Can Current Grazing Practices Preserve Biodiversity in Semi-natural Pastures? A Study of the Historical Ecology of Swedish Infield Pastures

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ABSTRACT

In order to preserve the biodiversity and cultural heritage in semi-natural pastures, it is important to manage each type of pasture in a way that resembles the historical land use that has shaped the ecosystem. We monitored the grazing regime in 28 pastures in Sweden from 1987 to 2012, and compared their management with the historical grazing regimes. The studied pastures, as well as a majority of the remaining high nature value pastures in Sweden, are located in historical infield areas, where grazing was determined by the system of fencing and use of meadows and arable fields, the so-called cultivation system. Using various sources, we compiled information about the major Swedish cultivation systems and interpreted their significance for the grazing regime. Historical grazing regimes are chacaterized by frequent late grazing and interannual variations in grazing period and grazing pressure. In contrast, the current grazing is rather intense through the entire summer and with little between-year variation. Also, the grazing in the 1980's and 1990's was considerably more varied and less intense than it is today. A pronounced shift in pasture management took place in the late 1990's, and interviews with the farmers show that the shift was mainly caused by the criteria for agri-environment subsidies. Interviews also show that the subsidies have been important for continued use of the semi-natural pastures. We claim that the differences between current and historical grazing regimes constitute a severe threat to pasture biodiversity, and that it is urgent to adjust the eligibility criteria for agri-environment payments.

KEYWORDS

Semi-natural pasture; grazing regime; open-field farming; biodiversity; agri-environment subsidies.

Introduction

Historical pastoralism in Sweden

Before the introduction of mineral fertilizers and fossil fuels, agriculture in Sweden and elsewhere in Europe was based on local sources of nutrients and energy. Cultivation of arable fields as well as transports were carried out using horses and oxen, and farmland was fertilized with manure from the livestock, which also provided milk products, meat, and other products for local consumption or sale. In this article, we refer to such agricultural systems as pre-industrial.

The livestock grazed in pastures during the summer and were fed hay from meadows

in the winter (Lennartsson et al. 2016). All collectible manure was needed for the fields, hence pastures were not fertilized, and meadows only occasionally. Through this system, pastures and meadows became the nutrient base for both animal production and, through manure, the production of crops. Anthropogenic meadows and pastures that are not regularly fertilized, tilled or sown, are often referred to as semi-natural grassland—created by humans but primarily colonized by "wild" species. Large areas of meadow and pasture were needed to feed enough livestock and provide sufficient manure, which made grasslands dominant in most agricultural landscapes. Arable fields were created on the best soil, meadows on the next best, and pastures on what was left. In many landscapes in Sweden, all available land—both wooded and open—was used for grazing.

Mineral fertilization was introduced in Sweden during the second half of the 19th century and, together with the use of nitrogen fixing legumes, gradually became more common during the twentieth century (Lennartsson et al. 2016). As a consequence, arable fields could provide both cereals, hay, and pasture, and the unfertilized semi-natural meadows and pastures became redundant. They were either cultivated into arable land, abandoned to spontaneous overgrowth, or converted into production forest. In most European countries, only fragments of the former grasslands remain. Larger areas are mainly found in regions where topography or climate limits arable farming, and thus grassland-based pastoralism is the main focus of agriculture. The main examples are the mountainous regions of Central and Eastern Europe and the Mediterranean summer-dry areas (Emanuelsson 2009). Also northern Scandinavia's reindeer pastoralism is based on pastures in mountain and forest landscapes.

Biological and cultural values of semi-natural pastures

The constant flow of biomass and nutrients from grasslands to livestock and arable fields have depleated semi-natural meadows and pastures of nutrients. Nutrient deficiency, combined with mowing and grazing, makes such grasslands species-rich because competitive species are prevented from taking over, allowing a large number of plant species to coexist. These plants, in turn, serve as food for a rich fauna of invertebrates.

A majority of grassland types in Europe are human-made; without domestic livestock, they would have been forests or shrublands. Even most primary grasslands, such as alpine, steppe or wetland grasslands, naturally devoid of forest due to climatic or site-specific reasons, are influenced by domesticated or (in reindeer husbandry) semi-domesticated grazing animals. European grasslands and their biodiversity can thus be considered a biological cultural heritage, i.e., nature that has been shaped or modified by humans that, just like other types of cultural heritage, can tell about human history (e.g., Persic and Martin 2008). For example, remnant populations of grazing-favored plants in forests indicate that the forest was previously grazed.

Due to the decline of grasslands, a large proportion of the more demanding grassland species are threatened. Remaining traditionally managed meadows and pastures are biodiversity hotspots throughout Europe and are in the focus of specific agri-environment schemes in the EU's Common Agricultural Policy (CAP, see e.g., Veen et al. 2009). In Sweden, some 500,000 hectares of semi-natural pasture remain, whereas traditional mowing is almost non-existent (Westin, Lennartsson, Ljung 2022, 32).

Need for historical-ecological knowledge in pasture management for conservation purposes

When aiming to preserve a pasture and its species today, it is necessary to employ a grazing regime that closely enough resembles the historical grazing practices that have shaped the pasture. Therefore, knowledge of historical grazing methods is essential for designing contemporary management. It is

rarely possible to fully replicate pre-industrial land use in current grazing systems, but historical components that are indispensable for biodiversity and other value elements need to be identified and implemented into the management (Lennartsson, Westin, Crumley 2018). Typical components of significant ecological importance in pastures include the timing of grazing, grazing intensity, interannual variation, livestock species, and the structure of the pasture, such as the presence of trees and shrubs. Some of the components related to the grazing can be controlled by herding, fencing and other means of organising the grazing, which are, in turn, anchored in the local agricultural system, including culture and traditional knowledge.

The largest area of pasture was on unenclosed common outlying land (swe, *utmark*), in most of Sweden consisting of forest (including mires and other wetlands), but in some areas of open or semi-open heaths. To protect meadows and fields from grazing animals, those areas were fenced in enclosures known as *gärden*. Most of the enclosed land was gathered around the villages, constituting an infield area (Gadd 2011, 124).

Due to irregular topography, infield areas in central Sweden typically consisted of a mosaic of fields and meadows, as well as areas too rocky and unproductive for plowing or mowing, and therefore used for grazing only. Such former infield pastures today constitutes a significant proportion of Sweden's high nature value pastures. It is therefore crucial to design appropriate grazing regimes for conservation of their biodiversity and biological cultural heritage.

To utilize the forage in infields, while protecting growing crops in arable fields and meadows, intricate fencing systems were developed, allowing livestock into different parts of the infields at certain times of the year (Gadd 2018, 55). To understand the historical grazing regimes on infield pastures, one needs to analyze how grazing was controlled by these fencing systems in combination with the use of meadows and arable land, looking at details such as timing of mowing in meadows and crop rotation in fields. The combination of fencing systems and field/meadow management is often referred to as a cultivation system (Myrdal and Söderberg 1991, 299).

In this article, we focus on the infield pastures, i.e., areas that were neither arable fields nor meadows, but used only for grazing. We look closer at timing and intensity of grazing on infield pastures, and discuss their significance for biodiversity. Based on historical knowledge, we identify different pre-industrial grazing regimes and compare them with modern grazing in 28 pastures in central Sweden over 26 years, from 1987 to 2012. The modern period includes both pre- and post-EU accession.

Methods

Identifying grazing regimes in pre-industrial agriculture

Using published literature, we identified the major cultivation systems in Sweden. The identified systems were interpreted based on their influence on the grazing period in pastures in the enclosures. For this interpretation we also used local village regulations, by-laws (swe, *byordning*) from the eighteenth and nineteenth centuries, which provide information about local grazing organization. The by-laws are found in regional archives, but they have been transcribed and compiled for some regions in southern and central Sweden, mainly part of the provinces of Skåne (Erixon and Ljung 1955), Västergötland (Thölin 1965), Uppland, Västmanland and Södermanland (Ehn 1982).

We used historical cadastral maps from the eighteenth and nineteenth centuries to identify the pre-industrial grazing regimes for each of the 28 studied pastures. The maps show fences, meadows, arable fields and pastures, and this information could be combined to

reveal the cultivation system. Pasture on outlying land and different types of enclosures with pasture can be easily identified.

Grazing regimes during the period 1987-2012

We selected 28 pastures in the province of Uppland, all featuring the red-listed field gentian, *Gentianella campestris*, which is a good indicator of species-rich meadows and pastures (Lennartsson 1997, 21). The vegetation type on all pastures was species-rich dry to mesic grassland, of *Avenula pratensis-Fragaria viridis-Filipendula vulgaris* type (on drier soil) and *Agrostis capillaris-Alchemilla* spp-type (mesic) (Påhlsson 1994, 481). Each pasture was visited twice a year, in mid-July and mid-August, during the period 1987–2012. This allowed for the estimation of the grazing period during the summer, if necessary supplemented with information from landowners.

