Chapter 14. 6270* *Fennoscandian lowland species-rich dry to mesic grasslands* (S. Rūsiņa, A. Auniņš, V. Spuņģis)

14.1 Characteristics of the Habitat Type

14.1.1 Brief Description

Habitat type 6270* *Fennoscandian lowland species-rich dry to mesic grasslands* (referred to as *Species rich pastures and grazed meadows* in the text) includes mesic and permanently moist pastures in poor and moderately fertile soils, as well as mesic and permanently moist meadows, the aftermath of which is grazed annually. Pastures in wet floodplains, dry pastures and pastures in soils which dry

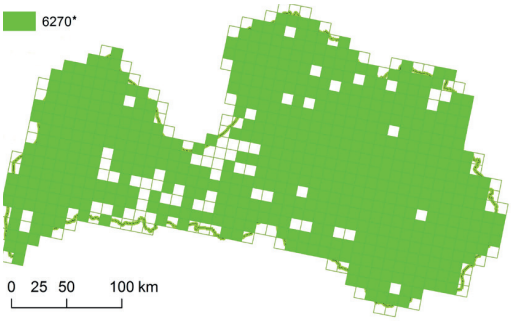

Fig. 14.1.1. Distribution of EU protected habitat type 6270* *Fennoscandian lowland species-rich dry to mesic grasslands* in Latvia (Anon. 2013a).

Table 14.1.1. Variants of habitat type 6270* *Fennoscandian lowland species-rich dry to mesic grasslands*. Photo: S. Rūsiņa, *Crepis paludosa* – A. Priede, *Briza media* – G. Dolmanis.

Mesic pastures and grazed meadows in neutral to slightly acid soils (6270*_1, typical variant)	Mesic pastures and grazed meadows in acid, very nutrient-poor soils (6270*_2, poor soil variant)
Depending on soil fertility, sward is either low (20–30 cm) or high (50–70 cm). More fertile soil is dominated by grasses: *Festuca rubra, Festuca pratensis, Poa pratensis, Cynosurus cristatus*; in less fertile soils there is no single dominant species, but there is high colour diversity – grasses: *Briza media, forbs: Primula veris, Plantago media, Leontodon hispidus, Fragraria viridis*. Hay yield 0.5–2.0 t ha^{-1}.	Grasslands with low sward (20–30 cm). Dominated by grasses: *Agrostis tenuis* and *Anthoxanthum odoratum, forbs: Dianthus deltoides, Plantago lanceolata, Ranunculus acris, Centaurea jacea, Leontodon autumnalis*. Higher number and abundance of species characteristic of acid soils, for example, *Nardus stricta, Sieglingia decumbens, Rumex acetosella, Hieracium umbellatum*. Hay yield 0.5–1.5 t ha^{-1}.

Permanently moist pastures and grazed meadows (6270*_3, moist variant)

Sward can be low (20–30 cm), but can also be tall (1 m). Dominated by moisture-demanding grasses: *Deschampsia cespitosa, Holcus lanatus* and forbs: *Geum rivale, Potentilla erecta, Succisa pratensis; Filipendula ulmaria, Geranium palustre, Lysimachia nummularia* occur frequently. Hay yield 0.5–1.5 t ha^{-1}.

up periodically correspond to other EU protected semi-natural grassland habitat types.

Habitat occurs both in plains and on hills and hillsides, the moist type of the habitat also occurs in terrain depressions. Diversified management in Latvia has allowed the formation of plant communities with diverse species composition and vegetation structure (Rūsiņa 2013 g.).

Of all EU protected grassland habitats, it covers the largest area – 18,500 ha or 40% of all semi-natural grasslands in Latvia (Fig. 14.1.1). On average, for every 2,500 ha (one square in Fig. 14.1.1), there are 6.6 ha of this habitat. Latvia has 11% of the total habitat area in the EU boreal region. Permanently moist sites in Latvia are often drained by internal drainage or open ditches. In such locations grasslands have been ploughed or improved and not all of them meet the criteria of EU protected habitat. To classify the grassland as an EU protected habitat:

- the grassland should contain plant communities characteristic of the habitat with typical dominant plant species;
- if the turf is very sparse and there are pronounced signs of ex-arable land or cultivated grassland, then the grassland should contain at least five semi-natural grassland indicator species (Annex 4) that occur across the entire grassland and not just in some of its parts (for more details *see Chapter 1.2*).

Species-rich pastures and grazed meadows in Latvia occur randomly and there are no sites which are richer with this habitat type than others. Most often they occur at higher elevations, where the hilly terrain facilitates the use of semi-natural grasslands for pastures. Species-rich pastures in very poor and acid soils are preserved in some areas in the Coastal Lowland (Fig. 14.1.2–14.1.5).

14.1.2 Vegetation, Plant and Animal Species

Plants and vegetation. Vegetation is dense and approximately 40 cm high, but it can also be lower (10–20 cm), especially in sites grazed for a long period of time. Very well-developed turf and distinct micro-terrain as a result of grazing – trampling and unevenly grazed grass (Fig. 14.1.6 – 14.1.10). Herb vegetation is polydominant (it does not have one clearly dominant species), two layers can be distinguished – layer of lower plants consisting of species with creeping or decumbent stems and rosette leaves (for example, *Trifolium repens, Prunella vulgaris, Leontodon hispidus, Primula veris, Plantago media, P. lanceolata*), and a medium-tall layer consisting of medium-tall grasses (*Anthoxanthum odoratum, Briza media, Festuca rubra, Agrostis tenuis,* in

Fig. 14.1.2. Typical variant of the habitat type 6270* *Fennoscandian lowland species-rich dry to mesic grassland* near Druskas hillfort in Korneti. Photo: S. Rūsiņa.

