Chapter 18. 6510 *Lowland hay meadows* (S. Rūsiņa, A. Auniņš, V. Spuņģis)

18.1 Characteristics of the Habitat Type

18.1.1 Brief Description

Habitat type 6510 *Lowland hay meadows* (referred to as *Hay meadows* in the text) includes mesic species-rich meadows in moderately fertile and fertile soils. They feature a great diversity of forb species. They are mown only once or twice per year with aftermath grazing. This habitat also includes moist grasslands outside river floodplains dominated by tall nutrient-demanding competitive grasses. Such grasslands in floodplains are included in habitat type 6450 *Northern boreal alluvial meadows* (Rūsiņa 2013k).

Habitat occurs rarely and in small areas across Latvia. The total area is 5,300 ha or 11.4% of all semi-natural grasslands – there are only 0.5 ha of this habitat for every 2,500 ha on average (Fig. 18.1.1). Latvia has 23% of the total area of the habitat type in the EU boreal region.

Depending on vegetation composition and its determining environmental conditions, two variants can be distinguished (Auniņš (ed.) 2013) (Table 18.1.1).

Permanently moist sites in Latvia are often drained using internal drainage or open ditches. In such locations grasslands have been ploughed or improved and not all of them meet the EU protected habitat status. To classify the grassland as an EU protected habitat, they:

- 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 former arable land or improved grassland, then the grassland should contain at least five semi-natural grassland indicator species (Annex 4) that occur across the entire grassland and not in just some of its parts (for more details *see Chapter 1.2*).

Hay meadows in Latvia are very fragmented and dispersed, and there are no sites where they occur together in a larger area. Most often they have formed in areas with fertile soils, as well as in river valleys on terraces and slopes and in elevations of the floodplain where excessive moisture does not remain all summer (Fig. 18.1.3–18.1.6). In Zemgale region these meadows often occur in valleys of small rivers, however, there they have been significantly affected by excessive fertilisation with floodwater from adjacent agricultural land.

[1] Version of 23 August 2005.

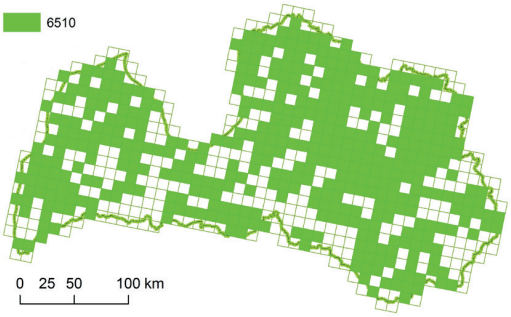

Fig. 18.1.1. Distribution of EU protected habitat type 6510 *Lowland hay meadows* in Latvia (Anon. 2013a).

18.1.2 Vegetation, Plant and Animal Species

Plants and vegetation. Vegetation is dense, medium-tall to tall (0.5-1-2 m) with dense, well-formed turf. Plant communities typically have several layers. Moss layer is usually poorly developed, because of being shaded by herbaceous vegetation. There are usually several grass species in these meadows, but none of them are dominating. The main layer is the tall grass layer (Fig. 18.1.7, 18.1.8). It contains *Alopecurus pratensis, Arrhenatherum elatius, Helictotrichon pubescens, Festuca pratensis, Phleum pratense, Poa trivialis, P. palustris. Dactylis glomerata* is often important, but its large proportion (more than 30-50% of sward) indicates previous improvement or a previous arable land stage and soil fertility that is too high for the development of species-rich meadow. Tall forbs are also typical, for example, *Tragopogon pratensis, Anthriscus sylvestris, Pastinaca sativa.* The layer of medium tall herbs is also well defined with *Agrostis tenuis, Anthoxanthum odoratum, Festuca rubra, Cynosurus cristatus, Poa pratensis, P. angustifolia, Centaurea jacea, Hypericum perforatum, Solidago virgaurea, Rumex acetosa.* Usually a well-defined low herb layer (especially in meadows with grazed aftermath) mostly consisting of plants with rosette-type leaves and plants with decumbent or creeping shoots or stems: *Prunella vulgaris, Trifolium repens, Plantago lanceolata, P. media, Alchemilla* spp. (Rūsiņa 2013k). Moist, alternately moist and moderately fertile soils and moist slopes contain species-rich plant communities co-dominated by *Deschampsia cespitosa, Filipendula ulmaria, Carex panicea, Geum rivale, Geranium palustre.* Depending on the dominant species, the height of vegetation varies from moderately high to high.

