

STANDARDS OF NATURE AND LANDSCAPE MANAGEMENT

MANAGEMENT OF
SELECTED TERRESTRIAL
BIOTOPES

RESTORATION OF
GRASSLANDS USING
REGIONAL SEED MIXTURES

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SERIES D

Grünlandrenaturierung mit regionalen Samenmischungen

This standard contains definitions of technical and technological procedures of grassland restoration using regional seed mixtures.

References:

Act No. 219/2003 on the marketing of seed and planting material of cultivated plants and amending certain acts, as amended.

Act No. 114/1992 on nature and landscape protection, as amended.

Decree No. 129/2012 on details of marketing seed and planting material of cultivated plants, as amended.

Decree No. 378/2010 on the designation of a list of cultivated plant species, as amended.

Decree No. 395/1992 implementing some of the provisions of Act No. 114/1992, as amended.

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<http://eagri.cz/public/web/ukzuz/portal/odrudy/ochrana-prav-k-odrudam/>

Standard development:

This Standard was compiled by the Faculty of Science, University of South Bohemia, České Budějovice in 2013–2017.

Second reader institution:

Prof. RNDr. František Krahulec, CSc., Institute of Botany, Czech Academy of Sciences
Ing. Ivan Houdek, DLF-Trifolium Hladké Životice, s.r.o.

Authors:

Ing. Magdalena Ševčíková, RNDr. Ivana Jongepierová, Prof. RNDr. Karel Prach, CSc.

Documentation used for compilation of the Standard is available from the library of the NCA CR.

Standard approved by

RNDr. František Pelc
Director of NCA CR

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1. Standard purpose and content

The Standard “Restoration of grasslands using regional seed mixtures” defines procedures for the preparation of mixtures, acquisition of seed material and restoration methods with the aim of creating near-natural ecosystems and habitats for plants and animals, preserving local genetic resources, and increasing biodiversity and landscape diversity as a whole.

This Standard is primarily intended for applicants for support from landscape funding programs, i.e. contractors, government and municipality workers, non-governmental organisations, farmers, landowners and land tenants.

It deals with the restoration and establishment of grasslands which fulfil non-productive purposes, i.e. whose primary aim is not biomass production.

Composing seed mixtures is a highly professional activity, demanding sufficient knowledge. It is recommended to consult the composition and application of seed mixtures with botanists.

Legal framework

Act No. 114/1992 on nature and landscape protection, as amended, regulates the intentional distribution of alien plant species and their hybrids, specifies the protection of wild plants in general, the protection of protected plant species (referring to Decree No. 395/1992 providing a list according to degree of threat), and further restrictions to collecting seeds and access to donor sites in protected areas.

Act No. 219/2003 and also **Decree No. 129/2012** specify the conditions and procedures for marketing seed mixtures for the protection of the natural environment and their licensing. Approval of these seed mixtures and their marketing must be requested by submitting a Request for authorisation to put into circulation seed mixture designed to protect the natural environment and a Statement of compliance with the requirements of the permit the marketing of seed mixture designed to protect the natural environment to the Central Institute for Supervising and Testing in Agriculture (both forms are mentioned in Decree Appendix 9 – Formats for forms, par. u) and v)).

2. Delimitation of provenance regions in the Czech Republic

2.1 Delimitation of provenance regions

2.1.1 The delimitation of provenance regions, including detailed descriptions, is given in Appendix 1.

2.1.2 Regions of seed origin:

1. Hercynian-Sudetic Mts. and their foothills
2. Elbe Lowlands and adjacent thermophytic hills
3. Pannonian Basin and adjacent thermophytic hills
4. Carpathian Mts. and their foothills

2.2 Guidelines for utilizing seed sources

2.2.1 Within the delimited provenance regions the geographic proximity of habitats of corresponding donor and receptor (target) sites is respected, especially in the case of restoration by means of directly harvested seed mixtures.

2.2.2 In the case of more distant sites at least the approximate altitude of donor and receptor sites is respected.

2.2.3 Seeds from a donor site may be used at receptor sites of similar natural conditions also outside the boundaries of the delimited provenance regions up to a distance of approx. 10 km.

3. Restoration methods

3.1 Spontaneous succession

3.1.1 Sites of up to one hectare in size in the vicinity of a donor grassland are left to spontaneous succession.

3.2 Restoration with seed mixtures

3.2.1 In case fast regrassing is needed but a regional seed mixture is not available, a **commercial grass or grass-clover seed mixture** may be used.

