Chapter 7. Preparing for Grassland Habitat Management

7.1 Planning of Grassland Habitat Management in a Specific Area

7.1.1 How to Determine Whether a Grassland Requires Maintenance, Ecological Restoration or Creation (S. Rūsiņa)

When creating a grassland in a place where it is not present, or restoring and maintaining an existing one, there must be clear plan of measures to be taken, as well as their sequence and time interval.

First it should be determined whether grassland habitat creation, restoration or only maintenance is necessary in the target area. To do this, the existing habitat type in the area must be determined (Table 7.1.1).

Only traditional extensive grassland management is suitable for the conservation of biodiversity in semi-natural grasslands. If the grassland has been managed more intensively (improvement, intensive drainage) or more extensively (mulching, infrequent mowing, abandonment) for several years, it is more likely to require restoration. Restoration includes all measures required in addition to the daily/annual maintenance activities - mowing or grazing. The most common cases that require restoration are summarised in Table 7.1.2.

7.1.2 Grassland Restoration and Maintenance Planning (S. Rūsiņa)

Grassland restoration planning should be started by setting the objective – determining what the restored grassland should be like. What will the environmental conditions be, what ecological processes will take place, what vegetation and species can be restored? The objective depends on the extent of change in environmental conditions and ecological processes important for the EU protected grassland habitat type, as well as on financial resources and the desired timeframe (Crofts, Jefferson (eds) 1999; SER 2004) (*see Chapter 6.4*). Depending on the degree of degradation, grassland restoration takes at least 5-10 years.

Maintenance of grassland in a favourable condition is only possible if appropriate grassland maintenance methods are used. Unlike grassland restoration, where objectives can differ depending on the restoration possibilities, the conservation objective of grassland maintenance usually means the maintenance of grassland habitat and/or its species populations in a favourable condition. However, there can also be problems during the planning of maintenance, which may require the specification of the objective. In ecosystem restoration one should always consider the restrictions: environmental (climate, soil, geological and hydrological conditions, landscape fragmentation and its impact on species populations), economic (financial constraints), social (public, often also funders', opinion). They should already be taken into consideration when planning the works – possibly, more money, more time will be required and less success should be expected. However, it does not mean giving up all the plans and accepting that it is not worth doing anything. Even if in many cases it is not possible to achieve restoration of the original "ideal" condition, improvement is definitely possible. Action will be more successful if the planning is wise and includes a risk assessment. Without realising obstacles, we risk making more mistakes.

Grassland restoration and maintenance objectives can be achieved by different solutions at the same site. Methods and techniques can vary significantly both in terms of financial and time resources, therefore a thorough feasibility study and evaluation of alternatives must be conducted to select the best restoration solution.

Selection of restoration and maintenance works and procedure is determined by three aspects: ecological conditions of the site, available resources of species and the desired timeframe for the achievement of the objective (Table 7.1.3).

Key steps of grassland restoration and maintenance plan development are summarised in Table 7.1.4.

7.1.3 Grassland Creation Planning (S. Rūsiņa)

The creation of grassland should be started by assessing the environmental conditions on site (moisture regime, soil properties, vegetation, species availability), as this will determine the type of grassland habitat that can be created. It is impossible to provide a detailed creation plan for each EU protected grassland habitat type. It should be developed with the participation of soil experts, hydrologists and ecologists, as well as experts in vegetation and those groups of organisms that are important in the habitat to be created. The grassland creation plan should be developed in the same way as the grassland restoration plan.

Table 7.1.1. How to determine whether a grassland requires maintenance, restoration or creation.

The characteristics of the territory, where the creation or restoration of the grassland is planned, must be determined

It is possible to clarify, whether the grassland is an EU protected grassland habitat, by checking its status on Nature Data Management System *Ozols* (https://ozols.gov.lv/ozols/) or Rural Support Service, if the support for the maintenance of the grassland as an agricultural activity has been granted.
If no information on the grassland is available on these resources, it has to be determined, whether the grassland is semi-natural and conforms to any of EU protected habitat types, or it is an improved grassland or a fallow land.
Chapter 1.2 contains instructions on how to distinguish semi-natural grassland from an improved grassland or a fallow land.
The conformity of the semi-natural grassland to the EU protected habitat types can be determined in accordance with the descriptions of the EU protected habitat types included in Chapters 8 - 19 or EU protected habitat type interpretation manual (Auniņš (ed.) 2013).
An alternative is to invite a habitat expert (the list of experts is available on the website of Nature Conservation Agency www.daba.gov.lv).

No grassland specific vegetation is present in the area	Improved grassland / fallow land	Semi-natural grassland
Creation (*see Chapter 7.1.3*)	**The potential for restoration must be determined** Chapters 1.2 and 8 provide advice on how to evaluate the degree of naturalness of an improved grassland / fallow land and the possibilities of creating a semi-natural grassland.	**The type of EU protected grassland habitat and its conservation status must be determined** Subsection 3 of Chapters 8–19 provides features of grassland habitat type in favourable condition and features indicating the need for restoration. Annex 1 summarises indicators for grassland evaluation in general.

No features of semi-natural grassland or bird habitat, key environmental conditions are unsuitable for target EU protected habitat type or bird habitat	There are some features of a semi-natural grassland, the environmental conditions and ecological processes have been changed, however, they can be restored	Bad, inadequate condition	Good or inadequate but improving condition
Creation *(Chapter 7.1.3)*	**Restoration** *(Chapter 7.1.2)*		**Maintenance** *(Chapter 7.1.2)*

Table 7.1.2. The most common cases when grassland requires ecological restoration.

Grassland type	Indications of restoration necessity
Grassland affected by abandonment	
Grassland overgrown with trees and shrubs	Overgrows with trees and shrubs, thick layer of litter, semi-natural grassland indicator species are few or absent, patchy vegetation, dominated by expansive plant species (for the most common expansive species, see the description of each habitat). Grassland completely transformed into scrub or forest cannot be restored. In such a case, the creation of grassland habitat is required.
Grassland overgrown with expansive species	No trees or shrubs; the remaining features similar to grassland overgrown with woody species.
Grassland with a thick layer of litter	The litter covers the soil evenly, thus changing the habitat environmental conditions and adversely affecting the characteristic species of the habitat. Sparse, loose litter layer covering the soil unevenly (sometimes develops in a regularly mown or grazed grassland if the grass has grown abundantly in aftermath in autumn), is not considered to be a problem.
Grassland affected by change of land use type	
Ploughed grassland, ex-arable land	Ex-arable land weeds, poorly developed turf, many annual plant species, domination of *Elytrigia repens, Agrostis tenuis, Phleum pratense*, legumes, also shrubs and trees in abandoned ex-arable land, few semi-natural grassland indicator species or none. Restoration of grassland habitat in arable land that has been fertilised for a long period of time is not possible – habitat creation is necessary.
Afforested grassland	Tree canopies are still not closed and therefore the characteristic herb layer is partially preserved. If there are no such species or a characteristic forest groundcover has developed, restoration is impossible and grassland habitat creation is necessary.
Grassland affected by inappropriate management	
Fertilised, improved grassland	Dense vegetation and high yield or, if the grassland has not been managed for a longer period of time, patchy vegetation with thick grass in some places and sparse in others, dominated by *Taraxacum officinale*. Poorly formed turf. Few semi-natural grassland indicator species or none. Low species richness.
Overgrazed grassland	Many overgrazing indicators, for example, *Plantago major, Polygonum arenastrum, Prunella vulgaris, Poa annua*. Trampled turf, many open soil patches.
Frequently mown grassland	Resembles a lawn, dominated by low grasses, very low species diversity.
Mulched grassland or cut grass left uncollected	High yield, dense layer of litter developed due to annual mulching, many expansive plants species, low diversity, few semi-natural grassland indicator species or none. Dominated by nitrogen-demanding grasses: *Phleum pratense, Dactylis glomerata, Calamagrostis epigeios, Holcus* spp.*, Deschampsia flexuosa* and forbs *Anthriscus* spp., *Taraxacum officinale*, *Aegopodium podagraria*.
Grassland mown late for a long period of time	See the properties of mulched grasslands.
Grassland managed by unsuitable tractor equipment	Tyre tracks with vegetation which differs from the rest of the grassland. Peat can accumulate and species characteristic of fens may dominate in the tracks, such as *Eriophorum latifolium, Menyanthes trifoliata, Comarum palustre, Sphagnum* spp.
Grassland that is mown too infrequently or grazed inefficiently	Overgrown with trees and shrubs, thick layer of litter, few semi-natural grassland indicator species or none at all, patchy vegetation, dominated by expansive plant species.
Grassland affected by drainage	
Drained grassland	Ditches or sub-surface drainage. Many expansive species in the vegetation (see the indications of fertilised, improved grassland).

(continued)

Table 7.1.2 (continued)

Grassland type	Indications of restoration necessity
Grassland affected by eutrophication	
The grassland is located next to intensive agricultural land	High abundance of expansive species, denser and higher vegetation near the intensive agricultural land; further from the area of influence, vegetation becomes more typical for the habitat.
Grassland in river floodplain	High yield, dense vegetation. Few semi-natural grassland indicator species or none, dominated by expansive nitrogen-demanding species (*see the description of each habitat*). Low species diversity.
Grassland overgrown with expansive species	Dominated by expansive herb species (*see description of each habitat*), low species diversity.
Grassland affected by wild animals	
Grassland affected by wild boar rooting	Turf rooted up, ex-arable land species and weeds growing in the damaged areas (*see properties of ploughed grassland, ex-arable land*).
Grassland affected by beaver dams	Wet conditions not characteristic for the habitat. Establishment of tall sedge species. Signs of paludification.
Grassland with constructed game feeders	Signs of eutrophication (*see properties of grassland affected by eutrophication*). Many nitrogen-demanding perennial and annual weed species in the direct vicinity of the feeder. Characteristic vegetation of semi-natural grassland has disappeared.

Table 7.1.3. Time and finances necessary for habitat restoration depending on the initial ecological conditions and availability of species.