Fig. 14.1.3. 6270* Typical variant of the habitat type 6270* *Fennoscandian lowland species-rich dry to mesic grassland* in Grobiņa Municipality. Photo: S. Rūsiņa.

Fig. 14.1.4. Moist variant of the habitat type 6270* *Fennoscandian lowland species-rich dry to mesic grassland*. Photo: S. Rūsiņa.

Fig. 14.1.5. Moist variant of the habitat type 6270* *Fennoscandian lowland species-rich dry to mesic grassland* in Jaunpiebalga Municipality. Photo: S. Rūsiņa.

Fig. 14.1.6. Pasture vegetation structure. *Cirsium vulgare* is desirable in small amounts because its seeds in winter are food for birds, but it can proliferate excessively and outcompete other species, therefore its spread should be controlled. Photo: S. Rūsiņa.

Fig. 14.1.7. Pasture vegetation structure is characterised by intensively grazed areas with low grass and less-grazed areas with taller grass. Photo: S. Rūsiņa.

Fig. 14.1.8. Species-rich pastures have very many species even in a small area. Photo: S. Rūsiņa.

Fig. 14.1.9. The lowest layer of vegetation is best developed in species-rich pastures. Moist pastures are often dominated by *Geum rivale*. Photo: S. Rūsiņa.

Fig. 14.1.10. A grazed meadow with high species density, blooming before it will be mown. Photo: S. Rūsiņa.

moist areas also *Holcus lanatus, Cynosurus cristatus* and *Deschampsia cespitosa*). Tall herbaceous plant layer is almost absent or very sparse (consisting of some tall grasses with low abundance, for example, *Helictotrichon pubescens, Festuca pratensis.*

Birds. Species that form the typical grassland passerine community, such as *Motacilla flava, Anthus pratensis, Saxicola rubetra, Acrocephalus schoenobaenus, Locustella naevia, Emberiza schoeniclus*, often occur in species-rich pastures and grazed meadows. The grassland may feature a mosaic of low-density shrubs and shrub clusters (desirable) that attract certain passerine species (*Emberiza schoeniclus, Carpodacus erythrinus*), however their presence is not decisive. If there are permanently wet depressions in the grassland, *Rallus aquaticus* and, less commonly, *Porzana porzana* may occur there. If the grassland area is sufficiently large, meadow waders may also occur there, such as *Tringa totanus, Gallinago gallinago, Vanellus vanellus*, and, less commonly, also *Limosa limosa* and *Philomachus pugnax*. If a pasture borders on a water body or water course with developed vegetation mosaic, grassland nesting ducks – *Anas querquedula, A. clypeata, A. strepera* breed there. If pastures feature larger areas with tall herbaceous plant vegetation, *Crex crex* can also occur there. The occurrence of other species depends on the configuration of surrounding habitats – the feeding resources of pastures attract species that usually breed near farmsteads, such as *Sturnus vulgaris, Ciconia ciconia*, as well as species feeding on flying insects – *Hirundo rustica, Delichon urbicum* and *Apus apus*, or in reeds – *Circus aeruginosus*, or in forests – various forest edge species (for example, *Emberiza citrinella, Columba palumbus*), raptors (for example, *Accipiter nisus* and *Buteo buteo*). During passage migration (especially in spring, if the pastures are partially flooded), they are used as resting

and feeding grounds by a large number of various waterbird species, especially waders.

Invertebrates. There is a large number of species in pastures related to animal excrement and the main decomposers of excrement are, for example blow flies *Calliphoridae*, flesh flies *Sarcophagidae* and many other Diptera. *Scatophaga stercoraria, Copris lunaris* (mainly in eastern Latvia), *Asilus crabroniformis* and *Emus hirtus* live in dry excrements in dry pastures. These habitats also have a rich soil fauna – small arthropods, nematodes, insect larvae, earthworms (at least five species) and potworms. These habitats are not directly inhabited by protected species, but the flowering plants attract butterflies. If the pasture is located near a forest habitat suitable for *Parnassius mnemosyne*, then the butterflies feed in the pasture because it contains flowering plants. *Lycaena dispar*, which can fly for large distances, also occurs there. *Hypodryas maturna* occurs near forests with ash-trees. Ground beetles are represented by species of the *Poecilus* genus that inhabit open habitats. Pastures have a great diversity of fungi and microorganisms.

14.1.3 Important Processes and Structures

Grazing is the main process that determines the establishment and existence of this habitat. It forms the typical micro-terrain and vegetation structure, as well as creates the conditions for biodiversity by creating different ecological niches. Key factors creating the environment specific of pastures are the selective feeding habits of grazing animals, uneven distribution of animal excrement and urine in the area and mechanical turf and soil disturbances created by animals (trampling, pulling out of plants) (Rook, Tallowin 2003) (Fig. 14.1.11–14.1.13, *see also Chapter 22.3.1*).

