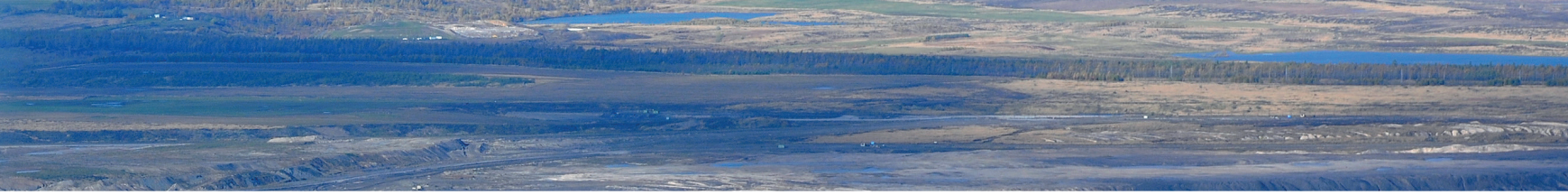

Ochrana přírody

2022 Czech Nature Conservation

Ecological Restoration of Coal Quarries
Jizera Mts. Beech Forest as UNESCO WH

Soil as Biodiversity Hotspot
EU Funds for African Nature

Agreements in Nature Conservation
Invasive Alien Species Monitoring

Summary

Cover photo: Patchwork of habitats on an inner spoil heap of the Vršany quarry in northern Bohemia. © Markéta Hendrychová

Dear friends, dear readers,

You have got another issue of Ochrana přírody/Nature Conservation Journal presenting the selected articles published there in 2021 describing approaches of nature conservation in the Czech Republic, in both national and international contexts.

Allow me to namely highlight four contributions. The first presents an intention to restore extensive abandoned brown coal quarries in northern Bohemia using natural succession; if it is implemented it will provide significant economic and ecological benefits. The second proposes in accordance with the European Green Deal a new system of using the European Union funds for protected area management in Africa to preserve unique biological diversity and ecosystem services/nature's contributions to people there. The third deals with experience of the Nature Conservation Agency of the Czech Republic in using management agreements, having been an important tool in cooperation with landowners and land managers in nature conservation and landscape protection. And last but not least the fourth points out inscription of the Jizerské hory/Jizera Mountains Beech Forest National Nature Reserve on the UNESCO World Heritage List as the very first natural site in the Czech Republic.

On 1 July, 2022 the Czech Republic will take over the six-month Presidency of the Council of the European Union. In environment protection and management, our priority will be supporting implementation of the European Green Deal. We are going to particularly aim at mitigation and adaptation measures to reduce climate change negative impacts and at biological diversity. The context of the ongoing Russian aggression against Ukraine has been to everybody well-known as well as helpful and unequivocal attitude of the EU Members States including our country to Ukraine. It is clear that wars are not a suitable time for implementation of effective environmental policy, but this is not the only reason to believe that the conflict will shortly end justly and fairly in favour of the attacked country. At the same time, the principal geopolitical event obviously affects also implementation of measures agreed during the United Nations Climate Change Conference (UNFCCC COP 26) in Glasgow in the autumn of 2021 or of the above European Green Deal. Nevertheless despite negative aspects of the war in Ukraine European and other countries do not be discouraged from applying further environmental measures. In many cases, synergy among environmental, economic and geopolitical aspects in the current development can be expected; some European Green Deal's visions have been accelerated, e.g. renewable energy source development in the Czech Republic. Rational energy savings through current technologies, wise use of renewable energy sources, and their supplementation by nuclear power shall probably be one of the current crisis outputs.

It definitely is not easy for Ukraine to fight against the dangerous aggressor for freedom and integrity and I am glad that the developed world including the EU Member States did not maroon it or leave it alone. Ukraine has been fighting not only for the territorial integrity and sovereignty, but also for humanity, democracy, freedom and other ideas which the European Union has been built on since its very beginning. I am very pleased and it is encouraging that the Czech Republic plays extraordinary positive role in it.

To conclude, allow me to express my sincere thanks to all professional and amateur nature conservationists in Europe and all over the world for their meaningful, useful and often brave work. Their efforts has been important for our life nowadays – as well as in the future.

Wishing all the best and finally peace for Ukraine

Anna Hubáčková

Minister of the Environment
of the Czech Republic

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NATURE CONSERVATION AGENCY OF THE CZECH REPUBLIC

The Jizerskohorské bučiny / Jizera Mountains Beech Forest National Nature Reserve – A Part of the World Natural Treasury

Jan Plesník, Jiří Hušek & František Pelc

Rare natural monument conservation is not a question of sentimentality, but of a mandatory respect.
Karel Čapek: Beg for Mercy (1928)

It would not be far from the truth to say that in summer 2021 the Jizerské hory/Jizera Mountains Beech Forest National Nature Reserve (NNR) became the most often mentioned Specially Protected Area in mass media in the Czech Republic. In July 2021, the NNR was inscribed on the prestigious UNESCO World Heritage List becoming a new component of the serial World Heritage Site *Ancient and Primeval Beech Forests of the Carpathians and Other Regions of Europe* (Plesník & Hušek 2021). Because in previous articles we have provided only a brief description of the NNR and have paid attention more to its nomination and approval (Plesník & Hušek 2020, Plesník 2020) it is quite appropriate to present the extraordinary site not only from a point of view of nature and landscape heritage protection, conservation and management in more detail.

In July 2021, the Jizerskohorské bučiny/Jizera Mountains Beech Forest has become the very first UNESCO natural World Heritage Site in the Czech Republic. © Zdeněk Patzelt

Not only size but also quality matters

The Jizerské hory/Jizera Mts. Beech Forest National Nature Reserve is located on the northern slopes of the Jizerské hory/Jizera Mts. in the country's northern part (Liberec Region, northern Bohemia), close to the Czech-Polish border (N 50°51'30", E 15°9'20"). Even at first sight it gets out of the traditional model of a single compact protected area surrounded by a buffer zone on the whole perimeter. It in fact consists of six segments covering in total impressive 950.9 hectares. To find why it is we have to go more than sixty years back into the past. In 1960, six State Nature Reserves (SNRs), namely the Oldřichovský Špičák, Poledník, Štolpichy, Frýdlantské cimbuří, Paličník and Tišina SNR, were declared at six sites in a fifteen kilometre long zone of forest growth dominated by the European Beech (*Fagus sylvatica*) ranging from the municipality of Oldřichov v Hájích/Buschullersdorf up to that of Bílý potok pod Smrkem/Weissbach. After re-declaration five years later, the original Oldřichovský Špičák SNR was divided into two smaller ones, namely the Špičák and Stržový vrch SNR. The best preserved beech or spruce-beech forests on steep rocky habitat on the northern Jizerské hory/Jizera Mts. slopes became a part of the Jizerské hory/Jizera Mts. Protected Landscape Area (PLA) established in 1967.

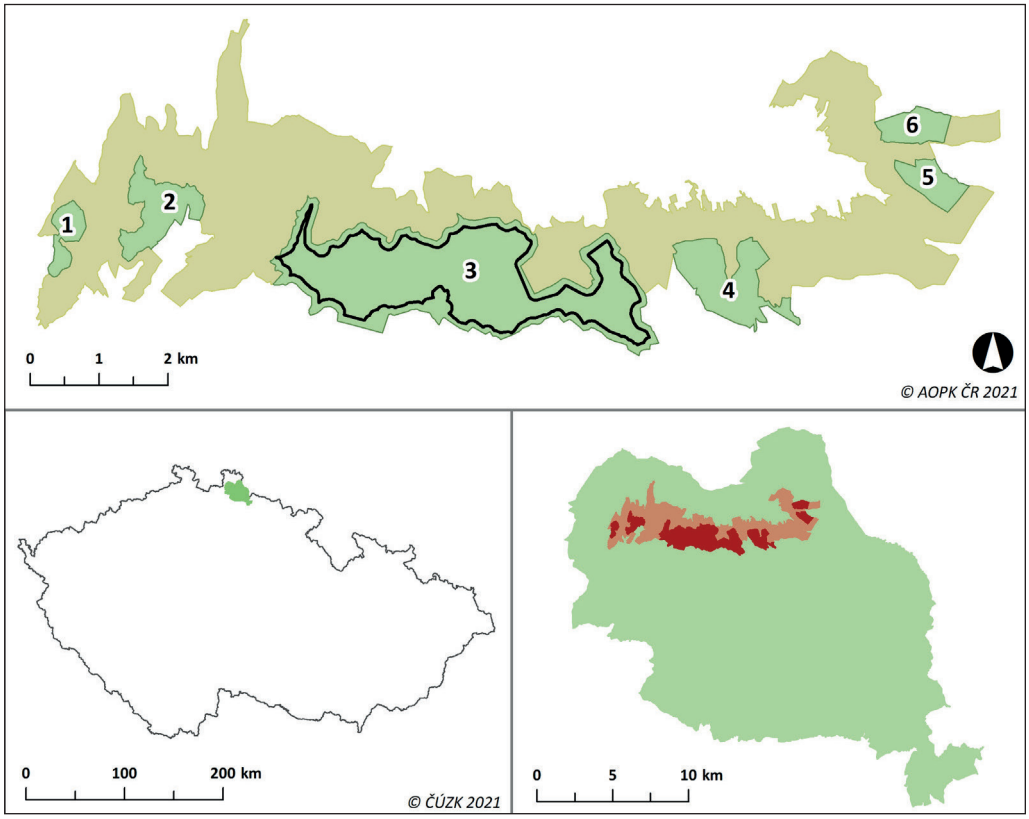
The intention to establish a single National Nature Reserve there was for the first time presented at the conference on the 25th anniversary of the Jizerské hory/Jizera Mts. Protected Landscape Area (Pelc 1992). Globally well-known ecologist and forester Jan Jeník wrote in his peer review: "The proposal for establishing the Jizerskohorské bučiny/Jizera Mts. Beech Forest NNR is based on (i) a topical requirement to preserve a unique complex of broad-leaved deciduous forests in the forest area disastrously damaged by air pollution, particularly acid rains; (ii) a demand at the national scale to maintain a continuous complex of broad-leaved deciduous forests in marginal mountains of the Czech Highlands to keep ecosystems and genetic diversity of the Czech Republic's forests and of the Central European landscape as a whole; (ii) current ecological principles of integrated nature conservation." The robustness of the intent finally enhanced forest quality there but it also was one of the pros during a comprehensive assessment of the natural beech forest site for inscribing it on the UNESCO natural world heritage.

After passing progressive Act No. 114/1992 Gazette on Nature Conservation and Landscape Protection, unequivocal classification of all the seven SNRs as National Nature Reserves had confirmed their at least national importance

View of an extensive beech forest continuing to the northern slopes of the Jizerské hory/Jizera Mountains from Mt. Paličník © František Pelc

Acidophilous, floweing and mountain sycamore beech forests and scree forests cover 94.5% of the the Jizerskohorské bučiny/Jizera Mountains Beech Forest. ©Jiří Hušek

(Pelc *et al.* 1994). The NNR is the most strictly protected category of the Specially Protected Areas in the Czech Republic. In August 1999, long-term effort to maintain the unique ecosystem culminated by declaring the Jizerskohorské bučiny/Jizera Mts. Beech Forest NNR. The individual core areas were sensitively and at the same time functionally nested into an extensive buffer zone spreading on 1,750.4 hectares (see map on page 4). The whole area covering more than 27 km^2 became a part of the PLA's Zone I and at the same time it is one of the most extensive National Nature Reserves in the Czech Republic. It protects the most extensive complex of old-growth forest dominated by beech in Bohemia, in addition developed in unique contours of the mountain landscape with numerous outcrops of the granite bedrock (Vacek *et al.* 1996, 2000). The significance of the Jizerskohorské bučiny/Jizera Mts. Beech Forest was once again emphasized by including it into the well-known European Union's Natura 2000 network, namely as the Site of European Importance (pursuant to Act No. 114/1992 Gazette on Nature Conservation and Landscape Protection, as amended later, the term for Site of Community Importance, SCI under the European Union's Habitats Directive) of



Map of the Jizerskohorské bučiny/Jizera Mountains Beech Forest © Jan Vrba

1 Špičák
2 Stržový vrch
3 Poledník-Štolpichy
4 Frýdlantské cimbuří
5 Paličník
6 Tišina

NPR –NNR
OP NPR – NNR's buffer zone
CHKO – Protected Landscape Area
UNESCO Jizerskohorské bučiny – Jizerskohorské bučiny/Jizera Mts. Beech Forest UNESCO World Heritage Site/property
NPR Jizerskohorské bučiny – Jizerskohorské bučiny/Jizera Mts. Beech Forest NNR
ochranné pásmo NPR – NNR's buffer zone

the same name (CZ0510400) and a part of the Jizerské hory/Jizera Mountains Bird Area CZ11008 (pursuant to the above act, the term for Special Protection Area, SPA under the EU Birds Directive). NNR's unique well-preserved state and naturalness is meaningfully supported by the fact that it is together with the Mt. Praděd/Alvater NNR (the Jeseníky Mountains PLA, northern Moravia) the only Specially Protected Area in the Czech Republic meeting the demanding criteria of the category Ib, *i.e.* Wilderness Area, including the size set by the IUCN – International Union for Conservation of Nature (IUCN & UNEP 2021).

It is worth of mention that the UNESCO World Heritage Site property (445 hectares) and its protection buffer sub-zone (189 hectares) cover the largest NNR's segment, *i.e.* two original NNR (Poledník and Štolpichy) merged after establishing the Jizerskhorské bučiny/Jizera Mts. Beech Forest NNR. Thus, the property itself includes also the Poledník area (71.6 hectares), having been left to spontaneous development as a model/study area of national importance by the agreement between the Nature Conservation Agency of the Czech Republic (NCA CR) and Forests of the Czech Republic, State Enterprise signed in May 2007. The landscape conservation buffer sub-zone covering 2,090 hectares includes not only the NNR's buffer zone, but also 5 other NNR's core areas. Therefore, in its some parts the protection level is stricter there than required for this zone type by UNESCO.

Not only living nature

In the Jizerskohorské bučiny/Jizera Mountains Beech Forest, both biota (the living organisms of a particular region) as well as abiotic environment are significantly influenced by very humid climate because the Jizerské hory/Jizera Mts. are the first transcontinental barrier of the humid oceanic flow from the North Sea. The average total annual rainfall is approx. 1,000 mm there. Therefore, it is one of the sites with highest total annual rainfall in the Czech Republic. By comparison: based on the most recent data, the long-term average annual precipitation is 674 mm/year in the country. The location on the Jizerské hory/Jizera Mts. northern slopes causes a relatively high frequency of hard winters. The average annual temperatures, which are strongly related to altitude, range from 3 to 7.5°C. Moreover it is by 1°C higher than in the 1960s. The Jizerskohorské bučiny/Jizera Mts. Beech Forest National Nature Reserve displays an altitudinal gradient ranging from 360 to 1,006 m a.s.l.

