Nature and Landscape Management Standards		
MANAGEMENT OF SELECTED TERRESTRIAL BIOTOPES	**RESTORATION OF LONG-TERM UNCULTIVATED GRASSLAND COMMUNITIES (INCLUDING REMOVAL OF TREE AND SHRUB SPECIES**	**SPPK D02 002: 2021**
SERIES D		

Obnova dlouhodobě neobhospodařovaných travních společenstev (vč. likvidace náletových dřevin) / Restoration of long-term uncultivated grassland communities (including removal of tree and shrub species) / Wiederherstellung von langfristigen unbewirtschafteten Grünlandgemeinschaften (einschließlich Fällen von Baumarten)

This standard contains definitions of technical and work procedures for restoration (rehabilitation) management of long-term uncultivated non-forest communities.

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Act no. 156/1998 Coll. on Fertilizers, as amended
Act no. 185/2001 Coll. on Waste and on amendment of certain acts, as amended.
Act no. 254/2001 Coll. on Waters and on amendment of certain acts, as amended.
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Ministry of the Environment Decree no. 189/2013 Coll. on Protection of woody plants and permitting of their felling, as amended.
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Decree no. 132/2018 Coll. on Preparations and other products for plant protection.
Decree no. 17/2018 Coll., amending Decree no. 206/2012 Coll. on Determining professional qualification for handling products.
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Expert review:
Faculty of Science, University of South Bohemia in České Budějovice

Authorial collective:
RNDr. Ondřej Sedláček, PhD., Mgr. Jiří Malíček, PhD., RNDr. Blanka Mikátová, Ing. Tomáš Janata, Ing. Klára Čámská, PhD.
Besides, authorial contributions to the Standard text were made by Mgr. Jan Mládek, PhD. and Doc. RNDr. Jakub Těšitel, PhD. (chapter 3.8, Hemiparasitic plants).

Documentation for the standard development is available in the NCA CR library.

Standard approved on .....

RNDr. František Pelc
Director of NCA CR

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Standard purpose

The standard “Restoration of long-term uncultivated grassland communities (including removal of tree and shrub species)” defines procedures aimed at restoration of valuable grassland communities, creation or expansion of areas of species biotope types for forestless landscape types valuable in terms of conservation.

The procedures described in the standard concern most commonly two biotope types: 1. Biotopes in ordinary agricultural landscape where original management methods (such as municipal pastures) have been suppressed. These include parts of forestless landscape in military areas, both large-scale (such as Brdy, Boletice) and many small-scale. 2. Previously valuable forestless landscape, often in protected areas, which long lack adequate management, or areas deliberately left over to “natural” processes, degraded due to absence of disturbing effects (large herbivores, fires, floods, windfalls, landslides, etc.). Degradation and reduction in areas of forestless landscape due to overgrowing with woody plants contributes to increasing isolation of natural habitats, impossibility of migration and spreading of populations of animals and plants bound to non-forest biotopes.

The standard brings an overview of tools for rehabilitation and restoration management. Interventions typically have to be made with relatively high intensity, because too cautious interventions mostly lead to restoration of target communities and populations of endangered species only very slowly. At the same time, there is a mandatory rule not to carry out an intervention across the entire site at once, to avoid affecting residual populations of target species.

Removal of trees is a one-time intervention if successful. The scope depends on the restoration objective. It is typically advisable to leave scattered trees, their groups or torsos on the site. Complete clearance is advisable for invasive species. Exceptions may include old trees that already support specially protected or rare animal species (e.g., the hermit beetle in old black locust trees).

2. Legal framework

Act no. 289/1995 Coll. on Forests and on amendment of certain acts (Forest Act), as amended. The Act specifies activities prohibited in the forest (Section 20) and its immediate surroundings. The Act only applies to restoration on land intended for performance of forest functions.

Act no. 114/1992 Coll. on Nature and Landscape Protection, as amended, deals (among other things) with general protection of wild plant and animal species and special protection of rare or endangered species, positive influencing of their development in nature, and ensuring of preconditions for their conservation, possibly including special silvicultural and breeding facilities, as well as restoration and creation of new ecosystems of natural value. Furthermore, the Act deals with protection of non-forest woody plants, protection of prominent landscape features and landscape character, and basic protection requirements of specially protected areas.

Act no. 334/1992 Coll. on Agricultural Land Fund Protection, as amended, specifies general principles of agricultural land protection (Section 3) from contamination and erosion and restricts uses other than agricultural.

Act no. 541/2020 Coll. on Waste, as amended, defines, among other things, when an item, including grass and wood materials, becomes waste as well as disposal and processing of biodegradable waste (so-called organic waste), which is specified in more detail by Decree no. 273/2021 Coll. on Waste management details. Pursuant to Section 3, any waste management has to observe a hierarchy of waste management methods, specifically prevention of waste generation, preparation for reuse, recycling of waste, other uses and finally, waste disposal. Prevention of waste generation includes uses for domestic or community composting, mulching, chipping, fodder, harvest for seeds, biodiversity promotion, manufacturing of enclosures or visitor infrastructure, etc., where the material is not regarded as waste. Any other handling method shall comply with provisions of the Waste Act.

Act no. 254/2001 Coll. on Waters and on amendment of certain acts (Waters Act), as amended, specifies, inter alia, requirements for protection of surface and groundwater, namely that composting and landfilling of grass material must not endanger the environment and quality of surface and groundwater.

Act no. 89/2012 Coll., the Civil Code, as amended, specifies that the owner of a thing is prohibited from seriously encroaching on other people's rights beyond a scope adequate to circumstances (Section 1012). When handling grass material or removing or reducing woody plants, it is mandatory to refrain from any activity causing pollution to enter another owner's property on a scope inadequate to local conditions and significantly restricting normal use of the property (Section 1013, Para. 1), e.g., smoke and odour from burning of biomass or waste and noise from removing of woody plants.

Act no. 201/2012 Coll. on Air Protection, as amended, deals with prevention of air pollution and reduction of pollution levels so as to reduce risks to human health caused by air pollution, reduction of environmental burdening with substances emitted to the air and damaging ecosystems, and creation of conditions for recovery of environmental components impaired as

a consequence of air pollution. For the purposes of the present standard, it applies notably on burning of biomass.

Ministry of the Environment Decree no. 189/2013 Coll. on Protection of woody plants and permitting of their felling, as amended, defines details, particularly size of woody plants that require a felling permit.

3. Methods

3.1 Removal of trees

3.1.1 Method application

3.1.1.1 The method involves removal of woody plants – trees growing at a quantity or in a place that endangers the forestless character of a site that is a valuable grassland biotope or home to protected or endangered species (e.g., wet meadows, peat bogs, rock steppes, sandy areas or heaths).

3.1.1.2 Woody plant reduction can be done using both manual and heavy equipment. The work may include application of herbicides (see chapter 3.6). Other methods are mentioned that require a longer period of time (e.g., tree banding, application of wood-decaying fungi).

3.1.1.3 Felling has to comply with regulations applicable to forest stand management (Act no. 289/2005 Coll. on Forests) and requirements for felling of non-forest woody plants (Act no. 114/1992 Coll. on Nature and Landscape Protection). Felling of non-forest woody plants is specified by standard SPPK A 02 005 Tree felling. Treatment of ageing trees and other types of tree treatment (cutting to torso) are specified in standard SPPK A02 009 tree treatment and SPPK E 02 005 Treatment of trees as biotopes of rare species of organisms.

3.1.1.4 Felling of trees is an expert activity requiring qualifications, tree inspection and work area security as per standard SPPK A02 005 Tree felling.

3.1.2 Method description

3.1.2.2 Ways of removing or reducing woody plants

Recommended work procedures for general tree felling are described in standard SPPK A02 005 Tree felling; additional and special recommendations are made herein.

