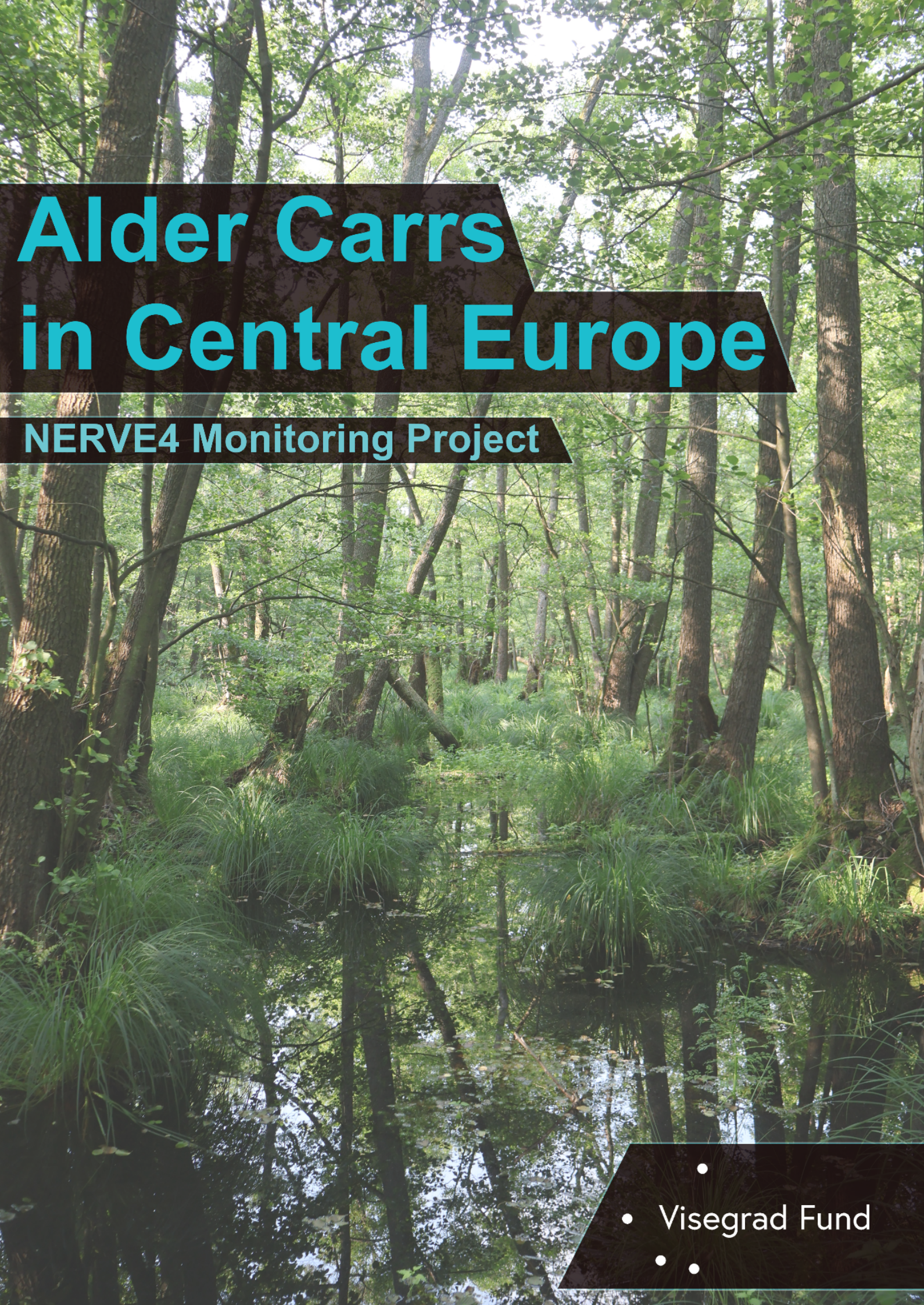


Alder Carrs in Central Europe

NERVE4 Monitoring Project

Visegrad Fund

Alder Carrs in Central Europe

Conservation of swamp wetland forests

Introduction – The Focus of This Book

Wetland ecosystems, significantly impacted by human activities, are among the most vulnerable habitats. Human-induced changes in landscape hydrology and the continuing increase in the frequency of droughts have had a significant impact on the dynamics of wetland vegetation. Swamp forests, at the intersection of land and water, have undergone extensive management throughout European history. Often transformed into wet meadows or degraded due to drainage and eutrophication, they now exist as small wilderness fragments within intensively managed forest and agricultural landscapes, rich in nutrients. Despite their degradation and loss of area, swamp wetland forests remain crucial and fulfil a wide range of ecosystem functions. By providing the only suitable habitat for many endangered regional species of flora and fauna, they play an important role in enriching the regional biodiversity pool. These species are associated with the unique ecological conditions of swamp wetland forests, which represent an ecotone between aquatic and terrestrial environments, as well as an ecotone between treeless vegetation and forest environments. Larger fragments of swamp forests can also contribute to the water quality of the adjacent water body by removing toxic compounds and excess nutrients. In addition, swamp forests have been recognised as 'early warning systems'. They are the first to detect the environmental changes associated with climate change affecting landscape-wide hydrology.

The purpose of this publication is to extend knowledge about variability, distribution, vegetation trends, and conservation issues in Central European wetland swamp forests. We feel that these forests are being overlooked by researchers and conservationists. For researchers, these forests can be a valuable model system for the study of species adaptation to semiaquatic habitats and their response to ongoing climate change. For conservationists, wetland forests can be important remnants of old-growth forest in a human-altered landscape. Most are now left to their fate without any forestry intervention due to waterlogging. This publication focuses primarily on swamp wetland forests, briefly touching upon shrub vegetation and wetland meadows as potential successional stages. We also mention alluvial forests, as they might occur in the same localities and form transitions with wetland forests. There are many more vegetation types, such as reed vegetation, sedge vegetation, and wet meadows, which are rarely mentioned in this book, but they are connected with swamp forests as serial stages in time or spatially in a space, forming a rich mosaic in the landscape. Also, even though many notes from this brochure apply universally, we are limited by our practical experience mainly on conditions in the Czech Republic, Hungary, Poland, and Slovakia, and therefore we are referring mostly to Central Europe.

We think that, especially, but not exclusively, three groups of people may benefit from this brochure. Firstly, as you could expect, any nature conservationist who encounters this type

of environment in any protected area or any impact evaluator in an open landscape. We are discussing threats like changes in the climate or human change in hydrological regimes, protection variations, and management types. The second group that might find this publication useful are ecologists, scientists, and students of the environmental sciences. Apart from conservation, we also bring information from ecology, phytosociology, and various other fields, which might serve as a basic educational source or give you inspiration for your research focus. The third group, for whom this brochure is made, is the general public. We intended to create a handbook for practitioners from the field but also to enlighten the public, because, as we can imagine, many people have limited or no knowledge about forest swamps in Europe, as it is more unusual and not attractive at first glance, and rather know this type of environment from the documentaries abroad. So if you are a more casual reader, you can skip the more specialised parts, focus on the many image additions, and also watch the supplementary video.

Alder *Alnus glutinosa* forest inventory at Černiš (CZ)

Relevance of the habitats

Alder carrs is a term that refers to swamp forests dominated by tree species of the genus Alnus. The black alder (*Alnus glutinosa*) dominates this habitat in central Europe. It is usually an open canopy forest with a high water table, which can fluctuate throughout the season, with a maximum in the winter months. Alder carrs are mostly found in the oxbows of river floodplains, on the banks of lakes and fishponds, or in large terrain depressions. They are rare in the arid lowlands and higher mountain areas. A particular characteristic of the alder stands is an apparent micro-topography of hummocks, sometimes over a metre high, formed by alder roots. These elevated dry sites are surrounded by flooded depressions between

alder trees, known as hollows. Within a few metres of the alder stand, this strong moisture gradient ensures the coexistence of water- and drought-tolerant species.