Birds. Species that belong to the typical grassland bird communities, such as *Motacilla flava, Anthus pratensis, Saxicola rubetra, Acrocephalus*

Table 18.1.1. Variants of habitat type 6510 *Lowland hay meadows*. Photo: S. Rūsiņa.

Mesic grasslands on fresh moderately fertile to fertile neutral soils (6510_1, typical variant)	Moist grasslands on fertile well-aerated soils (6510_2, moist variant)
Species-rich meadows in moderately moist, usually moderately fertile and fertile slightly acidic to neutral-alkaline soils. Can be located in floodplains and outside them. Of tall grasses, *Arrhenatherum elatius, Festuca pratensis* and *Helictotrichon pubescens* dominate. The second, lower herb layer is composed of various forbs and rich grass flora – *Briza media, Festuca pratensis, Agrostis tenuis, Anthoxanthum odoratum, Festuca rubra*. Vegetation height in *Arrhenatherum* grassland up to 2 m, elsewhere 1-1.5 m). Hay yield 1.3–3 (4) t ha^{-1}.	Meadows relatively poorer in species, develop in moist, very fertile soils in terrain depressions and moist flat sites (in river floodplains this vegetation is included in the fertile variant of habitat type 6450 *Northern boreal alluvial meadows*). The most important plant species are *Alopecurus pratensis, Poa palustris* and *Poa trivialis*, sedges *Carex* spp. also occur. The most characteristic forbs are *Veronica longifolia, Galium* spp., *Lathyrus pratensis, L. palustris*. Hay yield 1.5–3 (4) t ha^{-1}.


Arrhenatherum elatius


Festuca pratensis


Alopecurus pratensis


Poa palustris


Tragopogon pratensis


Crepis biennis


Veronica longifolia


Gladiolus imbricatus

Fig. 18.1.3. Hay meadow in Lielupe floodplain near Bauska. Photo: S. Rūsiņa.

Fig. 18.1.4. Hay meadow with *Festuca pratensis* and richly flowering *Geranium pratense* in Venta valley near Piltene. Photo: S. Rūsiņa.

Fig. 18.1.5. A hay meadow near Lake Āraiši on a hill slope with a very rich grass species composition. Photo: S. Rūsiņa.

Fig. 18.1.6. A hay meadow with richly flowering forbs in Gauja floodplain, Gauja National Park. Photo: S. Rūsiņa.

schoenobaenus, Locustella naevia, Emberiza schoeniclus, often occur in hay meadows. The grassland also usually has a mosaic of low-density shrubs and shrub clusters that are suitable for certain passerine species (*Emberiza schoeniclus, Carpodacus erythrinus, Lanius collurio*). *Porzana porzana* and *Rallus aquaticus* occur in wet depressions. If the grassland area is large enough, *Crex crex* or some meadow wader species – usually *Gallinago gallinago,* on rare occasions also *Vanellus vanellus, Tringa totanus* also nest there, while *Gallinago media* can also occur in large and high-quality grasslands in river floodplains. Moderately damp grasslands are also used by *Tetrao tetrix* for lekking. If the grassland is next to a water body or water course with emergent vegetation mosaic, meadow ducks – *Anas querquedula, A. clypeata, A. strepera* – nest there. The presence of other species depends on the configuration of surrounding habitats – the feeding resources of floodplain grasslands attract species that usually nest 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 forests – raptors (for example, *Aquila pomarina*) and owls. During passage migration (especially during spring floods), they are used as resting and feeding grounds by a large number of various waterbird species, especially waders.