Grazing intensity was assessed in the latter half of August by estimating the proportion of the pasture area with shortly grazed versus lightly or ungrazed vegetation (vegetation in shrubs excluded). The proportion of shortly grazed vegetation was estimated in 2 x 10 meter plots along six transects in the center of the pasture, each transect being 50 meters long and two meters wide. The transects were placed parallel with a spacing of 20 meters, thus representing a 50 x 112 meters area. In order to visually present the data (Figure 5), we split the proportion of shortly grazed vegetation into three categories: weak grazing (<30 percent shortly grazed), moderate grazing (30–60 percent) and intense grazing (>60 percent). Previous studies have shown that the degree of grazing in early August is an ecologically relevant measure of grazing intensity in central Sweden, as a large proportion of the pasture plants undergo seed maturation at that time (Dahlström et al. 2008; Lennartsson, Wissman, Bergström 2012; see Figure 8). The degree of grazing thus determines the likelihood of plants producing seeds before being grazed. The relationship between proportion grazed biomass and seed production of various species is, however, complicated by the fact that different species and races of grazers select plant species differently. Grazing intensity was not estimated during years with late onset of grazing (see Figures 4 and 5).

Landowners were interviewed about the grazing regimes that had occurred in the pastures prior to the study, providing information about grazing practices in the 1960s and 1970s, in some cases even the 1950s. On two occasions, 1987–1988 and 2008–2010, we also interviewed the farmers about their motives for the use of semi-natural pastures.

The degree of grazing, i.e., grazing intensity, can be assumed to depend on the amount of forage produced in a pasture during the season. During dry years with low production (e.g., Milchunas, Forwood, Lauenroth 1994), a larger proportion of the vegetation is likely to be grazed compared to rainy years. To examine the relationships between grazing intensity and precipitation, we used precipitation data for May–July (the main growing season for forage) from the SMHI weather station in Uppsala, located approximately in the middle of the study area.

The information is mainly qualitatively evaluated, and, when presented, quantitative data are discussed descriptively.

Results—pre-industrial grazing

Collective and co-ordinated grazing

Both pastures on outlying land and those in most infield enclosures were common land shared by the villagers until the mid-nineteenth century, when land reforms began to divide and privatise the commons (Karsvall, Jupiter, Wästfelt 2023). New legislation in 1857 stipulated that fences should be set along property boundaries instead of around common enclosures (Kardell 2004). The livestock was normally herded on the pastures on outlying

land, whereas in the infields, grazing was mainly controlled by the use of fences. As long as grazing was communal, both the grazing period and the number of animals (grazing intensity) were often regulated in local village by-laws, primarily to distribute the grazing resource fairly among farmers. Such grazing regulations were expressed in paragraphs stating that the village animals should be herded collectively on the outlying land,[1] or that leasing grazing animals from farmers outside the village was prohibited,[2] etc.

All infield grazing resources occurred in enclosures, containing various combinations of fields, meadows, and pasture (Figure 1). As mentioned, such resources were crucial in large parts of Sweden where outlying land was limited. Some villages in plain regions even relied entirely on the infield for summer grazing.

Some infield enclosures contained only pasture (swe, *hage*), and were primarily used for animals that needed to be kept under supervision or readily available, such as calving cows and working animals. These enclosures could be grazed throughout the season, as illustrated in Figure 2, No. 9.

However, enclosures with only pasture constituted but a small part of the infield area and grazing resource. Most of the grazing was done in enclosures that also included meadows and/or fields (swe, *gärde*). Their forage consisted of regrowth on mown meadows, weeds on fallows and stubble fields, and areas with more low productive grassland that were neither cultivated nor mown, but only grazed (Vestbö-Franzen 2005, 15, 202). These grazing resources could be utilized either in late summer after the harvesting of fields and meadows, or earlier in the season in enclosures where the field was left fallow. Both national laws and local village regulations from the medieval period to the nineteenth century contain numerous provisions regarding grazing in enclosures (e.g., Holmbäck and Wessén 1933, 162; Erixon and Ljung 1955; Thölin 1965; Ehn 1982; Kardell 2004, 75). In the regulations of southern and central Swedish villages, such provisions are so common that grazing in field and meadow enclosures must have occurred annually almost everywhere (Figure 10). Even in northern Sweden, aftermath grazing in meadows and stubble fields seems to have been common, while summer grazing on fallow fields had less significance since animals grazed on transhumance summer farm pastures (e.g., Antonson 2018, 91).

The regulations of grazing were motivated by the collective use of field and meadow enclosures; therefore, it was the village's common concern to protect hay and crops from grazing animals and to utilize fairly the grazing resource of the infield pasture. Most of a village's arable land was consolidated into several large blocks in the field enclosures, and each farmer owned several strips or parcels of land within these blocks (Figure 1). There were no fences between the strips, and agricultural activities were coordinated so that all activities were carried out collectively—a so-called open fields system (Dyer, Thoen, Williamson 2018; Karsvall et al. 2023). Meadowland could also be divided into strips, or the meadow was collectively mowed, and the hay then shared among farmers. The pasture only area in the enclosures was collectively owned.

The basic formulation of the local regulations was that both the timing of grazing and the number of animals allowed should be collectively determined by the village. For example, a village by-law for all parishes in Öster and Västerrekarne hundred in the province of Södermanland stated:

> After the meadows and field enclosures are harvested, no animals are allowed to graze therein until the village alderman has gathered the neighbors, and they have agreed on both the time for grazing and the number of animals, according to each farmer's type of animals and share of the pasture; anyone who breaks the agreement is fined 16 öre.[3]

Another rather universal provision was that farmers should inspect all fences together

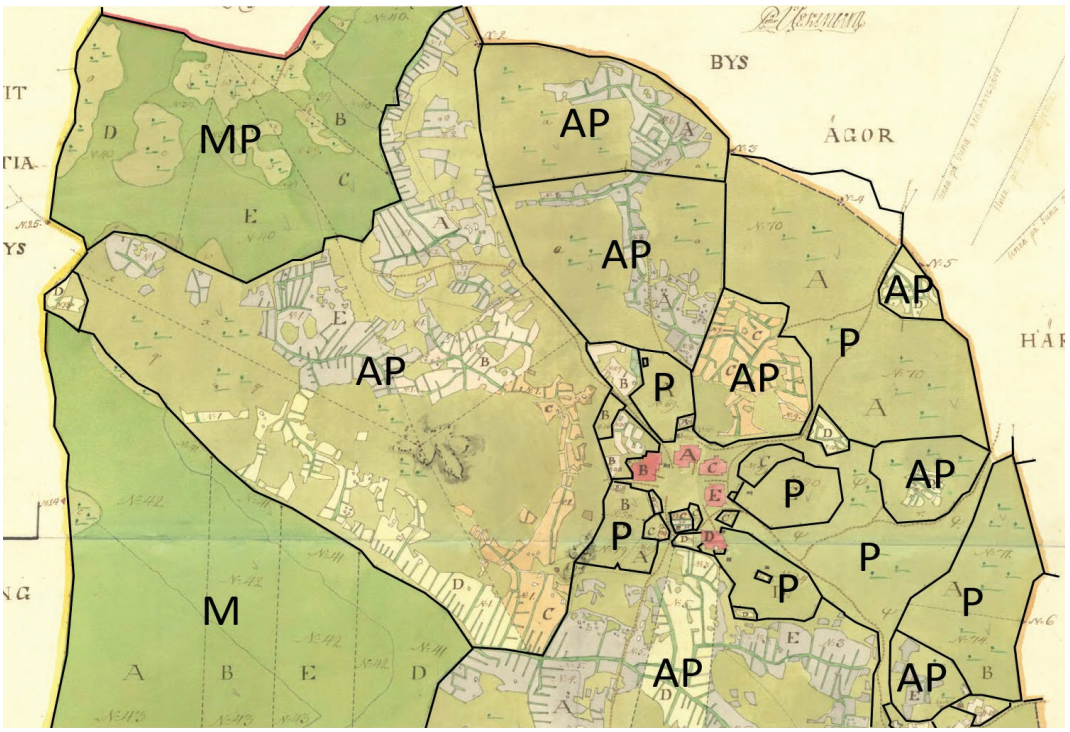
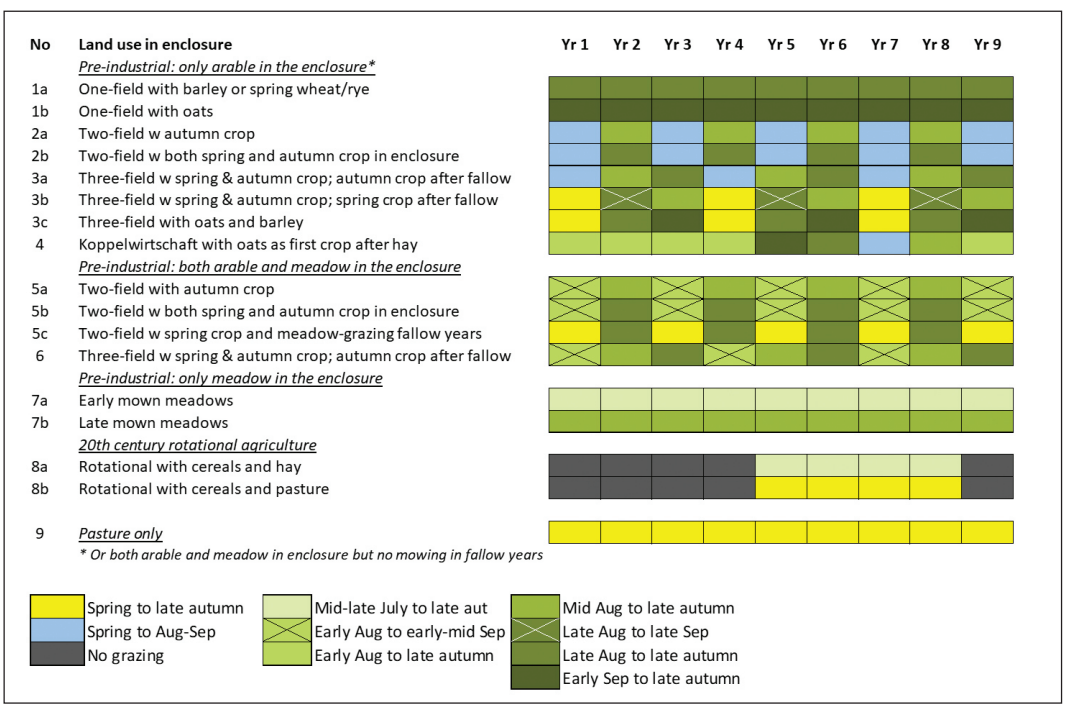