Soils are usually moderately moist or moist, poor to medium-rich in nutrients, with moderately acid to neutral reaction. Permanent grazing can also lead to habitat formation in fertile soils, but fertile soils in Latvia are usually used for arable land, therefore semi-natural grasslands are not common in such places. The moist variant of the habitat only occurs in permanently moist soils. This is ensured by poor surface water infiltration due to terrain conditions (depressions where surface water accumulates) or soil properties (for example, heavy mechanical composition with poor infiltration capacity).

14.1.4 Succession

If management is ceased, grasslands gradually overgrow with forest (young *Betula pendula* and *Populus tremula* stands usually develop, less frequently *Picea abies* stands). In the intermediate stage, monodominant grass vegetation with *Calamagrostis epigeios* is often characteristic. In the case of eutrophication, *Dactylis glomerata*, *Holcus lanatus* or nitrophilous plants such as *Aegopodium podagraria* or *Anthriscus sylvestris* may dominate (Fig. 14.1.14).

In Latvia the habitat has usually developed in ex-arable land in mesic soils after the commencement of grazing. Historically, the moist variant of the habitat type has also developed under the influence of wild animal or livestock grazing and mowing in fens and moist forests. Moderate drainage using

Fig. 14.1.11. Selective grazing gives the plant species the chance to bloom and shed seeds in some places. Photo: S. Rūsiņa.

Fig. 14.1.12. Uneven distribution of animal excrement creates the diversity of vegetation structures. Photo: S. Rūsiņa.

Fig. 14.1.13. Animal excrement in pastures is a habitat for various fungi and a habitat and feeding place for invertebrates. Photo: S. Rūsiņa.

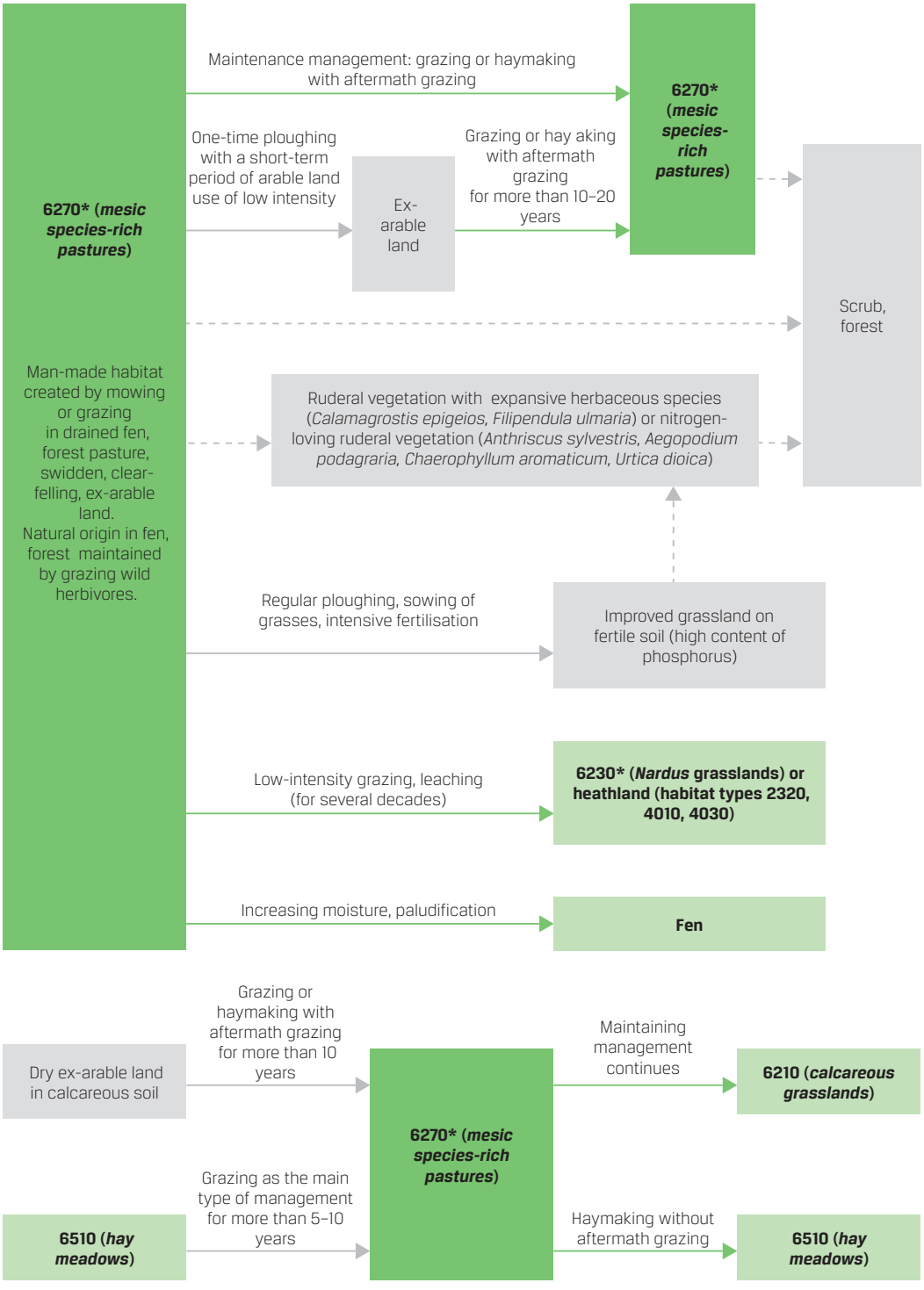

Fig. 14.1.14. Development of species-rich pastures and grazed meadows under various management regimes.

shallow ditches has often been done in moist soils, which contributed to the formation of mesic and moist variants of this habitat in sites of fens and wet grasslands.