Adequacy of ecological conditions and processes with the target habitat	**Availability of species resources**	
	Good (similar habitats are closer than 500 m)	**Poor** (no similar habitats in the landscape or their condition is poor)
Good (soil properties, water regime match the target habitat or are only slightly altered and easy to restore)	The objective can be reached quickly, cheaply and efficiently, even with simple methods	Simpler and cheaper methods will reach some result, but it will be slow and the outcome cannot be foreseen. For faster results, time-consuming and expensive methods should be used
Poor (heavily altered ecological conditions, restoration is complicated)	Simpler and cheaper methods will achieve the result, but slowly and the outcome cannot be foreseen. For faster results time-consuming and expensive methods should be used	The objective can be reached slowly, with high investment of time, work and finances. Often the ideal objective is impossible to achieve.

Table 7.1.4. Steps of grassland restoration and maintenance planning.

Planning steps
1. Collecting information about the area
For restoration: to determine the condition and processes or structures of the grassland that needs restoration (for example, vegetation, animal and plant species composition, soil characteristics, terrain, moisture regime, drainage system and status, past and current management). **For maintenance:** to determine the condition and processes or structures for which maintenance is necessary to ensure habitat existence. The objective of this planning step is to understand which factors and ecological processes impair the habitat conservation status. In the case of ex-arable land and improved grassland – the factors and processes that limit the restoration of semi-natural grassland. Specific restoration measures can only be planned after the identification of these factors. Information sources are: cartographic material from different time periods, previous research materials (if any), grassland inventory forms filled out by a habitat expert (contact the Nature Conservation Agency), local population opinion surveys, local history museum materials (memories, photos), nature conservation plans, spatial plans of local governments, field research, involvement of relevant experts. *Chapter 3 lists and describes factors and processes that most frequently cause deterioration in habitat condition and that need to be eliminated to conserve the habitat in favourable condition. Factors and threats specific to each EU protected habitat type are described in the chapter dedicated to the habitat (Chapters 8-19), Sub-chapter 1.*
2. Establishing the grassland maintenance or restoration objective
For restoration: the ideal goal is to achieve a favourable condition of the habitat – create or restore the grassland to a condition where it has the structure, ecological processes and species composition characteristic of the respective EU protected grassland habitat type. **For maintenance:** the ideal goal is to maintain a favourable condition of the habitat and prevent its degradation – maintain and preserve the grassland in a state where it has the habitat structure, ecological processes and species composition characteristic of the respective EU protected grassland habitat type. *See Chapter 6.4. For conflicting management priorities, see Chapter 7.1.4.*
3. Assessing the suitability of the current management for the achievement of the objective
The suitability of the current management for the achievement of the objective can be assessed by using the description of the respective EU protected grassland habitat that needs restoration (*Chapters 8–19, Sub-chapter 3, Annex 2*). If management is inappropriate, it must be adjusted.
4. Identifying required habitat restoration or maintenance measures and methods
Different parts of the same grassland may require different restoration or maintenance measures and their various combinations. For example, in the part of grassland with an abundant population of a protected plant species, restoration measures will focus on favourable condition of this species, while elsewhere the objective will be to ensure suitable vegetation structure for Corncrake, and further elsewhere to restrict expansive species.

(continued)

Most methods used in grassland creation are described in *Part IV* of the book.

7.1.4 Conflicting Management Priorities (S. Rūsiņa, A. Auniņš, V. Spuņģis)

There are at least two conflicting situations in the conservation and management planning of semi-natural grassland habitats and species. Firstly, conflicts can arise when there are target species that require different environmental conditions and therefore can react to management differently in grassland. Then, either the main value of the grassland is selected and the management approach is adapted to that (in such cases other nature values can suffer and decrease over time), or a compromise is chosen that will preserve all target species, even if each species will occur in a smaller number or proportion. For example, Corncrake breeds more successfully if mowing is performed late, after 20 July. This substantially reduces Corncrake nest and chick destruction when mowing. However, this reduces the number and diversity of plant species, because long-term annual late mowing (especially annual mowing only in August or later) causes the accumulation of soil nutrients and leads to the excessive growth of certain grass species that suppress the diversity of other plant species. If Corncrake is chosen as the main value of the grassland and it is mown in late July or later each year, a decrease in plant species diversity is expected. If mowing is performed early each year, the breeding success of Corncrake population will decline, transforming the grassland into an eco-

Table 7.1.4 (continued)

Planning steps
In such cases, it is desirable to map the required measures. *Habitat type chapters (Chapters 8–19, Sub-chapter 3) contain references on restoration and maintenance measures possible in a specific habitat. Restoration methods for each EU grassland habitat type are listed in Sub-chapter 3 of the chapters on each habitat type (Chapters 8–19). Description and comparison of restoration and maintenance methods is given in Part IV, Chapters 20–23 of the book.*
5. Identifying ecological and landscape constraints and advantages for the implementation of restoration or maintenance measures
The existing ecological restrictions or advantages for grassland restoration must be clarified. *See Chapters 6.4 and 24.* The potential side-effects of the restoration process should also be established. For example, whether soil grinding will create favourable conditions for the spread of invasive species. If it can happen, then additional measures to prevent invasion must be included in the restoration process.
6. Identifying socioeconomic constraints and advantages of restoration or maintenance measures
See Chapter 6.4. For cost calculation, see Chapter 7.3.
7. Identifying legal restrictions for restoration or maintenance measures
See Chapter 7.2.
8. Specification of grassland restoration or maintenance objective, setting an alternative "compromise" objective
The objective of grassland restoration and maintenance should be specified, considering environmental, legal and socioeconomic constraints and advantages. If the ideal objective cannot be achieved, then less ambitious objectives should be set. In the case of restoration, they are, for example, improvement of habitat vegetation structure, improvement of moisture conditions or the creation of suitable living conditions for a specific plant, bird or other species. The ideal objective of grassland management - preserving grassland in a favourable condition - is sometimes impossible to achieve. For example, the EU protected grassland habitat type 6270* *Fennoscandian lowland species-rich dry to mesic grasslands* can only be maintained in a favourable condition by grazing, but the grassland manager is unable to provide it. In this case, adjusting the objective should be considered by introducing maintenance methods with the lowest and slowest adverse impact on the habitat conservation status available to the manager. The objective of such action is the preservation of biodiversity until more appropriate management methods become available.
9. Developing the restoration and maintenance activity schedule
Planning the sequence and time of the required restoration and maintenance works, considering the restraints faced during planning. *Chapter 20 describes the sequence of work depending on the initial condition of the grassland for which restoration is needed.*
10. Developing restoration and maintenance success monitoring
During the grassland restoration and maintenance, periodic re-evaluation of the grassland conservation objectives is required to adapt to the situation and changes on site and the influence of restoration measures on the grassland habitat structure, species and ecosystem as a whole. To objectively assess the changes that have taken place during restoration and maintenance, they should be documented. This is ensured by restoration success monitoring. *Assessment of grassland restoration success has been described in Chapter 7.4.*
11. Periodic review and adjustment of the restoration and maintenance objectives and strategy
When evaluating the monitoring results, make the necessary adjustments in the restoration and maintenance process.

Table 7.1.5. Conflicting management priorities of EU protected grassland habitat

Biodiversity value	Nature of contradiction	Solution
Plants and vegetation *versus* birds and invertebrates	To preserve the diversity of plant species and vegetation, grassland should be mown much earlier as it is necessary for birds and invertebrates. Early mowing destroys bird nests, whereas late mowing reduces the diversity of plant species by changes in vegetation composition.	Select the mowing time depending on nature conservation priorities in grassland. Balance the different requirements by mowing parts of the grassland at different times.
Conservation of rare plant species populations	Rare plant species usually have poor dispersal ability, their seeds develop only every few years or their germination capacity is low, therefore annual mowing before seed shedding weakens the population of such species.	Choose the mowing time after the maturation of seeds of the species or leave flowering patches unmown. Preferably, these patches should be changed each year.
Early flowering plant species *(Iris sibirica)*	Many species flower relatively early (late May-mid June) and early mowing can weaken or even destroy their population.	Choose the mowing time after the maturation of seeds of the species or leave flowering patches unmown. Preferably, the patches should be changed each year.
Late flowering plant species *(Gladiolus imbricatus)*	Many species flower late in the second half of summer and intense grazing or early mowing without letting the plants bloom can eradicate these plant species from the grassland.	During mowing, patches of blooming plants should be left unmown, grazing intensity should be reduced in pastures or some patches should be left ungrazed (for example, by using fences).
Plant species sensitive to grazing *(Platanthera* spp., *Orchis* spp., *Dactylorhiza* spp.*)*	Orchids do not tolerate trampling. If a newly grown leaf rosette is damaged, it will no longer regrow. Early mowing is also unsuited for them since the species flowers in June and July.	Leave areas with the highest number of individuals unmown.
Butterflies	Butterfly larvae need host plants. Early mowing or intensive grazing reduces the food base available to them.	Mow or graze grasslands in parts or leave unmown or ungrazed belts every year and alternate them every year.
Maculinea teleius – a protected butterfly species in Latvia	Larvae lives on *Sanguisorba* spp. and at one stage of its development in the ant *Myrmica scabrinodis* hills. Low mowing with tractor equipment destroys the anthills.	Mowing should only be done manually, preserving the anthills, or a part of the area should be left unmown.
Whorl snails *Vertigo* spp.	Grazing encourages the establishment of places where the animals stay more often and degrade soil and vegetation, thus destroying whorl snail habitats.	By changing the grazing areas, maintaining the soil and vegetation structure, it is possible to create areas inaccessible to grazing animals where they cannot affect the whorl snails.
Birds	For species that require maximum areas of open landscapes, trees, shrubs and other vertical elements are undesirable. However, the same elements are important to increase the diversity of grassland passerines. Meadow waders prefer pastures, while Corncrake prefers meadows. Mowing during the bird breeding season (usually before mid-July) usually affects the birds breeding adversely, because it destroys nests or chicks. However, this time can individually differ for each meadow, depending on the phenology of the species breeding there. Mowing does not affect the birds that nest in the shrub layer or higher, unless they are destroyed while mowing.	When the management is planned, the bird species breeding in the grassland must be determined and, depending on their requirements, the type of management should be adjusted (see Chapter 20.9). If possible, choose a type that is also favourable for the conservation of plant species diversity (for example, mowing in an appropriate direction using animal scaring devices, rather than late mowing). It may be possible to vary the type of management within one grassland thus ensuring appropriate management for its different values.