Alder carrs are often preceded in succession by willow scrubs, where species of the genus *Salix* (e.g., *Salix aurita*, *Salix cinerea,* and *Salix pentandra*) dominate. This shrubby vegetation begins to grow in sedge-grass wetland vegetation after sufficient organic material has accumulated in the littoral zone. Alder carr then replaces the shrubby vegetation. Alder is a relatively short-lived tree; in some cases, an alder can live up to 200 years, but usually they die out at around 100 years. The growing alder stand begins to oxydize the organic sediments, causing waterlogging at the site. When they reach their maximum age, most alders die within a short period of time, creating highly heterogeneous open wetland vegetation with scattered individual alder trees and willow shrubs (a phenomenon known as alder dieback). However, regeneration of the alder forest occurs through vegetative resprouting on the trunk basis of dying trees and generative regeneration of seedlings on fallen trees and hummocks.

Similarly, they may look like alluvial forests, but there are some differences, and managers should not mix them up. Alder carrs are associated with dynamic water levels, but the water there is stagnant or slowly moving. However, alluvial forests are associated with periodic flooding due to their association with rivers, and these floodings can enhance productivity of the soil by nutrients and sediment. That has an impact on the different species compositions. They are periodically flooded during the season, especially in the spring when the snow melts in the mountains. Compared to the alder carrs, the presence of mesophilous trees and herbaceous species is common because the water table is lower for most of the growing season. Montane grey alder forests are formed around higher parts of rivers, usually dominated by grey alder (*Alnus incana*) and sycamore (*Acer pseudoplatanus*). The most common type of alluvial forest is composed by black alder (*Alnus glutinosa*) and ash (*Fraxinus excelsior*) in the canopy and can be found around streams and rivers in the middle parts, while lowland forests can be differentiated into hardwood forests with oak (*Quercus robur*), ash (*Fraxinus excelsior*), and elms (*Ulmus laevis* and *Ulmus minor*), and willow-poplar forests with the willow species (*Salix alba* and *Salix fragilis*) and poplars (*Populus alba* and *Populus nigra*).

According to a recent phytosociological classification, European alder carrs belong to the alliance Alnion glutinosae that is widely distributed across Europe. Five associations are distinguished based on differences in species composition and habitat conditions. The first three are differentiated on the basis of the acidity and nutrient status of the site. The other two are typical for the southeastern Europe and Iberian Peninsula.

1. *Sphagno palustris-Alnetum glutinosae* Lemée 1937 – Oligotrophic peatland carrs characterised by the dominance of *Alnus glutinosa* with an admixture of *Betula pubescens*. This association occurs in lowlands with a humid climate on peaty or gley soils, that are usually not flooded. Water often sinks more than 50 cm below the surface. The appearance of the association is characterised by dominance of *Sphagnum* species, such as *S. fimbriatum*, *S. palustre,* and *S. squarrosum*. Typical is vegetation of oligotrophic and acidic sites characterised by species such as *Carex canescens*, *C. nigra*, *C. rostrata,* and *Comarum palustre*.

2. *Carici elongatae-Alnetum glutinosae* Tüxen 1931 – Mesotrophic carrs with the dominance of *Alnus glutinosa*. It is most common in the humid lowlands of northwestern and Central Europe. Characteristic are swamp species such as *Calamagrostis canescens*, *Carex elata*, *C. elongata* and *Thelypteris palustris*. It occurs on acidic gley, fen, or peaty soils, with the groundwater fluctuating around soil surface. There are often shrubs like *Frangula alnus*, *Ribes nigrum* or *Salix cinerea*. It creates the typical microrelief composed of hummocks and hollows.

3. *Carici ripariae-Alnetum glutinosae* Weisser 1970 – Eutrophic carrs with the dominance of *Alnus glutinosa* commonly found in floodplain depressions along large rivers in lowlands of the European nemoral zone and the Mediterranean basin. They are characterised by the presence of nutrient-demanding species such as *Carex acutiformis*, *C. riparia,* and *Glyceria maxima*.

4. *Leucojo aestivi-Fraxinetum angustifoliae* Glavač 1959 – Swamp forests dominated by *Fraxinus angustifolia*, that represent the transition between alder carrs and floodplain forests occurring along oxbows. They are usually found in lowlands of southeastern Europe, but they were also recorded in Italy and France. Typical species are *Alisma lanceolatum*, *Euphorbia palustris*, *Leucojum aestivum,* and *Sium latifolium*.

5. *Carici lusitanicae-Alnetum glutinosae* Díaz et Prieto 1994 – Alder carrs distributed in the northwestern oceanic part of the Iberian Peninsula. This association is characterised by occurrence of endemic southwestern European species such as *Carex paniculata* subsp. *lusitanica*, *Peucedanum lancifolium,* and *Scrophularia auriculata*.

Flooded alder carr at Šúr (SK)

Current conditions

Czech Republic

Přemysl Král, Jan Douda

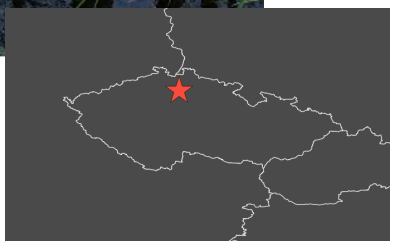
Alder carrs in the Czech Republic covers around 3900 ha, while other alluvial forest habitats covers around 103 000 ha. They are distributed all over the Czech Republic, with the main parts being at pond areas at Třeboň basin, České Budějovice basin, or area around Česká Lípa. We identified 193 habitats of alder carrs that overlap with small-scale protected areas and alder carrs are also part of 21 large-scale protected areas (from 28 in total) based on the spatial analysis of habitat and vegetation mapping in the Czech Republic. The Czech nature conservation legislation distinguishes six types of protected areas with different protection statuses. They are divided into two groups, namely small protected areas (NR - nature reserve, NM - nature monument, NNR - national nature reserve, and NNM national nature monument), and large protected areas (PLA – protected landscape area, and NP – national park). As the name suggests, the main difference is in area size, with PLA (IUCN Category V) and NP (IUCN Category II) often covering a wider range of habitats and often including human settlements. On the contrary, small protected areas (IUCN categories I, III, IV) are more focused on the object of protection and tend to include fewer habitat types, but especially NNM and NNR should be important at the national level. Some of the most important protected areas covered by alder carrs, which also represent their species compositional variability, are presented below. Because of the mosaic structure of landscape and various human management practises, wetland forest habitats are often accompanied by other non-forest habitats like reed and sedge beds, aquatic vegetation, willow carrs or other types of shrub vegetation. In the examples, you will find some of the common problems faced by these habitats, plant and animal species, and the management solutions that have been used.

Alder carr with *Carex elata* and *Phragmites australis* (CZ)

NR Vrbenské rybníky (Černiš)

Protection level: Nature Reserve (IUCN - IV), 1990
Size: 315.7796 ha (alder carr: about 80 ha)
Additional habitats: wet *Cirsium* meadows (1%), intermittently wet *Molinia* meadows (3%), tall-sedge beds (1%), reed beds of eutrophic still waters (5%), mesotrophic vegetation of muddy substrata (<1%), macrophyte vegetation of shallow still waters, fish ponds
Alder carr type (association): *Carici elongatae-Alnetum glutinosae* Tüxen 1931
Plant species: *Alnus glutinosa, Frangula alnus, Salix cinerea, Sorbus aucuparia, Calamagrostis canescens, Calla palustris, Carex elata, C. elongata, C. vesicaria, Cardamine dentata, Deschampsia cespitosa, Dryopteris carthusiana, Dryopteris cristata, Equisetum fluviatile, Galium palustre* agg.*, Glyceria maxima, Hottonia palustris, Iris pseudacorus, Lemna minor, Lycopus europaeus, Lythrum salicaria, Lysimachia thyrsiflora, Molinia caerulea* agg.*, Peucedanum palustre, Phragmites australis, Comarum palustre, Scutellaria galericulata, Solanum dulcamara, Stellaria longifolia, Sparganium erectum, Valeriana dioica*
Animal species: *Dendrocopos, Ficedula albicollist, Muscicapa striata, Oriolus oriolus, Picus viridis, Pragmitiphila nexa*
Status and threats: Alder carr is fully protected (forest management is completely prohibited). It might be the largest alder carr of the association *Carici elongatae-Alnetum* in the Czech Republic. The main problem in the reserve is the eutrophication and expansion of *Phragmites australis* and potentially other nutrient-demanding species. The alarming situation is in the southern part of the alder carr, where the herbaceous layer composed of sedges and Iris pseudacorus has recently been replaced by dense and species poor *Phragmites* vegetation.
Additional interests: It is worth mentioning the importance of alder carr for entomofauna, especially for moth butterflies, which are connected to the typical vegetation of alder carrs. Within 30 years of monitoring, almost 1000 species were recorded, which is about 30% of all Czech butterflies. It is an important habitat not only for wetland forest specialised moth species (e.g., *Archanara dissoluta, Gagitodes sagittatus,* and *Phragmatiphila nexa*), but also for species whose primary habitat is near the alder carr, as they can occasionally use it as shelter. Populations of those species fluctuate in the surrounding landscape, but in alder carr they remain stable.
Additional literature and sources:
Jaroš & Spitzer 2010, Křivan et al. 2014