The Jizerskohorské bučiny/Jizera Mts. Beech Forest has developed, contrary to other growths dominated by beech in the Subatlantic-Hercynic Beech Forest Region, on granites and granodiorite. The fact has significantly influenced the unique patterns in fungi, plant and animal communities (species composition, community structure, functionality, *etc.*) and their natural habitats. Although acidic, flowering and mountain sycamore beech forests and scree forests cover even 94.5% of the Specially Protected Area there are important geomorphological phenomena created on steep dissected slopes by weathering and mass-wasting. Both processes resulted numerous rock formations, *e.g.* there are deep slopes and gorges, rock walls, overhangs, aigutes, culoirs, cracks, slabs and pillars as well as stone screes. Other geomorphological features typical for the NNR include in slopes deeply sliced valleys of various sizes, sometimes reaching a huge depth thus increasing area's anyhow extraordinary segmentation. Mountain streams fall down some valleys through cascade rapids and waterfalls. The highest waterfall in the Jizerské hory/Jizera Mts., the Velký Štolpich Waterfall on the Černý potok/Black Brook gets over in some steps a height of 30 meters. It is said that in 1814 the extremely romantic landscape inspired Carl Maria von Weber, a German composer, virtuoso pianist, and in the current wording entertainment manager, who was undergoing treatment at nearby Libverda Spa, to compose his best known opus, The Freeshooter: a rock of the same name as the famous opera rises on a slope above the Bílý Štolpich Brook Valley. The whole area belongs to the Odra/Oder River Basin, thus to the Baltic Sea basin.

In respect to habitats combining biota and abiotic environment, in the NNR there are five natural habitat types listed on Annex I to EU Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (Habitats Directive). While siliceous rocky slopes with chasmophytic vegetation (Code 8220) cover only 1% of the NNR's territory, in the case of Luzulo-Fagetum beech forests (Code 9110) it is 65%. Other natural habitat types protected under the above EU legislation include Asperulo-Fagetum beech forests (Code 9130) occurring on 30% of the NNR and Medio-European subalpine beech woods with *Acer* and *Rimex arifolius* (Code 9140) spreading over 3%. The EU priority natural habitat type Tilio-Acerion forests of slopes, screes and ravines can be

found on even lesser proportion of the Specially Protected Area, specifically on 1% of its territory.

The Forest of World Parameters

But let us go back to the phenomenon which has appeared in the NNR's name and which has made it famous. Also in this case we have to go back to the past. For in Central Europe not so common well-preserved state the Jizerskohorské bučiny/Jizera Mts. Beech Forest has to thank to the fact that the terrain is permeable only with huge difficulties in some parts of the NNR.

That is why there has never been intensive and massive cutting/harvesting with all negative impacts on the primeval forest since the 16th century having been stimulated by high demand from famous local glass factories and later from other factories, *e.g.* ironworks, as it has been on the plateau. Active forest management was significantly reduced on the current NNR's territory after World War II and in the late 1950s it was fully supressed. The main reason was technological complications and difficulties of such management. Wood was felled in summer and stored directly at the edge of the forest. In the winter, brave woodsmen then took the felled trees down steep sledge runs to the rivers, along which they were then floated to the villages and towns in the foothills. After expulsion of German old residents new settlers did not command these technologies and they were not willing to risk their lives. In addition, most of the area was not accessible even for cableways.

At a closer look we can find that neither the fifteen kilometre long structurally rich and diverse forest growth is and cannot be homogenous. Acidophilous beech forests on boulder slopes are complemented by sycamore-beech forests growing in brook deep valleys and by preserved spruce forests with rowan/mountain ash on outcrops at higher elevations. Let us remember that on most of the NNR's territory the forest ecosystem has been left to spontaneous development for more than six decades, thus maintaining natural processes including random disturbances (temporary changes in environmental conditions that cause a pronounced change in an ecosystem). Therefore, spatial structure, plant species composition and dynamics reflect the site conditions.

Species composition of the extensive forest complex of natural character confirms, as can be expected from its name, dominance of the European beech (79%), followed by the Norway spruce *Picea abies* (13%). At the same time, the Sycamore *Acer pseudoplatanus* (2.8%), the Rowan/Mountain ash *Sorbus aucuparia* (2.2%), and the Silver birch

The Jizerskohorské bučiny/Jizera Mountains Beech Forest is the most extensive complex of old-growth forest dominated by beech in Bohemia. © Jan Plesník

The Frýdlantské cimbuří and the Polední zub/Noon Tooth Rocks in winter. © Jiří Hušek

Betula pendula (1.2%) are admixed throughout, and a few species, *e.g.* the European larch *Larix decidua* (0.64%), the European ash *Fraxinus excelsior* (0.19%), the European silver fir *Abies alba* (0.08%), and the Norway maple *Acer platanoides* (0.01%), occur only rarely within the proposed site as well as in the Jizerské hory/Jizera Mts. as a whole. Moreover, the European silver fir has been native there displaying high dominance, but it was step-by-step eliminated by forest management and its regeneration has been blocked by overpopulated hoofed game.

The mixed beech-dominated forest in the Jizerskohorské bučiny/Jizera Mts. Beech Forest National Nature Reserve displays a huge variety of old-growth characteristics which is consistent with previously reported studies on primary old-growth forests that have never been managed or have been unmanaged for even longer time periods, *e.g.* multi-layered canopies, large variation in tree sizes, many large and old trees or standing dead trees. Growths older than 120 years at present occur on 67% of the NNR's territory and the average stand age

Pursuant to the Birds Directive, The Jizerské hory/Jizera Mountains Special Protection Area to protected, *i.a.,* Tengmalm's Owl, also known as the Boreal owl (*Aegolius funereus*). In the Jizerskohorské bučiny/Jizera Mountains Beech Forest the small owl nests both in natural tree holes or erected nest-boxes. © Jan Plesník

was 196 years, but the oldest tree is more than 290 years old (LÁBUSOVÁ *et al.* 2019).

The NNR also plays an important role as a unique gene bank of native woody plant species, *e.g.* the European beech, Sycamore, European silver fir, Wych elm (*Ulmus glabra*), European ash, Sessile oak (*Quercus petraea*), Small-leaved lime (*Tilia cordata),* Large-leaved lime (*Tilia platyphyllos*) and the Norway maple, irreplaceable forest ecosystem restoration in the Jizerské hory/Jizera Mts. as well as in the Krkonoše/Giant Mountains.

Due to its location, the Jizerskohorské bučiny/Jizera Mts. Beech Forest interconnects the Subatlantic-Hercynic Beech Forest Region with the Polonic-Podolic-Moldovan one, thus contributed to repeated spread the important woody plant into northern and western Europe after the end of the last glacial, 5,000 – 4,000 years ago (MAGRI 2008, MAGRI *et al.* 2006).

Fauna and flora at a close look

During a survey of lichens, in total 117 species were found within the NNR, of them 9 classified by the Red List of the Czech Republic as threatened, *i.e.* Critically Endangered (CR), Endangered (EN) or Vulnerable (VU). One species was reported from the Czech Republic for the first time (MALÍČEK & VONDÁK 2013).

Botanical inventory confirmed in 2005 showed, that the Jizerskohorské bučiny/Jizera Mts. Beech Forest is inhabited by 357 vascular plant species: 184 live in the NNR a 339 in its buffer zone. Among from a point of view of nature conservation significant species, the Alpine coltsfoot or purple colt's-foot (*Homogyne alpina*), Clasping twistedstalk (*Streptopus amplexifolius*), Martagon lily (*Lilium martagon*), Braun's hollyfern (*Polystichum braunii*), Common or European yew (*Taxus baccata*), Wolf's bane (*Arnica montana*), Broad-leaved marsh orchid (*Dactylorhiza majalis*), Northern firmoss (*Huperzia selago*), Perennial honesty (*Lunaria rediviva*), Stiff clubmoss (*Lycopodium annotinum*) or the Common bogbean (*Menyanthes trifoliata).*

Similarly as flora, also fauna in the Jizerskohorské bučiny/Jizera Mts. Beech Forest is not remarkable for its species richness (number of species) there, but by species diversity and particularly by its well-preserved state. The forest growth hosts, *inter alia*, the Fire salamander (*S. salamandra*), Black stork (Ciconia nigra), Honey buzzard (*Pernis apivorus*), Tengmalm's Owl, also known as the Boreal owl (*Aegolius funereus*), Stock dove (*Columba oenas*) or the Red-breasted flycatcher (*Ficedula parva*). Rocks offer suitable nest-sites for the Eagle owl (*Bubo bubo*), recently also for one of the fastest animals, the Peregrine falcon (*Falco peregrinus*). Water habitats or their vicinity is preferred by the Swan mussel (*Anodonta cygnea*), European or noble crayfish (*Astacus fluviatilis*), European brook lamprey (*Lampetra planeri*), Common minnow (*Phoxinus phoxinus), Alpine newt (Ichthyosaura alpestris*) and the Eurasian otter (*L. lutra*).

NNR is not locked up

The Jizerskohorské bučiny/Jizera Mts. Beech Forest is transected by some tourist trails going through the above deep boulder valley with the Velký and Malý Štolpich Waterfalls and reaching top of the Mts. usually equipped by among visitors popular vantage points, e.g. Frýdlantské cimburří, Ořešník, Poledník or Krásná Máří. Therefore, interested persons can visit the NNR's most beautiful sites without harming the natural environment. Similarly to other NNRs, there also are specific rules for tourists there.

The Jizerskohorské bučiny/ Jizera Mts. Beech Forest yesterday, today and tomorrow

Due to difficult accessibility and since the 1960s also effective territorial conservation through protected areas, the Jizerskohorské bučiny/ Jizera Mts. Beech Forest displays high ecosystem integrity: all significant extremely valuable natural ecological and evolutionary processes, functions and services are not almost not influenced by humans. Maintaining and if possible, improving values common for all UNESCO natural World Heritage Sites dispersed all over the world should be ensured by the The Jizerskohorské bučiny/Jizera Mountains Beech Forest National Nature Reserve Management Plan for 2021–2030 (NCA CR 2021) implemented by the State Nature Conservancy authorities in co-operation with the Forests of the Czech Republic, State Enterprise, and other stakeholder. Nature is worthy of it there. ■

The list of references is attached to the online version of the article at www.casopis.ochranaprirody.cz.

Beech stands are at many sites accompanied by granite outcrops within the NNR. © Zdeněk Patzelt

Uranium Spoil Heaps near the Town of Příbram as a Part of Cultural Landscape Heritage and a Threatened Flora Habitat

Jiří Malíček, Linda Trunečková & Rudolf Hlaváček

Mineral mining has had a long tradition as an important national economy sector in the Czech Republic. Sites disturbed by mining have become an integral part of the landscape in many regions. The most altered sites include quarries, dumps and heaps, sand- and gravel pits, kaolin mining sites, and slag and fly ash tailing ponds. The traditional negative view of sites affected this way has rapidly been changing among experts. Early successional (development) stages and diverse habitats with extreme conditions and low productivity, common at such sites, often serve as substitute habitats for many species disappearing from the landscape in the Czech Republic. Several studies demonstrating the considerable conservation potential of these sites come from the Czech Republic.

Top plateaus are usually levelled and various material (*e.g.* building material) is deposited on them. Spoil heap no. 9 near Jerusalem. © Jiří Jiroušek

Naturally created, colourful vegetation mosaic at the foot of spoil heap no. 9 near Jerusalem. © Rudolf Hlaváček

At the foot of spoil heap no. 4 near Lešetice, basic soils rich in cyanolichen communities are found. Several threatened species have been recorded there. © Jiří Jiroušek

Spoil heaps in the Příbram area

Spoil heaps in the surroundings of the town of Příbram (Central Bohemia) originated by uranium ore mining in the second half of the 20th century, so they have been a part of the landscape for several decades. For many people, it is difficult to imagine the surroundings of Příbram without them. Spoil heaps were usually established on farmland. After tailings had been dumped, technological and biological reclamation was carried out. Some dumps were left without reclamation. Technological reclamation primarily consisted of spreading the material to the sides, lowering the top of the dump and altering its slope. The dump plateau was usually levelled and soil was deposited on it. Biological reclamation of spoil heaps included woody plant planting (*e.g.* pine). To a lesser extent, heaps were just sown with a grass mixture of unspecified species composition.

Lunar landscape extremes

Stone heaps piled up after uranium mining are a raw substrate, *i.e.* a site for primary succession. At first sight it may look like a rough, uninhabitable or even toxic landscape. Conditions for plants to settle there are generally unfavourable, sometimes extreme, primarily due to the influence of different abiotic factors. Spoil heaps have steep slopes, so there is strong erosion there and thus a loss of important nutrients. Surface temperatures of the substrate reach high values in the summer months, causing a lack of water for plants. Other limiting factors are the low fertility of the substrate (particularly low nitrogen and phosphorous contents) and also its physical properties (coarse-grained). Tailings contain heavy metals and sometimes radioactive elements, so the toxicity of the habitat is definitely not negligible. All these factors slow down vegetation development, so we can say that the course of succession on uranium spoil heaps in the surrounding of Příbram is delayed by minimally 20 years compared to other areas disturbed by mining.

Spoil heap flora and vegetation

Presently a vegetation gradient can be found on the uranium spoil heaps of Příbram, from nearly bare substrates settled by some of the most resistant bryophytes and lichens to closed-canopy woodland. Many of these woods have been created by natural succession. They are dominated by trees like the Silver birch (*Betula pendula*), Common aspen (*Populus tremula*) and the Pussy willow (*Salix caprea*). The herb layer consists of a very diverse mixture of ruderal, forest and grassland

species. To a lesser extent, also other ecological groups are represented there, *e.g.* species of arable land and rock habitats. The most abundant plants are the Wild strawberry (*Fragaria vesca*), Bush grass (*Calamagrostis epigejos*) and the Fireweed (*Chamerion angustifolium*). Non-native species are strongly represented by invasive alien plants, of which a total of 30 species have been recorded there. The most common plants on the spoil heaps, however, are invasive archaeophytes like the Bulbous oat grass (*Arrhenatherum elatius*) and the Canada thistle (*Cirsium arvense*). Common neophytes are the Canadian fleabane (*Conyza Canadensis*) and the Small balsam (*Impatiens parviflora*). Other invasive species are seen relatively rarely. An interesting species among the non-native immigrants is the Tall willowherb (*Epilobium brachycarpum*), a neophyte new to the Příbram area. An already large and numerous population was recorded on spoil heap no. 19 near Dubenec. In the Czech Republic, this species has so far only been found in western Bohemia.

Rare and threatened plants

Two legally protected species have been recorded on the spoil heaps: the Thuringian cinquefoil (*Potentilla thuringiaca*), found in small numbers on four spoil heaps, and the Basket of gold (*Aurinia saxatilis*), deliberately sown more than 30 years ago and subsequently spreading over a large area of spoil heap no. 9 near Háje. A total of 35 taxa included in the Red List of Vascular Plants of the Czech Republic (GRULICH 2012) have been found on the spoil heaps. Besides the mentioned species these include the strongly endangered Burr chervil (*Anthriscus caucalis*) and endangered, mostly pioneer species of open habitats, such as the Field cottonrose (*Filago arvensis*), red hemp-nettle (*Galeopsis angustifolia*), Childing pink (*Petrorhagia prolifera*), Annual fescue (*Vulpia myuros*), Wild parsnip (*Pastinaca sativa* subsp. *urens*) and the Common wintergreen (*Pyrola minor*). Forest species recorded there are *e.g.* the endemic Bohemian blackberry (*Rubus bohemiicola*) and further the European barberry (*Berberis vulgaris*), Broad-leaved hemp nettle (Galeopsis ladanum) and *Myosotis sparsiflora*.

Regarding threatened taxa, *Filago arvensis* has gained the most ground, settling bare spots or places only sparsely covered with grass-herb vegetation on gravelly or stony tailings, together with other pioneer plants. Also *Pastinaca sativa* subsp. *urens* is locally very successful, sometimes dominating open pioneer vegetation which colonises scree slopes of unfixed tailings.

