NATURE CONSERVATION AGENCY OF THE CZECH REPUBLIC

NATURE AND LANDSCAPE MANAGEMENT STANDARDS

MANAGEMENT OF SELECTED TERRESTRIAL ECOSYSTEMS	**MANAGEMENT OF SELECTED ALIEN PLANT SPECIES**	**SPPK D02 007:2023 1st revision**
SERIES D		

Likvidace vybraných invazních druhů rostlin
Entfernung von ausgewählten gebietsfremden Pflanzenarten

This standard is intended as a definition of management of selected alien plant species and restriction of their spreading inside and outside protected sites.

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Act no. 289/1995 Coll. on Forests and on amendment of certain acts (Forest Act), as amended.
Act no. 334/1992 Coll. on Agricultural Land Fund Protection, as amended.
Act no. 78/2004 Coll. on Handling of Genetically Modified Organisms and Genetic Products, as amended
Act no. 350/2011 Coll., on Chemical Substances and Chemical Mixtures and on amendment of certain acts, as amended
Decree no. 5/2020 Coll., on protective measures against harmless plant organisms
Decree no. 327/2012 Coll. on protection of bees, wild animals, aquatic organisms and other non-target organisms when using plant protection products
Regulation (EU) No 1143/2014 of the European Parliament and of the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species

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1 Purpose and contents of the standard

The standard “Management of selected alien plant species (including follow-up site management)” describes selected invasive and alien species, situations where to intervene against them, and rules leading to their eradication or mitigation of their impact on native communities. The standard is based on the species classification in Pergl et al. (2016) *Black, Grey and Watch Lists of alien species in the Czech Republic based on environmental impacts and management strategy*; NeoBiota 2016 (hereinafter, *Blacklist CR*) and list of species with significant impact on the Union for Regulation (EU) No 1143/2014. The classification used is based on the following criteria: invasion impact (on ecosystems and humans), invasion spread and dynamics, eradication and management options and type of invaded community. Species included on *Blacklist CR* are divided into 3 lists (black, grey and watch lists). The black list is subdivided into three categories, corresponding to the degree of risk associated with their presence and recommended management strategy. The standard is focused on the black list species. However, the standard methods can also be applied if communities are threatened by other invasive or expansive species not shown herein. It all depends on the specific situation.

Legal framework

Regulation (EU) No 1143/2014 of the European Parliament and of the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species (hereinafter, “Regulation 1143/2014”) introduces a detailed procedure for invasive alien species at the EU level. Regulation 1143/2014 establishes strict legal regulation for invasive alien species with significant impact on the Union (i.e., species included on the Union list). The Union list includes the giant hogweed, common milkweed, tree of heaven, Himalayan balsam and other species listed on invaznidruhy.nature.cz/invazni-druhy-z-unijniho-seznamu. Regulation 1143/2014 specifies restrictions on handling of the Union list species (bans on holding, cultivation, transport or marketing and ban on release into the environment) as well as the obligation of Member States to adopt measures to eradicate or regulate the species spread, minimizing the invasion impacts. The MoE has set regulation rules for Union list species that are considerably widespread in the Czech Republic.

Act no. 114/1992 Coll. on Nature and Landscape Protection, as amended (hereinafter, NLPA), contains legal regulation on alien species, namely in Section 5, Para. 4, under which deliberate spreading of an alien plant or animal species into the landscape is only possible with a permit from a nature protection authority. In national parks, protected landscape areas, national nature reserves and nature reserves, basic protective requirements apply, which include a special ban on deliberate spreading of alien species; an exemption from the ban can be granted under Section 43, Para. 1 of the NLPA. The special legal definition of Regulation 1143/2014 and applicable adaptation provisions of Sections 13d–13l of the NLPA apply to invasive alien species. Non-native, alien and locally absent species in aquaculture are then governed by the special legal definition of Regulation (EC) No. 708/2007 concerning use of alien and locally absent species in aquaculture and applicable adaptation provisions of Sections 13a–13c of the NLPA.

Provisions of Sections 68 and 69 of the NLPA are applicable as support in terms of management and control of non-native and invasive alien plant species on the Union list (Section 13j, Para. 4 of NLPA). On specially protected sites, basic and detailed protective requirements typically restrict eradication options using herbicides.

Act no. 326/2004 Coll. on Phytosanitary Care and on amendment of certain acts, as amended, deals with so-called harmful organisms in relation to plant production (notably quarantine pests). The Act defines rules for the use, registration and testing of plant protection products (and auxiliary substances). The ÚKZÚZ publishes annually updated overviews of registered products and rules for their use.

Act no. 289/1995 Coll. on Forests and on amendment of certain acts (Forest Act), as amended, sets out the "obligation to carry out measures to prevent and avert action of harmful factors in forests" (Section 32). In the case of invasive species, those reducing the production (tree growth) and non-production functions of forests could be regarded as forest pests. As part of its forest inventorying, the Forest Management Institute monitors the presence of some invasive alien plant species and their adverse impacts (Section 28a).

Act no. 334/1992 Coll. on Agricultural Land Fund Protection, as amended, sets out, among other things, protection of agricultural land from contamination with risk substances and defines powers of agricultural land fund protection authorities, which are municipal authorities with devolved powers, municipal authorities with extended powers, regional authorities, national park administrations, the Czech Environmental Inspectorate and the Ministry of the Environment.

Act no. 254/2001 Coll. on Water and on amendment of certain acts (Water Act), as amended, does not deal with protection from invasive species as such, but is the regulation to follow when using herbicides for eradication. It defines handling and limits the entry of hazardous, particularly hazardous substances and other potential pollutants into groundwater and surface water, and defines protection of water resources and water quality protection from pollutants listed in the Annex.

Act no. 128/2000 Coll. on Municipalities (Establishment of Municipalities), as amended, can only be used for alien species issues to a limited extent, notably for issuance of generally binding ordinances and fines.

Act no. 78/2004 Coll. on the Use of Genetically Modified Organisms and Genetic Products, as amended, defines, among other things, introduction of genetically modified species into the environment and risk assessment of handling such species.

Decree no. 327/2012 Coll. on the protection of bees, wild animals, aquatic organisms and other non-target organisms when using plant protection products defines handling of products identified as dangerous or particularly dangerous for bees, land vertebrates and aquatic organisms.

2 General instructions for management of all undesirable species

2.1 Each intervention has to be preceded by a mapping of the presence of species of interest (scheduled for management/eradication as well as species of nature protection interest present on the site) and endangered habitats, including identification of land owners, site protective requirements and other potential limitations.

2.2 Management priorities have to be set with respect to the invaded areas and species of interest, using mapping data and with a view to available resources. The objective is not to assure complete eradication of all invasive species throughout the Czech Republic. Priorities include valuable sites for nature protection (SPS, TSES, places with specially protected and endangered species), timely interventions (on newly colonized and isolated smaller sites without intensive supply of seeds, aimed at preventing emergence of new sources of spreading) and selected risk species (e.g., due to danger to human health). Management has to engage land owners and administrators.

2.3 Depending on the nature of the invaded site, some target species (scheduled for management and eradication) have partial tolerance recommended, but their effect can be reduced by change in site management. The tolerance applies particularly to plantings in parks and built-up areas, where historical and landscaping aspects significantly outweigh nature protection interests (e.g., tolerance of black locust in urban areas). Decisions about tolerance have to reflect the risk of spreading along roads and watercourses or via contaminated soil.

2.4 In forestry, the primary means is modification to forest management plans (LHP) so that non-native trees and shrubs can be gradually replaced with native ones, suitable for sites in terms of ecological conditions. If the alien species intervened against is not a target tree or shrub, agreement with the owner on pruning interventions is an efficient solution compared to application of requirements in LHP.

2.5 Management has to take into account local restrictions on different methods. Management has to be defined with respect to habitat and target species properties to avoid endangering the surroundings. Where water protection, natural healing resources, protective requirements of protected sites or ecological agriculture rule out the use of chemical products, only mechanical methods can be used. Moreover, farmland is subject to subsidy rules of DZES no. 7 (relating to the giant hogweed and Himalayan balsam). If herbicides are applied, the recommendation is to use selective herbicides that retain the undergrowth. Total herbicides are only suitable for small areas, coating of individual plants, if the species does not respond to a selective herbicide, or on explicit request of nature protection authorities.