Every mentioned species has its own specific requirements for nesting or feeding habitat, therefore they can only occur together, if the grassland is sufficiently large and diverse and provides the required ecological niches to all these species. Only some of the species usually occur there.

Invertebrates. Hay meadows have a great diversity of day moths Rhopalocera, bees and bumblebees Apoidea, Orthoptera, bugs Heteroptera,

leafhoppers *Cicadellidae*, leaf beetles *Chrysomelidae*, weevils *Curculionidae* and many other insect species. 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 individuals. Ground beetles are represented by species of the *Poecilus* genus that inhabit open habitats. There are no species with marked dominance over other species in terms of number of specimens; polydominance (similar amount of specimens of different species) is observed.

18.1.3 Important Processes and Structures

Mowing is the most important factor that forms the typical vegetation of this habitat – species assemblage, vegetation layers, even distribution of species (no single dominant plant species, polydominant communities). Mowing creates equal growing opportunities for all species (grazing has completely different effect, since it is selective – some species are suppressed, others promoted) (Fig. 18.1.2, 18.1.9). For more on the influence of mowing, see Chapter 22.2.1.

Habitat can develop in very diverse terrain conditions – plain areas, hills and gently sloping hillsdes, shallow terrain depressions, river valley terraces and shallow terrace slopes (usually north- or west-facing), river and lake floodplains that become inundated rarely or temporarily. Soils are mesic and moist with favourable moisture conditionthroughout the vegetation season. Conditions can be periodically moist in terrain depressions. Soils are well aerated, with weakly acidic to neutral reaction. In moister places they can be peaty. The soil is rich in nutrients – moderately fertile and fertile.

Although this habitat develops in soils that are some of the most fertile among semi-natural grasslands, their fertility is still much lower than in improved grasslands. Biodiversity decreases significantly, if the amount of phosphorus exceeds 50 mg kg^{-1} (ac-

Fig. 18.1.7. Hay meadows in a favourable condition are very rich in plant species. Photo: S. Rūsiņa.

Fig. 18.1.8. Hay meadows are characterised by a tall grass layer (*Arrhenatherum elatius* and slight occurrence of *Dactylis glomerata*), medium grass layer (*Briza media*) and forb layer (*Galium album, Lathyrus pratensis, Vicia cracca* in the image). Photo: S. Rūsiņa.

Fig. 18.1.2. An appropriately maintained habitat type 6510 *Lowland hay meadows* in a favourable condition. For differences from habitat type 6270* *Fennoscandian lowland species-rich dry to mesic grasslands*, see Insertion 2).

cording to the Olsen method), in the optimal case it should be much (under 25 mg kg^{-1}) lower (Janssens et al. 1998).

18.1.4 Succession

It is likely that the habitat has been developing both naturally and in former arable land. Natural development was possible as a result of wild herbivore grazing in mesic and moist broadleaf and mixed forests and in river floodplains. Pastures developed initially and later, following the introduction of haymaking, were transformed into a meadow habitat. Recently the development of the habitat has been mostly occurring under the direct influence of human activity through the conversion of arable land into meadow, or extensive mowing of previously improved grasslands (Fig. 18.1.9).

As dominant grasses of hay meadows are nutrient-demanding, they also get established in habitats with poorer soils, as soon as their soil has become enriched, for example, by temporary abandonment or mulching. In such cases it cannot be considered that the habitat type 6510 *Lowland hay meadows* has developed, because under appropriate management these demanding plant species will disappear and the initial grassland vegetation structure and species composition will return. Thus, tall grasses of hay meadows should be considered as expansive species, the establishment of which in grasslands indicates eutrophication (enrichment of soil with nitrogen).

