PART IV METHODS OF MAINTENANCE, ECOLOGICAL RESTORATION AND CREATION OF GRASSLAND HABITATS

Chapter 20. Selection of Methods and Work Sequence (S. Rūsiņa)

When selecting the restoration, maintenance methods and work sequence, all factors and influences, as well as interactions in the particular area must be taken into consideration. First of all, removal of excessive biomass – trees and shrubs and/or the litter, which has accumulated over the long period of abandonment, is recommended. It is necessary to be sure that free movement across the grassland is possible in order to implement other restoration works. The biomass, if left scattered or mixed with the upper layer of soil (by means of tilling), would deteriorate the condition of the habitat due to the increased level of nutrients, thus slowing down the restoration and even making it impossible. Therefore, it is necessary to carry out the works in the right sequence, e. g. it is not practicable to initially raise the groundwater table and afterwards fell and remove trees and shrubs in humid conditions. Taking these considerations into account, Table 20.1 presents the restoration measures and sequence of the performance thereof.

Table 20.1. The restoration works of EU protected grasslands in the sequence of the performance at the site level. Depending on the condition of the grassland only some restorative measures or the entire set of measures must be implemented. The chapter where the methods used in restoration and the comparison of methods is provided, is given in the parentheses.

Code of the EU habitat type	Restorative measures and principal aspects that need to be considered
1. Removal of shrubs and trees and control of shrub regrowth. *If shrubs and trees are not present, see 2.*	
Methods (*Chapter 21.4*): *grazing, felling, cutting, mowing, grinding, bark ringing, stump extraction, treatment with herbicides.*	
All habitat types	Grazing is a more effective method for controlling tree and shrub sprouts. If the habitat is restored by grazing, the need for grinding roots and stems must be evaluated depending on the composition of tree species, possibilities of ensuring regular grazing (which reduces the regrowth of sprouts) and grazing livestock density.
6120*, 6210, 6230*_1	Dry grasslands typically overgrow with *Pinus sylvestris.* They do not develop sprouts, therefore tree felling is a relatively cheap measure, which must be performed only once during the first year of restoration. Grinding is usually required, if a large area of the grassland is occupied by deciduous woody species that are resprouting (*Populus tremula, Betula pendula*, invasive non-native species *Amelanchier spicata*). The presence of protected snail species must be checked in grasslands on calcareous soils prior to restoration. If they are present, grinding must be performed part by part over a period of several years in order to prevent damage to these invertebrates.
6230*_2, 6230*_3, 6270*, 6410, 6450, 6510, 6530*, 9070	Mesic, moist and wet grasslands typically overgrow with *Alnus incana, Populus tremula, Betula* spp. and in damper areas – with *Alnus glutinosa* and *Salix* spp. All these tree species are prolific sprout producers, therefore repeated management for several years must be taken into account.
6410, 6450, 6530*	The occurrence of protected snail species and other invertebrates must be checked prior to restoration. If they are present, grinding must be performed part by part over a period of several years in order to preserve these invertebrates.
2. Removal of litter and mosses. *If litter and mosses are absent, see 3.*	
Methods (*Chapters 21.2, 21.3*): *burning, harrowing, grazing, grinding, raking.*	
All habitat types	Dense layer of litter (dead grass) accumulated over a long time and thick layer of mosses considerably changes the conditions of the topsoil (it becomes wetter and more fertile) and reduces the germination of seeds. If the surface is uneven, mowing and removal of litter and mosses is almost impossible, therefore, the most efficient type of management is prescribed burning (*see Chapter 21.2*). If protected snail species occur in the grassland, burning is not recommended.
3. Smoothing of grassland surface. *If the smoothing of grassland surface (mounds, molehills and wild boar holes) is not required, see 4.*	
Methods (*Chapter 21.3*): *burning, grazing, disk harrowing, disk tilling, grinding, toothless drag-harrowing, grinding.*	

(continued)

Table 20.1 (continued)