2.6 Change in sowing procedures and crop rotation is an easy method of reducing some species on arable land. If herbicides cannot be applied on some arable

land plots (e.g., against ragweed in sunflower crops due to their relatedness), crop rotation is the only possible approach.

2.7 For species reproducing mostly by seeds or otherwise easily transportable parts, it is crucial to proceed methodically in management (preferring remote sites, first clear upper reaches of a catchment area and proceed downstream). Species propagating also vegetatively (knotweed, goldenrods) require monitoring of dumping sites and other areas affected by soil relocation.

2.8 It is important to destroy the whole stand at once, so that it cannot regenerate from individuals left behind. For the same reason, interventions have to be repeated as necessary.

2.9 Interventions have to include management of adjacent areas, so as to reduce additional supply of seeds from the surroundings.

2.10 After soil cover disturbance, it is advisable to treat areas, e.g., by sowing a grass mixture that produces sufficient cover and is composed (if possible and adequate) from local species (see standard SPPK D02 001 Restoration of grasslands using regional seed mixtures), while preventing colonization by unwanted species.

2.11 Monitoring of interventions made (success, costs) has to include inspection during works, adherence to methodology and timetables. The effectiveness of an intervention is inspected after the intervention and for several following years (at least 5 years), and the intervention is repeated as needed.

2.12 Management workers have to follow occupational health and safety rules (protective clothing and equipment) and adhere to legislation and directives relating to places of implementation and activities done.

3 Management technique principles

3.1 Mechanical methods

3.1.1 Mechanical methods are usually sufficiently effective for annual species (e.g., Himalayan balsam). With perennial species (particularly those capable of clonal spreading), they often fail to eradicate the growth even after several years.

3.1.2 Mechanical methods can efficiently reduce the quantity of seeds produced, which is necessary for extensive growths, where herbicide application is unsuitable.

3.1.3 With plants propagating with seeds, interventions are carried out no later than at the flowering time, before seed production, so that the plant material handling does not lead to release of seeds or their ripening in stored biomass. With grazing or girdling, the intervention has to be made earlier.

3.1.4 Species characterized by strong vegetative spreading and regeneration from rhizomes and stalks may spread via soil and removed biomass when eradicated mechanically. That is why caution is necessary and biomass and soil relocations are minimized.

3.1.5 With species with root and stump regeneration (e.g., black locust, tree of heaven), purely mechanical methods are unsuitable and are combined with herbicide application if site conditions permit.

3.1.6 Mechanical methods are usually the only option for eliminating undesirable species, e.g., on ecological agricultural land, in protective zones of water sources and in first and second zones of PLA and NP; if herbicide application is advisable, an exemption from the ban on the use of biocides on the sites has to be obtained.

3.1.7 ***Grazing***

3.1.7.1 Grazing can be used to reduce the density of invasive species on extensive sites; it seldom leads to complete eradication.

3.1.7.2 Grazing is also advisable after herbicide spraying to reduce emerging seedlings, but not before the protective period of the product has expired. The procedure can be recommended for agricultural land before registration as ecological.

3.1.7.3 Management planning has to take into account the grazing properties and weight of animals. Grazing intensity is chosen with respect to the carrying capacity of the plot, to avoid damage to vegetation cover.

3.1.7.4 Grazing starts before the plants or shoots become woody. It is timed to prevent formation of seeds, which the animals might spread in their excrements or fur. Ungrazed patches and edges have to be eliminated in other ways additionally on time (before seed formation).

3.1.7.5 Some invasive species may be toxic for animals when ingested (e.g., milkweed; bird cherry for ruminants; black locust for horses; photosensitizing plants such as giant hogweed may cause problems to all animals).

3.1.7.6 Grazing is done in a way that ensure adequate duration and dates, herd size and suitable animal species. Grazing has to be done repeatedly for several years. A one-time intervention is not recommended due to its minimal effect.

3.1.7.7 For more details on grazing (fencing, grazing systems), please refer to standard SPPK D 02 003 Grazing.

3.1.8 ***Mowing***

3.1.8.1 The intervention timing is crucial; if too early, the plants have time to regenerate and form seeds; germinating seeds are formed even before the mowing if the intervention is too late. The mowing usually has to be repeated in the course of the growing season to prevent any seed formation.

3.1.8.2 When eradicating species that respond to mowing by growing low near the ground (e.g., ragweed), which enables them to avoid eradication by repeated mowing at the normal height and form seeds, the mowing height has to be reduced gradually.

3.1.8.3 If there is a risk of any seeds ripening during the milky or yellow phases, any mown biomass has to be removed immediately and must not be left on the site.

3.1.9 ***Pulling / digging / removal by excavator***

3.1.9.1 Pulling can be used for both annual and perennial species. For annual plants, it is a suitable strategy given their mostly shallow and simple root system and high efficiency. For perennial plants, it is mostly effective with freshly established individuals, but roots of older or repeatedly mown tufts can seldom be removed completely. Pulling of perennial species is used for small populations as an auxiliary method suitable for reducing density; it usually does not lead to complete eradication.

3.1.9.2 Removal by an excavator is suitable for trees and shrubs that do not make root suckers (box elder, green ash, northern red oak). The advantage is the high efficiency and absence of stumps that would preclude follow-up management.

3.1.9.3 Both the intervention and biomass handling must avoid establishing new sites by inappropriate biomass handling processes.

3.1.9.4 For some species with very good regeneration ability from underground biomass (e.g., knotweed, ragweed), this procedure is unsuitable as it is too risky in terms of spreading. If it is chosen, all the underground biomass has to be separated from the earth, dried and burned.

3.1.9.5 For species capable of regeneration from aboveground biomass, it must not be placed in conditions that permit such regeneration (rooting). For some species (e.g., Himalayan balsam), the biomass can be left on the site, but only if the intervention preceded flowering and the plants thus cannot contain pollinated flowers, from which germinating seeds might develop.

3.1.9.6 Pulling and digging is a method that significantly disturbs the vegetation on most sites. Particularly in compact extensive growths, it is necessary to consider reclamation and restoration of compact turf to prevent recolonization by undesirable species.

3.1.10 ***Partial girdling***

3.1.10.1 On sites where herbicides cannot be used, partial girdling is used for trees that regenerate copiously by root or stump shoots when damaged (e.g., black locust, box elder). Even though trees after partial girdling usually regenerate less than after cutting, it usually leads to juvenile growth, which requires an additional intervention.

3.1.10.2 The partial girdling method is demanding in terms of correct execution, time and tool wear, which is why it is hardly used nowadays.

3.1.10.3 The method consists in removing a strip of bark (about 20 cm wide in adult black locusts) at a height of 1–1.5 m down to the wood, i.e., about 2 cm deep. The depth has to be sufficient to remove vascular cambium, a thin layer of living tissue that transports nutrients between leaves, roots and growth segments.

3.1.10.4 To reduce formation of shoots, it is important to not complete the girdle, leaving a strip of bark several centimetres wide (about 15-20%), which enables partial flow of nutrients. The tree becomes weaker gradually and does not shoot as massively as it would if the girdle were made along the whole trunk circumference.

3.1.10.5 Partial girdling proceeds so that the girdle is closed in the second year and the tree is cut down in the third year.

3.1.10.6 Ultimately, it is a variation on felling, which 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 (NLPA). Woody plants on the Union list are not covered by general woody plant protection if the procedure follows requirements for general measures under Section 13h, Para. 2 of the NLPA; the same applies to alien species for which a control measure is ordered under Section 5, Para. 6 of the NLPA.

3.1.10.7 The method is only implemented where the falling of dead trees and branches does not endanger human activity. The most efficient implementation is at intensive growth time, i.e., spring to early summer.

3.1.11 ***Cutting / felling***

3.1.11.1 Felling is a suitable method for woody plants that do not produce shoots. For plants with copious vegetative propagation, felling causes a dense growth of shoots, so it has to be replaced with mechanical interventions combined with targeted herbicide application.

3.1.11.2 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 (NLPA). Woody plants on the Union list are not covered by general woody plant protection if the procedure follows requirements for general measures under Section 13h, Para. 2 of the NLPA; the same applies to alien species for which a control measure is ordered under Section 5, Para. 6 of the NLPA. Felling of non-forest woody plants is specified by standard SPPK A 02 005 Tree felling.