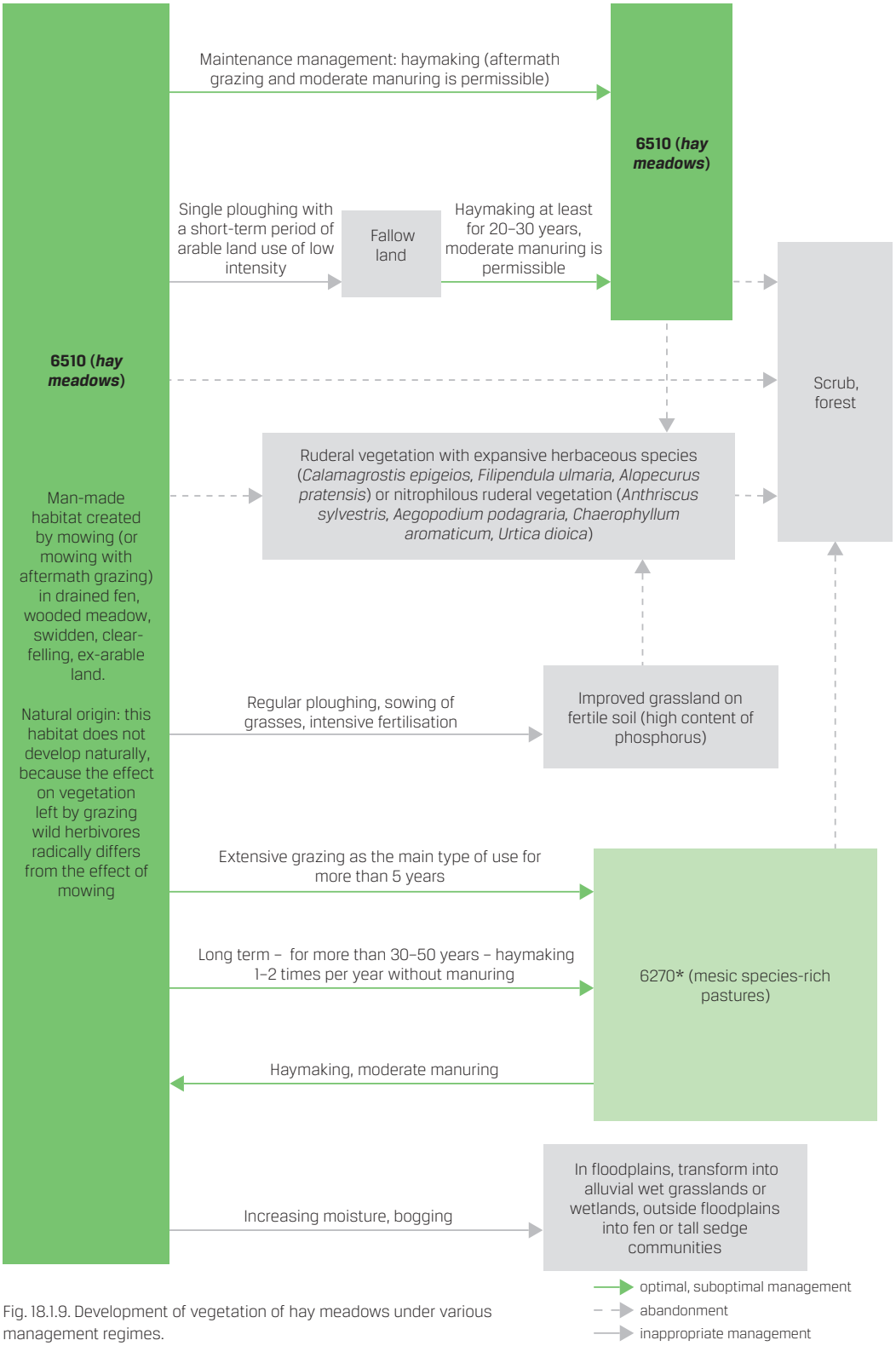

Fig. 18.1.9. Development of vegetation of hay meadows under various management regimes.

Table 18.3.1. Indications of a well-managed habitat type 6510 *Lowland hay meadows*.

