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GUIDELINES FOR EVALUATION OF SEED (GENETIC) SITES OF MEDICINAL AND AROMATIC PLANTS IN LITHUANIA

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Abstract

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The aim of the study is to discuss and establish tentative guidelines for the original selection and evaluation of genetic sites for *in situ* conservation of medicinal and aromatic plant genetic resources in Lithuania and provide baseline recommendations for their management and monitoring. The methodology applied is largely based on the one used in crop wild relative conservation *in situ*. Three groups of criteria, including species, site and threat assessment, are used on a 5-point evaluation scale to evaluate genetic sites, with '5' representing the highest quality or state and '1' representing the lowest quality or state. Top ten criteria are selected out of more than twenty those discussed for the application in genetic site evaluation. Four of these pertain to target species: species number and cover abundance (20% weight), number of red-listed species (10%), number of cultivated/CWR species (10%), distinctive properties of populations (10%); two to site: area size (5%), protected area status (15%); and four to threat assessment: open site overgrowth with woody plant species (5%), mechanical damage of soil surface (5%), abundance of invasive non-native species (10%) and abundance of problematic native species (10%). Then, a weighted summing up is made to get an overall evaluation of a genetic site. For long-term conservation only sites scored not less than three points on average are recommended. An interpretation of final evaluation scores is also provided. Baseline recommendations for genetic site management focus on intervention measures, while those for monitoring – on periodicity of evaluation and some organizational aspects of implementation.

Keywords: evaluation score, genetic site, habitat, *in situ* conservation, medicinal and aromatic plants (MAP), target species, threat assessment.

INTRODUCTION

There is a growing demand to safeguard natural plant resources worldwide. According to the United Nations estimates, the current world population is 7.7 billion and will reach 10 billion in the year 2056 (Worldometers, 2019). As the population growth is gathering pace, the consumption of food, forage and other economic plant resources increases accordingly. It has been estimated that 60–90% of medicinal and aromatic plants in trade are collected from the wild and that the increase in trade in medicinal and aromatic plants since 1999 is threefold (Jenkins et al., 2018). The Convention on Biological Diversity reaffirms in its Preamble that "States are responsible for conserving their biological diversity and for using their biological resources in a sustainable manner" (UNEP, 1992). The Convention's Aichi Biodiversity Target 13, one out of 20 Strategic Plan's for Biodiversity 2011–2020 targets, states that "By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity" (CBD, 2015).

Lithuania is one of the first countries in Europe, which has adopted the Law on National Plant Genetic Resources. The Article 8 of the Law states that "For the *in situ* conservation of national plant genetic resources, genetic reserves, gene conservation areas, seed collection stands shall be established, or populations, groups or single trees shall be selected" (Seimas..., 2001). To facilitate the implementation of the Article 8, the Regulations for Seed Sites Attributed to the National Plant Genetic Resources have been issued by the Ministry of Environment (Lietuvos..., 2003). The purpose of establishment of seed (genetic) sites, as provided by the Regulations, is a long-term conservation of genetic resources and use of genetic material for breeding purposes, cultivation of medicinal and fruit-berry plants as well as propagation of ornamental and other categories of plantings. Regarding evaluation, the Regulations provide only very basic provisions, common for all plant species, by stating that seed (genetic) sites should be attributed to the national plant genetic resources considering their biological, ecological, genetic and socio-economic value.

According to the Article 4 of the Law on Protected Areas, genetic sites are attributed to the category of restorative protection priority. The Article 4 also states that "Protected areas of the Republic of Lithuania or their parts may, in accordance with the procedure laid down in Article 24^1 of this Law, be included in the Natura 2000 network" (Seimas…, 1993).

The above-mentioned legal acts provide a legal framework for the targeted activities on *in situ* conservation of plant genetic resources. This is a necessary, but insufficient condition for the achievement of the *in situ* conservation goals. The practical steps and decisions related to the evaluation, management and monitoring of the *in situ* sites are to be elaborated and protocoled. There are some guidelines developed for genetic reserve location and design (Dulloo et al., 2008), genetic reserve management (Maxted et al., 2008) and for the conservation and sustainable use of crop wild relatives and wild food plants (FAO, 2017), which provide general overviews of the approaches available and some recommendations. For practical applications, however, more detailed guidelines are needed. Considering that one of the first practical steps is genetic site evaluation, which applies to both the original site selection and the subsequent site monitoring, the development of guidelines for genetic site evaluation is among the highest priorities enabling manageable and effective plant genetic resource conservation *in situ*.

This paper aims to discuss and establish tentative guidelines for the original selection and evaluation of genetic sites for *in situ* conservation of medicinal and aromatic plant genetic resources in Lithuania with some recommendations for their management and monitoring.