Habitat also develops as an intermediate stage by grazing or mowing ex-arable land in dry areas. For example, habitat type 6210 *Semi-natural dry grasslands and scrubland facies on calcareous substrates* can be found in rarely flooded areas of the Gauja floodplain, in sandy soil with weakly acid to slightly alkaline reaction. If it is ploughed for several years and later is used for haymaking or grazing again, then grasses typical both for perennial ex-arable land and species-rich pastures and grazed meadows (*Agrostis tenuis, Anthoxanthum odoratum, Festuca rubra*) and forbs (*Prunella vulgaris, Hypericum* spp., *Plantago lanceolata*) establish initially. This stage can last for long time in pastures. However with time, as the grassland development continues, species characteristic of habitat type 6210 *Semi-natural dry grasslands and scrubland facies on calcareous substrates*, such as *Filipendula vulgaris, Helictotrichon pratense, Trifolium montanum, Fragaria viridis*, return.

In extensively used mesic areas, the habitat can persist for long periods of time, possibly for decades and centuries, almost unchanged. Paludification and the establishment of plants characteristic of fens may occur in moister areas, for example, *Calliergonella cuspidata, Aulacomnium palustre, Sphagnum* spp. in the moss layer, *Menyanthes trifoliata, Comarum palustre, Thelypteris palustris, Phragmites australis, Eriophorum* spp. in the herb layer.

Long-term use of pastures without maintenance (mowing, moss harrowing, etc.) and completely without fertilisation slowly induces vegetation changes (over 50–100 years or faster in especially acid and poor soils). As the soil becomes poorer in nutrients, habitat types 6230* *Species-rich Nardus grasslands, on siliceous substrates in mountain areas (Nardus grasslands)* and 4030 *European dry heaths* (in coastal lowland – 2320 *Dry sand heaths with Calluna and Empetrum nigrum*) may develop.

As the regularity or intensity of management decreases, the abundance of grasses in plant communities increases, the vegetation becomes taller, thicker and less colourful (blossoming forbs disappear). Often upon the cessation of mowing and grazing, the grassland first overgrows with expansive herb species – *Calamagrostis epigeios, Anthriscus sylvestris, Aegopodium podagraria*, in permanently moist places, also with *Filipendula ulmaria* or *Urtica dioica* (if the areas are drained and rich in nitrogen). These plants are able to absorb nutrients faster and better, thus outcompeting smaller plants. Such overgrown grasslands can persist for decades because the thick herbaceous plant cover prevents the development of woody plant seedlings. Shrubs and trees enter with time, helped by rodents that create areas free of herbaceous plants.

Habitat typically overgrows with *Betula pendula, Populus tremula*, in moist places with *Salix* spp. and *Alnus incana*; sometimes overgrowth with *Picea abies* is observed, especially in places with thick vegetation where *Betula pendula* cannot establish easily.

14.1.5 Pressures and Threats

The habitat is adversely affected by all factors listed and described in Chapter 3. The most important of these has been the change of land use type, converting species-rich pastures into arable fields, as well as inappropriate management by improving and fertilising these grasslands and, in recent years, mulching without the removal of mown grass. Moister species-rich pastures and grazed meadows have been affected or even destroyed by drainage. Nowadays, river regulation, restoration and digging of ditches threatens both the sites that so far have been protected from drainage as well as former arable fields and previously improved grasslands, where semi-improved or even semi-natural grasslands have developed in recent decades. Use of unsuitable tractor equipment and uncontrolled grazing leads to soil compaction. It's a major threat for invertebrates. In the long term, it also affects vegetation because it increases the cover of *Deschampsia cespitosa*, which is resistant to compaction, and the diversity of other species decreases.

An important threatening factor is overgrazing, which degrades the vegetation and reduces the diversity of herb layer invertebrates. Soil compaction causes a sharp decrease in the population density of soil inhabitants. The diversity of birds is adversely affected by the increased occurrence of predators that destroy nests.

14.2 Conservation and Management Objectives of Species-rich Pastures and Grazed Meadows

- Ensure the landscape connectivity and ecological processes characteristic of species-rich pastures and grazed meadows (diversity of pasture vegetation structures and micro-terrain, nutrient cycling ensured by appropriate mowing or grazing), creating preconditions so that the