3.1.2.2.1 Felling to low stump

3.1.2.2.1.1 The trunk is cut off low over ground. Suitable for large areas and for species producing fewer sprouts. Trees are usually felled between November (October) and March. In the event of presence of specially protected species, the date has to be adjusted to suit their requirements.

3.1.2.2.1.2 Species with a high regeneration ability require destruction of sprouts in the following two or more years (by cutting, chopping or breaking off).

3.1.2.2.1.3 In the case of herbicide application, the suitable date for felling is in August and September (or first half of October).

3.1.2.2.2 Felling to tall stump

Felling to tall stump (about 1.5 m) is used to reduce production of sprouts.

3.1.2.2.3 Debranching of solitary trees

3.1.2.2.3.1 Removal of lower tree branches in order to increase the insolation of the area under the tree. This leads to microhabitats important for animals. Around conifers, it is often necessary to rake clear the forest floor.

3.1.2.2.3.2 The intervention must not result to major increase in the tree centre of gravity, so ensure professional execution. Failing that, the intervention could be interpreted as damaging the tree.

3.1.2.2.4 Banding

3.1.2.2.4.1 Banding is suitable for tree species that regenerate copiously when damaged, either from roots or from stumps (e.g., black locust, aspen, alder, willow). It is done from spring to September; the method is described for invasive tree species in standard SPPK D 02 007 Management of selected alien plant species, chapter 3.1.10.

3.1.2.2.4.2 Banding involves removal of a strip of bark several centimetres wide along the trunk circumference, at a height of approximately 1.3-1.5 m. The trunk is incised down to wood, i.e., about 2 cm deep.

3.1.2.2.4.3 Another way is to chop the tree with a machete or cutting with a chainsaw to make a strip about 20–30 cm wide along the entire trunk circumference or over about 70% of the circumference (for black locusts).

3.1.2.2.6 Plastic sheeting

3.1.2.2.6.1 The tree is felled to a tall stump, the upper half of the stump is wrapped in a dark plastic bag and the bag is left loose over the cut. The bottom end of the bag is fastened around the stump. The stump begins to produce sprouts, but they grow inside the bag.

3.1.2.2.6.2 The method is most efficient in June and July. The method efficiency decreases in later months, and spring sprouts may tear the bag open.

3.1.2.2.7 Self-seeding removal by area-wide milling

3.1.2.2.7.1 Suitable where the self-seeded plants make a blanket. The miller crushes the wood material and mixes it with earth at the ground level, even on slopes with a gradient up to 35°. It removes shrubs and trees up to a trunk diameter of 20 cm, including roots up to 5 cm deep.

3.1.2.2.7.2 The technique can only be used in exceptional cases. It is an intensive technique pursuant to Act no. 114/1992 Coll. (due to nutrient enrichment, surface damage, environmental homogenization, etc.). The risks and restrictions for this method are specified in chapter 3.1.5.3. Chipping.

3.1.2.2.8 Use of the fungus silver leaf ***Chondrostereum purpureum***

3.1.2.2.8.1 The use of this fungus is effective for some tree species. It is a European species growing on dead wood as well as freshly felled trunks and cut-off stump surface.

3.1.2.2.8.2 Silver leaf spores are applied via a suspension, ideally to freshly cut-off stump surface. The fungus inhibits regeneration not only from the stump, but also from the roots. The success rate of tree recovery inhibition is high (up to four years).

3.1.2.2.8.3 The fungus cannot penetrate through intact bark, so its uncontrolled spreading is not a risk. For more, see standard SPPK D 02 007 Management of selected alien plant species, chapter 4.2.6.4.1.

3.1.3 Technique and material

3.1.3.1 Manual: young tree stands (coppice, self-seeded up to about 10 cm in diameter) are removed using a heavy-duty trimmer with a trident or circular saw; a chain saw is used for taller trees. On sloping ground, a handheld saw or a light one-hand saw is recommended.

3.1.3.2 Heavy machinery is described in the standard SPPK D 02 006 Disturbance management in non-forest areas.

3.1.4 Intensity, extent, period

Shrub removal is usually a one-time intervention. In the case of regeneration, the procedure has to be repeated in the following year.

3.1.5 Biomass handling

Chapter 2 explains briefly when biomass is considered waste.

3.1.5.1 Use of biomass to promote environmental heterogeneity

Leave heaps of branches or stacks of trunks in selected places as various types of habitats for animals, located in places with varying sunshine exposure, or branches leaning against a tree or another solid object on the site.

3.1.5.2 Biomass removal

Biomass is removed manually or using machinery (timber trailer).

3.1.5.3 Chipping

3.1.5.3.1 Part of the chips can be left on the site in lower heaps in places exposed to sunshine. Ideally interspersed with branches or stumps.

3.1.5.3.2 In specially protected areas (NR, NNR, PLA zones I and II), chipping may be regarded as “site management requiring intensive techniques” and thus prohibited under the basic protection requirements for the listed sites. In such cases, it can only be done based on an exemption approved by an applicable nature protection authority (Section 43 of the NLPA).

3.1.5.3.3 After removal, a residual layer (up to 3-5 cm) often remains in wood chip storage or processing areas, which has to be removed, particularly from nutrient-poor sites (such as sandy areas or wet meadows).

3.1.5.3.4 Large heaps of wood chips left in place before removal pose a risk of self-ignition.

3.1.5.4 Burning

3.1.5.4.1 Method application

Biomass can be burnt after less extensive felling or in areas inaccessible for machinery.

3.1.5.4.2 Risks and restrictions

3.1.5.4.2.1 Any burning has to be announced in advance to the Fire Rescue Service (via website). Safety regulations have to be complied with, and the possibility of fire spreading minimized. Pursuant to Section 16, Para. 5 of the Air Protection Act, burning of biomass can be restricted or prohibited by a municipal ordinance for the municipality in whose territory the burning is to take place; thus, check whether such an ordinance is in force for the area in question. If such a restriction or ban exists, the municipality has the obligation to assure biomass disposal in another way in accordance with the Waste Act; thus, consult the disposal method with the municipality in advance and check biomass disposal options in the municipality in question.

3.1.5.4.2.2 Areas of national parks, protected landscape areas outside built-up areas of municipalities and developable areas of municipalities in national nature reserves are subject to a ban on making fires outside places designated by a nature protection authority (Act no. 114/1992 Coll., Sections 16(2), 26 and 29, Para. 1, item b).

3.1.5.4.2.3 Burning is not safe during long-term drought due to the risk of uncontrolled spreading of fire.

3.1.5.4.2.4 Burning is prohibited in areas of extraordinary conservation value. Generally, it is better to burn biomass in ruderalized places or even places where fire can remove undesirable vegetation (e.g., areas with removed expansive shrubs).

3.1.5.4.2.5 Open fires can only be used for burning dry plant material in accordance with Section 16, Para. 4 of the Air Protection Act.

3.1.5.4.2.6 Burning has to take place outside forest and its buffer zone, i.e., more than 50 m from the forest boundary in order to minimize any threats to it.

3.1.5.5. Stump removal

3.1.5.5.1 Stump removal is described in chapter 6. Adjustment to areas after felling of standard SPPK A02 005 Tree felling.

3.1.5.5.2 Tree stumps are an important habitat for many animal species, and removing them may endanger the local population (e.g., the stag beetle).

3.1.6 Follow-up management

Follow-up management consists primarily in removal of root and stump sprouts (mechanically, chemically).

3.1.7 Risks and restrictions

See standard 02 005 Management of trees as biotopes of rare species of organisms.

3.1.8 Specifics of different trees species

3.1.8.1. Black locust (*Robinia pseudoacacia*)

3.1.8.1.1 Introduced species successfully adapted to Czech landscape and turned invasive. Regenerates from stumps and roots extraordinarily well.