Terms and definitions

The following terms and definitions are used in this study:

crop wild relatives (CWR) – wild plant species that are genetically related to cultivated crops (Bioversity International, 2019);

***in situ* conservation of plant genetic resources** – conservation of plant genetic resources in their habitats of origin or creation environment;

invasive plant species – alien (non-native) plant species, rapidly distributing in the country, changing species composition of local plant communities and ecosystem characteristics; list of the invasive species in Lithuania has been approved by the Ministry of Environment of the Republic of Lithuania (Lietuvos…, 2004).

national plant genetic resources – plant genetic resources, which have been selected and included into the Central Database of National Plant Genetic Resources as having ecological, genetic and economic importance for the Republic of Lithuania (Seimas…, 2001);

plant population – the whole number of individuals of a species with the potential to interbreed in a defined geographic region;

seed (genetic) site – a type of protected area established with the purpose of maintenance and sustainable use of natural plant genetic resources; sometimes called plant micro-reserve.

METHODOLOGY

With respect to *in situ* conservation, wild medicinal and aromatic plants (MAP) could be placed into the same category as crop wild relatives (CWR) as both are wild plant species. Therefore, the methodo-

logical approach to the development of the guidelines was largely based on the respective studies of CWR conservation *in situ* (Dulloo et al., 2008; Maxted et al., 2008; Maxted et al., 2013), including quality standards developed for genetic reserve conservation of CWR (Iriondo et al., 2012) and core descriptors for *in situ* conservation of CWR (Thormann et al., 2013). For the identification of habitat type, the Handbook of Inventory of Natural Habitats of EC Importance (Rašomavičius, 2012) is suggested. The Red Data Book of Lithuania (Rašomavičius, 2007) was used for the establishment of species endangerment status at national level. For threat assessment, the classification developed by European Topic Centre on Biological Diversity (Eionet, 2011) was used. Pragmatic approach with authors' own experience on selection and evaluation of genetic sites (Labokas & Karpavičienė, 2018) was employed to develop guidelines suitable for the given geographical context.

There are two basic approaches used in genetic site selection: single species and multiple species. As the multiple-species approach is more common for medicinal and aromatic plants, the current evaluation guidelines focus on that approach. Generally, a five-point scale, with '5' representing the highest quality or state and '1' representing the lowest quality or state, is used to make evaluation easily applicable practically. Then, weighted summing can be applied to get an overall evaluation.

CRITERIA FOR EVALUATION OF GENETIC SITES

Evaluation of genetic sites is a complex endeavour, which comprises three major data levels: species, site and threat assessment. Each of these data levels encompass a set of criteria to be used for genetic site original selection and evaluation. A list of these criteria may look as presented below:

1. Species
1.1. Cover-abundance
1.2. Total number
1.3. Endangerment status according to national criteria
1.4. Cultivated status
1.5. Distinctive properties
2. Site
2.1. Location
2.2. Physical geographical area
2.3. Area (ha)
2.4. Habitat type
2.5. Site protection
3. Threat assessment
3.1. Agriculture
3.2. Forestry
3.3. Mining, extraction of materials and energy production
3.4. Transportation and service corridors
3.5. Urbanization, residential and commercial development
3.6. Biological resource uses other than agriculture & forestry
3.7. Human intrusions and disturbances
3.8. Pollution
3.9. Invasive, other problematic species and genes
3.10. Natural system modifications
3.11. Natural biotic and abiotic processes (without catastrophes)
3.12. Geological events, natural catastrophes
3.13. Climate change

Most of these criteria have several to multiple different values, and not all are equally applied. Therefore, the first step is the determination of their threshold and intermediate values as well as their prioritization for practical application.

SETTING CRITERIA VALUES

1. Species

For the inventory of target species, the list of 135 priority MAP species (Labokas & Karpavičienė, 2018) is taken as the basic reference list. During the inventory, species-by-species estimation of cover abundance on Braun-Blanquet (1964) scale is performed on a site. The mean cover abundance of target species is calculated by dividing the sum of Braun-Blanquet scores by the total number of target species inventoried. Then, by using a simple, empirically developed matrix (Table 1), the site is assigned an evaluation score.

Site evaluation by species endangerment status according to national criteria (for Lithuania see Rašomavičius, 2007) is carried out using the scale presented in Table 2. The highest priority is given to the threatened and near-threatened target species

(Lithuanian Red Data Book categories 1(E), 2(V) and 3(R)). Species cultivation status is meant to identify how many species are cultivated or considered as crop wild relatives (CWR). For this purpose, a similar ranking scale could be used (Table 2) with the reference list of CWR (Labokas et al., 2016).

An important point in genetic conservation is detection of any distinctive (phenotypic, ecotypic) properties of target species populations. These may serve as potential indicators of genetic diversity of the species, while encompassing as much genetic diversity as possible is the main aim of the whole conservation endeavour. For this purpose, the evaluation scale is also developed and presented in Table 2.

Although the species criteria are of utmost importance, site-related criteria also play a significant role and should be considered during the original genetic site selection.