Flooded Černiš with *Calla palustris* and hummocks of *Carex elata* (CZ)



NNM Rečkov

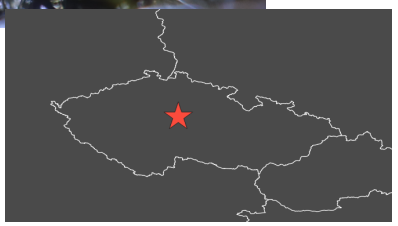
Protection level: National Nature Monument (IUCN - IV), 1949
Size: 24.3588 ha
Additional habitats: fens (<1%), intermittently wet *Molinia* meadows (4.5%), tall-sedge beds (4.6%), water stream (2%)
Alder carr type (association): *Carici elongatae-Alnetum glutinosae* Tüxen 1931 and *Sphagno palustris-Alnetum glutinosae* Lemée 1937
Plant species: *Alnus glutinosa, Alnus incana, Carex acutiformis, C. cespitosa, C. davalliana, C. flava, C. paniculata, Deschampsia cespitosa, Juncus subnodulosus, Ligularia sibirica, Phragmites australis, Solanum dulcamara, Valeriana dioica*
Animal species: *Acrocephalus scirpaceus, Emberzia schoeniclus, Locustella fluviatilis, Lophoma punctatum, Rallus aquaticus, Theridiosma gemmosum, Vertigo moulinsiana*
Status and threats: The locality is permanently waterlogged, but some parts of the alder carrs were drained by the built canal, and therefore vegetation shifted to the ash-alder alluvial forests of *Alnion incanae*, which are undergrown by competitive species indicating eutrophication, such as *Urtica dioica*, *Galium aparine,* and *Rubus fruticosus* agg. The serious threat also poses the spread of invasive *Impatiens glandulifera*. This can be solved by damming the drainage, thus restoring the hydrological regime. The most important habitat-forming factor is the condition of the adjacent water source, so it is important to keep watercourses (Rokytka) in natural condition.

Additional interests: Well-preserved alder carrs are also important from a mycological perspective. During vegetation research it was found overall 15 red list species of fungi, of which two are critically endangered, namely *Resinomycena saccharifera* and *Epithele typhae*, but also other endangered *Lactarius lilacinus, Steccherinum oreophilum, Pluteus hispidulus,* or *Gyrodon lividus*. This site is also important for the occurrence of *Ligularia sibirica*, a plant with a wide Euroasian distribution, that grows rarely in Central Europe as a relic of the glacial and early Holocene landscape.

Additional literature and sources:

AOPK 2021

Scenery look at the alder carr



NNR Libický luh

Protection level: National Nature Reserve (IUCN - IV), 1985

Size: 444.4916 ha

Additional habitats: hardwood forests of lowland rivers (66%), willow-poplar forests of lowland rivers (0.5%), macrophyte vegetation of naturally eutrophic and mesotrophic still waters (2.5%)

Alder carr type (association): *Carici ripariae-Alnetum glutinosae* Weisser 1970

Plant species: *Alnus glutinosa, Frangula alnus, Prunus padus, Caltha palustris, Carex acutiformis, C. riparia, Lemna minor, Lycopus europaeus, Lysimachia vulgaris, Ranunculus lingua, Solanum dulcamara*

Status and threats: The large representative alder carrs are found in the most eastern part of the reserve. The biggest impact on the locality was changes in the flow of the Labe River. The straightening of the channel reduced the periodicity and intensity of flooding, and alder-poplar swamps and floodplain forests in oxbows and depressions were replaced by

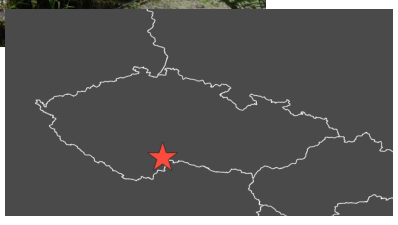
hardwood alluvial forests. Between 2011 and 2013, several ponds were created and restored to support biodiversity. The invasive *Reynoutria japonica* has been significantly reduced by herbicides, but *Impatiens glandulifera* is still a potential danger and should be monitored. A major problem is the uniformity of the forest in terms of age and height structure, which limits the potential biodiversity associated with canopy-open forests. The edge area of the alder carr next to the settlement is threatened by ongoing eutrophication.

Additional interests: Libický luh is one of the largest complexes of alluvial forests in the Czech Republic. The protected area of alluvial forests and alder carrs is characterised by a large amount of dead wood and hollow trees. This creates microhabitats for many species. For example, the monitoring survey found 79 species of saproxylic beetles, 10 of which are on the Red List of the Czech Republic. Hollow trees are important for bird and bat species that use them for nesting. Bat species included 8 species such as *Myotis daubentoniid*. There were 66 species of birds, 10 of which are endangered.

Additional literature and sources:

[ANON] Plán péče o národní přírodní rezervaci Libický luh 2016

NNR Stará a Nová řeka (CZ)



NNR Stará a Nová řeka

Protection level: National Nature Reserve (IUCN - IV), 1956

Size: 812.7797 ha

Additional habitats: hardwood forests of lowland rivers (15%), ash-alder alluvial forests (6%), wet acidophilous oak forests (2%)

Alder carr type (association): *Carici elongatae-Alnetum glutinosae* Tüxen 1931 and *Carici ripariae-Alnetum glutinosae* Weisser 1970

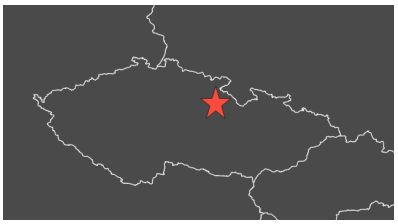
Plant species: *Bidens tripartita, Calamagrostis canescens, Calla palustris, Carex acutiformis, C. elongata, C. riparia, Iris pseudacorus, Lysimachia thyrsiflora, Solanum dulcamara, Thelypteris palustris*
Animal species: *Dicerca alni, Necydalis major, Pycnomerus terebrans*
Status and threats: The water level is influenced by the management of neighboring fishponds and the hydrological situation of the Lužnice River. Currently, the alder carrs are going through the stand-scale alder dieback. The reasons for the synchronised alder dieback are probably a combination of waterlogging of the site after the historical drainage of the site that has lost its function. The age of the alder trees that colonised the site in the first half of the 20th century and also the putative presence of *Phytophthora* disease at the site support the dieback. In many places, alder is successfully regenerated by vegetative resprouting at the base of trees after canopy dieback or generatively on fallen trees and hummocks. The character of the stands is very heterogeneous, formed by open areas with standing water and shaded areas with canopies of young alders and willows. It seems to be a valuable habitat for the biodiversity of invertebrates and vertebrates.
Additional interests: Two water streams flow through the reservation: original river Lužnice (called Stará řeka) and an artificially created canal for regulation of floods (called Nová řeka). The area includes other small canals and fishponds. The river regularly spills into the surrounding habitats, which allow for the invasion of non-native species such as *Impatiens glandulifera* and *Rudbeckia laciniata*.
Additional literature and sources:
AOPK 2022a