Code of the EU habitat type	Restorative measures and principal aspects that need to be considered
All habitat types	The smoothing of grassland surface is necessary for site preparation for further management which includes mowing with a tractor. The surface of pastures may be more uneven than that of the meadows. Surface smoothing is only necessary in sites where the grassland is overtaken by tussock-forming highly competitive grasses or sedges. Grasslands that have been abandoned for a long time may have an uneven surface (turf covered molehills, anthills, holes dug by wild boar, burrows created by badgers and foxes, in wet places there might also be tussocks of *Deschampsia cespitosa, Carex cespitosa* etc.), which can significantly interfere with mowing. Removal of the accumulated litter and moss layer is recommended before smoothing (tilling, disk harrowing, harrowing, toothless drag-harrowing) by prescribed burning or raking in order to prevent excessive eutrophication. If protected snail species occur in the grassland, burning is not desirable, but smoothing must be performed gradually over a period of several years.
4. Loosening of compacted soil. *If the soil is not compacted, see 5.*	
Methods (*Chapter 21.5*): *subsoil tillage, solid manure incorporation, regulation of grazing intensity, construction of shallow draining ditches.*	
Mainly 6270*_3, 6410, 6450	If air supply in compacted soils is insufficient, the growth of plant roots and the development of soil macro-fauna and micro-fauna, which is critical for the successful development of herbaceous vegetation, is diminished. As a result, the moisture in the topsoil in mesic and wet grasslands increases, resulting in an anaerobic environment, which can be tolerated by a few plant species only.
5. Reduction of soil fertility. *If the soil fertility does not need to be reduced, see 6.*	
Methods (*Chapter 21.7*): *frequent mowing with removal of grass, removal of turf and topsoil, cultivation of cereals, deep ploughing.*	
All habitat types	Soil fertility must definitely be reduced in grasslands that have been fertilised for long periods of time and are now densely overgrown with expansive species. In mesic grasslands, it is recommended to reduce soil fertility, if the phosphorus content exceeds 50 mg kg^{-1} according to the Olsen method or 80 mg kg^{-1} according to the Egner-Riehm method, in dry grasslands – even if the content of phosphorus is lower).
6. Rewetting. *If rewetting is not required, see 7.*	
Methods (*Chapter 21.6*): *maintenance of drainage system, preservation of shallow ditches, changing the profile of ditches, damming or filling up of ditches, removal or fragmentation of ditch berms, regulation of beaver activity, creation of floodgates and spillways, creation of shallow valleys, variation of terrain, restoration of natural river flows.*	
6120*, 6210	In floodplains, the impact of drainage systems on dry grasslands must be evaluated. If an unfavourable influence is detected, the spring flood regime must be restored. If the drainage has stopped regular flooding, it is highly possible that this will negatively affect the dry grassland due to a lack of natural circulation of nutrients promoted by flooding, lack of accumulation of alluvial sediments (creating additional niches for plant and animal species in dry grasslands). At the same time, soil erosion and acidification increases, which may cause degradation of the habitat.
6230*, 6270*, 6410, 6450	The filling up of shallow ditches dug manually in the first half of the 20th century is undesirable, because the grassland has adapted to the moisture conditions created 50–100 years ago, and corresponding semi-natural vegetation has been developed. Therefore these ditches must be maintained – trees and shrubs must be cleared, and ditch cleaning might be necessary.
Mesic and wet grasslands 6230_2, 6230_3, (6270*_3, 6410, 6450)	Filling up of deep ditches must be planned depending on the purpose of restoration and long-term management plan. There is no sense in rewetting, if mowing and grass removal will be impossible afterwards due to excessive moisture.
7. Creation of species-rich sward. *If the creation of plant species composition is not necessary, see 8.*	
Methods (*Chapter 21.8*): *sowing seeds, spreading of hay or grass containing seeds, turf transplantation, planting of seedlings, sowing of Rhinanthus* spp.	
All habitat types	The method is efficient, if the chemical properties of the soil resemble chemical properties of a habitat in good conservation status. If the soil is too fertile, the turf must be removed prior to this activity, or other measures of soil fertility reduction must be applied.
8. Control of expansive and invasive plant species. *If there are no expansive and invasive species, see 9.*	
Methods (Annex 3, *Chapter 21.9*): *frequent mowing, grazing, deturfing, herbicide application, ploughing, weeding.*	

(continued)

Table 20.1 (continued)

