Chapter 19. 6530* *Fennoscandian wooded meadows*, 9070 *Fennoscandian wooded pastures* and 5130 Juniperus communis *formations on heaths or calcareous grasslands* (V. Lārmanis)

In this book, wooded pastures, meadows and scrub formations are arranged in a separate group that covers three EU protected habitat types: 6530* *Fennoscandian wooded meadows*, 9070 *Fennoscandian wooded pastures* and 5130 *Juniperus communis formations on heaths or calcareous grasslands* (hereinafter – wooded grasslands). All three wooded grassland types belong to the same agricultural system ecologically and in terms of cultural heritage (Insertion 5, Fig. 19.2). They are often adjacent to each other or overlapping, or one of them develops into another over time. Therefore, the management issues of these habitats have been addressed jointly, with only a separate introduction and restoration descriptions for each habitat type and some special notes highlighted in other chapters. The special feature of wooded grasslands is a unique layer of trees and shrubs developed as a result of long-term extensive agriculture, which is addressed in more detail in this book. The herb and dwarf shrub layer of these habitats does not contain unique plant communities. They can overlap with various grassland and sometimes heathland or forest habitat types.

19.1 Characteristics of the Habitat Types

19.1.1 6530* Fennoscandian Wooded Meadows

EU protected habitat 6530* *Fennoscandian wooded meadows* is a landscape that consists of scattered trees or tree and shrub clusters that alternate in a mosaic with open grassland fragments (Anon. 2013c) (Fig. 19.2–19.4). The most characteristic tree species of this landscape include *Quercus robur*, *Tilia cordata*, *Ulmus glabra*, *Ulmus laevis*, but a tree layer can also be composed of other tree species. To plan habitat conservation, both currently mown or grazed areas and abandoned ancient landscapes in already afforested areas should be identified (Fig. 19.3.d). However, abandoned areas cannot be considered as a habitat in good quality (Anon. 2013c). Traditional management was a combination of several activities – haymaking, grazing, use of branches (Kull et al. 2003; Eriksson 2008b; Emanuelsson 2009; Glimmerveen 2013; Hartel, Plieninger

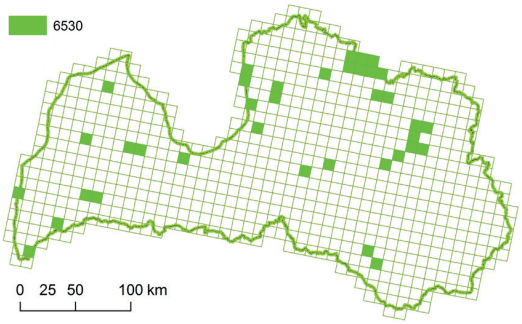


Fig. 19.1. Distribution of identified areas of habitat type 6530* *Fennoscandian wooded meadows* in Latvia (Anon. 2013a).

2014; Bergmeier, Roellig 2014; Jørgensen, Quelch 2014; Oppermann 2014). The interpretation of EU habitat type differs in different countries. In Latvia 6530* *Fennoscandian wooded meadows* means relic areas that usually formed before the second half of the 20th century or earlier and that contain a comparatively large number of old trees formerly developed in sparse wood or open conditions (Lārmanis 2013a; Lārmanis 2015b; Bāra et al. 2014). For comparison – EU protected habitat type 9070 *Fennoscandian wooded pastures* in Latvia means younger areas – currently grazed forests with no old trees from former sparse wood or few of them (Lārmanis 2015a). 6530* *Fennoscandian wooded meadows* often overlaps with other EU habitat types, such as 6210* *Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco–Brometalia)*, 6270* *Fennoscandian lowland species-rich dry to mesic grasslands* (Lārmanis 2012). Currently identified sites of habitat type 6530* *Fennoscandian wooded meadows*, including naturally or artificially afforested areas, occupy 0.02% (1160 ha) of the area of Latvia (Anon. 2013a) (Fig. 19.1), but there could be many more areas that have not yet been identified (Bāra et al. 2014).

19.1.2 9070 Fennoscandian Wooded Pastures

EU habitat type 9070 *Fennoscandian wooded pastures*, similarly to 6530* *Fennoscandian wooded meadows*, is a landscape, where the tree layer can vary from forests and sparse forests to tree and shrub groups or individual trees. It can consist of various woody species, and the mosaic may also contain open grassland fragments (Eriksson 2008b; Anon. 2013d; Garbarino, Bergmeier 2014) (Fig. 19.6, 19.7. j). In Latvia, habitat type 9070 *Fennoscandian wooded pastures* means a mosaic landscape or individual forest fragments and forest edges if they are cur-

rently or have been recently grazed and, unlike habitat 6530* *Fennoscandian wooded meadows*, has few or no ancient relic trees or sparse woodland trees (Lārmanis 2015a). Wooded pastures should have features resembling permanent pastures – trees and shrubs of the respective shape and appropriate groundcover structure. This habitat includes only pastures managed by humans. It does not include similar natural situations created by wild animals, where similar landscape elements are sometimes found in forest gaps or similar places. Habitat also includes grassland or heathland patches completely integrated in forest or scrub formations within the grassland (usually not larger than 1 ha) and forest edge curves, in an attempt to cover all of the area where an effect typical to the ecotone is present.
Habitat type 9070 *Fennoscandian wooded pastures* is included in the forest habitat group, but it depends on agricultural activity, like grassland habitats (Halada et al. 2011; Luick et al. 2012). The key process occurring in wooded pastures is grazing, but their traditional use, as in the case of 6530* *Fennoscandian wooded meadows*, has been very diverse.

A peculiar type of wooded pastures in Latvia is the specific subtype of nutrient-poor *Pinus sylvestris* forests on wet, sandy soils called *grīnis* (Fig. 19.6.f) (some of them correspond to the EU protected habitat 4010 *Northern Atlantic wet heaths with Erica tetralix*). In the past they were managed by grazing and groundcover burning (Gailis 1958 quoted by Auniņa (ed.) 2008; Pekmane 2006 quoted by Auniņa (ed.) 2008). Nowadays these forests are no longer managed in a traditional way and their restoration is needed through grazing (Auniņa 2017). In this case *grīnis* will also be classified as habitat type 9070 *Fennoscandian wooded pastures*. As an EU protected habitat, forest pastures have not been mapped so far in Latvia, therefore there are no exact data on their area and distribution. A survey among herd managers revealed that in 2011 there were approximately 3,000 ha of grazed forests and scrub formations in Latvia that may correspond to the habitat type 9070 *Fennoscandian wooded pastures* (Lārmanis 2015a).

19.1.3 5130 Juniperus Communis Formations on Heaths or Calcareous Grasslands

Habitat 5130 *Juniperus communis formations on heaths or calcareous grasslands* is a stage of grassland and heathland afforestation, where they are starting to overgrow with junipers, and this stage is permanently maintained by appropriate management (Lārmanis 2013b, Anon. 2013b) (Fig. 19.8, 19.9). Some of today's juniper groves of Latvia have only formed in recent decades as a result of overgrowth (Lārmanis 2013b), but there are also stands of 50–70 year old junipers (Salna, Kalniņš 2007); in the period of traditional agriculture they could have also been much older. In traditional agriculture juniper stands existed mainly as pastures, but were also used as hay meadows. Farmers were also interested in maintaining the juniper stands, because juniper itself was important for them. Juniper wood was used in a wide range of constructions (most often fences). Juniper berries were used as a condiment or for making jams, while juniper branches were used for smoking meat and fish.

In both wooded grasslands described above, juniper groves occupy the undergrowth layer and are often a smaller component in a wider landscape of habitat types 6530* *Fennoscandian wooded meadows* or 9070 *Fennoscandian wooded pastures* or are transitioning into it. Unlike the other two wooded grassland habitats, there are no known specific juniper grove invertebrate species (Greķe, Teļnovs 2005). Habitat type 5130 *Juniperus communis formations on heaths or calcareous grasslands* is one of the five rarest EU protected habitats that are characteristic of the agricultural landscape of Latvia; they occupy only 0.001% (66 ha) of the area of the country (Anon. 2013a) (Fig. 19.5). Habitat conservation value in terms of plant communities overlaps with several grassland habitat types: 6120* *Xeric sand calcareous grasslands*, 6210 *Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco–Brometalia)*, 6270* *Fennoscandian lowland species-rich dry to mesic grasslands* and 4030 *European dry heaths*. The presence of junipers in these habitats diversifies the environmental conditions, thus contributing to relatively higher species diversity than in the same grasslands or heathlands in open areas.

19.1.4 Ideal Wooded Grassland

The size of the area is one of the main features of an ideal wooded grassland landscape, which determines the biodiversity of the habitat. The larger the area, the richer and more stable the biodiversity of the habitat (Ranius 2002b, 2002c; Ranius et al. 2011; Bergman et al. 2012; Glimmerveen 2013). The size of area is especially important for the habitat types 6530* *Fennoscandian wooded meadows* and 9070 *Fennoscandian wooded pastures*, where the landscape varies from forests and sparse forests to solitary trees. Open grasslands of up to 1 ha are also considered as part of the landscape (Eriksson 2008b).

The best-known representative of the saproxilic species community of wooded grasslands in Latvia is the hermit beetle *Osmoderma eremita*[1]. It inhabits tree cavities and the requirements of this species explain the ecological criteria of an ideal habitat and the necessity for large areas. *Osmoderma eremita* (Fig. 19.10) is a so-called umbrella species, which means that life conditions that are appropriate for it will benefit hundreds of other species of invertebrates (Antonsson 2002). The group of species represented by *Osmoderma eremita* is closely associated with the number of appropriate trees per unit of area, as well as with the overall scale of the landscape (Bergman et al. 2012).

An individual viable population of *O. eremita* requires approximately 20 trees with cavities inhabited by these species, where the inhabitants mutually interact, otherwise the metapopulation will disappear in the long term (Jansson, Bergman 2006; Bergman 2006). Hermit beetles do not inhabit all seemingly suitable trees with cavities and research shows that the required amount of inhabited trees is usually achieved if there are at least 160 trees with cavities suitable for the species in the area (Ek, Johannesson 2005; Bergman 2006). If trees with cavities that are not suitable for the species are taken into account, up to 2,670 trees with cavities may be required to obtain 20 suitable ones that are inhabited by the species (Jansson, Bergman 2006; Bergman 2006).

What is the area in which a matching number of trees is possible in the respective conditions? In addition to hollow trees, which, for instance, in the case of oaks, develop hollows starting from the age of 150 years or older (Ranius, Nilsson 2005; Ek, Johannesson 1997; Teļnovs 2005), younger trees that will replace the old trees in the future are also necessary. There are also dead or dying and damaged trees that are important for many other species (Eriksson 2008b). Trees must be sufficiently sparse so that sunlight and heat can reach their trunks. Sunny, warm areas are also required on the ground under the trees because some species of invertebrates live in fallen branches in insolated places (Alexander 2013). Ideal wooded grassland also needs abundantly blooming sun-lit trees and shrubs, because some of the species living in the trees feed on tree flowers. These tree properties are best observed in open mosaic conditions (Eriksson 2008b; Vodka et al. 2009; Alexander 2013; Falk 2014). An abundantly flowering herb layer has the same importance. There are also openings up to 1 ha large (Eriksson 2008b). The combination of all of the conditions listed above allows us to conclude that the minimum area of a sustainable landscape that ensures habitat for the hermit beetle starts at approximately 57 ha (further on, the approximation of 60 ha will be used), while certain species may even need an area several hundreds of hectares large (Jansson, Bergman 2006; Bergman 2006). Species inhabiting oak hollows have been researched most extensively and it has been established that about 250 old/hollow oaks (circumference of at least 3.1 metres) would be needed in an area of 1600 ha to ensure a rich saproxylic oak fauna (Bergman et al. 2012).

A larger landscape gives a higher probability of achieving the required number of suitable trees with cavities, but these trees may not be ecologically linked due to the distance between them. Hermit beetles do not usually move further than 200–300 m (Antonsson 2002; Teļnovs 2005). Trees inhabited by the hermit beetle should be located sufficiently close to each other to ensure the interaction of their populations. Therefore, not only is the size of the wooded grassland important, but also the density of their arrangement.

19.1.5 Processes and Elements Important for Wooded Grasslands

19.1.5.1 Overview of Developments in Traditionally Managed Wooded Grasslands

The main precondition for the existence of biodiversity characteristic to wooded grasslands is the diversity of approaches in traditional agriculture (Fig. 19.2). Woody plants were used for wood harvest – for construction and other materials, and for firewood (Fig. 19.9.d, 19.12). Tree leaves or branches were used for animal fodder (Fig. 19.7.f). Beehives were installed in some trees (Fig. 19.2.i). Various fruit trees, for example, wild apple trees, berry shrubs, hazel trees also served as sources of food for humans. The tree layer was also maintained as a part of the pasture system infrastructure. It provided shade or shelter for animals and shepherds from insects on hot days (Fig. 19.3.h), and animals also used the leaves, branches and fruits of growing trees on a daily basis (Fig. 19.3.c). The grass layer was used for haymaking (Fig. 19.2.c) and for pastures (Fig. 19.2.d); sometimes there was a combination of both within one season, or they were alternated over years. Small temporary arable lands could be arranged in more open parts of the landscape.

[1] According to recent studies (Audisio et al. 2007; Audisio et al. 2008) the species *Osmoderma eremita* represented in Europe, based on molecular research, is divided into four species (*Osmoderma eremita, O. barnabita, O. cristinae, O. lassallei*), of which only *Osmoderma barnabita* is found in Latvia.

All activities and landscape elements indicated above maintain different ecological niches and a certain forest stand structure, creating the unique features of these habitats (Kull et al. 2003; Emanuelsson 2009; Bergmeier, Roellig 2014; Hartel, Plieninger 2014; Jørgensen, Quelch 2014; Oppermann 2014; Varga, Molnár 2014).

The listed ancient management aspects may give the impression that nowadays such a set of actions is not possible and the maintenance of these habitats is no longer realistic. The purpose of the above list is not an invitation to imitate all the actions in exactly same manner as the previous generations did. This awareness is necessary to understand how this system functioned and to adapt modern practices for its maintenance. A lot of the above is still relevant today. For example, shade and shelter from insects is still important for farm animals, and fruit trees complement the animals' diet well. We still use firewood and if its gathering is combined with, for example, clearing an old wild apple tree from suppressing grey alders, the result of the action will be very similar to traditional farming. In a small household, once-popular tree pollarding for animal fodder can still be useful and it can be combined with the idea of aesthetic landscaping.

19.1.5.2 Tree and Shrub Layer Structure

Browsing of lower branches of trees in permanent pastures results in a horizon that is relatively free of foliage (usually at a height of approximately 1.5–2 m) (Buttenschøn, Buttenschøn 2013; Glimmerveen 2013) (Fig. 19.6.c), which allows more light to reach the groundcover and creates ecological conditions that differ from the forest environment (Fig. 19.6.a, 19.6.c, 19.6.h, 19.19.f). For comparison: in a non-grazed forest stand 9.5% of light reaches the groundcover, in a grazed forest stand this figure is 15.8%, and there is a higher diversity of lighting conditions that supports vegetation diversity (Buttenschøn, Buttenschøn 2013). In grazed or regularly mown places the tree stand is usually sparse and transparent (Fig. 19.6.a, 19.6.c, 19.6.h, 19.19.f). In larger pastures, areas with thicker forest stands may also occur, which are less frequently visited by livestock (Fig. 19.19.e). In permanently grazed areas there are always some tree trunks nibbled or rubbed by animals and withering or withered trees (Fig. 19.13). Various types of dead wood in wooded grasslands are important for invertebrates (Eriksson 2008b; Sverdrup-Thygeson et al. 2010; Falk 2014).

Standalone trees and shrubs that grow in more open parts of wooded grasslands have wide crowns compared to those growing in a dense stand. Almost all native tree species of Latvia occur in the canopy layer. In the subcanopy layer and undergrowth there are wide-crowned *Malus sylvestris, Crataegus* spp. (their presence may indicate long-term grazing (Buttenschøn, Buttenschøn 2013; Jørgensen, Quelch 2014), *Juniperus communis*, *Corylus avellana, Sorbus* spp., *Rhamnus cathartica, Rosa* spp. The contribution of these trees and shrubs to biodiversity is best observed in open mosaic conditions where they bloom abundantly (Fig. 19.3.b) and serve as a feeding environment for some saproxylic species and also increase the overall species diversity (Eriksson 2008b; Vodka et al. 2009; Alexander 2013; Falk 2014). In traditional farming, the development of wide-crowned trees and shrubs has been encouraged not only by grazing, but also by targeted human activity such as the development of fruit-producing trees, or cutting of treetops or branches for animal fodder or firewood, thus promoting cavities and microniches in clusters of regrown branches (Fig. 19.7.f). Manure of grazing animals also has an important impact on the woody plant layer (Fig. 19.6.i, 19.6.j). *Malus sylvestris, Crataegus* spp., *Prunus* spp. tree seeds demonstrate better survival in manure. (Buttenschøn, Buttenschøn 2013). Animal excrement also promotes diversity of epiphytic lichens (Leppik et al. 2011).