The Field cottonrose *Filago arvensis*) is a frequent psammophilous plant on the spoil heaps. © Jiří Malíček

The Red hemp-nettle (*Galeopsis angustifolia*) is a rare plant of natural scree slopes as well as similar anthropogenic habitats. © Jiří Malíček

The Common wintergreen (*Pyrola minor*) is a rare plant in the present Central Bohemian landscape and as well as in the Příbram area. © Jiří Malíček

Rhizocarpon ridescens is a lichen which prefers rocky substrates rich in metals. The Příbram spoil heaps are one of its five sites in the Czech Republic. Spoil heap no. 15. © František Bouda

Acarospora sinopica is a characteristic species of communities on silicate stones and rocks enriched with metals. Spoil heap no. 15. © František Bouda

Lichen ecology and diversity

A diversity of life forms can also be found on a smaller scale. Extreme spoil heap habitats have namely been settled by a range of lichens, organisms which thanks to the mutually beneficial symbiosis of a fungus and an alga (or cyanobacterium) manage to grow even on the bare surface of rocks and stones. They can survive there direct sunlight, long drought or exposure to strong frost. Some even tolerate toxic habitats with a high content of metals, and some of them have adapted to such habitats during evolution.

From the perspective of lichen species diversity, some spoil heaps are biodiversity hotspots, as a relatively high number of species grow there compared to the surrounding intensively used farmland. However, not all heaps are favourable for lichens. Their occurrence depends on several factors: heap age and rate of succession, microclimate and stone size. Old spoil heaps left to natural succession have given lichens sufficient space for their diaspores to be gradually captured, and sites can thus be settled by a diverse range of species. As for microclimate, the species diversity of non-afforested heaps usually increases with growing humidity. The opposite is dry sunlit heaps, where just a few of the most resistant lichens can survive for a longer time. Also stone size is very essential. Too fine material is loose, shifts and does not offer sufficient microhabitats to lichens, and therefore often lichens are completely missing there. Spoil heaps composed of larger stones, on the other hand, may be relatively species-rich. Such types are however rather rare in the Příbram area. Their ecology strongly resembles the stone screes which we can see in *e.g.* the adjacent Brdy Highlands. Inside they maintain a constant temperature and humidity, so in the summer cold comes out of the lower parts, in winter they release warmth.

Lichen communities

The spoil heaps of Příbram possess a range of interesting substrates for lichens. These are mainly stones, bare soil, but also broad-leaved deciduous trees and shrubs. Both acidic silicate and slightly calcareous stones occur there. Substrate variability is supplemented by stones enriched with metals. Each of these types has its own specific physical and chemical properties and also its lichen inhabitants, so that we can find there species with rather different ecological preferences in one place. Saxicolous dominants of most spoil heaps are the common pioneer species *Amandinea punctata*, *Buellia aethalea*, *Caloplaca holocarpa* and *Lecanora polytropa*. More calcareous rock types are quite reliably indicated by the lichens *Candelariella aurella*, *Protoparmeliopsis muralis*

and *Xanthoria elegans*. Substrates enriched with metals are the most interesting from the lichenological point of view. These can be colonised by only a handful of specialised species which are rare elsewhere. Of these, *Acarospora sinopica*, *Lecanora epanora*, *Rhizocarpon ridescens* and *Stereocaulon nanodes* occur on the spoil heaps of Příbram.

Another suitable substrate is exposed soil. The steep loose slopes of the heaps lack lichens, but at their foot, and sometimes also on top plateaus, many remarkable species can be found. Conspicuous representatives encountered there include *e.g.* several cup lichen (*Cladonia*) and felt lichen (*Peltigera*) species. The cup lichens *C. cariosa* and *C. humilis* are relatively rare in the Czech Republic. Also several microlichens, whose presence can easily be overlooked at first sight, appear on the soil. For example, spoil heap no. 11A is only the third site of the inconspicuous *Bacidina brandii* in the Czech Republic. Probably the most interesting terrestrial lichens of the Příbram spoil heaps are cyanolichens. Their symbiotic partner is not a green alga but a cyanobacterium. They usually have a black thallus which can increase its volume up to several times its original size when humid. Although cyanolichens are found rather sparsely on the spoil heaps, several rare representatives have been recorded there, *e.g. Collema limosum*, *Gregorella humida* and three *Leptogium* species (*L. byssinum*, *L. subtile* and *L. tenuissimum*).

Trees and shrubs growing on the heaps or in their immediate surroundings are an attractive substrate for epiphytic lichens. The bases of the spoil heaps are generally significantly richer in lichens than their top parts, primarily for reason of more favourable microclimatic conditions (most of all humidity). Of the available woody plants, lichens clearly prefer the Common aspen and the Pussy willow, which are characterised by a relatively high bark pH, which is essential for lichens. Nitrophilous lichens, *i.e.* those associated with a high nutrient level (mainly nitrogen) in the environment, usually prevail on bark. Among them, however, also some less common macrolichens with a foliose or fruticose thallus, like *Bryoria fuscescens*, *Evernia mesomorpha* and representatives of the genera *Ramalina* and *Usnea*, sometimes appear there.

Conclusions for nature conservation

The spoil heaps in the surrounding of the town of Příbram are a unique landscape element and an extensive example of natural succession. At the same time, they provide a wide range of rare plant and lichen species with suitable habitats.

Typical example of a spoil heap with natural succession. Spoil heap no. 15 near Brod. © Jiří Jiroušek

As for plants, this concerns most often weak competitors of early succession stages, which have been still disappearing from the current Central European landscape. For lichens, spoil heaps are moreover a place of high biodiversity and a site of narrowly specialised species.

To preserve the unique flora of the Příbram spoil heaps, the only recommendation which can be made is to leave them without intervention. Reclamation and any other activities disturbing natural succession, causing landslides and shifting of material, are very undesirable for lichens and mostly also unfavourable for vascular plants. The heaps in the surrounding of Lešetice are particularly valuable as they are generally species-rich and host many rare lichen species, primarily the abovementioned specialists preferring substrates rich in metals and also terrestrial cyanolichens.

Present state of uranium spoil heaps

The Czech Republic's legislation imposes mining operators the obligation to reclaim sites exploited this way. Each company therefore collects the necessary funds in the actual mining period. This obligation also applies to the uranium spoil heaps of Příbram.

At present, some heaps are used as a source of sorted aggregates, have been mined for a great part or are being exploited. Extensive discussions are taking place on the use of other heaps and their possible elimination. By reclaiming the heaps in the form of dislocating the material, the local landscape would lose one of its dominants documenting regional mining activity. The habitats of many threatened organisms would be destroyed. Especially spontaneously developing communities of early succession stages, unique in the current intensively farmed landscape, would disappear. Moreover, the actual reclamation may lead to a release of radioactivity and more dust in the environment. The use of tailings in the construction of roads in the Czech Republic could however be a positive aspect of the planned reclamations.

Concluding, it is clear that uranium heaps must be viewed from many perspectives and decisions about their destiny should be considered carefully – not only from the perspective of human health or economy, but also from the scientific and nature conservation point of view. At the end of 2020, the Ministry of the Environment of the Czech Republic approved partial extraction of the first three Příbram heaps (nos. 11S, 15 and 19) without the need of an EIA procedure. Taking the mentioned arguments into consideration, we think that a comprehensive assessment of this plan in terms of environmental impact should definitely be carried out. ■

The list of references is attached to the online version of the article at www.casopis.ochranaprirody.cz.

Which Forest Is Formed by Spontaneous Processes in the Šumava/Bohemian Forest Mts.?

Pavla Čížková & Pavel Hubený

The thirty years of the Šumava/Bohemian Forest Mts. National Park (NP) have provided many findings – due to natural disturbances. European spruce bark beetle (*Ips typographus*) outbreaks culminated in 1996–1997 and 2009–2010, leading to a mass Norway spruce (*Picea abies*) decline in 1997 and 2011. But the European spruce bark beetle has left its traces until today, although to a lesser extent, just like a range of hurricanes. The result is that a quarter of the NP's non-intervention area (approx. 18,000 hectares until 2019) is formed by stands with dead trees. Non-forest areas and peat-bogs account for about 22% and variously old stands dominated by spruce for the remaining 53%. The world of large spruce temples with tall column trunks has changed rapidly in a part of the territory.

Mountain spruce forests with patches of spruce and rowan rejuvenation in the top part of Mt. Plechý. © Pavla Čížková

Would Šumava be a spruce area after all?

For the past 9,000 years, the Šumava/Bohemian Forest Mts. have been dominated by spruce (Carter *et al*, 2018; Svobodová *et al.* 2001). It dominated and has still been dominating despite the fact that it has experienced many disturbances over this long period of time. After its minimum around the beginning of the Christian era (45–55% spruce) it had increased again and around the year 1500 it roughly reached its present level. The Central Šumava/Bohemian Forest Mts. were at that time practically bare, so the change in species composition could not have been caused by man. Likewise, man could not influence the decline in European beech (*Fagus sylvatica*) and European silver fir (*Abies alba*) share/dominance at that time (glassworks came later). Still in the mid-19th century, original primary/virgin forests represented a considerable proportion of today's woodland in the national park and also these consisted predominantly of spruce according to descriptions of that time (Kruml 1964, 1968; Mayer 2013; Ministr 1963, 1969, 1964; Saitz 1898).

Biomonitoring – more than just a thousand permanent monitoring plots

We have searched for an answer to the question whether the position of spruce does not shake under the pressure of climate change in the recent period of predominant spruce by comparing the species composition of the tree layer (all trees with a trunk of more than 7 cm in diameter at breast height) and rejuvenation (all trees and shrubs of at least 10 cm high up to a trunk diameter of 6.9 cm at breast height) on permanent monitoring plots under the Biomonitoring project in an area of the Šumava/Bohemian Forest Mts. National Park having been left to natural processes since 2007. At the time of staking out the plots, a significant part of the area had been affected by large disturbances (felled and reforested clearings, stands uprooted by storms and forests with a mostly dead crown layer) or spruce trees were just dying due to the pressure of a European spruce bark beetle outbreak. With exception of Nature Conservation Zone I, afforestation was carried out in the NP, in which 54% of the permanent monitoring plots is located. Our results could therefore have been influenced by artificial plantings. But more about that later...

Waterlogged spruce forest on the Ptačí potok/Bird Brook stream. Rejuvenating spruce survive more easily on fallen trunks. © Pavla Čížková

Mixed scree forests in former Zone I of the Stožec-Medvědice site. © Pavla Čížková

Natural rejuvenation is conservative (i.e. spruce-oriented)

In the area studied under Biomonitoring, spruce is responsible for 71% in the crown layer (living trees) or 76% if we add dry trees. Rejuvenation copies this trend uncompromisingly with 78% spruce. Beech (enumerated diameter 7 cm and more) is represented for nearly 9% in mature trees, and also 9% in rejuvenation. However, numbers and also shares/proportions of these two trees in rejuvenation are influenced by plantings. At present there are a total of

Windthrows reveal the shallow soil layer in which the giants were rooted at the top of Mt. Plechý. © Pavla Čížková

Slow onset of rejuvenation in the top part of Mt. Poledník. © Pavla Čížková

350 million rejuvenating individuals (based on an average rejuvenation density of 6,323 individuals/ha and a woodland area of 55,000 ha) on the territory of the national park. At the same time we know that 15 million trees have been planted in the NP since 1996. Even if all planted trees have survived, this represents only 4% of all rejuvenation.

Is beech spreading?

The changing climate should provide beech with benefits from this change. Beech should occupy higher and higher elevations and spread from beech stands to the surroundings. Such a trend is locally indeed evident in the Šumava/Bohemian Forest Mts., but basically only in places with a higher amount of beech already today, *e.g.* around the village of České Žleby and on the slopes of Mt. Smrčina. Beech forests (defined as stands with more than 50% beech in the tree layer, not as surveyed potential vegetation) cover approx. 9% of woodland in the non-intervention area. They are mostly found at 800 to 1,200 m a.s.l., stands with 75% beech at an elevation of 950–1,150 m a.s.l., but not everywhere in the NP. Its occurrence is small-scale and isolated. Our measurements show that even natural beech rejuvenation reacts (by increasing its density) to a high proportion of beech at the crown level. Beech rejuvenation density increases with elevation up to 1,000 m, then rapidly falls down to zero. In contrast to spruce, beech prefers moderately steep slopes and avoids flatlands. It is almost missing on the plains in the central Šumava/Bohemian Forest Mts., but also in the inversion valleys of the Křemelná and Vltava Rivers. In places where beech dominates in the main stand it rejuvenates most often, but spruce is the most common tree in rejuvenation also there. Areas with beech dominance form islets or strips on hill slopes. Beech spreads from its sources into the surrounding, but its expansion rate does not indicate that it could endanger the dominant position of spruce in the near future, not even after disturbance by wind or the European spruce bark beetle. Spruce can react to stand opening very quickly, becoming a strong and numerous competitor, also in the case that spruce rejuvenation has been delayed in comparison to already rejuvenated beech. This phenomenon was described by Antonín Klečka more than 90 years ago (Klečka 1934).

Will Šumava/Bohemian Forest Mts.' spruce and beech forests change by climate change?

The ongoing climate changes in the Šumava/Bohemian Forest Mts. are documented by a series of measurements. Results from the Bavarian Forest/Bayerischer Wald Mts. (Bernsteinová *et al.* 2015) show increased evaporation with unchanged annual precipitation caused by demonstrable warming (~2 °C). Based on repeated assessment of phytosociological relevés, a shift in vegetation towards species of drier habitats or heliophilous species has been described. These changes are however rather attributed to a reduction in canopy caused by storms and European spruce bark beetle outbreaks. The study from the Bavarian Forest/Bayerischer Wald Mts. predicted a considerable dying of the predominant spruce and fir due to rising summer droughts and winter temperatures. These species would gradually be replaced by beech. In contrast, Martínez-Vilalta & Lloret (2016) conclude in their critical assessment of vegetation changes that a clear change in vegetation could be demonstrated in only 8 out of 35 case studies. In three cases the original species composition was restored, but in the remaining 24 cases it could not be definitely decided whether a change in the vegetation cover will take place in the future.

That 'repulsive' spruce

Despite the fact that spruce is an autochthonous tree in the Šumava/Bohemian Forest Mts., some authors still regard it as an expansive domestic species and also as the greatest threat to natural forest vegetation there. They draw attention to the fact that it is difficult to distinguish autochthonous Šumava/Bohemian Forest Mts. spruce populations from those which foresters have enriched the Šumava/Bohemian Forest Mts. with. Recently an extensive genetic study was carried out in the Bavarian Forest/Bayerischer Wald Mts. (Opgenoorth & Heer 2015), whose database is probably the largest set of population-genetic data on spruce. They compared the variability of spruce trees from various elevations in the Bavarian Forest/Bayerischer Wald Mts. And the results? Mountain spruces cannot be distinguished from lowland ones. There are no clearly autochthonous native mountain spruce populations! And there is another argument for spruce. Surprisingly, its current dominant position in the Šumava/Bohemian Forest Mts. National Park is in accordance with descriptions of forests in historical surveys of natural forests from the turn of the 18th and 19th centuries. The local high natural share/proportion of spruce in the tree layer was also described during the 19th century and in the early 20th century, and

has been documented by a survey of primary/virgin forests during the 20th century.