3.1.11.3 Felling to tall stump (about 1 m) is used to reduce production of shoots in places where girdling or drilling and injecting herbicide to leave the woody plant to die is not an option for safety reasons. For plants with copious vegetative propagation, targeted herbicide application is used after resprouting from the trunk (see 3.3.7).

3.1.11.4 For extensive neglected stands that shoot as a consequence of inappropriate management and for species where targeted herbicide application cannot be used at the moment, cutting immediately followed by coating the cut surface with herbicide can be used exceptionally. This method is also possible for species with low stump resprouting and no root resprouting.

3.1.11.5 For the black cherry, resprouting can be reduced by both herbicide application and application of a wood-decaying fungus to the cut surface (see 4.2.6.4).

3.1.11.6 Where combined management is chosen (e.g., injection and felling), damage to individuals before the intervention has to be avoided.

3.2 Chemical methods

3.2.1 Chemical methods and their combinations with mechanical ones are preferred due to their efficiency. Their use has to be considered in light of the scope of eradication (purely mechanical methods are always more considerate, but sometimes not meaningful), taking into account restrictions applying to their use, e.g., due to water protection or location in a specially protected area, and if possible, more considerate forms of application should be preferred.

3.2.2 Herbicides differ in the active substance, dosage and protection limits. Some can be used in watercourse protective zones according to the registration decision, which is issued for each product and defines its applicability (see List of Permitted Products published annually by the ÚKZÚZ).[1]

3.2.3 Blanket spraying is applied in management of extensive growths (e.g., of knotweed, alpine dock, giant hogweed, tree of heaven, or black locust). If total herbicide is used, vegetation cover restoration and follow-up monitoring are necessary. With blanket spraying with total herbicide on small sites (up to tens of m^2), artificial vegetation restoration can be skipped, relying on the seed bank from the surroundings.

3.2.4 Spot spraying using extenders for accurate action is done particularly in biologically valuable areas, on sites with mixed vegetation, near watercourses and water bodies, on SPS and to remove individual plants.

3.2.5 Leaf coating is a considerate method that reduces impact on surrounding vegetation and environment. Due to its time-consuming nature, it is only applicable for less extensive growths. The herbicide is applied to approx. 1/4 to 1/3 of the leaf surface. Application using herbicide poles and wick poles is advisable.

3.2.6 Cut stem herbicide application is used particularly on resprouting woody plants. herbicide application has to be done immediately after the cutting, before the cut surface dries. When used correctly, the method has minimum impact on the surroundings.

3.2.7 Selective herbicides retain grass, reducing the erosion risk and probability of recolonization by the alien species. When using total herbicides on more extensive sites, the intervention has to be followed by a reclamation (e.g., sowing local grass species) and subsequent monitoring.

3.2.8 The herbicide application has to be timed depending on the species. Details are shown in management chapters for each species. Herbicide is applied during the growing season and under suitable weather conditions, when optimal efficiency is guaranteed. Leaf spraying is done under full foliage in the first half of summer; cutting/felling followed by herbicide application to the damaged spot is done typically from mid-August to late October. For woody plants where felling is combined with herbicide application, winter felling is ruled out due to greatly reduced efficiency.

[1] https://www.agromanual.cz/cz/pripravky/herbicidy

3.2.9 Spraying is inappropriate during flowering, when flowers of the treated species are visited by various pollinators, for which the intervention could be fatal (e.g., when managing the common milkweed).

3.2.10 Herbicide is applied in calm and dry weather. It must not rain in the few hours (approx. five) after the application. If it does rain, the spraying has to be repeated in good weather.

3.2.11 To get an overview of individuals already treated and inspection when handing over, it is advisable to add a pigment to the herbicide. Water-soluble pigments, such as food pigments or special colourants used in forestry, are suitable.

3.2.12 To increase the herbicide efficiency, a surfactant or other adjuvants can be used (i.e., substances improving the properties of the application liquid).

3.2.13 The herbicide application effect is visible within a few days. Areas where the targeted species has not been eradicated sufficiently shall be treated again at another good time.

3.2.14 When repeating the use of herbicides based on the same active substances, some species may develop resistance (e.g., common ragweed).

3.2.15 Product application has to comply with rules set by the manufacturer. Avoid contamination of water in a watercourse with the product or its packaging, and avoid application of the product on water surface, except products designed for that. Application equipment must not be cleaned in or near watercourses; avoid washing of application products off paved areas.

3.2.16 When applying herbicide, use the recommended protective equipment and adhere to the manufacturer’s safety instructions.

3.2.17 Only clean water is recommended for diluting chemical products to avoid reducing their efficiency.

3.3 Targeted herbicide application methods

3.3.1 Combinations of mechanical and chemical methods are used where mechanical method cannot be used because they lead to the species regenerating, causing greater growth density and spreading.

3.3.2 Stem injection of herbicide (in drilled holes or notches) or into wounds after bark removal is known as the targeted application method. The method is considerate to the surroundings. Its advantage is its high efficiency. The overwhelming majority of individuals die after a single application without producing any shoots. The method requires leaving the trees to die spontaneously, after which they can be left to decay or felled.

3.3.3 Woody plants are not felled before the herbicide absorption is proven successful (leaves are shed), i.e., about 1-2 months after the intervention; crowns can be lightened by an arboricultural intervention. It is best to wait 1-2 years, until the actual death of the individual and its entire root system is proven.

3.3.4 The best time for targeted application is the second half of the growing season (always after flowering). Approximately one month after targeted application, the treated trees have to be checked and any surviving individuals treated.

3.3.5 Stem injection of herbicide is suitable for treating trees from a 4 cm diameter. The injection is optimal into holes drilled at a 45° angle, extending approximately 2 cm into the wood, spaced along the perimeter at about every 5 cm. In multiple-trunk clumps, each trunk has to be drilled separately along the entire perimeter. Even regrowing stumps can be drilled. Herbicide is injected into the holes immediately.

3.3.6 In thinner trees (trunk diameter 3-7 cm), herbicide can be applied into notches made by a machete or axe. The notches must cover the whole trunk circumference evenly and have gaps between them. In thin trees, notches are made at different trunk heights, again along the whole perimeter.

3.3.7 Trees with a trunk thickness up to approx. 3 cm can be treated by partial bark removal followed by herbicide application. The bark is peeled off at the trunk base, about 10-15 cm long. The removed bark strip should make up about 60% of the trunk circumference. From trunk 2-3 cm in diameter, one strip of bark should be peeled off at the trunk base and another a little higher up on the opposite side of the trunk. Do not remove the bark along the whole circumference. In clumps of multiple shoots, each individual has to be treated separately. The wounds have to be coated with herbicide immediately. Trunks of non-woody shoots can be coated with herbicide without peeling.

3.3.8 Tall trees that cannot be left standing after the injection for safety reasons can be felled to tall stumps (at least 1.5 m), which can be done even in winter. Target herbicide application into the trunk is done after shoots have sprouted from the trunk in the second half of the growing season (July-September). Until then, restrict damage to roots by machinery movements and removal of wood material, to prevent formation of root suckers. It is important to skip mowing in the surrounding area until the herbicide application, so that root suckers can be treated. Another treatment of root suckers is typically necessary near the ends of the season or in the following year. The dead torso can be felled in the following year.

3.3.9 Lightly diluted product (75%) is used for the tree of heaven; a 30-50% dilution ratio is sufficient for other trees. The quantity of liquid applied (ml) into drilled holes is approximately twice the trunk diameter (cm). When using the partial peeling method, about 1 ml of the solution per wound is applied.

3.3.10 Injection can also be used for herbs, particularly on biologically valuable sites or near water sources. The consideration to the surroundings is offset by the labour and time intensity.

3.3.11 Injection can be used even in worse weather; it is enough if it does not rain for at least one hour after application.

3.4 Removed biomass handling

3.4.1 To prevent emergence of new invasive species sites, management requires careful handling of biomass from the eradicated species and earth contaminated with rhizomes or seeds. Many species are capable of regenerating even from small fragments of rhizomes and stems or from seeds, which survive in soil for several years.