19.1.5.3 Herb Layer and Topsoil

Wooded grasslands do not have specific herbaceous plant communities or species (Mägi, Lutsar 2001; Paal 2002; Bergmeier, Roellig 2014). However, the biodiversity is positively affected by numerous ecotones (forest and grassland overlapped areas) that enrich the grassland groundcover with forest species and vice versa. In pastures, the herb layer and topsoil have a peculiar structure developed under constant grazing, which encourages biodiversity. Herd animals establish trails (Fig. 19.6.e, 19.19.a, 19.19.b, 19.19.c), leave scattered tracks, and in some places create so-called "sand baths" (Buttenschøn, Buttenschøn 2013; Bergmeier, Roellig 2014; Garbarino, Bergmeier 2014). In autumn they tend to gather around fruit-producing trees (Fig. 19.3.g), trample the vegetation around them more intensively and hinder the establishment of competing trees and shrubs.

Animal excrement is scattered throughout pastures. The grass is often relatively less grazed around them, or stands of nitrogen-loving plant species form there (Eriksson 2008b; Talvi 2010; Rupp 2013), for example, *Urtica dioica* or *Stellaria media*.

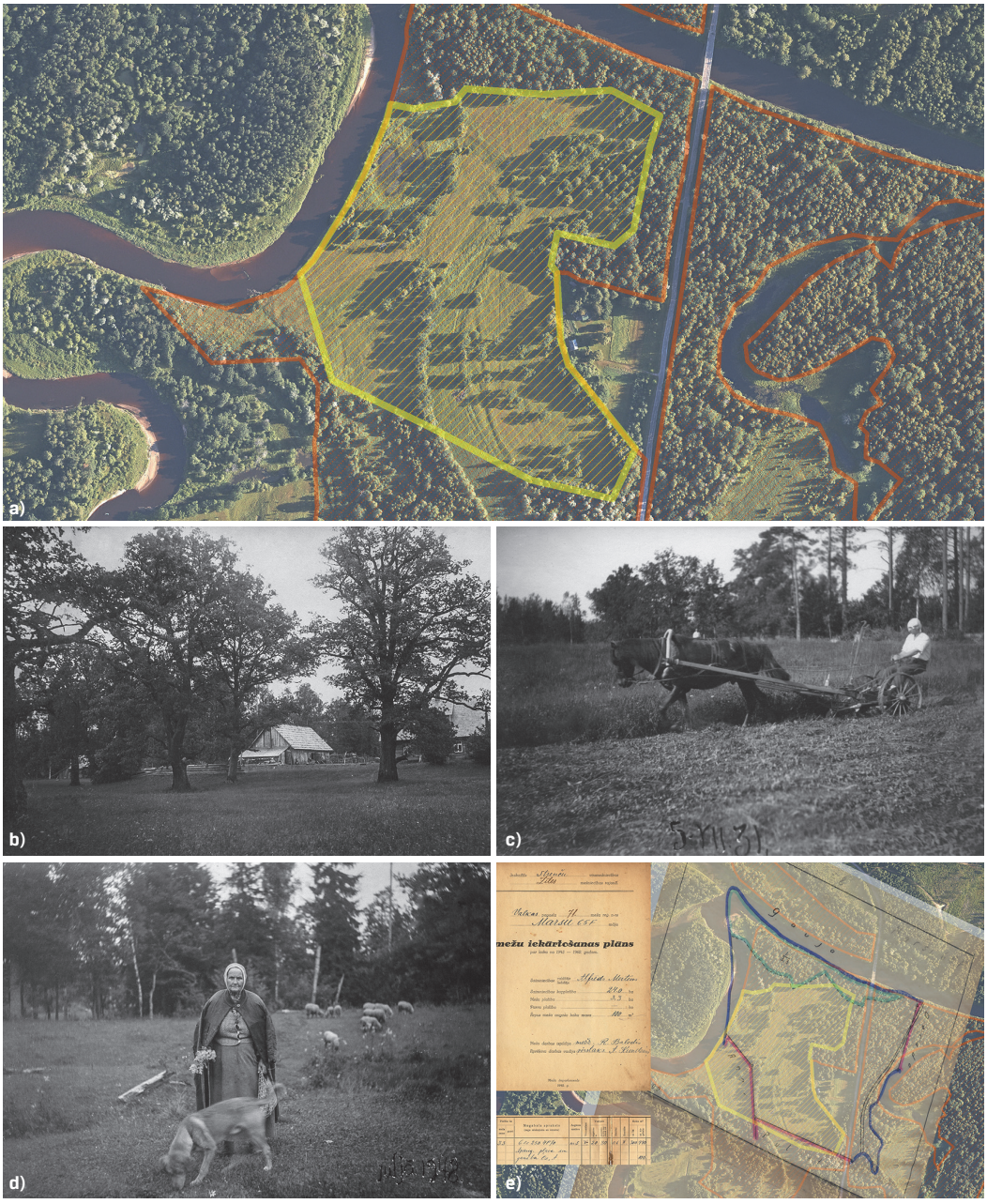
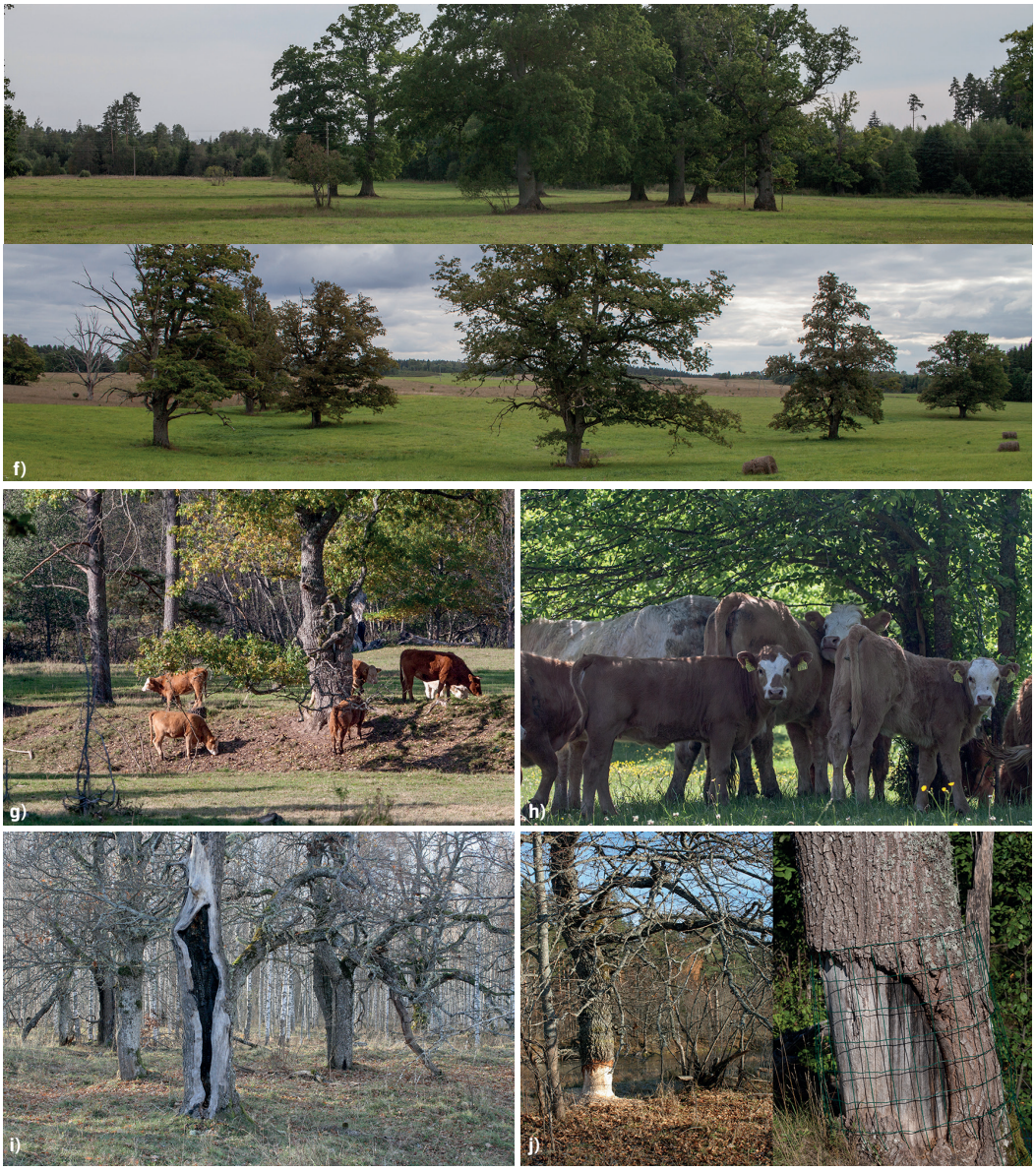


Fig. 19.2. Wooded grasslands in the farm "Marsi", Valka Municipality. According to the current methodology, in Latvia, this landscape belongs to the EU protected habitat type 6530* *Fennoscandian wooded meadows*. However, its historical development, current developments and elements might also be found in two other types of wooded grassland habitats. (**a**) The yellow outline in the orthophoto marks an ancient fragment of wooded grassland that is currently arranged and managed. It has been mostly preserved through the ages and in some places restored between 2005 and 2013. However, it may not be called a habitat in a good quality because its area is only 15 ha, which is much too small for the long-term existence of some of the saproxilic species specific to the sparse tree layer of wooded grasslands. This 15 ha area is included in a 60 ha landscape (red outline continuing outside the image) where ancient wooded grassland has been afforested and the important ancient landscape elements are gradually disappearing. Restoration of the whole area of wooded grassland is possible. (**b, c, d**) Landscape of "Marsi" farm and management from 1930 until 1948. As seen in the picture, the wooded grassland landscape included both pastures and meadows and also a house with small arable fields. The locations where photos were taken are marked with a number in (**f**).

(**e**) Forest management plan of 1942 (with modern orthophoto in its background) marks the only forest patch of that time with a green outline, but it also contains an appraiser's note that it is an overgrown meadow and pasture. Since trees that are older than this document nowadays occur in the entire landscape outside the marked forest plot, apparently, they have been considered by the forest appraiser as belonging to agricultural land rather than forest. (**f**) Overlap with three other EU protected habitat types included in wooded grassland (shaded parts): 6210* *Xeric grasslands in calcareous soils*, 6270* *Species-rich pastures and grazed meadows*, 6450 *Floodplain grasslands*. (**g, h**) Clearing of shrubs in the habitat in 2006 and 2013. (**i**) Withered monumental pine with more than a century-old artificial hollow for beekeeping, which was cut out wider later in the 1970s to install a bee swarm trap. Such man-made structures in trees of wooded grasslands represent important elements, which, along with branch cutting and similar activities, maintain additional ecological niches in the habitat and promote the overall biodiversity. (**j, k**) The view today on the most open part of the landscape during spring floods and in October after the leaves have fallen. Orthophoto: Institute for Environmental Solutions, (**b-d**) Mertens' family archive, (**h**) S. Ikauniece, other images: V. Lārmanis.

Fig. 19.3. EU habitat type 6530* *Fennoscandian wooded meadows* in Latvia. (**a**) Fragment of habitat overgrown with shrubs in Valka district, Zvārtava Municipality. Such oak groups of various densities, alternating with open meadows, continue in the wider surroundings. In the first half of the 20th century, oaks were the dominating landscape feature of an approximately 25 km-long continuous section of the Gauja valley starting from Melnupe fork along the border of Estonia to the Valka–Smiltene road bridge. It is one of the two largest habitat complexes in Latvia that has not been completely destroyed yet and can be restored. (**b**) Habitat with a flowering hawthorn (*Crataegus* spp.). Such lush and abundantly blooming trees and shrubs that grow in full sunlight are important as a source of nectar for some saproxylic species that inhabit the old wooded grassland trees; they also increase the overall invertebrate species diversity. (**c**) Mosaic of various habitats and their overlapping is one of the main reasons for the very high biodiversity in the habitat. An abundantly blooming herb layer, as well as blooming trees and shrubs are an important aspect for maintaining the diversity of invertebrate species. Therefore restoration of a semi-natural, species-rich grassland in wooded grasslands poor in herb species (example of such landscape in (**f**)) should be promoted. (**d**) A fragment of a partially restored habitat, where the undergrowth and subcanopy tree layer has been removed, but secondary forest (a stand of younger pines around the oak) still needs to be removed (further, other groups of oaks can be seen). The trunk of a young linden can be seen on the left of the oak. The linden has been left as a potential future tree, but it is too close to the old oak and will interfere with the restoration of its crown. Potential new wooded grassland trees should be located outside the expected crown projection of the old trees and at a sufficient distance not to shade the old tree as they grow.



A deliberately preserved large log is seen in the foreground, preserved to maintain biodiversity. (**e**) Old oak next to two younger trees. The young trees are too close and interfere with the restoration of the old tree crown, which ten years after shrub removal, has recovered surprisingly well from an almost dead state. (**f**) Wooded grasslands that do not extend far beyond the landscape seen in the image. In Latvia such small areas correspond to EU habitat type 6530* *Fennoscandian wooded meadows*. Upper part of the figure: landscape near Mežmuiža in Vāne Municipality in Kurzeme region; below it: area near Lake Zvārtava in Gaujiena Municipality in Vidzeme region. (**g**) Cows eating acorns under an oak in autumn. A similar situation is often observed near wild apple trees and rowan trees. The interest of animals in fruit trees should be kept in mind in the restoration process, by first clearing shrubland and secondary forest around fruit trees, because then it can be expected that animals will trample the sprouts near these trees and hinder their development. (**h**) Animals use the shade of trees in summer. This is one of the advantages that wooded grassland landscapes have over open grasslands in terms of livestock welfare. (**i**) Oak suffered in a grass fire. Burning of dead grass near old trees is not acceptable because tree cavities catch fire easily, fire also kills smaller trees, such as junipers. (**j**) On the left: a dry oak damaged by beavers. Latvian wooded grassland landscapes are often located near waters, where beavers often destroy important old trees or even entire parts of wooded grassland landscape. Therefore the protection of important trees from beavers should be included in the landscape management plan. On the right: an oak partially damaged by beavers and later protected by a mesh. The tree has survived and is recovering.
Photo: V. Lārmanis.

Fig. 19.4. Habitat type 6530* *Fennoscandian wooded meadows in Estonia.* (**a**) Muhu Island. Habitat in a good condition with varied tree species composition. The density and location of the tree and shrub layer in this picture can be a model for the restoration of overgrown or maintenance of managed habitat. (**b, c**) Wooded meadow in "Nedrema" Nature Reserve. The part of the meadow seen in (**b**) has set the European record for the species diversity of herbaceous plants per one square metre – 63 species (Kull, Zobel 1991). The tree layer of the meadow fragment seen in (**c**) is dominated by small birches that are not typical to Latvian wooded meadow landscapes. (**d**) Lady's-slipper orchid *Cypripedium calceolus* in a wooded meadow on Saaremaa Island. In Latvia, this endangered species grows almost exclusively in forests (Cepurīte 2003), while in Estonia it abundantly occurs in wooded meadows. (**e**) Restored wooded meadow, where most secondary forest trees were felled a year ago. The density of such tree stand would have been too high if restoration of the habitat was related to the conservation of the *Osmoderma barnabita* (Fig. 19.7) species group. Photo: V. Lārmanis.

The invertebrates living there also attract birds and mammals (Fig. 19.6.i, 19.6.j). Long-term grazing leads to the formation of tussocks characteristic of pastures, thorny plants get introduced (Fig. 19.6.c). As the shrub layer and lower part of tree foliage is browsed not only in open spaces, but also in woody parts of the landscape, more light reaches the patches of herb layer, which also contributes to vegetation diversity (Buttenschøn, Buttenschøn 2013) (Fig. 19.6.a, 19.6.c, 19.19.f, 19.6.h). All of the above create a patch-type vegetation of various heights and areas free of trees. If hay meadows are included in a wooded grassland, then, depending on the type of plant community, they correspond to the open landscape grassland habitat types described in the first part of the book.

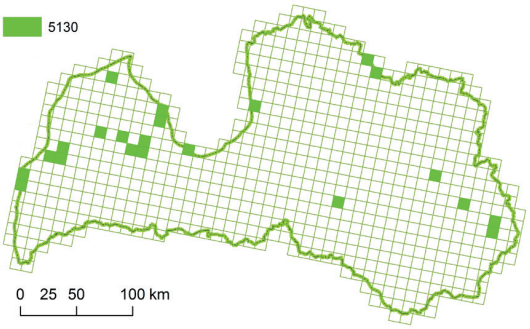


Fig. 19.5. Distribution of identified areas of habitat type 5130 *Juniperus communis formations on heaths or calcareous grasslands* in Latvia (Anon. 2013a).