Potential vegetation has a great potential for deviations

The term potential natural vegetation indicates vegetation which would be formed in a certain territory provided that any human intervention is excluded. In other words, it is the vegetation that would be expected given environmental constraints (climate, geomorphology, geology) without human intervention or a hazard event. Of all the plots surveyed in the Šumava/Bohemian Forest Mts. by the authors where spruce prevails in the current vegetation, 84% are located in units where spruce is mentioned as the only or a possible dominant in the tree layer. Of these, 37% are a part of the *Calamagrostio villosae-Fagetum* unit/association (acidophilous mountain spruce-beech forest), in which spruce is one of the possible dominants (Neuhäuslová *et al.* 2001). Although the description of acidophilous mountain spruce-beech forest allows spruce to be a dominant tree, this is not taken much into account. Authors in some notes doubt the dominant position of spruce even at localities which were in the early 19th century described as pure primary/virgin spruce forests with four-century old spruce trees (Bečka 2012). Probably a range of significant factors play a role there, different from the assumptions on which the potential natural vegetation is based. These are undoubtedly the influence of micro- and mesoclimate, but also historically caused forest dynamics or natural barriers to the spread of some species.

Change in species composition as an impossible dream?

All the time we feel that we are able to adjust species composition by artificial plantings. We want to help nature and step forward to a model species distribution. As we have seen above, artificial plantings have not changed species composition on the landscape level. But what about the local level? We have tried to verify the effect of plantings at three localities for which we have sufficiently precise information on artificial reforestation/afforestation.

One of them is the former Modravské slatě Reserve, a very large area which has practically not been exploited since 1996, except for plantings in Zone II. We know that nearly a million trees were planted there in the late 1990s – predominantly spruce, but also the rowan, beech, maple and birch, *i.e.* 1,152 trees per hectare. Fifteen years later we counted a total density of 3,165 rejuvenated trees per hectare, *i.e.* three times the number of trees planted there. Spruce was represented for 94%. The prevailing impact of natural rejuvenation is thus indisputable.

Beech forest on slope of Mt. Smrčina. © Pavla Čížková

Another area is a clearing originated from incidental felling east of Laka lake. There we counted rejuvenation 7 years after felling. Today an average of 5,135 rejuvenated trees per hectare are found there while the artificially planted trees, if they had all survived, would make up 15% of all trees. This already makes clear that natural rejuvenation prevails. Beech, fir, alder, birch, sycamore and pine trees, making up 47% of the planting, reach a proportion of just 5% in the resulting rejuvenation density. Spruce is already present for 58% today.

The third area is a clearing near the village of Lenora. The total rejuvenation density is 5,900 individuals/ha, the trees planted included beech (70%), fir (28%), the Wych-elm (*Ulmus glabra*) and sycamore (2% together). When assessing the origin of particular trees on the plots, we found the proportion of natural rejuvenation to be 80%, artificial planting 18% and rejuvenation of undetectable origin 2%. Although not a single spruce tree was planted there, its density reached a value of 891 individuals/ha and its share/proportion was 15%. The clearing also has three large fenced areas of various age (2010, 2012 and 2019). The rule seems to be that the older the fence or the longer the time since felling, the larger the proportion of spruce is. Fir has a share of 12% and beech 5%. Trees which we did not plant strongly dominate. An example is rowan, originating from natural rejuvenation only, representing 42%. Other trees are willows, aspen, birch, pine, *etc.*

Some questions to conclude

It has been demonstrated that artificial restoration is responsible for 15 to 40% in reforested clearings. It is true that we do not plant trees in such high densities as was the case in commercial forests, *i.e.* approx. 3,000 to 5,000 saplings per hectare. If we applied these rates, artificial restoration would probably reach a higher proportion.

This raises the following questions. Is this actually not the case with most Šumava/Bohemian Forest Mts. forests, with the felled and artificially reforested stands in which spruce prevails? Is the significant dominance of natural restoration over artificial restoration not an explanation for the conservatism of species composition, *i.e.* the constant dominance of spruce, and perhaps the resilience of forest species structure to the ongoing climate change? ■

The list of references is attached to the online version of the article at www.casopis.ochranaprirody.cz.

What Attract Rare Invertebrates to Brown Coal Spoil Heaps?

Hendrychová Markéta, Bogusch Petr, Weisová Kristýna & Miroslav Šálek

The lunar landscape image of coalmine regions keeps clinging to people's minds, despite the fact that a lot of good has happened since the boom of brown coal surface mining below the Krušné hory/Ore Mountains (northwestern Bohemia). Mining companies are in good faith fulfilling their mining obligations including the reclamation of spoil heaps and residue pits in extensive surface quarries as is imposed by law, primarily the Mining Act, the Forest Act and the Act on the Protection of Agricultural Land. An area of more than 12,000 hectares has already been technologically and biologically reclaimed, and at least CZK 20 billion (EUR 0.8 billion) have been invested there (figure converted to today's value of the Czech Crown based on common reclamation prices) from the miners' financial reserves as well as governmental resources (see www.15miliard.cz).

A diverse mosaic of habitat patches suitable for specially protected species including sites with sparse vegetation or bare substrate where rare stinging insects breed. The Velká podkrušnohorská výsypka or Great Krušné hory/Ore Mountains Foothills Spoil Heap, the Sokolov area. © Markéta Hendrychová

Figure 1 Great changes in the post-mining landscape of the Vršany quarry – left: 2011, right: the same area after 10 years. © Markéta Hendrychová

Reclaimed areas have been green, pastures are full of cows, older reclaimed woodland is hardly different from that around spoil heaps. Residents enjoy leisure time in parks, swim happily in crystal clear lakes or visit sports grounds frequently... As we have known, however, less is more. This is definitely true for rare wild animal species.

A landscape you cannot create yourselves

Brown coal spoil heaps result on the one hand in varied terrain in all aspects, on the other hand they cause special climatic and other site conditions, particularly oligotrophy, which makes areas remaining after mining very interesting from the perspective of nature conservation (but also aesthetics, possible adventures and other ecosystem services), and that without any further human intervention. Something similar and extensive cannot be created in a common landscape. The national uniqueness of post-mining sites has been observed for many years (*e.g.* Bejček 1981 and Prach 1989 as the first ones). Although we wrote "remaining" (without technological reclamation), nature does certainly not just sleep. Just on the contrary. New life rapidly arrives at fresh spoil heaps, various species fight for space, new and changing communities interact with at the same time developing soil (Frouz *et al.* 2008), large numbers of amphibians settle spontaneously and dynamically changing pools in small depressions (Vojar *et al.* 2016), rare birds nest abundantly in various places, from mining machines to old, mostly closed-canopy woodland, which have developed there spontaneously without having to plant a single tree (Šálek 2012). Many remarkable ecological processes hardly recorded in the landscape elsewhere can be observed and studied there. Nevertheless, these are rather small habitats and difficult to perceive. It is very hard or impossible to maintain such valuable sites/areas in the post-mining landscape permanently, since formerly approved general remediation and reclamation plans are strictly adhered to, and most of all there is pressure on a return them to farmland and forests. Therefore, technological and subsequently biotechnical reclamation strongly prevail: landscape elements are homogenised, the soil is enriched with minerals, and biotopes unique to the Czech Republic's landscape therewith gradually disappear. In the article, we would like to demonstrate the value of non-reclaimed parts on the example of invertebrates, which are regarded good bioindicators thanks to their species richness and diversity in ecological requirements (Majer 1998). Our studies have mainly dealt with taxa inhabiting predominantly aboveground parts of ecosystems, which may well reflect the soil environment (where often their juvenile stages take place), as well as with vegetation which provides them with shelter and food.

Invertebrates in forests

Since succession in the northern Bohemian landscape should most often direct to forest communities, our research started with comparing communities of the selected invertebrate taxa in forest reclamations and woodland spontaneously formed on spoil heaps (without planting and subsequent management, hereinafter 'succession'). We only studied plots with a cover of trees (min. 5 m tall) of more than 50%. We further made sure that the distance of the study plots to the margin of the vegetation was min. 50 m and captured stands of different ages, from 18 to 45 years. A total of 14 one-hectare large succession plots and 14 reclaimed plots were selected, situated at least 500 m from each other. In each study plot, three sites representing a gradient in shading (*i.e.* in tree and shrub layer density) were chosen. In the 20-metre surrounding also the following parameters were assessed: humidity (categories dry, partly wet, and wet), cover (%) of vegetation layers, dominance of particular tree species, average height of herb cover, plant species richness, terrain slope (degree), microclimate (mild or severe with regard to prevailing southern or northern winds), proportion of deadwood (low, medium, high), litter depth, and microtopography (flat, terrain unevenness <20 cm, or >20 cm).

As model groups, seven taxa (see Fig. 2) were used. Their representatives were captured from May to September by sweeping vegetation, pitfall traps with bait, whereas molluscs were also collected manually for 15 minutes at each site. At the same time, soil samples were taken, from which total nitrogen content (NC), Ca, P, K, and Mg, grain composition, sorption (S – sum of basic cations) and sorption capacity (T) were determined. To reduce pedological and habitat variables, Principal Component Analysis (PCA) was performed, resulting in correlated variables (see PC1 a PC2 in Tab. 1) explaining 48% of variability. Subsequently, the effect of soil variables and site management on the species richness at the sites was assessed by a linear mixed-effects model.

Succession or reclamation? Combine them!

Detailed results of the research have been published by Hendrychová *et al.* (2008, 2016), therefore only the most important conclusions

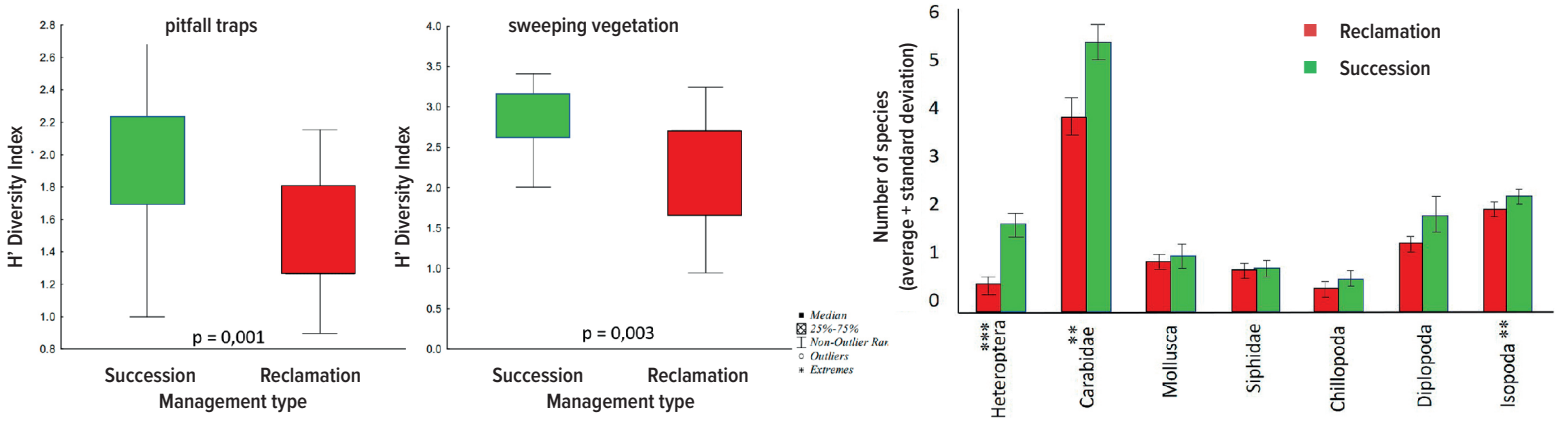


Figure 2 Diversity index and species numbers in the monitored taxa at reclaimed and spontaneously developing spoil heaps in the North Bohemian Brown Coal Basin. © Markéta Hendrychová

are mentioned here. A total of 16,003 individuals of 140 species were identified. Nearly half of the species (47%) were found to inhabit reclaimed as well as succession plots, but as many as 37% of species were only documented from succession plots, which is much more than the 16% which occurred exclusively in reclaimed plots. The diversity of ground beetles (Carabidae), heteropterans (Heteroptera) and isopods (Isopoda) was statistically significantly higher at succession plots, while the other taxa did not differ much in species numbers. The species diversity index was higher at succession plots both in the case of the pitfall trap method and sweeping (Fig. 2).

The species richness of all monitored taxa, except for molluscs (Mollusca) and centipedes (Chilipoda), was shown to be influenced by microclimatic site conditions. Species composition was further influenced by pedological characteristics in various ways: a higher humus content, thicker litter layer and presence of deadwood in combination with terrain/land cover heterogeneity and site management mostly acted in a positive way.

An essential driver influencing invertebrate communities is soil handling (*e.g.* changes in the proportion of clay particles and granular components and in mineral content, relief shaping – also see MORADI *et al.* 2018 and VICENTINI *et al.* 2020). In this way the diversity as a whole but also particular species can be supported. For example, the presently rare ground beetle, the Bombardier beetle (*Brachinus crepitans*) inhabits acidic forest soils in spontaneously developing woodland in large numbers. Also the vertical as well as horizontal vegetation structure plays a significant role there. Both ornithological and entomological research has confirmed the positive effect of small open patches (ŠÁLEK *et al.* 2010). For example, ŠEBEK *et al.* (2016) describe the irreplaceable importance of sunlit trees in half-open woodland for arachnids (Arachnida), beetles (Coleoptera) and hymenopterans.

Rare bees and wasps enjoy sandpits

The group of stinging insects (Hymenoptera: Aculeata) on spoil heaps was the next, non-forest experiment we dealt with (HENDRYCHOVÁ & BOGUSCH 2016). This included 114 collection plots at 3- to 35-year old sites (without significant age differences between succession and reclaimed study plots). Using coloured Moericke traps, a total of 2,706 individuals, 212 species of 13 families, were captured (Fig. 3). As many as 54 species (2 extinct from the region, 7 critically endangered, 14 endangered and 23 vulnerable) were

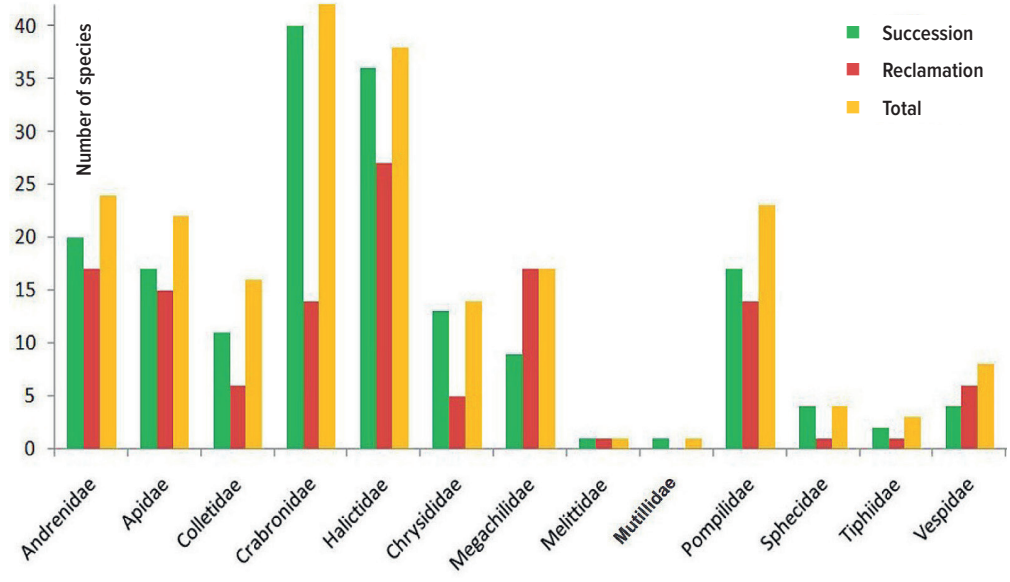


Figure 3 Representation of different families in the studied reclaimed, succession and all post-mining plots. © Markéta Hendrychová