3.4.2 During earth moving works around species with a rhizome system or a persistent seed bank, earth has to be stored separately and its spreading across the area has to be prevented.

3.4.3 On sites valuable in terms of nature protection and with limited availability of nutrients, all the biomass has to be removed to prevent it enriching the soil particularly with nitrogen, which slows down restoration of natural communities (e.g., fabaceous plants).

3.4.4 In areas where increase nitrogen content is not a risk, the biomass can be retained and the areas can be mulched. For species where regeneration from aboveground biomass is a risk, the biomass has to be crushed. Biomass left on the site must not contain rhizomes and seeds or pollinated flowers, from which germinating seeds might develop.

3.4.5 To reduce biomass transport and possible spreading of seeds and rhizome fragments into the surrounding area, pulled plants are collected on an impervious canvas; any potential regenerating plants are then removed or sprayed with herbicide. The canvas is removed before winter.

3.4.6 The biomass can be used in biogas stations or industrial composting plants. If biomass contains seeds or vegetative parts capable of regeneration, it can only be used if the thermal treatment is sufficiently strong and long to destroy them (see ragweed composting, 4.1.1.8). Biomass from invasive species has to be processed with priority to prevent its storage and potential regeneration. Composting in household composters is not recommended due to unstable temperature, which has to be adequate for seed destruction.

3.4.7 Burning is a suitable method for destroying dry biomass (see Standard D 02 002 Restoration of long-term uncultivated grassland communities). The method is recommended for destroying biomass from flowering or fruiting plants, their parts (e.g., removed giant hogweed umbels) or seeds, as well as for destroying dried rhizomes. The advantage of burning on the intervention site is minimized risk of diaspora.

3.5 Restoration

3.5.1 Area restoration after eradication of alien species is an important part of management, as is area monitoring.

3.5.2 In non-forest areas, particularly if a radical disturbance of vegetation results from mechanical methods or total herbicide application, colonization by another alien species must be prevented.

3.5.3 Restoration of vegetation cover of non-forest areas should use locally produced seeds. Sources may include partial mulching with green hay from surrounding land (see standard SPPK D02 001 Restoration of grassland using regional seed mixtures and SPPK C 02 007 Grasslands), or seeds obtained by direct collection or browsing from suitable surrounding sites. It is important that the mixture be capable of producing sufficient cover.

3.5.4 Non-forest areas where vegetation dominated by a fabaceous plant has been eradicated have increased nitrogen concentrations for many years, which

slows down the return of native vegetation. That is why aboveground biomass has to be removed and transported away.

3.5.5 Forest area restoration has to comply with forest management plans and nature protection requirements.

3.5.6 After woody plants with allelopathic abilities, the successor species may thrive less initially. That is why grasses should be used in the first stages of restoration in the early years.

3.5.7 It is desirable to use natural development on the site for restoration. For example, gradual dying of woody plants after girdling or targeted herbicide application does not lead to sudden bright sunlight on the site or erosion, and the successor community gradually prepares for the change of dominant species.

4 Recommended management

This section describes procedures for selected species. Management of other species proceeds analogously based on similarity with the species shown here. In addition to the classification of Pergl et al. (2016), the basic classification parameter is the ability of species to propagate vegetatively.

4.1 **Species category BL1** contains species with the highest degree of negative impact on natural communities and human health. Union list species are also described, for which the target status according to the control rules is complete eradication (milkweed) or eradication with the exception of retention of selected individuals as the case may be (tree of heaven). The described procedures include both direct eradication and gradual reduction by means of management changes. Besides eradication on biologically valuable sites, the priority is eradication of population that could serve as sources: along roads, railways and watercourses.

4.1.1 **Common ragweed** – *Ambrosia artemisiifolia*

4.1.1.1 Reproduces only by seeds. They are not easily spreadable by wind, but may remain in the soil seed bank for more than 20 years. It is an aggressive pollen allergen and a noxious weed.

4.1.1.2 The priority is prevention, avoiding transportation of soil, biomass or seed stock containing ragweed seeds.

4.1.1.3 Reducing the seed production is important. Interventions are made before flowering. Imperfectly destroyed plants regenerate and produce viable seeds.

4.1.1.4 The ragweed is sensitive to a wide range of herbicides (e.g., glyphosate, triazine), meaning that standard herbicide application against other weeds tends to be sufficient for its eradication on arable land. Resistance develops after repeated use of herbicides.

4.1.1.5 Crop rotation is a suitable measure to reduce the species (also given the resistance development). On arable land where herbicides cannot be used (e.g., on sunflowers due to their relatedness to the ragweed), crop rotation is the only possible management method.

4.1.1.6 It responds to mowing by growing flat on the ground, which helps it avoid further eradication by repeated mowing at the normal height. The mowing height therefore has to be gradually lowered.

4.1.1.7 Mechanical pulling is recommended for valuable sites with relatively small ragweed populations. Biomass removal in plastic bags is necessary to prevent scattering of seeds. Use of hessian sacks or bigbags is unsuitable due to seeds clinging to them.

4.1.1.8 Biomass containing seeds can be destroyed in industrial composting plants. To destroy the seeds reliably, the composting temperature has to achieve 55°C for 3 weeks or 65°C for 1 week. Composting in household composters is strongly discouraged due to unstable temperatures. The biomass can be used in biogas stations providing that it remains in the biogas reactor for 10

days. Biomass from the ragweed has to be processed with priority to prevent its storage and potential regeneration.

4.1.1.9 Another eradication method is application of hot steam using machinery. The use of this method has been tested along roads. It is a very effective, albeit costly method.

4.1.1.10 Interventions should be followed by revegetation by sowing local species (except in fields), because the ragweed is sensitive to competition from other species.

4.1.2 **Giant hogweed** – *Heracleum mantegazzianum*, Persian hogweed (*H. persicum*), Sosnowsky's hogweed (*H. Sosnowskyi*).

4.1.2.1 Reproduces only by seeds. Flowers usually at 3-5 years of age. Dies after producing seeds. Produces a soil seed bank – most of the seeds germinate in the first and second years, a small portion survives in the soil for up to 7 years and poses a risk of spreading.

4.1.2.2 The only methods that destroy giant hogweed plants immediately are herbicide application or chopping of the roots. Management has to be repeated due to unharmed/overlooked individuals, and maintained for at least 5-10 years, until the soil seed bank is exhausted.

4.1.2.3 Chopping and subsequent digging up of roots is used on sites with low coverage and area (up to about 500 m^2 and 200 individuals). The chopping must break the root at least 10 cm below the root shank. In places with alluvially deposited soil or long-term grazing, the roots may be deeper. Excavated roots can be left to dry on the surface, but have to be removed from waterlogged sites. For reasons of passability, the best time is the beginning of the growing season (April to June), which can prevent the problematic handling of flowering plants. The method is effective throughout the year, but has to be applied before fruits develop.

4.1.2.4 Digging up of roots is similar to spring digging, which is done using a hoe in early spring, as soon as the plants appear (late March – April). The advantage is that the plants are small, root only 5-10 cm deep and the risk of contact with the toxic sap of the giant hogweed is low.

4.1.2.5 Herbicide is applied to small populations and scattered plants by direct coating of leaves or cut surface of the stem after chopping it down, which minimizes impact on surrounding vegetation, or in the form of point spraying. Injection into stems and roots is a considerate, but time-consuming and costly method. Herbicides are applied in a blanket fashion to extensive stands.

4.1.2.6 The giant hogweed is sensitive to a wide range of herbicides. Selective products are recommended, as they allow fast growth of grass, which suppresses young giant hogweed plants and prevents colonization by other alien species. The application is ideal in May, when the stands are easily passable, the leaf heads fully developed, but the plants are only about 0.5 m tall. The product is sprayed on the leaves from above and the aerosol is not spread around. The spraying is ideal before the plants start producing the flowering stem. Later on, some herbicides are not effective at normal

dosage, and increased concentrations are not favourable to the surroundings. Some herbicides can be applied even when the terminal umbels start flowering, as the flowering plants are usually unable to produce seeds after the intervention.