19.1.6 Pressures and Threats

Wooded grasslands are adversely affected by all factors listed and described in Chapter 3. They also have several specific threats.

Interruption or insufficient intensity of management that causes overgrowth, or **artificial afforestation** for the industrial production of timber. A specific problem in juniper stands is excessive increase in juniper density themselves (Fig. 19.9.c, 19.9.e).

The consequences of this process are as follows:

- due to shading, species diversity decreases in the herb layer;
- shading leads to the disappearance of light- or warmth-loving invertebrate and lichen species in the tree layer and decrease in species diversity (Ranius, Nilsson 1997; Ranius, Jansson 2000; Ranius 2001; Ranius, Hedin 2001; Eriksson 2008b; Leppik, Jüriado 2008; Vodka et al. 2009; Leppik et al. 2011; Paltto et al. 2011; Ranius et al. 2011; Jüriado et al. 2012; Johansson et al. 2014);
- the number of wide-crowned blooming trees and shrubs decreases, limiting the feeding options for invertebrates (Eriksson 2008b; Alexander 2013; Buttenschøn, Buttenschøn 2013; Falk 2014);
- suppression by secondary trees and shrubs causes the destruction of old wide-crowned trees, and the populations of protected species dependent on them decreases accordingly (Ranius 2002c; Eriksson 2008b; Paltto et al. 2011; Green 2013; Johansson et al. 2014);
- the fragmentation of habitats into smaller and smaller units has increased due to overgrowth and drainage, which reduces the populations of species dependent on the habitats (Ranius, Hedin 2001; Ranius 2002b; Ranius 2002c; Hedin et al. 2008; Eriksson 2008b).

Destruction of wooded grassland habitats by logging. Felling of old wooded pasture trees usually occurs in old wooded grasslands overgrown by secondary forest without consideration of their connection with the protected habitat.

Destruction of wooded grassland through agricultural land drainage. Wooded grasslands were damaged by drainage, especially during the Soviet period when trees that prevented the creation of large continuous fields were removed (Fig. 19.15). There have also been cases in recent agricultural policy, when land managers cleared juniper stands to comply with support payment requirements (Tomsone 2006).

Overgrazing. Consequences:

- decrease in herbaceous species diversity;
- destruction of trees and shrubs; damage to woody plants by grazing animals is positive to a certain extent, but in the long term they should not cause the disappearance of the tree stand characteristic for the habitat.

Dead wood removal. Mainly characteristic to excessively managed landscapes. Most frequently this happens due to the exaggerated human understanding of safety or tidiness – removal of all dry and decaying trees from the landscape and cutting of dry branches. The consequences of such actions are a reduced amount of microniches for invertebrates (Eriksson 2008b; Sverdrup-Thygeson et al. 2010; Falk 2014) and also limited conditions for bird species that feed on them.

Beaver activity. Most of the currently known wooded grasslands in Latvia are related to river valleys where a large proportion of ancient trees grow in direct proximity to water. Beavers damage old trees,

Fig. 19.6. EU Habitat type 9070 *Fennoscandian wooded pastures* in Latvia. (**a, b**) Habitat in good condition grazed by goats and sheep in Gauja National Park. (**c**) Forest edge with the characteristic browsed layer of tree canopy. Tussocks and thistles characteristic of pastures can be seen in grassland. (**d**) Long-term pasture is characterised by densely branching shrubs as a result of browsing by animals. (**e**) Another feature of permanent forest pasture is tracks created by domestic animals. The image on the left shows a still living wild apple tree that once grew in more open conditions but now is suppressed under the crowns of surrounding taller trees. It is recommended to create a wider opening around such an apple tree to restore its crown volume. On the right, there is an old pine that has grown in an open area, around which shrubs have been cleared and the recovery of which is now restricted by the proximity of an animal trail. Photo: Fig. 19.6 (f) L. Auniņa, others – V. Lārmanis.

(**f**) A peculiar type of forest pasture in Latvia is grīnis – poor *Pinus sylvestris* forests on wet, sandy soils that were managed earlier by burning and grazing. The image shows a wet *Pinus sylvestris* forest that has not been managed for several decades. Dense stands of heather *Calluna vulgaris* have been preserved under crowns of young pines and birches. (**g**) Veteran trees that once grew in an open area are often found in wooded pastures. They need to be gradually freed from suppressing trees and shrubs (picture on the left). There are often wild fruit trees on forest edges, the volume and blooming of which can be promoted by freeing them from suppressing trees and shrubs (wild apple tree in the image on the right). Both elements are important for wooded pasture biodiversity. (**h**) Grazed birch stand in cattle pasture. Similarly to (**a**), it can be seen that sunlight reaches the groundcover in sparse stands, which is an important precondition for greater species diversity. A stack of stones free of shrubs in the foreground. It is an important element of pasture diversity that is used by various small animals. For example, lizards use the stone stack as a hiding place. The sun-warmed stones are important for ectothermic animals to be active. (**i, j**) Animal manure has an important role in the maintenance of pasture biodiversity. In (**i**) at least three different species of fungi can be seen on cow dung. In (**j**), a common starling *Sturnus vulgaris* has picked up the lump of manure and is feeding on insects found under it.

Fig. 19.7. Habitat types 6530* *Fennoscandian wooded meadows* (**f**) and 9070 *Fennoscandian wooded pastures* (all other images) in Sweden and Finland (only (**j**)). (**a**) A cluster of oaks characteristic of the habitat, where a dense secondary forest was removed five years ago and cattle is now grazed in summers. Deliberately preserved low rose shrubs are seen between the trees. Photo taken in early May. This landscape has been restored to suit the requirements of the species group represented by *Osmoderma barnabita*. (**b**) Landscape seen in (**a**) continued. Preserved lush shrubs and low trees that flower abundantly in spring can be seen in the foreground. Here, they are wild plum (*Prunus* spp.) and apple trees *Malus sylvestris*. (**c**) The landscape seen in (**a**) and (**b**) continued. A denser group of alders *Alnus glutinosa* is seen on the right side of the image behind a terrain elevation. It is a wet depression where all trees have been preserved to retain a darker place in the landscape for shade- and moisture-loving species and thus increasing the overall biodiversity. (**d**) Ancient, long-term horse pastures where afforestation has not occurred. In the foreground: a cluster of hazel trees characteristic of wooded pastures. (**e**) A wooded pasture cleared from secondary forest five years ago that is being grazed in summer. The shrubs visible in the background are deliberately preserved hazel trees. Photograph taken in early September.
Photo: V. Lārmanis.

(**f**) Habitat with ash trees *Fraxinus* spp., the branches of which are regularly cut for use as animal fodder. In Sweden, wooded grasslands with pollarded trees are included in habitat type 6530* *Fennoscandian wooded meadows*. Although historically the grassland in such areas has been primarily used as hay meadows, the typical grassland structure with tussocks and the enclosure shows that it is currently being grazed. Nowadays these types of locations, with limited access for agricultural machinery, are usually grazed. It is an economically more feasible solution than the restoration of hay meadows. (**g**) Secondary forest that was an opening more than 50 years ago; a component of a wider wooded pasture landscape. Restoration of this landscape by gradually felling the trees over 40 years and retaining the potential wooded pasture trees is planned. (**h**) A veteran oak that once grew in an opening, cleared from secondary forest in the same forest stand that can be seen in (**g**). The viability of such very important trees should be improved as soon as possible to avoid die-off caused by shading and competition with younger trees. For this reason, the secondary forest around it has been cleared. This example shows that the space to be freed up is much larger than the projection of the tree crown. The thickest fallen branches have been preserved under the tree as a habitat for invertebrates. (**i**) A glade that has been cleared from spruce monoculture and shredded, around which forest continues, where a wooded pasture will soon be restored. Withered spruces and piles of branches have been left as habitats for invertebrates. (**j**) A field where secondary forest has been cleared recently and grazing has been commenced to promote open areas with poor groundcover where *Thymus* spp. will play an important role in the protection of invertebrates. In Finland, habitat type 9070 *Fennoscandian wooded pastures* also includes deciduous forests established after slash-and-burn cultivation that was a characteristic of the former land use (Anon. 2013d).

Fig. 19.8. Habitat type 5130 *Juniperus communis formations on heaths or calcareous grasslands* in Latvia. (**a**) Juniper stand in Ķemeri National Park, Riekstu peninsula of Lake Kaņieris in 2013. This stand is maintained by regularly clearing shrubs, but no mowing or grazing occurred at the moment of taking the photo, which can be evidenced by the high grass of the previous year. (**b, c**) Juniper grove in Ķemeri National Park near Čaukciems before restoration (2013) and 1.5 years later (2015). The images show that prior to restoration, the stand was completely merged in secondary forest. After restoration, the overall landscape will be created with semi-natural grassland, individual larger trees and junipers. Tree and shrub stumps were ground after clearing to avoid interference with future mowing. This has resulted in a large area of bare soil for the grasslands to restore gradually. (**d**) Another juniper stand in Ķemeri National Park near Čaukciems, restored in 2015. Both this and the previous image show the dispersed arrangement of junipers to enable operation with mowing equipment. (**e**) Juniper stand on the Abava valley slope near Drubazas in 2008. Image was taken at a time when secondary forest trees were starting to establish between junipers, therefore regular mowing or grazing should be resumed. (**f**) Good-quality juniper stand in a pasture on the Abava valley slope near Zvejnieki bridge in 2010. (**g**) In certain conditions, junipers can be among the first woody plants that get introduced in abandoned grasslands. Image: Abava valley near Veģi in 2013. The number of junipers and their age are sufficient for this site to qualify as EU protected habitat type 5130 *Juniperus communis formations on heaths or calcareous grasslands*.

(**h**) Juniper grove typically located in the highest, driest and sandiest areas of terrain in "Ziemeļgauja" Protected Landscape Area (the next images are from the same site). In the foreground and further away between junipers, there are abundantly flowering fern-leaf dropworts *Filipendula vulgaris*, which indicate overlapping with another EU protected habitat type 6210* *Semi-natural dry grasslands and scrubland facies on calcareous substrates*, while a sedge stand in the middle indicates overlapping with habitat type 6450 *Northern boreal alluvial meadows*. (**i**) The juniper stand overgrown with young pines, in a belt narrower than 20 m, behind which an open grassland continues. Although the secondary forest trees are much taller than those seen in (**b**), due to the small area they do not establish a typical environment of the forest. Thus, restoration of the juniper stand is still possible by gradual clearing of secondary forest. (**j**) 12 years ago, this juniper row was suppressed by taller young pines which were felled. The junipers themselves were also lower and much more densely located. In the first years after felling of the pines, there was a risk that all the junipers would die off because their crowns got damaged under the new conditions. There was also an impression that junipers were incompatible with cattle grazing because the animals toppled several trees by rubbing against them. However, the situation has stabilised since. Animal activity has resulted in the development of a sparse, more viable stand of junipers and the introduction of new juniper trees, including some with a low crown, and which can withstand the impact of cattle better. Photo: A. Priede (**b, f, g**), others – V. Lārmanis.

Fig. 19.9. Habitat type 5130 *Juniperus communis formations on heaths or calcareous grasslands* in Estonia. (**a**) Old junipers in a sheep pasture on Hiiumaa Island. Picture taken on 7 July, when the development of vegetation was particularly rapid. Very short grass indicates overgrazing, which most likely decreases the grassland species diversity and is not desired even if it does not harm the juniper stand. (**b**) Low-shaped junipers in a grassland near Pärnu. (**c**) Long-term unmanaged, low-shaped juniper stands on the coast of Hiiumaa Island. The juniper stand is too dense, which reduces biodiversity in the herb layer. (**d**) A traditional structure on Hiiumaa Island using juniper wood. (**e**) Too dense, tall juniper stand. Due to shade, no stable grassland can develop, vegetation is uniform and poor, dominated by common nettle *Urtica dioica* and ground elder Aegopodium podagraria. Photo: V. Lārmanis.

usually until the loss of viability, but without felling them. Sometimes trees are destroyed because beavers create burrows under the roots and the trees are uprooted. It is possible that the increased beaver activity and focus on old trees is provoked by the clearing of secondary trees and shrubs in the habitat (Vilka (ed.) 2007).

Inbalanced tree stand age structure that causes a lack of trees of certain age at present or in the future (Fig. 19.16). Imbalanced age structure in certain situations can be caused by a combination of the various factors mentioned above. Imbalanced tree stand age structure is the cause of the disappearance of species ecologically related to trees of a certain age (Ranius, Jansson 2000; Jansson, Hultengren 2002; Eriksson 2008b). In Latvia, this problem has been analysed and explained in more detail in the example of Moricsala Island (Jansson, Hultengren 2002).

Fig. 19.10. Hermit beetle *Osmoderma barnabita*. Photo: V. Lārmanis.

19.2 Conservation and Management Objectives of Wooded Grasslands

- Provide a suitable living environment for species specific to wooded grassland trees by restoring and maintaining the favourable conservation status of these species.
- Restore and conserve wooded grasslands as unique examples of the traditional rural cultural landscape of Latvia.

The conservation value of wooded grasslands is at least threefold – they have a cultural heritage and biodiversity importance and they may be an example of a sustainable future landscape.

In terms of cultural heritage, wooded grasslands represent an ancient traditional farming system with a complex structure and processes (Kull et al. 2003; Eriksson 2008b; Emanuelsson 2009; Glimmerveen 2013; Hartel, Plieninger 2014; Bergmeier, Roellig 2014; Jørgensen, Quelch 2014; Oppermann 2014) (Fig. 19.2). It is even proposed to include Estonian wooded meadows in the UNESCO World Heritage list, emphasising that the wooded grassland landscape created by the interaction of humans and nature may have existed for 7,000–8,000 years (UNESCO 2004).

Wooded grasslands are also outstanding in terms of biodiversity, promoted by the overlapping of forest and grassland ecosystems and the unique environmental conditions of these habitats in the tree layer (Eriksson 2008b; Emanuelsson 2009; Bergmeier, Roellig 2014; Hartel, Plieninger 2014; Falk 2014). For example, wooded meadows of Estonia have set the European record for herb species diversity per square metre – 63 species (Kull, Zobel 1991), while the number of lichen species growing on trees reaches 192 species (Leppik, Saag 2006). Great species diversity has been found in the grass layer of wooded grasslands in Latvia as well – up to 60 herbaceous plants species in 25 m² of area (Rūsiņa 2008; Rūsiņa et al. 2013b).

An aspect of biodiversity specific to wooded grasslands is related to the sparse tree layer. Compared to dense forests, it has a relatively higher species diversity, as well as communities of fungi, lichens and saproxylic invertebrates characteristic of sparse forests or trees growing in open areas (Eriksson 2008b; Leppik, Jüriado 2008; Sverdrup-Thygeson et.al. 2010; Paltto et al. 2011; Leppik et al. 2011; Johansson et al. 2014).

Wooded grasslands are also rich in protected species of various groups of organisms, and for some of them they are an indispensable or the most important habitat. In Latvia, wooded grasslands are the main habitat for wood-decay fungus *Hapalopilus croceus* (Fig. 19.17) that grows on old, large oaks (Meiere, Smaļinskis 1999; Bāra et al. 2014). Lichens growing on tree trunks *Calicium adspersum* and *Chaenotheca phaeocephala* are directly related to the semi-open environment of wooded grasslands (Paltto et al. 2011; Johansson et al. 2014). The population of invertebrates – EU priority-protected *Osmoderma eremita*, *Elater ferrugineus* and *Anthrenochernes stellae* – largely depend on the maintenance of wooded grasslands in a favourable conservation status (Ranius, Nilsson 1997; Ranius 2002a; Ranius 2002b, 2002c; Ranius et al. 2005; Teļnovs 2005; Ranius et al. 2011; Bāra et al. 2014). Protected

bird species characteristic of wooded grasslands are *Picus viridis, Dendrocopus medius, Coracius garrulus* (Talvi 2010; Bergmeier, Roellig 2014; Roellig, Sammul 2014). All of these species have been discovered in relation to at least one locality of wooded grasslands in Ziemeļgauja (Račinskis 2005; Vilka (ed.) 2007). Conservation of wooded grassland usually means the conservation of several habitats of EU importance because they can overlap with other grassland habitats and sometimes also forest or mire habitats.

Wooded grasslands may have an aspect of value related to a sustainable lifestyle that has not been fully appreciated to date, but that may be understood in the future. For thousands of years, they have been the everyday living environment of humans, being a source of various products, where human economic activity coexisted with an exceptional level of biodiversity that is usually found nowhere else. By understanding this system of interaction, we can search for future solutions to a broader and deeper question of how high biodiversity and humans can successfully coexist in the same landscape (Kull et al. 2003).