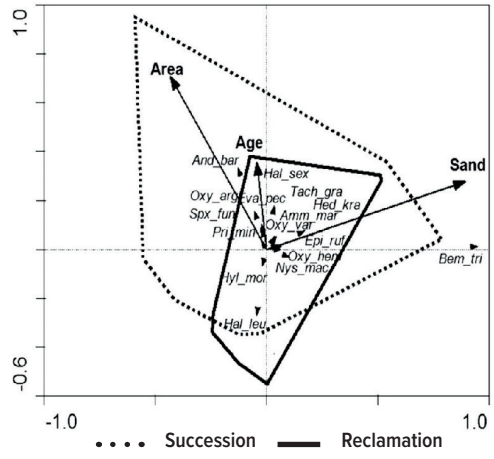


Figure 4 Redundancy Analysis, RDA (explaining 76.2% of variability), confirms, *inter alia*, that the sandy or early succession environment hosts a larger number of rare species. A wider range of these characteristics is offered by non-reclaimed sites. © Markéta Hendrychová

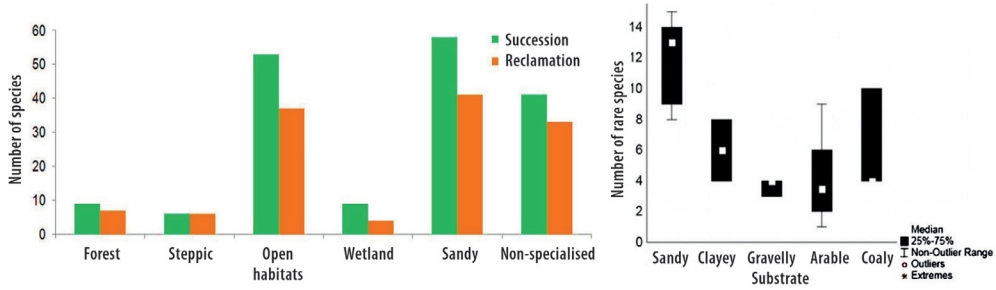


Figure 5 Spoil heaps were dominated by Aculeata preferring open and sandy habitats. © Markéta Hendrychová

Tab. 1. Comparison of ecologically restored spoil heap sites with records from the Střezovská rokle/Střezov Gorge Nature Monument.

Degree of threat	Střezovská rokle	Spoil heaps
Vulnerable	6	21
Endangered	1	8
Critically endangered	1	6
Extinct	0	2

Developed by Markéta Hendrychova

classified as rare, 5 species as legally protected, and also 3 other rare (rapidly declining) species were recorded. The assumption of higher species richness at non-reclaimed sites was confirmed: succession plots were found to inhabit twice as many rare species in four times higher numbers (84 species only captured at succession plots). This occurrence was not exceptional, as red-list species settled at 35 succession plots and at only two reclamation sites. Two species regarded extinct from the Czech Republic, namely the spider-hunting wasp *Evagetes littoralis* and the cleptoparasitic bee *Nomada minuscula*, were only recorded in succession plots, the inner spoil heap of the Vršany quarry and the Radovesice spoil heap (today registered Significant Landscape Elements). Species of sands and open landscapes (64%) prevailed and mostly belonged to the group of ground-nesting species (59%). Pollen and nectar collectors exceeded predators and parasitic species in number. Rare species and high biodiversity are correlated to sandier (granular) substrates (Fig. 4). Interesting habitats have also been developing in places with residual coal affected by strong erosion, or with sparse vegetation for other reasons (Figs. 5 and 6). These are not necessarily large areas – a number of small sandpits is enough (Fig. 7).

We supplemented these studies with research into the Střezovská rokle/Střezov Gorge Nature Monument nearby the Doly Nástup Tušimice quarry, where Aculeata are the main subject of conservation. Spoil heaps were found to be many times more significant in occurrence as well as abundance of rare species (Tab. 1).

What to apply in practice

If nature conservation must be the only target of restoring a post-mining landscape, the most appropriate approach turns out to be a well-considered combination of technological and biological reclamation using natural restoration processes or possibly management which blocks succession and reduces dense vegetation cover, a state which all reclaimed sites direct to. The results of our entomological research show that presence of a fine mosaic of different habitats including shrubbery and species-rich grasslands (even as a part of reclamation) is important for a high species diversity and occurrence of rare and endangered species. If we allow not only for succession sites but also small non-production habitats like hedgerows, baulks and fallows, insects will pay us back in adjacent arable fields where they pollinate, regulate crop pests, *etc*. As indicated by the preliminary results of our study into orthopteran insects on brown coal spoil heaps, besides diversity in soil characteristics and presence of terrain unevenness, the species diversity of restored grasslands is also essential.

Acknowledgements

We thank the following entomologists for their fantastic assistance with collecting and identification of invertebrates: J. Růžička, K. Tajovský, P. Kment, O. Nakládal, J. Kupka, K. Hradil, L. Sirovičová, A. Červenková, M. Oktábec, M. Radics, Z. Jarkovská and V. Drozenová. Part of the research was supported by grant GACR 105/09/1675, Specific Research of the University of Hradec Králové No. 2101/2015, and by grant No. 42900/1322/3208 of the Faculty of Environmental Sciences of the Czech University of Life Sciences Prague. ■

The list of references is attached to the online version of the article at www.casopis.ochranaprirody.cz.

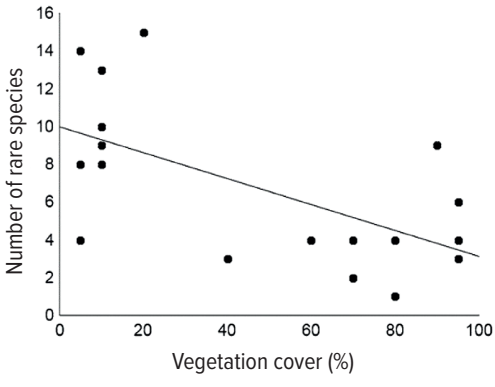


Figure 6 The number of rare Aculeata species decreases with increasing vegetation cover. © Markéta Hendrychová

Figure 7 Nest colony of the critically endangered digger sand wasp *Bembix tarsata* on sandy slope of an erosion-affected part of the Radovesice spoil heap with very sparse vegetation (left) and the psammophilous Black-banded spider wasp (*Anoplius viaticus*) (right), commonly inhabiting non-reclaimed spoil heaps. © Markéta Hendrychová

The Landscape of Cooperation – Forty Years of the Bílé Karpaty/White Carpathians Mts. Protected Landscape Area

Libor Ambrozek

What comes to mind when you hear the word the Bílé Karpaty/White Carpathians Mts.? A hundred years ago it was still the most remote corner of the Czech Republic, from which people were leaving for America to find a job. Today it is a popular destination for an increasing number of visitors of the entire country. Everyone will come up with something else – probably most often meadows full of orchids stretching to the horizon, but also (from west to east) wine cellars near the municipality of Petrov and the town of Strážnice, old service/sorb trees (*Sorbus domestica)*, the Horňácko/Upper Moravian Slovakia region folk culture, the Moravian Kopanice region with the Goddesses of Žítková, the virgin forest below the top of Mt. Velká Javořina/Great Maple Forest, beech forests in the Vlára Pass, or the well-preserved landscape of Southern Moravian Wallachia around the municipality of Nedašov. The landscape and nature of the picturesque mountains on the Slovak border has really extremely many faces.

The South Wallachian landscape near the municipality of Nedašov. © Libor Ambrozek

Already much has been written about natural beauty of the Czech Republic in this journal, therefore the author would rather like to complete the Bílé Karpaty/White Carpathian Mts. mosaic with shards about efforts of nature conservationists and particularly collaboration, as they would not be able to conserve local nature and the landscape on their own there. When the Bílé Karpaty/White Carpathians Protected Landscape Area (PLA) was festively declared in autumn 1980, it had had only one small-size protected area, the Mt. Velká Javořina/Great Maple Forest primary/virgin forest. Seven years later there were 49, most of them meadows and pastures! More details of this fantastic result can be found in *Ochrana přírody/ Nature Conservation Journal, 72, 6, 2–5, 2017*.

Landscape restoration and LIFE+

However, even the most remote areas had not escaped the devastating pressure of socialist agriculture. Therefore, in the 1990s the main challenge was landscape restoration. Hundreds of hectares of illegally ploughed meadows were 'regrassed', often with a regional herb seed mixture, whereas nearly three quarters of official arable land was converted to grassland for economic reasons and on the farmers' own initiative. The long-term monitoring o permanent plots has demonstrated that the number of species (species richness) at sites restored in different ways gradually increases in the course of time.

Another significant success has been the extensive elimination of self-sowing encroaching woody plants. Due to the intensification of agriculture, meadows on steeper slopes were abandoned and became naturally seeded and encroached first with shrubs and later even trees. However, they have been still registered as a meadow, which makes a simple intervention administratively simple. Thanks to finances from the Ministry of the Environment of the Czech Republic as well as projects from the State Environmental Fund dozens of hectares have been restored. A rapid recovery of the species diversity has taken place at these sites, as they had not been exposed to the application of chemical fertilisers.

One of nine Carpathian gentians (*Gentianella lutescens*) that flowered in the Bílé Karpaty/White Carpathians Mts. in 2020. © Libor Ambrozek

The colourful aspect of the Elder-flowered orchid (*Dactylorhiza sambucina*) is a decoration of species-rich orchid meadows (in central and northern parts of the mountain range). © Libor Ambrozek

At Paličky near Javorník, 22 hectares of former pastures with solitary trees have been restored under both LIFE projects. © Libor Ambrozek

After several years of silence caused by a lack of funds, a new chapter in the history of self-seeding woody plant elimination and eradication was written in 2011 with the Butterflies CZ-SK LIFE+ project (see issue no. 3/2015). And it has been written to this date for the benefit of the Bílé Karpaty/White Carpathians Mts. meadows and the plant and insects inhabiting them. The first successful project was followed up in 2017 by another, more broadly entitled *From the Life of Insects*, which besides meadow and pasture restoration also deals with interventions in woodlands. Both projects have brought tens of millions of CZK (EUR millions) from the European Union sources to the Bílé Karpaty/White Carpathians Mts. and have, in addition to more active habitat management, supported the development of farmers' involvement, communication, education and public awareness (CEPA), and last but not least also extensive monitoring of butterflies and other insect species.

Under the first LIFE+, 110 hectares of invasive self-seeding woody plants were eliminated within the PLA, whereas the target of the second project is another 200 hectares. The sites are very diverse. In the Moravian Kopanice region, many local residents with land around their homesteads were involved. In the southern part even several-hectare large sites were restored *(e.g.* Paličky near Javorník, Roštovica near Tasov, slopes in the buffer zone of the Porážky National Nature Reserve), at which solitary trees have been preserved. Insect surveys at these sites have demonstrated a high species diversity including many rare species.

Species management

The management of rare wild plant and animal species, which the Bílé Karpaty/White Carpathians Mts. are very rich in, deserves a chapter of its own. The numbers of critically endangered species alone run into the dozens. Many of them are bound to meadows and pastures, but woodland species are neither forgotten. It is true that the area of permanent grasslands significantly narrows the space for 'gardening', but some sensitive species cannot do with special management and even then their future survival has not been guaranteed.

Gentians of the genus *Gentianella* are a textbook example. The Carpathian gentian (*Gentianella lutescens*) had once used to be a common species of pastures and grazed meadows in the entire Carpathians. However, under the influence of changes in farming methods and nitrogen deposition it rapidly disappeared in the second half of

The Aesculapean snake (*Zamenis longissimus*), nicknamed 'housekeeper snake' in the Moravian Kopanice region. © Libor Ambrozek

Removal of self-sowing encroached woody plants at Stráž near Bylnice, a significant entomological site. © Libor Ambrozek

the 20th century. Now we can count the sites and in dry years even flowering individuals on our fingers. In 2020 it flowered at only two of the monitored six sites, representing a total of 13 plants only. Although the sites of its occurrence are regularly cleaned by raking in spring and mowing takes place in late autumn, the populations are very poor. At least the resumption of mowing at a site near Nedašov has been successful. There, its original farmer stopped maintaining the meadow several years ago after disputes with nature conservationists. Two years after mowing was resumed, 9 gentians germinated from the seedbank were found flowering.

The Autumn dwarf gentian (*Gentianella amarelle*) is in a much better situation. The species has recently been found at three sites. At two of them, old sunken pathways, even several hundred specimens flower in good years (more than 600 near Javorník and 300 near Nová Lhota in 2020). Another species honoured with a recovery programme or at least an action plan and doing well is the endemic fleawort *Tephroseris longifolia moravica* (several hundred flowering plants at the two largest sites in 2020). Also the only population of the Spiked star-of-Bethlehem (*Ornithogalum pyrenaicum sphaerocarpum*) grows slightly. The lousewort *Pedicularis exaltata*, one the PLA's iconic species, received a decent fence around its main population at Porážky. In recent years, one of the two localities of the Lady's-slipper (*Cypripedium calceolus*), the Čertoryje National Nature Reserve, has become the target of a nerdy who has gradually dug out all the flowering tufts. On the other hand, populations of the Late spider-orchid (*Ophrys holoserica*) are stable, and pyramidal orchid (*Anacamptis pyramidalis*) even appeared at formerly fertilised sites in 2020.

If we leave out large carnivores, which have been surveyed in the Bílé Karpaty/White Carpathians Mts. for three years, the best known animals inhabiting the mountains are apparently the Aesculapean snake (*Zamenis longissimus*) and the Rosalia longicorn (*Rosalia alpina*). For our largest snake, known in the Moravian Kopanice area as 'housekeeper snake', a number of artificial hatcheries have been placed in Vlára Pass and at Žítková, where the snake is regularly monitored. Also the Rosalia longicorn, one of the most beautiful beetles in the Czech Republic, has its largest Czech population around the Vlára Pass. We have been trying to create a sufficient number of suitable habitats for the insect in collaboration with state forestry. Currently negotiations are taking place about more sensitive management in well-preserved beech forests adjacent to the old-growth forests of two Nature Reserves, Okrouhlá and Sidonie. In surveys, a number of other beetle species not occurring elsewhere in the Czech Republic were also found there.

Besides the meadows in the southern part, also the surrounding of Brumov-Bylnice takes in an exceptional position among entomological localities. Thanks to the proximity of the Váh River, rare thermophilic beetle species and other insects arrive there. Some of them, long regarded as extinct from the Czech Republic, have newly been discovered there (*e.g.* the Critically Endangered leaf beetle *Cassida atrata*). Recently, slopes of the most valuable site of Stráž near Bylnice have gradually been cleaned of shrubs. As part of the LIFE+ project the PLA Administration collaborates there with landowners and local associations, for example footballers who play on the pitch directly below the slope.

Amphibian populations benefit from new pools which are restored by *e.g.* hunting associations and local chapters of the Czech Union for Nature Conservation. Thanks to more thorough monitoring (particularly caused by the boom in camera traps) but also because of changes in woodlands, more and more new species are being observed. Examples are the Eurasian three-toed woodpecker (*Picoides tridactylus*), Ural owl (*Strix uralensis*) and the European wildcat (*Felix silvestris*).