Parameter	Meadow
Litter	Litter covers no less than 10% and no more than 30% of the ground.
Vegetation	Not one, but several grasses are dominating: *Festuca pratensis, Arrhenatherum elatius* and *Helictotrichon pubescens* in the tall herb layer, *Festuca rubra, Agrostis tenuis, Anthoxanthum odoratum, Briza media* in the medium layer, many forbs.
Vegetation structure	A very colourful meadow in full bloom, proportion of forbs and grasses is at least 1:1. Three layers of vegetation can be well distinguished: tall herb layer, medium layer and low (rosette-type and decumbent) plant layer. There is a high botanical diversity rather than just one or some dominant species.
Indicator species of semi-natural grasslands	At least 3-5 indicator species of semi-natural grasslands are widely distributed: in moist areas – *Carex panicea, Galium boreale, Geranium palustre, Ranunculus auricomus, Scorzonera humilis, Succisa pratensis, Trollius europaeus*; in mesic areas – *Plantago media, Leontodon hispidus, Briza media*.
Bird species	*Crex crex* breeds here, rich passerine fauna (*Crex crex* may be absent from grasslands smaller than 10 ha).
Invertebrate species	Grasslands are rich in invertebrate species that contain most of the meadow species. Dominated by butterflies, various Hymenoptera, many Diptera and beetles. Species of all other grasslands may be represented in various proportions in mesic meadows.
Expansive plant species	*Anthriscus sylvestris, Aegopodium podagraria, Filipendula ulmaria, Calamagrostis epigeios* and other expansive species are not present or dominate only up to 10% of the grassland area.
Drainage ditches	Shallow drainage ditches (~20 cm) are maintained, deep ditches are absent.
Shrubs and trees	Large trees are preserved, small shrubs in at least 10% of the area, but no more than 30%, no taller than 1.5 m.

Upon the cessation of management, habitat type 6510 *Lowland hay meadows* overgrows with *Alnus incana, Betula pendula, Populus tremula, Picea abies, Salix caprea*, while in moister places mostly with various *Salix* species. Broadleaf trees such as *Quercus robur, Fraxinus excelsior,* and *Tilia cordata* can also get introduced. The vegetation of tall nitrophytes often develops before overgrowing with shrubs. It may contain *Chaerophyllum aromaticum, Aegopodium podagraria, Anthriscus sylvestris.*

If moisture increases and aeration decreases in moister areas of floodplains, humidification may occur and the habitat type 6450 *Northern boreal alluvial meadows* or even wetlands with tall sedge and water edge vegetation may develop. Paludification and the establishment of fen plants may occur under the influence of a persistently increased ground-water table.

With the extensive use of grassland, hay meadows can remain almost unchanged for a long period of time (decades), especially in floodplains, where they become inundated and where the spring floods provide both fertilisation and aeration. However, prolonged use of meadows without works of meadow care (for example, harrowing of moss) and completely without fertilisation for several decades, causes vegetation changes. It occurs slower in fertile soils, if the use is very extensive by mowing only once per year, and more quickly in more acidic and moderately fertile soils, where the fertility decreases quicker. As soil becomes poorer in nutrients, the proportion of tall grasses and forbs decreases and medium-tall herbs become more important. It can become more similar to habitat type 6270* *Fennoscandian lowland species-rich dry to mesic grasslands.*

Depending on how mowing is combined with grazing, vegetation can change year by year and become more similar to habitat type 6510 *Lowland hay meadows* (only if mowing is combined with low-intensity aftermath grazing) or habitat type 6270* *Fennoscandian lowland species-rich dry to mesic grasslands* (if the main use is grazing for some consecutive years or if aftermath grazing occurs every year and is relatively long – several weeks).

18.1.5 Pressures and Threats

The habitat is adversely affected by all factors listed and described in Chapter 3. Change of land use type by ploughing and inappropriate management by im-

provement and fertilisation are the most important factors reducing the area and diversity of habitat type 6510 *Lowland hay meadows*. Today this process is becoming more and more active, as farmers, who manage their fields intensively and restore drainage systems and improve the fields, receive more rural support payments. As a result of eutrophication, the tall grasses characteristic for the habitat (*Arrhenatherum elatius, Festuca arundinacea, Alopecurus pratensis*) become expansive and suppress the diversity of other species. The amount of tall forb species (*Anthriscus sylvestris, Aegopodium podagraria, Urtica dioca*, in moist areas – *Filipendula ulmaria*) increases as well.