4.1.2.7 In small stands, gradual removal of flowering umbels can be used to prevent seed formation. Plants that do not flower in the year are not the target of intervention; thus, their flowering age is not increased. The intervention timing, regular repetition and removal of new inflorescences are crucial. Cut umbels have to be destroyed (burnt). With continuity (several years), this is an efficient eradication method.

4.1.2.8 On large sites with herbicide restrictions, where no other eradication method can be used given the size of the area, it is important to reduce seed production and focus on prevention of further spreading. That can be achieved by mowing and grazing. It does not kill the plants directly (conversely, it prolongs their flowering age, thus postponing their death), but it can effectively reduce the seed production if done correctly, and is suitable for long-term control of extensive growths.

4.1.2.9 Grazing can be done by sheep, cattle or other animals. Cattle and sheep target the giant hogweed primarily, but cases of photosentivity have been reported even in animals. Grazing should start early on, while the plants are soft. Umbels have to be removed from plants that do flower as soon as flowering starts.

4.1.2.10 Mowing and grazing (with mowing of ungrazed patches) have to be repeated several times per season to prevent seed formation in regenerating plants. The first mowing is most efficient during budding. The giant hogweed often responds to first mowing by producing a low leaf rosette and a short (approx. 0.5 m) stalk with a smaller inflorescence. To minimize the numbers of flowering plants, the second mowing has to come about 4 weeks after the first one. If the plants regenerate, an additional (third) mowing can be combined with mulching and the regenerating plants can be chopped/dug up.

4.1.2.11 If the intervention is late, during the flowering or even later, the entire inflorescence/infructescence has to be chopped off, collected in a plastic bag and destroyed safely (burnt). Chopped umbels must not be left on the site, because they could develop germinating seeds (under favourable conditions, they can develop from umbels removed just after pollination). The remaining parts of the plants do not have to be cut/removed.

4.1.2.12 When destroying plants with ripe seeds, plastic canvas sheets have to be laid on the ground before handling and any fallen seeds collected. This method can be applied exceptionally if plants in a late development stage are found, and cannot be considered efficient – it only reduces the number of seeds that would add to the seed bank. Increased attention has to be paid to such spots in the following years.

4.1.2.13 All interventions require the use of protective clothing with face protection due to the high phototoxicity of giant hogweed sap.

4.1.3 **Common milkweed** – *Asclepias syriaca*

4.1.3.1 A species included on the Union list of invasive species, for which the management recommended in the control rules consists in its complete eradication due to its impact and ability to spread.

4.1.3.2 The milkweed is a perennial clonal plant, which propagates both by seeds and by rhizomes. Down helps seeds spread easily by wind over large distances, and seeds survive in soil for over 5 years. Individual shoots are annual and die in autumn; new ones grow each spring from the rhizome system. Rhizomes usually grow horizontally at a depth of 10-40 cm, but can extend to depths of 1.5 m.

4.1.3.3 The milkweed regenerates easily from rhizome fragments. This poses a risk in the event of earth transport or contamination of agricultural machinery.

4.1.3.4 To achieve complete milkweed eradication on a site, chemical methods are required for the desired efficiency.

4.1.3.5 Herbicide is applied by spraying; contact application by direct coating of leaves is possible in the case of scattered plants.

4.1.3.6 The first spraying is applied just before flowering or at its start (June–July), when the plants are taller than approx. 30-40 cm and have about 6-8 leaves developed. Earlier spraying is less effective. A greater leaf surface is more suitable, especially for shoots are part of a larger clonal cluster. It is important to treat the plants before full flowering to prevent seed formation. It is advisable to check the site about ten days later and spray any overlooked or insufficiently treated individuals; a second herbicide application is advisable at the end of August or early September, depending on the growing season.

4.1.3.7 The herbicide application has to be repeated for at least three years, ideally five or more, depending on the growth age and the resulting density of rhizomes and roots and on the herbicide application method. Due to the long survival of seeds in soil, further monitoring with potential destruction of sprouting plants is necessary.

4.1.3.8 The milkweed is more sensitive to interventions just before flowering, when stored nutrients are invested in the inflorescences; it thus significantly reduces the plant regeneration from root suckers and the amount of nutrients stored in roots. Later interventions are not suitable with respect to their negative impact on pollinators.

4.1.3.9 Herbicides with glyphosate and 2.4-D as the active component are suitable for milkweed control. Fluroxypyr-based herbicides cannot be recommended, as they are less effective.

4.1.3.10 The herbicide concentration is optimal if the milkweed begins to turn yellow 7-14 days after application, shedding all its leaves, and the entire aboveground shoots dry. If the leaves become only partially yellow and the shoots stay green (exuding latex when broken), the solution was too thin. If the entire aboveground part becomes brown during a week after application,

the concentration was too strong, the aboveground parts were damaged quickly and the rhizome system sustained little damage.

4.1.3.11 To shorten the time needed for herbicide absorption, an addition of fertilizer (ammonium sulphate/nitrate) and surfactant can be used. The fertilizer can only be used on sites where eutrophication is not a risk. A 5% concentration is ideal.

4.1.3.12 To scattered milkweed plants, glyphosate-based herbicide can be applied in a contact method by direct coating of leaves (e.g., using a herbicide pole). Use a higher herbicide concentration (10%) with an addition of surfactant and fertilizer if possible. The timing is identical to the spraying application (see 4.1.3.6).

4.1.3.13 On sites where herbicides cannot be used, seed production has to be prevented mechanically. Such methods do not kill the plants; on the contrary, they stimulate the plants and its further spreading, as the milkweed responds to damage by copious vegetative growth and branching from rhizomes.

4.1.3.14 Mowing and grazing are only additions for reducing seed production and can be used temporarily. Ultimately, they have to be replaced with herbicide application for complete eradication.

4.1.3.15 Mowing can even stimulate denser growth. Mowing twice per season is advisable – first just before flowering (budding stage), and then before flowering of regenerating plants. Mowing at an earlier stage stimulates faster regeneration, requiring more frequent repetition of the intervention. The biomass always has to be collected and destroyed suitably with a view to the regeneration ability (see 3.4).

4.1.3.16 Grazing is less efficient than mowing, because animals do not seek the milkweed (it may cause them health problems), so that ungrazed patches have to be controlled. If fruits form in grazed areas, seed scattering in animal fur is a risk; moreover, seeds are trampled into the soil by their hooves.

4.1.3.17 Digging up the roots is very laborious and does not lead to complete eradication. Ploughing has little effect (only on seedlings); on the contrary, it may stimulate the milkweed. Both methods pose a risk of spreading by means of plant remains by machinery or contaminated earth.

4.1.3.18 Pulling can only be efficient on young seedlings, which do not yet have a branching rhizome system.

4.1.4 **Tree of heaven** – *Ailanthus altissima*

4.1.4.1 A Union list species, for which the control rules specify the long-term goal of gradual elimination throughout the Czech Republic, with the exception of retention of individuals that can be controlled efficiently.

4.1.4.2 It is a fast-growing tree with an early start of seed production (4 years for seedlings and even earlier in individuals from regeneration). The seeds spread easily by wind and water. They have a high germination capacity, but survive in the soil seed bank only for about 2 years. Vegetative spreading by root suckers is significant on a small scale, but very important

for regeneration after damage and formation of dense growth clusters. The tree responds to damage with fast resprouting from roots or stumps.

4.1.4.3 The priority is eradication of populations and individuals that might act as sources of further spreading. This concerns sites along roads, railways, watercourses, field and forest edges, and surroundings of parks and gardens. In forests that are not clear-cut have a relatively low risk of tree of heaven spreading due to its lower competitiveness. Selective management is preferable instead of clearcutting in areas with tree of heaven presence.

4.1.4.4 In newly colonized areas and isolated individual trees outside areas of extensive growth, it is essential to prevent seed formation. It has to be done in a way that prevents vegetative regeneration. Purely mechanical removal has to be avoided; for instance, when managing land by mowing, young trees of heaven have to be skipped and treated separately immediately after foliation using a suitable method (partial trunk peeling with herbicide application, spraying).

4.1.4.5 Trying to eradicate the tree of heaven without using herbicide is not only inefficient, but even counterproductive.

4.1.4.6 The management is based on targeted herbicide application into the trunk. In trees from 4 cm in diameter, herbicide is injected into holes or notches; in younger trees up to approx. 2 m in height, herbicide is applied to a wound resulting from partial bark stripping (see chapter 3.3).