3.1.8.1.2 Removal is possible using any of the described methods (see chapter 4.2.5. of standard SPPK D 02 007 Management of selected alien plant species). Felling to a tall stump at the end of the growing season followed by coating with arboricides appears the most efficient.

3.1.8.2 Ashleaf maple (*Acer negundo*)

3.1.8.2.1 The ashleaf maple (chapter 4.2.6.2 of standard SPPK D 02 007 Management of selected alien plant species) is a fast-growing tree reproducing primarily by seeds. It grows mostly in lowlands and bottomlands along big rivers. It frequently overgrows ruderalized sites or long-term uncultivated areas.

3.1.8.2.2 Mechanical damage is followed by strong stump and trunk regeneration. The same removal procedures as for the black locust are suitable.

3.1.8.3 Quaking aspen (*Populus tremula*)

3.1.8.3.1 The quaking aspen is a resilient tree species, the first to colonize exposed soil surface alongside the birch, sallow or pine. It grows on both moist and dry sites, but most frequently on sandy loams and nutrient-rich soils.

3.1.8.3.2 Cut surfaces soon form a callus and frequently suffer from rot, accompanied with formation of large open cavities.

3.1.8.3.3 The aspen grows fast from self-seeding and shows prolific root regeneration, which is reduced by felling to a tall stump. The sprouts should be removed for several years using a trimmer, possibly with herbicide application to the cut. It also regenerates fast by seeds entering any vacant area from outside. Aspen regeneration rate can be reduced by grazing or periodic annual mowing. However, the results are not as convincing as for the black locust, and any ungrazed leftovers have to be mowed down. The aspen can also be suppressed using the silver leaf fungus.

3.1.8.4 White birch (*Betula pendula*)

3.1.8.4.1 The birch is an undemanding, fast-growing photophilous tree species. It is one of the first pioneer species colonizing exposed areas. When felled to a stump, adult trees mostly die completely, while young trees may regenerate.

3.1.8.4.2 The birch regenerates mostly by seed; it is advisable to follow removal of sprouts with mowing or grazing.

3.1.8.5 Black cherry (*Prunus serotina*)

3.1.8.5.1 Found mostly in lowlands, but growing up to 500 m a.s.l. The black cherry grows very fast (chapter 4.2.6.4 of standard SPPK D 02 007 Management of selected alien plant species). In sunny spots, it regenerates very fast from stump sprouts. Herbicides or biocontrol can be used. It has shallow roots, so extraction of stumps is an efficient solution.

3.1.8.6 Tree of heaven (*Ailanthus altissima*)

3.1.8.6.1 The tree of heaven (chapter 4.2.6.3 of standard SPPK D 02 007 Management of selected alien plant species) is a short-lived pioneer species, living for up to about 50 years. It is a strongly invasive species with a great ability to adapt to site-specific conditions, including valuable biotopes, e.g., rock steppes. It produces dense growths. The young trees do not tolerate severe frost; temperature and sufficient light are limiting factors. In Central Europe, the tree of heaven prefers average annual temperatures above 8°C and altitudes approximately up to 400 m a.s.l. It spreads very easily via wind and water, even across great distances. Seedlings can grow practically anywhere, and may reach 2 m in height in the first year.

3.1.8.6.2 Felling or burning promotes regeneration. Extraction is successful only in young individuals, but all remaining roots have to be removed. Felling is most efficient after blossoming, when the tree has lowest root reserves. Sprouts have to be removed repeatedly, several times during the season (ideally once a month).

3.1.8.6.3 Felling the tree and coating the cut surface with herbicide, as well as banding or repeated mechanical removal, are partially effective when treating individual trees on shaded sites. The most effective method of getting rid of the tree is application of capsules with glyphosate (or other adequate herbicide) using the EZ-Ject Lance injection technique, using one capsule per 7.5 cm of trunk circumference.

3.2 Removal of shrubs and shrub stands

3.2.1 Method application

3.2.1.1 Shrub stands are very common in Czech landscape nowadays. The expansion of shrubs and the speed of their growth are amplified by increased nutrient content in the landscape.

3.2.1.2 Shrubs are removed where the objective is increasing the area of a desirable biotope, its restoration or succession suppression.

3.2.2 Method description

3.2.2.1 Intervention types

3.2.2.1.1 Light machinery

3.2.2.1.1.1 Low stands are mown using a trimmer; taller stands with thicker trunks are cut clear using a chainsaw. Handheld tools (saw, shears) are used in small-scale interventions or in extreme terrain. Trunks are cut off as close as possible to soil surface.

3.2.2.1.1.2 After felling, the cut surfaces have to be coated, as soon as possible after the intervention (ideally within 1-2 hours, depending on weather), with herbicide; alternatively, sprouts have to be periodically removed mechanically. Removal of shrubs followed by herbicide application is most suitable from August to October (but keep in mind the restriction under 3.1.3). In winter interventions, it is advisable to leave higher stumps (approx. 15 cm), followed by their cutting and herbicide application against in August-October.

3.2.2.1.2 Heavy machinery

Used relatively rarely for extensive and tall shrub stands on flat or gently sloping terrain. A tractor or a machine with hydraulic shears cuts off shrubs and smaller trees. The material is laid in storage areas or work heaps in close vicinity of the intervention. For removal of younger shrub stands on sites accessible for machinery, one-time deep mulching is efficient, including the stumps, ideally followed by raking out the material (see chapter 3.5. Rehabilitation mulching). Mulching is absolutely unsuitable for runner-producing species with good root sprouting (e.g., blackthorn, rose).

3.2.2.1.3 Biomass removal

3.2.2.1.3.1 This is done manually, using a fork or heavy machinery. The material is collected in a storage area, from where it is then transported outside the site (e.g., to an organic material deposit).

3.2.2.1.3.2 In hard-to-access areas, biomass can be burnt on site. The area for the burning has to be chosen carefully so as to comply with the biomass burning requirements specified in chapter 3.1.5.4.2.

3.2.2.1.3.3 It is also possible to consider leaving shrub biomass on the site in the form of compact heaps stacked up and compressed as much as possible using heavy machinery and placed in visually hidden areas in order to promote biodiversity – shelter and bioclimatically convenient shady refugia for small vertebrates and invertebrates.

3.2.2.1.4 Grazing

Livestock grazing makes it possible to reduce particularly sparse shrub vegetation. Goats and some sheep breeds can effectively prevent shrub spreading. Winter grazing is very effective, as the animals prefer woody plant sprouts. For more detail, see chapter 3.8.2 and standard SPPK D02 003 Grazing.

3.2.3 Technique and material

3.2.3.1 Chainsaw, spare chain, heavy-duty trimmer with a trident blade or rotary saw blade, protective work equipment (strong gloves, e.g. welder's, helmet, face shield, work clothes,

strong footwear) and herbicide (see chapter 3.6. Use of herbicides). We also recommend a file set for continuous filing of the chainsaw chain.

3.2.3.2 An alternative to the chainsaw is an excavator, digger or tractor with hydraulic shears, which can cut off even smaller trees. Extraction of shrubs complete with roots is also suitable. There are also specialized military machines designed for removing extensive shrub stands. Their disadvantages include difficult transport between sites, tall height of cut-off trunks, large amounts of biomass left behind on the site, and greatly reduced herbicide application.

3.2.3.3 For raking and transport of small loppings (up to 1 m), it is advisable to use forks or heavy forester rakes. Material is transported manually; in the case of more extensive and continuous shrub stands, using a timber trailer, tracked digger or front loader is efficient.

3.2.4 Biomass handling

See chapter 3.1.5.