Cooperation with farmers

There are many ways of cooperation with local residents and farmers. The remoteness of the Bílé Karpaty/White Carpathians Mts. is fully manifested there not only in the exceptionally preserved folk culture but also in the relation to the land and landscape around. Next to larger farmers, traditional farmers can still be encountered there, and now and then we find more species on their land than in nature reserves. It looks like plants and animals are sometimes able to appreciate the management that given to them. This is because we do by far not know everything about them. It is therefore appropriate to perceive all farming methods.

The extent of collaboration is reflected by the fact that 18 thousand hectares of permanent meadow/grassland are included in the Agri-environment-climate measures (AECM) subsidy schemes, which is more than a quarter of the PLA's size! The proportion of land farmed organically is even slightly larger: 70% of farmland as registered in the **Land Parcel Identification System**. Moreover, six thousand hectares of meadows and pastures are located in Zones I and II. Thanks to the activities under and finances from the LIFE+ 'butterfly' project the PLA Administration has started to meet with farmers on a regular basis. The debate is not only about farming subsidies, the weather or requirements of the PLA Administration, but we have also tried to explain the motives and intentions for the way we act. This has shown to be extremely successful. Even hardened landowners became impressed by a colourful description of the life cycle of blue butterflies and then reconciled with mosaic mowing much easier.

Besides mowing and grazing subsidies the PLA Administration also supports other farming activities. More and more arable land is regrassed with regional seed mixtures, and some stakeholders plant solitary trees in meadows. Javorník CZ Farm Company has even implemented two large landscape structure restoration projects under the Operational Programme Environment (OPE), *i.e* EU funds. Resources of the Landscape Management Programme for the planting of fruit tree landraces have gained great popularity, being used by dozens of small applicants. A similarly successful subsidy programme of the Ministry of Industry and Trade of the Czech Republic for the building of new fruit distilleries would be useful now.

Municipalities and non-profit organisations

For more than 20 years the PLA Administration has regularly been meeting with the mayors.

Wild pear tree in the proximity of the Drahy Nature Reserve, one of the oldest in the Bílé Karpaty/White Carpathians Mts. © Libor Ambrozek

Due to their activity, the Administration has one of the highest number of OPE projects to assess within the Nature Conservation Agency of the Czech Republic as a whole. We support the planting of lines of trees and treatment of old trees. Some municipalities maintain valuable sites on their territory themselves. These are mostly former municipal pastures which are now refuges for many rare species.

A separate chapter is formed by PLA Administration's cooperation with natural allies, non-profit organisations in nature conservation. Some of them have gained reputation outside the region. Kosenka, a Local Chapter (LC) of the Czech Union for Nature Conservation (CUNC), has purchased 30 hectares of an old fir forest named Ščúrnica and two meadow reserves. Their traditional mowing event was held for the 40th time in 2020! Kosenka members also stood at the birth of one of the largest events in the region, the Wallachian St. Nicolas Fair in the town of Valašské Klobouky.

LC CUNC Bílé Karpaty operates in the south, where it manages more than 200 hectares of valuable orchid meadows. It participates in both LIFE+ projects and its role as a regional grass mixture producer is irreplaceable. In 1997 it established, together with the PLA Administration and the Municipality of Veselí nad Moravou, the Bílé Karpaty/White Carpathians Mts. Education and Information Centre, today the main CEPA centre in the region. Their lesson package named *The Meadow Secret* enjoys great popularity with schools of all levels, and also field excursions and tourist guide trainings are in demand.

At the end of our probe into the world of the Bílé Karpaty/White Carpathians Mts., the international aspects of our mountain range must be mentioned. On the other side of the ridge, our Slovak colleagues from the Biele Karpaty/White Carpathians Mts. PLA operate, even one year longer than we have done. Their work is not easy because Slovak state nature conservation has very limited possibilities compared to those in the Czech Republic, but they have done a huge piece of work thanks to their enthusiasm. We met each other in the first LIFE+ project, under which they bought their own equipment, now used to manage several dozen hectares of the most valuable protected areas. Non-governmental organisation BROZ, which also participates in the other LIFE+ project, is just as active: it manages a range of sites, *i.a.* a large orchard, and cooperates closely with local farmers.

A charming beauty of the Bílé Karpaty/White Carpathians Mts. landscape and its natural treasure jointly formed by humans have been able to win recognition also abroad. In 1996, the Bílé Karpaty/White Carpathians Mts. were declared UNESCO Biosphere Reserve and since 2000, they have been a holding area of the European Diploma for Protected Areas awarded by the Council of Europe which was prolonged for the second time in autumn 2020. These awards are an appreciation of all the local and non-local people who live and farm in the region and have left a piece of their heart there. You will leave it there too when you walk through the meadows and forests and sing a song with the locals over a glass in the evening. ■

Soil as a Biodiversity Hotspot, Namely that of Small Soil Arthropods

Ladislav Miko

When presenting examples of particularly species-rich ecosystems, we will most probably name tropical coral reefs, tropical gallery forests or selected types of tropical rainforests. To visit these ecosystems, one must travel a long journey far outside of homeland, and even beyond borders of our continent. Still, a comparably species-rich ecosystem can be found, even in our conditions – yet escaping broader awareness when speaking about biodiversity. This is perhaps caused by simple fact, that thousands of species inhabiting this ecosystem could only rarely be observed by the naked eye, as they are mostly of the microscopic size. Indeed, healthy, and well-functioning soil – in our conditions mostly soil of broad-leaved deciduous or mixed forests – is a real biodiversity hotspot reachable just "beyond our courtyards" or next door. Presence of the particular species, overall species richness and relative numbers of soil organisms serves at the same time as great indicator of soil conditions, and often also of the quality of respective above-ground ecosystem at the place.

Functions are the key

Soil and soil surface represent in terrestrial ecosystems a space securing one of the principal ecosystem services: gradual decomposition of dead organic matter. Only a small part is not finally completely decomposed to original components – mineral nutrients and carbon dioxide – and enters complex chemical transformations leading into creation of humic substances with the very variable and complicated structure. Despite the fact, that it includes only a fragment of overall volume of dead organic matter, the process is spatial and rather constant in healthy soils. This results in fixation and accumulation of atmospheric carbon in the soil, where it can be stored for variable, but sometimes very long time, making it in principle similar to that of fossil fuels. Soil is by far the largest terrestrial sink on the Earth, storing around 2300 Gt of carbon (Stockmann *et al.* 2013), about 2.3 times more than atmosphere and 3.5 times more than in living plant biomass.

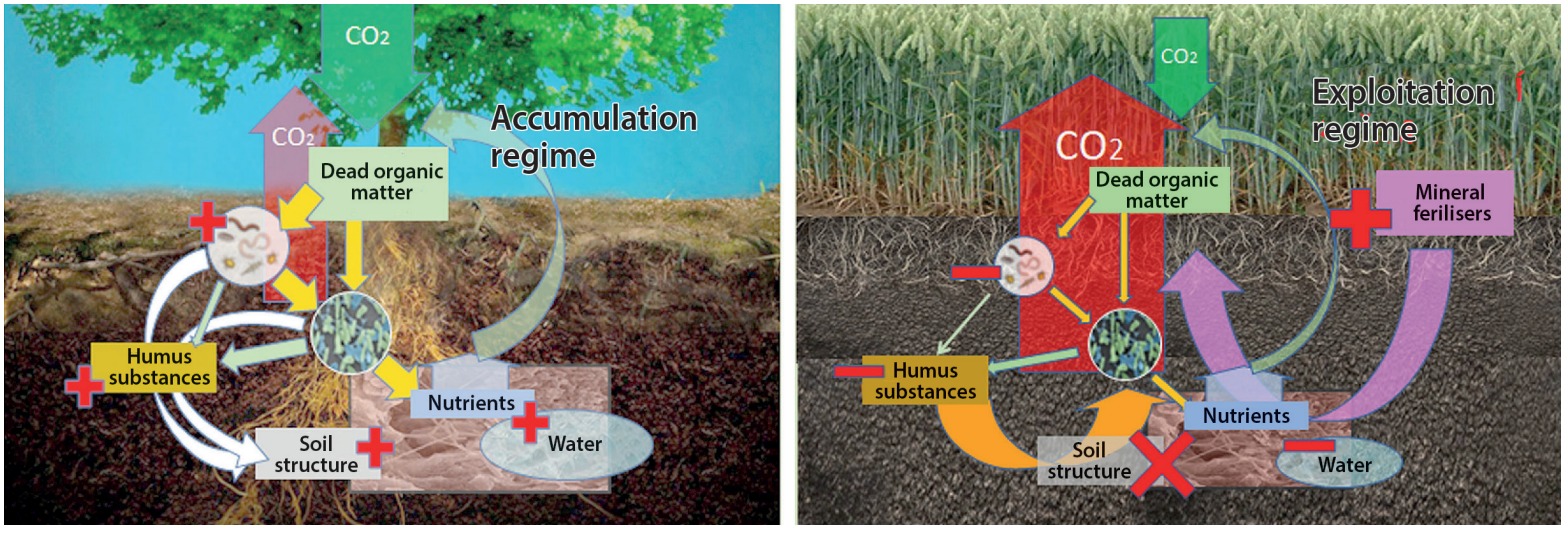


Figure 1 Simplified scheme of soil ecosystem functioning. Under normal conditions, dead organic matter in soil is decomposed by soil decomposers (bacteria, fungi, soil fauna) back to nutrients, part of decomposed matter however remains in the soil as complex humus substances. Thanks to the process, carbon is accumulated in soil and at the same time a complex soil structure is built and maintained. Soil structure is a precondition for effective water holding capacity and capturing of nutrients in the system (this regime is called "accumulation regime") [left]. In intensively utilised soils, the entry of dead organic matter may be dramatically lowered, and plant nutrition is served by addition of (soluble) mineral fertilisers. Mineral fertilisers cannot be used by soil organisms as a source of energy, therefore organic deposits in the soil are more utilised and humus substances are more intensively decomposed ("the soil is feeding itself"). Numbers of soil organisms are declining, soil structure is collapsing and subsequently also the water and nutrient holding capacity is declining, too. Consequently, amounts of released carbon dioxide from the soil excess amounts stored in the system (exploitation regime). Red plusses and minuses indicate increase or decrease, size of the arrows indicates schematically intensity or volume of the particular process.

Therefore, disturbances of soil decomposition processes – such as warming, increased oxidation or limitation of dead organic matter input – may cause increased decomposition, mobilisation and release of stored carbon, resulting ultimately in transformation of soil sink into atmospheric carbon dioxide (or other greenhouse gas) source (Fig. 1). Farming, for example, has resulted in emission of approx. 116 Gt of carbon into atmosphere since its beginning (Sandemann *et al.* 2017), with more substantial part of it having been released in the last several decades by intensive farming (data refer to 1998, so at present the values are even higher).

Within the ecosystem, however, the nutrient cycling is a key service of organic matter decomposition. Dead organic matter is still relatively energy-rich, which is the main attractant for soil organisms involved in decomposition. The most significant role in decomposition, leading up to mineralisation to original components (nutrients), is played by primary decomposers – soil bacteria (including archea) and fungi, called sometimes historically "soil microflora". The species richness of these organisms is enormous and has mostly been unknown – partly because it is very difficult to study without DNA analysis or specific cultivation approaches.

Activities of the primary decomposers in soil are broadly "assisted" by numerous representatives of soil fauna. Their abilities and functions in soil ecosystem are influenced by multiple of factors such as availability of specific enzymes but also relative size and ability to actively penetrate the soil environment, speed and rate of movement and other specific adaptations. Some of these traits seem to be functionally related to size (or diameter) of the body and therefore reflected in usual size categories of soil fauna (Fig. 2). The way of exploitation of resources in decomposition processes is a base for functional categorisation of soil fauna (Šantrůčková *et al.* 2018).

Soil engineers (earthworms, but also termites, ants or insect larvae) create soil burrows and spaces, thus securing a distribution of dead organic matter across the soil profile, as a prerequisite for activities other soil organisms. Large and medium sized species (millipedes, isopods, insect larvae, enchytraeids or potworms) are feeding on organic debris, causing its fragmentation and transformation into structured excrements (faecal pellets, *etc.*); they represent therefore the functional group (a guild) of litter transformers. Smaller species (microarthropods, mostly mites and springtails, and diverse group of nematodes) are feeding dominantly on fungi and bacteria. Some of them are adapted to penetrate the cells and fungal hyphae to suck their content, but mostly they are not able to separate microflora from

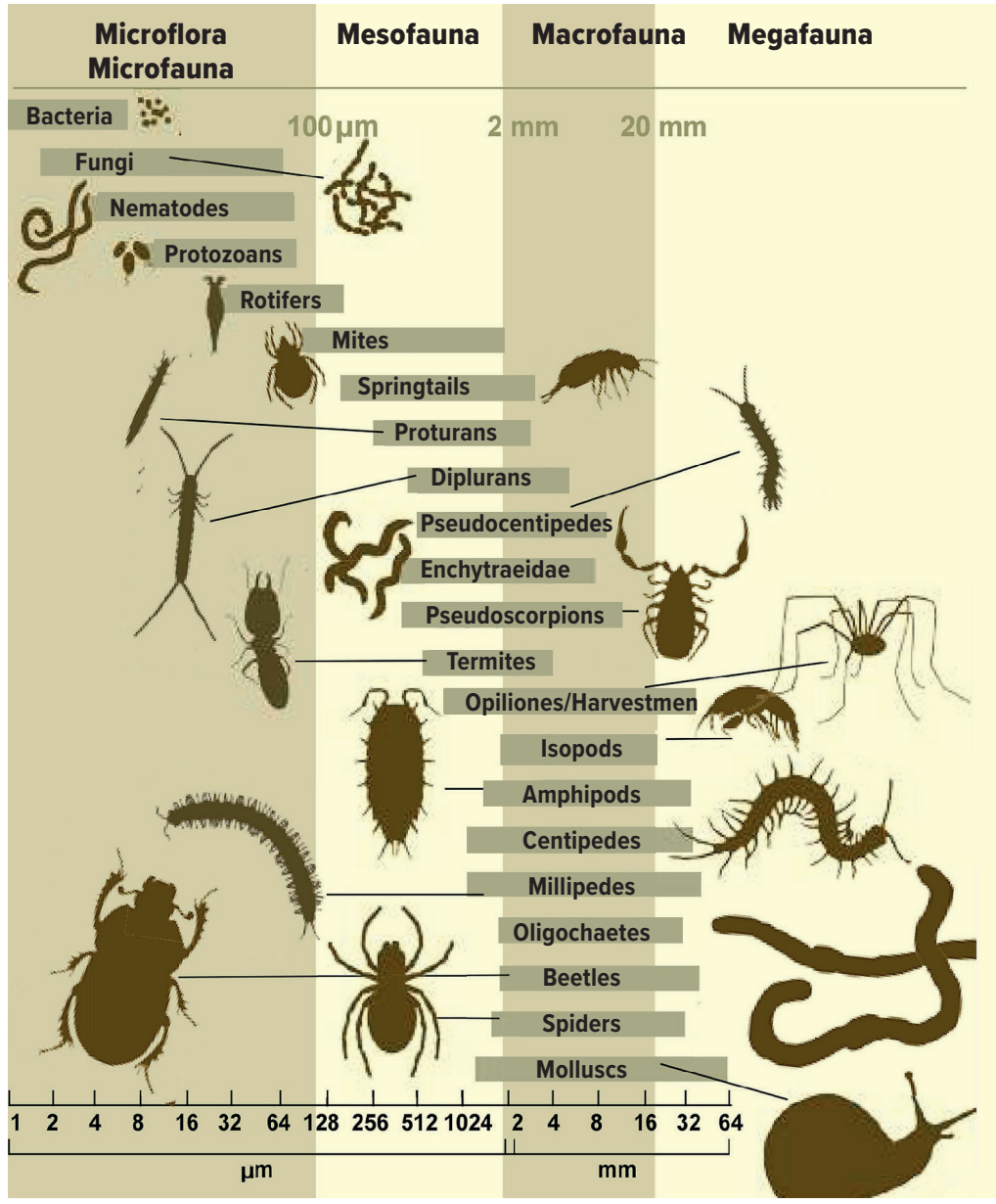


Figure 2 Categorisation of soil organisms based on effective diameter of the body, which is related to functioning in the soil ecosystem. Source: Miko *et al.* (2019). © Ladislav Miko

the substrate (organic debris), so they consume both together, creating a functional group of microbial feeders and browsers. This broad group, however, contributes also to fragmentation of organic matter, leading ultimately to creation of increased surface available for primary decomposers activities, and generally to acceleration of decomposition. Movements of soil fauna in litter and organic debris of soil result in efficient mixing of organic fragments with mineral soil particles (bioturbation). Soil microfauna represented by the smallest-bodied set of species (protists, rotifers, tardigrades, many nematodes) inhabits usually water-filled micro-spaces or water films on soil particles surface, often feeding by filtration of bacteria or other small species (predation, in principle), or utilise dissolved energy-rich substances (osmotrophic).