Fig. 19.11. Wooded grassland landscape near Strenči in the 1920s. Photo: Digital library collection Lost Latvia of the National Library of Latvia. Photo from the collection of "Latvian Museum of Photography", a branch of the Museum of the History of Riga and Navigation.

19.3 Optimal, Suboptimal and Inappropriate Management of Wooded Grasslands

A summary of optimal, suboptimal and inappropriate management types is given in Table 11 of Annex 3.

19.3.1 Grazing – Maintenance Management of Wooded Grasslands

Management of the open grasslands included in a wooded grassland landscape is described in more detail in this book under the respective open grassland habitat types (*see Chapters 22 and 9–18*). In earlier times, the tree layer was affected not only by grazing, but also by the use of trees by humans (*see Chapter 19.1.5*) (Fig. 19.2.i, 19.7.f, 19.12). The same actions would be recommended nowadays to preserve the habitat and its characteristic structures. The main activity of wooded grassland conservation is grazing (Eriksson 2008b; Paltto et al. 2011; Rackham 2013; Garbarino, Bergmeier 2014; Johansson et al. 2014; Uytvanck, Verheyen 2014).

One of the most frequently reviewed issues is that of how many animal units per unit of area must be used, to ensure that the habitat is not overgrazed, while preventing afforestation (Hall 2013; Garbarino, Bergmeier 2014; Uytvanck, Verheyen 2014). Experience in western Europe and mathematical models on the afforestation of open pastures and former arable land based on this experience (Uytvanck, Verheyen 2014) shows that grazing with an intensity of 0.1 – 0.3 LU ha^{-1}, in open pastures over a period of 75 years results in the development of a wooded grassland landscape, but on arable land even higher grazing intensity – 0.34 LU ha^{-1} leads to wooded grassland development within 50–75 years. The outcome greatly depends on soil fertility, which is usually higher on arable land. Modelling of grazing intensity in the existing wooded grasslands, where part of the area is covered by trees, is much more complicated. Species and varieties of grazing animals, which cannot always be freely selected for various economic considerations, can also affect the result. Upon summarising several examples, a vastly differing recommended quantity of pasture animals is indicated: it ranges from 0.1 to 1 LU ha^{-1} (Eriksson 2008b; Talvi 2010; Hall 2013; Uytvanck, Verheyen 2014). The results of grazing are difficult to forecast in practice, because the variability of situations is very high. Wooded grasslands can occupy small areas with homogeneous soils, and vast areas with a great diversity of environmental conditions, therefore, in every situation an individual solution must be sought (Garbarino, Bergmeier 2014; Uytvanck, Verheyen 2014).

In a high-quality habitat the herd must ensure the presence of grassland in the woody areas below tree crowns. In places where grazing has been commenced recently, the development of a grassland herb layer below tree crowns is set as one of long-term objectives. The ratio of wooded areas and open grasslands, as well as the productivity of the

Fig. 19.12. An oak in wooded grassland with a felled branch in "Ziemeļgauja" Protected Landscape Area. Some posts of an ancient enclosure made from branches of a similar diameter are still preserved nearby. The cut surface in the tree and the branch that served for several decades as a fence post, ensure additional permanent ecological niches in the landscape, especially for various lichens. This method of wood harvesting is interesting in terms of the sustainable use of resources because the tree is not felled and only some of its branches are cut. Photo: V. Lārmanis.

grassland and the species of grazing animals, are of great importance. The best method is to practically test what density of grazing animals ensures the required effect as a result of long-term grazing in the particular area. The number of animal units can be significantly lower in rewilding (natural grazing) territories (*see Chapter 19.3.1*), where animals do not receive supplementary feeding until the permanent snow cover develops in winter, and higher in places where the area is managed traditionally or special conservation measures of individual trees or pasture sectors are implemented.

Various species of animals can be pastured in wooded grasslands, characteristic landscape elements occur in some of the deer gardens as well. However, the component that is disappearing in contemporary Latvian landscapes and therefore should be stimulated, is the influence of large herbivores, not browsers (*Cervus elaphus, Capreolus capreolus*), which still occur in the wild. Locally, a deer garden can prove to be the only available method for the maintenance of a habitat and, in these cases, it should be used. If possible, herbivores must be given the decisive role in the maintenance of habitat.

In order to avoid the supply of additional nutrients to the habitat, supplementary feeding during the grazing period is not recommended (Eriksson 2008b; Talvi 2010). For additional feeding, it is recommended to use hay, which has been mown in semi-natural grasslands, to feed them, thus facilitating the spread of semi-natural grassland species in the pasture. Unless supplementary feeding is organised in a specially constructed place with artificial surfacing, the soil is increasingly fertilised and trampled and the grassland vegetation disappears at the feeding site. A few of the trampled patches are a permissible constituent part of the landscape.

19.3.2 Natural Grazing or Traditional Management?

Wooded grasslands are structurally and functionally similar to the landscapes described by F. Vera (2000) in the hypothesis on the ecology of primeval broadleaf forest being affected by large herbivores. Some of the statements of this hypothesis have been rejected by further studies, however many questions still remain (Mitchell 2004; Birks 2005; Emanuelsson 2009; Rotherham 2013; Rackham 2013). This hypothesis has promoted the opinion that in the absence of direct human involvement large

Fig. 19.13. Trees that are freshly and previously browsed by animals are usually found in permanent pastures. The wood exposed in the scars can be a substrate for lichens. Cavities develop, which are used by various invertebrates. Photo: V. Lārmanis.

herbivores can be the leading force in landscape formation. According to this principle, so-called natural grazing (rewilding) areas have been created in many places, where the main landscape "designers" are large herbivores, most frequently, *Konik* breed horses, *Heck* breed cows (British Wildlife 2009; Rackham 2013; Rotherham 2013; Bergmeier, Roellig 2014). In Latvia, this kind of management is performed in Pape Nature Park and in Ķemeri National Park (Fig. 19.19). Usually the term – natural grazing or continuous stocking, is used regarding such pastures (see Chapter 22.3.1.2).

It has been observed that territories left to the impact of large herbivores alone develop into areas that are structurally simpler than wooded grasslands which have developed as a result of traditional farming, suggesting that the potential of large herbivores might be overestimated (Bergmeier, Roellig 2014; Plieninger, Hartel 2014; Uytvanck, Verheyen 2014). However, to disregard this method completely would be ill-considered. Often, the task of these herds is to maintain open landscapes in floodplains or similar areas, where the development of wooded grasslands is only a side effect in a small portion of the area. Furthermore, semi-wild herds could serve specific additional functions. For instance, in Ķemeri National Park and "Engures ezers" Nature Park, the animals that have died in the pasture serve as food for protected birds of prey (J. Ķuze, personal report., R. Šiliņš, personal report) (Fig. 19.19.h). Sometimes natural grazing is the only possible solution. Consequently, different approaches can be useful for the maintenance of wooded grasslands in accordance with the natural conditions of the site, natural values and socio-economic context. Imitation of the impact of traditional agriculture or integration in contemporary economic activity as well as landscaping left to semi-wild herbivores alone, or various combinations of these types of management can be used for the conservation of wooded grasslands.

19.3.3 Mowing – Maintenance Management of Wooded Grasslands

In the past, wooded grasslands were both mown and grazed within the same landscape. Therefore wooded grasslands can be maintained as hay meadows as well. Ideally, part of the landscape is hay meadow, another part – pasture. Alternatively, grazing can be performed in the aftermath. The maintenance of hay meadows in the open part of wooded

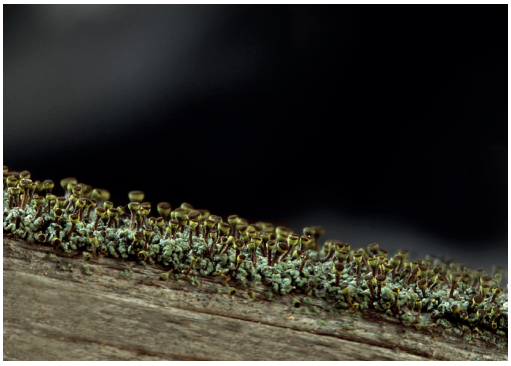


Fig. 19.14. Lichen *Chaenotheca phaeocephala* is one of the lichen species dependent on old trees of wooded grasslands in semi-open conditions, and it is threatened by afforestation. This approximately 1.5 mm tall lichen grows on the bark of old trees. It requires light and at the same time also high humidity, which is provided by the wide crown of old trees in more open areas. Photo: V. Lārmanis.

Fig. 19.15. Remains of an oak removed from a field several decades ago in Soviet times. This tree, along with several similar trees, is located in Krimulda Municipality next to a field where it possibly grew before drainage. On the trunk, there are still remains of a wire rope that was used to pull it into the forest. Several living or standing withered oaks that once grew in an open area are now surrounded by forest. These may have once been part of a wide wooded grassland. Photo: V. Lārmanis.

grasslands or among very sparse trees is simple. However, haymaking is particularly difficult in the parts more densely covered with trees (Fig. 19.18). Furthermore, mowing and haymaking cannot maintain aspects important for biodiversity, which depend on grazing; for instance, the presence of animal excrement or browsed trees. From an ecological point of view it is possible to mimic the effects of animals, however, such actions may only be possible in small areas.

The possibility of mowing alone as an alternative is different for various types of wooded grasslands. For habitat type 9070 *Fennoscandian wooded pastures*, mowing alone cannot replace grazing, because the main criterion of this habitat is the effect of long-term grazing. For the other two habitat types – 6530* *Fennoscandian wooded meadows* and 5130 *Juniperus communis formations on heaths or calcareous grasslands* – situations can differ. For instance, mowing alone can be sufficient in very sparse tree stands, where mowing is possible up to the trunks of trees (Fig. 19.3.f). In wooded grasslands that are maintained by mowing alone the recommendations for mowing described in the first part of this book, together with corresponding open grassland habitats, must be followed and the introduction of grazing is not mandatory. However, most of the wooded grasslands also contain places with very uneven terrain, excessively wet areas, or areas covered with denser tree stands, which are inaccessible by modern agricultural machinery. Mowing only relatively open parts of the habitat, while leaving other parts afforested or overgrown with shrubs cannot be considered good maintenance of habitat. A brush cutter can be used to mow the most inaccessible areas, while the only sustainable management model in larger areas is the inclusion of the area into a pasture.

19.3.4 Creation of Artificial Tree Hollows, Dead Wood and Other Elements

19.3.4.1 Why are Artificially Created Habitat Elements Necessary?

Currently not a single wooded grassland is known in Latvia, even including parks and avenues, which would combine a sufficient area, quality and sustainability (Bāra et al. 2014), in terms of satisfying the requirements of rich saproxylic fauna (*see Chapter 19.1.4*). Therefore, even if the reconstruction of wooded grasslands is commenced immediately, the remaining populations of rare species will not always be able to survive before the development of appropriate conditions (Fig. 19.16). There will definitely be cases, where the populations of endangered species will be small and fragile, and require temporary additional support, which can be provided by the creation or facilitation of specially significant elements.

Artificially created or facilitated landscape elements can be useful in at least four cases:

- if the habitat lacks the required elements, for instance, hollow trees or dead wood;

- if separated populations need to be connected, for instance, the populations of *Osmoderma barnabita* of two wooded grassland polygons, which are situated further away from each other than *Osmoderma barnabita* dispersal distance 200 – 300 m, for instance, at a distance of 500 m, then a functional migration corridor can be constructed in the empty space between the two polygons by means of creating artificial habitats;
- if a habitat with individuals of rare species has disappeared, for instance, and old tree with larvae of rare beetles in the hollow has fallen down, they can be preserved by moving them to an artificial hollow (Kalniņš 2016) and then to a natural hollow near the former tree or, if no conditions for the development of a sustainable metapopulation are present close by, the rescued individuals of the species can be moved to another location, thus helping in the cases indicated in the next paragraph;
- if the long-term prospects of the habitat are good, but the number of individuals in the remaining metapopulation is expected to fall below the critical threshold and the number of micropopulations in it is insufficient, additional micropopulations can be introduced into the habitat by using the measures indicated in the previous paragraph, or by borrowing individuals from another, sufficiently strong population, without harming it.

The next two chapters generally describe the creation of hollows and dead wood. These elements can be created by any manager of wooded grassland. There is not much experience of dead wood creation in Latvia, which is why cooperation with entomologists is recommended in the planning stage. These elements must be in harmony with the daily economic activities and the impact of livestock. For instance, dead wood should not excessively interfere with mowing. Furthermore, it must be considered that animals are curious and therefore cages – hollows – must be placed at a safe height out of the

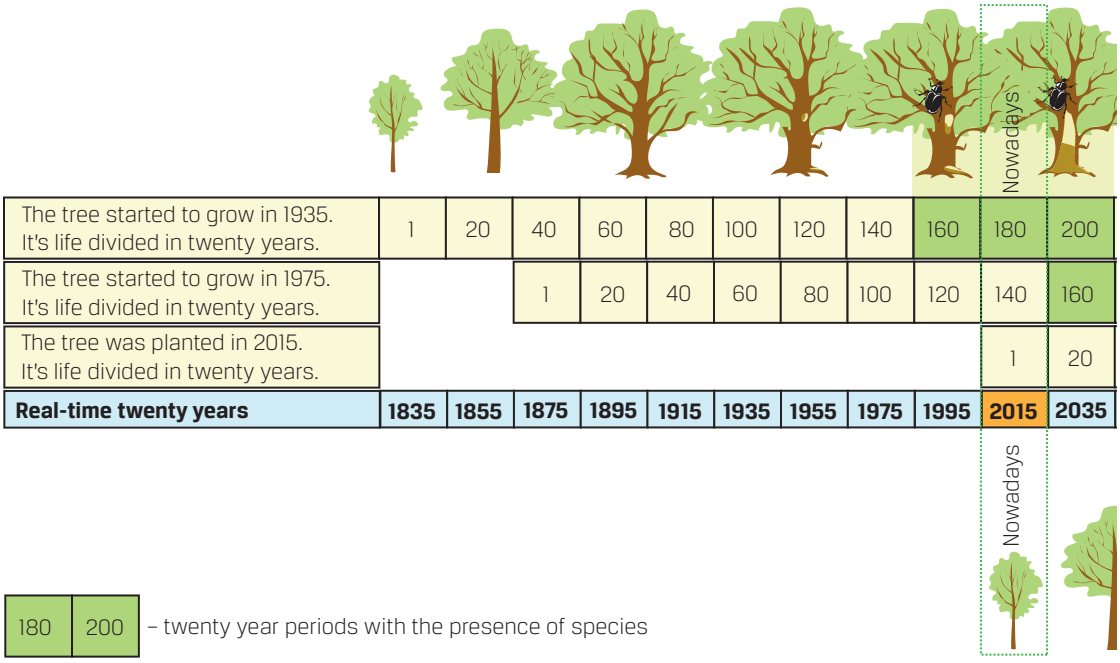


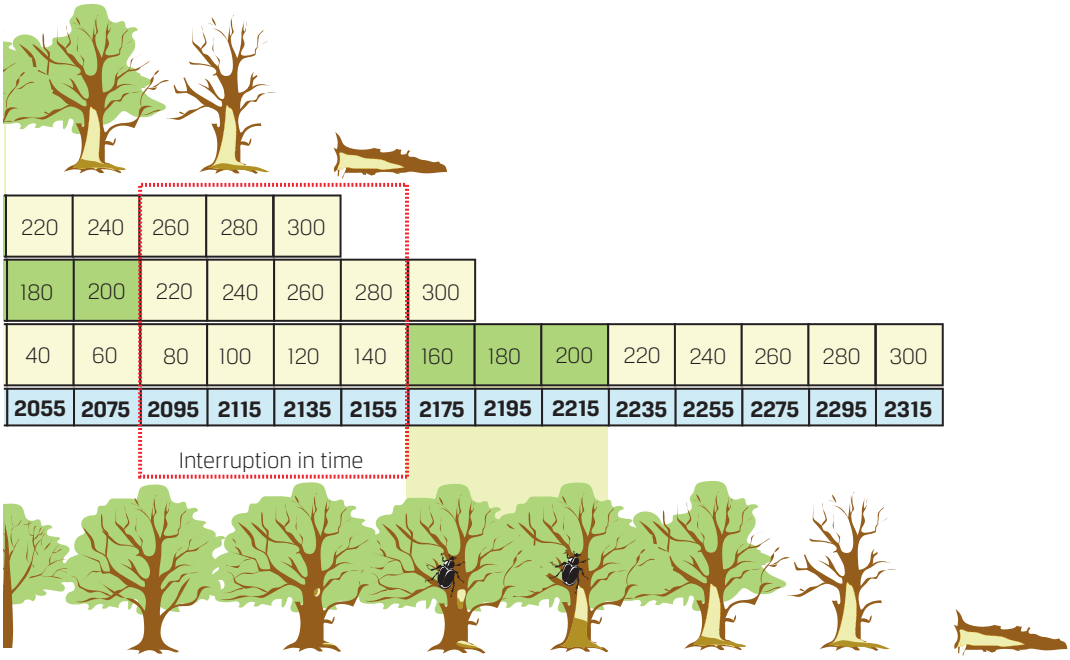
Fig. 19.16. Problem of interrupted age structure of suitable trees. In this example, it has been assumed that a cavity of a certain tree serves a certain species for 60 years and the age of the tree at the beginning of this period is 160 years old. This roughly corresponds to a realistic situation of oaks inhabited by hermit beetles, however the basic principle applies to any endangered species that is related to the tree species of a certain age. If a cavity is no longer suitable for the species, another suitable tree must be located nearby. Such tree should have started to grow in approximately the year 1875, because suitable cavities may only be present in trees of such age. If a new oak were to be planted next to the old one now, it would not benefit the endangered species in the future because once the oak has grown old and hollow enough, the rare species will no longer be present in this area because there will be nowhere for it to come from. In order to ensure the

reach of animals, thus preventing their damage.