3.1.5 Intensity, extent, period

Shrub removal is usually a one-time intervention. In the case of sprouting, it has to be repeated, ideally the following year. The extent is determined based on the desired target state. Typically, it is advisable to leave scattered individual shrubs or groups thereof across the site. In the case of continuous tall-grown stands (e.g., blackthorn, dogwood), complete clearance is advisable.

3.2.6 Follow-up management

3.2.6.1 Follow-up management is typically necessary and frequently long-term.

3.2.6.2 The ideal management type is grazing by goats or other livestock in combination with a trimmer. Another alternative is periodic mechanical removal of sprouting shrubs at least once a year. In the case of more extensive shrub regeneration, herbicide application is an efficient intervention type (see chapter 3.6. Use of herbicides).

3.2.7 Risks and restrictions

3.2.7.1 Clearing away the material, i.e., transporting it to deposits, is often the most demanding job. Use of machinery (timber trailer) is efficient. When using machinery, the stump height has to be minimized to prevent damage to tyres or tracks.

3.2.7.2 Grazing sheep or goats may suffer injury (spines get jabbed between hooves).

3.2.7.3 Individual shrubs or shrub groups left standing contribute to increased habitat heterogeneity. If the site is an important nesting place for birds bound to shrubs (e.g., the barred warbler, common nightingale or red-backed shrike), more extensive continuous shrubbery can be left standing. A savannah-like biotope structure is important for many insect species.

3.2.7.4 Felling continuous vegetation exceeding 40 m^2 requires a permit from the locally applicable nature protection authority in whose jurisdiction the site is located.

3.2.8 Specifics of different trees species

3.2.8.1 Common blackthorn and myrobalan plum (*Prunus spinosa* and *Prunus cerasifera*)

3.2.8.1.1 They make continuous, dense and impassable stands. They regenerate by root sprouts. Lower shrubs (up to 1 m) can be removed using a trimmer. Taller, fully grown stands can be tightly interwoven, and their clearance is difficult. The blackthorn is among woody plants with the hardest wood. Cutting thicker trunks requires a heavy-duty chainsaw with a sharp chain. Regeneration is reduced by periodic mowing or coating the cut surfaces of the stumps with common herbicides. Stronger regeneration occurs on moister sites.

3.2.8.1.2 In some cases, the use of a tractor or tracked machine with shears is efficient.

3.2.8.2 Hawthorn (*Crataegus* spp.)

3.2.8.2.1 Hawthorns grow as individual shrubs or trees or groups thereof. They regenerate primarily from trunks. Regeneration can be controlled by periodic mowing or coating of stumps with herbicides. The wood is very hard. Felling of hawthorns is very risky. The biggest problem is very long and extremely sharp spines, which easily pierce even leather gloves or boots. In the open, hawthorns have dense branching, making access to the trunk difficult. The branches tend to be thickly interwoven. Pulling up hawthorns complete with roots using an excavator has proven successful. For transport to a deposit without using heavy machinery, the tree has to be cut into smaller pieces.

3.2.8.2.2 We recommend against removing hawthorn shrubs on a large scale, as they are very valuable biologically.

3.2.8.3 Common dogwood (*Cornus sanguinea)*

3.2.8.3.1 Dogwood is widespread particularly in areas with limestone or other alkaline rocks. It produces continuous growths. It is easy to fell because it typically branches in the upper parts of the trunk and does not produce any thorns. Very strong root suckering is the biggest risk with dogwood. Thus, stumps have to be carefully coated with herbicide after cutting.

3.2.8.3.2 The effectiveness of commonly used herbicides is very limited; Garlon is effective, for example. The best time for spraying suckers is the second half of summer, but the efficiency of the intervention can be significantly affected by drought periods, when dogwood leaves become partially dry. In autumn, when dogwood leaves have turned red, the effectiveness of the herbicide is minimal. Regenerated growth is typically significantly denser than before, and attempts to destroy them with grazing or mowing tends to fail.

3.2.8.3.3 Gradual thinning of dogwood stands (over several years) is another suitable method. The species invests energy into growing the individuals left standing instead of massively regenerating from the richly developed root system. Dogwood can also be pulled up complete with the roots. Burning dogwood down to the roots is very effective, but demanding.

3.2.8.4 Rose (*Rosa* sp.)

Rose tends to produce thickly interwoven and thorny trunks, often meshing in with surrounding plants. Typically, only individuals mixed in with stands of other species are removed. The degree of rose regeneration, and efficiency of herbicides, is comparable with the blackthorn,

and it can be suppressed mechanically. Solitary individuals of roses or their thin linear stands are a valuable landscape feature and their removal tends to be undesirable.

3.2.8.5 Shrub willows (*Salix* sp.)

They grow individually or in stands. Felling is relatively easy due to their soft wood, but clearing is demanding due to large amounts of wood biomass. Older willow stands tend to sprawl out, and trunks may take root even in the horizontal position. Removing such vegetation turns difficult. Willows regenerate primarily from trunks, which is why their suppression frequently requires herbicide or heavy machinery.

3.2.8.6 Common snowberry (*Symphoricarpos albus*)

It spreads in abandoned places where it was historically planted. It makes homogeneous stands particularly on moister sites. Mechanical removal is done using a trimmer. The species has good regeneration ability and sprouting, which is why it is advisable to apply herbicide on the cut surface. In existing experience, the species can be removed by a combination of cutting and herbicide over approximately ten years; removal with roots using heavy machinery is more efficient.

3.3 Cutting of dwarf mountain pine (*Pinus mugo*)

3.3.1 Method application

3.3.1.1 The dwarf mountain pine is native species in its natural habitats in some of the Czech mountains (Krkonoše, Šumava, Jizerské Mountains). Increasing average temperatures result in expansive behaviour with an unfavourable effect on summit phenomena, such as windy grassland or snowbed habitats, which host specific communities.

3.3.1.2 Where introduced (Hrubý Jeseník, Králický Sněžník, Beskydy, etc.) and where planted at unnatural densities in native habitats, individual dwarf mountain pines, their group or entire populations are removed.

3.3.2 Method description

3.3.2.1 Planning and implementation of dwarf mountain pine felling measures have its specifics due to the uniqueness of the sites and the form of the tree. In temporal respect, the second half of the growing seas (after 1 August) is appropriate, after the end of nesting of birds bound to mountain tops (primarily pipits, *Anthus* spp.).

3.3.2.2 For selective thinning of dwarf pine stands in areas of their native presence, take into account the health status and age of individual shrubs, dying of infested or less vital individuals and the dynamics of dwarf pine growth.

3.3.2.3 For selective removal, it is advisable to leave shrubs along hiking paths as natural barriers and focus the cutting in the best-preserved alpine grassland and snowbed habitats and natural wind passages to retain the anemo-orographic systems.

3.3.3 Technique and material

3.3.3.1 Given that the dwarf mountain pine grows in the most sensitive and unique natural environment, the cutting and transporting of the material have to use most considerate techniques with a fundamental share of manual labour.

3.3.3.2 The dwarf mountain pine does not regenerate by sprouting, but all the green parts of the shrub have to be removed so that it cannot regenerate from them.

3.3.3.3 Cutting

3.3.3.3.1 Two-handed lever shears are suitable for smaller shrubs (up to about 50 years old). The wood is soft, very resinous, resilient, but responds well to shearing. The trunk can be snapped with the lever shears even with multiple cuts in the same place. The advantage of using shears is the ability to snap the shrub off right on the ground, easy and safe handling and low cost.

3.3.3.3.2 Tall-grown shrubs require the use of a chainsaw: first cut off the outer branches and then the trunk as low by the ground as possible. The shear worker and the chainsaw worker need assistance from another worker, who holds branches so that they can be sawn/snapped off.

3.3.3.4 Transporting the material

3.3.3.4.1 The dwarf mountain pine provides no normally usable wood, so the cut biomass stays in heaps and is treated similarly to loppings. Depositing the material on the site is very rarely possible.