3.2.1.1 The mixtures must only consist of native species (without inter-generic and inter-specific hybrids of grasses and clovers) and Czech cultivars bred without using polyploidisation and (if possible) also without mutagenesis.

3.2.2 **Regional seed mixtures (seed mixtures for the protection of natural environments)** originate from natural habitats in a provenance region, i.e. consist of directly harvested or separately reproduced seeds, and are used to establish or restore a grassland of a corresponding type of community in the same provenance region.

3.2.2.1 Directly harvested and separately cultivated seeds can be combined, if necessary also with suitable grass and clover cultivars (see List of cultivars registered in the State Cultivar Book, accessible at <http://eagri.cz/public/web/ukzuz/portal/odrudy/informace-o-odrudach/odrudyregistrovane-v-cr/seznam-odrud/> → Feed crops, and List of protected cultivars, accessible at <http://eagri.cz/public/web/ukzuz/portal/odrudy/ochrana-prav-k-odrudam/>).

4. Methods of obtaining regional seed mixtures

4.1 Directly harvested seed mixtures

4.1.1 Directly harvested seed mixtures are obtained from a seminatural species-rich grassland receptor site (see regulation in Act No. 219/2003, §12b, par. 1).

4.1.2 According to harvesting method this may be green hay harvesting, on-site threshing, seed stripping (or vacuum harvesting) and collecting seed-rich chaff.

4.1.3 The **harvest time** at a receptor site is determined by the phenology of the target grassland species.

4.1.4 The first cut is used to obtain seeds of grasses. Seeds of herbs need a later first cut or can be obtained from a second cut.

4.1.5 In order to get a species-rich seed mixture, harvesting is carried out several times per season in different parts of the sward.

4.2 Methods of direct seed mixture harvesting

4.2.1 Green hay harvesting

4.2.1.1 The donor grassland is mown in a term optimal to obtain ripe seeds of the target species.

4.2.1.2 Large and flat areas are mown with tractors equipped with a cutter bar or rotary mower. The green hay is loaded and transported with a loader wagon or a tractor-pulled trailer.

4.2.1.3 Small, steep or shrub-invaded areas are cut with a mowing machine or by hand. The biomass is raked manually, loaded onto a trailer and removed from the site.

4.2.1.4 The green hay is transferred immediately after harvesting (the same day) to the receptor site and spread out.

4.2.2 On-site threshing

4.2.2.1 The donor grassland is mown in a term optimal to obtain ripe seeds of the target species.

4.2.2.2 A combine-harvester or small plot combine is used.

4.2.2.3 In dense vegetation the cutting height for harvesting is set to more than 30 cm in order to reduce the quantity of biomass, which can block the machine.

4.2.2.4 The cylinder should be set leaving a small gap between the rasp bars and the concave,

and the air flow is minimised to prevent small seeds from being blown away.

4.2.2.5 The mesh size should be set to allow most seed to pass through, while keeping most stems and leaves out.

4.2.3 Seed stripping

4.2.3.1 The donor grassland is mown in a term optimal to obtain ripe seeds of the target species.

4.2.3.2 As a harvester, a pull-type (with adjustable brush height), hand-held type or front-end loader type is used.

4.2.3.3 This method allows for another one or two harvests of the same sward, which continues growing.

4.2.4 Vacuum harvesting

4.2.4.1 For harvesting in small plots or harvesting selected target plant species, light hand-held devices are used in a term optimal to obtain ripe seeds.

4.2.4.2 In large plots a heavier tractor-mounted model is used.

4.2.5 Seed-rich chaff

4.2.5.1 This method can be used in case the hay is stored in barns.

4.2.5.2 In spring the accumulated mixture of seeds and leaf and stem fragments is salvaged from the floor. It is sown in the same season.

4.2.5.3 For later use it must be stored in a dry and cool place.

4.3 Mixtures from separately reproduced seeds

4.3.1 Individual species are collected by hand at donor sites and reproduced separately in seedbeds by means of common agricultural techniques according to Act No. 219/2003.

4.3.2 After harvesting of the seedbeds, the seeds are mixed to create a mixture typical of the habitat type of the receptor site (or the provenance region).

4.3.3 Seeds of particular species may be sown in larger reproduction fields or are used for sowing directly at the site in case small plots are restored.