4.1.4.7 Targeted application method require leaving the tree to die spontaneously. Trees are left to decay naturally or (for tall trees) removed before they become a threat to their surroundings (ideally 1-2 years later, but no sooner than the herbicide is absorbed approx. 2 months after treatment).

4.1.4.8 In exceptional cases, where the tree cannot be left standing for the time needed for herbicide absorption, it can be felled to a tall stump; then when the stump shoots, inject herbicide into the stump and treat the root suckers (see chapter 3.3). Earlier felling induces regeneration, which is why the intervention is more demanding in terms of time, material and quality of following treatment.

4.1.4.9 For young individuals, the recommended procedure is partial debarking with herbicide application; this is only rational for individual trees or groups of tens of individuals. Very dense and continuous stands require spraying on the leaves, which poses a risk of damage to surrounding vegetation. The resulting clearing is prone to colonization by undesirable species.

4.1.4.10 Felling immediately followed by coating the stump with herbicide is the least effective method, only usable if no other procedure is possible for any reason. The herbicide coat has to be applied to the fresh wound.

4.1.4.11 Individual seedlings without a well-developed taproot can be pulled up manually. With respect to the soil seed bank, the pulling has to be repeated several times a year for several years.

4.1.4.12 Tree of heaven control is concentrated in the growing season. The best time for injection is after flowering (June-July) until the end of the growing season; the highest efficiency is in August and September. Spraying on

leaves is done after the shoots foliate fully in June, and then in September. Felling with herbicide coating of stumps should be done in late summer (August-September), when the stump regeneration ability is the lowest. Winter felling has to be avoided at all costs (the only option being felling to tall stumps with delayed injection).

4.1.4.13 Follow-up management for treating surviving or new individuals is necessary for at least 2-3 years. It is advisable to reduce maintenance works in tree of heaven control areas; if the treated area overgrows spontaneously until the clump has died completely, bunchy herbs and grass will effectively prevent re-establishment.

4.1.4.14 The procedures shown for the tree of heaven are also suitable for other regenerating tree species, such as the black locust (see 4.2.5), box elder, black cherry and others.

4.2 **Species category BL2 and BL3** contains species that can be tolerated to a limited extent in suburban areas if they form extensive populations where eradication would be disproportionately demanding/unrealistic. The priority is to minimize planting and reduce presence in biologically valuable areas. It is necessary to reduce populations that can serve as sources of spreading, typically with an emphasis on presence along watercourses and roads.

4.2.1 **Himalayan balsam** – *Impatiens glandulifera*

4.2.1.1 Himalayan balsam is an annual species propagating by seeds. Under suitable conditions (moisture), it can also spread by regenerating stalk fragments, which may root from the nodes and flower/fruit again. The seeds spread very easily by water (particularly with sediment) and vehicles (tyres, machinery). They have a great germinating ability and most germinate immediately in the next season.

4.2.1.2 Management has to focus on prevention of spreading to more sites (transport of soil with seeds). Source sites are eradicated first. Given its good spreading by water and along roads, the management plan has to be adjusted in light of spreading in the area and possible recolonization of cleared areas. It is important to eradicate the complete stand, beginning in the upper reaches and continuing downstream across the whole river basin.

4.2.1.3 Pulling up entire plants with the roots is the recommended method. Tall or regenerating plants are pulled up, no later than at the early flowering stage, which prevents seed formation; ripe seeds are shot into the surroundings when handling the plant, unripe ones can ripen even after pulling up the plants, making biomass handling difficult.

4.2.1.4 Treated areas have to be checked after the intervention (2-3 weeks later) and any remaining individuals are pulled up. Subsequent inspection is necessary for several years. Zero tolerance and consistency are important, along with prevention of seed supply to the site.

4.2.1.5 When handling the plant material, avoid establishment or seed spreading at the storage site. The biomass can be left on the site only if the intervention preceded flowering and the plants contain no fruits. It is necessary to avoid

re-establishment, e.g., by separating the roots from the stalk and breaking the pulled plant so as to minimize regeneration and adventive rooting from nodes.

4.2.1.6 Pulled plants can be stored in safe places (with direct sunlight outside the reach of watercourses or other sources of moisture to prevent regeneration; they can be laid on surrounding tall vegetation). In the case of large quantities, plants can be collected on an impermeable canvas and then damaged mechanically (by trampling); any regenerating plants can be sprayed with herbicide if possible in terms of nature protection. The canvas sheets are removed at the end of the growing season to prevent frost damage and disintegration.

4.2.1.7 Mowing may be suitable for extensive stands. Mowing is done 2-3 times in the first year, and the mown plants are crushed by vehicles or feet or turned into mulch. The stand is reduced to individual plants over approx. two seasons, which are pulled up. The plants are cut as low as possible (below the first node) to reduce regeneration. The first mowing has to come no later than the budding of first flowers. The plants will regenerate if the intervention is too early; seeds will ripen if too late. The areas are checked (to remove any sprouting plants) several times, about every three weeks. If the plants are mown in time, the biomass can be left on the site. If the biomass is contaminated with seeds, it has to be removed. Machinery becomes contaminated too – all equipment has to be cleaned thoroughly.

4.2.1.8 Grazing results in considerable trampling of plants, which then regenerate and produce seeds. The seeds can be spread by animal hooves. A combination of grazing and mowing is advisable: mow or mulch the vegetation before the start of flowering and then implement grazing (accompanied by inspection for presence of flowering plants and their removal).

4.2.1.9 Mowing and grazing are also used as management towards reduced seed production, particularly along and near forests, to prevent spreading to further sites.

4.2.1.10 Herbicide application is not recommended due to the existence of an efficient mechanical method. Blanket application can be used on sites with combined presence of multiple invasive species for which no other methods are usable.

4.2.1.11 In case the intervention results in large, disturbed areas without natural vegetation, colonization by undesirable species has to be prevented by restoration of compact turf.

4.2.2 **Perennial herbs with high regeneration ability, propagating mostly by seeds**, such as **alpine dock** (*Rumex alpinus*), **large-leaved lupine** (*Lupinus polyphyllus*) and **heart-leaved oxeye** (*Telekia speciosa*)

4.2.2.1 These are mostly species with very low response to mowing due to their very good regeneration ability; mowing only prevents seed formation but does not destroy the individual plants. The seeds usually survive in soil for a long time.

4.2.2.2 In addition to mechanical management, successful eradication requires the use of herbicides.

4.2.2.3 The recommended spraying doses are 3-5% and 10% glyphosate-based herbicide solution to the leaves of the dock and lupine, respectively.

4.2.2.4 If the character of the site permits (e.g., in terms of water source protection), blanket application of total herbicide to alpine dock can be tolerated in the first year, because the extensive rhizome system can prevent erosion to some extent. Herbicide application has to be repeated in the next years as a point intervention against regenerating plants. Plants sprouted from the seed bank are eradicated by grazing or mowing.

4.2.2.5 The herbicide is applied no later than at the initial flowering stage to prevent seed formation. At a later flowering stage, the inflorescences/infructescences are removed before herbicide application and destroyed (ideally by burning) at a suitable place.

4.2.2.6 Germinating plants thrive less well in compact grass vegetation, which is why it has to be restored on management sites as soon as possible. Besides sowing local species, the treated area is covered with mown grass from surrounding unaffected areas.

4.2.2.7 Treated sites have to be maintained (mowing, grazing) and monitored regularly after the intervention. If necessary, the intervention has to be repeated locally until the species is completely eradicated, including exhaustion of the soil seed bank.

4.2.2.8 For isolated individuals and very small areas, the plants can be dug up as well.

4.2.3 **Perennial species propagating widely by both seeds and rhizomes/roots**, such as **goldenrods** (*Solidago* spp.), **asters** (*Symphyotrichum* spp.) and **Jerusalem artichoke** (*Helianthus tuberosus*)

4.2.3.1 These are mostly species whose propagation depends on seeds. Management has to precede seed formation. These species form some germinating seeds even on plants mown while flowering. They can also spread locally via rhizomes.

4.2.3.2 Species management has to take into account the context of the invaded areas. The species can be tolerated, for instance, in urban environments, where they pose no risk to nature protection interests.

