

# Wooded meadows

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## 1. Introduction

There are few examples of human influences on nature which enhance the species richness of communities, and these all deserve more detailed study, both from the point of view of ecology and cultural history.

Some of the world's highest plant community species richnesses on a small-scale have been recorded on old regularly mown temperate meadows with a sparse tree layer on neutral soils. The best still preserved examples of these communities are wooded meadows, particularly those on calcareous soils in western Estonia.

Wooded meadows were widespread traditional seminatural ecosystems, particularly abundant in the countries around the Baltic Sea until the middle of this century. They represented a perfect example of green management, with a very long-term and stable multifunctional use of land. By now, they have almost entirely disappeared due to fundamental changes in land management. The aim of our project was to carry out an inventory of the still existing rare sites, to collect the available information about them, and to inform biologists of the value of wooded meadows and about the possibilities and importance of preserving them.

This book gives a review of the various available data on wooded meadows, using both literature sources and the authors' own studies. The main previous research on wooded meadows can be attributed to H. Hesselman, E. Julin and H. Sjörs on Sweden, C. Cedercreutz, A. Palmgren and C.-A. Hæggström on Finland, H. Krall and K. Pork on Estonia. Wooded meadow research in Estonia has been concentrated in the Laelatu Biological Station. Many people have participated in the research works on Estonian wooded meadows, to whom the authors are deeply indebted.

The authors attempt to show the global importance of these local traditional ecosystems.

## 2. Typology and distribution

### 2.1. Naming and definition of wooded meadow

Of the many names given to wooded meadows in various languages, the more widespread are *Gehölzwiese* (*Laubwiese* in older literature) in German, *löväng* in Swedish, *lehtoniity* in Finnish, *lesolug* in Russian, *puisniit* in Estonian.

Wooded meadows are defined here as *sparse natural stands with a regularly mown herb layer*. Tree canopy cover is usually in the range 0.1-0.5. Typically, deciduous trees and several shrub species are present, which are distributed in quite small irregular patches. Regular mowing is important, however there may be some years when mowing is interrupted. Grazing on wooded meadows can be quite various, usually they were slightly grazed by sheep or cattle in late summer (after mowing). Wooded meadows differ from parks due to their natural (not planted) vegetation. However, through the selective removal of trees its species composition and appearance are influenced by humans. The minimum size, as used in this inventory, was 1 ha.

A review of previous definitions is given. Usually, wooded meadows are defined as meadows with trees, or a combination of forest and meadow, which makes their distinction from parks, woody pastures, sparse swamp

forests, and forest steppe quite ambiguous. The main thrust of the definition given here is the emphasis on naturally grown stand, where regular mowing is applied.

## 2.2. Types of wooded meadow

Traditionally, branches and twigs of trees and shrubs were collected from wooded meadows for cattle and sheep winter leaf fodder. There are large regional differences in whether the trees were pollarded when collecting twigs (mainly in Sweden), or coppiced (in Estonia).

In Estonia, wooded meadows have been classified into (a) meadows on calcium-rich soils (species-rich), (b) on acidic soils (species-poor), and (c) on flooded river valleys. In addition, all these types have subtypes according to the moisture conditions (wet wooded meadows).

Due to the breaks in regular mowing, there exists a continuous series of successional stages between wooded meadow and forest.

## 2.3. World distribution of wooded meadows and similar communities

The main distribution area of wooded meadows covered the region around the Baltic Sea (islands, western and northern Estonia, south-western Finland, central and southern Sweden), and the mountains of central and southern Europe. This is typically associated with the geographical areas where hay was made for cattle. It may also include some examples from North America and Asia. During the last half century, they have been abandoned and have disappeared almost everywhere. The remaining few which are best preserved are situated in Estonia. Some have also been restored in Sweden and Finland.

Forest steppe, savannah, and forest tundra bear some similarity to wooded meadows. The sparse distribution of trees on them is due to factors other than mowing. However, forested meadow steppes may show a great similarity to wooded meadows.