3.3.3.4.2 Burning is cheap, but demanding organizationally and only usable with maximum care (see **3.1.5.4.**).

3.3.3.4.3 Biomass is most commonly transported to lower-lying areas, chipped and trucked to a power plant for combustion. The resin content in the wood is not a problem if a heavy-duty forestry chipper is used. Material transport in the most sensitive areas has to be done manually or using winches pulling canvas sheets (efficient for distances up to 200 m), alternatively using ATVs with trailers. Light timber trailers can be used in less sensitive areas. Lighter freight vehicles transport material down paved roads to storage areas or chipping areas.

3.3.3.4.4 If cutting areas are away from access roads, a heavy transport helicopter can be used to transport approx. 1-2 tonnes of biomass in one flight. Helicopter work is ideally scheduled for cooler autumn or even winter dates, when the helicopter carrying capacity increases due to better thermals.

3.3.4 Intensity, extent, period

Planning of measures requires detailed knowledge of objects of protection in the area of implementation, so that intensive movement of people and machinery does not damage any of them. In critically endangered alpine biotopes, the cutting is ideally organized as a one-time intervention that is not repeated.

3.3.5 Follow-up management

It is advisable to monitor the site for at least three years after the measure implementation and, as necessary, to remove any overlooked branches still bearing assimilating needles.

3.3.6 Risks and restrictions

3.3.6.1 Both lay and expert public have to be informed about any activity on sensitive sites which are normally out of bounds to the public.

3.3.6.2 The timetable and organization of interventions under demanding climate and terrain conditions have to be planned in detail due to the short working season (August-October).

3.3.6.3 Dwarf mountain pine cutting is no standard forestry or gardening activity in which contractors would specialize. Thorough supervision in all implementation stages is therefore necessary.

3.3.6.4 If dwarf pine is cut on land intended for performance of forest functions, it requires a decision from the applicable state forest administration on exempting or restricting land performance of forest functions (Section 16 of the Forest Act). In cases of permanent or even temporary exemption, it is necessary to pay an exemption fee pursuant to Section 17 of the Forest Act, assessed in the forest authority decision (there is no fee for restriction).

3.4 Removal of common bilberry (*Vaccinium myrtillus*)

3.4.1 Method application

The common bilberry is a clear indicator of advanced degradation of grassland in mountain conditions on acidic and nutrient-poor soils. When removing the bilberry, take into account all circumstances that enable bilberry infiltration into grassland communities (oligotrophication, shading, increasing humidity, absence of management, etc.).

3.4.2 Method description

3.4.2.1 Direct removal consists in mowing, mulching, low mulching below ground level similar to milling, and turf removal. For small-scale presence (tens of square metres) on weak soil horizons, it can be pulled up by hand. If a fast vegetation conversion is needed, chemical intervention using arboricides is justifiable. Always expect large amounts of biomass to be removed.

3.4.2.2 Bilberry control can also be supported indirectly, e.g., by increasing lighting by cutting away surrounding trees, enriching the site with nutrients, ideally organic fertilizers, possibly in combination with lime. A gentle change in the hydraulic regime towards less soil moisture on the site can also be considered.

3.4.2.3 The biomass is raked away and removed from the site, possibly burnt. The biomass can also be spread and left to decay in nearby forest stands.

3.4.3 Technique and material

3.4.3.1 The initial intervention in lignified shoots requires resilient machinery. Regular mowing of young annual shoots is done using ordinary machinery.

3.4.3.2 The trimmers have to be professional-grade, fitted with a steel trident. A rotary saw blade is better if self-seeded trees are present. Professional-grade protective equipment against sharp flying fragments is also necessary.

3.4.3.3 Hand-operated mowers have to be heavy-duty and typically including a mulcher. Mowing extenders have a short service life when mowing the bilberry.

3.4.3.4 Turf mulching below ground level (approx. 5 cm) is much more technically demanding and energy-intensive and typically requires special machinery modifications. The shrubs are completely destroyed or crumbled. Removing the thicker layer of bilberry mulch accelerates regeneration of grassland communities.

3.4.4 Intensity, extent, period

3.4.4.1 The optimal time is early summer, when the bilberry produces leaves and flowers, not stores for the next growing season.

3.4.4.2 Periodic mowing down to turf level can achieve, within 5-8 years, a thinning of bilberry vegetation and gradual restoration of grassland.

3.4.4.3 Turf mulching provides faster results.

3.4.5 Follow-up management

Annual site management is necessary (even after mulching), ideally by mowing. Grazing will not remove even young bilberry shoots. Repeating the intervention once every three years will only maintain the status quo.

3.4.6 Risks and restrictions

Mulching, particularly below turf level, is suitable for vegetation dominated by the bilberry.

Awareness raising among the public and land owners is necessary to make them understand the purpose of interventions in the popular fruit-bearing shrub.

3.5 Rehabilitation mulching

3.5.1 Method application

3.5.1.1 This chapter deals with measures on sites aiming at stopping succession processes and restoring target habitats.

3.5.1.2 Mulching is a less technically and financially demanding measure with a significant impact on the site. It can be used as a first blanket measure in demanding conditions (slope, shrub vegetation, dips, stones, waste, waterlogged patches, tree stumps, etc.).

3.5.1.2 Mulching can accelerate regeneration of species-rich grassland if done at the appropriate time, i.e., between May and June (July).

3.5.2 Method description

3.5.2.1 A mulcher will process even self-seeded trees with a trunk diameter up to several centimetres, and is resilient to impacts on obstacles.

3.5.2.2 If there is a high mulch layer (5 cm or more), or a high proportion of woody material, the biomass has to be removed from the site.

3.5.2.3 Mulch made in the first half of the growing season, with a high water content, typically decomposes fast (except high altitudes).

3.5.3 Technique and material

3.5.3.1 Resilient hand-operated machinery, or a strong tractor with a hammer/flail mulcher or chain mulcher adapter.

3.5.4 Intensity, extent, period

3.5.4.1 Rehabilitation mulching should be a one-time action, repeated only in exceptional cases. If done in the second half of the growing season, the importance of removal of biomass increases as it is increasingly less prone to decompose.

3.5.4.2 With respect to animals, particularly invertebrates, do not mulch the site all in one go, but leave one half to one third of the area for mulching with an interval of at least two months.

3.5.4.3 If invasive or expansive species are present, consider the risk of their spreading via distribution of stem fragments and/or seeds across the mulched area.

3.5.5 Follow-up management

3.5.5.1 If there is tall old uncut grass, it can be raked out after mulching using rotary tedders placed as low by the ground as possible and slowly moving machinery, followed by removal of the material, either manually or using Horal-type or similar collectors.

3.5.5.2 If mulching is necessary at the start of the growing season, then grazing (ideally cattle) is a suitable compensatory measure, followed in the spring by intensive harrowing using heavy spike harrows or manual raking with metal rakes or, in specific justified cases, sharp moss-removing rakes or verticutter.

3.5.6 Risks and restrictions

3.5.6.1 Mulching is a forceful and intensive intervention type for justified cases. The risk is biotope homogenization and interference with microhabitats for plants and animals, ant nests, bog bumps, small rockeries, etc.

3.5.6.2 Mulching can be viewed as an intensive technique, subject to approval of a nature protection authority.

3.5.6.3 Mulching is followed by activation of the mulch nutrients and potential old uncut grass, which are used by expansive and ruderal species, such as *Holcus mollis*, *Galeopsis tetrahit.*

3.6 Moss and old grass raking

3.6.1 Method application

3.6.1.1 Removal of old uncut grass and moss is done on long-term uncultivated meadows or meadows that are repeatedly mulched at inappropriate times, characterized by limited decomposition of old grass and its accumulation, or formation of continuous moss patches as the case may be.