Figure 1. Excerpt from the land consolidation map (1757) for the village of Saringe in Tuna parish, the province of Uppland (National Land Survey's archive B69-18:1). The map shows part of the infield area, surrounded by outlying land. The village farms, five in total, are clustered together in the center of the map. Black lines indicate fences, dividing the village infield area into enclosures that could be grazed or protected from grazing at different periods during the season. Green colour represents meadow, grey-green pasture, and grey, yellow-white and orange is arable land. In the arable land, there are numerous ditches that both drain the field and divide it into strips owned by different farmers in the village. AP indicates an enclosure with arable land and pasture (*swe, åkergärde*), MP an enclosure with meadow and pasture (*ängsgärde*), M an enclosure with only meadow (*ängsgärde*), and P denotes enclosure with only pasture (*hage*).

Figure 2. How grazing regimes in infield enclosures are determined by the cultivation system on the arable land, together with the presence/absence of meadow in the enclosure. The grazing regime is shown as grazing period over a span of nine years.



before spring grazing, for example, around May 1, in central Sweden, or the last day of March in southern Sweden. Often, a second inspection was required before autumn grazing.[4]

The use of arable fields and meadows determined the grazing regime on infield pastures

The grazing by agreement in the above quote implies that the grazing period in enclosures was adjusted annually based on when the year's sowing and harvest were completed. There also occurred fixed dates for the beginning of autumn grazing. These dates were locally adapted and varied between villages, even within the same region. In Göinge hundred in the province of Skåne, many villages used Holy Cross Day, September 14, as the date for the start of aftermath grazing in the enclosures,[5] but in the villages of Aplehult, Torshult, and Vejsljunga, horses could graze the infield pastures from August 10.[6] In the villages of Kylen, Mjöböke, Drakaberga, Torup, and Kulleröd, a farmer could tether a cow or a few horses on their own strips of meadow or arable land in the enclosure after August 1, but only during daytime to keep the animals under supervision.[7] Tethering was prohibited in many villages, and where it was allowed, it applied only to one's own field and meadow strips, not the communal pasture in the enclosures (Gadd 2011, 127).

It is clear that the temporal arrangement of grazing in field and meadow enclosures was determined mainly by the mowing of meadows, together with the activities of sowing, harvesting, and fallowing on the fields. In the following, we discuss how these activities were organized and what grazing regimes in infield pastures they gave rise to.

The identified grazing regimes indicate a number of temporal patterns of grazing. Deviations from the pattern have, of course, occurred historically, both in single pastures and the village as a whole, as well as in terms of both inter-annual variation and change of cultivation system. However, as long as mowing, the working of arable fileds, and the grazing were performed collectively in the village, the possibilities for deviation from the common practice were limited. Therefore, the identified grazing regimes were likely stable enough to make imprints in the species composition of the pastures.

Grazing regimes in arable field enclosures

The different cultivation systems in Sweden have been discussed and summarized by several researchers (e.g., Lägnert 1955; Göransson 1985, 65; Myrdal and Söderberg 1991; 2018), but few authors have addressed the grazing regimes resulting from the cultivation systems (Gadd 2011, 124). Three types of cultivation systems dominated: one-field (swe, *ensäde*), two-field (*tvåsäde*), and three-field (*tresäde*) agriculture. Four-field and even more complex enclosure systems could occur locally. In the typical one-field system, all arable land was sown with cereals or other crops every year, and the system is therefore also referred to as continuous cropping (Gadd 2011, 126). In the two-field system, half of the area was sown while the other half lay fallow, and in the three-field system, two-thirds were sown, and one-third lay fallow (Gadd 2018, 51). Within each system, various sequences of different crops could be practiced.

The one-field system was most common in areas with little arable land and abundant meadows, pasture, and livestock. This ensured an adequate amount of dung per hectare of the continuously cropped arable land. Typically, spring cereals, especially barley, were cultivated, although oats was often grown in western Sweden. The pasture in the one-field enclosure could be grazed after harvest every year, i.e., beginning mid to late August in barley cultivation or early September when growing oats (No. 1a and 1b in Figure 2).

Wheat and especially rye were often sown as autumn crops in August (or September in the southernmost part of Sweden). Autumn crops are difficult to cultivate in a one-field system because, due to short growing season, there is not enough time to harvest the rye and

then till, harrow, and sow new rye the same autumn. Therefore, to prepare the soil before autumn sowing, a summer of fallow needed to preceed the sowing of rye. The fallow period also offered an opportunity to decimate weeds through summer grazing and harrowing. In order to graze the arable fields that lay fallow they had to be separated by fences from those that had crops, leading to the introduction of two-field and three-field systems (Gadd 2018, 57). In the two-field system, one enclosure bore grain during the summer while the other enclosure was summer-fallowed and sown in the autumn. The following year, fallow and grain switched places. The grain enclosure could be grazed after harvest, i.e., from mid-August throughout the fall, and the fallow enclosure from early summer until the autumn sowing in August or September (No. 2a in Figure 2).

In three-field systems, the sequence was fallow, autumn rye, spring barley, fallow and so on. For the pasture in a specific field enclosure, this meant a grazing regime with (year 1) grazing from early summer until the autumn sowing in August or September, (year 2) grazing from mid-August after the harvest of rye, and (year 3) grazing from late August or early September after the harvest of barley (No. 3a in Figure 2).

The cultivation of rye, which encouraged the transition from one-field to two-field or three-field systems, is related to changes in food culture from the sixteenth century. In much of Sweden, the one-field spring crop originally consisted of barley, which could not be baked into leavened bread. When leavened bread became popular, rye was often chosen, and rye bread could also easily be dried and stored (Campbell 1950, 252; Vestbö-Franzen 2005, 113). We can here see a direct connection between culture, farming systems, and grazing regimes, which ultimately altered biodiversity in pastures.

Pasture availability in infield areas during the summer varied depending on whether the enclosure was in a one-field, two-field, or three-field system. In one-field systems, the enclosure was blocked for grazing animals every summer until the harvest in August–September. In two-field and three-field systems, half or one third of the arable enclosures was fallow available for grazing from the spring until the autumn sowing. The need for grazing on infield areas has been suggested to be one factor contributing to the transition from one-field to two-field and three-field systems. For example, agricultural expansion and land clearance for arable land may have reduced pasture availability on outlying land, causing both fewer animals and less manure per hectare of arable land (Kjærgaard 1994, 81), as well as a need to utilize infield areas for grazing. Both requirements could be met with a fallow year that allowed the field to rest without fertilization and provided forage in parts of the field enclosures (Gadd 1983, 207; Fox 1990).