Table 7.1.6. Imaginary contradictions of habitat conservation and management

Question	Solution
Should all drainage ditches in grasslands be eliminated if possible?	No, not all drainage systems set up in grasslands adversely affect the grassland biodiversity. Shallow hand-dug drainage ditches maintain appropriate hydrological conditions of the grassland, thus ensuring its existence. Despite initially reducing the habitat quality, large drainage systems are also important, since they enable the management of grassland.
Is it worth fighting against natural succession to keep the grassland open, if after abandonment they would naturally transform into forests?	Yes, it should be done in areas where the obtained result justifies the financial investment and the biodiversity has an important place on the national and, preferably, public scale of values.
Is it permitted to mow meadows and graze pastures, where rare and protected plants or animals of Latvia or the EU occur?	Yes, in most cases it is necessary to maintain the population of protected species characteristic of grasslands, because they have adapted to these specific living conditions over millennia. They have been included in the protected species list because the area of semi-natural meadows and pastures has significantly decreased and continues to decrease. Failure to mow or graze grasslands endangers their existence because the overgrowth of grassland with shrubs or forest will change the environmental conditions and the protected species of grasslands will disappear. To strengthen the protected species population in cases where the species is very rare in the region, one should choose management measures that preserves the species, for example, late mowing after the shedding of plant seeds or maturation of animal offspring.

logical trap for the species. A compromise in this case would be mowing in early July with the use of bird-friendly mowing methods (animal scaring devices, mowing direction). The diversity of plant species will be preserved at the expense of a slight decrease in Corncrake breeding success in the specific grassland, since some nests will be damaged. In general, however, both plant diversity and Corncrake population will be retained.

Secondly, contradictions in justification of the habitat types selected for restoration can arise. For example, the creation of habitat type 6530* *Fennoscandian wooded meadows* can destroy a broadleaved forest habitat if wooded meadow abandoned for several decades has already transformed into a valuable broadleaved forest. In such cases, contradictions can be easily resolved by assessing the value and landscape-ecological importance of the existing and the potentially restored habitat in a regional context, giving priority to the action that will have the greatest contribution to the preservation of biodiversity in the habitat and in a regional context (*see Chapters 6.3 and 6.4*).

In both cases the conservation priority and the conditions of the grassland should be evaluated, avoiding trying to transform the grassland into a system that will not be sustainable due to local environmental conditions. When assessing the conservation priority, one should consider the potential threat to species in a wider context, giving priority to species whose populations are globally endangered (according to IUCN criteria), and then species and habitats endangered on an EU or regional level (annexes of the Birds Directive and Habitats Directive). Finally, the national and local threat level should be evaluated.

If the main value of the grassland is a species rather than a habitat, then management should be selected to ensure the survival of the species. It should be noted that different protected species have different requirements.

The most common management contradictions of EU grassland habitats are listed in Table 7.1.5.

Many contradictions in nature conservation are merely seeming and imaginary due to differing nature conservation approaches, a lack of knowledge or insufficient knowledge of ecology of species and habitats (Table 7.1.6).

7.2 Legal Framework of Habitat Management (Ē. Kļaviņa)

To understand what is allowed, what actions are permitted, careful examination of the applicable regulations or consultations with professionals is always necessary in each specific situation (Fig. 7.2.1).

7.2.1 Species and Habitat Types that are Protected

The Law on the Conservation of Species and Biotopes[5] states that species and habitat conservation is a set of measures required for conservation or restoration to a favourable conservation status of species populations and habitats.

The Cabinet of Ministers has issued a number of regulations on the basis of the law, which include protected habitat types[6] and species in Latvia[7], EU plant and animal species that require conservation, and which also define a list of EU-priority species[8] and habitats[9].

All the EU protected grassland habitat types are protected also at national level – they are protected grassland habitat types in Latvia, and favourable conservation status should be ensured for their conservation. Unlike other types of habitats, the conservation of grassland habitats mainly depends on appropriate management. Therefore, the regulatory framework has evolved not only as a set of different restrictions in protected nature territories, but also as a set of support measures. The regulatory enactments governing the support of grassland habitat management and defining the conditions are amended according to particular planning periods and can be accessed on the website of the Ministry of Agriculture http://zm.gov.lv/.

7.2.2 Defining Protected Areas

The **Law "On Specially Protected Nature Territories"**[10] defines the basic principles of the protected nature territories system. To protect and maintain the nature diversity of Latvia, strict nature reserves, national parks, nature reserves, nature parks and other protected nature territories have been established. These territories can be divided into functional zones with different conservation and management regimes.

Such protected nature territories, which significantly contribute to the maintenance of favourable conservation status of protected habitats or species in the relevant EU biogeographical region, are included in the **common network of protected nature territories of European significance (Natura 2000)**. In these territories, the necessary conservation measures are taken to maintain or restore favourable conservation status of protected habitats and species.

Boundaries of protected nature territories and functional zones are specified in the regulatory enactments and in the State Management System of Nature Data "Ozols" (http://ozols.daba.gov.lv/).

Protection and management of protected nature territories is regulated by the **general regulations on the protection and use of protected nature territories or their individual protection and use regulations**. To harmonise the interests of nature conservation, use of natural resources and sustainable development interests of the region while maintaining the natural values of the area, **a nature conservation plan** can be elaborated for a protected nature territory[11]. The nature conservation plan recommends the actions required for the conservation and management of natural values.

General regulations for the protection and use of protected nature territories[12] are the main regulatory provisions that determine the permitted and restricted economic and other activities in protected nature territories that do not have their own developed and approved individual regulations on conservation and use.

7.2.3 Habitat Restoration Actions that Need to be Approved

It should be considered that many protected habitat and species habitat restoration and management activities in protected nature territories and micro-reserves must be coordinated with the responsible public authorities (Fig. 7.2.1). According to the General regulations[13] a written permit of the responsible institution – Nature Conservation Agency is required when performing the restoration of protected habitats and species habitats, for example, deforestation. Furthermore, giving a written notice to the authority

[5] With the amendments as of 1 January 2016.
[6] Cabinet Regulation No. 421 of 5 December 2000, On the List of Specially Protected Habitats.
[7] Cabinet Regulation No. 396 of 14 November 2000, On the List of Specially Protected Species and Specially Protected Species for Limited Use.
[8] Cabinet Regulation No. 1055 of 15 September 2000, On the List of those Animal and Plant Species of European Community Significance, for which Protection is Necessary, and the List of those Specimens of Animal and Plant Species for the Acquisition of which in the Wild the Conditions for Restricted Use may be Applied.
[9] Cabinet Regulations No. 153 of 21 February 2006, On the List of the Priority Species and Habitats of the European Union in Latvia.
[10] With the amendments as of 11 January 2014.
[11] Cabinet Regulation No. 686 of 9 October 2007, On the Content of and Procedure Regarding the Elaboration of Nature Conservation Plans for a Specially Protected Nature Territory.
[12] Cabinet Regulation No. 264 of 16 March 2010 General Regulations on the Protection and Use of Specially Protected Nature Territories.
[13] Cabinet Regulation No. 264 of 16 March 2010, General Regulations on the Protection and Use of Specially Protected Nature Territories.
[14] Cabinet Regulation No. 562 of 21 August 2007, On the Procedures of Land Use Classification and Definition Criteria.

in charge of fire safety is required when implementing prescribed burning of heath, reeds, forest groundcover and litter (dead grass). Restoration activities like establishment of drainage systems and their reconstruction or renovation must be approved by the State Environmental Service.

Written permission is not required for grass mowing, grazing or shrub cutting.

7.2.4 Why the Land Use Category Needs to be Known

A specific land use category and the purpose of use is determined for each land property. According to the classification[14] of land use types , the category of land use is a set of land use types with similar features.

The categories define several types of land use that one should be familiar with when managing the habitats: for example, "meadow" and "pasture" correspond to the category "agricultural land". Land use types "forest", "scrub" and "mire" correspond to the categories of a similar name. "Land under water" corresponds to the category "water object area". Land use types "sands", "openings", "flooded openings" correspond to the category "other lands".

To change the category of land use in a protected nature territory, a written permit from the National Conservation Agency must be received.

The changes in land use categories are reflected in the National Real Estate Cadastre. The State Land Service maintains the National Real Estate Cadastre Information System regarding which the local municipalities and the State Forest Service must submit up-to-date information. The types of land use are reflected (explicated) in certain documents of legal boundaries of the land.

7.2.5 Cases in which an Environmental Impact Assessment is Required

Restoration and management of habitats and species habitats includes not only careful planning but also an assessment of the estimated impact of an activity. For restoration of habitats, a certain procedure, expertise, activity coordination and authorisation are required. The assessment of whether the proposed activity will result in any environmental changes that may significantly affect humans, landscape and cultural heritage is required prior to habitat restoration. **The Law "On Environmental Impact Assessment"**[15] is applicable to the activities that meet specific criteria according to which the impact of the intended activity[16] on the environment can be assessed, especially if it is implemented in protected nature territories, micro-reserves, wetlands of international importance, coastal protection belt of the Baltic Sea and the Gulf of Riga, protection belt of surface water objects, and can affect protected species, their habitats and protected habitats.

Activities that require initial impact assessment are listed in the law; among them, applicable to habitat restoration may be: agricultural land use category change, if the area of the land is greater than 50 ha; construction of new drainage and irrigation systems, if their land area is larger than 100 ha; reconstruction of existing drainage or irrigation systems if the area is greater than 500 ha; afforestation and deforestation if the area is greater than 50 ha.

If the results of initial impact assessment show that the intended activity does not require an environmental impact assessment, the State Environmental Service issues the technical regulations.

Activities requiring technical regulations in terms of habitat management are, for example, establishment of animal enclosures (for grazing) if they are designed for five or more livestock units, if the enclosure is located in a particularly sensitive area, or 10 or more livestock units in other areas; restoration of water drains of national importance and other important management works.