18.2 Conservation and Management Objectives of Hay Meadows

- Ensure the landscape connectivity and ecological processes characteristic of hay meadows (vegetation structure diversity and nutrient cycling ensured by appropriate mowing), creating preconditions that do not decrease the diversity and quality of the ecosystem services offered by this type of grassland habitat.
- Promote improvement in the number of localities and conservation status of species typical of hay meadows, as well as rare and declining species, by restoring suitable habitats for them in degraded grasslands.
- Restore and maintain the diversity of plant species, communities and habitats suitable for them: hay meadows are an important habitat for *Dactylorhiza* spp., *Platanthera* spp., *Cnidium dubium*, *Gladiolus imbricatus*.
- Restoring and maintaining the diversity of invertebrates, their communities and habitats suitable for them: at least 30 butterfly species can be observed in one season in a meadow rich in plant species. These meadow habitats are not directly inhabited by protected species, but the flowering plants attract butterflies. If meadows are located near a forest habitat suitable for *Parnassius mnemosyne*, then the butterflies feed in the meadows. *Lycaena dispar*, which can fly for large distances, also occurs there. *Hypodryas maturna* occurs near forests with *Fraxinus excelsior*.
- Providing sufficient living space for protected species related to grasslands (for example, *Crex crex*), and other grassland species, whose populations in Latvia have been reducing lately (*Motacilla flava, Carpodacus erythrinus (*Auniņš, 2016)).

18.3 Maintenance and Restoration of Hay Meadows

If the habitat is in a favourable condition, then restoration is not required and maintenance management is necessary (*see Chapter 18.3.1*). If any habitat features point to the opposite (see *Chapter 18.3.3*), restoration is necessary first. Examination of the area is necessary to ascertain the present nature values before commencing habitat restoration or management and a management plan has to be developed (*see Chapter 7*), considering the legal framework of habitat management (*see Chapter 7.2*).

18.3.1 Hay Meadows Requiring Maintenance

Maintenance is required for all hay meadows that are in a favourable condition. A hay meadow in a favourable condition is maintained by mowing once or twice per season each year with haymaking, is not overgrown with shrubs, it has no thick litter layer and there is a high diversity of plant species. Mown meadow has a distinct tall grass layer and medium herb layer. A meadow with grazed aftermath also has a layer of low (decumbent and rosette-type) plants. A meadow has many colourful flowering plant species on which butterflies, bees, bumblebees and other insects feed. Grassland has not been drained, no ditches have been dug or they are shallow and have not altered the moisture conditions substantially (Table 18.3.1, Fig. 18.1.6-18.1.8, Insertion 4).

18.3.2 Optimal, Suboptimal and Inappropriate Management

A summary of optimal, suboptimal and inappropriate management types is given in Table 1 and 10 of Annex 2.

The most appropriate maintenance is extensive mowing with haymaking once per season from late June until mid-July and moderate short-duration aftermath grazing in enclosures instead of continuous stocking in the entire grassland. Mowing with haymaking once or twice per season without aftermath grazing is permissible as well.

It is important to follow the traditional hay mowing and raking methods (turning hay while drying, stacking, carrying of loose hay to the barn) which helps the spread of species. Harrowing supports the destruction of the moss layer and ensures a favourable oxygen regime in the soil and preservation of a neutral soil pH. Moderate fertilisation

using solid manure is also possible.

The best mowing time in terms of bird conservation is starting from late July, because by that time the chicks of *Crex crex* from the first broods are able to fly. Earlier mowing is acceptable if grass is necessary for animals or improvement of grassland vegetation is prioritised, but it should be taken into account that earlier mowing means more destroyed nests and chicks. In any case, mowing should be carried out in a correct direction (from the centre towards the edges or from one edge to the other, in the direction towards a forest or another natural habitat), the use of animal-scaring devices is also recommended.