3.6.1.2 Removing or thinning moss and old uncut grass results in gaps in the grass, which permit germination of seeds and emergence of less competitive species.

3.6.2 Method description

3.6.2.1 The best time for removing old grass and moss is late autumn to early spring, when damage to target species is not a risk.

3.6.2.2 It is inappropriate to perform this intervention in the growing season, when target species are damaged and, if expansive species capable of vegetative proliferation are present, they may spread to other parts of the site.

3.6.2.3 After raking, the material has to be removed from the meadow. In moist meadows, it is advisable to leave the material to dry at least partially before removal.

3.6.3 Technique and material

3.6.3.1 Metal rakes are best for manual moss and old grass raking. An alternative is modern plastic rakes, which are lighter, but do not penetrate the turf as well as iron rakes.

3.6.3.2 Mechanical moss and old grass raking uses bar harrows or meadow spike harrows, with which at least two runs are made perpendicular to one another.

3.7 Herbicides

3.7.1 Method application

3.7.1.1 It is always necessary to consider well in advance whether there is an effective mechanical method for the given purpose and whether the positive aspects of herbicide use will prevail over possible negative ones. In restoration of grassland communities, herbicides are applied either in point fashion to cut surfaces of trees and shrubs, i.e., coating of stumps, or in a blanket fashion, i.e., spraying over the undesirable plant species. Point spraying of individual clumps or individual undesirable plants is somewhere between the two base types. Other ways of using herbicides are injections and herbicide capsules, designed for destruction of adult plants.

3.7.1.2 Blanket spraying can only be used on small sites to remove an invasive or expansive plant species, or other undesirable species; see standard SPPK D 02 007 Management of selected alien invasive plant species, chapter 3.2.

3.7.1.3 The most common target expansive species are the wood small-reed and the common dogwood. Both species produce very dense, single-species stands, the removal of which using common methods (grazing, mowing) tends to be very lengthy and frequently unsuccessful.

3.7.1.4 Coating of stump cut surfaces is done in various biotope types. The objective is local destruction of undesirable shrub species (e.g., blackthorn, hawthorn, dogwood, rose) or trees (e.g., black locust).

3.7.2 Method description

3.7.2.1 Herbicide is diluted with water as per instructions. The instruction manuals for some herbicides distinguish recommendation working concentrations for blanket spraying and for stump coating. The concentrations may differ widely, and the herbicide has to be diluted as per manufacturer recommendation (instruction).

3.7.2.2 Herbicide is applied using a sprayer or with a brush directly to cut surfaces of tree and shrub stumps. Release of the active substance has to be minimized. If the effectiveness is good, the individual dies completely, including underground organs.

3.7.2.3 The efficiency of leaf spraying may differ depending on the plant species. Generally, it is highest from May to July. In later months, the intervention is often less effective due to hardening of plant tissues, accumulation of assimilates in roots and often also partial drying of leaves due to drought in late summer. Herbicide is applied to fully developed and undamaged plants (e.g., by mowing, grazing, etc.).

3.7.2.4 Herbicide is applied in windless and dry weather, when the site is not under direct sunshine. Early morning or early evening are good times of day. Conversely, application on a sunny, windy or rainy day tends to be unsuccessful.

3.7.2.5 Application of a blanket spraying with a total herbicide also suppresses any accompanying plant species, resulting in an area devoid of vegetation. If the herbicide application is successful, the result is evident within one or two weeks. The treated area is primarily colonized by species from the seed bank and species that colonize new habitats fast.

3.7.2.6 Stump coating can be done from July to October, the most efficient period is from August to October, when the plant retracts nutrients from leaves. Herbicide application has to follow trunk cutting as soon as possible, i.e., within an hour in sunny weather; otherwise, the cut surface dries partially and the absorption efficiency decreases rapidly. The cut surface should be compact and horizontal. In the case of thicker trunks (10 cm or more in diameter), herbicide is applied only around the perimeter, where the vascular bundles are located.

3.7.3 Technique and material

3.7.3.1 Herbicide, water, sprayer, protective equipment (gloves, goggles, face shield, headgear) and clothing. The most common type is a pressure handheld (garden) or motor sprayer. Both sprayer types enable highly accurate application of herbicide even in difficult terrain. The herbicide quantity is limited by the tank capacity. When destroying individual plant clumps, one can even use a small handheld sprayer, designed for moistening pot plants.

3.7.3.2 Stump coating is done using a brush adequate to the stump size, a herbicide container and food colourant, ink or Indian ink. Colouring of the herbicide solution serves marking stumps that are already coated. However, some food colourants may cause the herbicide to coagulate.

3.7.3.2 Herbicide application has to be entrusted to properly trained staff, qualified for handling plant protection products under Decree no. 206/2012 Coll. on Determining professional qualification for handling products. Analogously, purchasing larger quantities of active substances is impossible without showing a licence for the given activity. However, this restriction does not apply to some types of herbicide. Product application has to comply with rules set by the manufacturer.

3.7.3.3 Injection

3.7.3.3.1 A hole is drilled or a cut or notch is made in a living, standing tree, and a herbicide solution is injected in the opening. The hole has to be deep enough for the herbicide to penetrate the wood and be distributed throughout the tree. Best results are achieved by application in August, when nutrients are transported from the crown to the roots. The necessary notch or hole can be made using a machete, drill, etc.

3.7.3.3.2 The best tool is the so-called piston axe, designed for herbicide application. Cutting into the trunk activates a piston inside the tool, which applies the product into the tree's conductive tissues and, at the same time, draws in a new solution dose. The dosage is adjustable. The recommended rate is one cut per 10-20 cm of trunk circumference. The axe can be used throughout the year except spring, when the sap flow in the trunk is too strong.

3.7.3.3.3 Herbicide capsules can be injected directly into selected parts of the tree. The advantage of this method is that it avoids herbicide contact with the surroundings.

3.7.4 Intensity, extent, period

3.7.4.1 Spraying is typically a one-time measure. If unsuccessful, the application can be repeated in the same year, ideally with some alteration (different herbicide, its concentration, time of day, etc.).

3.6.4.2 Stump coating should ideally be repeated, two or three times with an interval of a few minutes to allow more of the active substance to be absorbed.

3.7.5 Follow-up management

3.7.5.1. Identical to other vegetation on the site, i.e., mowing, grazing, disturbance, etc.

3.7.5.2 For restoration after destruction of invasive plant species, see standard SPPK 02 007 Management of selected alien plant species, chapter 3.4.

3.7.6 Risks and restrictions

3.7.6.1 Use of biocides is only possible based on an exemption, and their use is explicitly prohibited in national parks under Section 16/2/h of Act no. 114/1992 Coll., in PLA zones I and II under Section 26/3/a of Act no. 114/1992 Coll., in NNR under Section 29/a of NLPA, in NR

under Section 34/1/b of Act no. 114/1992 Coll., and in buffer zones of water sources and along watercourses.

3.7.6.2 A high risk when using herbicides is their direct toxic effect on animals, including humans, and their residues in soil and organisms (e.g., glyphosate). The risk can be reduced by using very small quantities of herbicides on limited sites.

3.7.6.3 Herbicide application may be unsuccessful due to the wrong time of year/day of the intervention, inappropriate herbicide concentration or type, and failure to observe manufacturer instructions. Some plant species may be highly resistant to selected herbicide types, which is usually specified in the herbicide instructions for use.

3.7.6.4 Another risk is application without knowledge, training, compliance with dosage and safety rules and manufacturer recommendations.

3.7.6.5 If herbicide application is combined with grazing, limit livestock access to sprayed plants until the protective period expires (as shown instructions for use of the herbicide) or until after the first major rain. Herbicides must not be applied on land classified for ecological agriculture (as per the Ecological Agriculture Act no. 242/2000 Coll.).