Large-scale habitat restoration measures, for example, restoration or filling of drainage ditches and other similar actions require a construction permit. When submitting the building conception at the building authority the applicant will be informed of which institutions they need to additionally receive the technical requirements, permissions from (public and municipal institutions shall issue them within 20 days), and informed of the need to carry out the initial impact assessment (State Environmental Service), and afterwards, probably, a complete environmental impact assessment as well.

7.2.6 Grassland Habitat Restoration Outside Forest

Restoration of overgrown grassland usually requires the removal of trees and shrubs. If the restoration of grassland habitats is planned by felling trees in lands that are not a forest, then it is done in accordance with Cabinet Regulation[17] on the felling of trees outside forest. The appropriate land use type

[15] With the amendments as of 1 January 2017.

[16] An intended activity – project implementation, construction, extraction or use of natural resources, influencing of areas and landscapes that are not affected or little transformed by human activities, as well as other activities, the performance or result of which may significantly affect the environment.

[17] Cabinet Regulation No. 309 of 2 May 2012, On the Felling of Trees Outside Forest.

must be registered in the National Real Estate Cadastre Information System.

The owner or the legal possessor of land may fell trees outside forest in the area under his/her ownership or possession at his/her own discretion, except in city and village areas (those are governed by binding municipal regulations), protected nature territories (with certain exceptions), in protection areas of culture monuments, in the protection zone of surface water objects, in the coastal protection zone of the Baltic Sea and the Gulf of Riga. **In protected nature territories the restrictions related to forestry limitations in the corresponding functional regime zones and during animal breeding period must be respected.**

In these exceptional cases the manager of the land needs to receive a permit from the local municipality for the felling of trees outside forest.

To restore protected grassland or heath habitats, prescribed burning of litter, heath and reed areas is permitted, if a written approval from the Nature Conservation Agency is received and after a written notification of the institution in charge of fire safety and fire-fighting. It should be noted that these activities are only permitted in protected nature territories and micro-reserves.

General and individual regulations on the protection and use of protected nature territories include a requirement concerning the management of agricultural land: to mow from the centre to the edges and in the case of uneven terrain to mow in bands in the direction from the open side of the field (also courtyard, road, open ditch, fence, river or lake) towards the scrub or forest.

When planning habitat conservation with the admixture sowing of seeds in protected nature territories, micro-reserves and populations of protected plant species, it must be ensured that seed gathering does not contradict the nature conservation plan of the respective territory or regulatory enactments that govern the management of the area. General regulations on the conservation and use of protected nature territories prohibit the gathering of wild mushrooms, plants and plant products in regulated regime zones of strict nature reserves and of national parks. Agricultural activity in the agricultural land of protected nature territories is permitted if chemical plant protection products are not used and floodplain and terrace meadows are not ploughed. It is forbidden to damage or destroy (including by ploughing, cultivation or afforestation) the floodplain and terrace meadows in nature reserves. Protected habitats and habitats of protected species may be restored in nature reserve territories pursuant to a written permit by the Nature Conservation Agency.

7.2.7 Grassland Habitat Restoration in Forest

Restoration of protected habitats and protected species habitats in forest lands takes place in accordance with the criteria defined in Cabinet Regulation[19]. The planned activity cannot contradict the local government spatial plan.

If deforestation is necessary for the restoration of a protected habitat or species habitat, it can be performed upon the receipt of a permit issued by the Nature Conservation Agency. The competent authority issues the permit on the basis of the opinion of the certified species and habitats expert of the relevant group of species or habitats. When restoring the habitats in forest the applicant of the activity should also clearly divide the planned activity types (felling of trees, extraction of stumps, filling up ditches, digging of land, prescribed forest burning or other types). The permit for prescribed burning in protected nature territories and micro-reserves is issued by the Nature Conservation Agency and outside those areas by the State Forest Service, if no deforestation is planned.

The regulations provide that the planned activity of deforestation or prescribed burning of a certain area should meet at least one of the four criteria. For example, it must contain either species or other indications of protected habitat; protected habitat or species have disappeared from the territory but their previous existence can be approved by the results of scientific research or environmental monitoring.

7.2.8 Change of Hydrological Regime

Habitat restoration work related to rewetting (restoration and/or construction of ditches) is regulated by

The types of grassland habitat which can be restored in forest by deforestation:
juniper stands in grasslands and heathlands, coastal grasslands, sandy grasslands, rupicolous grasslands, wooded meadows and pastures, dry grasslands in calcareous soils, matgrass (wasteland) grasslands, *Molinion* grasslands, species-rich pastures and grazed meadows, hydrophilous tall herb fringes, floodplain grasslands, mesic meadows.

Fig. 7.2.1. Actions, when planning habitat restoration or management.

WHERE TO FIND INFORMATION AND WHO SHOULD BE CONSULTED ABOUT ANY UNCERTAINTIES?

- Nature Conservation Agency: permitted and prohibited activities in protected nature territories and micro-reserves, and other issues of nature conservation: www.daba.gov.lv.
- State Forest Service: change in use of forest land, issues of forest management and use: www.vmd.gov.lv.
- State Environmental Service and its Regional Environmental Boards: habitat restoration and management outside the protected nature areas and micro-reserves, environmental impact assessment, and other issues: www.vvd.gov.lv.
- Rural Support Service: agricultural and forestry support payments and the administration thereof: www.lad.gov.lv.
- State Inspection for Heritage Protection: protection of memorial sites of national significance: www.mantojums.lv.
- Local municipal authorities: local issues – spatial planning, binding municipal regulations, locally protected nature territories and locally protected cultural heritage objects: contacts on websites of local municipalities.

the **Amelioration Law**[20]. It provides that the construction of a drainage system is controlled by the building authority of the local municipality, the data of the drainage cadastre is maintained and updated by the state limited liability company "Immovable Properties of the Ministry of Agriculture", which is responsible for the construction, maintenance and operation of the state drainage system in the country and drainage system of national significance.

The drainage cadastre regulations[21] provide that the drainage system, regardless of its ownership and status, shall be registered in the Amelioration cadastre by assigning a drainage cadastral number.

While carrying out the grassland rewetting, for example, cleaning ditches, the Latvian construction standard LBN 224-15 "Amelioration systems and hydrotechnical structures", approved by Cabinet Regulation[22], should be followed, especially the detailed environmental conservation provisions in Chapter 9. For example, when cleaning or deepening drainage ditches, the following requirements must be followed: soil dug from watercourse beds must be smoothed in the surrounding area, except forest land, in a layer that is not thicker than 0.2 m, and after smoothing this area must be ploughed or tilled using a disc harrow. In areas where the smoothing is not necessary and it remains in the berm, topsoil is removed to the width of the berm and stored for later use.

If drainage systems are established in the coastal protection zone of the Baltic Sea or the Gulf of Riga, an application needs to made to the building authority of the local municipality regarding the activity, and a task assignment must be received for further activities and approvals before developing the building design. It is prohibited to construct (or restore) amelioration structures in the coastal protection zone of the Baltic Sea or the Gulf of Riga without the approval of the State Environmental Service (as it is defined in the Protection Zone Law).

7.2.9 Habitat Restoration and Management in Micro-reserves

Establishment of micro-reserves, habitat restoration and management in micro-reserves is governed by Cabinet Regulation[23], according to which the Nature Conservation Agency defines micro-reserves in nature reserves, national parks, nature parks and agricultural land outside these areas. The boundaries of micro-reserves are set in decisions on the establishment of micro-reserves as well as in the State Management System of Nature Data "Ozols" (http://ozols.daba.gov.lv/).

Micro-reserves are managed to ensure favourable conservation status for those species or habitats for which conservation the micro-reserves were established. This is done according to the judgement of an expert; it lists necessary activities such as reed cutting and removal, cutting and removal of shrubs and dwarf shrubs, prescribed burning of heathland, meadows and grasslands, and hydrological regime restoration and maintenance, as well as other activities that the expert has recommended. The statement of the expert is not required for the grass mowing and removal in micro-reserve.

[18] Cabinet Regulation No. 264 of 16 March 2010, General Regulations on the Protection and Use of Specially Protected Nature Territories.

[19] Cabinet Regulation No. 325 of 18 June 2013, On the Restoration of Protected Habitats and Protected Species Habitats in Forest.

[20] With the amendments as of 1 January 2015.

[21] Cabinet Regulation No. 623 of 13 July 2010, On the Amelioration Cadastre.

[22] Cabinet Regulation No. 329 of 30 June 2015, Regulations about the Latvian Construction standard LBN 224-15 "Drainage Systems and Hydrotechnical Structures".

[23] Cabinet Regulation No. 940 of 18 December 2012, On the Procedures for the Establishment of Micro-reserves and their Management, Conservation, as well as Interpretation of Micro-reserves and Buffer Zone.

Table 7.3.1. Cost of dry grassland restoration in complicated terrain conditions.
**The calculation example includes actions and costs that the authors have considered necessary based on many years of practical experience in habitat management and analysis of the economic environment. Any activity and cost position may differ and they should be calculated in each particular location and case according to the principles presented in this chapter.*

No.	Type and specifics of work	Units	Cost, EUR	Notes
Selected activities, methods and work allocation by stage				
First year of restoration				
1	Felling of trees and shrubs	5 ha area with 2 ha of scrub and forest stand	900	Stumps very low (maximum 2–3 cm) to prevent interference with future management.
2	Removal of trees, burning of shrubs and branches	200 m^3	400	
3	First-time burning of litter on a slope with moss and tussocks, where mowing equipment cannot be used	1.8 ha	800	Performed in spring, when the ground in most of the area is frozen. A suitable time may only be a few days in the season.
4	First-time smoothing of tussocks after burning. Manual tools and mini-tractor with a 2 m drag harrow, where the slope angle permits its use	1.8 ha 3.2 ha	500 180	Tussocks and anthills remaining after the soil has thawed are moist and easily removable without damaging the groundcover next to them. A suitable time may only be a few days in the season.
5	Mowing with a trimmer. Mowing with a rotating disc mower.	1.8 ha 3.2 ha	630 180	Steep slope.
6	Hay collection - swathes, raking and removal from the area	1.8 ha 3.2 ha	480 250	Manual labour. Device working width up to 2.5 m.
Second year of restoration				
1	Delimitation of burning areas, burning of shrubs cleared in the previous year and recently	0.5 ha	200	As a voluntary work-party, at least 20 person-days.
2	Mowing with a trimmer. Mowing with a rotating disc mower.	1.8 ha 3.2 ha	630 160	Steep slope. Device working width up to 2.5 m. Automatic disc and blade protection because of stumps, stones, loamy turf.
3	Hay collection – swathes, raking and removal from the area	1.8 ha 3.2 ha	480 220	Manual labour. Device working width up to 2.5 m.
Third year of restoration = first year of regular management				
1	Mowing with a trimmer. Mowing with a rotating disc mower.	1.8 ha 3.2 ha	630 160	Steep slope. Device working width up to 2.5 m. Automatic disc and blade protection because of stumps, stones, loamy turf.

