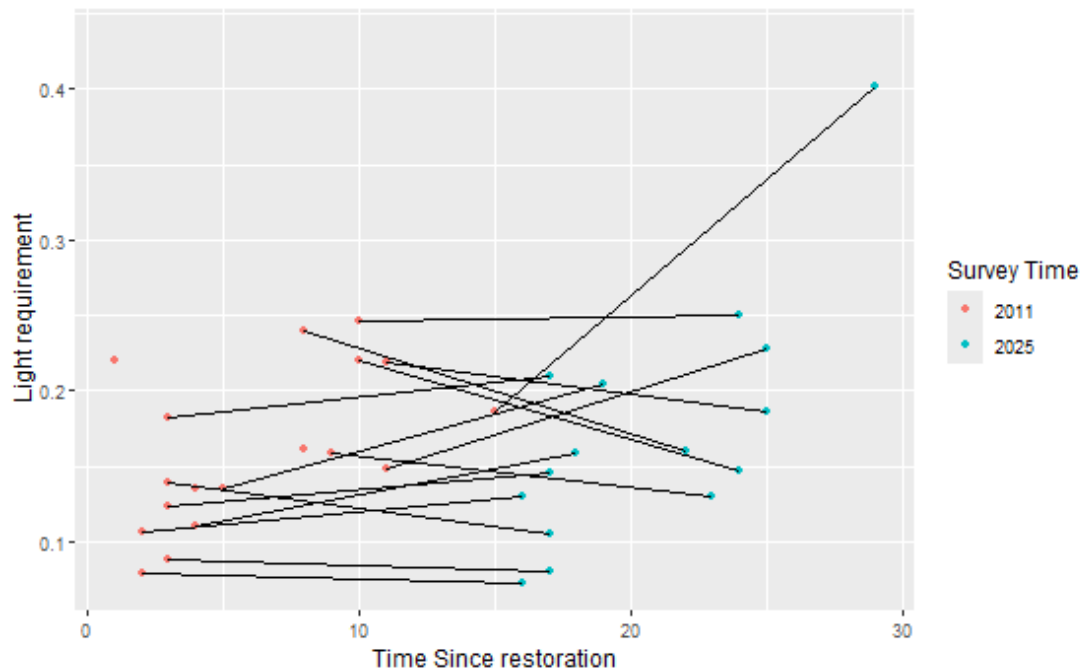


Figure 10 change of number of average light requirement of plants and time since restoration using both old and new data result of pairwise t -test: $t = 1.9485$, $df = 369$, p -value = 0.05212 and a mean difference of 0.0173325

There seems to be an increase in the light values here, but the p -value is just above 0.05 so the difference here is not significant (Fig 10).

4. Discussion

4.1 Changes in indicator values and possible implications

In contrast to my expectations, there were very few changes over the 14 years between the surveys. I expected generally more increases, in species richness and grazing optimum values, but this was not the case. The statistically significant results were, when analyzing all species, a general decline in species numbers for all types of grasslands, a large decline in both invasive and red listed species for all grasslands, increase generalist cover in abandoned grasslands and increase in narrow specialist species in continuously grazed grasslands. These changes were in general small, but nevertheless significant and in accordance with my hypothesized trends. There were some additionally significant results when not including grasses in the analyses. These changes are a bit more aligned with expectations and patterns one might expect, but there are still fewer significant changes than hypothesized. It may also indicate that there was a difference caused by the trouble in identifying species of grass.

Looking at indications that were not significant (Fig 2 C, Fig 3 E) we can see that there are larger decreases in grazing optimum values and light optimum values in abandoned and continuous habitats than in restored habitats. This lack of change could mean that there is an impact of restoration that is not seen due to a general decline in values caused by background change or methodology change between surveys.

Semi-natural grassland is a habitat in Sweden under threat due to many environmental factors, particularly abandonment and exploitation for agriculture or silviculture. The loss of grazed grasslands removes a place of safety for species who need these habitats but also decreases the possibility for dispersion due to fragmentation and isolation of the lasting grasslands. The trend of decrease has been observed for a while and seems to continue. In my study two habitats were lost to exploitation? Which may contribute to an increased fragmentation and may increase the long-term threat of grassland species that need continuous grazing.

In this study the results generally show few significant differences, which may have several different explanations. One might simply be that there is no significant difference between the habitats now and the habitats in 2011. This might not mean that there are no differences or that nothing is changing or improving with time it might just be that the 14 years between inventories is not enough time for the grasslands to respond significantly. Other factors might also impact the results, like a large difference between grasslands within the same grassland type, which makes it more difficult to detect a change over time. The actual cause for a lack of observable patterns and full effects of restoration might

not be detectable yet. While 37 grasslands and 10 plots per site are quite a few, more sites or simply more revisits of the same grasslands over time, both between 2011 and 2025 might have made for a clearer pattern. Future visits might also help in understanding some of the patterns of change. The similarities between the restored habitats and the continuous habitats have increased in most cases (Table 4). And the restored and abandoned habitats are generally, in some cases, also increasingly similar (Table 3), but the trend of increasing similarity of those have fewer significant results. A large change in both red listed and invasive species in all grasslands is not entirely likely and might be the result an error in the survey for this paper or a is caused by a coincidence due to where the plots in this survey were placed as very few species of both invasive and red listed species were identified. This could also be the result of misidentification of species during one of the surveys, or that the position of the plots in the second survey did not exactly match the position of the first.