diversity and quality of ecosystem services offered by this type of habitat do not decrease.
- To promote the improvement in the number of localities and conservation status of typical species, as well as rare and declining species by the restoration of suitable habitats in degraded sites.
- To restore and maintain the diversity of fungi, lichen, moss and vascular plant species and communities related to grazing and characteristic pasture environment and habitats suitable for them: although no protected plant species are specifically related to this habitat, it is nevertheless suitable for several of them: *Platanthera* spp., *Dactylorhiza* spp., *Gladiolus imbricatus*, *Gentiana cruciata*, *Gentiana pneumonanthe*. Diverse plant communities are characteristic for the habitat.
- To restore and maintain the diversity of invertebrates related to grazing and pastures and communities and habitats suitable for them: species included in the Red Data Book of Latvia *Copris lunaris* (mainly in Eastern Latvia), *Asilus crabroniformis* and *Emus hirtus* that live on dry excrement in dry pastures. One seasonal sample (collected using an insect net in the spring, mid- and late summer) can contain more than 100 different arthropod species (insects, spiders, mites) and hundreds of specimens. There are no species with pronounced dominance, but many species with a small number of individuals are observed.
- To restore populations of meadow waders (protected species: *Tringa totanus, Philomachus pugnax, Limosa limosa,* etc.). Grassland management should be aimed at the preservation of breeding places of these species, where they still exist or appropriate management, where they currently do not exist, but the configuration and moisture conditions of grassland are suitable for these species.
- To ensure sufficient living space for other protected species related to grasslands (for example, *Crex crex*) and species with declining populations in Latvia (*Motacilla flava, Carpodacus erythrinus;* (Auniņš, 2016)).

14.3 Maintenance and Restoration of Species-rich Pastures and Grazed Meadows

If the habitat is in a favourable condition, then restoration is not required and only maintenance management is necessary (*see Chapter 14.3.1*). If there are any indications of the opposite (*see Chapter 14.3.3*), then restoration is needed. Examination of the area is necessary to ascertain the present nature values before starting habitat restoration or management and a management plan has to be developed (*see Chapter 7*), taking into account the legal framework of habitat management (*see Chapter 7.2*).

14.3.1 Species-rich Pastures and Grazed Meadows Requiring Maintenance

Maintenance is necessary for all species-rich pastures and grazed meadows that are in a favourable condition. Habitat in a favourable condition is managed – extensively grazed or mown and its aftermath is grazed. It is not overgrown with shrubs, there is no litter layer, and the plant species diversity is high, there are various plant communities (both with low grass and high sward). No ditches have been dug in the grassland or they are shallow and have not altered the moisture conditions substantially (Insertion 2, Table 14.3.1).

Grassland is not overgrazed, but the grazing intensity ensures the structural diversity of the sward, elsewhere there are blooming herbs, where butterflies and other insects feed. Various species of meadow waders (*Vanellus vanellus, Tringa totanus, Gallinago gallinago*) nest in the grassland. In spring, wet depressions are filled with water, various species of migratory waterbirds and waders are present there.

Favourable condition is indicated by the presence of pasture umbrella species, for example, *Briza media, Carex panicea, Polygala vulgaris, Cynosurus cristatus*, *Linum catharticum*, and bird and invertebrate species (*see Chapter 14.1.2*).

14.3.2 Optimal, Suboptimal and Inappropriate Management

A summary of optimal, suboptimal and inappropriate management types are summarised in Table 1 and 6 of Annex 2.

The most appropriate maintenance is extensive grazing using continuous or controlled stocking. Optimal grazing pressure creates a mosaic of low-grazed and partially grazed or ungrazed grass. It has been found that in mesic sheep pastures in the Netherlands and the United Kingdom the optimal load to create a vegetation mosaic was 0.5 LU ha^{-1} for 10 months (three sheep per ha) (Bakker et al. 1984; Stewart, Pullin 2006).

If grazing is not available, mowing is permissib-

Table 14.3.1. Indications of a well-managed habitat type 6270* *Fennoscandian lowland species-rich dry to mesic grasslands.*

Parameter	Grazed meadow	Pasture
Litter	Litter covers no less than 10% and no more than 30% of the land.	
Vegetation	High plant species diversity, rather than one or few dominant species; there are several dominating grasses: *Festuca rubra, Agrostis tenus, Anthoxanthum odoratum, Briza media, Cynosurus cristatus*; at the same time there are many forbs, for example, *Centaurea jacea, Plantago media, Prunella vulgaris, Leontodon autumnalis, Campanula* spp., *Fragaria viridis, Dianthus deltoides.*	
Vegetation structure	A very colourful meadow in full bloom, proportion of forbs and grasses at least 1:1.	At least 20% of the area with grass shorter than 7 cm and at least 20% of the area with grass taller than 20 cm; richly blooming plants in at least 20% of the area.
Indicator species of semi-natural grasslands	At least 3–5 indicator species of semi-natural grasslands are widespread: in moist areas – *Carex panicea, Galium boreale, Geranium palustre, Ranunculus auricomus, Scorzonera humilis, Succisa pratensis, Trollius europaeus*; in mesic areas – *Plantago media, Primula veris, Dianthus deltoides, Linum catharticum, Leontodon hispidus, Briza media.*	
Bird species	*Vanellus vanellus, Tringa totanus, Gallinago gallinago* and other meadow wader species are breeding. Also the passerine community characteristic of grasslands is found (if a grassland is smaller than 10 ha, there can be no waders and the passerine community may be incomplete). If there are areas subject to flooding in the grassland, many different species of waterbirds and waders are present during the migration.	
Invertebrate species	Characteristically rich insect fauna, dominated by plant bugs, beetles, Hymenoptera, as well as many insect species related to the excrement of grazing animals. Many Orthoptera.	Characteristically rich insect fauna, dominated by plant bugs, beetles, Hymenoptera, as well as many insect species related to the excrement of grazing animals. Few Orthoptera.
Tussocks	Large sedge tussocks which are important for birds are preserved in moister areas.	
Expansive plant species	Absent or only up to 10% of the grassland area is dominated by *Anthriscus sylvestris, Filipendula ulmaria, Calamagrostis epigeios* and other expansive species.	Overgrazing indicators cover less than 30%, for example *Trifolium repens, Plantago major, Polygonum arenastrum, Poa annua, Prunella vulgaris. Lolium* spp. are absent.
Drainage ditches	Shallow drainage ditches are maintained, no deep ditches.	
Shrubs and trees	Large trees are preserved, small shrubs in at least 10% of the area, but no more than 30%. No shrubs or trees in places important for waders.	

le with the removal of hay once or twice per season (depending on the grassland yield). The typical and moist variant of the habitat in such a case will transform to habitat type 6510 *Lowland hay meadows*.