(continued)

Table 7.3.1 (continued)

No.	Type and specifics of work	Units	Cost, EUR	Notes
2	Hay collection – swathes, raking and removal from the area	1.8 ha 3.2 ha	480 220	Manual labour. Device working width up to 2.5 m.
TOTAL direct costs: 7,400 EUR				
Indirect habitat management and restoration work preparation costs				
1	Expert work: surveying, activity planning, restoration success monitoring over three years.	12 person-days	1560	
2	Organisation and supervision of activities.	10 person-days	1500	
3	Costs of managerial personnel transport and accommodation	50 EUR per day x 22 person-days	1100	If the driving distance per day from another part of Latvia exceeds 380 km.
TOTAL indirect costs: 4,160 EUR				
Regional differences in costs in Latvia				
1	Organisation and supervision of activities. Ensuring continuity of activities.	10 person-days	1500	Additional communication to find contractors and conclude agreements.
2	Increase in direct costs to motivate workers.	30% of direct costs.	2400	
3	Organisation of voluntary work-parties to complete the work not completed by the contractors.	Two voluntary work-parties, 20 person-days each. Expenses for meals.	400	
TOTAL regional cost increase: 4,300 EUR				
The total cost of habitat restoration in complicated conditions over a period of 3 years*: 1,057 EUR ha^{-1} $year^{-1}$				

7.2.10 Control of Invasive Species

If the control of invasive plant species is necessary to conserve and restore a habitat, the Plant Protection Law[24] and the related regulations of the Cabinet of Ministers must be followed to avoid potential risks and to comply with mandatory safety requirements. In Latvia, the Law provides that it is prohibited to cultivate species of plants included in the list[25] of invasive plant species. According to Cabinet Regulation[26], the land owner or possessor is obliged to destroy the invasive plant species if they have spread to land that is in their property or possession.

The regulations regarding the use of plant protection products[27] define the requirements for the use and storage of plant protection products, liabilities and rights of professional users and operators of plant protection products, procedures for the issuing of permits for the application of plant protection products and other measures of combating invasive species. In addition, other normative enactments that may restrict the application of these products (such as Regulations for the protection and use of a particular protected nature territory) should be taken into account.

[24] With the amendments as of 25 November 2016.

[25] Cabinet Regulation No. 468 of 30 June 2008, List of Invasive Alien Plant Species.

[26] Cabinet Regulation No. 559 of 14 July 2008, Regulations Regarding Restricting the Spread of the Invasive Plant Species – Heracleum sosnowskyi.

[27] Cabinet Regulation No. 950 of 13 December 2011, Regulations Regarding the Use of Plant Protection Products.

Fig. 7.3.1. Hay voluntary work-party in Ķemeri. Photo: K. Lapiņš.

Fig. 7.3.2. A farmer helped collect the hay in swathes by using a horse-powered rake pulled by a small tractor. Photo: K. Lapiņš.

Fig. 7.3.3. Hay transportation. Photo: K. Lapiņš.

Fig. 7.3.4. It was impossible to gather hay just like in the old days, so suitable solutions were found on the spot. Photo: A. Priede.

Fig. 7.3.5. Small haystacks were pulled off the field using old curtains, which proved to be a rational solution for small meadows, as there was no need to use fuel or pay for the use of a tractor. Photo: A. Priede.

Fig. 7.3.6. The objective of voluntary work-parties was not only meadow management, but also the promotion of Latvian culture heritage and education on nature values through cooperation. Photo: A. Balandiņa.

7.3 Cost Estimation (J. Jātnieks, A. Priede)

Cost assessment is one of the most important steps in the preparatory process. Cost varies over time and can rarely be generalised for specific types of work or a set of actions required to improve the habitat condition. Costs for similar works can differ greatly – depending on the geographic location, complexity of works, availability of workers and special equipment, as well as other factors. These guidelines are meant for use over an extended period of time, therefore exact costs are not given. They must be assessed separately for each action or for the whole work in a particular place and time.

The following principles should be used by developers of nature conservation plans, LIFE and other large projects to estimate the cost of habitat management and restoration activities for the period of 2–5 years, at one large or several Natura 2000 sites.

In small areas (up to 1 ha), as well as in cases where management is regular or certain parameters are known (for example, annual mowing, pasturing, digging or filling up of ditches of certain size), the cost can be generally equated to works performed elsewhere, or by interviewing the potential workers and agreeing on the total cost of all works.

Key principles in determining reasonable costs of planned actions.

- After the evaluation of a site scheduled for management, **the most appropriate actions, methods and technical means are chosen.** It is advised to divide the works into parts, by timing and by types of work. For example, manual work, use of particular type of equipment, determining the pricing of each job separately and summing up to obtain more objective assessment. The costs and efficiency of works often depend on the season, for example, rewetting of wetlands should be carried out in the dry season, otherwise the cost can grow unpredictably, but the objective may remain unrealised or the quality may be poor. To ensure that habitat management and restoration actions are chosen correctly, a species and habitat conservation expert should be invited.
- **Direct costs should be calculated in appropriate units** – man-hours, person-days, the cost of equipment per hour, cost of materials per area or volume depending on the works (m^3, km, kg, t). The number of units required for all the works should be assessed and summed up. Experience shows that mistakes in these calculations are the most common, therefore it is always advisable to use both the information on similar, already implemented works, such as reports on projects, specific works, and the experience of institutions (Nature Conservation Agency, JSC "Latvia's State Forests", Rural Support Service, municipal and non-governmental organisations). Objective costs of technical works for many types of habitat restoration and management works over the years are published on the website of the Rural Support Service, costs of materials and construction works are annually published on the website of Latvian Rural Advisory and Training Centre. Such cost estimates are also available on websites of construction companies and the biggest forest management companies. If the set of planned activities consists of various works not performed before or their pricing is not available, at least three potential contractors can be surveyed. In this case, the result can be obtained faster, however the risk increases that unforeseen costs that can complicate the reaching of the objective may arise during the works.
- **The indirect preparatory costs of habitat management and restoration works** should be assessed – site surveying, expertise, technical regulations, permits and agreements provided for by the regulatory enactments (see Chapter 7.2). This involves working time, transport and administrative costs, which are often inadequately assessed. The time and means to inform the public and explain the necessary steps must be scheduled in complex work projects.
- **Regional cost differences in Latvia** and the availability of contractors in the given region at a distance of up to 30 km from the planned activity site must be considered. The costs may rise significantly if executors and/or equipment must come from a larger distance. For this reason, specific activities that require special equipment or skills (e.g., dam construction on ditches, topsoil removal) will always be more expensive than simple activities (mowing, shrub felling, topsoil grinding).
- **Cost assessment should be entrusted to professionals** – managers, managing specialists, practitioners, entrepreneurs, – and schedule this job and adequate funding.

The planning, including financial planning, should also include potential income related to ha-

bitat restoration and management – wood, mown grass, removed topsoil and other materials. Ideally, they can be used, at least partially, on site (for example, for the construction of dams in rewetting) or removed from the area and used elsewhere (such as wood chips or wood, reeds for roofing, biomass for animal feed, cogeneration, or as a seed-containing material of target species for species introduction elsewhere), peat – for composting or gardening. However in practice, these materials rarely find practical application, if the volumes are low, extraction sites are dispersed over a wide and hard-to-reach area. Therefore it should be considered that the use of habitat restoration "byproducts" may not always be economically beneficial.

7.4 Evaluation of Management Success

7.4.1 Importance of Evaluating Management Success (S. Rūsiņa, A. Priede)

To restore and maintain a habitat successfully, the development and implementation of a management success monitoring programme is necessary, because result assessment is an integral part of the decision-making process. The purpose of monitoring is to ensure decision-making that results in appropriate habitat management.

Result assessment including success and failure is important. Evaluation of success means systematic documentation of changes or at least comparing the situation before and after the restoration or management of the habitat. A reliable and scientifically justified result can only be obtained if the changes are documented systematically, following certain techniques and on a regular basis. The monitoring results should be able to answer the questions – whether and to what extent the restoration and management have reached the initial objective and why the objective has not been reached. Assessment of results is also required to implement corrections in management. If the objective has not been reached, one should understand why and take the necessary steps to improve the result and eliminate the mistakes at least partially.

Habitat management efficiency depends on the management objective and specific habitat. The success of grassland restoration and management is most often evaluated by the changes in number and abundance of plant and animal species and changes in soil chemical properties, as well as changes in the hydrological regime in the case of moist grasslands.

To evaluate the restoration success and transfer

Fig. 7.4.1. Example of a photography point. Landscape elements (in this case, birch in the foreground and grey alder trunks in the background) show that the same grassland has been photographed. The photographs demonstrate the changes in grazing intensity. In all years, it has been photographed at approximately the same time and vegetation development phase (flowering of meadowsweet *Filipendula ulmaria*). The photographs demonstrate that in the respective period of 2006 the grassland has been grazed more intensively than in 2005 and the grazing animals have consumed the meadowsweet so intensively that only a few plants of the species are blooming. In 2014, meadowsweet is no longer visible and the grazing intensity is even higher. These photos show that grazing animals do not always avoid eating the meadowsweet and grazing can be effective in restricting this expansive species. Photo: S. Rūsiņa.

the obtained experience to other restoration sites, thorough, well-considered, planned and implemented monitoring of restoration success must be carried out with the help of expert. The monitoring will only provide reliable results if the vegetation and other parameters are surveyed in both the habitat which has remained unrestored (control), and in the restored habitat before commencing the work and after its completion (preferably, in several restoration locations and with several replicates). The changes brought by restoration can only be evaluated by comparing it with the original condition.