19.3.4.2 Creation of Hollows

Hollows can be created in living trees. They can also be made from trunks of felled trees or planks, like bird boxes. Cavity development in living trees can be promoted by drilling a hole in the trunk of a living tree (Fig. 19.20). Rot will develop in the holes with time, followed by a wider natural hollow. This helps in resolving the time lapse problem, as the development of hollows can be achieved in trees that are relatively younger than hollow trees developed under natural conditions (Fig. 19.16). The preferable direction of the hollow hole is to the south or to the west. For boxes, the recommended shape of the interior of the construction is a cylinder, instead of a rectangle, which would not ensure a homogeneous microclimate (Lārmanis et al. 2014). The volume of the boxes is from 100 to 1,000 litres, and they are filled with a mixture of punkwood and various other materials, which stimulate the development of punkwood (Jansson et al. 2009). Research in Sweden

Fig. 19.17. *Hapalopilus croceus* usually grows on large oaks that are at least 200 years old. This species is a good example to demonstrate the nature values that would disappear if all trees were felled at an age that is suitable for commercial timber harvest (approximately 100 years). *Hapalopilus croceus* along with *Osmoderma barnabita* (Fig. 19.10) are the best known examples of species dependent on wooded grasslands. In wooded grassland conditions *Hapalopilus croceus* occurs more frequently than in dense forests. It may be due to the fact that oaks can grow larger and live longer in open or semi-open conditions than in dense forest stands where they need to compete with surrounding trees. Photo: V. Lārmanis.



sustainable existence of the population, the two-decade periods shaded in green in the image should overlap. This abstract example lacks trees of some other ages needed to avoid interruption in the timeline. In real life, the situation is much more complex because the necessary number of trees in an ecologically comprehensive landscape reaches hundreds or even thousands. This illustration explains another question of why the creation of wooded grasslands in new places today does not compensate for the disappearance of old ones in the context of biodiversity conservation. This does not mean that new wooded grassland trees should not be planted. However, in the forthcoming decades it is especially important to restore the ancient wooded grasslands (mainly those that have established in the 19th and until the mid-20th century), where specific endangered species still occur and not all trees of the age that ensures continuity have been destroyed yet. Drawing by D. Segliņa.

Fig. 19.18. This is wooded grassland delimited by the oxbow of the River Gauja in "Ziemeļgauja" Protected Landscape Area. In the 1940s, there was a wooden hay shed and access road over the oxbow for horse carts, which indicated that the area was used as a hay meadow. Due to the complex terrain, interference of the tree stand and limited mass of grass, nowadays this area can only be sustainably managed by including it into a pasture.

found that during the third or fourth season, the artificial hollows were already inhabited by up to 70% of all saproxylic beetle species associated with oak hollows that are common in Sweden (Jansson et al. 2009). To protect *Osmoderma barnabita* and *Liocola lugubris*, which are found in felled or wind-thrown trees, M. Kalniņš (2016b) successfully used 2–3 m long hollow fragments of tree-trunk (Fig. 19.21).

In the long run artificial cavities – boxes – cannot replace wooded grassland with a naturally sufficient number of hollow trees. Therefore, habitat management by artificial cavities should only be used where they are really necessary, and all opportunities to restore the old wooded grassland tree stand must be used first. Such grassland often already has the necessary hollow trees, but appropriate conditions must be created around them and regular management must be restarted. The populations of animals that have been facilitated by boxes will become dependent on such boxes, the boxes grow old, they must be restored and long lasting continuity of the population is difficult to guarantee. Therefore, the creation of boxes must always be complemented with appropriate planning and action to develop the appropriate number of hollows in live trees. The situation must be reached where the development of boxes and artificial hollows in trees is no longer necessary, because they should be provided by a considerably large area with the appropriate age structure and management of trees.

19.3.4.3 Creation of Dead Wood and Pollarding

In wooded grasslands and in their vicinity in Latvia, the presence of decayed wood is easy to observe, especially because the most important sites occur near water bodies, where trees are frequently damaged by beavers (Fig. 19.3.j). However, the volume of decaying wood may be insufficient and the promotion of its development can be necessary. In situations when the habitat is deforested, separate heaps of cut tree branches can be preserved as habitats for invertebrates (Fig. 19.7.i). It is recommended to create such heaps in various insolation conditions – in darker, as well as in better sunlit locations (Eriksson 2008b). Damage or withering of separate trees can be promoted by ring barking or damage to individual living trees in order to increase the volume of standing dying off wood (Fig. 19.22).

Additional niches in the habitat are created by pollarding (Figs. 19.7.f, 19.12), which is a traditional ancient farming practice in wooded grasslands. This promotes the development of micro-niches (bunches of branches). If performed correctly, it allows one to extend the life of the old trees, as well as it can facilitate the development of hollows (Eriksson 2008b). Trees grown specifically for pollarding for animal fodder were also used in Latvia in the past. The pollarded trees can be seen in the collection of drawings by K. Broce of the late 18th century and early 19th century (Anon. 1997). Twig fodder is still being prepared nowadays as well; it is used to feed game animals and, sometimes, livestock. However, pollarded trees have almost disappeared nowadays. It is unlikely that productive agricultural farms could restart this or similar practices, because it is difficult to find economic justification, if farming is implemented on a large scale. However, it might be possible in a small farm, or in places where agricultural wooded grasslands border well-managed parks.

19.4 Restoration of Wooded Grasslands

19.4.1 Planning of the Restoration of Wooded Grasslands

In accordance with the Habitats Directive all EU Member States should ensure the favourable conservation status of EU protected habitats, which is a specific legal, as well as practical concept. This means that stability or increase in habitat area and distribution must be achieved, the habitat must occur in appropriate quality and the populations of

species dependent on the habitat must be stable or increasing. This means that all currently managed wooded grasslands must definitely be preserved. A good quality habitat in Latvia may only be abandoned if another site is created to compensate for it. However, such creation would require a very long time. The restoration of those habitats that have been overgrown by secondary forest is more complicated, because there are places that were overgrown with forest such a long time ago that they cannot be associated with the favourable conservation status of habitat any longer.

Upon the evaluation of every type of wooded grassland separately, the details of their restoration in Latvia differ. 5130 *Juniperus communis formations on heaths or calcareous grasslands* is a habitat that is known to occupy a total area of only 60 ha in Latvia. It is divided into much smaller habitat fragments, which are situated far from each other. Such amount is obviously below the critical ecological minimum, therefore there is no justification for the separation of more significant areas of this habitat from less significant ones. Each place must be preserved or renewed in order to ensure the favourable conservation status of juniper stands.

Meanwhile habitat *9070 Fennoscandian wooded pastures,* in its current interpretation in Latvia, does not require wider reconstruction of the landscape; the main issue is to ensure that the total area of the habitat does not decrease. However, in any site where this habitat is present, it is necessary to facilitate and maintain different characteristic elements of the landscape (gradual forest edges, individual wide-crowned trees and shrubs, etc.), in order to ensure the diversity of species characteristic of the habitat.

In the habitat *6530 Fennoscandian wooded meadows,* special attention has been paid to ancient situations, including places which have been afforested. All sites that are currently good quality must be preserved, as well as those that have been overgrown with shrubs relatively recently, because some habitat specific species that also require favourable conservation status usually occur in the canopy layer. The issue of habitats that have been overgrown with forest for longer periods of time is more complex because the circumstances and main nature conservation values in those habitats in certain cases are more related to forest habitats. To structure the vision of the restoration of the habitat *6530 Fennoscandian wooded meadows* concerning its overgrowth and the degree of significance, the different possible cases in habitat protection plan are divided into five priority classes (Bāra et al. 2014).

A) **Localities with large area** – where the locality of *Osmoderma barnabita* is present in an area of potentially restorable habitat amounting to 60 ha or larger, including parts of habitat overgrown with forest – **all such localities must be restored and maintained.**

The most significant currently known objects of this class are situated in the Ziemeļgauja Protected Landscape Area, three – in specially protected nature areas of the lower reaches of the River Pededze and around the rivers Stende, Rinda and Irbe in the vicinity of "Ances purvi un meži" Nature Reserve (Bāra et al. 2014; Vilks 2014). But it also applies to every wood-pasture landscape elsewhere in Latvia that is similar in area and characteristics, if such is found. It must be taken into account that in terms of *Osmoderma barnabita* localities, wooded grasslands are sometimes ecologically more related to surrounding parks or tree alleys. The priority status of large area habitats not only means that they must be the first sites where restoration activities are planned, but also that all of their restoration potential must be explored to restore the maximum area of the habitat. The connectivity of adjacent habitat fragments must be ensured, if they are situated at a distance of 300 m or closer (the distance of dispersal of *Osmoderma barnabita*). If ancient wooded grassland is overgrown with a secondary forest, complete reconstruction and creation of the landscape must be performed by deforestation.

B) **Localities of habitats or parts of any size in good quality** – all of them must be maintained.

C) **Areas of the habitat recently overgrown with shrubs or abandoned** – all areas must be restored and maintained.

Habitats overgrown up to the degree that is permissible in open grassland habitats are referred to here (Rūsiņa 2013b) (Fig. 19.3.a).

D) **Small abandoned or overgrown sites (smaller than class A) bordering agricultural land** – all localities must be restored and maintained, if the main nature conservation value at these sites is related to wooded grassland habitat.

Restoration should not be carried out in cases if these sites are unmanaged for more than 50–60 years (Eriksson 2008b), which is the approximate period of time that leads to the loss of grassland features in the herb layer (Palo et al. 2013) and decrease of the diversity of lichens growing on trees (Plociņa 2007). The sites corresponding to such age

Fig. 19.19. Wooded pastures with semi-feral large herbivores with year-round grazing (natural grazing territories) – habitat type 9070 *Fennoscandian wooded pastures*. (**a**) Forest edge trampled by animals in Ķemeri National Park. Although stable grassland has not developed in this type of forest, it has several ecological niches, which could not be present in a forest unaffected by herbivores. For instance, the undergrowth is sparse, improving the access of light to the lower part of the tree trunks and, consequently, benefitting several species of epiphytic lichens. The diversity of species is also promoted by the presence of animal manure. (**b**) In situations where open pastures border with forests, an especially high number of animal paths are seen along the forest edge. It is not perceived as an indication of a negative impact of overgrazing. Even if the available areas are sufficiently large, animals concentrate at the border between the forest and the grassland, because it is the closest place to the grassland, where shade and refuge from blood-sucking insects can be found. (**c**) Intensively trampled patch without groundcover. Too high concentration of such patches in the entire area would indicate overgrazing. In this case it should be considered a normal pasture element because it is the junction of several paths commonly used by animals as natural routes, determined by the location of ditches and the forest edge. (**d**) Dense "skirts" of shoots caused by frequent browsing that develop on groups of shrubs and on trees is a characteristic feature of permanent pastures. It develops ecological niches characteristic specifically of pastures. Such dense thickets of shoots in a sunny forest edge can be a good nest sites for bumblebees. (**e**) The same pasture that is seen in the previous images, contains swampy woodland close to the edge of the field. Herbivores affect swampy forest vegetation insignificantly. The vegetation that conforms to the respective forest habitat type is retained because animals enter them relatively rarely.

However, sometimes even these types of forests can attract herbivores (the photo was taken in late November). In the picture Iris *pseudacorus*, partially grazed by animals, can be seen. (**f**) Pastures on the shore of Lake Engure. Fourteen years of grazing have replaced the reed and shrub stands in the open part of the grassland with grassland vegetation with low groups of bog myrtle *Myrica gale*. As the grassland stabilised, undergrowth disappeared in the grazed part of the forest. (**g**) Natural grazing areas are frequently characterised by clusters of dried and uprooted shrubs. Trees and shrubs that fail to adapt to permanent grazing gradually disappear, while trees that are adapted to this start reproducing or stabilise their population. Such a relatively natural process is often provided for by the basic concept of natural grazing areas, with dry woody plants serving as ecological niches for certain invertebrate species. (**h**) Grazed forest with animal bones. Often, one of the additional functions of natural grazing areas is the maintenance of a food base for specially protected species that feed on animals that have died in the pasture; for instance, this helps *Haliaeetus albicilla* to survive in winter. (**i**) *Konik* breed horses and tourists in the farm *Jaunievi̧as*. In contrast to traditional farming, the managers of natural grazing territories are frequently blamed for the failure to productively use their agricultural land in the conventional meaning of the term – generating income. However, this argument is not justified. These areas serve as rural tourism infrastructure, and provide services to the public, by maintaining certain nature values. (**j**) The same area as that of the previous image. The characteristic crown shape of several *Salix caprea* has developed as a result of long-term browsing.
Author of images: V. Lārmanis.

threshold, as well as sites with viable localities of habitat umbrella species, should be treated as sites where the main nature conservation values are related to wooded grassland. Deviations from these conditions are permissible if grasslands can be included in existing pastures or another constantly maintained system.

E) **All other localities of the habitat that are overgrown with forest** – restoration by felling secondary forest, must only be performed if, according to the general mapping of EU protected habitats in the country and consequent ecological analysis, these measures may have a functional role in maintaining the ecological network.

19.4.2 Relation of Wooded Grasslands to Parks and Tree Avenues

The tree layers of parks and tree avenues are similar to that of wooded grasslands and possess some of the characteristics that are required by habitat specific species. For instance, many localities of *Osmoderma barnabita* beetles in Latvia are located in old parks and avenues, frequently, even in the urban environment (Kalniņš 2016a; Telnov, Matrozis 2012) (Fig. 19.23). When planning the conservation of wooded grasslands, the interaction with parks and avenues must be considered. For instance, when determining the areas that need to be deforested in the habitat type *6530* Fennoscandian wooded meadows*, the priority class A sites (*see Chapter 19.4.1*) must include areas where the minimum area criterion is met, if the habitat is combined with parks and avenues. Such areas are situated, for instance, in the vicinity of Ungurmuiža in Gauja National Park or in the vicinity of Krimulda–Turaida–Sigulda, where small fragments of ancient wooded grasslands are associated with a much larger system of parks and avenues, which extends into the town of Sigulda through avenues along the streets (Lārmanis, Andrušaitis 2016).

Although similar, parks and avenues are not exactly the same systems as traditional wooded grasslands. Parks and avenues lack several important pasture elements, for instance, animal excrement which promotes the diversity of species, or semi-natural grasslands, where the diversity of herb species is much higher than, for instance, in park lawns. These differences affect the biodiversity of the entire system. Parks and tree avenues are valuable and must be conserved, and they make an important contribution to the maintenance of the favourable conservation status of the group of species represented by *Osmoderma barnabita* beetles. However, they cannot replace EU protected habitats in ancient agricultural landscapes, because they are simpler ecological systems that maintain a relatively smaller diversity and richness of wild species.

19.4.3 Restoration of Habitat Type 6530* Fennoscandian Wooded Meadows

The objective of restoration is the development of habitat that resembles its former status before afforestation (Fig. 19.24). Purposeful promotion of the development of new wide-crowned trees, in order to achieve a structure of tree stand that would ensure the sustainable existence of the species that depend on such habitat, is also a part of this objective. In sites that conform to priority classes A and D (*see Chapter 19.4.1*) the felling of secondary tree stands in the appropriate places is also required, leaving only ancient or potential wide-crowned trees and shrubs. This means that deforestation of the land must be performed. This leads to a change of the land use type, which involves the implementation of a special legal procedure defined by the regulatory enactments (*see Chapter 7.2).* Other cases are simpler because only shrubs or smaller trees must be cut, which are actions that can be sanctioned by the local municipality or State Forest Service.

Deforestation should definitely not be started,

Fig. 19.20. A cavity cut in an oak tree in order to make habitat for endangered saproxilic invertebrate species. Sweden. Photo: V. Lārmanis.