Table 1. Genetic site evaluation by number of target species and their cover abundance

Number of target species	Mean Braun-Blanquet score*	Suitability	Evaluation score
1–5	0.5–1.0	Inadequate	1
	1.1–2.0	Marginal	2
	2.1–3.0	Fair	3
	3.1–4.0	Good	4
	4.1–5.0	Excellent	5
6–10	0.5–1.0	Marginal	2
	1.1–2.0	Fair	3
	2.1–3.0	Good	4
	3.1–4.0	Excellent	5
11–15	0.5–1.0	Fair	3
	1.1–2.0	Good	4
	2.1–3.0	Excellent	5
16–20	0.5–1.0	Good	4
	1.1–2.0	Excellent	5
> 20	0.5–1.0	Excellent	5

*Braun-Blanquet scores of species cover abundance: '+' denotes cover less than 1% with very few individuals (here we treat it as '0.5'); '1' denotes 1–5% cover and many individuals; '2' – cover 5–25%; '3' – cover 25–50%; '4' – cover 50–75%; '5' – cover 75–100%.

2. Site

Site location has a direct relation to the conservation of the resources. It has been observed by Schulze et al. (2018) that the number of reported threats is lower in protected areas with greater remoteness. On the other hand, it has been established globally that protected area networks are biased towards places that are unlikely to face land conversion pressures even in the absence of protection (Joppa & Pfaff, 2009). Nevertheless, a protected area bias in suitability for agriculture or forestry and distance to roads and cities is a very important factor contributing to MAP conservation. Therefore, any remote or hardly accessible site should be identified and, if appropriate, given the highest rating point. In Lithuania, examples of such sites are river or lake islands and peninsulas, border zones, slopes of hills, regularly flooded areas, etc.

There are 22 physical geographical areas identified in Lithuania based on paleogeographical land development (Basalykas, 1965). A general rule could be applied stating that at least five populations should be conserved per area (Dulloo et al., 2008). However, considering that the genetic site area is quite small in Lithuania (7.2 ha on average) (Labokas & Karpavičienė, 2018), a minimum of 10 populations, as suggested by Whitlock et al. (2016), should be more reasonable. The criterion of physical geographical area is important as a proxy indicator of plant genetic diversity (Maxted et al., 1995). Thus, it is considered that the genetic diversity of the species selected for conservation is as big as the number of physical geographical areas represented with that species.

Site area is the criterion, which has a definite effect on long-term conservation. This is related to the

Table 2. Genetic site ranking by species endangerment status according to national criteria, cultivated status and distinctive properties observed in target species populations

Evaluation score	1	2	3	4	5
Number of red-listed species*	0	1	2	3	> 3
Number of cultivated/ CWR species	0	1–3	4–6	7–9	> 9
Distinctive properties	Not observed	Negligible	Observed quantitative	Observed qualitative	Quantitative & qualitative

*Evaluation score is increased by 1 point, when threatened and near threatened target species occur.

Table 3. Distribution of established genetic sites by area

Site area, ha	0.4–1	1.1–10	10.1–20	20.1–30	30.1–40
Number of sites established up to 2019	7	15	3	2	1
Percentage of total	25.0	53.6	10.7	7.1	3.6

Table 4. Genetic site ranking by habitat type and status of protected area of its occurrence

Evaluation score	1	2	3	4	5
Habitat type	Artificial	Artificial to semi-natural	Semi-natural	Natural	Natural, EC importance
Protected area status	Not protected	Municipal protected area	Ecological protection zone	Natura 2000 territory	State park/ reserve

well-known SLOSS (single large or several small) debate contributed significantly by Higgs and Usher (1980). These researchers have found that a number of small reserves have more species than a single large reserve. For the small countries such as Lithuania, this approach is even more appropriate. A successful implementation of small genetic sites, the so-called plant micro-reserves (2–20 ha), has been proven in Spain (Laguna et al., 2004). In Lithuania, the established genetic sites vary by their area from 0.4 to 38.0 ha and can be grouped into five categories of size (Table 3).

Based on this statistical data, we could state that optimal site area is 1.1–10 hectares. Smaller areas could be unsustainable in the long run. Larger areas are acceptable in cases, when genetic site overlaps with the existing protected area or a distinctive part of it (like forest block, peninsula and so on) or are otherwise reasoned pragmatically. Therefore, when evaluating potential genetic sites by area, an area of 0.4 ha should be considered the lowest threshold and applied only in cases, when there are no threats observed from the closest neighbourhoods or a larger buffer zone is established around it. Normally, the lowest threshold should be 1.0 ha. Meanwhile, an area exceeding 40–50 hectares (which is one of the standard forest block sizes) could hardly be justifiable pragmatically, except for the cases mentioned above, and, therefore, could be considered a tentative upper threshold. Thus, all sizes in-between the given range of 1.1–50 hectares should be considered appropriate or close to optimal.