Involvement of competent experts (experienced professionals who can use the research methods and assess competently and are familiar with the conditions and species) is recommended. Since the involvement of experts is not always possible, especially under the conditions of limited funding, or the monitoring cannot be funded for a longer period of time, a simplified indicator system can be used, which can also partially be implemented by amateurs which are trained to correctly identify the plant species present in the territory, assess their proportion and record other changes (such as water table measurements). The most important thing is to do it systematically and in good faith, consulting professionals in the event of doubt.

7.4.2 Evaluation Parameters (S. Rūsiņa)

When planning the monitoring, it should first be formulated what parameters need to be evaluated and only then choose the monitoring methods. The minimum monitoring would include the evaluation of species diversity, vegetation structure and ecological processes (Ruiz-Jaen, Aide 2005). At the same time, all management requirements should be carefully documented to evaluate which management methods have provided the best result and in what combinations (Table 7.4.1). Various external factors and processes affecting the grassland should be documented as well (Table 7.4.2).

The parameters for habitat restoration and maintenance success monitoring have to be chosen depending on the types of restoration and management, restoration objectives, as well as available financial, time and human resources. Often one and the same parameter can indicate the success of several management types. Both direct parameters directly influenced by the specific management, and indirect parameters that are influenced by the management through ecosystem processes, may be used (Table 7.4.3).

7.4.3 Methods to Evaluate Management Success (S. Rūsiņa, A. Auniņš, A. Priede, V. Spuņģis)

This section provides some simple methods that do not require in-depth knowledge of ecology and species identification skills and can be used by any grassland manager. These methods allow an indicative evaluation of management success to be obtained. They cannot be used for detailed analysis of ecosystem succession processes and scientific evaluation. A number of biodiversity monitoring methods that can be used for the monitoring of semi-natural grassland habitats and species have been developed and approved in Latvia (Auniņš et al. 2013; Auniņš 2014; Lārmanis (ed.) 2014).

The indications that can be used for a simplified evaluation of restoration and management success are summarised in Annex 1. If the evaluation of several parameters shows that grassland condtion has improved, restoration has had a positive impact on grassland biodiversity.

7.4.3.1 Photography

Photography is a quick and easy way to document landscape and habitat structure changes (e.g., volume of flooding, shrub cover changes, grazing intensity), but it is not a suitable method to assess species composition and numbers. It is important to select representative photography points reflecting the nature of the changes, so that they can be attributed to the entire territory. This can be done most successfully by establishing a permanent photography point (preferably more than one) – for example, a thick wooden stick dug into the ground with a colour or other marking to indicate the direction of shooting. In each inspection the same general picture should be taken from this point in the same orientation. To get correct information on changes, pictures should be taken both before the restoration or management and several years after (Fig. 7.4.1).

7.4.3.2 Plant species Diversity And Vegetation Structure Monitoring

Vegetation monitoring is a relatively simple and cheap way of assessing the nature of changes. Vegetation changes are recorded by establishing sample plots (Fig. 7.4.2). Several sample plots should be established. They can be permanent (easily found each year) or located randomly in a different place each year. Establishment of at

least 30 sampling plots is recommended in one uniform grassland, however several vegetation monitoring studies in Latvia have shown that 10 sampling plots can also be enough to evaluate the changes in vegetation induced by management (Rusina, Kiehl 2010). There are usually fewer permanent sample plots and more randomly placed ones. It is most important to ensure that the positioning of sample plots represents the overall situation of the grassland. For example, if the purpose of the monitoring is to evaluate the occurrence of semi-natural grassland indicator species in a grassland that is very heterogeneous with moist sedge depressions and dry elevated sites, there should be an equal number of sample plots in depressions and on dry sites.

To accurately locate the sample plots each year, fixed permanent spots in the landscape after which plots can be found are necessary. Usually there are few such spots in grasslands. Even a growing tree is a temporary landscape element: it can unexpectedly fall down, the stump can decay in a few years' time and the reference point will be lost. A pole dug into the ground can serve as a reference point. However, it can be washed away by floodwater, damaged by wild animals or grazing animals or taken by people, so it is better to have at least two reference points for each sample plot. Coordinates of corners of the sample plot (or one specific corner, for example, northeast) may be taken using a GPS receiver and 20-30 cm metal stakes that cannot be seen by the eye, but easily found using a metal detector, can be driven into the ground.

Another method is arranging the sampling plots in a transect in equal intervals. In such a case, only two points need to be accurately located each year - the beginning and the end of the transect, and sampling plots can be localised easily by using measuring tape (Fig. 7.4.3). It is sufficient to accurately mark only one point - the beginning of the transect - and find the transect end point using the distance from the start and the azimuth of the transect from the starting point.

Vegetation parameters that are recorded should be selected depending on the monitoring objective. It is possible to list all plant species or species of special interest, such as semi-natural grassland indicator species, protected species or expansive species, the control of which is the objective of restoration works (Table 7.4.4). The abundance of each species in grasslands is usually measured in percentage points, rather than counting individual specimens, because many species reproduce vegetatively and it is complicated to determine, for example, how many specimens of *Elytrigia repens* there are in the grassland. A simplified quantitative species evaluation scale (cover-abundance scale) that can be used in grassland monitoring is as follows (Fig. 7.4.4):

5 points – the species is dominating (its cover is larger than any other species), a species can be assigned 5 points in a grassland if it completely dominates covering 75% or more of the plot); species can rarely be rated with 5 points, it is most often possible when an expansive species has almost completely outcompeted other species;

4 points – the species is abundant (its cover can be from 50 up to 75%, however it has not completely suppressed other species);

3 points – the species is common (its cover ranges from 25 to 50%); 3 points is often the highest rating possible in long-term managed grasslands since there are no clearly dominant species, but the cover of the most common species in the vegetation is within this range;

2 points – a fairly common species, but not dominating, its cover usually ranges from 5 to 25%; usually there are several species in the vegetation with higher cover, but there are many species that can be rated with 2 points;

1 point – the species is rare, its cover is negligible and less than 5%.

+ – species with only one or a few specimens in the sample plot.

Such scale is not suitable for the monitoring of rare species because the quantitative changes in species can be too negligible over the years to be represented by points. For such species, it is better to count the blossoming shoots or individuals (if that is not possible, then rate the percentage of cover of species in the sample plot).

Such easily obtainable data illustrates the changes in species diversity and the abundance of certain species during the restoration or maintenance well (Fig. 7.4.5, 7.4.6).

7.4.3.3 Bird Monitoring

The most accurate method of management success assessment on bird species is the evaluation of target species population change Monitoring should be commenced several years before the management to enable an objective assessment of dynamic change. It should be noted that the size of target species populations may fluctuate due to reasons not related

to management. In addition to monitoring in grassland, where management measures are launched or changed, monitoring should also be carried out in the so-called background areas, where management does not change. This will help to explain the observed changes (or lack of changes) in the target areas.

The use of ornithological monitoring methodology in biologically valuable grasslands is recommended (Auniņš et al. 2013) to ensure full observation by walking through the grassland three times in a breeding season, mapping all bird observations and evaluating their status. This monitoring requires a good knowledge of bird species.

For some species, the monitoring can be carried out by the managers themselves, since they can be easy to recognise by outsiders, for example, the number of calling *Crex crex* in the first half of June (from late May to early July) or the total number of *Vanellus vanellus* and other waders ("long-legged and long-beaked", without dividing them into species) in early May (from late April to late May).

It should be noted that the desired changes in populations may fail to occur in the next season(s) after restoration or management changes. A delay is possible as time is needed for them to appear in the grassland structure. Positive change in grassland availability and structure may be reflected in the *Crex crex* population as early as the next breeding season,

Table 7.4.1. Example of management activity documentation.
A grassland with the habitat type 6450 *Northern boreal alluvial meadows*, total area 7 ha, restored after drainage and overgrowing with trees and shrubs.

Year	Month, day	Description of actions
1 Felling of trees and shrubs, regrowth control		
2012	20–25 August	Shrubs are cut by a bush cutter, gathered in piles and taken away for wood chips in early December.
2013	20 June 30 August 10 October	Regrowth is cut using a brush-cutter and gathered in heaps. Regrowth is cut using a brush-cutter and left in the grassland. Felling residues are burnt.
2014	27 June	Regrowth is mown together with the grass and collected with the hay.
2015	–	Almost no shrub regrowth, no need for special control measures.
2016	...	...
2017	...	...
2. Filling up of ditches		
2012	–	Has not been performed.
2013	20-25 January	Trenches are filled with an excavator, taking soil from the part of the grassland with many expansive species and increased soil fertility (shown on map).
2014	–	Has not been performed. Moisture regime has improved, therefore further rewetting is not planned.
3. Targeted re-creation of plant species composition		
2012	–	Has not been performed.
2013	15 April	*Festuca rubra* sown in the part of the grassland from where the soil for filling ditches was taken. Sown by hand in broadcast sowing technique – 20 kg ha^{-1}, rolled with a hand roller.
2014	10 August	In the part of the grassland where soil was taken for filling ditches, grass containing seeds from a semi-natural grassland (5 km away from "Bērziņi" farm, habitat type 6410_1) was spread in the proportion 2:1 (mown and gathered in an area that is two times as large as the covered area).
2015	–	Has not been performed.
2016	...	...
2017	...	...