Fig. 19.21. A hollow for *Osmoderma barnabita* filled with punkwood established in a section of a tree trunk. Photo: M. Kalniņš.

if a clear plan for further management of the site has not been developed. The plan must ensure the maintenance of the necessary quality, i.e. the development of a tree stand structure that conforms to a stable wooded grassland and the introduction of characteristic grassland plant communities. In the ideal case, after deforestation the site must be maintained by management that resembles traditional agriculture (extensive mowing, grazing), or natural grazing (rewilding) concept. In some cases, if special conditions and measures are available, such sites may be maintained in a manner that is similar to the maintenance of parks, for instance, in popular tourist attractions; however, even in these cases the grass must be removed, because other methods will decrease the diversity of grassland species.

19.4.3.1 Felling of Undesirable Trees and Shrubs

In the context of wooded meadow restoration, trees and shrubs that have colonised the old wooded grassland area, causing afforestation, are generally considered to be undesirable (Figs. 19.3.a, 19.3.d, 19.26, 19.28). They threaten the species characteristic for the habitat, as well as landscape elements. However, some of the trees and shrubs of this generation must be retained as wide-crowned future trees (Fig. 19.25, 19.27). Felling of undesirable trees and shrubs is performed to:

- ensure a better insolated environment around the trunks of old or future wide-crowned trees, which restores the living conditions of light-demanding insect and lichen species;
- eliminate the negative influences of trees and shrubs growing around old wide-crowned trees, promote their longevity and the development of larger dimensions;
- restore the openings characteristic for wooded grassland landscapes.

The trees and shrubs of the ancient landscape, with rare exceptions, must all be retained. The felling of unwanted trees and shrubs should first be planned in the direct projection of the crowns of the ancient wide-crowned trees and in their close proximity (Fig. 19.7.h, 19.25, 19.27). Afterwards, openings can be created in the remaining area (Fig. 25, 19.30.d) or space can be planned for wide-crowned future trees. All shrubs and trees that do not belong to a wooded meadow landscape must be felled at the restoration site, except for those that must be retained as wide-crowned future trees (Fig. 19.27).

One of the issues to be addressed in the tree felling process involves the distances at which the prospective wide-crowned trees and newly introduced trees must be left from each other. The area that they will occupy after growing in more open conditions must be predicted. The oldest and largest wide-crowned trees can be used as an example for calculation, for instance the tree in Fig. 19.7.h. This tree will enable assessment of how much space a wide-crowned future tree can occupy in the future and, accordingly, to predict the necessary free space around it. If it is possible to implement any other restoration operation in the more distant future, the wide-crowned future trees can be left in a relatively denser stand, and the decision regarding which tree to leave can be left for the next series of restoration measures, when it is easier to evaluate which tree is developing faster. The felled trees and felling residues must be removed or burnt in a place where such burning does not endanger the trees that must be saved (Fig. 19.30.a).

19.4.3.2 Trees and Shrubs to be Retained – Wide-crowned Trees

Most frequently, the trees that have survived from the times when the wooded grassland was not yet overgrown with secondary forest or shrubs (Figs. 19.30.a, 19.30.b) must be retained. Since care must be taken to ensure that there are trees that will replace the old wide-crowned trees in future, younger trees should also be left in a density that conforms to the needs of the habitat – the wide-crowned future trees (Figs. 19.26, 19.30.e). The tree species, the protection of which should be prioritised are oaks, since they live longest. Depending on the circumstances, other species of broadleaved trees are important: *Tilia cordata, Ulmus glabra, Ulmus laevis, Fraxinus excelsior*. Also some of the undergrowth

Fig. 19.22. Intentionally damaged oaks in Sweden, with the purpose of facilitating the ecological niche for saproxylic species of invertebrates. Photo: V. Lārmanis.

and subcanopy trees and shrubs must be retained and the development of their wider crowns must be promoted. These usually include *Malus sylvestris, Corylus avellana, Rhamnus cathartica, Rosa* spp., *Salix caprea*. The proportion of low trees and shrubs that need to be retained in the area can be highly variable, depending on their incidence. Sometimes no other trees are preserved in the projection of a wide-crowned tree, while in other cases even several trees and shrubs are left under one such tree. The average cover of low trees and shrubs is recommended to be 10–20% of the total area of the site.

In wooded grassland landscape, other species of trees remaining from the ancient wooded meadow can also be found, which do not directly benefit from the conservation of broadleaf species. These trees must also be retained. Most frequently they are old *Pinus sylvestris, Picea abies, Betula pendula* that once grew in open landscapes (Fig. 19.6.e). They are both valuable elements of the ancient cultural and historical landscape, and enrich the overall biodiversity of the landscape. Old pines of wooded meadows are often inhabited by a protected insect species – *Nothorhina punctata*, while heavily branched spruces, which are usually found in old pastures, are often nesting places for various bird species.

If the restored habitat contains large (at least 50 cm in diameter) standing or lying dead wood (Figs. 19.3.d, 19.30.c), it is recommended to retain it. If dead trees interfere with further management, they can be moved to a place where they create less interference, while leaving them within the area of the habitat. If the stem of a fallen tree is approximately 1 m in diameter or larger, then it should not be moved. Such moving can be too labour-intensive, and there is also a greater probability that the trunk is hollow and inhabited by endangered species, which can be accidentally destroyed while moving. If especially large specimens, for instance, aspens, occur among the secondary forest trees scheduled for felling, which overshadow an older and larger ancient oak, ring-barking of such trees must be considered. In this case the trees will not be felled. They will be left standing in their place and slowly wither (Fig. 19.26). This method allows gradual elimination of the adverse influence of such trees on wide-crowned trees, while enhancing biodiversity, since they will serve as dead wood. Leaving standing dry trees that have decayed to the degree where they can endanger grazing animals or people by falling, is not recommended. Separate heaps of branches

can be left during restoration works as dead wood. If necessary, dead wood and cavities can be created by causing damage to some of the living wooded grassland trees (*see Chapter 19.3.4*).

19.4.3.3 Proportions Between Tree, Shrub Cover, and Open Areas

The proportion of different parts of landscape to be either retained or created depends on several factors. It is determined by the combination of the total renewable area size, the location of ancient wooded grassland trees, and quantity of prospective wide-crowned trees, as well as open areas that must be restored or retained. The total area is important because in a standalone, compact wooded grassland tree stand, which is only, for instance, 1 ha large, no space is available for establishing larger openings, whereas in broad landscapes they should certainly occur. For instance, in Estonian wooded grasslands the cover of trees in wooded grasslands is estimated at 20–40% (Mägi, Lutsar 2001). The guidelines for the management of wooded grassland landscapes do not recommend creating openings that are larger than 1 ha (Eriksson 2008b). During practical restoration work the glades will develop in the areas that have been cleared from secondary forest or shrubs and where potential wide-crowned are absent.

19.4.3.4 Gradual Deforestation for the Protection of Wide-crowned Trees

Gradual felling of secondary forest in old wooded grasslands is important for at least two reasons – it helps in reducing the stress to old wide-crowned trees caused by rapid changes of environment and it limits fast resprouting of felled tree shoots.

To reduce the risk of death of wide-crowned trees due to rapid changes, it is recommended to perform deforestation gradually, in at least two steps over a period of 3 – 5 years, in places that have been overgrown for longer than 20 years (Fig. 19.28). The works should be started from the forest edges or edges of openings that have not overgrown. In the forest stands the largest trees must be uncovered first (Ek, Johannesson 2005; Eriksson 2008b) (Figs. 19.3.d, 19.7.h). Table 19.1 provides recommendations on how to gradually cut the undesirable trees and shrubs relative to the age of the wide-crowned trees to be retained. These recommendations apply mainly to fertile forest conditions or thick spruce monocultures and similar situations, where a relatively thick canopy or dense stands of younger trees have been growing around wide-crowned trees for longer periods of time, and where sudden simultaneous felling causes rapid environmental changes. Sometimes wide-crowned trees have been over-

Fig. 19.23. Old oak avenue in Raiskums, where *Osmoderma barnabita* was found. If the habitat 6530* *Fennoscandian wooded meadows* overgrown with forest were to be situated near it, even without *Osmoderma barnabita*, both the tree avenue and the overgrown wooded grassland would have to be assumed to be a common area of this species habitat. A nearby avenue with *Osmoderma barnabita* provides an additional argument in favour of restoration of wooded grassland that has been overgrown with forest. Photo: V. Lārmanis.

grown by younger pines or birches (Fig. 19.3.d) that have relatively sparse crowns, which means that the wide-crowned trees have been growing in relatively light conditions for most of their life and the expected environmental changes caused by felling are less severe. In these cases the gradual deforestation of secondary forest felling is less significant or not necessary at all.

Although gradual deforestation is always recommended, the possibility of various approaches is often limited by economic conditions or project deadlines. If all methods of restoration can be funded from an external source and it is known that the funding will be available after several years, there are no obstacles to the gradual implementation of the plans (Fig. 19.7.g). The situation is different if the restoration is, for instance, performed at the initiative of a private land owner and at their own expense, assuming that the costs will be compensated by the income from the felled trees and shrubs. Then felling in several phases can be economically inviable, because the volume of trees felled during each separate phase can be too low to pay for their transportation and other expenses. If the idea of habitat restoration must be cancelled due to economic considerations, or if it is not known whether the next phase of restoration will actually take place, it is better to give up on the idea of gradual felling and to perform deforestation of the entire area at once, which will slightly increase the risk of losing individual wide-crowned trees.

19.4.3.5 Control of Resprouting by Means of Gradual Deforestation

The gradual nature of restoration can also affect costs that are necessary to combat stump shoots. Resprouting (Fig. 19.30.j) after the felling of trees is stimulated by the increased availability of sunlight to the leaves of young trees and more nutrients that were previously used by the felled trees, as well as nutrients that are generated by rotting dead parts of these trees in the soil. If the canopy layer trees are not cut at once, it can be estimated that the resprouting shoots will receive less sunlight and some of the nutrients will be consumed by still growing trees of the canopy layer. Grassland is successfully introduced under the crowns of the trees, especially in pastures, which later, after the felling of the canopy layer, competes with the resprouting shoots for nutrients; furthermore, animals will play a significant role in nutrient removal, as they prefer grass to tree shoots.

Situations where sprouts must be controlled in large areas at once are the most difficult. In the case of gradual deforestation, the next phase in pastures can be commenced, when it is observed that animals have already limited the shoots after the previous felling. This process is even more successful, if the removal of shrubs and smallest trees under the first storey of the forest is carried out first, instead of starting with the canopy layer of the forest. Then shoot regeneration is limited both by grazing and by shade created by the canopy layer trees. During the first years in pastures the cutting of shoots is usually necessary; however, the amount of work is

Fig. 19.24. Habitat before and after restoration. The situation has been planned in accordance with the needs of habitat specific species, especially, *Osmoderma eremita* beetles. A Swedish example. Restoration was completed by a single effort. Photo: V. Lārmanis.

significantly lower due to grazing and shade. In areas that are not included in pasture territories, the shade created by the canopy layer can be used to delay the shoot development, if the canopy layer is felled a couple of years later instead of felling it at once. This additionally removes some of the accumulated nutrients, which would otherwise be available to shoots.

During gradual restoration of the habitat the regrowth does not create a homogeneous vegetation cover. It rather consists of separate clusters. Therefore attracting animals to the resprouting areas is easier, thus additionally delaying the regrowth. If the first deforested areas are created around oaks, wild apple trees and larger rowan trees, it can be expected that animals will frequently visit these places during the season of fruit ripening and simultaneously intensively trample the resprouting shoots. To some extent, trees that attract the attention of animals with fruits, maintain more open conditions under their crowns themselves (Fig. 19.3.g). Pastures usually have permanent paths created by animals (Fig. 19.6.e), along which they eat shrubs more intensively, because animals stay near these shrubs relatively more frequently. The attention of animals can be attracted to certain shoot clusters by placing salt licks in them. Regrowth can also be limited by changing the number of animals in the area of the pasture and by choosing animal species or breeds that use relatively more wooded plants in their food. The next chapter provides more detail on the possibilities of regrowth control, while a summary of various techniques has been provided in Table 19.2.

Gradual deforestation can also be affected by the administrative conditions of the implementation. If the amount of trees felled during the first step enables classification of a tree stand after deforestation as a forest habitat in the meaning of the Law on Forests, the biotechnical measure can be

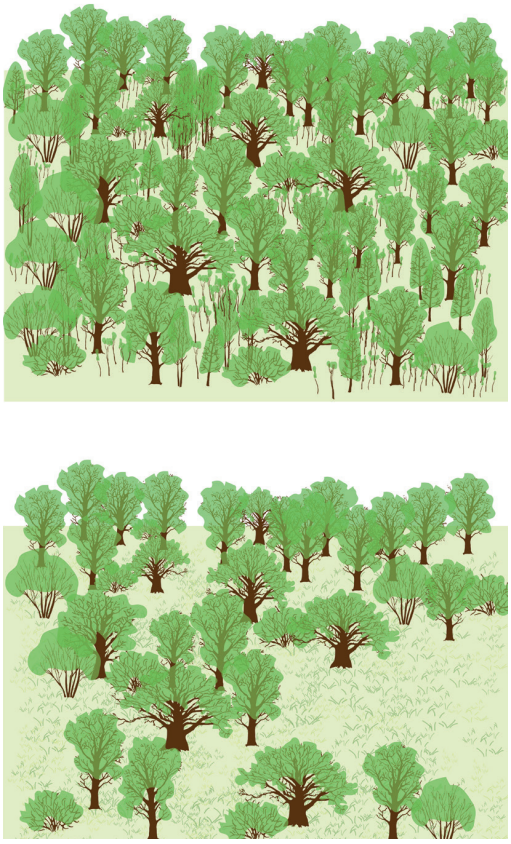


Fig. 19.25. The general picture of habitat restoration before and after the felling of undesired trees and shrubs. Drawing by D. Segliņa

Fig. 19.26. Large, ring-barked birch, which endangers a veteran oak, left to gradually wither. Photo: V. Lārmanis.

defined as one of the types of forest felling. After the next phases most forest stands will not have the density that conforms to a forest habitat and then deforestation will have to be performed in accordance with the procedures provided by the regulatory enactments (*see Chapter 7.2)*.

19.4.3.6 Stump Removal from a Deforested Area

In a deforested habitat, stable and diverse grassland must be maintained, therefore the area must be cleared of stumps. The area must be prepared for mowing with agricultural equipment and later for the collection and removal of grass or shoots. The most common technique is grinding of stumps, leaving the underground part of the stump in the soil (Fig. 19.30.f). The stumps can also be extracted and removed (Fig. 19.30.g), however, it is a more labour intensive and expensive measure, because it requires more work to be invested in smoothing the area. Additional difficulties can also arise because the wood of stumps is not in demand on the market and it is difficult to find a place to store the extracted stumps. However, if it is decided to extract stumps, no damage may be inflicted on the roots of retained wide-crowned trees, therefore, some of the stumps that are situated closer to the wide-crowned trees will have to be ground. In the places where stumps do not interfere with the management of grassland, a few large stumps should be left. They will serve as dead wood for invertebrates (Fig. 19.28).

19.4.3.7 Management in the First Years after Deforestation

As the conditions become more insolated and soil nutrients are released after deforestation, tree shoots, as well as nitrogen loving plants, for instance, *Urtica dioica, Filipendula ulmaria, Impatiens parviflora* (Figs. 19.30.i, 19.30.j) grow vigorously, which interferes with the establishment of a diverse and stable grassland vegetation. In traditional clearance cropping farmers particularly relied on the increased fertility of soils during the first years after deforestation, which enabled higher cereal and other field culture crops. The nutrient removal of the area occurred with every following crop (Eriksson 2008b). Nowadays, areas with fertile soils in the European landscape have considerably increased and relatively poor growing conditions with natural vegetation are becoming an increasing rarity (Emanuelsson 2009); this applies to wooded grasslands as well.

The initial soil fertility in newly deforested wood-pasture is one of the most serious problems (Eriksson 2008b). It is recommended to keep a higher number of animals in pastures during the first years after felling. Tree shoots always resprout and nitrogen-demanding plants always proliferate in the first years, therefore mowing is necessary. However, this is less pronounced in intensively grazed areas, resulting in faster development of stable grassland vegetation. Large-scale manipulations with animal numbers in permanent pastures are usually not possible, because such manipulations are normally limited by logical herd development; furthermore, they could create administrative obstacles for the receipt of rural support payments, as the indications of overgrazing may appear after longer exposure to a larger number of animals. However, there are examples of the successful use of short-term (1–2 weeks) high animal concentration by installing smaller temporary enclosures (with portable electric fencing) to limit regrowth and nitrogen-demanding plants, where their numbers are particularly high, as well as to ensure faster nutrient removal (Eriksson 2008b). If the number of animals is high, an impression can arise that the limited area is excessively fertilised with animal manure; however, if the animals do not receive supplementary feeding, the total nutrient balance is negative, because animals use a lot of received nutrients for body growth. For instance, an average calf gains more than one kilogram in weight during the day. If animals of different species are kept in the particular farm, the composition of species of pasture animals can also be manipulated; for instance, by initial grazing with goats, which are the most successful species for the abatement of shrubs, in the places where intensive regrowth is expected.