Differences in pasture availability can be observed also between two-field and three-field systems, as well as between different crops and crop rotations within these systems. As mentioned, in two-field systems with only autumn crops, the grain enclosure became available for grazing after the harvest in August. However, it was common to sow both autumn rye and spring crops in the grain enclosure—rye in the autumn on part of the fallow and spring crops the following spring on the rest of the field in the enclosure (Gadd 2005, 71). The presence of spring crops forced the grazing onset to be delayed by another few weeks, until after the harvest of spring crops (No. 2b in Figure 2). With three-field systems this disadvantage was avoided as spring and autumn crops could be separated into different enclosures, and the enclosure with autumn crops could thus be grazed from August without being hindered by spring crops.

There are also examples of two-field systems being changed to three-field systems because farmers wanted to cultivate both barley and oats. Oats mature two to three weeks later than barley, which further delayed the onset of grazing in the grain enclosure, but with a three-field system, oats and barley could be cultivated in separate enclosures

(Lindgren 1931, 41). The grazing regime in a specific enclosure became (year 1) grazing all summer, (year 2) grazing from late August, and (year 3) grazing from September (No. 3c in Figure 2). In areas with shortage of pastures in southernmost Sweden, a variety of the three-field system is found, in which the normal three-field sequence fallow, rye, spring crop was replaced by the sequence fallow, spring crop, rye. This was possible since the season in the south was long enough to allow sowing of autumn crops after the harvest of spring crops in the same autumn. This practice had the advantage that grazing on the fallow did not need to be interrupted already in August by the autumn sowing, but could last throughout the season (Myrdal and Söderberg 1991, 301; 3b in Figure 2).

There have, of course, been several deviations from the typical one-, two-, and three-field systems. For example, in one-field systems the soil could become nutrient-depleted after many years of cultivation, especially on light soils and where there was a shortage of pasture, animals, and manure (Olsson 1988). The enclosure was then divided, and the arable was allowed to grow with grass that was mown or grazed (Dahl 1989, 99). As long as the field rested, the grazing regime changed from late onset of grazing to mid-summer onset (after mowing) or grazing all summer (if the field became a pasture).

A more systematic cultivation of hay on arable land is known from the late 1700s in the mining areas of central Sweden, the so-called *Bergslagen*. Agriculture here was strongly focused on livestock, requiring many draft animals for the transport of charcoal, ore, and iron. Grain could be purchased with income from the metal production, and the fields were largely used for hay production. Hay was harvested on arable land during a ley (swe, *linda*) period of 5-10 years, sometimes longer, during which the field carried grass vegetation. After the ley period, the ley's grass sward was tilled for an oat harvest, followed by one or two oat or barley harvests. The grain period ended with a summer fallow, fertilization, and sowing of autumn rye, sometimes also grass seed, after which the field was left with grass again, turning it into a ley. The system, which was a kind of rotational cropping, with long grass periods, is commonly referred to as convertible husbandry, or by its German term, *Koppelwirtschaft* (Gadd 2011, 155). The grazing regime on pasture in the enclosure followed the pattern in Figure 2, No. 5.

Grazing regimes in enclosures with meadow

Harvesting hay on various types of meadows was crucial for pastoralism in Scandinavia. Especially in the north, where the period of stabling could be up to nine months, all available time was devoted to mowing, utilizing shores and wetlands in the forest landscape many kilometres away from the farms. The hay was stored in stacks and barns and transported to the village during winter. In northern Sweden, mowing was often linked to summer farming: everyone in the household was needed for the hay harvest, and the livestock was brought to graze and be milked at the summer farm (swe, *fäbod,* Larsson 2012). Thus, the organisation of the mowing partially influenced the grazing period at summer farms.

In southern Sweden, most or all meadows occurred on the infields. The meadows were located in meadow enclosures or in combined meadow and arable enclosures, and both could also contain pasture only areas (Figure 1). From a biodiversity perspective, such pasture areas, together with the meadow, constituted semi-natural grasslands, while the arable fields did not. In the meadow enclosures, the grazing regime was governed by the mowing, and in combined meadow/arable enclosures by both mowing and cultivation of cereals.

Enclosures with both meadow and arable land were common in one-field systems (Gadd 1983, 206). The presence of meadows in enclosures did not influence the access to the enlosure's pasture because the arable land was harvested later than the meadow, and, thus, it was the use of the arable that determined when the enclosure could be

opened for grazing (No. 1a, 1b in Figure 2). In two-field and three-field systems, in contrast, meadow in the same enclosure as arable would impede grazing of the fallow. Therefore, arable enclosures in two- and three-field systems usually lacked meadows, i.e., meadows and arable fields were fenced in separate enclosures. However, in villages with abundant pasture on outlying land, meadows could occur in two-field and three-field enclosures because fallow grazing was not necessary, and especially if the village had a shortage of hay. In such cases, the grazing period in fallow enclosures was delayed until after mowing, while in cereal enclosures the autumn grazing was not affected by the meadow since the grazing onset had to wait until harvest of the arable field (No. 5a, 5b, and 6 in Figure 2). The grazing period in the fallow enclosure became quite short if meadow was present, from the end of mowing in July–August to the autumn sowing in September at the latest.

In two- and three-field enclosures with both meadow and arable fields, the timing of mowing thus determined when grazing could begin in fallow years. Ethnological sources contain many notes on local dates for the beginning of mowing, where specific dates usually had the function of coordinating the hay harvest in the village's common meadows. Data from the provinces of Småland, Östergötland, Västergötland, Södermanland, Värmland, and Uppland indicate highly different starting dates for mowing, from the end of May to mid-July, with early July being the most common (Dahlström et al. 2008). However, the timing of aftermath grazing in meadow enclosures was determined by the end of mowing, not its beginning, and the information on the finishing of mowing is more limited. The grazing could not begin until all the hay in the enclosure was dried and brought to the hay barns, which in large enclosures could take several weeks from the start of mowing (Lennartsson and Westin 2019, 81). Usually, the onset of grazing was further postponed for some time to allow for regrowth. This is reflected in the abovementioned type of provision in village by-laws, stating that the enclosures were not to be opened for grazing until the villagers had agreed that the enclosure was ready for grazing. In other village by-laws, a specific date for aftermath grazing was set.[8] In Figure 2, we illustrate early cut meadows on infield areas that could be opened for grazing in mid to late July, and later cut meadows in mid-August (Figure 2, 7a and 7b), but there were also other, especially later, dates for the end of mowing. For meadows in arable enclosures, we have indicated an intermediate date in Figure 2, i.e., the beginning of August (No. 5a, 5b, 6).

In some areas where pasture on outlying land was particularly scarce or lacking entirely there was a two-field system with both meadow and arable land in the enclosures. Here, only meadows in the cereal enclosure were mowed, while in the fallow enclosure the meadow was grazed together with the arable that lay fallow. In parts of the province of Västergötland, the village's land was divided into two halves, each with arable land, meadow, and pasture only areas (Jansson 1998, 121). This saved fencing materials, which was an important advantage in this plain area without forest. They usually grew spring crops, and the grazing regime in pastures was every second year with grazing all summer and every second year with grazing from late August (No. 5c in Figure 2).

Grazing regimes in crop-rotation agriculture

In the mid-nineteenth century, a land reform, *laga skifte*, disrupted the collective use of fields and meadows, assigning individual plots to each farm (Gadd 2011, 152). This change enabled a new cropping system, crop rotation, where the use of arable fields alternated between cereal and hay production, typically in a four-year rotation. Although crop rotation was introduced during the nineteenth century, unfertilized meadows and, especially, pastures continued to be utilized until mineral fertilization became widely adopted, gradually during the twentieth century (Lennartsson et al. 2016).

The land reform, combined with the introduction of crop rotation, brought about

some changes to the previous grazing regimes on the infield pastures. The large common field and meadow enclosures were replaced by smaller, privately owned enclosures. Most of these were enclosures with arable fields and pasture or solely fields. Meadow in enclosures became rare as meadow mowing was replaced by hay production in the fields, which implied that all grazing regimes connected to meadow and combinations of meadow and arable disappeared. Furthermore, in the arable enclosures, autumn grazing on the stubble ceased, resulting in a new grazing regime for the pasture in arable enclosures: four years without grazing (when the field had cereals) followed by four years with late-season grazing (after hay harvest in the field, see No. 8a in Figure 2). Some low-productive fields were not mown but used only for grazing during the grass years (No. 8b in Figure 2). Some of the larger areas of pasture in former arable and meadow enclosures were fenced separately to serve as pasture only enclosures, which could thus be grazed throughout the season (No. 9 in Figure 2).