Mowing time should be aligned with the moisture conditions. Mowing should be done in the driest period of summer. In wetter sites, it is recommended to use "floating" machinery that is suitable to wet soils, for example, tracked tractor or wheeled tractor with wide wheels to provide greater support surface (*see Chapter* 22.2.1).

Late mowing or mowing with leaving of the grass is harmful for the vegetation because in both cases the grassland becomes enriched with nitrogen and transforms into a homogeneous sward consisting of nitrophyte species.

In order to maintain the diversity of invertebrates, cattle should mainly be used for grazing because it creates a more diverse vegetation structure than sheep or horses (Kirby 2001). Mowing is recommended in drier years and grazing in wetter ones. Clearing of shrub and tree cover in overgrowing areas is necessary, yet it should be done so that, if necessary, areas of favourable microclimate can be established or maintained (New 1995).

To maintain bird diversity, prevention of grassland overgrowth and ensuring vegetation of differing height during the breeding season is necessary. This is best achieved by grazing. Shrubs and trees are permitted in small quantities in a mosaic distribution to increase the diversity of passerines, but trees and tall shrubs (taller than 1.5 m) should not be permitted near pools and moist depressions that may be suitable for meadow waders. Free and gently sloping access to the water's edge if any,

Fig. 14.3.1. The moist variant of species-rich pastures and grazed meadows overgrown with *Filipendula ulmaria* with open ditches in a drained floodplain. Dominance of *Filipendula ulmaria* indicates that the moisture conditions are still suitable for the moist variant of the habitat and the filling of ditches is not required for restoration. Photo: S. Rūsiņa.

Fig. 14.3.2. Tall and thick vegetation of cultivated grassland indicates high soil fertility, therefore restoration of semi-natural grassland will be complicated. Photo: S. Rūsiņa.

Fig. 14.3.3. Former arable land overgrown with *Aegopodium podagraria*. Restoration of species-rich pasture or grazed meadow is complicated because topsoil needs to be removed to strip nutrients and eliminate the highly competitive ground elder. Photo: S. Rūsiņa.

should be ensured. Grazing intensity should be adjusted to grassland conditions, however in larger and moister grasslands suitable for wader nesting it needs to be relatively higher to ensure low vegetation and free access to soil.

14.3.3 Species-rich Pastures and Grazed Meadows Requiring Ecological Restoration

Grassland requires restoration if it has one or more of the following indications:

- it has been drained using internal drainage or deep open ditches;
- it has not been managed for several years;
- it has been mown with mulching or leaving the grass for more than five years;
- it is very tussocky;
- overgrown with trees and shrubs;
- sward is dominated by one or more expansive species, for example, *Calamagrostis epigeios, Aegopodium podagraria, Anthriscus sylvestris, Elytrigia repens, Filipendula ulmaria, Taraxacum officinale, Dactylis glomerata, Lolium perenne;*
- there are signs of overgrazing – disturbed turf or overgrazing indicators (*Plantago major, Trifolium repens, Polygonum arenastrum, Poa annua* in more than 30% of the grassland area);
- there are many invasive species: *Solidago canadensis, Rumex confertus, Heracleum sosnowskyi*;
- vegetation consists of sown grasses and legumes: *Lolium perenne, Poa pratensis, Dactylis glomerata, Phleum pratense, Festuca pratensis, Trifolium repens.*

14.3.4 Restoration Potential

The typical variant of the habitat type has developed in some of the most fertile and agriculturally suitable soils that occur naturally in Latvia. Therefore, for historical reasons this habitat is not common nowadays because it has been transformed into arable fields or sown and improved grasslands. The moist variant has been drained in large areas and converted into arable land or improved grassland. Therefore, restoration of habitat requires the restoration of environmental conditions that were changed during agricultural use period – restoration of moisture regime and soil nutrient removal.

The poor soil variant and, to a lesser extent, the moist variant is usually abandoned and overgrown with shrubs; the soil conditions have changed little and only the vegetation structure needs to be restored.

The restoration potential depends on the ex-

Fig. 14.3.4. Although grass yield in such ex-arable land is not high, the dominance of *Taraxacum officinale* indicates that the soil is fertile and restoration of semi-natural grassland requires nutrient removal. Otherwise the semi-natural grassland species will not be able to compete with the dandelion and other nitrophilous species. Photo: S. Rūsiņa.

Fig. 14.3.5. A mesic grassland that is relatively easy to restore with low soil fertility and low sward with many wild species on hilltops and fertile soil with tall nitrophyte vegetation in depressions. Extensive grazing is necessary with intensive grazing or mowing and hay removal in more fertile areas two or three times per season. Photo: S. Rūsiņa.

tent of the transformation of the grassland. There are a number of situations depending on the type of restoration and difficulty level.