Pasture systems, especially, if they include adjacent semi-natural grasslands, are the best solution for maintaining a restored habitat, because animals promote the spreading of plant seeds and faster development of semi-natural grassland. Mowing and removal of the resprouting shoots and tall herbs can be considered as a worse alternative to grazing.

The management of deforested habitat in the first years considerably differs from the management after the establishment of stable grassland. When there are numerous shoots, the mown grass cannot be effectively collected with hay collecting equipment, or the equipment is frequently damaged. Unlike open landscape grasslands, wooded grassland landscapes are abundant with areas that are inaccessible by conventional agricultural machinery, and therefore shoots can be mown by

manual tools only. The collected mass cannot be used as fodder and it is difficult to find other uses for it, if large areas must be managed. More manual labour-intensive solutions can only be used if the deforested area is very small, and all management activity occurs within a small backyard farm for instance. These can include, for instance, the production of bundles of twigs, which can later be

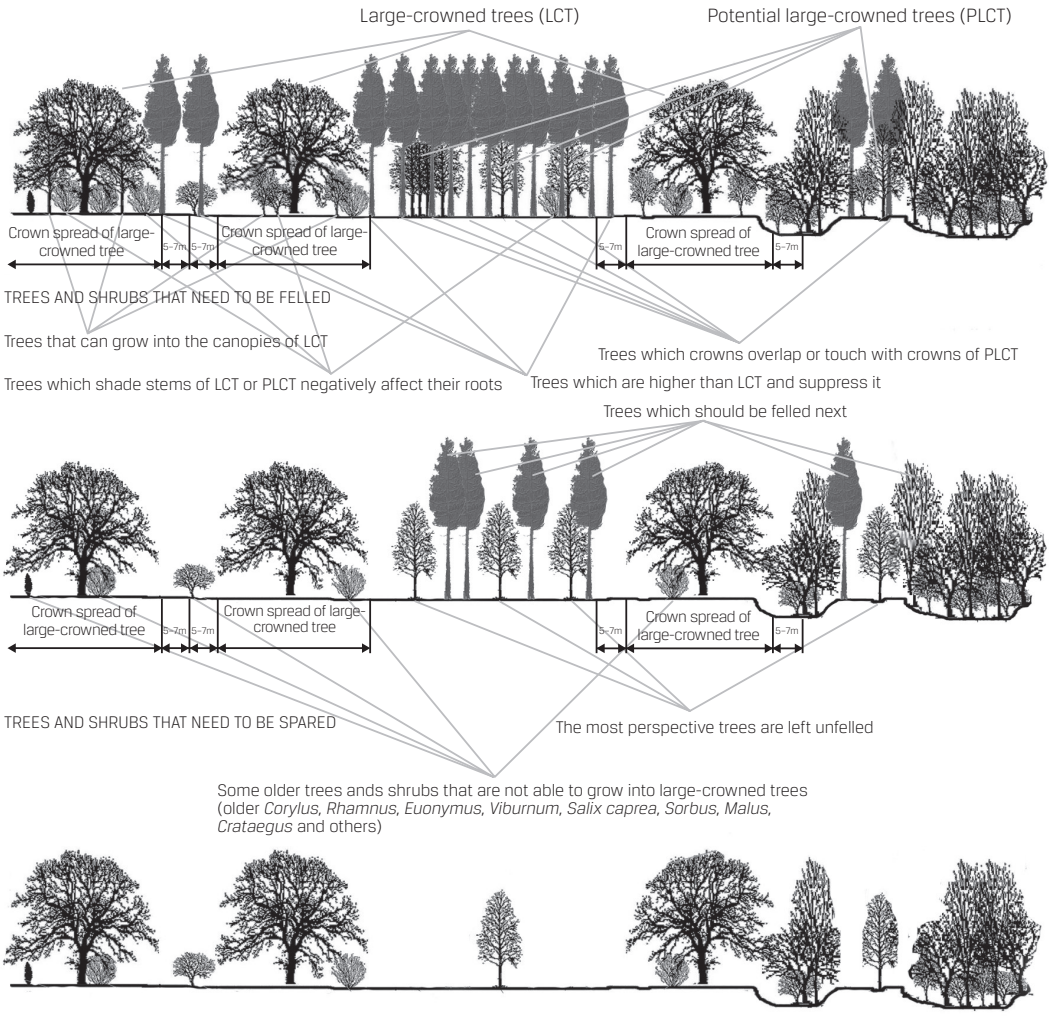


Fig. 19.27. A simplified scheme of gradual habitat restoration. Drawing by V. Lārmanis

Table 19.1. How to determine how to carefully clear around an oak which has been overgrown (according to Ek, Johannesson (2005); with additions; concept may also be used for other tree species).

	Oak tree is extremely overgrown, e.g. if a spruce plantation or the secondary forest exceeds the height of the veteran tree.	**Oak is slightly or moderately overgrown e.g. in young deciduous undergrowth**
Ancient oak tree 〉250 years	Clear in 2 – 3 steps over a 10 year period.	Usually – clear in a single step.
Ca 150–250 year old oak	Clear in 2 steps over a 10 year period.	Clear in a single step.
Young wide-crowned future oak	Clear in a single step.	Clear in a single step.

Table 19.2. Summary of the methods of regrowth control

Technique	How does it help?
Gradual deforestation, initially by removing shrub layer and trees around wide-crowned trees, followed by gradual thinning of remaining area.	The regrowth is delayed by the shade of remaining canopy layer trees. Pasture animals are more successful at controlling a small amount of shoots, instead of vast areas of regrowth. Grassland is gradually introduced under the canopies of trees and animals facilitate nutrient stripping on site.
Deforestation, starting with the places that are most interesting to animals: around fruit trees, animal trails, forest edges and glades.	These are the places where animals stay longer and more frequently than elsewhere, and the impact of trampling and grazing is stronger, as well as faster establishment of grassland herbaceous plant species can be expected there.
Attraction of the herd to particular especially overgrown areas by means of livestock salt licks or feed.	Animals stay in these places especially frequently and a higher effect of trampling and grazing on the shoots can be expected. When the objective of regrowth control is achieved, the attraction of the herd must be stopped, because trampling is frequently so intensive that it delays the establishment of grassland herb species.
Concentration of the herd in a smaller, temporary enclosure.	Increased livestock density, will reduce shoots and tall nitrophyte plant species by means of trampling and grazing, as well as will increase nutrient removal.
Temporary replacement of animal species or breeds.	Different species of pasture animals have different foraging habits. By using the species or breeds that prefer tree branches and shoots, labour costs of mowing can be significantly reduced, or even eliminated.

used as fodder, or composting of the mown mass. If the habitat is not included in the pasture, one of the solutions for the first years after restoration is the mowing of shoots and tall herbs or shredding and leaving on the ground. Within two or three years, if mowing is performed at least twice per vegetation season, the domination of herbs over tree shoots can be achieved and mowing with grass removal can be commenced afterwards, which must also be performed twice per season during the first years. This solution, where mown green mass is removed after the creation of the grassland, is more expensive than grazing. It is also much slower than integration of the area in the pastures; however, this method can also help in the gradual development of diverse grassland that is rich in species. The restoration and maintenance of a wooded grassland without grazing will usually be possible in small areas only, for instance, at popular tourist attractions or in residential areas and in small backyard farms.

After clearing an area from shoots, if grassland vegetation was absent in the restored area and the plant species characteristic for semi-natural grasslands have disappeared, the regeneration of semi-natural grassland must be promoted. This is done by various methods: admixture sowing of grassland species that correspond to the environmental conditions and other ways described in more detail in Chapter 21.8.

19.4.4 Promoting the Diversity of Landscape Elements of the Habitat Type 9070 *Fennoscandian Wooded Pastures*

In accordance with the interpretation of EU protected habitat type 9070 *Fennoscandian wooded pastures* used in Latvia (Lārmanis 2015a), there are no ancient, relic situations that require large-scale reconstruction of landscape, in contrast to part of the habitat type 6530* *Fennoscandian wooded meadows*. However, individual old trees, which were previously growing in open or sparse places and that require a reduction of shade and need younger, competing trees or shrubs to be cleared, can also occur in habitat type 9070 *Fennoscandian wooded pastures* (Figs. 19.6.e, 19.6.g). It is also significant to have different thick and abundantly blooming trees and shrubs like wild apple trees in the entire landscape (Fig. 19.6.g). The creation of landscape elements in the habitats that include larger fragments of forest should be started from the forest edge. Usually abundantly blooming tree and shrub species are already present on forest edges. They must be cleared from excessive competition to promote richer crown formation (Fig. 19.29). On forest edges, where animals tend to stay longer, the shoots are nibbled more intensively, thus reducing the regrowth of felled deciduous trees. Less success is expected, if animal density is low. The elements of this landscape must be managed like those of the

habitat 6530* *Fennoscandian wooded meadows* (*see Chapter 19.3.3*), but landscape deforestation is not needed; only work with individual wide crowned trees and diversification of forest edges must be performed.

19.4.5 Restoration of the Habitat 5130 *Juniperus communis Formations on Heaths or Calcareous Grasslands*

Habitat type 5130 *Juniperus communis formations on heaths or calcareous grasslands* must be restored in all cases where it meets the criteria of this habitat (Lārmanis 2013b). Juniper stands can be in various stages of overgrowing ((Fig. 19.8.b, 19.8.e, 19.8.g, 19.8.i). If grassland or heathland with a juniper stand has overgrown but the grassland characteristic species composition is still present, juniper stands that are currently situated under the canopy of other, higher trees must be restored, if the projection of other trees in relation to the total area of the habitat is up to 75% and their average height does not exceed 7 m (Fig. 19.8.b). Deforestation of sections that are narrower than 20 m, if they are surrounded by open grasslands or juniper stands in better conservation status is also permissible, if the secondary tree stand of these compartments has a denser cover and larger height than indicated earlier (Fig. 19.8.i). Solitary large trees or old shrubs that have existed before the introduction of the secondary forest or shrub cover can be retained in juniper stands just like in habitat types 6530* *Fennoscandian wooded meadows* and 9070 *Fennoscandian wooded pastures*. These landscape elements must be conserved and managed in the same way as in the other two wooded grassland habitats.

Excessive density of the juniper trees themselves (Figs. 19.9.c, 19.9.e) is a specific problem of juniper stands. In this case the juniper stand must be thinned. In a habitat in good conditions in Latvia, the projective cover of junipers does not usually exceed 25%. However, the distribution of junipers can be non-homogeneous and it may include dense individual groups, where the crowns of junipers have completely closed (Fig. 19.8.a, 19.8.e, 19.9.a).

Individual dead or damaged junipers can persist in a juniper stand for long periods of time. Also, their positive effect on biodiversity has not been definitively proven but it is possible that one exists (Greķe, Teļnovs 2005). If a stand is too dense, both living and dry junipers can interfere with habitat management and deter pasture animals from using certain parts of the area. In this case some of the junipers can be removed during scheduled thinning works.

The oldest and largest junipers must definitely be preserved. The introduction of a new generation of junipers, which in the future will gradually replace

Fig. 19.28. Not all tree stumps created during restoration of the habitat must be ground or removed. For instance, mowing of hay will not be possible on the edge of a steep terrace in the future as well, therefore stumps can be left here. They will help in conserving the biodiversity associated with dead wood. Photo: V. Lārmanis.

the old ones, must be ensured. Even in a fairly intensively grazed pasture, where mowing of the pasture does not occur every year, the new junipers usually get introduced well. In grazed grass, especially in the autumn and spring, they are easily noticeable, and some of them must be left intact when mowing. Young junipers are not usually present in meadows that are regularly mown with agricultural equipment, because they are cut down while mowing. In order to ensure that young junipers establish in these mead-

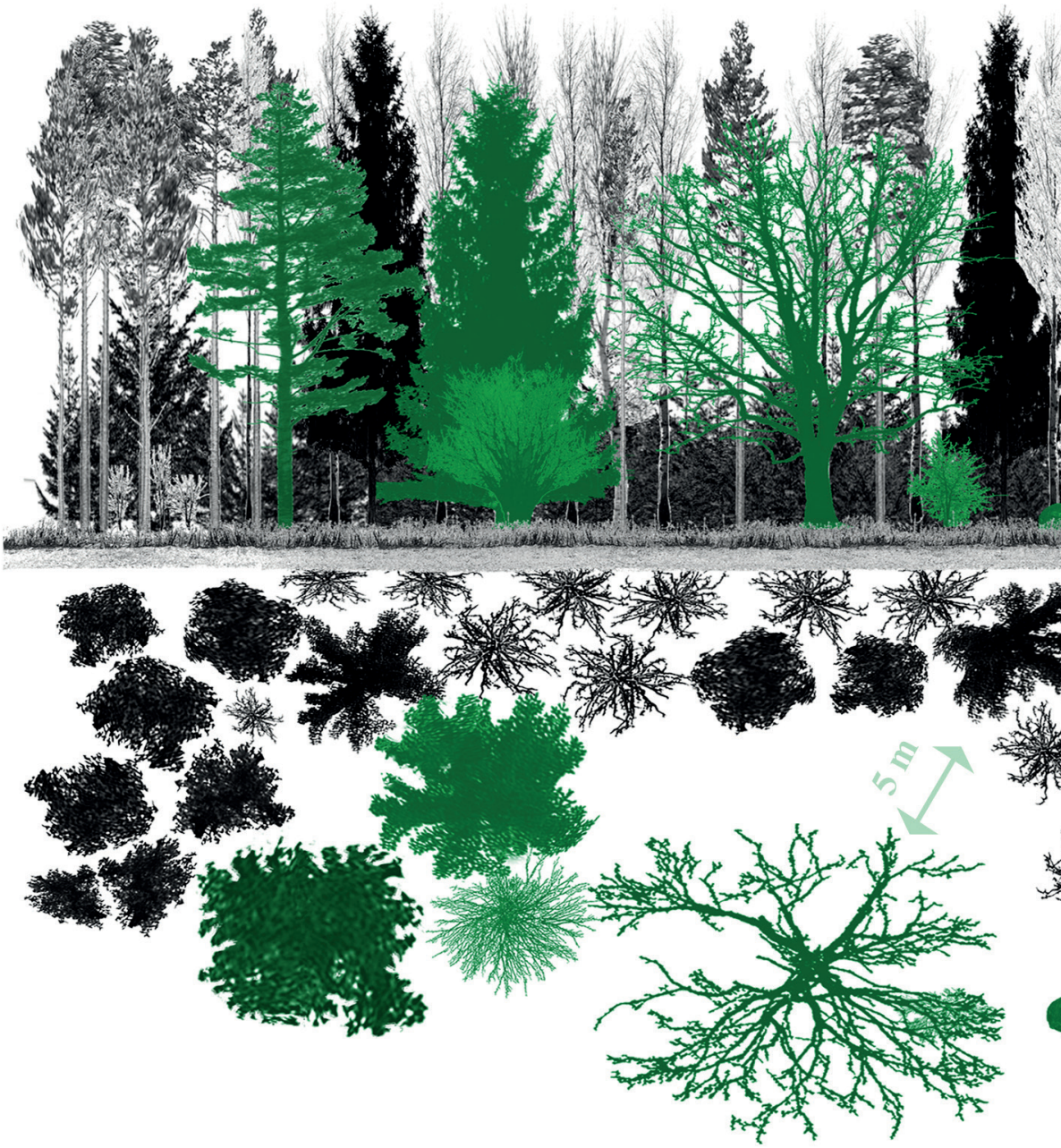
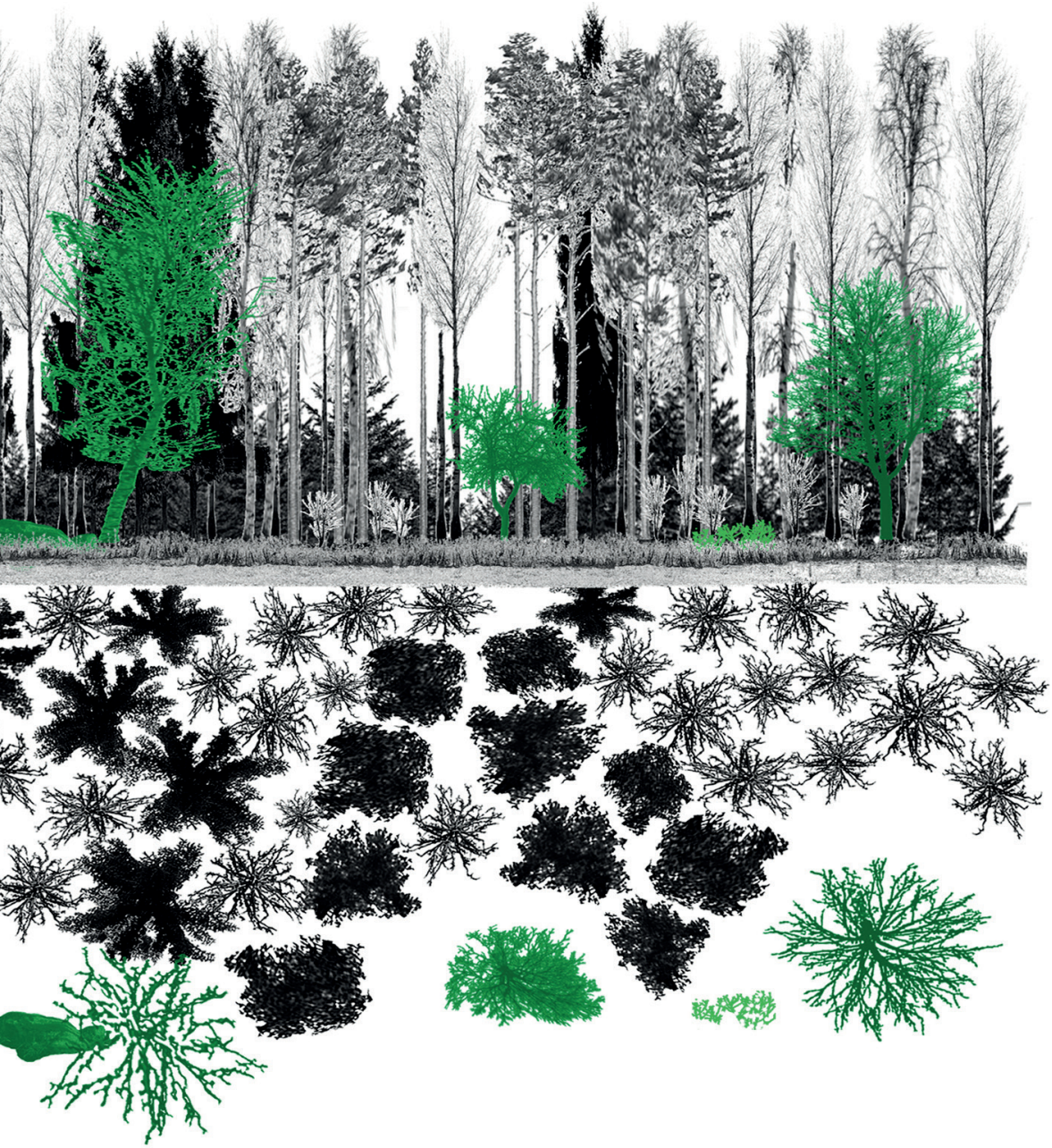