NR Olšina u Přeseky

Protection level: Nature Reserve (IUCN - IV), 1994
Size: 6.1456 ha
Additional habitats: Reed beds of still waters (10%), vegetation of muddy substrata (< 1%)
Alder carr type (association): *Carici elongatae-Alnetum glutinosae* Tüxen 1931
Plant species: *Alnus glutinosa, Betula pendula, Frangula alnus, Salix cinerea, Sorbus aucuparia, Calamagrostis canescens, Calla palustris, Caltha palustris, Carex elongata, C. pseudocyperus, Cicuta virosa, Dryopteris carthusiana, Epilobium palustre, Hottonia palustris, Iris pseudacorus, Lemna minor, Lycopus europaeus, Lysimachia thyrsiflora, L. vulgaris, Lythrum salicaria, Peucedanum palustre, Comarum palustre, Ranunculus lingua, Solanum dulcamara, Viola palustris*
Animal species: *Clethrionomys glareolus, Dendrocoptes medius, Ficendula albicollis, Hyla arborea, Lutra lutra, Lyssotriton vulgaris, Pelobates fuscus, Picus canus, Platycis consardi, Rallus aquaticus, Sorex minutus, Suphrodytes dorsalis*
Status and threats: In the second half of the 20th century, the local original mires, with rare species like *Carex chordorrhiza*, *Carex limosa,* or *Scheuchzeria palustris*, were overgrown by alders, and now alder carrs are the main habitats. In the past 20 years, the source lake water level has visibly decreased, because of a damaged dam with water leaks. Finding a solution is problematic because the dam is not in possession of Nature Conservation Agency and the owner does not have financial resources for repair. In relation to that, the water level in alder carrs decreased and in the long term, locality is endangered from drying out. This can lead to a shift from alder carrs to wet oak forests or other habitats. The reserve on the edges is recently been highly invaded by invasive *Impatiens glandulifera,* and somewhere by *Reynoutria japonica*. The lower water level caused easier spreading of

these species and they might occur even in the core of the area. Together with the drying out, fertilisation on surrounding arable fields leads to more mineralization and eutrophication of the soil, which is indicated by the occurrence of *Anthriscus sylvestris, Urtica dioica, Rubus idaeus,* and *Sambucus nigra*. There have also been reported high numbers of wild boar and deer, which can damage the alder saplings, but at the moment they are not a problem so far.
Additional interests: The alder stands are not economically managed for wood, so there are many dead trees and dead wood particles, which can serve as habitats for many species. For example, hollow trees are often used for nesting by the bird species *Picus canus* and *Dendrocoptes medius*.
Additional literature and sources:
AOPK 2022b

Flower of *Lysimachia vulgaris*



NM Na Bahně

Protection level: Nature Monument (IUCN - IV), 1933
Size: 3.3221 ha
Additional habitats: Hercynian oak-hornbeam forests (18%)
Alder carr type (association): *Carici elongatae-Alnetum glutinosae* Tüxen 1931 (historically also *Sphagno palustris-Alnetum glutinosae* Lemée 1937)
Plant species: *Alnus glutinosa, Betula pubescens, Frangula alnus, Prunus padus, Ulmus laevis, U. minor, Angelica sylvestris, Calla palustris, Caltha palustris, Cardamine amara, Carex acuta, C. acutiformis, C. elongata, C. paniculata, C. remota, Chrysosplenium alternifolium, Cirsium palustre, Dryopteris carthusiana, D. dilatata, Equisetum fluviale, Glyceria maxima, Glyceria fluitans, Impatiens noli-tangere, Iris pseudacorus, Juncus effusus,*

Leucojum vernum, Lycopus europaeus, Lysimachia vulgaris, Ranunculus repens, Scirpus sylvaticus, Thelypteris palustris, Valeriana dioica, Valeriana excelsa

Animal species: *Bufo bufo, Columba oenas, Dryocopus martius, Dryocopus martius, Ficedula albicollis, Jynx torquilla, Muscicapa striata, Natrix natrix, Oriolus oriolus, Rana temporaria, Sciurus vulgaris, Zootoca vivipara*

Status and threats: The original purpose of the protection was the presence of an open mire with solitary alders, surrounded by alder carrs with the presence of many endangered species such as *Drosera rotundifolia*, *Epipactis palustris*, *Menyanthes trifoliata*, *Oxycoccus palustris,* or *Comarum palustre*. These species have largely disappeared due to overgrowth by alder and successionally shifted to canopy closed and meso/eutrophic alder carrs even in the central area. The alder carrs are left to spontaneous forest dynamics without any forestry management. There are a few sources of unnatural disturbance that pose a threat to biodiversity. The outer edge of the monument is subject to intensive grazing, which could be a source of eutrophication, supporting the spread of invasive species (e.g. *Reynoutria japonica*).

Additional interests: Phytosociological monitoring has been carried out continuously since 1924. Klimešová et al. (1997) analysed the age structure of *Alnus glutinosa* and *Betula pubescens* using dendrochronological methods to explain the successional dynamics of alder stands. They recorded two peaks in the age structure (50 years and 90 years) of the alder stand. Older trees are those that surrounded the former mire, and younger trees are those that replaced it. Forest dynamics at this site were also studied by Pokorný et al. (2000) using pollen and macrofossil analyses. Their results showed that over the past 1,000 years the alder carr has alternated several times with an open *Carex* mire. The last shift from mire to alder carr is documented from the centre of the site, around 1950.

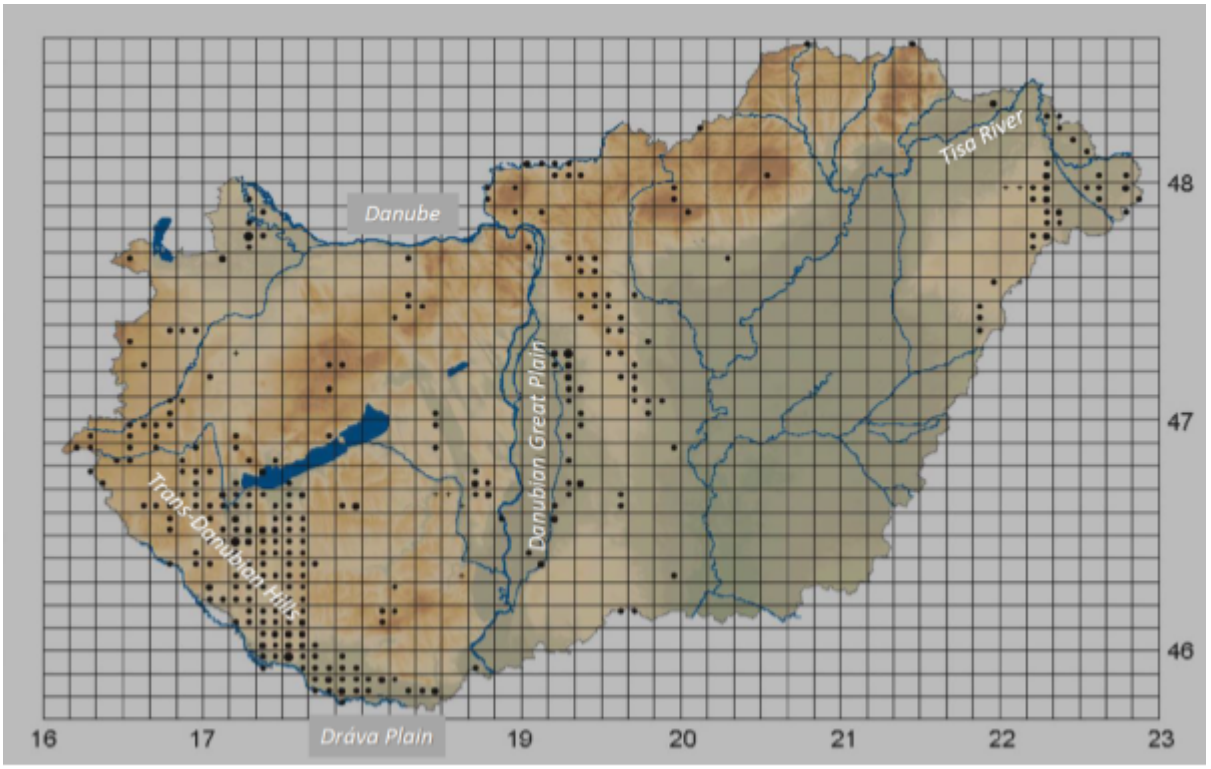
Additional literature and sources:

Klimešová et al. 1997, Pokorný et al. 2000, EKOSFER SOLUTIONS S.R.O. 2021

Hungary

Ferenc Horváth

Alder carrs and ash swamp woodlands in Hungary covers around 3600 ha (national habitat code is ‘J2’ according to Bölöni et al. 2008). These forests are dominated by *Alnus glutinosa* or partly by *Fraxinus angustifolia* subsp. *danubialis* on peat or peaty soils. The habitat is rich in mire species and is usually waterlogged also in the summer. Their water is constantly stagnant, or moving slightly only in rainy periods (marsh forests). Dried-out and drying stands with changed water supply also belong to this broad habitat type. More than half can be found in the Trans-Danubian Hills, but large stands also occur on the Danubian Great Plain, especially on Dráva Plain and Turjánvidék. On the plain of the Tisa River, it is common only in the eastern part.