14.3.4.1 Grasslands Affected by Drainage

The moist variant of the habitat type (6270*_3) is adversely affected by drainage. If it has been drained using shallow ditches (approx. 20 cm deep), no negative effect on the habitat usually occurs (*see Chapter 14.5*), but waders may be adversely affected (*see Chapter 20.9*). If it is drained using deep ditches, then the potential impact of blocking or filling the ditches on the development of vegetation and fauna and future management options should be evaluated. Biodiversity in drained grasslands is usually low because drainage, which is often accompanied by intensive fertilisation, increases soil fertility (increase in bioavailable nitrogen, phosphorus and potassium), and reduces the suitability for species of moist areas. Rewetting aims at achieving the opposite effect – reduction in soil fertility and making soil and moisture conditions suitable for moisture-loving species.

It is recommended to consult a professional hydrologist and botanist about whether the complete filling of ditches is necessary or a minor elevation of groundwater table could be sufficient. If the area has been a fen before drainage, then complete filling of ditches can raise the groundwater table too high, which can lead to paludification rather than the formation of a moist grassland.

No research on the optimum groundwater table in grasslands of the moist variant of the habitat type has been conducted in Latvia. Research elsewhere in Europe shows that it should be ap-

Fig. 14.3.6. Abandoned species-rich pasture that is easy to restore. All species characteristic of semi-natural grassland still occur there. Photo: S. Rūsiņa.

Fig. 14.3.7. Abandoned species-rich pasture that is easy to restore. Photo: S. Rūsiņa.

Table 14.4.1. Conflicting management priorities of 6270* *Fennoscandian lowland species-rich dry to mesic grasslands*

Question	Problem	Solution
Which habitat should be preserved – 6270* *Fennoscandian lowland species-rich dry to mesic grasslands or* 6510 *Lowland hay meadows*	Both habitats can be developed in the same soil conditions, but the main distinguishing factor of these habitats is the management type. Grazing supports the existence of habitat type 6270*, and mowing the existence of habitat type 6510.	To be assessed in a given situation. If a certain type of management is not possible, then it is better to implement the management that is possible and maintain the semi-natural grassland, although the habitat type could change over time.
Which habitat type should be preserved – 6270* *Fennoscandian lowland species-rich dry to mesic grasslands* or 6230 *Species-rich Nardus grasslands, on siliceous substrates in mountain areas*	Prolonged grazing gradually encourages the establishment of heather and transformation of habitat into *Nardus* grassland or heathland.	*Nardus* grasslands are a habitat with high conservation priority, which means they are threatened and occur mainly in the European Union, therefore priority should be given to the preservation of a *Nardus* grassland, unless there are protected species that require habitat maintenance.

proximately 15–30 cm deep in summer and almost 0 cm in the autumn-spring period (Van de Riet et al. 2010). If rewetting provides such groundwater table, then the amount of bioavailable nitrogen in soil will gradually decrease (because nitrogen mineralisation is slower in wet conditions, while denitrification accelerates), which is the objective. At the same time, the phosphorus content in soil will increase (because as a result of moisture phosphorus will be released, that until then was in iron compounds inaccessible to plants) to up to 40 kg ha^{-1} annually. Reduction in the soil nitrogen and potassium concentration should be attempted to reduce the negative effects of phosphorus on species diversity after rewetting. If the content of both these elements in soil is insufficient for tall competitive grasses, then a high amount of soil phosphorus will not cause intensive growth of vegetation and the biodiversity can be restored (Van de Riet et al. 2010). To reduce the concentration of nitrogen, any external sources of nitrogen should be eliminated, for example, the entry of fertiliser into grassland with runoff from adjacent arable land or nitrogen-enriched floodwaters should be prevented. After rewetting, grass should be mown and removed at least twice every summer for several years.

If the drained grassland still contains plant species characteristic of moist areas, for example, *Filipendula ulmaria*, *Carex* spp., *Lychnis flos-cuculi*, *Angelica sylvestris*, *Geum rivale,* then grassland restoration may be successful even without filling the ditches (Fig. 14.3.1). If there are very few such species, but the soil fertility is not high, slight elevation of the groundwater table will encourage the establishment of moisture-loving species.

If there are no species characteristic of moist areas in the grassland and mesic nutrient-demanding species are dominating, for example, *Dactylis glomerata, Phleum pratense, Anthriscus sylvestris*, the restoration of the moist variant of this habitat type is likely not possible and should be created from scratch by drastically changing the moisture regime, reducing soil fertility, and introducing species characteristic of moist pastures (e.g. from adjacent moist semi-natural pastures).

If it has been drained by internal drainage and it functions well, then it is complicated to restore this habitat variant, therefore the restoration of the typical (6270_1) or poor-soil (6270*_2) variant should rather be planned.

14.3.4.2 Grasslands with Long Period of Improvement or Arable Land Use

Restoration of species-rich pasture in a cultivated grassland or arable land that has been fertilised for a long period of time means creating it from scratch. Such grasslands are usually very fertile, dominated either by sown grassland or fertile ex-arable land vegetation with tall, nutrient-demanding grasses (*Phleum pratense, Agrostis gigantea, Dactylis glomerata*) (Fig. 14.3.2). Grasslands, where grass has been mulched and left on the field or that have been abandoned for a long period of time, can be dominated by nitrophilous tall forb species: *Anthriscus sylvestris*, *Aegopodium podagraria, Chaerophyllum aromaticum*, *Urtica dioica* (Fig. 14.3.3).