Fig. 19.29. A structural image of a specially managed forest edge in wooded pasture. View from the side and from the top. The objects in green symbolise elements that require special attention and should be cleared from overshading woody species. From left to right: a dense forest edge pine, an old spruce densely branched almost to the ground, which has

ows, patches of grass that are not mown for several years must be left next to old juniper stands. It is recommended to remove undesirable trees and shrubs gradually, by felling only part of them in one year. It is preferable to perform the felling during the darkest period of the year, because if junipers are rapidly exposed to sunlight they can get burnt (Kilevica 2005).



previously grown in an open space, a large, compact cluster of old hazel, a wide-crown oak, a dense buckthorn or rowan bush, boulders, sloping old birch, a wild apple tree, a group of wild roses, a young, abundantly branched oak. The image has been prepared partly according to Anon. (2011), drawing by V. Lārmanis.

Fig. 19.30. Reconstruction of the habitat 6530* *Fennoscandian wooded meadows* by felling the secondary forest (**a, b, d-g, i, j**) in Gauja National Park, in Sigulda near Gleznotājkalns or by removing shrubs from an ancient wooded grassland (**c, h**) in Gauja National Park near Ungurmuiža. (**a**) A fragment of reconstructed landscape with felled secondary forest. Wide-crowned oaks and individual old birches, which could have been part of this area before overgrowth with secondary forest or, which were among the first trees established in the area as it started to overgrow, are retained. A fireplace for branch burning is seen in the foreground at a safe distance from the trunks and crowns of the retained trees. (**b**) Marking of a wild apple tree that should be retained, as the area is prepared for deforestation. (**c**) Marking of coarse woody debris to be preserved in an area that has already been partially cleared from shrubs. (**d**) Location of an opening is chosen in dense *Alnus incana* stands. Apart from one old wide-crowned oak on the left, no old or prospective new wide-crowned trees are present here. (**e**) The overall landscape includes meadow, which has only recently begun to overgrow, and is also being restored. Several young prospective wide-crowned oaks have been preserved at its edge.

(**f**) For grinding stumps the widest possible grinder must be used, because it smooths the surface of the soil as well. This enables mowing of the area later. (**g**) Stump extraction and removal from the area is an alternative method. In the places where the stumps have been extracted, soil smoothing is necessary. (**h**) An ancient wooded grassland tree stand, where the layer of shrubs has been removed and stumps have been ground. After grinding, the area does not differ much from a ploughed field. Such damage to the soil surface is acceptable for restoration purposes; however, further management should contribute to the introduction of semi-natural grassland, if possible, with the help of admixture sowing. (**i, j**) The area deforested in winter is already densely covered with small balsam *Impatiens parviflora* and common aspen during the next summer (in the image – early August).
Photo: V. Lārmanis.

19.5 Additional Materials on the Restoration and Management of Wooded Grasslands and Examples on Site

The recommended methods for the care of trees of ancient open areas and management of wooded grasslands are described in various online materials. Wooded pasture management guidelines (Eriksson 2008b), which, according to the interpretation used in Latvia, refer, among others, to habitat type 6530* *Fennoscandian wooded meadows,* recommend to use materials prepared by the *Ancient Tree Forum* (http://www.ancienttreeforum.co.uk). The book *Veteran Trees*: *A guide to good management* (Read 2000) describes and illustrates the care for old standalone trees and the design of broader landscapes. The management of old trees is also described in the *Osmoderma barnabita* species conservation plan (Teļnovs 2005). Many practical examples of oak habitats and wooded pastures as well as actual problems for various wooded pastures and wooded meadows have been summarised in the book M*ulti-purpose management of oak habitats* (Ek, Johannesson 2005). The diversification of forest edges is explained in the manual of forest landscape planning and design (Bells, Nikodemus 2000) and in the recommendations for environmentally friendly management based on the example of several agricultural farms (Anon. 2011). To date, the best model in Latvia for planning the evaluation and appropriate management of a particular place, considering the status of the endangered species and future prospects, has been presented in the research study conducted on Moricsala Island (Jansson, Hultengren 2002).

Ancient paintings are an important visual source because they represent wooded grasslands at a time when they were much more common than today. Artists tend to embellish the paintings that they draw, which especially applies to various light effects, the ways of placing people, livestock and ruins of ancient buildings. However, in comparison with contemporary situations that are similar in content, it is obvious that the shape and arrangement of trees in pasture landscape is often shown very realistically. Paintings, probably, are the best and most comprehensive illustrational material that is currently available on how wooded grasslands looked at the time when they originated. They are also significant because they promote better perception of the cultural and historical dimension of wood-pasture landscapes. The cultural and historical aspects are significant, because they justify the protection of these habitats to at least the same degree as the protection of biodiversity. A rich variety of illustration material is available, if, for instance, the text "pastoral landscapes 18 (or 19) century" is entered into a G*oogle* image search. Several paintings of I. Shishkin, characterised by a particularly accurate representation of the natural environment, have been painted in areas relatively close to Latvia geographically, for instance, Иван Шишкин. Дубовая роща 1887, На покосе в дубовой роще 1874, В заповедной дубовой роще Петра Великого 1886 (Ivan Shishkin Oak Grove 1887, Mowing in the oak grove 1874, In the protected Peter the Great's oak grove 1886).

Before the commencement of habitat restoration, a review of on-site cases is recommended. Some of the most easily available examples are provided below. In 2015 a wooded grassland landscape was restored with deforestation in Gauja National Park, at the foot of Gleznotājkalns hill, as described in the recommendations of these guidelines on habitat type 6530 * *Fennoscandian wooded meadows* (19.30). Currently it is possible to see a fragment of habitat type 6530* *Fennoscandian wooded meadows* in the farm *Marsi* of Valka Municipality, situated next to the bridge over the River Gauja on the road from Valka to Vireši (Fig. 19.2). In the time period from 2013 until 2015 several juniper stands have been deforested or cleared from shrubs. The one that can be accessed most easily is situated on Rieksti peninsula next to the bird watching tower of Lake Kaņieris (Fig. 19.8.a).

19.6 Conflicting Management Priorities

Several conflicting situations in the management of wooded grasslands are observed, including those characteristic for open grassland habitats (*see Chapter 7.1.4*), as well as wooded grasslands. Wooded grasslands frequently overlap other grassland or forest habitats. Sometimes there are situations, where an old wooded grassland landscape overgrown with forest conforms to the criteria of another EU protected habitat type or is very close to it at the same time. These different habitats may require different management. Therefore decisions must sometimes be made in favour of protecting one habitat over another. There are usually no such conflicts with reference to habitat 5130 *Juniperus communis formations on heaths or calcareous grasslands*, mainly because this habitat type in Latvia is very rare. However, in Estonia, where juniper stands are very common, they can endanger different habitats of open grasslands. Meanwhile, the protection of habitat types 6530* *Fennoscandian wooded mead-*

ows and 9070 *Fennoscandian wooded pastures* may involve potential conflicts with other habitats in Latvia.

Restoration of the habitat 6530**Fennoscandian wooded meadows* can most frequently conflict with the protection of forest habitat values. Usually, the most preferable regime of management for forest habitats is non-interference, while wooded grasslands need restoration and constant management. Available data suggest that actual conflicting situations occur quite rarely on site. For instance in Ziemeļgauja Protected Landscape Area (which, according to current estimates, occupies 72% of the total area of the habitat type in Latvia) only 1.8% of 6530 *Fennoscandian wooded meadows* overlaps EU protected forest habitats. However, even these are transitory situations, where values associated with both habitats – forest and wood-pasture landscape occur simultaneously in the same area. Cases where ancient wooded grassland overlap with regular secondary forest or scrub, which lack special significance in the conservation of forest biodiversity, are much more common (64% of the areas). In these areas the quantity of old wooded grassland trees is sufficiently high to conform to the criteria of wooded grasslands, but too low for the forest stand to qualify as any of the EU protected forest habitat types now or in the closest future (Lārmanis 2012) (Figs. 19.3.d, 19.3.i). If it is assumed that all currently known areas of habitat type 6530* *Fennoscandian wooded meadows* (a total of 1160 ha in Latvia) overlap forest habitats with a ratio that is equivalent to the one indicated above, the total area of such overlapping territories in Latvia amounts to 21 ha. If compared to the total area of all EU protected forest habitat types in Latvia – 286 234 ha – this overlapping area is equal to 0.01% (Anon. 2013a).

If the situation is evaluated by separate EU protected forest habitat types, then overlapping with ancient wooded grasslands will most significantly affect the EU protected forest habitat type 91F0 *Riparian mixed forests of Quercus robur, Ulmus laevis and Ulmus minor, Fraxinus angustifolia along the great rivers.* This habitat is often located directly in ancient wooded grassland landscapes that are overgrown with forest, and due to cultural and historical origin its distribution and conservation is unclear and pending specification. Ecologically and in terms of protected species, it is similar to the much more common EU protected forest habitat type 91E0 *Alluvial forests with Alnus glutinosa and Fraxinus excelsior,* therefore individual conflicting situations with the EU protected habitat type 6530* *Fennoscandian wooded meadows* cannot be associated with the possibility of disappearance of any population of species specifically associated with habitat type 91F0. The restoration of habitat type 6530* *Fennoscandian wooded meadows* does not mean the destruction of specially protected species that are generally specific to forests; on the contrary – several forest species occur in these habitats. For instance, wooded grasslands are a characteristic habitat of tree lungwort *Lobaria pulmonaria* (Jüriado et al. 2012). Traditionally this species is only associated with forest habitats in Latvia, probably because the number of high quality wooded grasslands, where the presence of lungwort can be verified, is very low.

Considering the information on the proportion and significance of conflicts in the overall situation of forest habitats, restoration of the habitat 6530 *Fennoscandian wooded meadows* definitely is a higher priority in conflicting situations than the ensuring of non-interference with forest habitats, because these situations will most likely not be decisive for the overall conservation of forest habitats in the country. The priority of wooded meadow restoration refers to class A – D situations of the habitat (*see Chapter 19.4.1*), in particular to the class A locations, without the restoration of which the favourable conservation status of the habitat cannot be ensured in the long term. Since wooded meadows require constant maintenance, and farmers or other managers capable of maintaining them in the particular area are often absent, some wooded meadows that have overgrown with forest will transform into forest habitats anyway. Therefore, it is particularly significant to use all the restorative potential in the places where the management is available, without giving in to concerns of the possible hazard to forest habitats in general in the country.

For the habitat type 9070 *Fennoscandian wooded pastures*, wide-scale reconstruction is not necessary, therefore there are very few potential conflicting situations involving the protection of forest habitats. In larger wooded pastures individual fragments of forest habitats may occur, where the impact of grazing must be evaluated. For instance, it could be a forest habitat with a population of a rare species, which can be negatively affected by grazing. Therefore the evaluation of whether a hazard really exists and how severe it is for the conservation of the favourable status of the involved habitat and the respective species in the country as a whole must be carried out. If there is such a risk, the possibility of excluding the habitat from the territory of pasture must be considered. Grazing animals do not use all areas of pastures with the same intensity. The presence of the habitat in a pasture does not always

mean an actual hazard to this habitat. For instance, cattle avoid staying in swampy woods (Fig. 19.19.e). Exclusion of forest habitat from the pasture should not be rushed, the situation should be observed – to determine whether a negative effect really occurs over a period of several years – and only then must the decision be made.

19.7 Socio-ecological Issues of Management

Wooded grasslands are a complex system of traditional agriculture, where the nature values are determined by varied and economically viable use of the particular time. It is difficult to mimic it by using simplified techniques, but a full maintenance process is expensive, and, often, it is not implemented in practice. Listing and describing technical management measures of the habitat is not sufficient to eliminate the problems of habitat management. It is recommended to pay attention to the so-called socio-ecological dimension during the search for habitat maintenance solutions in the future. The management of habitats must be viewed at a socio-economic level, in connection with the local community, with research of what products can be obtained in this landscape, and how to integrate it in contemporary agriculture (Emanuelsson 2009; Hartel, Plieninger 2014).

Habitat management support measures used to date, which have not been commonly used in Latvia regarding wooded grasslands but are already extensively tested in Europe, include green certification, ecotourism, local marketing, niche products, payment for ecosystem services, recreation, all of which enable the maintenance of these habitats. However, this is not enough to address the problem on a broader scale (Hartel, Plieninger 2014). The common agriculture policy of the EU has also been unfavourable for wooded grasslands, as the support mostly fails to reach them (Beafouy 2014, Auniņa, Lārmanis 2012). The management of habitat must be integrated into conventional agriculture, and EU support payments must be treated as a payment for services that farmers provide for the maintenance of natural and cultural values (Emanuelsson 2009). In the long run, ways need to be found to ensure income that is independent from state support schemes for farmers managing wooded grasslands (Oppermann 2014).

Awareness of various values of the habitat can help in finding a way to use the land that is economically beneficial. The list of the values of maintained wooded grassland landscapes is extensive: they are significant as objects of cultural and historical heritage, they are significant for the maintenance of biodiversity, they limit soil erosion, they are appealing to visitors (aesthetic and recreational value), they can be partially combined with timber harvest by growing various species of trees in stands of different density, they enable the production of meat with low greenhouse gas emissions; they also support other systems (Oppermann 2014), for instance, wooded grassland landscape with stable grassland that is restored in a river valley reduces the runoff from arable lands into the river and, eventually, the sea. Wooded grasslands can positively affect the maintenance of herds both by reducing animal mortality and ensuring cheaper maintenance. Use of habitat for livestock farming is also more cost-efficient compared to conventional management that involves only mowing (Glimmerveen 2013). The management of systems of mixed use, like wooded grassland landscapes, is much more complicated than the management of simple systems; however, they involve a much wider range of potential products that can be used (Glimmerveen 2013).

The socio-ecological issues of wooded grassland management are of high significance in the practical implementation of management measures. Implementation of ecologically justified measures alone will rarely be possible. Each case must be considered in the broader and long-term perspective, by putting more consideration into products and services that wooded grasslands can generate under the current socio-economic situation, and the possibilities of integrating them into business and community life.