Broad array of species dependent on organic matter and primary decomposers on its surfaces obviously becomes a broad potential source of prey for cascades of soil predators. Many of them can utilise also freshly dead bodies (necrophagy). Other set of species in soil may feed on excrements of other species (coprophagy).

Regular input of dead organic matter (leaf litter or other dead parts of plant bodies, excrements, carcasses, *etc.*) is a relative surplus of feed, and contributes (together with products

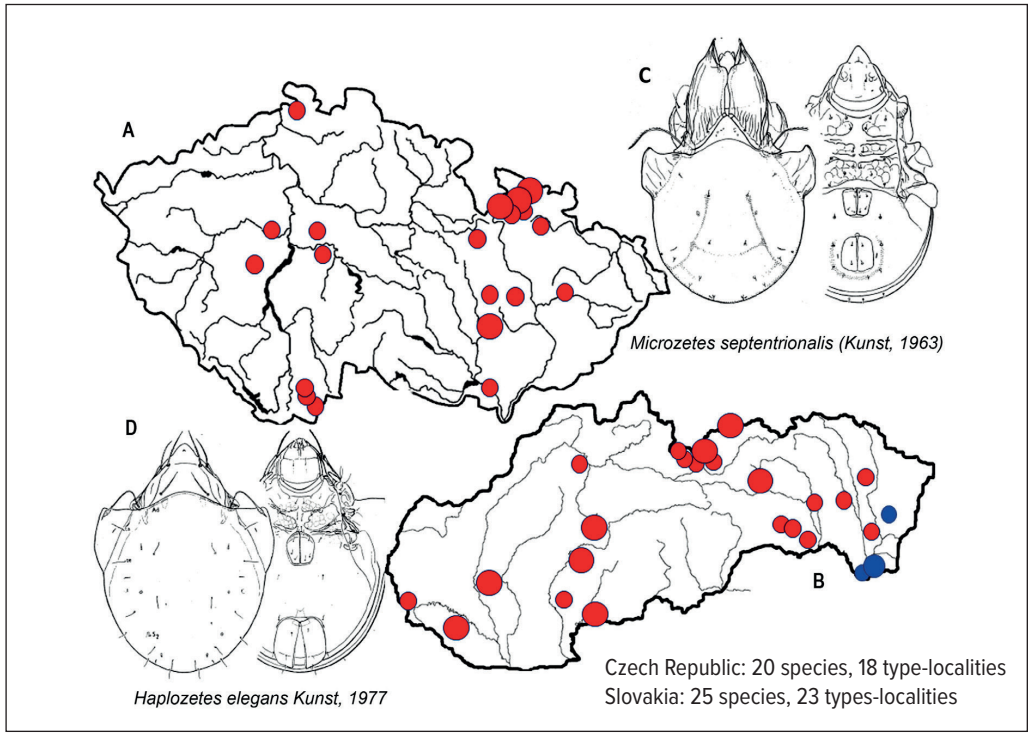


Figure 3 Many type-localities of newly described oribatid mite species can be found on the territory of the Czech Republic (**A**) and Slovakia (**B**). Only part of them is included in protected areas. Species (**C**, **D**) are examples of the species described from the territory of Czech Republic and Slovakia. © Ladislav Miko

of decomposition process) to creation of highly complex soil structure. As a result, soil organisms are not necessarily competing for space and energy, which allows for co-existence of extreme high number of species and consequently for very high biodiversity of the soil system. Principally important is also the phenomenon of functional redundancy (Setala *et al.* 2005) where many species can overlap in their way of resource utilisation (*e.g.* food preferences). This, at first sight unnecessary, redundancy is in fact an extremely useful "insurance" securing functioning of the system even in case of dramatic reduction in species composition in the soil (portfolio effect). At the same time, it can partly overshadow worsening of soil conditions, for example biodiversity decline, because in terms of ecosystem functions it may not be visible. As we can have an impression, that soil "still works" as usual, we may not notice that soil biodiversity declines and soil may irreversibly undergo degradation.

Probably the easiest way to observe and document the species explosion in the soil ecosystem is to study soil mesofauna, dominated usually by springtails (Collembola) and mites (Acarina), represented in particular by moss-mites, or oribatids (Oribatida). The species diversity and bioindication capacity of soil fauna is further demonstrated using example of oribatid mites.

Species richness and abundance

New species of soil microarthropods are regularly found and described from the territory of the Czech Republic and Slovakia, though the Central Europe is among the most studied areas of the planet in that respect. Type-localities of many oribatid species, located there (Fig. 3), should stay preserved in their natural state – but many of them have not even been included in the system of protected areas. Regular discovery of new species (or findings of species known from other – distant – localities only) in basically any territory searched more systematically and in detail, demonstrates first extraordinary species richness of soil microarthropods and second still very fragmented knowledge of it. According to the recent revision, 539 species of oribatids were confirmed in the Czech Republic's territory (Miko 2006). The number of species of other mite groups and springtails, even if slightly lower, is also counted in hundreds. Globally, the number of described species has also been fast growing – today about 10,500 species of oribatids and over 8,500 species of springtails

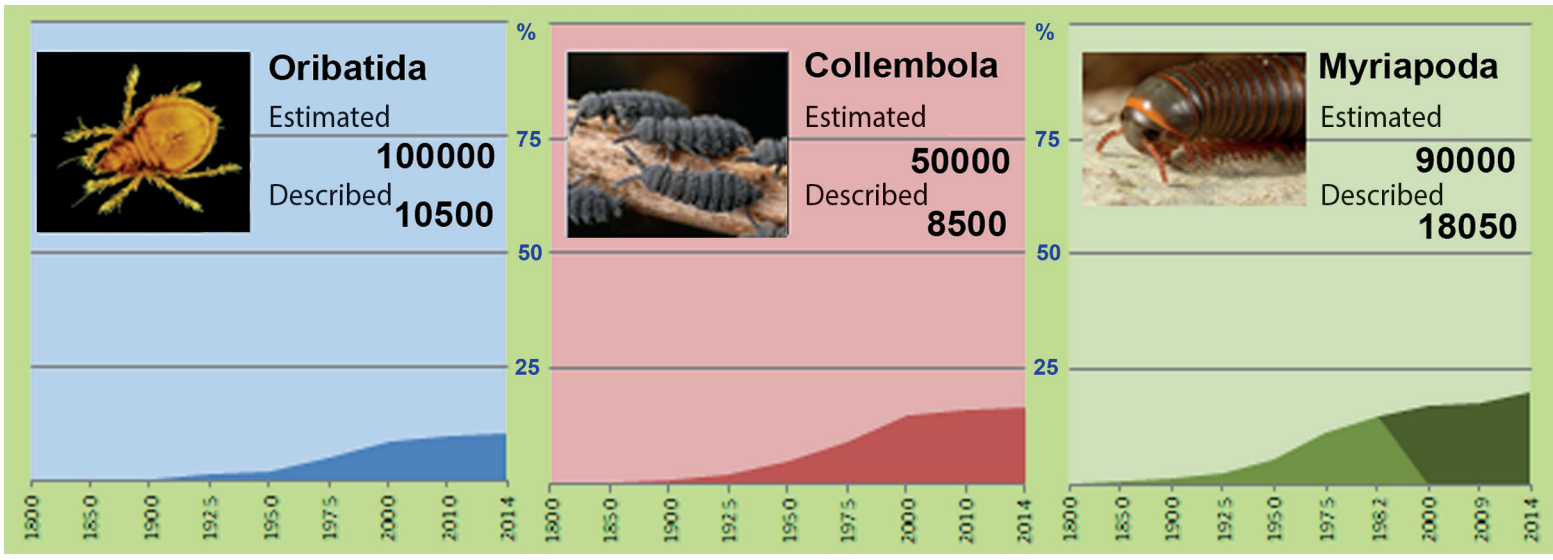


Figure 4 Increase in numbers of described (known) species as a part of overall estimated numbers of species in three soil fauna groups. All charts are demonstrating poor knowledge of overall biodiversity of soil organisms. © Ladislav Miko

(Orgiazzi *et al.* 2016) – still representing only a fragment of the estimated number of species (Fig. 4). Interestingly, the number of known species in the Czech Republic is not much different compared to other similarly explored countries (Jeffery *et al.* 2010).

Soil microarthropods can be found almost everywhere – even in dust on the road margins. Moreover, in habitats with intensive human impact there are mostly represented by few generalists, broadly tolerant species. Number and share of these (eurytopic) species in overall fauna may therefore indicate the quality, level of preservation or succession stage of the studied habitats. Similar information can also be provided by abundance of soil microarthropods. In general, increased intensity of human impacts not only simplifies the species composition, but also causes decrease in overall abundance. However, abundance is dependent on many other factors, such as overall amount of available dead organic matter, humidity, temperature, pH value or salinity of the soil – and this needs to be considered when assessing the anthropogenic impact. In mountain forest soils with acid deposits of humus of moder-type, for example, the abundance of oribatid mites may reach 250-300 thousand of individuals per square meter (exceptionally over 1 million), while even in the best quality farmed soil it hardly reaches several tens of thousands of individuals. In degraded, intensively farmed soils the abundance reaching few thousands or hundreds of individuals per square meter is not exceptional, and even "empty" samples may be found. This indicates a long-term loss of quality in the environment – and similar bioindication may be used to measure the restoration of soil quality parameters, *e.g.* in case of organic farming.

Relics and specialised species as indicators of high value ecosystems

From a point of view of nature conservation, soil microarthropods are not just remarkable due to their high species richness. Many species are quite narrowly adapted and specialised and at the same time able to survive for quite a long period of time at the particular site, even if original habitat has been significantly fragmented or altered. This allows to find which habitats were present at the given site, and together with analysis of potential vegetation to learn about history of a given place. Presence of relic species, or, from another perspective, species arriving due to changed climate and consequently induced habitat transformation, can provide useful information about ongoing changes. Alpine and sub-alpine meadows of the highest mountains, mountain peat-bogs or fragments of primeval forests are often characterised by the presence of boreal or boreo-montane species. The presence of species known primarily from high alpine European mountains (the Alps, the Carpathians) indicate the extraordinary character of Czech mountains, in spite of their relatively moderate elevation (Fig. 5).

Increased presence of xerophilous, heliophilous or termophilous species, often originating from the Mediterranean region and originally known only from southernmost sites of the Czech Republic, documented from several new, more northern localities (Fig. 6) may indicate direct or indirect climate change impact in Europe as well as in the Czech Republic. Presence of particular oribatid species may show the relic character of the whole habitat, this was the base for listing of several species in the Red List of Invertebrates of the Czech Republic (Miko 2017) as umbrella species of their soils. Also caves and generally karstic areas include very specific, and still mostly unknown microarthropod fauna, at least partly derived from species living in deep soil layers and crevices in weathering bedrock. Even if in Central Europe the species richness is apparently lower than in karst areas of the Balkan Peninsula (Romania, Slovenia, Croatia), even there some new and locally specific species have been discovered (Fig. 5). Detailed research in these areas may still bring some surprises – for example showing genetic heterogeneity (and hidden biodiversity) of cave populations, documenting colonisation of underground space and isolation or *vice versa* interconnections of their populations.

Table 1 Known and estimated species richness in the selected soil organism groups

group/taxon	known species	estimated species
Earthworms (Oligochaeta Lumbricoidea) – macrofauna	7,000	30,000
Myriapods – macrofauna	18,050	90,000
Ants (Hymenoptera Formicoidea) – macrofauna	14,000	25,000-30,000
Mites (Acari), soil living – mesofauna	55,000	100,000-150,000
Springtails (Collembola) – mesofana	8,000	5,0000
Nematodes – microfauna	25,000	1 to 10 million
Protists – microfauna	21,000	7 to 70 million
Fungi – microflora, primary decomposers	97,000	1.5 to 51 million
Bacteria and Archaea – microflora, primary decomposers	15,000	over 1 million
Total (many groups not included)	260,050	approx..11 to 132 million

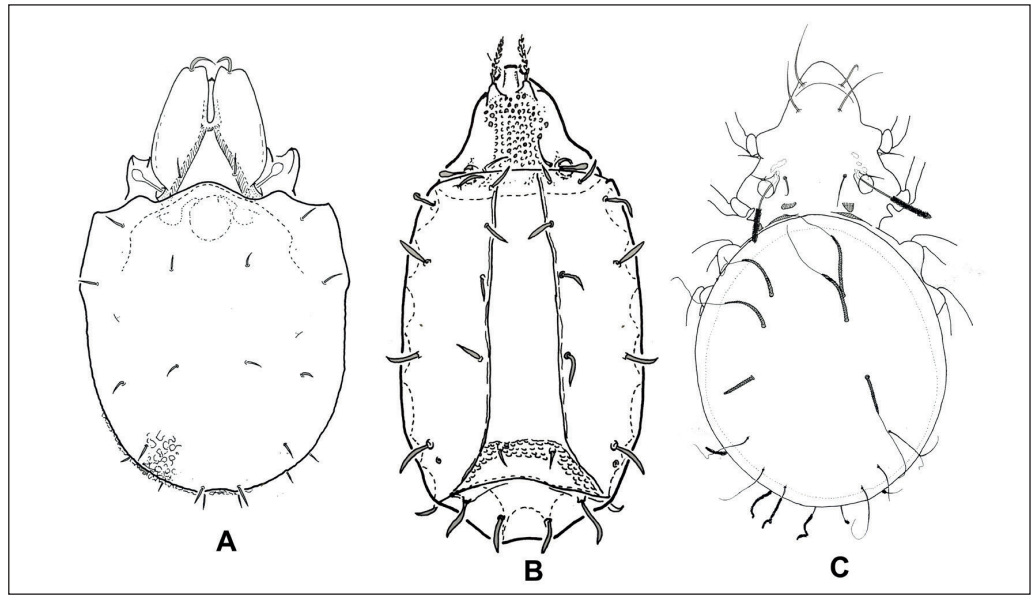


Figure 5 Rare, highly specialised or relic species of oribatid mites may indicate the extraordinary importance of their habitats – sub-alpine mountain areas with frost-modulated soils in the Krkonoše/Giant Mts. (**A**, **B**) or cave systems of the Moravský kras/Moravian Karst (**C**). **A** – *Unduloribates undulates* (Berlese, 1914); **B** – *Camisia (Ensicamisia) solhoeyi* Colloff, 1993; **C** – *Metabelbella clavigera* (Willmann, 1954). Source: **A**, **B** Weigmann (2006), **C** original © P. Ľuptáčik