Even if the actual yield of grassland is not high (for example, in the case of the prevalence of *Taraxacum officinale* or long-term mulching resulting in a thick layer of accumulated litter), the soil nutrient reserves can notably exceed the amount required for semi-natural grassland (Fig. 14.3.4).

The creation of species-rich pastures and grazed meadows in intensively cultivated grasslands or arable fields by mowing and grazing alone can

take 30–40 years or more because the level of nutrients accumulated in the soil during cultivation decreases very slowly. To accelerate this process, thorough restoration is required – soil nutrient removal by deturfing, deep ploughing or growing barley for 2–3 years without the use of phosphorus fertiliser (*see Chapter 21.6*), with subsequent sowing of semi-natural grassland seeds or the transfer of seed-containing hay (*see Chapter 21.7*).

14.3.4.3 Grasslands with Short Period of Improvement or Arable Land Use

In Latvia, there are large areas with previously improved grasslands and former arable land which appear semi-natural at first sight – they contain many wild plant species (*Leucanthemum vulgare*, *Campanula patula*, *Centaurea jacea*). They typically have a pronounced vegetation mosaic. Vegetation on hillsides is almost semi-natural and quite diverse, but in depressions or north-facing slopes it still resembles improved grassland or fertile ex-arable land – dominated by *Dactylis glomerata, Elytrigia repens, Phleum pratense* and other tall grasses or forbs such as *Anthriscus sylvestris, Aegopodium podagraria* (Fig. 14.3.5).

Such grasslands most often occur in hilly areas and plains with poor soils, where intensive farming was interrupted in the late 1990s. Due to terrain that is unsuitable for arable farming and other circumstances, these grasslands are abandoned or managed extensively – only by mowing for hay or grazing, but without improvement.

Such grasslands are relatively easy to restore back to a semi-natural grassland state because many semi-natural grassland plant species are already established there and hay harvesting and grazing have already reduced soil fertility over time. It is necessary to start mowing and grazing, after clearing shrubs and smoothing the grassland surface (if necessary). In the first years, it is recommended to mow twice per season, especially the grassland areas where the sward is taller and thicker with expansive species. Deturfing or deep ploughing, followed by spreading seed containing hay obtained from species-rich grasslands of the same type, is recommended in such places.

14.3.4.4 Grasslands without a Period of Improvement or Arable Land Use

If a previously managed species-rich pasture or grazed meadow has not been ploughed or improved for at least 30–40 years, and is abandoned and overgrown with shrubs and trees, only the felling of shrubs and trees and starting of grazing is required. If dense scrub or forest has established and no grassland vegetation patches are left, then species richness should be restored by transferring seed containing hay from species-rich grasslands (Fig. 14.3.6, 14.3.7).

If a previously managed species-rich pasture or meadow has been ploughed, but the period of arable land has been short (1–3 years) without the intensive use of mineral fertilisers, then the habitat can be restored relatively quickly (within 10–20 years), provided that management is appropriate and plant species characteristic of this habitat occur nearby.

14.3.5 Restoration Methods

The required restoration methods are presented in Table 20.1 of Chapter 20 and in Chapter 21.

14.4 Conflicting Management Priorities of Species-rich Pastures and Grazed Meadows

Managers of species-rich pastures and grazed meadows can experience conflicting management situations that can be observed for all grasslands (*see Chapter 7.1.4*), as well as specific conflicts, which can arise if the impact of management on all nature values present in the grassland is not evaluated during management planning (Table 14.4.1).

14.5 Examples of Restoration of Species-rich Pastures and Grazed Meadows in Latvia

In Latvia, species-rich pastures and grazed meadows have been restored in four LIFE projects: "Restoration of Latvian floodplains for EU priority species and habitats" LIFE04 NAT/LV/000198; "The improvement of habitat management in the Natura 2000 site – Vestiena" LIFE06 NAT/LV/000196 and "Measures to ensure the nature conservation management in Teiči Area LIFE00 NAT/LV/007127, "Protection and management of the Northern Gauja Valley" LIFE03 NAT/LV/000082," (Anon. 2015d). Monitoring was carried out in the last two projects (Rūsiņa 2008).

A project funded by the Latvian Environmental Protection Fund in Slītere National Park in 2014 included the restoration of Dāvidpļava meadow – clearing of shrubs, commencement of mowing and cleaning of the shallow ditch system.

Paludification of grassland is stopped, grassland mowing has been enabled and the volume of expansive plant species is decreasing (Fig. 14.5.1–14.5.2).

Fig. 14.5.1. Restoration of Dāvidpļava meadow. (**a**) Before restoration, (**b**) clearing of shrubs, (**c**) after restoration. Photo: S. Rūsiņa (a), Slītere National Park archive (b, c).

Fig. 14.5.2. A shallow ditch hand-dug in the first half of the 20th century is cleaned in Dāvidpļava. The removed soil has been spread out along the edge of the ditch. The vegetation there will recover in a few years. Photo: Slītere National Park archive.