3.7.6.6 Blanket spraying over larger areas poses a risk of release of active substances into food chains. Generally, blanket use of herbicides can only be recommended on limited sites, max. 1 ha, and if mechanical methods cannot be used.

3.8 Hemiparasitic plants

3.8.1 Method application

3.8.1.1 Use of hemiparasitic plants has great potential for targeted destruction of undesirable plant species, typically a dominant grass, on a site and reduction in total productivity of the plant community. So far, nature protection only has extensive experience with rattles (*Rhinanthus* spp.). The European yellow-rattle (*Rhinanthus alectorolophus)* has proven the most successful. Its advantages include high seed germination success rate on desirable sites and high efficiency in destroying highly competitive grass species, notably the wood small-reed.

3.8.1.2 The method can be employed in any non-forest biotope. The advantage is fast and efficient destruction of undesirable species, while not direct negative effect on desirable species has been observed (although it cannot be ruled out in some cases). However, the method application has to proceed in parallel with standard site management (e.g., extensive mowing), which has to be adjusted to the biological demands of hemiparasitic plants, mainly their phenology.

3.8.2 Method description

3.8.2.1 Yellow-rattle seeds are sown between August and November. The minimum recommended quantity is 500 seeds (approximately 1.5 g of purified seeds) per m^2. The seeds

are distributed straight into the undesirable grass species stand. Seed germination requires long-term cold stratification, which is why spring sowing is not successful.

3.8.2.2 Before the intervention, it is important to remove biomass from the area by mowing and raking old grass down to the mineral substrate. On low-productivity sites, the seed germination success rate is increased by disturbing the grass turf and ploughing in the seeds very shallowly with a rake.

3.8.2.3 The seeds germinate in late winter and seedlings use haustoria to connect to roots of neighbouring plants, from which they draw water and mineral nutrients, thus severely weakening the host plants. The main hosts of the rattle species include grass and fabaceous plants. However, the degree of damage to the host is variable across species, and even across genotypes.

3.8.3 Technique and material

3.8.3.1 A sufficient quantity of rattle seeds is critical. Seeds harvested in the year of sowing have to be used. The seed germination capacity decreases rapidly in longer storage. The seed germination capacity and usability can be probably maintained to a great extent by storage in freezers for no more than one year until the following autumn.

3.8.3.2 Seeds from local populations can be collected, and they can even be grown on target sites. Seeds have to be collected in the phenophase of capsule opening (typically in the course of July, and later in mountain areas). Whole plants are collected, or only the capsule infructescences can be snapped off. Material collected in this way is left to dry completely on a canvas sheet placed in a dry environment. Seeds shed onto the sheet can easily be collected for further storage. However, this approach requires good knowledge of the biology of hemiparasitic species and is time-consuming and demanding in terms of logistics on a larger scale. It can provide seeds of regional origin, though.

3.8.4 Intensity, extent, period

3.8.4.1 Rattle seeds can be sown on a small scale (single square metres of undesirable plant stands) or in a blanket fashion. If the intervention is successful, the sowing is not repeated, only follow-up management is applied. When applying rattle over larger areas, it can be sown in strips, from which the rattle will spread in the following years. This sowing strategy makes it possible to comply with the minimum recommended sowing density even if the seed availability is limited, and it is typically more successful than less dense sowing over a larger area.

3.8.4.2 Seedling monitoring can be done in spring (in April, depending on weather), followed by monitoring of flowering/seed-producing plants (to determine the cause of rattle sowing failure as the case may be).

3.8.5 Follow-up management

Mowing, grazing, disturbance and fencing to protect from game browsing are suitable. If the intervention objective is to keep the rattle population on the site permanently, any interventions have to take place after rattle seeds have matured at least where the rattle is present. Mowing at

the seed maturity time may promote rattle spreading across the site (seeds scattered by mowers, transferred by machinery).

3.8.6 Risks and restrictions

3.8.6.1 Use of rattles in nature protection is currently a controversial issue, because the European yellow-rattle enriches the landscape with a species that usually no longer grows on sites at present. In the past, however, the plant used to be widespread on most of the Czech Republic's territory and is a native species.

3.8.6.2 Besides the European yellow-rattle (*R. alectorolophus*) the lesser yellow-rattle (*R. minor*), which is more common in Czechia, or even the less common greater yellow-rattle (*R. major*) can be used. Use of the lesser yellow-rattle is less efficient. The greater yellow-rattle can be used in dry grassland of the *Bromion* association, but the availability of its seeds is low and the species is relatively ecologically sensitive, limiting its practical use.

3.8.6.3 On exceptionally valuable and specially protected sites, complete removal of sown rattle may be desirable after the successful intervention. The plants are annual and their seeds in the seed bank have a short germination period; thus, the plant removal usually only requires mowing of the site at the rattle flowering time in the following two years, with a significant reduction already after the first such intervention.

3.8.6.4 The greatest risk for rattle seedling is dry weather, i.e., lack of soil moisture in late winter and a generally warmer spring. This factor may lead to considerable fluctuation in sowing success rates.

3.8.6.5 Flowering rattles are frequently browsed by roe deer, which is capable of destroying entire populations. In such cases, it is desirable to fence off rattle-sown areas.

3.9 Restoration grazing

3.9.1 Method application

3.9.1.1 Grazing is handled in detail by separate standard SPPK D02 003 Grazing. Only restoration grazing procedures are specified herein. The following also describes procedures that combine grazing with other management types (e.g., tree and shrub cutting, mowing, controlled disturbances).

3.9.1.2 Restoration grazing can be used in various types of non-forest biotopes, in overgrowing orchards and even in biotopes that have already turned into forest (outside LIPFF). Specifics of grazing as a means to restrict invasive plant species are described in chapter 3.1.7 of standard SPPK D02 007 2016 Management of selected alien plant species.

3.9.1.3 Grazing can be either used as an initial biotope restoration tool, i.e., the first measure, or combined with other procedures as a secondary tool (following initial mowing or tree and shrub cutting). Depending on the livestock species, timing and intensity, grazing can be applied both in gradual restoration of more species-rich grassland communities and as a supporting tool for eliminating lower self-seeded trees and shrubs.

3.9.2 Method description

3.9.2.1 Shrub reduction is very conveniently achieved by intensive grazing of mixed herds of goats and some sheep breeds; winter grazing is efficient, as the animals prefer tree and shrub sprouts. Grazing is suitable before shrub cutting. The animals significantly reduce the vegetation density, making it more accessible for interventions using chainsaws or trimmers.

3.9.2.2 Another type of use of grazing in rehabilitation management is large-scale grazing of grassland areas lying fallow for long time, where large ungulates are more suitable. The advantage over mowing is that grazing can be employed in complex terrain. Grazing is more efficient at higher intensities. Conversely, it should be done very extensively or only locally intensively in places with residual populations of rare plant and animal species. Such refugia serve gradual dispersion of species over the rehabilitated areas. Grazing is unsuitable for peat bogs, but they may be a part of a grazed landscape.

3.9.2.3 If possible, it is advisable to mow the area before grazing, ideally in late summer or in autumn, and to remove all the biomass. In the case of large (semi)wild ungulates, mowing before grazing is pointless. Burning may be useful, if possible. In such areas with minimal old grass, animals are more willing in spring to graze on fresh sprouts and even less easily digestible species of grasses and forbs (e.g., extensive or invasive species).

3.9.3 Technique and material

3.9.3.1 Virtually any ungulate species are suitable for rehabilitation management. It is always important to consider the area size, site remoteness, terrain and biotope characteristics. Smaller sites (up to approx. 20 ha) are more suitable for goats, some sheep breeds, small quantities of horses, and cows as the case may be. Larger sites perform well if grazed by large ungulates – wisent, aurochs (obtained by retrograde selective breeding, as the native aurochs had been exterminated) or primitive horse breeds (e.g., Exmoor pony). These ungulates are not treated for worms, so the negative impact of use of antiparasitic medication on coprophagous and soil fauna is ruled out. The following list presents an overview of properties of different species of ungulates, their main advantages and disadvantages.