Identification of habitat type allows us to judge on the naturalness of a site, which is highly valued by nature conservationists. One option for habitat identification is by using the Handbook of Inventory of Natural Habitats of EC Importance (Rašomavičius, 2012), which describes 53 types of natural habitats of European Community importance in Lithuania. Nevertheless, for site evaluation by habitat type, we suggest a simplified scale presented in Table 4. In the case, when several habitat types are identified within the same site, a weighted average of scores could be used for site evaluation. For natural and semi-natural habitats, plant communities could be identified and used for site monitoring. For site evaluation by habitat type, the IUCN (2019a) Habitat Classification Scheme could be employed as well.

Site protection is an important criterion largely predefining success of conservation efforts implemented on genetic sites. Based on the functions of different protected areas in Lithuania (State …, 2009), genetic sites could be scored as presented in Table 4. Also, for this kind of evaluation the World Database on Protected Areas (WDPA) (Protected Planet, 2014–2019) can be employed to get internationally comparable definitions such as English Designation, IUCN Management Category, etc.

Species and site criteria are not enough for the effective genetic site selection for long-term conservation as many more conditions affecting site should be evaluated. A general term for those is threat assessment.

3. Threat assessment

There are many potential threats to the *in situ* conservation of MAP genetic resources. The European Topic Centre on Biological Diversity classifies them into thirteen major categories by their origin: agriculture, forestry, mining, extraction of materials and energy production, transportation and service corridors, urbanization, residential and commercial

development, biological resource uses other than agriculture & forestry, human intrusions and disturbances, pollution, invasive, other problematic species and genes, natural system modifications, natural biotic and abiotic processes (without catastrophes), geological events, natural catastrophes) and climate change (Eionet, 2011). On a local (national) scale, not all of these are relevant for genetic site evaluation. For Lithuania, the relevant threats could be abstracted as presented in Table 5.

In the final step, ten major evaluation criteria are selected out of more than twenty those discussed above, and weight percentages assigned each (Table 6) considering the minimum quality standards proposed by Iriondo et al. (2012) for *in situ* conservation of CWR in genetic reserves. Factors affecting the selection of criteria pertain chiefly to threats and include changes in agricultural profile causing extremely reduced practice of haymaking and livestock grazing in natural and semi-natural habitats, particularly on state-owned land, rare cases of critical states of some conditions such as impact of recreational activities, etc. Habitat type is not included among top 10 criteria, because it is a compound one derived from other lower level data. However, it could be successfully used for site evaluation reports as an informative overall indicator.

The overall evaluation of a site, using the criteria presented in Table 6, is obtained as a sum of products of evaluation scores multiplied by their weight percentage. If at least one of the criteria, except for the number of red-listed species, the number of

Table 5. Threat assessment for genetic site evaluation (adapted from Eionet, 2011). Scale interpretation: 1 – worst (non-restorable or unacceptable) condition; 2 – bad (restorable or tolerable) condition; 3 – satisfactory condition; 4 – good condition; 5 – best condition

Score threat	1	2	3	4	5
A. Agriculture:					
mowing	mown too often	not mown	mown every two years	mown annually, irregularly	mown annually after mid-July
grazing	overgrazed	not grazed	grazed occasionally	grazed less than optimally	grazed optimally (1 LU* per ha)
grassland removal for arable land, % area	> 30	21–30	11–20	1–10	< 1
B. Forestry:					
removal of forest undergrowth (as target species), % area	> 60	41–60	21–40	1–20	< 1
forestry clearance, % area	> 30	21–30	11–20	1–10	< 1
forest planting on open ground, % area	> 30	21–30	11–20	1–10	< 1
natural overgrowth with woody species, % area	> 40	31–40	21–30	11–20	≤ 10
mechanical damage of soil surface (e.g. temporary storage sites of wood), % area	> 30	21–30	11–20	1–10	< 1
D. Transportation and service corridors:					
roads**, distance from, m	≤ 70	71–140	141–210	211–280	> 280
G. Human intrusions and disturbances:					
outdoor sports and leisure activities, recreational activities, including trampling, % area constantly affected	> 75	51–75	26–50	11–25	≤ 10
I. Invasive, other problematic species and genes:					
invasive non-native species, % area	> 20	16–20	11–15	6–10	≤ 5
problematic native species, % area	> 40	31–40	21–30	11–20	≤ 10

*LU – livestock unit, as approved by the Ministry of Environment and the Ministry of Agriculture, Republic of Lithuania (Lietuvos …, 2011); one animal (cattle and horses) = 1 LU; one animal (sheep and goats) = 0.07 LU. **Based on the width of protection zone of main roads (category I) as approved by the Government Decree on Special Conditions for Use of Land and Forest (Lietuvos…, 1992). The lower categories of roads are assigned 50, 20 and 10 m protection zones, respectively, railroads – 45 m, with evaluation scores for genetic site location changing accordingly.