Grazing intensity

Grazing intensity is often measured as the proportion of the available forage that is consumed by the end of the season (e.g., Holechek and Galt 2000). This estimate relates to two important ecological variables: how much old vegetation remains as litter and the distribution of grazed, ungrazed, and lightly grazed vegetation patches, respectively, which can support species with different grazing tolerance. However, from an ecological perspective, not only the proportion of grazed vegetation matters, but also when the grazing occurs. Most of the grazing regimes for infield pastures described above have late grazing onset, allowing species to reproduce regardless of the proportion of vegetation grazed later in the autumn (see Figure 9).

There are hardly any direct historical or ethnological records of grazing pressure in older times, but grazing availability (or scarcity) is often mentioned in land reform documents. However, such information is usually difficult to translate into ecologically relevant estimates of grazing intensity, mainly because pastures in both infields and outlying land experienced periods without grazing, in early, late or the entire summer.

Local regulations on grazing intensity

Village by-laws frequently indicate concerns about overgrazing and trampling in the infield enclosures, for example: "As the hay harvest is considerably reduced by horses' and cattle's grazing and trampling of the young grass in the spring... Also in the autumn, too much grazing and trampling cause damage to next year's harvest..."[9] or: "For grazing on common meadows and pasture islands, no more than four cattle are allowed per ¼ taxation unit, since our land cannot stand more..."[10] Particularly, grazing in spring and late autumn was highlighted. In central Sweden, Michaelmas, on September 29, was a common final date for grazing in the meadows. Spring grazing in field enclosures and meadows was supposed to end on Saint Urban's Day, May 25, in the villages of Stavshult and Verum in Göinge hundred in Skåne,[11] on May 3 in Stora and Lilla Frösboholma, Granetorpet, and Skinnaretorpet,[12] and as early as April 16 in the village of Snärshult.[13] Spring grazing could also be entirely prohibited, but generally exceptions could be made if "all neighbors have agreed that spring grazing is called for by the outmost need"[14]—i.e., there was no hay left.

As mentioned, an annual assessment of how many animals the pasture could withstand without being overgrazed was often conducted for both meadow enclosures and arable enclosures. In the 1762 by-law of Ed village in the province of Uppland, it is stated:

> The meadows should always be cared for and protected from too much grazing and trampling; therefore, it is the responsibility of the alderman to make sure that in the spring, when the frost is out of the soil, no livestock is let in, at least not without exceptional need

> and after agreement among the neighbors. The same in the autumn, after the meadows have been just enough grazed. Anyone who breaks this agreement is fined 16 öre for every horse and old cattle, 24 öre for swine, 12 öre for small or large young cattle, goats, and sheep, and is obliged to immediately remove the animals. (Ehn 1982, 56)

A common alternative to the annual assessment of the supply of forage was to state specific numbers of animals of different kinds per enclosure and farm, usually proportional to farm size. Another way was to specify how long the enclosure can be grazed, for example: "Anyone who grazes the meadows Wästerängen, Hummelmora, and Enwiken more than 14 days per meadow is fined two Daler."[15] The regulations on the grazing period could sometimes be very detailed, as in the 1837 by-law of Gräddö village in the province of Uppland:

> Söderslåttssweden may be grazed without limitations according to each villager's preference. But in Österhägnaden livestock is not allowed longer than 12 days. Hägnaden can be grazed during three weeks. Lillängen no longer than nine days. Bergängen no longer than two days, and also Gräspottan. Durrwreten one day. Skärpan may be grazed by preference. Näset is opened on October 20 and can be grazed 10 days. (Ehn 1982, 145)

Even in the common enclosures with pasture only, the grazing period and number of livestock were often regulated, sometimes through a fixed number of animals,[16] sometimes by inspecting the forage supply every year.[17] In both cases the pasture was allocated among farmers according to the size of the farm: larger farms were allowed to graze with more animals.

Variation in productivity and number of livestock

Data from various sources, e.g., tax registers, indicate significant variations in the number of animals between years. Figure 3 shows the number of animals in 15 villages in the province of Södermanland from 1620 to 1638, where the maximum deviation was on average about 20 percent up and down from the mean during the period (Dahlström 2008). The variation was not synchronous between villages, indicating that it did not follow variations in weather and forage supply between years. If random variation in supply is added on top of the variation in the number of animals, it becomes apparent that grazing pressure must have varied much more than the variation caused by the number of animals alone. Presumably, the pasture was sufficient for livestock survival even in years with many animals and low production (i.e., under high grazing pressure). This implies that grazing pressure was much lower in years with high production, especially when this coincided with a low number of animals.

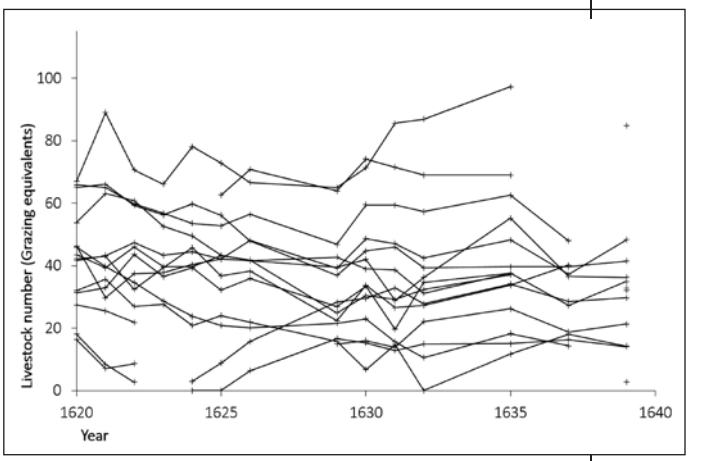


Figure 3. Livestock numbers 1620–1638 in 15 villages in Överselö parish in the Province of Södermanland, Sweden, according to livestock tax registers (Dahlström 2008). Different animal species are standardised to grazing equivalents = the forage need for one lactating cow.

Results: grazing during 1987–2012

Of the 28 studied pastures, 14 had a history as arable field enclosure, two as enclosure with both arable and meadow, six as meadow

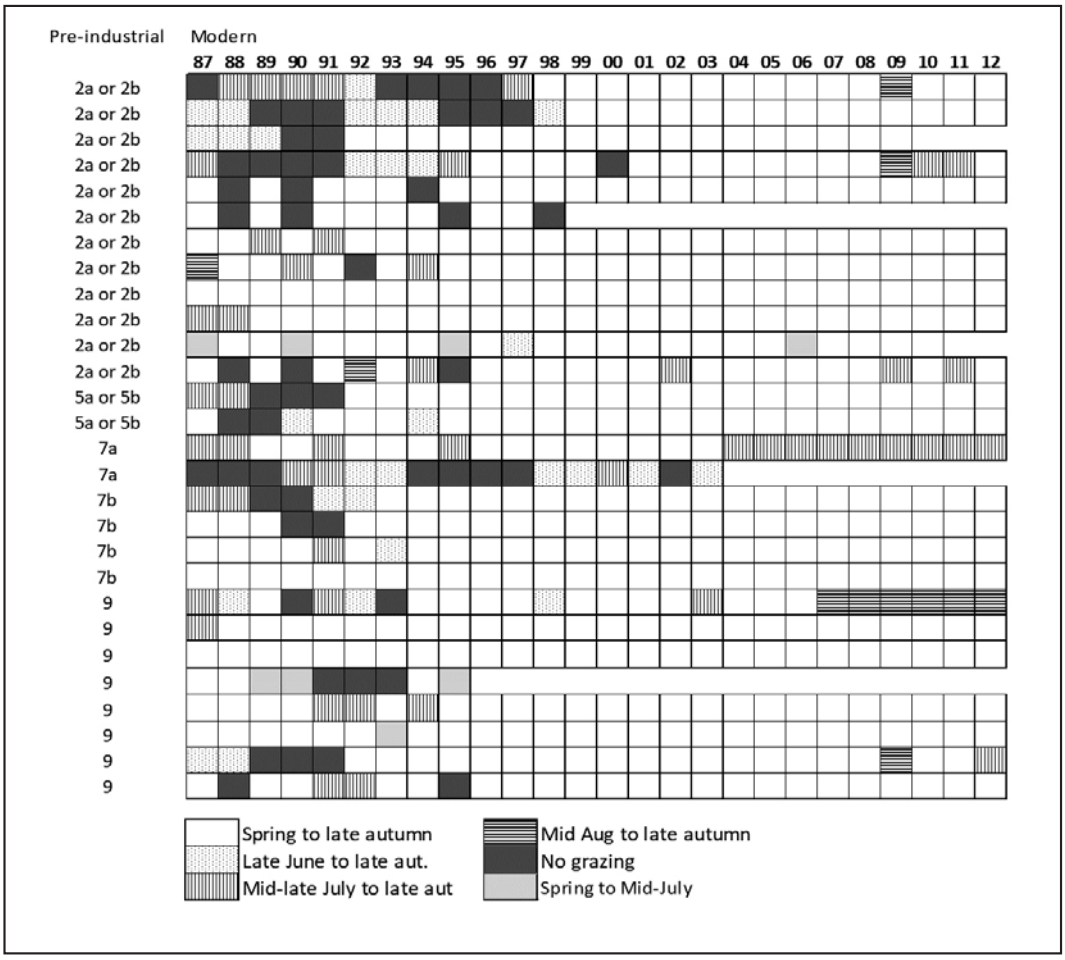


Figure 4. Timing of grazing in 28 pastures (rows) in the province of Uppland, Sweden, during 1987–2012. The pre-industrial grazing regime in each pasture is indicated to the left, with codes referring to Figure 2.

enclosure, and eight as enclosure with pasture only (Figure 4). The grazing regime from 1987 to 2012 could be followed throughout the entire study period in all pastures except for five, where grazing ceased before the end of the study.