## 3. Origin, evolution, and disappearance

### 3.1. Origin of wooded meadows

Wooded meadows started to appear probably before mowing was invented in the Baltic area. Multifunctional use of the land around settlements, where selective cutting of trees, collecting of twigs for leafy fodder, and grazing were used, in combination resulted in a quite stable wooded meadow like ecosystem already since 4000 years ago. Mowing by scythe from about 2000 years ago gave them their typical form. The majority of man-made meadows in the Baltic area were probably wooded meadows until about the 19th century, when the proportion of open and cultivated meadows started to grow.

### 3.2. The period of maximum wooded meadow distribution in Estonia (from the 18th century to the 1940s)

The area encompassed by natural grasslands in Estonia reached its maximum at the end of the 19th century. At their peak wooded meadows covered 850,000 ha (18.8% of Estonia's surface area). According to the

agricultural census of 1939, natural grasslands covered 1/3 of Estonia's surface area, which was more than in adjacent countries (Table 1). There were slightly more meadows than pastures, and of the meadows more than a half were wooded meadows. Particularly in the western part of Estonia, almost all meadows were wooded meadows. Often they were quite large, covering several square kilometres, including the meadows of the farms of a whole village.

### 3.3. The reasons for abandonment after the Second World War

The abandonment of wooded meadows in Estonia took place in several steps: (1) reduction of land use during the war; (2) the cessation of mowing by hand; (3) the cessation of mowing by horses. The first to disappear were wet wooded meadows, of which no preserved examples exist.

A general reason for the rapid decrease in the area of wooded meadows was the change in agricultural management from an extensive to an intensive type, which means that natural grasslands were replaced by cultivated grasslands, and that mowing by scythe was replaced by tractor-mowing. This change took place more slowly in Estonia than in Sweden and Finland. The reason for this was that besides the work in collective or state farms, the Estonian farmers kept a small number of animals for their own use, for whom hay was made from the old natural grasslands, often by hand or by horse. This situation changed only in the 1960s. After that, the overgrowing of wooded meadows has been very rapid (Fig. 6).

Our field-works from 1995-96 revealed that there are no more than 500 ha of species-rich wooded meadows still preserved in western Estonia, plus about 200 ha of species-poor and flooded wooded meadows in other regions of Estonia. These are mainly small, less than 5 ha one-farm meadows. In 1995-96, about 200 ha of the Estonian wooded meadows were mown. Quite often, meadow were abandoned in recent years, due to the cessation of cattle raising, or due to the high age of people who have worked there.

### 3.4. Traditional management of wooded meadows

The regular management of a wooded meadow included a series of related tasks in a certain order. These included (a) raking and picking of fallen branches (in spring), which were later burned, (b) mowing, in July, (c) making sheaves from twigs (after hay-making), which were dried and used for sheep fodder in winter, (d) coppicing (not every year), (e) cutting of trees (in winter), (f) pasturing (in August and September), (g) collecting of secondary products - birch sap in spring, berries, mushrooms, medicinal herbs, tea herbs, hazelnuts, wild apples, flowers, etc.; wild bee managing, bird egg collecting etc. were used locally; hunting, due to a good feeding area for large herbivores; (h) maintaining of drainage systems in some wet meadows, (i) use of the place for religious rituals, and parties.

The stability and continuation of wooded meadows was supported by their aesthetic value and multifunctional use.

## 4. Protection and restoration

### 4.1. Protection of wooded meadows

The oldest known regulations concerning nature protection in Estonia were connected with restrictions in the cutting of oaks (on the islands of Naissaar in the 13th century, and Hanikatsi in the 16th century), but since oak forests were often used for hay-making, this also meant the protection of some wooded meadows. Since

1957, there are also some nature reserves specifically for protecting wooded meadows (Tagamõisa, Laelatu, Halliste, Koiva).

During the first half of the 20th century wooded meadows represented the most common type of semi-natural ecosystems in several counties of western Estonia. In 1995-96, no more than 200 ha of them were still managed, of which 60 ha were situated within the bounds of state nature reserves.