(continued)

Table 7.4.1 (continued)

Year	Month, day	Description of actions
4. Smoothing of grassland surface		
2012	20 December–10 January	Grinding with root shredder, simultaneously smoothing sedge tussocks and grinding shrub roots. Ground material left on the field.
2013	–	Not performed.
2014	–	Not performed.
2015	10 April	Harrowed twice with a spring-tooth harrow to smooth turf rooted up by wild boar. Approximately 20% of the area harrowed (area marked on map), turf cover in the harrowed areas after harrowing was 20-30%, the rest was bare soil.
2016	...	...
2017	...	...
5. Mowing and haymaking		
2012	–	Has not been performed.
2013	10 July	Mown using a sickle mower. An area of 0.2 ha left unmown in the middle of the grassland to protect Corncrake.
	10–13 July	Hay was turned twice, then rolled in bales and removed from the field.
	10 August	The part of grassland where *Festuca rubra* was sown, mown for the second time. Grass immediately removed.
	20 August	The area left for the protection of Corncrake mown and cleared.
2014	25 June	Mown using a sickle mower. Corncrake was not heard this year, therefore areas for its conservation were not left.
	26–30 June	Hay turned three times, then stacked.
	10 July	Loose hay transported away from the field.
2015	–	Not performed. Grazing of beef cattle commenced.
2016	...	...
2017	...	...
6. Grazing		
2012–2014		Not performed. Permanent pasture fence installed in autumn 2014.
2015	1 May–10 November	Pasture (7 ha) included in single enclosure; three adult cattle animals; 24-hour grazing, no supplementary feeding. The height of pasture grass at the end of the grazing period – 10-15 cm on average. Mowing was not necessary. Manure smoothing and gathering was not carried out.
2016	...	...
2017	...	...

while populations with a small total number of individuals on a regional or continental level, for example, *Calidris alpina schinzii*, may fail to "discover" the newly available suitable breeding habitats.

In grasslands where target species populations are difficult to measure, indirect parameters may be used that characterise grassland structure or moisture changes. These indications will often enable the evaluation of the ongoing direction of change before the target bird species respond to changes. For example, in grasslands inhabited by *Gallinago media*, it is possible to evaluate the changes in the litter layer or access to free soil that is sufficiently moist (but not under water) and loose to become a suitable feeding place for *Gallinago media*. Similarly, in grasslands, where the objective is the preservation of *Anthus campestris*, a suitable indicator is the number and proportion of open sand patches in the grassland. If rewetting was the objective, than it is best evaluated by measuring the groundwater table in various locations of grassland.

During bird monitoring, the management carried

Table 7.4.2. Example of recording of factors affecting grasslands.

Affecting processes		
1. Spring floods		
2012	23 March–1 April	The flooding was short this year, its maximum height was 1.25 m (according to the flooding level measurement pole in the southwest corner of the grassland; location shown on map). The highest parts of the grassland were not flooded.
2013	27 March–20 April	Long flooding this year, maximum height 2 m. All grassland completely under water. After the flooding receded, a 2–10 cm layer of sand was left in many areas.
2014	–	No flooding.
2015	10–15 January	After heavy rains, the lowest areas of the grassland covered with water.
	10–20 April	Maximum level of floodwater – 1.55 m. The highest areas were under water for only a few days.
2016	...	...
2017	...	...
2017	...	...
2. Wild boar rooted up turf		
2012	–	Unknown (no attention was paid).
2013	–	No wild boar activity.
2014	Autumn	Wild boar rooted up turf in approximately 20% of the area (the area marked on the map). The impact is so severe that mowing will be impossible.
2015	–	No wild boar digging.
2016	...	...
2017	...	...
3. Other events		
2012	April	Fire from uncontrolled litter burning in the adjacent area entered the grassland in spring and burnt approximately one half of the grassland (area shown on map).
2013	–	–
2014	–	–
2015	Autumn	Hunters created deep tyre tracks in the southern part of the grassland while hunting.
2016	...	...
2017	...	...

Table 7.4.3. Management success evaluation parameters, related to management types.

Problem	Type of management	Parameters for the evaluation of management success
Tree and shrub cover	**Clearing of shrubs and trees and control of shrub regrowth,** for example, *grazing, felling, sawing, mowing, grinding, ring-barking*	Direct: total tree and shrub cover and the cover of each species by canopy layer. Indirect: number and composition of herb species, proportion of light-demanding species.
Thick layer of litter or moss	**Clearing of litter and moss,** for example, *burning, harrowing, grazing, grinding, raking*	Direct: litter and moss cover, litter layer thickness. Indirect: number of species and herb composition, proportion of grasses.
Uneven grassland surface, many tussocks	**Smoothing of grassland surface,** for example, *disc harrowing, drag-harrowing, shredding*	Direct: cover of tussock-forming species, density of tussocks. Indirect: number and composition of herb species.
Excessive soil fertility	**Nutrient removal,** such as *deturfing, frequent mowing with removal of grass*	Direct: soil chemical properties – phosphorus, potassium, nitrogen, soil pH, organic matter. Indirect: number and composition of herb species, abundance of nitrophilous species, number and occurrence of semi-natural grassland indicator species.
Inadequate hydrological regime	**Restoration of hydrological regime, rewetting measures,** for example, *ditch profile change, ditch blocking, filling, removal of berms*	Direct: monthly and annual groundwater table averages, presence and duration of spring flood, maximum, average and minimum level of floodwater. Indirect: number and composition of herb species, number of species and cover of moisture-loving plants and animals.
Undesirable plant species composition	**Creation of species-rich sward** (*sowing of seeds, spreading of hay or grass containing seeds, planting of turf or seedlings, sowing* Rhinanthus *spp. seeds*)	Direct: the original composition of sown or introduced plant species, their cover and its changes over time, number of species and cover of undesirable plant species. Indirect: total number and composition of herb species, number and cover of habitat characteristic plant and animal species, condition of umbrella species populations.
Expansive and invasive species suppress the habitat characteristic vegetation	**Control of expansive and invasive plant species** (*frequent mowing, grazing, removal of turf, application of herbicides, ploughing, weeding*)	Direct: number of expansive and invasive plant species and the cover of each species, vitality. Indirect: total number and composition of herb species, number and cover of habitat characteristic plant and animal species, condition of umbrella species populations.
A rare species or one characteristic of the habitat has disappeared or its abundance decreased	**Management appropriate for the species**	Direct: parameters of the rare species population, vitality. Indirect: total number and composition of herb species, number and cover of habitat characteristic plant and animal species, condition of umbrella species populations, parameters of environmental conditions necessary for the species (e.g., soil reaction, phosphorus content).
Maintenance necessary for the grassland	**Regular mowing**	Direct: mowing parameters (height, time, frequency, type). Indirect: total number and composition of herb species, number and cover of habitat characteristic species, condition of umbrella species populations, tree and shrub cover.
	Regular grazing	Direct: grazing parameters (grazing pressure, duration, type of grazing animals, grazing intensity, pasture vegetation height and its changes over the grazing period, turf disturbance, proportion of soil patches without vegetation). Indirect: total number and composition of herb species, number and cover of habitat characteristic species, condition of umbrella species populations, tree and shrub cover, number and cover of overgrazing indicator species.

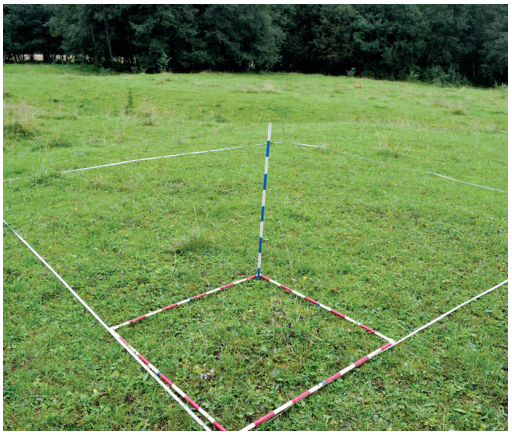

Fig. 7.4.2. Installation of sample plot for vegetation analysis. The smallest plot is 1 x 1 m. All species are recorded in it to evaluate the species richness. The larger plot, which includes the smaller plot, is 5 x 5 m – the species not present in the smaller plot are additionally recorded in it and the cover of each species is evaluated using the cover-abundance scale or percentage. Data from the larger plot allow the vegetation structure to be evaluated. A small metal stake is usually driven into the ground and coordinates taken with a GPS receiver at the point where the corners of the small and large areas meet (foreground of the image). Photo: S. Rūsiņa.

Fig. 7.4.3. Arrangement of sample plots in a transect with spacing of 2 metres. The transect starting point is fixed at the pine, where a 30 cm stake is driven into the ground. It is located each year using a GPS receiver and metal detector. The direction of the transect is determined by measuring the azimuth with a compass and sample plots are established with an interval of 2 metres, marking the first sample plot two metres from the transect starting point (to prevent the impact of trampling on vegetation during the localisation of the transect). Photo: S. Rūsiņa.

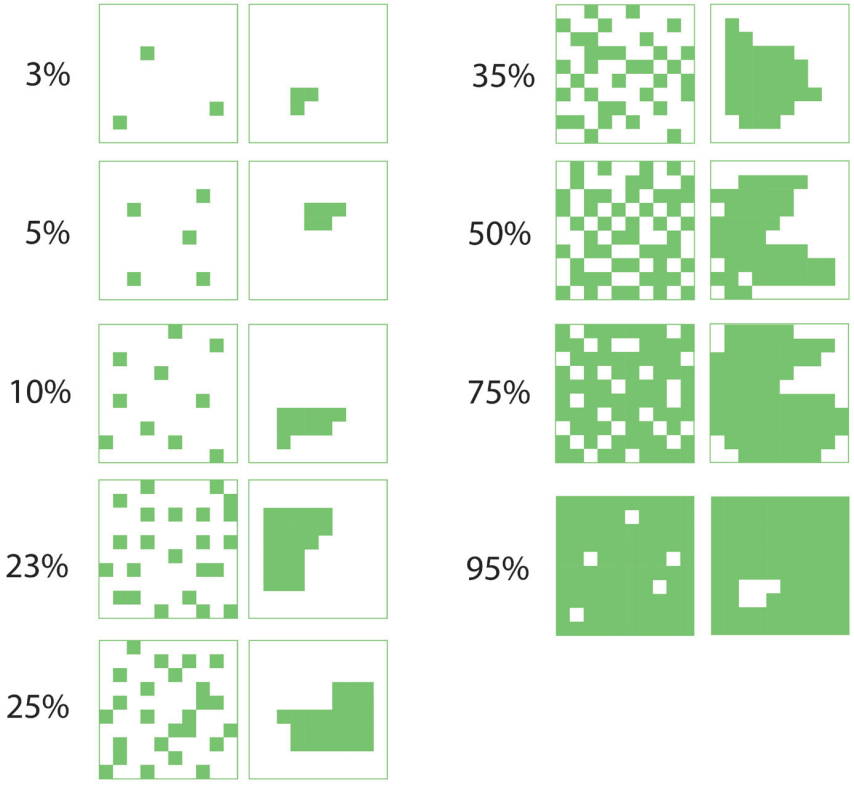

Fig. 7.4.4. Percentage of cover of plant species in the total area of the sample plot. Drawing by D. Segliņa.