To preserve invertebrates, the preferred mowing time is starting from late July, because by then all protected butterfly species have already finished flying. Grazing and mowing can be alternated year by year in the same meadow. Mowing is recommended in drier years and grazing in wetter ones. In larger grasslands (starting from 0.5 ha), it is recommended to leave up to 10% of the grassland area unmown each year to preserve the diversity of grass-dwelling insects. The location of these areas should be changed each year. Shrub and tree overgrowth is cleared while maintaining areas with a favourable microclimate (New 1995).

18.3.3 Hay Meadows Requiring Ecological Restoration

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

- it has not been managed for several years;
- it has a thick moss cover;
- it has been mown with mulching or leaving the grass for more than five years;
- it is very tussocky;
- overgrown with trees and shrubs;
- vegetation is dominated by one or more expansive species, for example, *Anthriscus sylvestris, Aegopodium podagraria, Elytrigia repens, Filipendula ulmaria, Urtica dioica, Dactylis glomerata, Phleum pratense, Taraxacum officinale*, weeds, such as *Artemisia vulgaris, Cirsium arvense, Barbarea* spp.;
- there are many invasive species, such as *Solidago canadensis, Rumex confertus, Helianthus tuberosus, Heracleum sosnowskyi, Lupinus polyphyllus*;
- sward consists of sown grasses: *Poa pratensis, Dactylis glomerata, Phleum pratense, Festuca pratensis*, and legumes: *Trifolium pratense, Trifolium hybridum, Medicago sativa*.

18.3.4 Restoration Potential

Hay meadows have developed in soils that under natural conditions in Latvia are among the most fertile and best-suited for agriculture. This habitat is not common nowadays because it has been transformed into arable fields or sown and improved grasslands.

The restoration potential depends on how much the grassland has been transformed. There are three levels of restoration difficulty. They do not differ from the situation with the habitat type 6270* *Fennoscandian lowland species-rich dry to mesic grasslands*; levels of difficulty and restoration potential have been described in Chapter 14.3.3.

18.3.5 Restoration Methods

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

When restoring hay meadows, several restoration aspects specific to the habitat should be considered.

Restorative mowing or grazing: grazing twice per season with haymaking is the most suitable. If there are many expansive species, mowing up to three times per season with the immediate removal of mown grass is preferable to reduce the amount of expansive species and their dispersal with seeds. Grazing as a restoration method is permissible, but after restoration it should be replaced with mowing, otherwise the habitat type 6510 *Lowland hay meadows* will not develop.

Creation of suitable conditions for birds of hay meadow grasslands: the main ornithological value of this grassland habitat is *Crex crex*, therefore, if this species is the restoration objective, restoration and management should be adapted to its requirements. For *Crex crex,* mowing is most appropriate after the chicks of the first brood are able to fly. If the grassland is located in a river floodplain and is frequently inundated, *Gallinago media* may also occur there. For the conservation of this species, it is essential to ensure regular flooding and a high groundwater table that maintain moist and loose soil, while vegetation parameters are less important.

18.4 Conflicting Management Priorities of Hay Meadows

Managers of hay meadows can experience conflicting management situations typical to all grassland habitats (*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 18.4.1).

Table 18.4.1. Conflicting management priorities of habitat type 6510 *Lowland hay meadows*

Question	Problem	Solution
Which habitat type should be preserved – 6270* *Fennoscandian lowland species-rich dry to mesic grasslands* or 6510 *Lowland hay meadows*	Both habitats can develop in the same soil conditions, but the main distinguishing factor of these habitats is the management type. Grazing supports the existence of habitat 6270*, and mowing the existence of habitat 6510.	It should be evaluated depending on the actual situation. If implementation of a certain type of management is impossible, the implementation of management measures that are possible should be preferred to maintain semi-natural grassland, although the habitat type could change over time.