4.2 Impact of restoration

The difference between restored and continuous grasslands decreasing might indicate that there is a positive effect on habitats when restoring them. It could also mean that the decrease of species in the restored grasslands is slower than the continuous that causes a decrease in differences. This is while there is a more general homogenization of numbers in the newer data, either caused by some change that generally impacts all plots or it could be caused because of differences in observers means a lower number of observed species in the 2025 survey (Schmidt et al. 2023). Looking at these results, we can see an improvement in the restored habitats that indicate a movement toward a diversity that matches that of the continuous grasslands.

Small changes or uncertain results are not unknown when assessing restored grasslands, for example Waldén & Lindborg (2016) found that, while improvement can occur, restored habitats might still not reach the values of comparable continuous habitats. Waldén & Lindborg (2016) also note that the chosen measurements used and the general goal of restoration needs to be clearly outlined to be able to assess the success of a restoration. Some grasslands can show response to restoration faster, likely as a result of the seedbanks and the resilience of many grassland species (Prangel et al. 2025).

Longterm studies of restoration in grasslands is lacking and a full understanding of the dynamics of restoration unclear (Slodowicz et al. 2023). The time at which these grasslands were surveyed might have been part of the reason for the results showing few significant differences. The time since restoration

varied between 2 to 15 years for the first study and then consequently between 16 to 29 years at the time of my re-survey. The time since abandonment before might also impact the impact of restoration as all restored grasslands had been abandoned for at least 28 years in 2011 and at most 51 years. The time since abandonment is quite a bit above the timeframes for the most effective restoration window, between five to ten years. Similarly (Redhead et al. 2014) discussed a larger differential between grasslands of similar age around 50 years and since many restored grasslands are a bit younger or around this age this might contribute to a lack of significant patterns. Another reason might be that many of the effects of the restoration might have occurred before the second survey in 2025 and that might have contributed to the many insignificant results.

Restoration can show results in shorter times than what I have observed. Many early and extensive studies of this kind have also been conducted on grasslands with closely monitored regimens for grazing while the results in private and less rigidly kept grasslands is a little less known, which could also explain my results (Pykälä 2003). The grasslands in this study were all privately owned with no way to ensure the same treatment of each grassland was even through the years and between grasslands and because of this the results might be impacted as differences in treatment within the groups (continuous, restored and abandoned) might affect the analysis.

Considering all the different factors that can decrease significance in results and clarity of patterns there are small but important differences seen here that indicate the value of restoration and the importance of the time needed for restoration to take effect.

The fact that there is some significant changes over time could be an indication of the impact of multiple measurements over time. This means more continuous nature of the time-data where there is a bigger span of years in this analysis which means more than two points of analysis to base the results on.

4.3 Statistical insignificance and possible causes

The statistical insignificance could mean that there is almost no difference between the restored, continuous and abandoned habitats for some values, but many other reasons could be the cause. Differences in the habitats within the same type of grassland such as abandoned, continuous or restored, could be cause for some of the statistically insignificant values. Things such as the intensity of grazing, also has an impact on the grasslands but are very hard to evaluate (Cao et al. 2024). The intensity of grazing over time and between the surveys is especially hard to evaluate and significantly impact the species of vascular plants present in

the grasslands. The changes in grazing values show some decrease even though the changes are not significant (Table 2, 3, Fig 2 C)

Correlations between land use, both in surrounding grasslands and within the surveyed grasslands, could be evaluated for a more comprehensive understanding of the changes over time in the grassland. This could show the effects of the historical change in the network of grasslands affecting the surveyed plot. More exact reporting of the grazing intensity could contribute to a better understanding of the effects of grazing intensity and regimens as this can vary both between grasslands and over time.

Changes over time and understanding of impact of climate requires long term data and high resolution of the data (Dornelas et al. 2013). The results in this paper might not show clear results in this instance but some trends can be found. The longest time since start of restoration until this study is 29 years (Sjöängen-Engsö) which is quite a while but only somewhere around one to two thirds of the time likely needed for real impact to be seen (Gustavsson et al. 2007, Lindborg and Eriksson, 2004), so it may actually be a bit too early to expect clear changes.

4.4 Potential measurement errors

The general decrease of species observed in this study can simply be a case of no actual change since so many of the analyses are statistically insignificant but if that is the real case it is alarming that the species numbers decrease even in restored and continuously grazed grasslands. The decrease of species in grasslands is usually attributed to either change in land use or climate change affecting the species (Montras-Janer et al. 2024). Vermaat et al. (2017) found that the predicted loss of vascular plant species in European grasslands could be mostly caused by land use rather than climate change at this point in time.