4.4 Procedure of separate seed reproduction

4.4.1 Manual collection in the field

4.4.1.1 Seeds of target species are collected separately in a term optimal to obtain ripe seeds.

4.4.1.2 The harvesting is carried out by manually stripping inflorescences upwards. For species which do not easily shed their seed, the inflorescence can also be stripped off.

4.4.1.3 Collected seeds are deposited into bags (each species separately), labelled with species name, collection site and date.

4.4.1.4 Harvesting is carried out by collecting seeds at different dates during the season in different parts of the sward in order to include the genetic variability.

4.4.1.5 Immediately after harvesting the seed is laid on paper or put into cloth bags to allow the seeds to dry.

4.4.2 Sowing and precultivation of parent plants

4.4.2.1 If a sufficient amount of collected seeds is available, the seeds are sown directly in rows in a seedbed according to the principles of native seed reproduction for agricultural crops or related species (see Appendices 2 and 3 of Decree No. 129/2012, accessible at <http://eagri.cz/public/web/ukzuz/portal/osivo-a-sadba/legislativa/legislativacr/100598754.html> and <http://eagri.cz/public/web/ukzuz/portal/osivo-a-sadba/legislativa/legislativacr/100598755.html>).

4.4.2.2 In case a small amount of seeds is collected, parent plants are cultivated further to obtain a higher amount of seeds in the next generation.

4.4.2.3 In single-species cultures, each generation is harvested for three years on average. The number of generations is limited to 5 (regulation in Act No. 219/2003, §12b, par. 2, letter e).

4.4.2.4 After this, new original material has to be collected to prevent loss of genetic variability of the species.

4.4.3 Methods of harvesting from seedbeds

4.4.3.1 Almost all grasses, legumes and some herbs are suitable for harvesting with a thresher.

4.4.3.2 Plants of genera able to continue ripening after harvesting are collected in two stages, i.e. the plants are first cut as a whole with a bar mower and then collected and threshed after drying.

4.4.3.3 Plants of genera with a long flowering time and a late ripening time are harvested manually several times per season.

4.4.3.4 Plants of genera dispersed by wind can be aspirated with diverse appliances.

4.4.3.5 Optimal terms to obtain ripe seeds are presented in Jongepierová & Poková 2006.

4.4.3.6 All harvesting methods require further treatment of the seeds after their collection, especially drying, ventilation and cooling.

4.4.3.7 For further use it is necessary to prevent germination of seeds, cleaning, packing and storing the seeds in a cold and dry environment, best of all in air-conditioned storerooms.

4.5 Mixing of seed mixtures

4.5.1 The mixture may consist of (a) seeds from single-species cultures, (b) directly harvested seeds, or (c) a combination of both.

4.5.2 In some cases these mixtures can be combined with suitable cultivars of commercial grasses and legumes.

4.5.3 The ratio of mixture components depends on habitat type and restoration objectives. Generally 70–90% of the mixture consists of grasses and 10–30% of herbs and legumes.

5. Methods of grassland establishment on arable land

5.1 Preparation of receptor sites

5.1.1 Reducing nutrient level by crop production

5.1.1.1 Soils rich in nutrients are left to crop production without fertilisation for 1–2 years.

5.1.2 Reducing nutrient level by ploughing

5.1.2.1 Plots with a high nutrient concentration in the topsoil are ploughed deeply (24–30 cm) to very deeply (over 30 cm) to shift nutrient-poor soil layers to the top.

5.1.3 Site preparation

5.1.3.1 The topsoil is dragged.

5.1.3.2 If necessary, large stones are removed (by collecting and depositing them on heaps outside the receptor site or by loading them directly onto a vehicle).

5.1.3.3 Weeds are controlled mechanically by repeated harrowing.

5.1.3.4 Finally the topsoil is rolled.

5.1.3.5 If combined site preparation equipment (compactors) is available, all agrotechnical work will be carried out in one operation.

5.2 Methods of establishing grasslands on arable land

The choice of a suitable method depends on availability of a diaspora source (donor site) of the desired target community in the surroundings of the receptor site and availability of a regional seed mixture on the market, but also on restoration objectives (restoration of specific plant communities of a high natural value, increase in landscape biodiversity, improvement of the quality of life and opportunities for recreation in the region, preservation of arable land, reduction in water and wind erosion, etc.).

5.2.1 Spontaneous succession

5.2.1.1 After harvest of the crops, the field can be left without management immediately. In case the land is ploughed, it is desirable to drag the topsoil and then leave the field unmanaged.