Table 6. Summary scoring of genetic sites with top 10 criteria

Criterion \ Score	1	2	3	4	5	Weight, %
Species number and cover abundance*	Inadequate	Marginal	Fair	Good	Excellent	20
Number of red-listed species	0	1	2	3	> 3	10
Number of cultivated/ CWR species	0	1–3	4–6	7–9	> 9	10
Distinctive properties	Not observed	Negligible	Observed quantitative	Observed qualitative	Quantitative & qualitative	10
Site area, ha	< 0.4	0.4–0.5	0.6–1.0	11.1–40	1.1–10	5
Protected area status	Not protected	Municipal protected area	Ecological protection zone	Natura 2000 territory	State park/ reserve	15
Open site overgrowth with woody species, % area	> 40	31–40	21–30	11–20	≤ 10	5
Mechanical damage of soil surface, % area	> 30	21–30	1 20	1–10	< 1	5
Invasive non-native species, % area	> 20	16–20	11–15	6–10	≤ 5	10
Problematic native species, % area	> 40	31–40	21–30	11–20	≤ 10	10

*For explanation of the criterion values see Table 1.

CWR species and protected area status, are scored one point, no further evaluation is carried out and a site is rejected. For long-term conservation, only sites scored not less than three points on average are recommended.

INTERPRETATION OF FINAL EVALUATION SCORES

Information sources for the original site selection include documents, databases and cartographic materials (maps) indicating land use, land ownership, protected area status, habitat type, species distribution, etc. The purpose is to get as much information as possible on the location of potential genetic sites. When potential sites are located, the in-place evaluation is carried out to make a final site selection. The obtained final site evaluation scores could be interpreted as indicated below:

1) Score 1 – inadequate condition – unsuitable/ non-restorable site is stated, when at least one of the following conditions is observed: there are ≤ 5 target species with average Braun-Blanquet score ≤ 1 (see Table 1); > 20% of site area is covered by invasive species or > 40% by nitrophilous (*Anthriscus sylvestris* L.) Hoffm., *Impatiens noli-tangere* L., etc.), ruderal or other problematic native species depending on habitat type (e.g. *Calamagrostis epigejos* (L.) Roth in some natural and semi-natural grassland formations); mechanical damage of soil surface (mineralization) > 30% of area; unfavourable conditions for long-term conservation (predictable land-use change, agricultural or silvicultural activities changing environment, intensive recreational activities, evident threat of woody vegetation to overgrow open habitats, etc.);

2) Score 2 – marginal condition – site is unsuitable only by those indicators, which could be improved, and site could be restored by adding some efforts, e.g. by removing shrubs and trees from open habitats;

3) Score 3 – fair (or satisfactory) condition – site corresponds to the following minimal requirements:

1–5 target species, the average Braun-Blanquet score is 2.1–3.0;

6–10 target species, the average Braun-Blanquet score is 1.1–2.0;

11–15 target species, the average Braun-Blanquet score is 0.5–1.0;

populations are in fair condition, they represent potential genetic diversity (based on ecogeographic analysis); invasive non-native species cover ≤ 20% of the site area; nitrophilous and other problematic

native species cover ≤ 40% of the site area; mechanical damage of soil surface (mineralization) is ≤ 30% of the site area; no other actual or potential threats or disturbances are observed threatening long-term conservation;

4) Score 4 – good condition – quantitative (percentage) indicators are intermediate between those of fair and excellent conditions; qualitative indicators correspond to those of excellent condition;

5) Score 5 – excellent (or very good) site condition is when species inventory results in high proportion of target species compared to the total number and/or cover of native species:

1–5 target species, the average Braun-Blanquet score is 4.1–5.0;

6–10 target species, the average Braun-Blanquet score is 3.1–4.0;

1–15 target species, the average Braun-Blanquet score is 2.1–3.0;

16–20 target species, the average Braun-Blanquet score is 1.1–2.0;

> 20 target species, the average Braun-Blanquet score is 0.5–1.0;

plants are healthy, developing normally, populations represent genetic diversity (based on ecogeographic analysis and/or genetic studies); there are no alien invasive and problematic native species or cover of such species is ≤ 5% and ≤ 10%, respectively; mechanical damage of soil surface (mineralization) amounts to < 1% of the site area; environmental conditions are diverse; site is in a favourable location for long-term conservation (slope, island, peninsula, floodplain, etc.); no external threats are established.

In all cases a special consideration should be taken of rare species and distinctive populations (Table 2), for which pragmatic decisions could be made in each case separately.