In studies that relay on correct species identification, inventory biases is always a concern that can impact the number of species found (Zhang et al. 2014; Schmidt et al. 2023). The impact that the observer has on the results of a survey is important to keep in mind when analyzing the data and when considering what is a statistically significant value. As stated before, there are differences in what and how many results are significant when discounting grasses, which may indicate that my results could be an impact of experience of the surveyor. Grasses generally are more difficult to identify and may explain why the result changes when omitting grasses from the analyses.

Another factor to keep in mind when analyzing the results is that the method for randomization is likely not the same for both studies. For both surveys, a plot that happened to be located within a bush was moved outside of the bush, however exact information on how the position of the plot was adjusted was missing and may have occurred and influenced the result. In my survey a plot was

only moved when located in a bush, or on a very sparsely vegetated patch of the ground, therefore some of the 2025 survey plots were not strictly of a meadow type. If more meadow-like plots were chosen in 2011, that way have impacted the results of the survey, and potentially explain the lower species number recorded in my survey.

4.5 Decrease of species in grasslands

In my survey, two grasslands that were restored in 2011 had now changed, one seemed abandoned while another was developed into housing. One other habitat had a recorded change in ownership and therefore a change in grazing intensity, likely lower intensity when assessed visually. These changes were obvious and easy to identify, but other changes in the time between surveys like short periods of abandonment or other changes in grazing species or intensity cannot be ruled out.

No previously abandoned grasslands showed signs of restored grazing in the same period. This is a purely observational data-point, but it seems to be indicative of the general trend for semi-natural grasslands in Sweden.

In this study, the temperature requirement for the plants were not found to have changed with the species decline in the habitats and this would concur with Vermaat et al. (2017). Other causes that could impact decrease of species within the grasslands is that, even with grazing animals, current grazing practices might differ enough from historical grazing that species decrease as they are adapted to a different grazing intensity and timing (Dahlström et al. 2008). Using a more traditional regimen when placing grazers in grasslands might help (Batáry et al. 2020).

For future studies regarding correlations that could yield more concrete results would likely need more time. Multiple points of reference in a continuous timetable could create results with more statistical power when more than two points of reference are used to understand change over time. The actual fluctuations and timing of change might also become easier to understand.

Much of this could be managed simply with help from landowners to record type of grazers, number of grazers and time in the pasture over time to understand how these interactions have changed.

Restoring habitats has a positive change over time if it is implemented correctly and successfully but these habitats still do not have the same level of diversity or number of species as the continuously grazed habitats. Increase in number of species in general has not been noted in this study (Table 2) and there are a few possibilities for this. This could be either the true difference or a result of the difference in knowledge with the surveyors or differences in method not corrected for in the survey.

4.6 Implications for grasslands and their diversity

If the results of this study are representative of a general trend it indicates that the time needed for successful restoration is long, perhaps longer than anticipated. If so, this also highlights the importance of the protection and continuation of grazing/mowing of remaining grasslands. This does not diminish the value of restoring habitats or even establishing new pastures. Proper protection of these pastures and understanding of the timescales involved in the restoration of biodiversity in these types of habitats is important for the protection of a large part of the grassland biodiversity in Sweden and northern Europe.

The complex mutualistic relationships are negatively impacted by the decline of grasslands and the decrease of species in present grasslands (Hederström et al. 2024). Understanding more of these complexities and all aspects of how grazing cattle influence grasslands is incredibly important to ensure protection of species that are very much at risk currently. The results here do indicate some improvement with trends that hint toward increases in narrow specialist and broad specialist numbers, even if the changes are not significant, in restored grasslands and a general worse condition of these than in continuously grazed grasslands but that does not mean that restoration is done in vain. We are still losing grasslands with long continuity and while protecting these are the most important, restoring grasslands will still create vectors for grassland species to spread and opportunities for some grassland species to grow and the full extent of the effects of restoration might be seen with more time.

5. Conclusion

Decrease of species even within managed grasslands is worrying for the future of species in grasslands, and a better understanding of the legacy effects of historical management of these could be important for future conservation of species.

A type of bounce-back or significant restoration cannot be clearly noted in this study but indications of an improvement in the restored grasslands can be noted and should be regarded positive. This includes the response of narrow and broad specialist numbers as well as a smaller decrease in general numbers than in the other types of grassland. The importance of maintained grazing is pertinent, and restoring grasslands might have a positive impact even though 14 years seems to be a timescale that is too short to note definitive trends in restored grasslands.

Even though my study raises many unanswered questions, the results could be part of a larger and more long-term analysis. With time, the trends we can see some of here might become significant changes. In this context, my study can contribute to more robust data sets that more clearly can define the trends we need to understand to help our biodiverse grasslands recover and flourish.

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