Timing of grazing

Figure 4 shows a pronounced change in grazing around the mid-1990s. Until then, years without grazing occurred in 17 pastures, in some, quite frequently. In many of the pastures, this reflects the grazing regime in the enclosures with crop rotation described above, i.e., a few years without grazing when the field had cereals and a few years with moderately late grazing when the field had hay (No. 8a in Figure 2). In interviews, 21 of the 28 land owners confirmed that this grazing regime had been common for all pastures in arable enclosures; the other land owners could not recall having any pasture in field enclosures. Consequently, during the period 1987–1997, years without grazing occurred in a total of 17 percent of the grazing years (one grazing year = 1 year x 1 pasture), and late grazing occurred in another 16 percent. Three farmers occasionally used the semi-natural pasture only in the early summer, applying moderate grazing pressure, but this regime was rare, occurring in c. 2 percent of the grazing years.

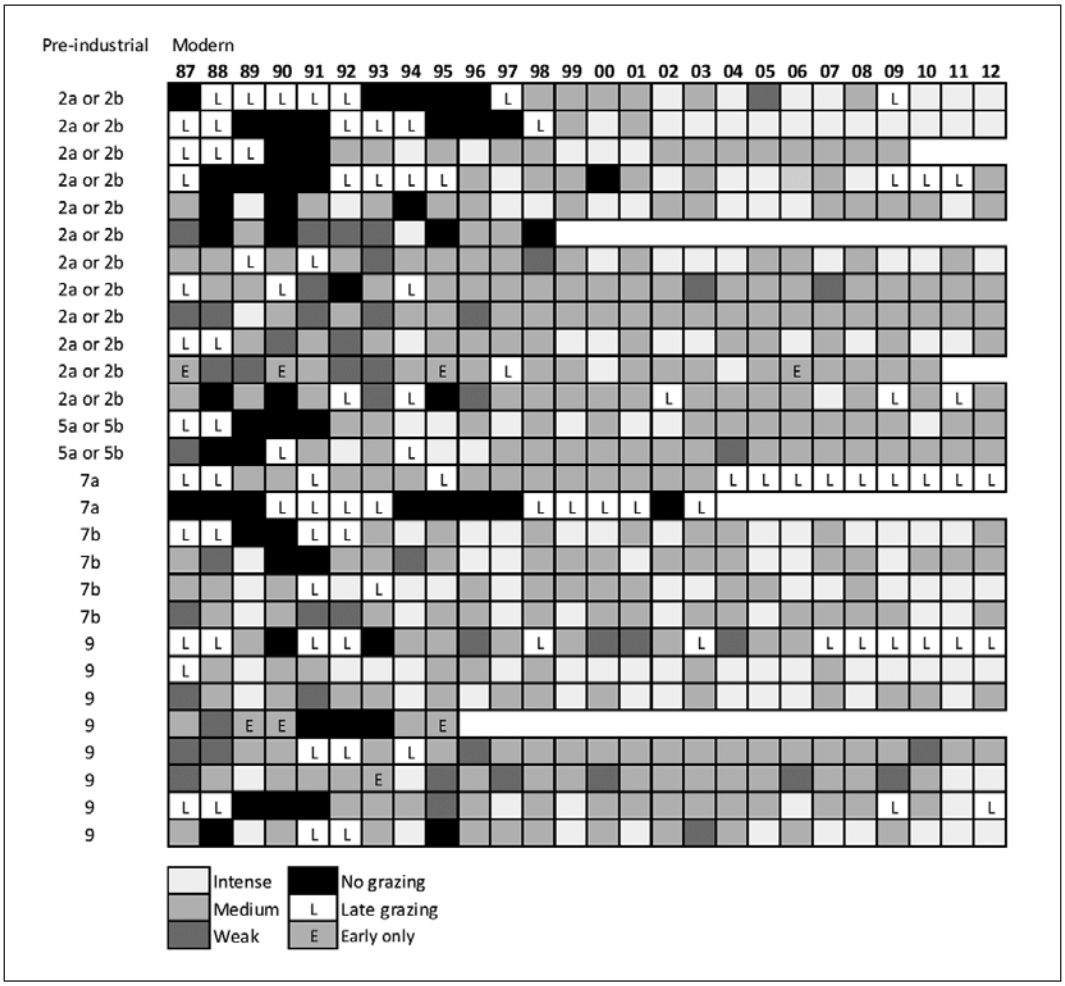
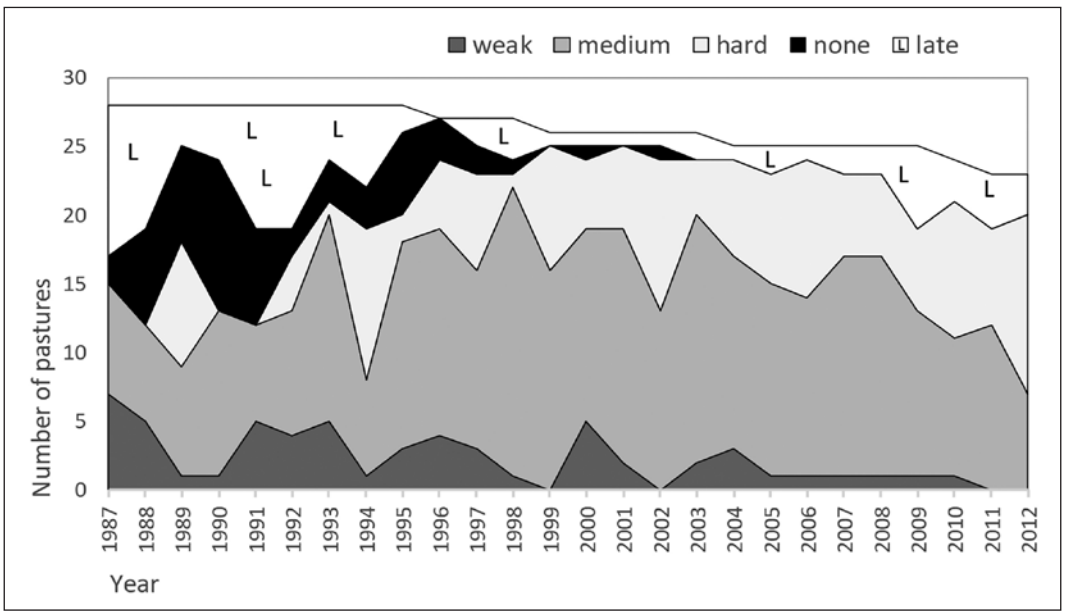


Figure 5. Grazing intensity in 28 pastures (rows) in the province of Uppland, Sweden, during 1987–2012. The grazing intensity was not estimated during years with late grazing. The pre-industrial grazing regime in each pasture is indicated to the left, with codes referring to Figure 2.

Figure 6. Change over years in number of pastures having either early onset of grazing with different grazing intensities, or late grazing onset, based on a field survey of initially 28 pastures in Sweden during 1987–2012.