Distribution map of alder and ash swamp woodland habitats in Hungary (Bölöni et al. 2008). Latitude and longitude degrees are shown at the bottom and side margins, respectively.

The distribution of this habitat refers mostly to hydrologic conditions. But many secondary stands are alder plantations on the sites of sedge communities. Effective conservation of natural or semi-natural habitats requires knowledge of where remnant patches of the natural vegetation occur to what extent and also knowledge of the naturalness and the actual quality of habitats. Fifty percent of the swamp woodland stands were classified as highly natural according to the MÉTA Programme (https://novenyzetiterkep.hu/english). The level and course of the water table are especially important to preserve the good natural state of these habitats. The highest threats are pressure of invasive species (i.e. *Solidago* sp., *Acer negundo*, *Fraxinus pennsylvanica*, *Amorpha fruticosa*) and water drainage.

Alder carr Ócsa with high abundance of *Urtica kioviensis* (HU)

Ócsai Turjános Forest Reserve – Hungarian site

Protection level: strictly protected site of the Ócsa Landscape Protection Area
Size: 70 ha, the most natural part of a 760 ha alluvial swamp forest (N2K habitat code: 91E0)
Additional habitats: riparian mixed forests of *Quercus robur*, *Ulmus laevis* and *U. minor*, *Fraxinus angustifolia* subsp. *danubialis* along the great rivers (91F0); *Molinia* meadows on calcareous, peaty, or clayey-silt-laden soils (6410); alluvial meadows of river valleys of the *Cnidion dubii* (6440) in the vicinity
Alder carr type (association): *Carici ripariae-Alnetum glutinosae* Weisser 1970
Plant species: *Acer negundo* (invasive), *Alnus glutinosa, Frangula alnus, Prunus padus, Arctium lappa, Bidens tripartita, Caltha palustris, Calystegia sepium, Cardamine pratensis, Carex acutiformis, Carex riparia, Dryopteris carthusiana, Galium palustre, Glyceria maxima, Hottonia palustris, Humulus lupulus, Iris pseudacorus, Lycopus europaeus, Lysimachia nummularia, Myosoton aquaticum, Scutellaria galericulata, Solanum dulcamara, Stachys palustris, Urtica kioviensis*
Animal species: *Barbastella barbastellus, Bombina bombina, Bufo bufo, Castro fiber, Ciconia nigra, Emys orbicularis, Hyla arborea, Lutra lutra, Misgurnus fossilis, Rana arvalis, Triturus dobrogicus, Umbra krameri*
Status and threats: Within the Pannonian biographic region, this wetland contains rare and unique natural wetland types – permanent freshwater marshes and swamp forests, and has an important role in maintaining the biological diversity of the Pannonic biogeographic region. In the beginning of the last century, these wetland types were much larger than they are nowadays. Human land use and flood protection have resulted in wetland habitats being drained and swamps, marshes, and bogs having totally disappeared. In the surrounding area, there is high agricultural activity in drained areas. Ócsai Turjános is one of the last remaining bogs, with unique hydrological conditions (rich springs in depressions). The region was drained at the beginning of the 20th century. The water table lowered drastically, so large parts of the alluvial forest dried a lot. Mostly the ash trees regenerated, and invasive tree species appeared. Recently (in the last 20 years), the nature conservation authority has

partly regulated and held back the spring water. The invasive trees were also put under control. As a consequence, the ecological and natural conditions were partly restored. The forest management approach was changed from the previous clear cutting to experimental gap openings to foster a more diverse stand structure.

Additional interests: A unique region, as its preserved habitats were elsewhere excluded and devastated in Hungary due to draining.

Additional literature and sources:

[ANON] Ócsai Turjános – Ramsar Information Sheet 2015, Kun & Rév 2018

High water level at Ócsa alder carr (HU)

Csörnyeberek (Zalakomár)

Protection level: Natura 2000 SAC – Special Areas of Conservation

Size: 2133 ha

Additional habitats: alluvial forests with *Alnus glutinosa* and *Fraxinus angustifolia* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*) (91E0, 11%); riparian mixed forests of *Quercus robur*, *Ulmus laevis* and *U. minor*, *Fraxinus angustifolia*, along the great rivers (91F0, 2%); pannonic woods with *Quercus petraea* and *Carpinus betulus* (91G0, 20%); lowland hay meadows (*Alopecurus pratensis*, *Sanguisorba officinalis*) (6510, 4%)

Alder carr type (association): *Carici ripariae-Alnetum glutinosae* Weisser 1970

Plant species: *Alnus glutinosa*, *Frangula alnus*, *Prunus padus*, *Caltha palustris, Carex acutiformis, C. riparia, Dryopteris carthusiana, Lemna minor, Lycopus europaeus, Lysimachia vulgaris, Ranunculus lingua, Solanum dulcamara, Thelypteris palustris, Urtica kioviensis*

Animal species: *Barbastella barbastellus, Bombina bombina, Cerambyx cerdo, Ciconia nigra, Cucujus cinnaberinus, Emys orbicularis, Eriogaster catax, Haliaeetus albicilla, Lucanus cervus, Lutra lutra, Lycaena dispar rutila, Misgurnus fossilis, Myotis myotis, Pelobates fuscus, Rhysodes sulcatus, Triturus dobrogicus*

Status and threats: Most ash trees have been harmfully impacted by biotic agents in the last 10-15 years

Additional interests: The large size of the site and low human impact make the marshy-woodland unique and it is important breeding site for *Myotis myotis*, *Bombina bombina*, *Haliaeetus albicilla*, *Ciconia nigra* species.

Additional literature and sources:

[Natura 2000 - HUBF20050], Szabó & Rozner (2023)

Flower and damaged leaves of *Solanum dulcamara*

Alder carrs of Baláta-tó

Protection level: Nature Conservation Area (IUCN IV)

Size: cca 20 ha

Additional habitats: alluvial forests with *Alnus glutinosa* and *Fraxinus angustifolia* (*Alno-Padion, Alnion incanae, Salicion albae*) (91E0); riparian mixed forests of *Quercus robur*, *Ulmus laevis* and *U. minor*, *Fraxinus angustifolia*, along the great rivers (91F0); lowland oak-hornbeam woodlands; tall-sedge beds *Caricetum elatae*

Alder carr type (association): *Carici elongatae-Alnetum glutinosae* Tüxen *1931*

Plant species: *Alnus glutinosa, Frangula alnus, Prunus padus, Athyrium filix-femina, Caltha palustris, Carex acutiformis, C. elongata, C. riparia, Dryopteris carthusiana, D. dilatata, D. expansa, Hottonia palustris, Lemna minor, Lycopus europaeus, Lysimachia vulgaris, Solanum dulcamara, Thelypteris palustris, Urtica kioviensis*

Animal species: *Ciconia nigra, Circus aeruginosus, Emys orbicularis, Haliaeetus albicilla, Lissotriton vulgaris, Vipera berus, Lutra lutra*
Status and threats: Well preserved natural *Sphagnum* mire surrounded by alder carrs and willow scrubs with no natural drain. The forest stands around the mire are important to maintain the favourable mesoclimate of the area. Long hot and drought periods threaten the mire to dry out.
Additional interests: There are mire habitats with unique plant species such as *Aldrovanda vesiculosa, Caldesia parnassifolia, Comarum palustre, Urtica kioviensis, Utricularia minor, Dryopteris dilatata, Sphagnum palustre,* and *S. subsecundum*
Additional literature and sources:
Borhidi & Járai-Komlódi 1959, Borhidi et al. 1998