5.2.1.2 The adjacent seed donor site is mown in a term which allows seed ripening of the target species.

5.2.1.3 Regular mowing of the site with ordinary mowing machines (1–2 times a year) starts in the 3rd to 5th year after abandonment. The biomass is raked and removed from the site.

5.2.2. Direct sowing

5.2.2.1 The seeds obtained with the above-mentioned methods are used for direct sowing except in the case of green hay (see paragraphs 4.2.2, 4.2.3, 4.2.4, 4.2.5 and 4.3).

5.2.2.2 A sufficient **seed rate** is 15–20 kg.ha⁻¹, depending on the amount of pure seed in the seed mixture and its germination. The amount of seed may be increased at extreme sites or in case of an impure seed mixture (e.g. containing chaff).

5.2.2.3 **Sowing terms** are spring or autumn, when soil moisture is sufficient.

5.2.2.4 According to the utilized method, the seeds are surface sown or to a depth of max. 5–10 mm.

5.2.2.5 **Techniques of direct sowing**

5.2.2.5.1 *Manual sowing*

Manual sowing is used in small plots or in areas with no access to vehicles. To secure uniform sowing, additional materials (sawdust or sand at a ratio of 1:1 to 1:3) should be added to the seeds.

The seeds are spread out widely on the soil surface from a seed bowl or another suitable container.

The sowing takes place in two directions perpendicular to each other, in both cases using half the seed mixture.

After sowing, the seeds are worked into the soil by gentle raking and subsequent rolling.

5.2.2.5.2 *Sowing with sowing machines and fertilizer spreaders*

Areas with vehicle access are sown with conventional agricultural sowing machines with runners (for clean, easily spilling seed) or with a brush (for badly spilling seed with a high proportion of awns).

In order to secure an equal seed flow into the seed metering mechanism, the seed is ruffled over the entire length of the container.

Turning off the seed tubes allows the seeds to fall freely out of the container onto the soil surface and prevents sowing in rows and too deeply.

According to foreign sources (Scotton et al. 2012), also fertiliser spreaders can be used for sowing. To make the sowing easier, the volume of sown seeds is increased by adding sand or sawdust (at a ratio of 1:1 to 1:3).

After sowing, the seeds are worked into the soil by rolling (e.g. with a Cambridge roller).

5.2.2.5.3 *Sowing by means of mulch*

This method can be used at sites with increased soil erosion risk. After sowing, the top-soil is covered with a mulch layer (green hay, hay or straw) without seeds of undesirable plant species.

The layer should be max. 2–5 cm deep.

5.2.2.5.4 *Sowing utilising organic biodegradable geotextiles*

Stones are removed from the receptor site, then the topsoil is graded and compacted.

At sites with increased soil erosion risk, after seeding (see paragraphs above) the area is then covered with organic biodegradable geotextiles (jute or coconut mats and nets) and fixed with pegs.

5.2.2.5.5 *Cover crop sowing*

Cover crops (summer cereals such as oats, diploid cultivars of annual *Lolium*, etc.) are sown separately in rows of 20–25 cm wide (especially cereals), rolled with a Cambridge roller and then the regional seed mixture is surface sown, or the cover crop (especially annual *Lolium*) is surface sown together with the regional seed mixture, then worked into the soil by harrowing and rolling with a Cambridge roller.

The amount of cover crop seeds must be low, about 60–80 kg.ha⁻¹ for cereals, 5–7 kg.ha⁻¹ for annual *Lolium*.

If the cover crop sward is dense, it is generally cut after 8–12 weeks. Sparse cover crop vegetation can be left without further maintenance.

5.2.3 Use of green hay

5.2.3.1 Harvested green hay (see par. 4.2.1) is transferred immediately after cutting to the receptor site, where it is spread out and left to dry.

5.2.3.2 At small sites, the hay can be spread manually.

5.2.3.3 At larger sites, mechanical spreading with a self-loading trailer, hay tedder or manure spreader is used.

5.2.3.4 Fine material should be spread in shallow layers (to avoid rotting), rough material can be spread in thicker layers.

5.2.3.5 In areas with increased soil erosion risk or areas susceptible to drought the amount of hay applied is 1–2 kg.m⁻² (5–10 cm thick), at level sites and in areas not endangered by erosion 0.5–1 kg.m⁻² (3–5 cm thick).

5.2.3.6 The ratio of donor site to receptor site size varies from 1:2 (vegetation with high biomass production and high seed content) to 8:1 (low vegetation of dry grasslands), depending on type of vegetation, biomass production, and amount of seed in the time of harvesting.