4.2.3.3 The species can be eradicated relatively well using mechanical methods, especially just before flowering or at its early stage. For persevering populations that are not sufficiently reduced by mechanical treatment, herbicide application is an option (spraying on leaves).

4.2.3.4 The recommended management is based on regular maintenance (grazing, mowing) of affected areas.

4.2.4 **Knotweed: Bohemian knotweed** (*Reynoutria ×bohemica)*, **Japanese knotweed** (*R. japonica*) and **giant knotweed** (*R. sachalinensis*)

4.2.4.1 Knotweeds propagate almost exclusively vegetatively. They produce an extensive rhizome system. Its greater part is located at depths of up to 1 m, but rhizomes may extend as deep as 4.5 m, capable of penetrating almost any substrate, reaching as far as 20 m from the parent plant.

4.2.4.2 Knotweeds have a very good ability of regeneration from very small rhizome fragments and aboveground shoots. This ability is a crucial factor in their spreading. Management requires careful handling of biomass and earth. During earth moving works on knotweed sites, earth has to be stored separately to prevent spreading.

4.2.4.3 None of the available methods can weaken the rhizome system sufficiently over one season. Mechanical removal of aboveground biomass leads to weakening, not eradication. Digging up the rhizomes may be effective, but is technically difficult, usable only for smaller stands and poses a risk of further spreading of rhizomes.

4.2.4.4 Foliar spraying is the optimal method; maximum leaf surface has to be affected. It is done as either early or late spraying; early spraying is more effective in reducing the rhizome regeneration ability, and the herbicide consumption is about one half compared to autumn spraying. Products containing glyphosate, fluroxypyr and triclopyr are effective.

4.2.4.5 In the early spraying, the first dose is applied approx. in late May (growth height up to 1 m) with another spraying following after regeneration (three weeks later). This is followed by monitoring of regenerating shoots and spraying them for at least two seasons (three for Japanese and Bohemian knotweed). The dosage should be species-specific to prevent excessive herbicide use. The giant knotweed can be sprayed with a 5% glyphosate concentration, while Japanese and Bohemian knotweed requires 8% concentration. A variation that can achieve a further reduction in the herbicide use is to mow the vegetation in late spring, do the spraying in summer after regeneration and then repeat in autumn, with monitoring and spraying of regenerating shoots in the following years.

4.2.4.6 The late spraying is done in late summer to autumn and is followed by monitoring of regenerating shoots and spraying in the following seasons (complete eradication was not achieved even after 3 years in an experimental study). As the plants are fully grown, the herbicide consumption is considerably higher compared to the early application. Passages have to be cut through more extensive stands to permit herbicide application to lower levels of leaves. The passages have to be treated after regeneration in the following year.

4.2.4.7 In some cases, knotweeds respond to herbicide by forming low plants with curly dwarf leaves that hardly respond to further spraying. If such plants are left alone, they will grow into the normal shape over a few years and standard intervention is then possible.

4.2.4.8 Injection is suitable on biologically valuable sites or near water sources. It can even be applied in worse weather. The injection is laborious and time-consuming. The herbicide consumption may be much higher than for spraying. It is effective already in the first season. If regenerating plants

appear in the following year that cannot be injected (too weak), leaf spraying is applied. Glyphosate is used most commonly, ranging 3-7 ml per stalk. The injection has to be made into about 50% of the stalks in the clump. The minimum recommended plant height is 1.5 m and stalk diameter 1.5 cm (typically 1.5–5 cm). The same conditions also permit leaf and stalk coating.

4.2.4.9 After the herbicide application, the dry biomass should be cut, raked or heaped and burnt in a safe place in good weather (dry knotweed burns very fast, the stalks crack and shoot out, so supervision of several workers with fire extinguishing equipment is necessary). Clearing the dry biomass helps faster site recovery and facilitates movement of workers during repeated spraying.

4.2.4.10 A combination of spraying preceded by a mechanical intervention (except the procedure in 4.2.4.5) is not recommended. Cutting in summer followed by herbicide application in autumn, digging up the rhizomes to a depth of 2.5 m using an excavator in spring, accompanied by spraying herbicide on the ground surface immediately after the intervention and pouring of herbicide into remaining shoots does not bring any better results than herbicide application alone, despite the higher costs and laboriousness, and posts an additional risk of spreading. Filling remaining shoots with herbicide requires much higher glyphosate dosage than herbicide spraying.

4.2.4.11 Mechanical methods themselves do not lead to total eradication of knotweeds, but are used for restricting their negative impact on communities or on sites where herbicides cannot be used for various reasons.

4.2.4.12 If knotweeds are present on a site accessible to machinery, machines with a mowing bar, drum mower or mulcher can be used. The machinery has to be cleaned after the intervention to remove all remaining biomass, preventing its spreading. Hard-to-reach sites are mown using string trimmers, machetes and scythes. Due to the rapid growth and lignification of the stalks, hand scything should be repeated several times a year, as low to the ground as possible. With an optimal plant height of 40 cm, scything is possible up to eight times a year. The method is effective in preventing spreading only if applied repeatedly over a long term.

4.2.4.13 On sites where grazing is possible, knotweed stands can be reduced by grazing and mowing ungrazed spots. The grazing has to start as soon as possible while the plants are digestible.

4.2.4.14 Digging up is not recommended due to the high regeneration ability from root fragments. It is only successful at initial stages. Entire plants including rhizomes have to be dug up; they can extend to depths of 2 m. The minimum digging depth is 30 cm. The intervention has to be repeated whenever the vegetation regenerates.

4.2.4.15 Handling of plant remnants after mechanical eradication is highly problematic. Tools and machinery have to be cleaned thoroughly. The biomass has to be dried to prevent regeneration. Aboveground biomass should be left to dry on the site (unless moist or prone to flooding) to prevent the risk of spreading by transport. If the intervention involves digging up of rhizomes, they have to be dried and burnt.

4.2.4.16 It is necessary to restore grass on the site after the intervention.

4.2.5 **Black locust** – *Robinia pseudoacacia*

4.2.5.1 Management has to take into account the fact that the species regenerates copiously after damage, including older individuals. It is light-demanding, so spreading into canopied forest is not a risk. Seedlings can only become established in disturbed naked soil. Felling is followed by swift regeneration up to 15 m from the removed individual, which is why clearcutting or strip cutting is absolutely inappropriate. Mechanical interventions always have to be combined with herbicide application.

4.2.5.2 In terms of the landscape context and nature protection needs, management can be divided into the following options:

4.2.5.2.1 Let the stand develop spontaneously with gradual replacement with more sciophytic species. This can be recommended where the black locust does not pose a risk to natural communities and where highly competitive native woody plants (ash, maple, spindle, blackthorn, buckthorn) are present nearby, which have the potential to supersede the black locust in decaying stands (about 50-70 years old). Lack of sunlight makes the black locust recede. It is crucial to avoid black locust regeneration by leaving the senescent stand without intervention (including removal or felling some of the wood).

4.2.5.2.2 Leave the black locust stand but prevent its spreading into adjacent communities. This method is suitable for intensively farmed areas, where the black locust overgrows ravines, gorges, baulks or bosks. They function as biocentres or biocorridors in the landscape. The black locust does not spread via resprouting into regularly ploughed fields. In meadows, pastures or fallow land, however, black locust spreading has to controlled, removing shoots and seedlings regularly.

4.2.5.2.3 Eliminate the black locust quickly. This is applied in the case of: (1) protection of valuable habitats and their buffer zones (e.g., steppe sites, sandy areas, dwarf oakwood and relict pinewood); (2) risk of windthrow in neglected black locust stands that are decaying and endangering human settlements, transport infrastructure, etc. Black locust stands always have to be destroyed in full, because its light-demanding nature and clonal growth ability would lead to rapid spreading from the undestroyed area. The procedure is based on a combination of mechanical and chemical methods.

4.2.5.3 The black locust is best eradicated using targeted herbicide application into the trunk (see 3.3; tree of heaven eradication, see 4.1.4).

4.2.5.4 Treated individuals have to be left to die spontaneously while standing. Once dead, they are left to disintegrate or removed before than can pose a threat to the surroundings. It is best to wait 1-2 years, until the death of the entire root system is proven. If not possible for safety reasons, the three can be felled, but no sooner than approx. 2 months after treatment (once successful herbicide absorption is established), or the crown can be lightened with an arboricultural intervention. Where this is impossible for safety reasons, another method has to be applied.