Table 7.4.4. Example of species abundance and vegetation structure assessment in a transect with five 1 m^2 plots.

Depending on the objectives of monitoring, this table can be adjusted by removing unnecessary parameters and species groups and adding relevant parameters and species.
*A list of expansive species is given in Annex 3, a list of semi-natural grassland indicator species in Annex 4, a list of protected species – in Cabinet Regulation No. 396 adopted on 14 November 2000[28], other rare species – in the Red Data Book of Latvia (Andrušaitis (ed.) 2003).

Grassland location or identification number: grassland No. 1 Monitoring date: 12.07.2015. Time: 10.00–11.20
Weather: cloudy, short shower bursts
Survey carried out by: Ilze Bērziņa
Transect No. 1, azimuth 106°
Transect starting point coordinates (in LKS–92 coordinate system): x 635902, y 215726
The distance of the first sample plot from the transect starting point is 5m, the distance between sample plots - 4 m, size of plot - 1 m^2

Sequence number of sampling plot in transect	**1.**	**2.**	**3.**	**4.**	**5.**
Vegetation structure					
Shrub and tree cover, %	0	2	5	0	0
Herbaceous plant cover, %	80	75	80	70	85
Moss, lichen cover, %	5	10	20	25	5
Cover of bare soil patches %	15	10	0	5	10
Litter cover, %	0	0	5	0	2
Herb layer height, cm	100	90	90	75	110
Expansive species*					
Total cover of expansive species, %	0	5	60	20	5
Calamagrostis epigeios (points)	0	2	3	2	1
Aegopodium podagraria (points)	0	0	2	1	1
Indicator species of semi-natural grasslands*					
Total number of species	7	5	0	3	7
Dianthus deltoides (points)	1	1	0	1	1
Primula veris (points)	2	1	0	0	2
Protected species*					
Orchis mascula (number of rosettes)	3	0	0	0	2
Indicator species of overgrazing*					
Total cover of overgrazing indicator species, %	0	0	0	10	30
Plantago major (points)	0	0	0	2	0
Poa annua (points)	0	0	0	1	3

[28] Cabinet Regulation No. 396 Adopted 14 November 2000 On the List of Specially Protected Species and Specially Protected Species for Limited Use.

Table 7.4.5. Indications of semi-natural grassland in a good conservation status based on invertebrate species.
* A "+" means that the indicator applies to the given grassland habitat group, a "–" means that it does not.

Indicators	Grassland habitat groups to which the indicator applies best*			
	Dry grasslands	Mesic grasslands	Moist grasslands	Forest edge grasslands
Anthills	+	+	–	+
Wild bee colony with at least 20 individual burrows	+	+	–	–
At least 8 bumblebee species	+	+	+	+
At least 5 earthworm species		+	+	
Any locust species with red or blue hindwings	+	+	+	+
At least 20 butterflies (species) of different forms (males and females)	+	+	+	+

out and the influencing factors should be recorded (Tables 7.4.1 and 7.4.2). Photo monitoring is also recommended.

7.4.3.4 Invertebrate Monitoring

Several invertebrate species and groups are particularly good indicators of management success (Table 7.4.5). When carrying out invertebrate monitoring, the management and the influencing factors should also be recorded (Tables 7.4.1 and 7.4.2). Photo monitoring is recommended.

7.4.3.5 Hydrological Monitoring

The changes in groundwater table is a factor that characterises the development of conditions typical for grassland well, thus it is one of the basic indicators to determine whether grassland rewetting is successful. Usually the average water table increases at rewetted sites, and water table fluctuations become less pronounced. This means that the conditions become appropriate for the development of moist grassland vegetation and the atypical species become extinct.

In the restoration of floodplain grassland, it is important to obtain data both on the surface water level (during spring floods) and the groundwater table.

For the monitoring of the hydrological regime in the sites of grassland habitat restoration, several rows of bore-holes (profiles) are usually established located perpendicular to the ditches (Fig. 7.4.7). The distance between the holes may be constant or, moving away from the edge of the ditch, the distance between the holes may increase. However, like in the vegetation monitoring, it is not possible to provide recommendations useful for all cases concerning the placement and number of monitoring bore-holes – it is determined by the specific hydrographical and topographical conditions of each site.

The bore-holes should be drilled sufficiently deep to be able to measure the groundwater table at its lowest level. Usually plastic pipes are inserted and covered with a lid. Observations must be regular – preferably once a week or at least 1–2 times a month. The water table can be measured with a tape measure with a float, from the top of the well until the water table, subtracting the height of the well above the surface of the grassland from this value (Indriksons 2008; Gruberts 2015). Automatic equipment can be used as well, which gives a more accurate overview of the changes over time.

Stakes solidly inserted into the ground can be used for surface water level measurement. They should be divided into equal sections of 10 cm and marked with colours well visible from a distance (for example, white and black). The water level during flooding is read from the edge of the floodplain using binoculars.

To objectively assess the changes, water table observations should be related not only to rewetting, but also to precipitation and its distribution within one year and over several years.

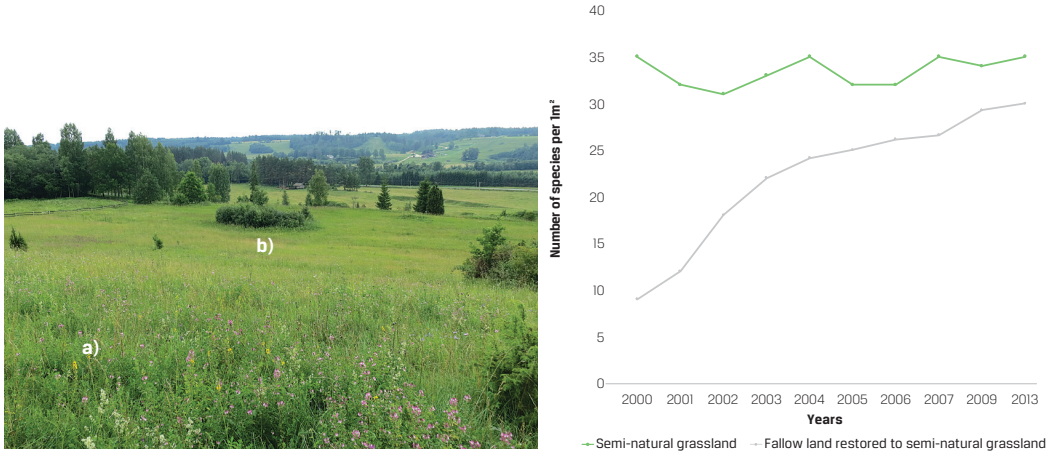

Fig. 7.4.5. In long-term managed semi-natural grassland (A - foreground) the number of species does not change over the years. In ex-arable land (B - background), where semi-natural grassland has been created since 2000 by mowing and haymaking, the number of species is gradually increasing. In thirteen years it has nearly reached the number of species in the adjacent semi-natural grassland. Photo: S. Rūsiņa, 2013, "Abavas Ieleja" Nature Park.

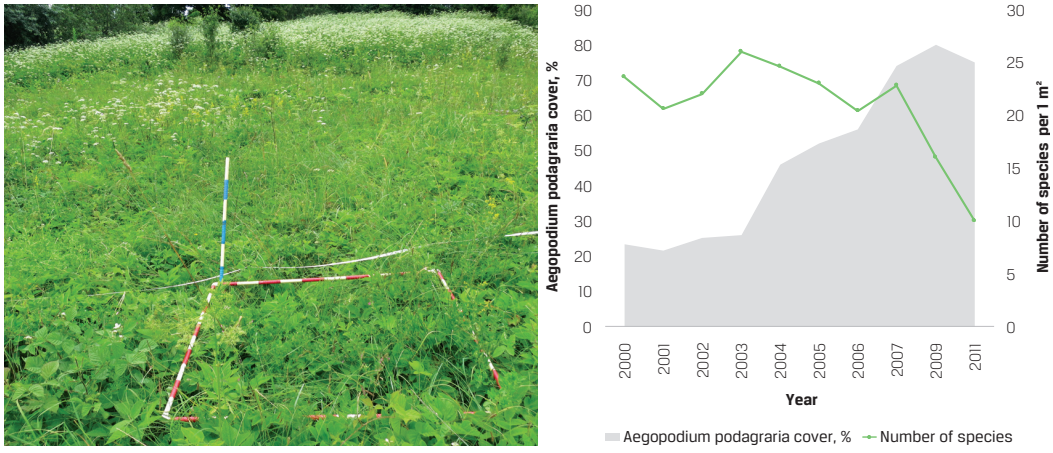

Fig. 7.4.6. An abandoned dry grassland overgrowing with *Aegopodium podagraria*, where the number of species per square metre over 11 years has decreased from 27 to 10 species, while *Aegopodium podagraria* cover has increased from 20% to 80%. Photographed in 2013 in "Abavas Ieleja" Nature Park. Photo: S. Rūsiņa.

Fig. 7.4.7. The groundwater table monitoring wells and surface water level measuring stakes must be surveyed and restored each year, especially in areas where floods occur or grazing animals are used. Condition of wells and stakes in 2015 constructed in Dviete floodplain in 2012. Photo: S. Rūsiņa.