6. Methods of restoring degraded grasslands

6.1 Species-poor grasslands with satisfactory species composition

6.1.1 Preparation of sites for grassland regeneration

6.1.1.1 Restoration is carried out without ploughing.

6.1.1.2 The sward is cut to a height of 3–5 cm; the biomass is removed.

6.1.1.3 If a considerable amount of litter or moss is present, the sward is harrowed, best by means of a tine harrow.

6.1.1.4 After that, the entire soil surface and the sward are disturbed by shallow harrowing.

6.1.2 Oversowing

6.1.2.1 The seed is surface sown with an ordinary sowing machine or special oversowing devices; also a fertilizer spreader may be used.

6.1.2.2 In case of dry weather rolling is best performed with a Cambridge roller or a grooved roller tandem. If only smooth rollers are available, the soil is harrowed with a light harrow before rolling.

6.1.2.3 Small areas can be sown manually.

6.1.2.4 The amount of seed to be used is 5–10 kg.ha⁻¹ of the grass-herb mixture, 1–2 kg.ha⁻¹ (seed volume increased) when sowing only herbs.

6.1.2.5 The sowing term is early spring or the end of summer.

6.2 Species-poor grasslands with unsatisfactory species/cultivar composition

6.2.1 These grasslands are regenerated radically.

6.2.2 The present turf is disturbed with a disc harrow and ploughed. Subsequently the new grassland is established in the same year or in spring the following year.

6.2.3 Exceptionally (occurrence of persistent weeds, invasive or expansive species) a non-selective glyphosate-based herbicide may be used locally or at the entire site.

6.2.4 Site preparation is identical to that described in par. 5.1.3.

7. Management after sowing

7.1 Management after sowing

7.1.1 The first cut aimed at controlling weeds is carried out 2–3 months after sowing (according to the state of the sward) before full cover of the weeds. In case of autumn sowing the first cut is performed not later than mid-June.

7.1.2 Cutting frequency depends on biomass development of the sward and occurrence of invasive and expansive species (1 to 3 cuts per year).

7.1.3 A cutting height of approximately 10 cm prevents disturbance of the developing target vegetation. A scythe cutter bar or disc mower is used, always well-sharpened.

7.1.4 The cut biomass is raked and removed from the site.

7.1.5 The third year after sowing, common grassland management is applied (see Standard 02 003 01 Grassland management – Grazing, and Standard 02 003 02 Grassland management - Mowing).

Appendix 1 Delimitation of provenance regions in the Czech Republic

Delimitation method

The delimitation respects the boundaries of phytogeographical regions (exceptionally subregions) according to Skalický (1988). These regions are in Skalický's overview arranged according to three basic units: (a) Oreophyticum, including mountains and some highlands; (b) Thermophyticum, including thermophytic lowlands and hills, and (c) Mesophyticum, comprising the remainder.

The delimitation in this Standard respects mostly the delimitation of the Thermophyticum (completed with some adjacent hills included into the Mesophyticum by Skalický). The Oreophyticum and Mesophyticum are not differentiated here, since grassland restoration, especially on arable land, is not expected to be very frequent in the mountains. If a mixture from the foothills is used in the mountains, the proper species will probably be selected due to the more extreme climate. Moreover in the past, seed must have been transferred (intentionally or unintendedly) between foothills and the mountains.

A part of the Czech Republic comprising mountains and their foothills was further divided into the Hercynian-Sudetic and Carpathian regions, which is in accordance with the geological and geomorphological division of the country. The grassland vegetation of these two regions differs significantly. Similarly, the thermophytic lowlands and adjacent hills of the Elbe Lowlands have been separated from the Pannonian lowlands and thermophytic hills in Moravia, which are directly connected with the Pannonian Basin (viz Chytrý 2010).