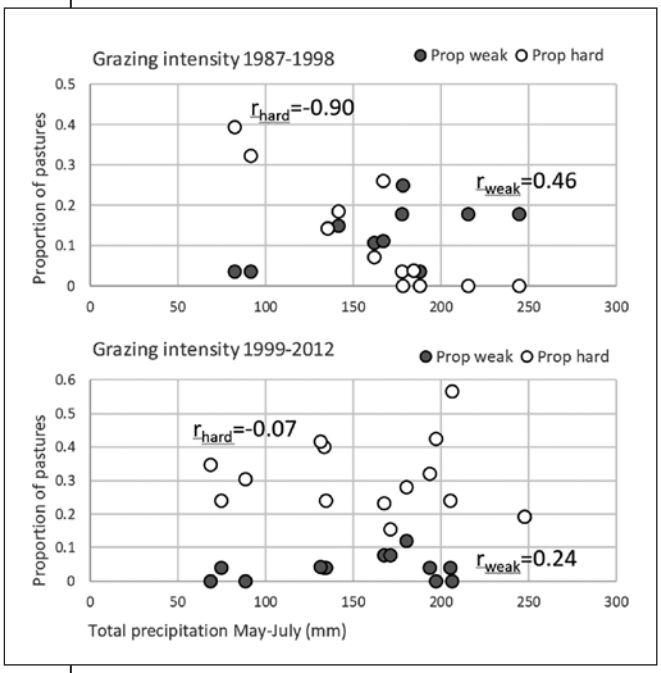


Figure 7. Relationship between grazing intensity and precipitation in 28 pastures in the province of Uppland, Sweden, for two periods, 1987–1998 (top panel) and 1999–2012 (bottom). One data point represents one year, showing the proportion of the 28 pastures having weak grazing (filled points), and intense grazing (unfilled points). Spearman rank correlation coefficients (r) are shown, indicating strength of the correlations (1=a perfect positive correlation; -1=a perfect negative).

This variation almost completely ceased after the 1990s, and during the period 2000–2012, ungrazed years occurred only on two occasions. Late grazing occurred in 9 percent of the grazing years, of which 5 percent were pastures where late grazing had been initiated by nature conservation authorities.

There was no obvious relationship between the pre-industrial grazing regime and grazing during 1987–1990s, or 2000–2012. Late grazing, as well as years without grazing occurred in all pre-industrial categories of infield pastures.

Grazing intensity

Also the grazing intensity changed during the 1990s. During the period 1987–1997, light grazing and intense grazing each occurred in approximately 15 percent of the grazing years (Figure 5). Moderate grazing was the most common, accounting for almost 50 percent of the grazing years. During the period 2000–2012, intense grazing became more than twice as common (36 percent of the grazing years), while the frequency of light grazing decreased to 4 percent of the grazing years. Moderate grazing increased slightly to 59 percent of the grazing years. Overall, this change implies increased grazing intensity with less variation (Figure 6).

Grazing intensity and summer rainfall

For the period 1987–1998, there is a strong relationship between grazing pressure and summer precipitation (i.e., production of forage). Intensely grazed pastures were more common during dry years (Spearman rank correlation r = 0.46), while light grazing was more common during rainy years (r = 0.90; Figure 7). For the period 1999–2012, in contrast, no effect of precipitation on grazing intensity can be observed, as intense grazing was common regardless of precipitation.

Changes in infield pastoral practices: causes and consequences

This study shows that today's semi-natural pastures in the study region are predominantly grazed throughout the summer with moderate to intense grazing pressure. Deviations from this pattern, such as years with light grazing, late onset of grazing, or no grazing at all, are very rare.

These current grazing practices differ significantly from most pre-industrial infield grazing regimes. Historically, grazing throughout the entire summer occurred only in pasture enclosures. Grazing in enclosures with meadow and arable fields was instead characterized by shorter grazing periods, either late grazing (from July or August, every second year or more often), or early summer grazing that stopped in August. Furthermore, several historical sources indicate substantial variability in grazing inten-

sity between years and that farmers tried to avoid intense grazing in enclosures with arable fields and meadows.

Current grazing practices also differ from practices in more recent history, in the 1980s and 1990s. Late grazing and years without grazing were quite common until the mid-to-late 1990s, both in arable field enclosures as a result of crop rotation (see 8a in Figure 2) and in pasture only enclosures. The interviews revealed several explanations for such variation in grazing. The information in the list of citations below was given by several farmers.

> Semi-natural pastures produce better if they are allowed to rest without grazing at times (12 farmers).
> Semi-natural pastures are utilized only in years when the cattle graze on nearby leys (8 farmers).
> Semi-natural pastures are not utilized until late summer when forage becomes scarce on the ley (7 farmers).
> The forage production in semi-natural pasture decreases if it is intensely grazed in early summer (6 farmers).
> Late onset of grazing some years is beneficial, as it allows the plants in the pasture to seed (6 farmers).
> During dry years, semi-natural pastures with trees are good to use in late summer because the trees provide shade, preventing the forage from drying out (4 farmers).
> Semi-natural pastures are primarily used in years when there are many heifers and young cows, but not so much in other years (4 farmers).

None of the responses suggests that the variation in land use practices was associated with an ongoing cessation of the use of semi-natural pastures.

Also the grazing intensity changed during the 1990s, shifting towards relatively intensive grazing with little variation between years. During the 1980s and 1990s, the grazing intensity was more varied and, on average, weaker. The key motivations were:

> Grazing pressure depends on the growth, so it becomes more intense in dry years (14 farmers).
> [On dairy farms], semi-natural pastures are used for heifers and young cows, which are not numerous enough to graze the pasture intensely (13 farmers).
> Animals graze both ley and semi-natural pasture, preferring the ley and leaving the semi-natural pastures lightly grazed in some years (10 farmers).
> Heifers and beef cattle grow poorly if they are forced to intense grazing (7 farmers).
> Semi-natural pastures produce better if not grazed too intensely (7 farmers).
> It is necessary to graze lighter at times to allow the land to recover (4 farmers).

As described earlier, the pre-industrial grazing regimes in enclosures with fields and meadows disappeared due to the cessation of collective use of infields, combined with the availability of mineral fertilizers that enabled production of forage and hay in cultivated fields.

The changes in grazing regimes in the latter half of the 1990s coincide with Sweden's accession to the EU in 1995, which allowed farmers to apply for agri-environment subsidies for the management of semi-natural grasslands for the programming period 1995–1999 (Medeiros 2015). All farmers in the study except three applied for payment; two of the three were in the process of retiring from farming, and the third preferred to continue managing the lands in his own way. In interviews from 2008 to 2010, 23 out of 25 farmers stated that engaging in the agri-environment schemes brought significant changes to their management of semi-natural pastures. A summary of the farmers' statements indicates the following main changes:

> Grazing was forced to become more intense than considered appropriate because inspectors repeatedly did not approve the management if the pasture was grazed and managed as it used to be (17 farmers).
> Late onset of grazing could not be used

any longer because if the management was controlled before onset of grazing, the inspector considered the pasture ungrazed and rejected the payment (14 farmers).

Previously, semi-natural pastures had been a flexible resource used as a complement to and in combination with ley grazing, but now the pastures had to be grazed every year to be eligible for payment (13 farmers).

It was no longer possible to adapt grazing to the conditions of the semi-natural pastures, such as grazing late or not at all to let an overgrazed pasture recover (10 farmers).

The farmers' answers clearly explain the changes we observed in the field, and connect the changes to the EU subsidies. All interviewed farmers had critical opinions about the eligibility criteria for payment, and a common type of criticism concerned the new way of grazing semi-natural pastures, as outlined in the above points. One farmer expressed it as: "Previously, the pasture was part of the farm, land we used for our own purposes, but now it is separated from our normal farming activities; it is now land that we manage for the county administrative board and the EU." Another farmer stated that: "Every new generation has learned how [place name] should be managed to provide good pasture, but now it doesn't matter how it [the pasture] is doing, instead you have to learn the rules."

The criticism, however, concerned only the eligibility criteria and how they were implemented by the inspectors, whereas the farmers' opinions about the agri-environment payments *per se* were generally positive. Around one third (8 farmers) stated that they would probably have stopped using semi-natural pastures if it were not for the subsidies. The main reasons for stopping would have been the increasing demand for high yield in milk production on a global market and the shift from milk to meat production, requiring high animal growth for profitability.

Figure 8. Date of fruit maturation (50 percent of the fruits in a plot are mature) for a number of grasses (white) and herbs (black) in a pasture at Harpsund, the province of Södermanland, Sweden. Error bars show standard deviation from mean of twenty plots (from Dahlström et al 2008).