RECOMMENDATIONS FOR MANAGEMENT AND MONITORING OF GENETIC SITES

One of the major points of the genetic reserve management plan is management interventions (Maxted et al., 2008). This pertains to the genetic sites as well. It has been acknowledged that climate change facilitates the spread and establishment of many alien species and creates new opportunities for them to become invasive (IUCN, 2019b). The same could be observed with the native expansive species. Therefore, to ensure sustainability of genetic sites, the prevention measures against the invasion of these problematic species should be strictly considered. This means maintaining as natural environment as possible by avoiding any clear cuts, soil surface damages, site trampling, etc. These requirements pertain to a high degree to the closest neighbourhood of the genetic sites. When the undesirable species are observed, the control measures should be applied in as early stages of their occurrence as possible and could consist of physical removal of individuals only. In later stages, eradication of undesirable species may become more complicated and force to search for the most effective method or a combination of different methods, including physical, chemical and biological, depending on species invaded.

Besides, depending on the type of plant communities and species conserved, the following intervention measures are recommended:

1) when target species are herbaceous plants:

a) grass mowing is necessary at least every second year, but not more frequently than twice a year – the best timing is in August, after mature seeds are produced by most of the plant species, breeding season of birds, insects and other animals has ended; the mown grass should be removed from the site;

b) when possible (e.g. site is trample-proof, soil moisture content is not too high), cattle, horse, sheep or goat grazing could be recommended in terms of one livestock unit per hectare (see Table 5 above); preferably, grazing should be maintained on sites, which were established based on species composition formed in a consequence of regular grazing;

c) in some cases, haymaking can be interchanged with grazing, e.g. every second year;

2) when target species are trees and shrubs:

a) for tree stands, selective cuttings by removing the most poorly developed individuals should be carried out in cases when too high density of target species individuals is being observed and when strong within species competition is on;

b) removal or thinning of the other woody plants is being carried out when they are shading or otherwise hindering the growth and fruiting of the target species;

c) protection against wildlife, including game species (elk, deer, beaver, etc.), caused damage (direct or indirect) should be implemented by using individual measures or site fencing.

The recommended intervention measures should be applied pragmatically in each case depending on site conditions and impact of the measure applied.

Protection and management of genetic sites is to be organized by the State Service for Protected Areas under the Ministry of Environment within its remit and in accordance with national conservation strategy.

The main objective of monitoring is detecting changes in certain parameters over time. The objectives may involve providing data for modelling population trends, assessing population size and structure, determination the effects of management actions, etc. (Iriondo et al., 2008).

Repeated evaluations of genetic sites for the purposes of monitoring should be carried out in a sustained way every four years on sites with prevailing herbaceous plant communities and every eight years on sites with forest communities. The monitoring periods can be reduced to two and four years, respectively, if actual or potential threats are detected. Monitoring of genetic sites should be performed by the directorates of state parks and nature reserves, if not decided otherwise by the Ministry of Environment, in accordance with the state monitoring programme.

Genetic sites located outside of protected areas and exhibiting good and excellent results of repeated evaluations can be proposed the status of state genetic reserves as defined by the Law on Protected Areas (Seimas …, 1993). On the contrary, genetic sites, which suffer unsatisfactory and non-restorable conditions due to objective reasons, could be considered for exclusion from the national plant genetic resources information system. In the latter case, new genetic sites of the same major species should be established within the same physical geographical area as substitutes to those excluded.

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REFERENCES

Basalykas A., 1965: Lietuvos TSR fizinė geografija: II. Fiziniai geografiniai rajonai. – Vilnius.

Bioversity International, 2019: Crop wild relatives. [Accessed 01.03.2019].

Braun-Blanquet J., 1964: Pflanzensoziologie. Grundzuge der Vegetation skunde. – Wien–New York.

CBD, 2015: Aichi Biodiversity Targets. CBD Secretariat, Ottawa, Canada. http://www.cbd.int/sp/targets/default.shtml [Accessed 01.03.2019].

Dulloo M.E., Labokas J., Iriondo J.M., Maxted N., Lane A., Laguna E., Jarvis A., Kell S.P., 2008: Genetic reserve location and design. – In: Iriondo J.M., Maxted N., Dulloo M.E. (eds), Conserving Plant Genetic Diversity in Protected Areas: Population Management of Crop Wild Relatives: 23–64. – Wallingford, Oxfordshire.

Eionet. European Topic Centre on Biological Diversity, 2011: Threats, Pressures, Activities (SDF field: 4.3). https://bd.eionet.europa.eu/activities/Natura_2000/Folder_Reference_Portal/Ref_threats_pressures_FINAL_20110330.xls [Accessed 28.02.2019].

FAO, 2017: Voluntary guidelines for the conservation and sustainable use of crop wild relatives and wild food plants. http://www.fao.org/3/i7788en/I7788EN.pdf [Accessed 06.03.2019].

Higgs A.J., Usher M.B., 1980: Should nature reserves be large or small? – Nature, 285: 568–569.