Slovakia

Michal Slezák

Swamp forests of the *Alnion glutinosae* alliance have been documented in more than 200 vegetation plots (phytosociological relevés) distributed from lowland to mountainous areas. They are more frequent at lower altitudes in the southern regions (e.g. Záhorská and Východoslovenská nížina Lowlands) and in the foothills or submontane areas of the Western Carpathians, including the intra-Carpathian basins. Plant community assemblages of alder carrs are naturally adapted to inter- and intra-annual fluctuations in groundwater levels, which control the availability of nutrients. Although most of the recorded stands thrive on meso to eutrophic soils, there are also stands with an affinity to oligotrophic sites. Alder carrs typically occur in landscape depressions, low-lying sites in alluvial zones of rivers, and in littoral zones of water reservoirs.
This vegetation is almost exclusively dominated by *Alnus glutinosa* in the forest overstory, while the shrub layer is composed of species well adapted to permanent waterlogging (e.g. *Frangula alnus*, *Salix cinerea*). The herb layer contains a rich group of wetland graminoids, herbs, and ferns. Typical physiognomy is often determined by the presence of sedges. The moss layer commonly contains generalists of wet habitats.
The main threats are habitat loss, deterioration of hydrological conditions, and human-induced eutrophication. Decline of precipitation and prolonged periods of low groundwater levels due to ongoing climate change and drainage of terrain depressions can accelerate succession towards riparian or more mesic forests. Indeed, drier sites may be subjected to urbanisation, agriculture, and deforestation (or at least changes in tree species composition). Alder carrs tend to form small patches in Slovakia, and therefore, it is important that the well-preserved and relatively larger stands with high ecological value are included in the national network of protected areas (e.g. Šúr). However, there is mounting evidence that conservation interests should also be addressed to adjacent areas because of their close hydrological connectivity. At the same time, it is necessary to raise public and policy-maker awareness of the ecosystem services provided by these wetland habitats.

Alder hummock NERVE4 plot at Šúr (SK)

NNR Šúr

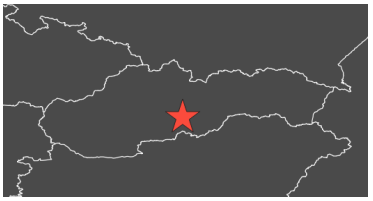
Protection level: National Nature Reserve (IUCN – IV), 1952
Size: 654.959 ha
Additional habitats: wet meadows and reed communities, vegetation of aquatic plants rooted in the bottom and pleustophytes (freshwater habitats of shallow waters and fishponds), minerotrophic mires, sub-halophytic pastures, willow shrubs, thermophilic lowland mixed elm-ash-oak forests
Alder carr type (association): *Carici elongatae-Alnetum glutinosae* Tüxen 1931
Plant species: *Alnus glutinosa, Calamagrostis canescens, Carex elata, C. elongata, C. pseudocyperus, Dryopteris carthusiana, Hottonia palustris, Oenanthe aquatica, Peucedanum palustre, Sium latifolium, Thelypteris palustris, Urtica kioviensis*
Animal species: more than 80 mollusca species and 32 dragonflies
Status and threats: One of the largest and best-preserved black alder swamp forest complexes in Central Europe. This wetland island embedded in an agricultural landscape significantly contributes to the regional species pool, as it hosts many Red List species of vascular plants, numerous species of fauna (amphibians, reptiles, and insects), and is also an important nesting site for birds and bats. Several attempts have been made to drain the area, but almost all of these activities have failed, except for those of 1941–1943. The main threats are associated with changes in the hydrological regime, which could be multiplied by anthropogenic pressures (changes in tree species composition, urbanisation).
Additional interests: The oldest available maps showing these swamp forests date from the middle of the 17th century. The species *Urtica kioviensis* was for the first time collected by J. Bolla in the area of Šúr in 1842. He published this botanical record in 1856 under

the name *Urtica radicans*. However, A. Rogowitsch had validly published this species as *U. kioviensis* a few years earlier, in 1843.

Additional literature and sources:

Bolla 1856, Zemanová 1996, Čejka & Dvořák 2007, Janský & David 2010, Petr et al. 2013

NR Ružinské jelšiny



Protection level: Nature Reserve (IUCN – Ia), 1988

Size: 13.200 ha

Additional habitats: tall-sedge beds

Alder carr type (association): *Carici ripariae-Alnetum glutinosae* Weisser 1970 *(Carici acutiformis-Alnetum glutinosae* Scamoni 1935)

Plant species: *Alnus glutinosa, Carex acutiformis, C. elongata, C. remota, Dryopteris carthusiana, Lysimachia vulgaris, Lythrum salicaria, Scirpus sylvaticus, Solanum dulcamara*

Status and threats: These well-preserved black alder swamp forests are situated in the southern part of central Slovakia. They developed on nutrient-rich and waterlogged sites. Intra- and inter-annual dynamics of the water level support a mosaic structure of the forest understorey. Drier or higher micro-elevated sites and those on the periphery of the area show a higher frequency of forest mesophilous plant species typical for riparian and mesic oak-hornbeam forests. The small area crossed by the electric field line could be the source of alien species in the future, and their potential spread should be monitored.

Additional interests: Two interesting eutrophic black alder swamp forests dominated by tall sedges can be found in the neighbouring area of the water reservoir Ružiná, which is an important nesting site for birds. While the Ružinské jelšiny nature reserve occurs in a low-lying alluvial zone of the Teplica stream, the Príbrežie Ružinej nature reserve occupies the littoral zone of the Ružiná water reservoir.

Additional literature and sources:

Kerestúr et al. 2011, Krištín 1996, Slezák et al. 2011

Bidens frondosa growing from alder fallen trunk

Jelešňa

Protection level: European system of protected areas of Natura 2000
Size: 66.88 ha
Additional habitats: mixed ash-alder alluvial forests of montane areas, bog woodlands, hygrophilous tall-herb fringe communities of the montane levels, vegetation of aquatic plants rooted in the bottom and pleustophytes (freshwater habitats of shallow waters and water bodies), vegetation of wetland herbs on organic muddy sediments, vegetation of exposed bottom, tall-sedge vegetation in littoral zones of meso-eutrophic water bodies, transition mires and bogs, alkaline fens
Alder carr type (association): *Carici elongatae-Alnetum glutinosae* Tüxen 1931
Plant species: *Calla palustris, Caltha palustris, Cardamine amara, Carex elongata, C. vesicaria, Crepis paludosa, Dryopteris carthusiana, Equisetum fluviatile, Glyceria fluitans, Lycopus europaeus, Lysimachia thyrsiflora, Peucedanum palustre, Scirpus sylvaticus, Scutellaria galericulata, Solanum dulcamara*
Animal species: *Bombina variegata, Cottus gobio, Eudontomyzon danfordi, Lissotriton montandoni, Lutra lutra*
Status and threats: These swamp forests grow in landscape depressions and in the estuary of the Jelešňa river in the north-eastern part of the Oravská priehrada water reservoir (northern Slovakia). Although swamp forests are not a widespread habitat in this area, they are characterised by an interesting combination of species with many rare vascular plants. The coexistence of the Red List species *Calla palustris* and *Lysimachia thyrsiflora* in the understorey layer of black alder carrs is extremely rare in Slovakia. The main management effort should be aimed at maintaining the natural hydrological regime

and avoiding deforestation and any activities that could promote eutrophication (e.g. urban and agricultural pollution from surrounding areas).

Additional interests: The first vegetation record of the association *Calletum palustris* in Slovakia was sampled in a low-lying depression with shallow water and deep muddy substrate in an open alder swamp forest of the Jelešňa river. This well-preserved and free-flowing submontane river forms a short natural border between Slovakia and Poland.