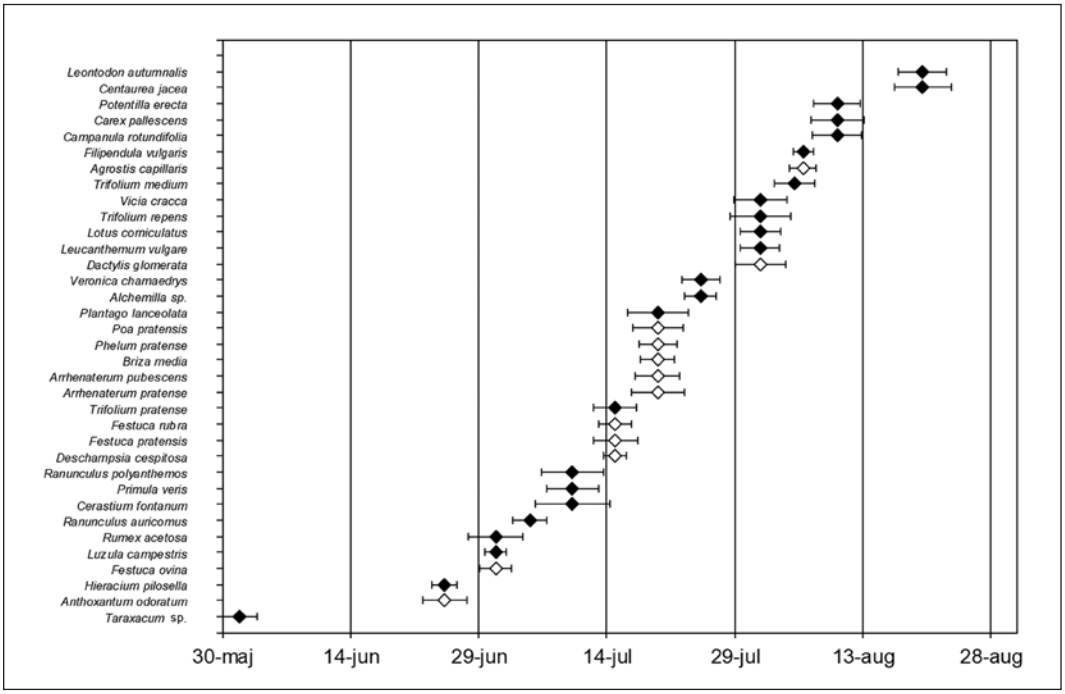


Figure 9. Enclosure with arable field and pasture in late summer, just before the grain crop is harvested. Note the lack of fencing between the arable and the pasture, showing that both belonged to the same enclosure. The enclosure has been protected from grazing all summer and the pasture plants have been able to flower and set seed. Painting by Alfred Thörne (1850-1916).

Grazing regimes and biodiversity: does it make a difference?

A starting point for understanding biodiversity in grasslands and other human-shaped natural habitats is that certain types of land use, such as a specific grazing regime, favor some species while disfavoring others. With time, the species composition and general structure of the biotope becomes more and more characterized by the prevailing land use type. The pre-industrial grazing regimes described here have existed for a long time: one-field farming essentially since the establishment of fixed fields in Sweden around 2.500 years ago (Pedersen and Widgren 2011, 47), and the two- and three-field systems since at least the sixteenth century (e.g., Vestbö-Franzén 2005).

For plant populations in a grassland, there must be a balance between grazing and the chance to produce seeds. Grazing keeps the vegetation low and reduces the litter layer, thus favoring seedlings and small-sized species. On the other hand, grazing reduces seed production, and also many insect species are sensitive to grazing during certain periods, when they are confined to their host plant as eggs, larvae, or pupae. If the grazing occurs in late summer, many plant species have already matured (Figure 8), and many insects have finished their reproduction. Low-intensity grazing during the summer, as well as years without grazing, have similar effects as late grazing. With light grazing, the consumption of the pasture's vegetation is extended over a long period, giving a certain plant or insect larvae a reasonable chance to complete their reproduction before the grazers arrive at that specific spot. In the case of between-year variation, the years without grazing promote high seed production, while seed germination is favored during the grazing years (Lennartsson and Oostermeijer 2001).

Through frequent late grazing, together with interannual variations in grazing period and grazing pressure, the pre-industrial grazing regimes of the infield pastures likely created

highly favourable conditions for grassland plants and insects (Figure 9). This probably also applied to the traditional grazing regimes associated with crop rotation, involving a rotation between a few years of moderately late grazing and a few years without grazing.

Conclusions

As seen in this study, today's grazing practices differ significantly from traditional grazing regimes, both pre-industrial regimes and those of the twentieth century. The differences are so substantial that it is not likely that current grazing will preserve the pasture biodiversity built up over hundreds of years of traditional management—the current management fails to ensure sufficient ecological quality of the pastures. This assumption is supported by a growing list of studies showing that pasture plant and invertebrate species decline even in places where their habitats are grazed. The cause of the decline is often shown to be changes in grazing practices of the kind that we have observed in this study, such as too intense or too early grazing. For example, in an analysis of action programs for 63 threatened species of plants and invertebrates in dry grasslands, intense grazing was the most significant threat (Lennartsson 2010). An analysis of the historical ecology of the endangered butterfly clouded Apollo (*Parnassius mnemosyne*) in the province of Uppland found that all known sites had a history of late management (Westin, Lennartsson, Björklund 2018). In pastures where late grazing was re-introduced, the clouded Apollo increased in population size and even started spreading to new locations. For the endangered field gentian (*Gentianella campestris* ssp *campestris*) in the county of Uppsala, 30 out of 36 current pasture populations have a history of late management. The current management, in contrast, is grazing from spring to autumn in 34 of the populations (Lennartsson and Westin 2023).

The studied pastures are located in a limited region in Central Sweden, but they represent a wide range of landscape types (coastal, forested, transition, and plain landscapes), farm types (from small to large farms), production forms (dairy farms, beef farms, horse farms), and grazers (cattle, horses, sheep). Therefore, we believe that the results are representative of Swedish pastures and highlight a national conservation issue.

We encourage more studies of potentially important management components in high nature value biotopes in agricultural landscapes. Interdisciplinary studies, combining ecology and history, as well as experimental ecological studies of the effects of management regimes on biodiversity, are needed. Areas where traditional land use still occurs provide important opportunities for studying management regimes, both in the field and in their cultural context (Lennartsson and Helldin 2007). The ecology of traditional hay meadow use has been subject to some studies (e.g., Johansen et al. 2019; Babai, Jánó, Molnár 2021; Janišová et al. 2023), but in pastures, links between land use and biodiversity are still poorly researched.

It is acknowledged that the EU subsidies have halted the decline of semi-natural pastures in Sweden (Andersson, Kaspersson, Wissman 2009, 5). Still, the eligibility criteria accompanying the subsidies have contributed to a drastic change in grazing management compared to the historical (including recent history) regimes that have shaped pastures and their biodiversity. This has caused a loss of ecologically important management components, an effect of subsidies that has been observed also in other European countries (Babai et al. 2015). However, given the substantial impact of the subsidies (Iancu and Stroe 2016), we believe that they could easily become a powerful driver for implementing pasture management that favors biodiversity and cultural heritage. All it takes is some adjustments to the current criteria and preferably a new agri-environment subsidy for using historically authentic grazing. Moreover,

the historical grazing regime is usually neglected in the planning of grazing in nature reserves, and all-summer grazing is the common regime. We recommend anchoring pasture management in knowledge of the local historical land use.

Acknowledgements

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Figure 10. In many villages most of the forage on the outlying land was consumed by the end of the summer. The infield grasslands, which had been protected from grazing during the summer, then constituted an important grazing resource.

NOTES

1. E.g., 1750 by-law for Mala, Matteröd, and Pålstorp villages in the province of Skåne (Erixon and Ljung 1955, 289); Vattensta and Långsunda in the province of Uppland, 1753 (Ehn 1982, 90); Rovsätra in Uppland, 1754 (Ehn 1982, 96).

2. E.g., 1753 by-law for Vattensta and Långsunda villages in Uppland (Ehn 1982, 87).

3. 1764 by-law (Ehn 1982, 314).

4. E.g., 1762 by-law for Ed village, Uppland (Ehn 1982, 55).

5. E.g., 1720 Stavshult and Verum villages (Erixon and Ljung 1955, 25); Harastorp, 1779 (Erixon and Ljung 1955, 14); Stora and Lilla Frösboholma, Granetorpet and Skinnaretorpet, 1694 (Erixon and Ljung 1955, 46).

6. 1779 by-law (Erixon and Ljung 1955, 41).

7. 1745 by-law (Ehn 1982, 32).

8. For example, 1844 by-law for Tjockö in Uppland, where aftermath grazing in meadows had to wait until two weeks before St. Michael (September 29) (Ehn 1982, 155).

9. 1742 by-law for Träslöv in the province of Halland (Thölin 1965, 47).

10. 1787 by-law for Alsvik in Uppland (Ehn 1982, 100).

11. 1720 by-law (Erixon and Ljung 1955, 25).

12. 1694 by-law (Erixon and Ljung 1955, 46).

13. 1745 by-law (Erixon and Ljung 1955, 65).

14. E.g., 1764 by-law for Öster- and Västerrekarna hundreds in the province of Södermanland (Ehn 1982, 313).

15. 1764 by-law for Bergshamra, Utanbro och Punskog in Uppland (Ehn 1982, 120).

16. E.g., by-law for Alsvik in Uppland 1787 (Ehn 1982, 100) and for Hyvena in Södermanland 1824 (Ehn 1982, 311).

17. E.g, by-law for Ölsta, Säby, Ransta and Säva villages in Uppland 1771 (Ehn 1982, 359).

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