Characteristics of provenance regions

1. Hercynian-Sudetic Mts. and their foothills. Also hilly areas belong here, such as the Bohemian-Moravian Highlands, and some hills with a cooler climate. Grassland vegetation consists mainly of mesic (mostly *Arrhenatherion*, but *Polygono-Trisetion* at nutrient-rich sites in higher altitudes, *Violion caninae* at nutrient-poor sites) and wet meadows (*Alopecurion* in floodplains, *Molinion* at intermittently wet sites, *Caricion fuscae* at nutrient-poor, permanently wet soils, *Caricion gracilis* at permanently wet, nutrient-richer soils). These are usually species-poor grasslands with suboceanic or perialpine species in the western and southern part of the area. Some Carpathian elements occur mainly in the foothills of the Giant Mts. (Krkonoše), Eagle Mts. (Orlické hory) and especially the southern part of the Jeseník Mts. foothills. Dry meadows are very rare here and rather species-poor (*Koelerio-Phleion phleoidis*).
2. Elbe Lowlands and adjacent thermophytic hills. The floodplain possesses remnants of *Cnidion venosii* vegetation. Dry meadows of the *Festuco-Brometea* class (*Festucion valesiaceae* and *Bromion*) are mainly characteristic of hills. Mesic meadows, if preserved, are enriched with some xerothermic elements.
3. Pannonian lowlands and adjacent thermophytic hills. This area covers the floodplains of the river Morava, thermophytic hills (some of them strongly thermophytic, such as Pálava), and lower altitudes of the White Carpathian Mts. (Steppe White Carpathians), unique for their species-rich grasslands. The vegetation is similar to that of the previous region, but shows a higher frequency of typical Pannonian, Carpathian or Carpathian-alpine species.
4. Carpathian Mts. and their foothills. This area comprises the Outer Carpathian flysch mountains. The vegetation units are similar to those of the Hercynian-Sudetic Mts., but the occurrence of Carpathian elements and absence of subatlantic species is characteristic of the grasslands.

The delimitation of these regions should not be taken too dogmatically. It is rather a guidance for the acquisition of suitable seeds and their utilization.

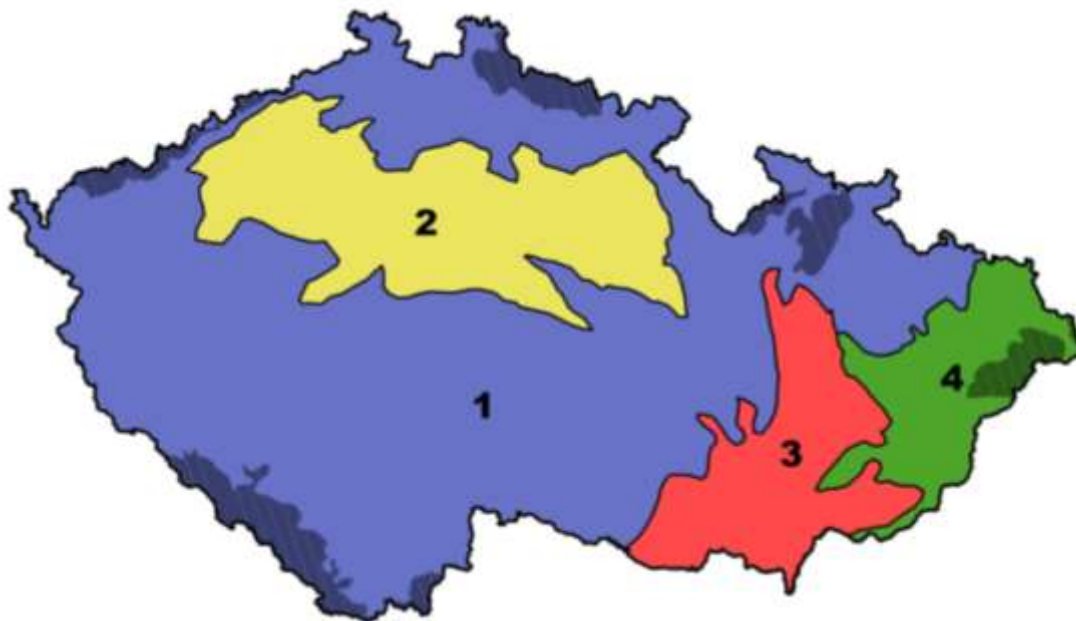


Fig. 1. Provenance regions in the Czech Republic.

**Appendix 2 List of processed Standards of nature and landscape management (Series D
-Management of selected terrestrial ecosystems)**

00 General

00 001 Terminology

02 Technological procedures

02 001 Restoration of grassland communities by using regional mixes

02 002 Restoration of long-term unmanaged grassland communities (including removal of natural seeding woods)

02 003 Management of grassland – Grazing

02 004 Management of grassland – Mowing

02 005 Disturbing management on non-forest areas

02 006 Measures to improve species composition of forest stands

02 007 Removal of selected invasive and expansive plant species (including follow-up site management).

03 Occupational safety and health protection