Considering the efforts needed to preserve wooded meadows, their persistence could be achieved with additional evaluation of the work needed (mowing, primarily). Species richness as an important quality of the environment should be protected by law.

#### 4.2. Restoration of wooded meadows and their contemporary management

The restoration of wooded meadows could be justified for nature protection (as a habitat for many rare species, and as a very rich community), for green farming, for eco-tourism, for cultural history protection programmes, for scientific interest, for landscape design, for aesthetic reasons, etc.

In several cases (Viidumäe, Laelatu), volunteer camps were used to organise works. However, the main aim is to guarantee stable long-term management, which cannot be based on volunteer camps.

The best results in wooded meadow restoration could be achieved using abandoned wooded meadows, in which many old trees are still alive and the former structure of the meadow can be detected. Some patches of meadow vegetation may still exist in these sites, which allows herb species to establish more rapidly in newly opened areas.

### 5. Estonian wooded meadows

The present review is based mainly on the inventory project organised by the authors in 1995-96. The islands and western Estonia were more thoroughly studied in comparison to the other regions. However, wooded meadows were never so widespread in central and eastern Estonia than in the western part of the country, and the relative area of still preserved wooded meadows is also lower in the eastern part due to more intensive changes in the agriculture of this region.

Data on the investigated wooded meadows is given in Appendix 1, and the map of their distribution in Figure 10.

#### 5.1. Islands

Of the four largest Estonian islands, the condition of wooded meadows is slightly better on Hiiumaa and Vormsi than on Saaremaa and Muhu. A more detailed description is given of some Saaremaa meadows: (5.1.1.1) Loode oak forest (protected since 1914), (5.1.1.2) Tagamõisa wooded meadow (protected since 1957), and (5.1.1.3) well-restored wooded meadows in Viidumäe Nature Reserve.

Saaremaa probably had the highest concentration of wooded meadows, until the Second World War. 69% of the island was covered by meadows and pastures, of which only 10% were without trees. The abandonment of wooded meadows has been most severe in Saaremaa, less than 50 ha were mown in recent years.

On the island of Muhu, a few hectares of wooded meadow still exist, whereas many abandoned wooded meadows can be seen.

On the island of Hiiumaa, about 30 ha of wooded meadow still exists, of which the most valuable are those in the villages of Lauka, Tärkma and Hirmuste.

On Vormsi island a particular characteristic of wooded meadows was the lack of *Quercus*, and the dominance of *Alnus glutinosa*, *Betula*, and *Fraxinus*. Today, less than 10 ha still have the appearance of a wooded meadow.

## 5.2. West-Estonian mainland

This is still the richest region of wooded meadows. Regional differences are connected with transgression areas. The low lying Estonian landscape has a great deal of *Quercus* and *Betula* in its forests, in the higher Estonian landscape *Quercus* is more rare, and *Picea* more abundant. A detailed description is given on four most interesting wooded meadows: (5.2.1.1) Allika (Läänemaa) in Matsalu Nature Reserve, (5.2.1.2) Laelatu (Läänemaa), which is well investigated and has a biological station (Table 4), (5.2.3.1) Nedremaa (Pärnumaa), and (5.2.3.2) Vahenurme (Pärnumaa), in which the maximum small-scale species richness was found (Table 5).

In Läänemaa, over 200 ha of wooded meadow still exist, of which about 80 ha have been mown in recent years.

In Raplammaa, at least 160 ha of wooded meadow exist, of which 80 ha have been mown.

In Pärnumaa, which has been very rich in wooded meadows, at least 200 ha still exist, of which more than 50 ha are still mown.

In western Harjumaa, about 20 ha of wooded meadow are still preserved.

## 5.3. Northern, southern and eastern Estonia

Data from this region is incomplete. Two protected wooded meadows are described: (5.3.1) Halliste, and (5.3.2) Koiva, both in flooded river valleys.