Code of the EU habitat type	Restorative measures and principal aspects that need to be considered
All habitat types	Chapter 21.9 lists the expansive and invasive species that most commonly endanger the biodiversity of the particular types of grassland. If the expansive and invasive species cover less than 20% of the vegetation, restorative and maintenance mowing or grazing is usually sufficient. If these species dominate in the vegetation, specific methods for controlling these species must be used. The methods for species that most commonly occur in grasslands have been briefly described in Annex 3.
9. Restorative mowing or grazing. *If restorative mowing and grazing is not necessary, see 10.*	
Methods (*Chapters 21.1, 22*): *mowing, grazing.*	
All habitat types	Extensive grazing is the most suitable method for restoration. If grazing is not possible, grassland must be mown and grass removed at least twice per vegetation season, in order to reduce the volume of expansive plant species and soil nutrients, as they have accumulated excessively in the time when the grassland was abandoned.
10. Maintenance mowing or grazing. *If maintenance mowing and grazing are not necessary, see 11.*	
Methods (*Chapter 22*): *mowing, grazing.*	
All habitat types	The most appropriate method must be selected, depending on the habitat type (Annex 2).
11. Reducing fragmentation. *If there are no negative influences caused by fragmentation, see 12.*	
Methods (*Chapter 24*): *maintenance and creation of landscape elements, seed introduction of semi-natural grassland plants, creation and restoration of target habitats.*	
All habitat types	Semi-natural grassland plants typically do not have persistent seed banks. During the period of cultivation or long-term abandonment the seed bank can be depleted or even destroyed. Thus, even proper management may not help to bring back the species characteristic for the particular habitat. Habitat fragmentation reduces grassland connectivity and species dispersal from other grasslands can hardly contribute to the restoration of plant communities. Therefore, not only in the restoration, but also in the maintenance management, the transfer of species rich seed material is of great significance.
12. Creation of conditions suitable for species of different organism groups	
12.1. Creation of conditions suitable for bird diversity	
Creation of conditions suitable for bird diversity includes most of the previously mentioned measures and methods, for instance, removal of trees and shrubs creates conditions that are suitable for *Gallinago media*, rewetting is beneficial for waders. However, there are also bird species-specific methods: *creation of tree and shrub mosaic, control of predators, maintenance of water bank free of vegetation, creation of bare sand patches, appropriate methods of maintaining habitats* (Chapter 23).	
All habitat types, except habitats suitable for breeding of waders.	Development of a diverse mosaic of shrubs and shrub patches that account for up to 10% of the area is recommended in order to increase the diversity of bird species.
All habitat types, which have conditions that are suitable for the breeding of meadow waders.	Predators are a specific threat for waders in grasslands. *Vulpes vulpes, Nyctereutes procyonoides, Mustela vison*, corvids, *Larus* spp, and *Circus aeruginosus* inflict most damage to the populations of waders. The influence of predators can be reduced as follows: 1) commencing grazing later, so that predators cannot easily see nests; 2) removal of tall shrubs, trees or other vertical elements, which enable the observation of nests; 3) active reduction of predator population by hunting; 4) constructing fences which would prevent the access of foxes and raccoon dogs to the territory. Ensuring the accessibility of water bodies. It is significant for the majority of wader species, therefore banks of water bodies must be cleared from tall herbs and shrubs.
12.2. Creation of conditions suitable for invertebrates	
Methods (*Chapter 22*): *development of tree and shrub mosaic and microclimate belts, creation of bare ground patches, creation of micro-habitats, appropriate methods of habitat maintenance.*	
All habitat types	Establishment of micro-habitats, e. g. stone heaps, or leaving tall tree stumps is recommended to ensure diversity of the populations of grasshoppers and katydids, as they use such elevations during their breeding period.
12.3. Creation of conditions suitable for reptiles and amphibians	
Methods: *creation of sandy patches, creation of micro-habitats.*	
6120*, 6210, 6230	Grasslands are important habitats for *Lacerta agilis* and *Lacerta vivipara*. To ensure conditions suitable for these species, the creation of at least 1 m^2 large patches of bare soil is recommended. In pastures this is achieved by regulating the intensity of grazing. In meadows these patches can be created mechanically – by harrowing or removing the turf. After the establishment of patches, mowing or grazing must be started (Schnoor et al. 2015). Also the establishment of hiding places – heaps of branches or stones – is recommended.
13. Non-interference regime	
Methods (*Chapter 22.1*)**:** *non-interference.*	