Additional literature and sources:

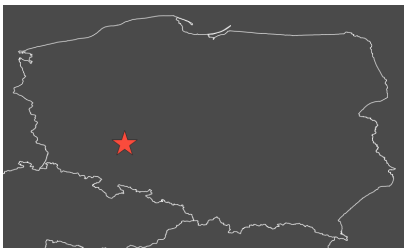
Migra & Mičieta 1995, Trnka & Kopilec 2007, Hrivnák et al. 2011, Slezák & Hrivnák 2012

Poland

Remigiusz Pielech

As Poland is dominated by lowland landscapes, about 90% of the territory of this country constitutes a potential range for wetlands. Alder swamp forests used to be widespread in the Polish lowlands; however, as in other parts of Europe, alder swamps were either converted to grasslands or dried and replaced by forest plantations. Despite that, alder swamps still constitute a typical and frequent element of the country's landscape. Alder swamp forests are also diverse, depending on geographic localisation, environmental conditions, and history. One of the most pristine patches can be found in the Białowieża National Park, the remnant of primaeval European lowland forests. Some large complexes of wetlands related to slowly flowing, medium-sized lowland rivers also share a great contribution of wetland forests, e.g. in the Biebrzański National Park. On the Baltic Sea coast in the Słowiński National Park, one can observe a stunning, contrasting landscape of large sand dunes encroaching wetland alder forests. In the valley of the largest lowland rivers, i.e. the Wisła and Odra Rivers, alder swamps typically occur in former oxbow lakes as a result of long-term vegetation succesion. In areas where extensive natural wetlands were transformed into complexes of fishponds, patches of alder carrs constitute a transition between ponds and surrounding terrestrial environments. Depending on edaphic and water conditions, all three types of Central European alder swamp forest occur in Poland but meso- and euthrophic types are the most common.

Alder carr with high herb cover at Niezgoda (PL)



Olszyny Niezgodzkie

Protection level: Nature Reserve, 1987
Size: 74.28 ha (part of the large alder carr complex covering in total ca. 900 ha)
Additional habitats: reed beds, oak-hornbeam forest
Alder carr type (association): *Carici elongatae-Alnetum glutinosae* Tüxen 1931
Plant species: *Alnus glutinosa, Frangula alnus, Salix cinerea, Sorbus aucuparia, Calamagrostis canescens, Carex elata, C. elongata, C. vesicaria, Cardamine dentata, Deschampsia cespitosa, Dryopteris carthusiana, Equisetum fluviatile, Galium palustre* agg., *Glyceria maxima, Hottonia palustris, Iris pseudacorus, Lemna minor, Lemna trisulca, Lycopus europaeus, Lythrum salicaria, Lysimachia thyrsiflora, L. vulgaris, Peucedanum palustre, Phragmites australis, Scutellaria galericulata, Solanum dulcamara, Stellaria longifolia, Sparganium erectum, Thelypteris palustris*
Status and threats: Strictly protected nature reserve with natural dynamic processes. Extensive black alder dieback started in the reserve about two decades ago and resulted in canopy openings, increase in water table, and periodic domination of reed communities. The reasons for forest dieback are not clear and can be both natural processes, i.e. due to black alder trees reaching over 100 years and being replaced by younger generation, or anthropogenic factors, mainly strong fluctuations of water level due to nearby fishpond management. Recent observations confirm vigorous forest regeneration after dieback and the overall good condition of swamp forests in the nature reserve.
Outside the nature reserve, there is a large complex of alder swamp forests reaching 900 ha. This forest is not protected but is the subject of planned forest management. For prioritising biodiversity protection as well as water resources, extension of the strict protection has been advocated but not implemented so far. The whole region known as “Dolina Baryczy” (the Barycz River valley) is recognised as a biodiversity hotspot and is designated as the Ramsar Site. The current landscape of this area results from the interplay of natural conditions characterised by extensive wetlands and long-lasting human impact and management (the largest complex of carp fishponds in Europe (285 ponds, total area of 77 km2), established in the 13th century by Cysterians). NERVE4 may help with increasing the protected area in this locality.
Additional literature and sources:
Marek 1965, Pender & Anioł-Kwiatkowska 1995, Pielech & Malicki 2018

Summary

Based on our examinations of various alder carr locations and their present conditions, we have identified several recurring threats to their preservation. These sites often face multiple challenges simultaneously, with the impact of one issue exacerbating others. A holistic approach to resolving these issues is therefore crucial. Below, we outline the most commonly identified threats, ranked by their severity.

1. **Drainage and Altered Hydrological Regimes:** The hydrological regime is a critical natural factor for alder carrs, warranting our utmost attention for preservation. Historically, land drainage and modifications to hydrological regimes have been common, particularly in Central Europe during the latter half of the 20th century. Driven by agricultural intensification and uniformity, these actions often disregarded

their ecological impact. Further, river and stream meliorations for flood protection - through stream narrowing, solid bottoms, and flow control - have expedited water flow out of landscapes, reducing floodplain inundation. Today, there's a growing appreciation of these impacts on nature, and the need for a more ecological approach is acknowledged. Restoring the hydrological regime to optimal conditions is possible by blocking or dismantling drainage canals and revitalizing streams.

2. **Eutrophication:** The increase in soil nutrient levels, or eutrophication, poses another significant threat. It often originates from the management of adjacent areas. Over-fertilized agricultural lands, intensively grazed grasslands, and production fishponds can all contribute nutrients to alder carrs. Urban wastewater is also a potential source. Given their typical location in terrain depressions, alder carrs can accumulate these nutrients, facilitating the spread of nitrophilous species (like *Urtica dioica*, *Rubus* sp., *Galium aparine*, and *Phragmites australis*) that outcompete native flora and might hinder alder regeneration.

   To counter eutrophication, sustainable practices in surrounding areas are essential. This includes reasonable and non-transportable forms of fertilization, managed fishpond production, and cleaning of urban wastewater.

3. **Invasive species:** Invasive species such as *Reynoutria japonica* or *Impatiens glandulifera* also pose a threat. These species should be actively managed, either through mechanical removal or the careful application of herbicides.

4. **Habitat Loss and Anthropogenic Pressure:** Forest management must respect the natural tree composition and avoid introducing non-native or atypical species. Historically, wetland forests were often coppiced, which increased species heterogeneity. We can simulate these practices or leave alder carrs undisturbed, depending on conservation goals. Urbanization and conversion to other land uses also contribute to habitat loss.

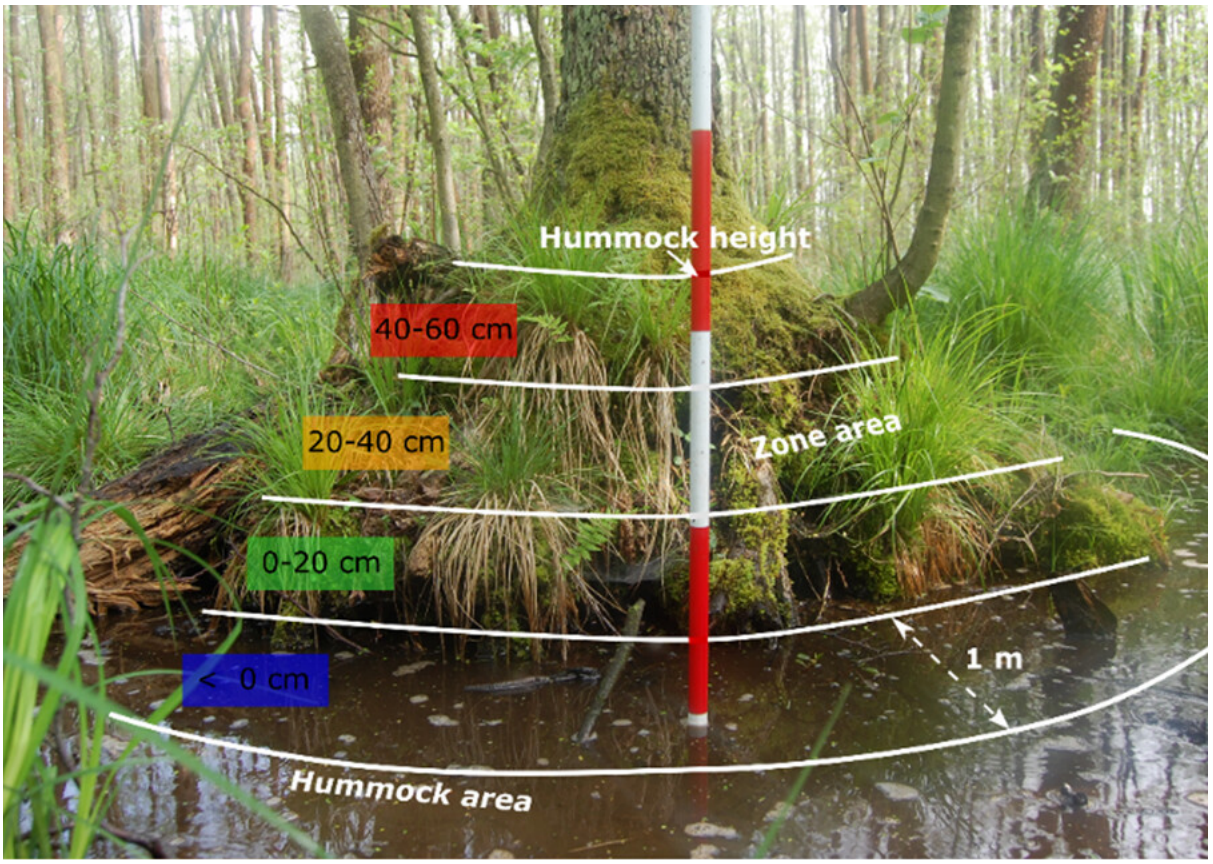
5. **Pressure from Wild Fauna:** The abundance of wildlife, such as deer or wild boars, can impact natural forest regeneration. While not a significant issue for alder carrs, it's a factor worth monitoring.