# 6. Ecosystem structure of wooded meadows

## 6.1. Environmental conditions and element turnover

Equilibrium hay yield (i.e. productivity after long-term management) from a wooded meadow is higher than from an open meadow in otherwise similar conditions. This is due to the additional input of mineral elements from tree leaf litter, since tree roots take nutrients from deeper layers than herb roots.

Of the annual biomass production of a herb community, only about 15% is removed in hay, on average in natural meadows.

From the point of view of nutritional quality, the hay from wooded meadows is richer than that produced on cultivated grasslands.

## 6.2. Horizontal (mosaic) structure

In the case of a traditional wooded meadow horizontal structure, only 10-15% of its surface area is not covered by a mowable herb community.

A map of the horizontal distribution of trees in a one-hectare plot in Laelatu wooded meadow is shown in Fig. 12 and 13.

A great deal of the horizontal variation in the herb layer in wooded meadows is connected to the distance from trees. Closer to trees, the herb community is higher, individual ramets are bigger, and the ramet density is lower than in open sites.

Small-scale species richness was horizontally very variable in the investigated meadows. Usually, the patches with very high richness are quite small.

## 6.3. Life forms and age structure

The density of the seed bank is quite low in wooded meadows. The number of annual species is very low, they are represented almost only by hemiparasites. Life cycles are extended, vegetative reproduction dominates.

## 6.4. Phenology

According to the measurements in Laelatu wooded meadow, the herb community above-ground biomass reaches its maximum at the end of June. The peak of the seasonal maximum of species richness (i.e. of number of species which have some living green organs above-ground) is wider than the biomass peak, but they generally coincide. About 40% of species also showed some green above-ground organs under the snow cover. Phenological spectra are described, with seven phenological periods. Due to many colourful flowers, these periods are quite remarkable in wooded meadows.

## 6.5. Plant communities

On the basis of the meadow community classification made by H. Krall and K. Pork, descriptions of twelve communities, which are characteristic to wooded meadows, are given. The plant communities, which are specifically connected to wooded meadows, are: *Filipendula vulgaris* - *Sesleria coerulea* community, *Melampyrum nemorosum* - *Scorzonera humilis* comm., *Carex pallescens* - *Scorzonera humilis* comm., *Sesleria coerulea* - *Carex montana* comm., and *Sesleria coerulea* - *Primula farinosa* community.

## 6.6. Vascular plant flora

The critical list of vascular plants in Estonian wooded meadows includes 596 taxa (Appendix. 3). This includes 328 species, for which wooded meadows are mentioned as a habitat in the "Estonian Flora". About 40% of the species in the Estonian flora are distributed in wooded meadows, among them 55 protected species (30% of all protected species)

It should be emphasised that the list is compiled on the basis of contemporary data, and the data of the "Estonian Flora" which represents the situation after the Second World War. In earlier periods, the flora may have been much richer.

## 6.7. Bryophytes

The number of bryophyte species in a 1x1 m meadow plot is usually between 4 and 10 in Laelatu wooded meadow. In a contrast to vascular plants, less rare bryophyte species are growing on these meadows.

## 6.8. Fungi

Data about the fungi in wooded meadows is referred from the works of K. Kalamees. The species richness is quite high, due to the coexistence of humus saprobionts, mycorrhiza fungi, and litter saprobionts. Forest species are usually well represented, in grazed meadows pasture species can also be found.

## 6.9. Fauna

The existing data about the fauna of wooded meadows shows that no group has its maximum richness in wooded meadows. However, relatively rich or well represented are such groups as *Bombus*, *Lepidoptera*, *Coleoptera*, and also *Reptilia* and *Aves*.

## 6.10. Successions

The following types of succession are described: (6.10.1) primary succession of wooded meadows in the areas of land uplift on the Baltic coast; (6.10.2) formation of herb community when a wooded meadow is cleared from a forest; (6.10.3) changes in the case of the abandonment of a wooded meadow; (6.10.4) influence of grazing on plant community composition; (6.10.5) influence of fertilisation and atmospheric pollutants.