- Goat – the advantage is easy handling and undemanding keeping. Suitable for steep slopes and rocks and reduction of self-seeded trees and shrubs. They can damage even adult shrubs and deciduous trees in winter. Similar to sheep, intensive blanket grazing in the growing season is unsuitable for restoration of valuable biotopes. More primitive goat breeds are more suitable, as they are less demanding and graze even on old grass (e.g., Cameroon dwarf goat). Using of anthelmintics is usually necessary, but is toxic for coprophilous insects.

- Sheep are the most commonly used animal. Intensive sheep grazing frequently has negative impacts in conservation management, because sheep selectively graze on flowering plant while mostly avoiding old grass, tough grasses and woody plants (particularly in summer). The disadvantage of intermittent sheep grazing is condensation of steppe grassland due to insufficient turf disturbance. Rotary grazing on a site is necessary, using at least three enclosures. More primitive sheep breeds are more

suitable, as they are less demanding and graze even on old grass (Cameroon sheep, heath sheep, etc.). Meat breeds (Suffolk, etc.) are absolutely unsuitable. Using of anthelmintic is usually necessary, but is toxic for coprophilous insects.

- Horse – the advantage is its heavier weight, as hooves often produce exposed soil patches. They graze selectively on grasses, including old grass and wood small-reed. Horses, Exmoor ponies in particular, are also usable on moister sites and for winter grazing in order to reduce woody plants. They will also graze on reeds and move in the littoral. Horse grazing on small sites has to be employed only for limited time, to prevent damage to the site.

- Donkey – suitable mostly for drier sites, does not tolerate moist biotopes. Undemanding, suitable for grazing on old grass, tough-leaved grasses, including wood small-reed.

- Cattle – essentially the same applies as for horses. Suitable for moister sites. The aurochs (Tauros cattle) is very resilient and suitable for year-round grazing on larger sites. The disadvantage is more demanding handling – the need for tranquillizing and subsequent handling of individual animals using heavy machinery, or using sturdy enclosures. Public access to areas grazed by aurochs is not possible for safety reasons. Particularly where increased aggressiveness might be a problem, the water buffalo is better for wetland sites. Intensive grazing by meat cattle is undesirable, as it produces large homogeneous areas.

- European bison (wisent) – resilient, suitable for year-round grazing. Requires sufficient-sized areas, both forestless for grazing and trees for shelter, browsing and seasonal fruit. Notably calmer than the aurochs or meat cattle, non-aggressive unless directly provoked, generally a timid animal unsuitable for sites under 50 ha. The disadvantage is more demanding handling – the need for tranquillizing and subsequent handling of individual animals using heavy machinery, or using sturdy enclosures.

3.9.4 Intensity, extent, period

3.9.4.1 With domestic animals, intensive restoration grazing is possible. With (semi)wild large ungulates, the long-term prospects of the management have to be taken into account, i.e., several years for herd formation from smaller founder groups, changes in numbers due to natural reproduction and year-round grazing duration, to avoid too large herds; see chapter 3.9.1.1.3.9.4.2. Only a portion of the site can be grazed at any one time (one third to one half). Intensive grazing by domestic animals on the entire site at once is not advisable, as it may weaken or exterminate populations of rare plant and animal species that may be surviving in small refugia on the site. Extensive grazing by wild animals (see below) is an exception.

3.9.4.3 A good time for starting grazing by domestic animals is early spring; grazing intensity can be reduced later in the season. With (semi)wild large ungulates, the grazing can start at any time, as they accept even low-quality, low-nutrient biomass. Autumn and winter is ideal, so that old grass is removed before the start of the new growing season.

3.9.4.4 With wisent, aurochs or Exmoor pony grazing, choose the number of heads so that the site can sustain the herd year-round. Said species are less fussy and will consume even the least digestible forb and grass species, including woody plants, when other food is scarce.

3.9.5 Follow-up management

3.9.5.1 If using grazing as a first measure, follow-up management has to be ensured. Grazing will reduce the grass biomass and thin self-seeded woody plants, making the site more accessible for other interventions, i.e., tree and shrub cutting (see chapters 3.1 and 3.2) or controlled disturbances (see chapter 3.10).

3.9.5.2 With domestic animals, the most suitable follow-up management type is extensive enclosure grazing. No more than one third of the site should be grazed at any one time. It is advisable to accompany grazing with mowing of leftover undesirable and less grazed plant species.

3.9.5.3 With (semi)wild large ungulates, it is ideal to practice maintenance grazing with appropriate numbers of animals, timing and spatial extent according to past vegetation development and current season progress. Highly extensive (0.2 head per hectare or less) year-round grazing across the entire area is ideal.

3.9.6 Risks and restrictions

3.9.6.1 The greatest risk of restoration grazing is the risk of destruction of the last remaining populations of rare species. This is particularly risky with sheep, which primarily search for and intensively graze on the least degraded vegetation while simply walking around overgrown area. Therefore, restoration grazing generally fares better with large ungulates and goats or winter grazing.

3.9.6.2 Another risk is the danger to populations of sessile organisms that do not thrive in significantly disturbed biotopes (typically rare lichens and bryophytes on stones, rocks and sandy patches). This can be avoided with thorough site knowledge. Another risk is animals escaping, as they have to be kept on the site for much longer than in ordinary extensive maintenance grazing. With domestic animals, there is also an increased risk of site eutrophication, as the animals are present for longer and in larger quantities than usual.

3.9.6.3 There is a great variability among grazing species and breeds as to the grazing preferences; for example, some sheep breeds (heath sheep, etc.) will consume even woody plants with success, while others graze only on flowering forbs and young grass. Similarly, horses, which are generally good at consuming grasses, may avoid overgrown stands in the second half of the season; ponies, on the other hand, will continue removing them efficiently. There are also differences in animals of different age.

3.9.6.4 When using grazing for restoration of grassland, it is necessary to continuously monitor the effect of the intervention and adjust it to current conditions.

3.10 Disturbances

3.10.1 Disturbances are treated in detail by separate standard SPPK D02 005: 2018 Disturbance management in non-forest areas.

3.10.2 Disturbances can be used as an initial tool for biotope restoration, but are typically only used for follow-up management after initial interventions of another type (mowing, grazing or woody plant cutting).

3.11 Species composition enrichment

3.11.1 The objective of this method is to accelerate succession towards species-rich grass-forb communities. The method is applied in restoration of species-impoverished, species-modified or severely mechanically damaged grassland where sufficient seed bank in the soil or near vicinity of the site is not available and natural succession would be too slow (e.g., on a slope at risk of undesirable erosion), or where spreading of invasive or expansive species is a threat. The method is described in detail in standard SPPK C02 007 Grasslands, chapter 6.1. Plot preparation and weeding.

Annex 1 List of Nature and Landscape Management Standards (Management of Selected Terrestrial Biotopes)

02 001 Restoration of grasslands using regional seed mixtures

02 002 Restoration of long-term uncultivated grassland communities (including removal of tree and shrub species)

02 003 Grazing

02 004 Mowing of grasslands

02 005 Measures to improve the structure of forest stands

02 004 Disturbance management on non-forest areas

02 007 Management of selected alien plant species

02 008 Management of selected alien animal species

SPPK D02 002 2021 02 002 Restoration of long-term uncultivated grassland communities (including removal of tree and shrub species

Faculty of Science
Ovocný trh 560/5
116 36 Praha 1

Kaplanova 1931/1
148 00 Praha 11
SPPK D02 001
aopk.gov.cz/platne-standardy

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