Iriondo J.M., Ford-Lloyd B., De Hond L., Kell S.P., Lefèvre F., Korpelainen H., Lane A., 2008: Plant population monitoring methodologies for the *in situ* genetic conservation of CWR. – In: Iriondo J.M., Maxted N., Dulloo M.E. (eds), Conserving Plant Genetic Diversity in Protected Areas: Population Management of Crop Wild Relatives: 88–123. – Wallingford, Oxfordshire.

Iriondo J.M., Maxted N., Kell S.P., Ford-Lloyd B.V., Lara-Romero C., Labokas J., Magos Brehm J., 2012: Quality standards for genetic reserve conservation of crop wild relatives. – In: Maxted N., Dulloo M.E., Ford-Lloyd B.V., Frese L., Irinodo J.M., Carvalho M.A.A.P. de (eds), Agrobiodiversity Conservation: Securing the Diversity of Crop Wild Relatives and Landraces: 72–77. – Wallingford, Oxfordshire.

IUCN, 2019a: Habitats Classification Scheme

(Version 3.1). https://www.iucnredlist.org/resources/habitat-classification-scheme [Accessed 10.02.2019].

IUCN, 2019b: Issues in brief: Invasive alien species and climate change. https://www.iucn.org/resources/issues-briefs/invasive-alien-species-and-climate-change [Accessed 29.05.2019].

Jenkins M., Timoshyna A., Cornthwaite M., 2018: Wild at home: exploring the global harvest, trade and use of wild plant ingredients. https://www.traffic.org/site/assets/files/7339/wild-at-home.pdf [Accessed 08.03.2019].

Joppa L.N., Pfaff A., 2009: High and far: biases in the location of protected areas. – PLoS ONE, 4(12): e8273. doi:10.1371/journal.pone.0008273.

Labokas J., Karpavičienė B., 2018: Creation of a network of seed sites for *in-situ* conservation of medicinal and aromatic plant genetic resources in Lithuania. – Botanica, 24(1): 87–97. https://doi.org/10.2478/botlit-2018-0008

Labokas J., Karpavičienė B., Rašomavičius V., Gelvonauskis B., 2016: Developing a national crop wild relative *in situ* conservation strategy for Lithuania: creation of a national CWR inventory and its prioritization. – In: Maxted N., Dulloo M.E., Ford-Lloyd B.V. (eds), Enhancing Crop Genepool Use: Capturing Wild Relative and Landrace Diversity for Crop Improvement: 217–230. – Wallingford, Oxfordshire.

Laguna E., Deltoro V.I., Perez-Botella J., Perez-Rovira P., Serra Ll., Olivares A., Fabregat C., 2004: The role of small reserves in plant conservation in a region of high diversity in eastern Spain. – Biological Conservation, 119: 421–426.

Lietuvos Respublikos Aplinkos ministras, 2003: Įsakymas dėl sėklinių sklypų, kurie priskiriami augalų nacionaliniams genetiniams ištekliams, nuostatų patvirtinimo. Valstybės žinios, Nr. 117-5362. Available at https://e-seimas.lrs.lt/rs/legalact/TAD/TAIS.223621/format/ISO_PDF/

Lietuvos Respublikos Aplinkos ministras, 2004: Įsakymas dėl invazinių Lietuvoje rūšių sąrašo patvirtinimo. Valstybės žinios, Nr. 130-4677 (Consolidated Version from 24/12/2016). Available at https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/TAIS.239692/YhDeAynfbm

Lietuvos Respublikos Aplinkos ministras, Lietuvos Respublikos žemės ūkio ministras, 2011: Įsakymas dėl mėšlo ir srutų tvarkymo aplinkosaugos reikalavimų aprašo patvirtinimo. Valstybės žinios, Nr. 118-5583. Available at https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/TAIS.407577

Lietuvos Respublikos Vyriausybė, 1992: Nutarimas dėl specialiųjų žemės ir miško naudojimo sąlygų patvirtinimo. Valstybės žinios, Nr. 22-652 (Consolidated Version from 01/01/2019). Available at https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/TAIS.6655/asr

Maxted N., Iriondo J.M., De Hond L., Dulloo E., Lefevre F., Asdal A., Kell S.P., Guarino L., 2008: Genetic reserve management. – In: Iriondo J.M., Maxted N., Dulloo M.E. (eds), Conserving Plant Genetic Diversity in Protected Areas: Population Management of Crop Wild Relatives: 65–87. – Wallingford, Oxfordshire.

Maxted N., Magos Brehm J., Kell S., 2013: Resource book for preparation of national conservation plans for crop wild relatives and landraces. http://www.fao.org/fileadmin/templates/agphome/documents/PGR/PubPGR/ResourceBook/TEXT_ALL_2511.pdf

Maxted N., van Slageren M.W., Rihan J.R., 1995: Ecogeographic surveys. – In: Guarino L., Ramanatha Rao V., Reid R. (eds.), Collecting Plant Genetic Diversity, Technical Guidelines: 255–285. – Wallingford: CAB International.