# 7. The problem of small-scale species richness

Small-scale species richness is extremely high in west-Estonian wooded meadows. However, comparative analysis of small-scale richness in plant communities on a world scale is still absent.

## 7.1 Methodical problems in species richness measurements

Measurements of species richness are quite sensitive to small differences in counting methods. We define the number of species in a plant community as follows:

- (a) the plot is quadratic (i.e. not longitudinal), its boundaries are fixed on the ground level, and only those ramets which are rooted inside the plot belong to it;
- (b) only ramets which possess living above-ground parts on the day of the making of the description are included;
- (c) diaspores or other unrooted parts of plants are not included.

Reliable results require a good knowledge of local flora (vegetative shoots and seedlings), and enough time to make the descriptions.

Species richness is largely scale-dependent. By small-scale richness we mean the number of species on plots of a size less than 10 square meters.

## 7.2. The plant communities of the greatest small-scale species richness in the world

The maximum recorded and published number of vascular plant species on a 1x1 m plot has been found in a meadow steppe site, in a forest steppe region of the Central Chernozem Nature Reserve (Strelets Steppe). In 1962, six plots with species numbers 61, 77, 80, 80, 84, and 87, were recorded in a mown community. There also exists unpublished data about a 1x1 m plot of 88 species in a traditional slightly grazed mountain meadow of Argentina. These are the only sites known in the world where the small-scale species richness exceeds that of Estonian wooded meadows.

Normally, the number of vascular plant species in a 1x1 m plot does not exceed 30 in natural meadows; in the richest alvar meadows it can be over 40; only in wooded meadows has it been found to exceed 50; the maximum (74 species in 1x1 m plot, or 68 as an average of ten plots) is recorded from Vahenurme wooded meadow in Estonia (Table 5).

The top five wooded meadows according to their local (1 sq. m) vascular plant species richness, on the basis of our existing data, are Vahenurme (74), Laelatu (68), Tagamõisa (67), Küdema (65), and Tärkma (61).

## 7.3. The factors determining the species richness of communities

The species richness of a community is the result of an equilibrium between immigration and extinction, where turnover with two pools is essential - with the species pool (the species present in the vicinity, outside the plot), and with the dormancy pool (the species which are in a dormant state, below-ground on the plot; it includes the seed pool). The first is defined as external turnover, the latter - as internal turnover; both are scale-dependent, having a larger importance in smaller plots.

There is a clear latitudinal trend in the size of the species pool. Local heterogeneity of habitat conditions increases the local species pool. From the other side, the number of specimens on a plot is connected to the size of ramets, which shows a contrariwise trend. An important factor is mowing, which diminishes the size of ramets, reduces the level of competition and makes the competition more symmetrical.

Scale dependence of species richness is related to the number of ramets which grow on the plot.



## 7.4. Factors determining species richness in wooded meadows

The wooded meadows which have the highest richness in their plant communities, have been found to be similar in the following characteristics:

- (a) they are very old, regular mowing has taken place sometimes for several centuries;
- (b) soil is neutral, calcium-rich;
- (c) grazing has not been used, or if used then not intensively;
- (d) their territory has been large (tens of hectares, as a minimum);
- (e) they include some more moist or wet patches;
- (f) tree layer is species-rich;
- (g) local species pool is large.

The large species pool assumes the diversity of niches on a small territory - shade and light, moist and dry, rich and poor (the last concerning mineral nutrition, i.e. different soil conditions). This corresponds to the conditions found in wooded meadows. The richest community patches were usually found in sites of lower productivity and more open canopy.

## 8. Final remarks

In global terms, the geographical region where hay-making takes place is not very wide latitudinally. The combination of relatively undisturbed nature (compared to the surrounded areas), calcareous soils, and a persistent culture possessing a long tradition of land-management, has given these rare examples of still existing rich and beautiful ecosystems.

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The book can be ordered from [toomas@elfond.tartu.ee](mailto:toomas@elfond.tartu.ee)  
Photos - [wooded meadows page](#)