4.2.5.5 The best time for targeted herbicide application is in summer (always after full flower) and in early autumn (before the first frost); the highest efficiency is in August and September, when the resprouting ability is significantly eliminated.

4.2.5.6 Other applicable methods include felling to tall stumps with delayed injection (see 3.3.7) and felling to tall stumps with immediate coating of the cut surface with herbicide (see 3.2.6), which should be done ideally in late summer (August-September). Compared to targeted herbicide application into the trunk of an intact tree, these methods are less efficient and lead to resprouting regeneration.

4.2.5.7 From nutrient-poor sites, all the biomass has to be transported away to prevent decaying material enriching the soil with nitrogen. Besides, the felled wood might start forming new shoots. The felled area must not be ploughed, as soil disturbance promotes black locust regeneration. If the biomass is burnt, it must be done where black locusts grow. They are stimulated by fire (root regeneration, seed germination).

4.2.5.8 Herbicide application to leaves can only be recommended in dense and continuous young stands with a maximum height of 4 m and leaf area index around 60-70%. It is effective, but poses a risk of damage to surrounding vegetation, and the resulting clearing is prone to colonization by undesirable species. If conditions permit, the priority is targeted herbicide application, which retains the surrounding vegetation, thus accelerating the biotope recovery. Spraying on leaves is done after the shoots foliate fully in June, and then in September.

4.2.5.9 In management of neglected black locust stands on hard-to-reach sites with a high erosion risk, it is recommended to use the black locust timber to build reinforcing strips along the contour lines and underplanting of species that are relatively more sciophytic than the locust, but still sufficiently light-demanding (e.g, ash, maple, linden). The resistance of black locust timber to decay makes it useful for building a stabilization grid by laying felled trunks crosswise to the slope and anchoring them to stumps, which have a low risk of decaying away. These stabilization interventions are done in winter while the ground is frozen, excluding heavy machinery and minimizing contact of pulling ropes with the surface. At the same time, any regeneration from the timber used is checked.

4.2.5.10 In managed forests with scatted black locust trees, blanket removal must be avoided. Due to the light-demanding nature of the black locust, it has to be replaced with selective cutting, promoting natural restoration by releasing native species. Thinning will gradually prefer younger individuals or groups of target species. Promotion of light-demanding species (Scots pine, birch) is not advisable, as the black locust will not disappear spontaneously in such stands. If black locust felling is chosen, targeted herbicide application must precede (see 4.2.5.3) and the felling may only follow after demonstrable herbicide absorption. It is important to avoid damaging the locust trees; otherwise, rapid regeneration follows.

4.2.5.11 Black locust management requires 3-5 years of follow-up management. On steppe sites, the black locust regeneration is ideally reduced by grazing

sheep and goats. Goats are preferred as the ideal means of long-term follow-up management, as they actively seek for black locust leaves and shoots. Regular grazing once or twice a year also blocks expansion of tall grasses and accelerates the return of native communities.

4.2.6 Trees in the category **box elder** *(Acer negundo)*, **green ash** *(Fraxinus pennsylvanica),* **Canadian poplar** *(Populus ×canadensis),* **myrobalan plum** *(Prunus cerasifera)* and **black cherry** *(Prunus serotina).*

4.2.6.1 These species have properties similar to those of the tree of heaven and black locust, but are less widespread in the Czech Republic so far. Similar management with a combination of mechanical and chemical methods is recommended for these species. Faster decay of the wood of most of the species avoids the problem of extreme accumulation of dead biomass. Thus, the timber cannot be used for erosion prevention.

4.2.6.2 The box elder is a fast-growing, early-fruiting tree that propagates mostly by seeds. It is not very competitive. It regenerates well after mechanical damage with stump and trunk shoots. An efficient eradication method is a combination of felling and immediate coating of the cut surface with herbicide. Application of herbicide into drilled holes or notches is also very efficient. The advantage is the applicability of these methods virtually throughout the growing season (from April to October). If herbicide cannot be used, the regeneration ability makes it more appropriate to remove the stump using an excavator than to fell or girdle.

4.2.6.3 The box elder invades primarily freshly silted valley bottoms and areas affected by floods. In warmer areas, it overgrows ruderal habitats and penetrates abandoned fields and pastures. Management has to focus on prevention and restriction of planting as part of land reclamation or as an accompanying species during revitalization and in big river alluvial plains, particularly in flood-prone areas.

4.2.6.4 The black cherry is characterized by a high regeneration ability. Besides mechanical-chemical methods, biocontrol is another eradication option. It consists in using the native European fungus *Chondrostereum purpureum*, the spores of which are applied to the stump in the form of a suspension. The regeneration reduction success rate is high. There is a risk of the fungus attacking native species of economically important woody plants, so it is recommended to restrict its use to areas more than 500 m away from orchards. The fungus is abundant in the wild and cannot penetrate through intact bark, meaning that its use is safe.

4.2.7 **Shrubs in the category Chinese wolfberry** *(Lycium barbarum)***, grape woodbine** *(Parthenocissus inserta)* and **common snowberry** *(Symphoricarpos albus)*

4.2.7.1 These species have a good regeneration ability and produce shoots after mechanical management. The Chinese wolfberry is particularly difficult, as it easily spreads via root suckers branch layering, and can produce high amounts of wood very soon. A combination of biomass removal and herbicide application to the cut surface is recommended. Any regenerating shoots should again be treated with herbicide.

4.2.7.2 The management priority is to prevent new planting (especially along linear structures) and reduce its presence in valuable areas.

4.2.8 **Weymouth pine** – *Pinus strobus*

4.2.8.1 The Weymouth pine regenerates very well and oppresses the Scots pine in particular. The fact that it spreads only by seeds is important for management. Removing fruiting trees (about 20 years old) first is crucial.

4.2.8.2 The seeds spread by wind very easily. The gradual eradication over several years proceeds from source populations in the higher parts of slopes, on plateaus, rock outcrops and ridges towards valley populations.

4.2.8.3 The recommended management method is felling the fertile trees using conventional forestry methods (selective or clearcutting, thinning). Depending on the site conditions, individual felled trees can be left on the site or trees can be girdled and left to die while standing.

4.2.8.4 All sprouting seedlings are removed 3-5 years after the felling. Seedlings and young individuals can also be removed later (until they reach fruiting age at approx. 20 years), but removal of taller trees is more costly.

4.2.8.5 Seedlings can be pulled by hand or removed using a string trimmer or saw. When cutting, it is important not to leave any living branches near the ground on the stump (or even an entire whorl). Such remaining branches may grow into new trunks.

4.2.8.6 The site has to be checked for several following years, removing any individuals sprouted later.

4.2.9 **Northern red oak** – *Quercus rubra*

4.2.9.1 Spreads via seeds, has a good regeneration ability and produces copious stump sprouts. Eradication has to combine mechanical and chemical methods. Seedling should be pulled up in biologically valuable open stands.

4.2.9.2 To reduce formation of stump sprouts, targeted herbicide application methods are suitable and most efficient (see 3.3).

4.2.9.3 An efficient eradication method is a combination of felling and immediate coating of the cut surface with herbicide. If herbicide cannot be used, the regeneration ability makes it more appropriate to remove the stump using an excavator than to fell or girdle.

4.3 **Species in categories on the grey and watch lists** currently have relatively little impact on the surroundings and do not spread significantly. If they become more widespread or show significant negative interaction with native species, they have to be reclassified rapidly as species for targeted management.

4.3.1 Maintenance of rural sites (grazing, mowing) is usually sufficient management, which restricts the spreading and impact of these species.

4.3.2 These species can be managed as necessary using the framework applicable to the respective life form (annual species, rhizome species, shrubs, trees, etc.) specified in sections 3 and 4.1–4.2.

4.3.3 The recommended management of grasslands should proceed in accordance with published methodologies (Jongepierová & Poková 2006, Mládek et al. 2006) and standards (SPPK D 02 001 Restoration of grasslands using regional seed mixtures; D 02 003 Grazing, D 02 004 Mowing of Grasslands).

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