Protected Planet, 2014–2019: World Database on Protected Areas. https://protectedplanet.net/c/world-database-on-protected-areas [Accessed 06.05.2019].

Rašomavičius V. (vyr. red.), 2007: Lietuvos raudonoji knyga. – Vilnius.

Rašomavičius V. (red.), 2012: EB svarbos natūralių buveinių inventorizavimo vadovas. – Vilnius.

Schulze K., Knights K., Coad L., Geldmann J., Leverington F., Eassom A., Marr M., Butchart S.H.M., Hockings M., Burgess N.D., 2018: An assessment of threats to terrestrial protected areas. – Conservation Letters, 2018; 11:e12435.

Seimas of the Republic of Lithuania, 2001: Republic of Lithuania Law on National Plant Genetic Resources. https://e-seimas.lrs.lt/portal/legalAct/en/TAD/TAIS.230551 [Accessed 28.02.2019].

Seimas of the Republic of Lithuania, 1993: Republic of Lithuania Law on Protected Areas. 9 November 1993 No I-301 (As last amended on 11 June 2015 – No XII-1784) https://e-seimas.lrs.lt/portal/

legalAct/lt/TAD/cf9f9132b60d11e6a3e9de0fc8d85cd8?jfwid=rivwzvpvg [Accessed 28.02.2019].

State Service for Protected Areas under the Ministry of Environment, 2009: The system of protected areas in Lithuania. http://www.vstt.lt/en/VI/index.php#r/75 [Accessed 14.05.2019].

Thormann I., Alercia A., Dulloo M.E., 2013: Core descriptors for *in si*tu conservation of crop wild relatives v.1. – Bioversity International, Rome. https://www.bioversityinternational.org/e-library/publications/detail/core-descriptors-for-in-situ-conservation-of-crop-wild-relatives-v1/ [Accessed 06.03.2019].

UNEP, 1992: Convention on Biological Diversity. https://www.cbd.int/doc/legal/cbd-en.pdf [Accessed 28.02.2019].

Whitlock W., Hipperson H., Thompson D.B.A., Butlina R.K., Burke T., 2016: Consequences of *in-situ* strategies for the conservation of plant genetic diversity. – Biological Conservation, 203: 134–142.

Worldometers, 2019: World Population Forecast (2020–2050). Dover, Delaware, U.S.A. http://www.worldometers.info/world-population/#table-forecast [Accessed 28.02.2019].

VAISTINIŲ IR AROMATINIŲ AUGALŲ SĖKLINIŲ (GENETINIŲ) SKLYPŲ ĮVERTINIMO LIETUVOJE METODINĖS GAIRĖS

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Santrauka

Darbo tikslas buvo nustatyti gaires pradinei genetinių sklypų, skirtų vaistinių ir aromatinių augalų genetinių išteklių išsaugojimui *in situ*, atrankai ir įvertinimui bei pateikti įvadines jų tvarkymo ir stebėsenos rekomendacijas. Darbe taikoma atitinkamai adaptuota kultūrinių augalų laukinių gentainių išsaugojimo *in situ* metodika. Genetiniai sklypai vertinami pagal tris kriterijų grupes – tikslinės rūšies(-ių), sklypo vietos ir grėsmių įvertinimo – naudojant penkių balų vertinimo skalę, kur ‘5’ atitinka aukščiausią, o ‘1’ – žemiausią kokybę arba būklę. Atrinkta 10 svarbiausių kriterijų, siūlomų naudoti genetinių sklypų įvertinimui. Keturi iš jų susiję su tikslinėmis rūšimis: rūšių skaičius ir individų gausumas-padengimas (svorio koeficientas 20 %), retų rūšių skaičius (10 %), kultūrinių augalų laukinių gentainių rūšių skaičius (10 %), populiacijų išskirtinės savybės (10 %); du – su sklypo vietos apibūdinimu: sklypo plotas (5 %), teritorijos statusas saugomų teritorijų atžvilgiu (15 %); ir keturi – su grėsmių įvertinimu: atviros buveinės apaugimas medžiais ir krūmais (5 %), mechaniniai dirvožemio paviršiaus pažeidimai (5 %), invazinių nevietinių rūšių gausa (10 %) ir probleminių vietinių rūšių gausa (10 %). Apskaičiuojant svertinį įvertinimų pagal aukščiau minėtus kriterijus vidurkį gaunamas bendras genetinio sklypo įvertinimo balas. Ilgalaikiam saugojimui rekomenduojami tik tie sklypai, kurių vidutinis įvertis yra ne mažesnis kaip trys balai. Taip pat pateikiamas galutinio vertinimo balų interpretavimas. Genetinių sklypų tvarkymo rekomendacijose akcentuojamos intervencinės sklypų būklės palaikymo priemonės, o stebėsenos – vertinimo periodiškumas ir kai kurie organizaciniai aspektai.