6. **Pathogenes:** Flowing water can spread the pathogens, namely *Phytophthora alni*, which can have negative impact on the alder stands vitality.

In conclusion, recall the succession path mentioned earlier in this brochure. Alder carrs may transition to other vegetation types over time. To prevent this, maintaining a heterogeneous forest structure with a mix of younger and older stands, a closed canopy, and gaps from fallen alders is important. This overview not only identifies key threats to alder carrs but also suggests practical measures for their mitigation, ensuring their continued ecological importance.

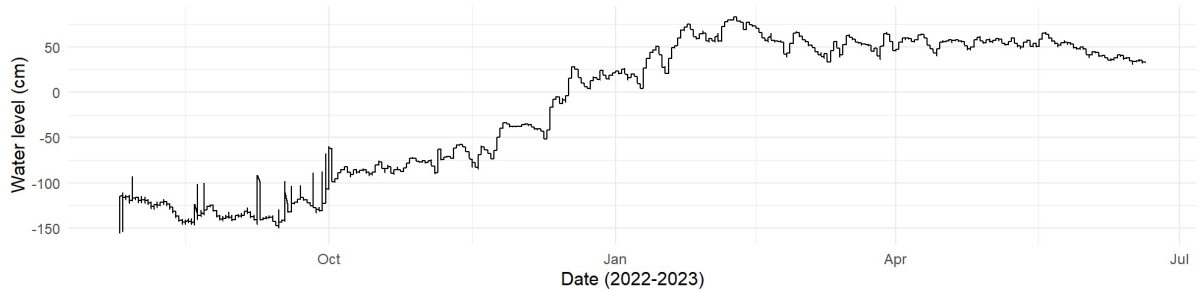
NERVE4 Action

The Network Establishment for V4 Wetland Forest Protection (NERVE4 Action) is an innovative project focused on safeguarding the wetland forests within the Visegrád Four (V4) nations: the Czech Republic, Slovakia, Poland, and Hungary. This initiative was born out of an increasing awareness of the need for wetland forest conservation and the potential threats posed by climate change to these native habitats and species. To this end, NERVE4 Action has worked on monitoring the changes in alder carrs under varying environmental conditions, sharing insights into biodiversity loss, and fostering collaboration in scientific research. Such efforts are crucial for developing informed, effective conservation strategies.



Hummock divided into layers (From Douda 2021)

In each participating country, a specific site has been designated for ongoing environmental monitoring and seasonal vegetation analysis. Our methodology, adapted from Douda (2021), involves the annual sampling of ten randomly selected hummocks at each site. These hummocks are further segmented into zones based on 20 cm intervals, differing in water availability. Additionally, an 8-meter diameter area surrounding each hummock is examined to capture the broader vegetation characteristics of the site. To accurately measure environmental variables, TOMST loggers with protective cages are installed at the top and bottom of each hummock to track humidity, while Solinst Level loggers are employed at each site to continually monitor water levels. Our observations indicate significant interseasonal water level fluctuations. We also gather data on light availability and hummock density. The primary objective is to link species variations with changes in water levels across diverse climatic zones.



Water level fluctuations at Ócsa (HU)

The NERVE4 Action project was launched in June 2022, initially supported by a year and half grant from the Visegrad Fund. Looking ahead, we aspire to extend the project for several more years and potentially expand our research to include other Central European countries. For the most recent updates and information about the project, please visit our website at:
https://plant-ecology-lab-czu.com/nerve4-action-news/.

TOMS-T humidity logger with protective cage at NERVE4 plot

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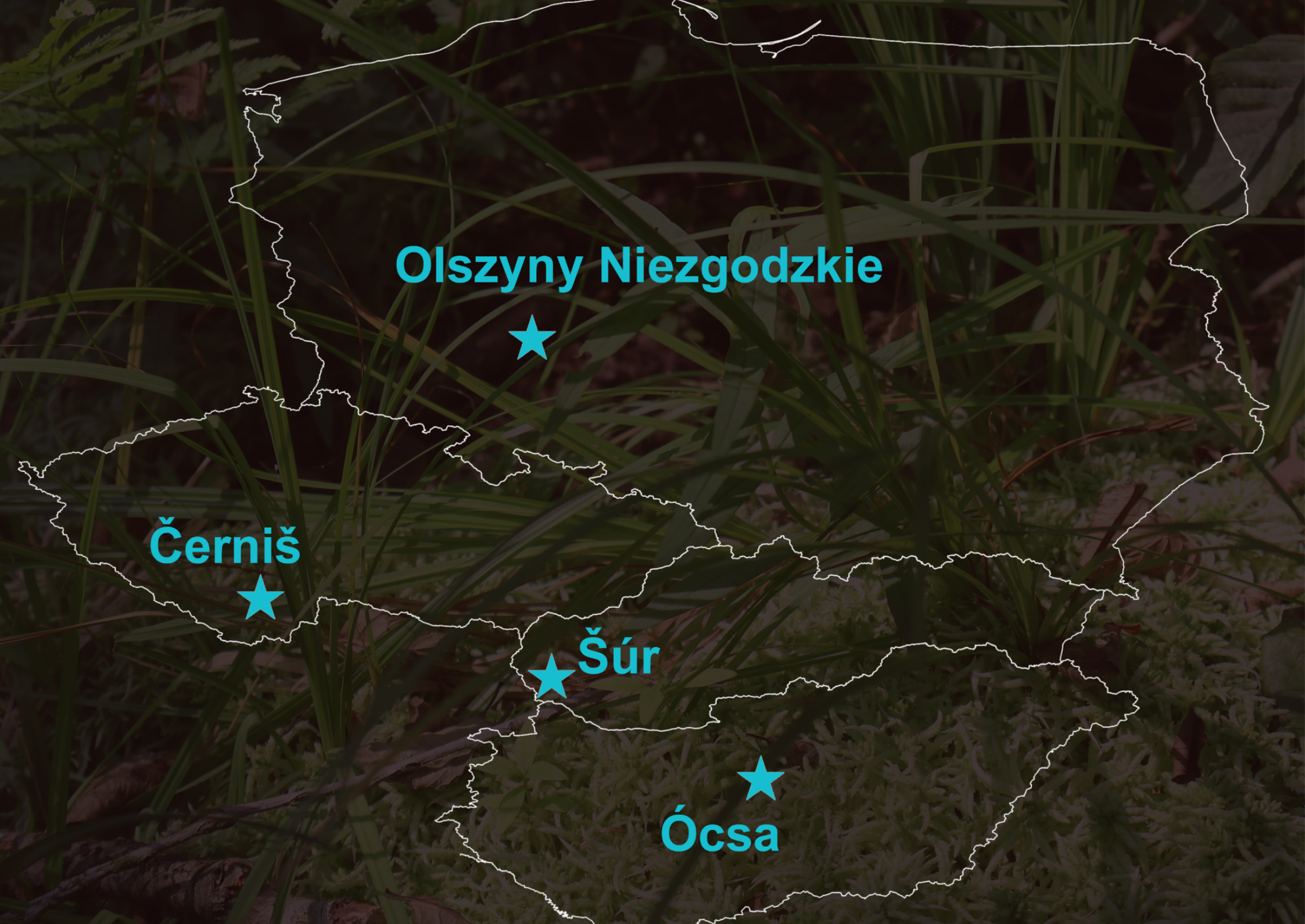
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