Figure 6 Oribatid mites may indicate habitat quality and level of anthropogenic pressure *e.g.* in open (non-forested) habitats. *Tectocepheus velatus* (Michael, 1880) (**A**) belongs to the most tolerant species and occurs almost anywhere, in soils with high level of disturbances may be often the single present species. – *Peloptulus phaenotus* (C. L. Koch, 1844) (**B**) is a common species of dry and warmer meadow habitats, could be found also outside of well-preserved steppic and forest-steppe habitats. – *Licnodamaeus pulcherrimus* (Paoli, 1908) (**C**) occurs in a majority of well-preserved xerotherm grasslands and steppes. – *Passalozetes africanus* Grandjean, 1932 (**D**) indicates well preserved fragemnts of indigenous steppes and forest-steppes. – *Eubelba sculpta* (Mihelčič, 1957) (**E**) has been discovered on the territory of the Czech Republic only very recently, and represents rare species of dry grasslands on sandy soils. In the best preserved steppic habitats and grasslands on sandy soils, specialised predatory mites from the family Caeculidae (belonging to Trombidiformes, Prostigmata), such as *Allocaeculus sandbergensis* Mangová, Krumpál et Ľuptáčik, 2014 (**F**), described recently from Devínska Kobyla Hill (Bratislava, Slovakia) with highly adapted raptorial front pair of legs are rarely present. © Ladislav Miko

Fossil and subfossil record, importance for paleobiology

Body of many soil microarthropod species is soft and not heavily sclerotized, so that dead individuals are either fast consumed or decomposed. Species with a robust, chitinized body – such as oribatid mites, but also other mites (Mesostigmata, some predatory Prostigmata) and exceptionally some species from other groups *(e.g.* pauropods) – may sustain for a long time in the particular conditions of peat bogs or in clastic sediments allowing their determination. Study on communities or particular species preserved this way in well-dated fossil or sub-fossil layers (Fig. 7) provides an useful proxy information about past environmental conditions at the site, or (in case of alluvial sediments) in the vicinity upstream. The gathered information may serve as a good background for modelling and forecasting future developments, *e.g.* again in relation to climate change impacts. This approach already allowed to proof changes in soil microarthropod communities with changed paleoclimate, confirmed or completed available information about changes in vegetation, or even indicated significant impact of human settlements and soil cultivation on ecosystems already in time of very extensive use (Moldovan *et al.* 2011, 2016).

The option to study (sub-)fossil material allows also for quite different, phylogenetic and taxonomic studies. The oldest known and described fossil oribatids were found in Devonian sediments (Norton *et al.* 1988), further findings from the Carboniferous and from the Deuterozoic periods allow to better understand evolutionary trends in the whole group of chelicerates. The very fact, that Devonian oribatids closely resemble some of the recent species (Fig. 8), indicates how different may be the evolutionary pathways in differing soil conditions, and supposes that evolution of different arthropods may apparently undergo in "pockets" – sometimes very slowly and sometimes very fast and with highly intensive species radiation. At the same time, we can say that the so called "living fossils" – such as well-known *Latimeria* fish – are not just phenomenon occurring in distant deep ocean waters, but may be, with a bit of luck, observed even in soil of our own gardens.

Soil health and ecosystem restoration

Traits and characters of soil microarthropods, mentioned above, are clearly very useful as practical indicators in biodiversity studies and nature conservation in general. They can be used to indicate a level of anthropogenic disturbance or soil degradation (*e.g.* when assessing the quality of agricultural soils), or as general indication of soil environment quality and function in assessment of planned interventions (for example as a part of EIA studies). Survey of soil fauna was used *e. g.* in deciding about alternatives of highway building across the České Středohoří/Central Bohemian Uplands Protected Landscape Area (even if ultimately other – political – interests prevailed, information from survey still helps in managing details, which are not available or achievable on the basis of other environmental studies and surveys). Studies of soil mesofauna can document the value of non-intervention management in Specially Protected Areas, preserving of soil quality and functionality in natural forests, or – as in the case of the Na Plachtě Nature Monument in the city of Hradec Králové (east Bohemia) – it may prove high biodiversity value of areas intended for further development. Species richness, together with presence of many rare species, may document unique quality of some Czech Specially Protected Areas – the Velká Kotlina/Grand Fold in the Hrubý Jeseník Mts., Nature Reserves of the Beskydy Mts., peat-bogs of the Šumava/Bohemian Forest Mts. National Park or habitats in the Krkonoše/Giant Mts. National Park may serve as good examples (Miko 1986, 2014, Starý 1988, 1993).

Recent studies have documented also usefulness of soil microarthropod communities as indicators of succession and ecosystem restoration. Studies on bare soil deposits/spoil heaps from surface open-pit brown coal mining in northern Bohemia show that spontaneous succession may deliver higher biological and ecological value including sustainability parameters, than often very costly artificial man-made active remediation approaches (Frouz *et al.* 2008). Development of soil microarthropod communities after targeted management measures – *e. g.* in heathland or peat-bog restoration projects – may help to check that restored ecosystems are brought after human disturbances back to more natural, spontaneous trajectories, which are desirable from the nature and biodiversity conservation point of view (Frouz *et al.* 2009).

Missing expertise and further research needs

From presented – and still incomplete – overview of possibilities, offered by soil organisms' studies, it is evident that their importance for applied ecology, biodiversity conservation and nature protection and management, but also for agricultural practice or environmental assessment approaches may be significant. The main obstacle at present is the lack of capacity, missing practical experience and absence of the agreed common methodologies, with linked absence of broadly accessible publication sources. Number of experts for particular groups of soil organisms, perhaps with exemption of microbiological studies, can be counted on the fingers of single hand, and this situation does not differ significantly from that in other European countries or even globally. Interest to study soil organisms and to apply study results in practice has been growing only very slowly. Recently published of Czech-language textbooks and practical manuals of soil biology and ecology (Šantrůčková *et al.* 2018; Miko *et al.* 2019; Šimek *et al.* 2019) could hopefully boost this interest and allow for far broader utilisation of opportunities, offered by study on soil fauna. ■

The list of references is attached to the online version of the article at www.casopis.ochranaprirody.cz.

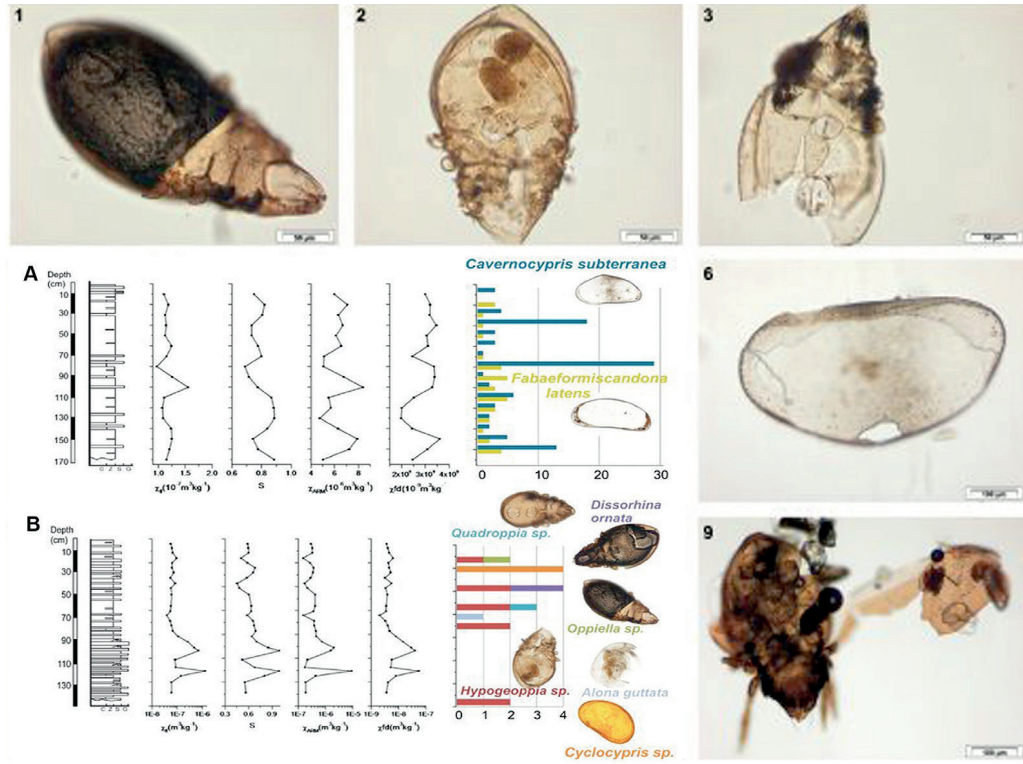


Figure 7 Fossil remnants of oribatids (**1-3**, **9**), together with other species with sclerotised body cover (such as Ostracoda – **6**) can be used in combination with different dating methods (**A**, **B**) to reconstruct ecological conditions in the near and distant past. Source: Moldovan *et al* (2016), adapted. © Ladislav Miko

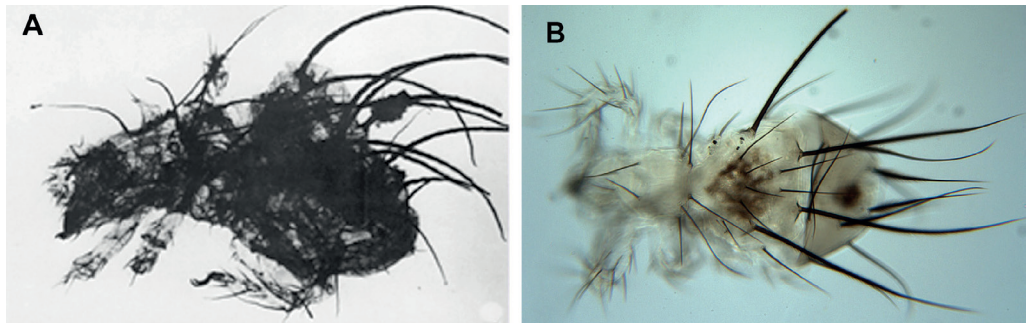


Figure 8 Findings of oribatid fossils suggest that some of the common species of the present are in fact a living fossil. (**A**) Fossil species *Devonacarus sellnicki* Norton *et al.*, 1988 from Devonian sediments in the U.S.A. is very similar to recent species *Paleacarus hystricinus* Tragardh, 1932 (**B**), which can also be found in the territory of the Czech Republic. © Ladislav Miko

Standardization in Nature Conservation and Landscape Management

Pavel Pešout & Pavel Štěrba

The Nature Conservation Agency of the Czech Republic (NCA CR) has been for ten years elaborating together with academic institutions standards in nature conservation and landscape protection. Almost 30 such standards have been published yet and approx. the same number has been under preparation. Up-to-date experience shows that the concept of standardization in various activities has proved itself successful and has fulfilled its purpose: standards are used by designers, customers, planners, project implementers, contractors, evaluators of application for a subsidy/subvention/grant and they are also applied in the State/Public Administration performance. Moreover, they are sometimes misapplied. Thus, the standards at present have been serving as a basis for establishing unified code lists of activities in nature conservation and landscape protection linked to costs of common measures and consequently for planning and documenting the interventions having been made in nature and the landscape.

Grass sod/turf removal is included in nature and landscape management standard D 02 006 Disturbance Management on Non-forest Areas. The photograph shows topsoil grass sod/turf Vysoká hole in the Praděd/Altvater National Nature Reserve, 2019. © Pavel Pešout

The NCA CR started it standardisation of landscape and management activities in 2010 after discovering that commented instructions (*e.g.* those issued in the NCA CR methodology series) fail to secure sufficient understanding among all partners and participants in the planning and implementation of practical nature conservation measures. They lacked a clearly defined denominator to which the different actions in the process of prioritisation, setting, assessment, designing, assignment, implementation in the field, acceptance and inspection/checking of practical nature conservation measures can be related (for details, see PEŠOUT & ŠTĚRBA 2013).

Although the term standard may be perceived as a synonym of a norm (KNOTEK 2012), it does not have the intention to be so. It differs in the way standards are developed: in a broad discussion with professionals, details adapted to their future use, and public availability free of charge. Long-term collaboration between state bodies and relevant academic institutions in order to secure continuous updating is also typical of standards (see Box 1).

The standards have become widely used. They help State Nature Conservancy authorities and other investors with defining assignments for designers, formulating the subject of the work, and assessing the work for its acceptance (KNOTEK 2013). They help State/Public Administration in comparing the effectivity of measures supported. The standards also contribute to a unification of the State/Public Administration performance (CHOTĚBOR 2013).

Current state of standard development

Standards have been developed for over ten years according to an unaltered plan including fixed stages from signing contracts with academic institutions and assembling a development team through development of the content and public and professional reviewing for approval and publication (PEŠOUT & ŠTĚRBA *l.c.*). The documentation of the development of a standard incl. the settlement of remarks is deposited in and available from the public NCA CR library.

Presently, 26 standards have been developed and are published at www.standardy.nature.cz, while other three have been submitted for review. Remaining 22 standards have been under development (see Box 2). In 2022, most standards dealing with the most common activities in nature and landscape management should be compiled and published.

During the development of the standards, all participants/stakeholders work together fruitfully, representatives of various opinions and approaches meet, opinions are refined, and concepts and interests are clarified. We appreciate the cooperation with colleagues from academic institutions and other professional collaborators who are willing to work on the development of the standards, just as specialists from reviewing institutions who correct the final form of the standards with their unbiased views. Participation of a broad range of professions, whose involvement is welcomed in the so-called 'public review' stage, is very essential.

Updating of the standards

As knowledge progresses and practical experience is gathered in the implementation of measures for nature and the landscape, particular parts of the standards may become obsolete. Therefore the collaboration between the NCA CR and academic institutions is permanent. It is based on mutual interest in keeping the standards up to date. Thus, although some standards have not been finished yet, the first ones have already been updated.

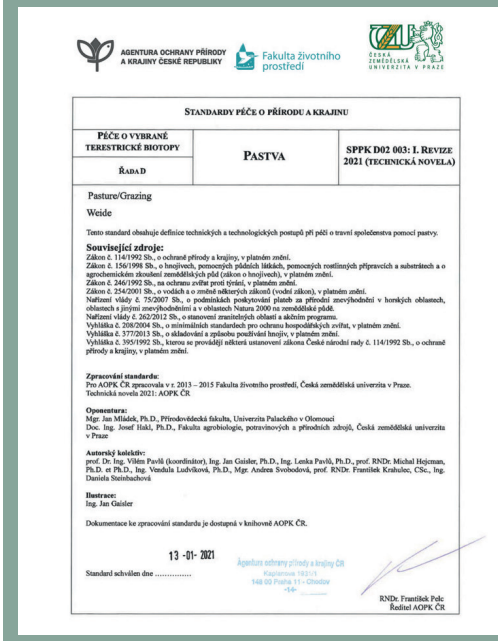
An example of an updated standard is Planting Trees (SPPK A 02 001). Another one is a standard dealing with grazing (SPPK D 02 003), where amendments to it were evoked by the need to adopt a standard for livestock protection against large carnivore attacks (SPPK E 02 006), which had initially not been planned. This shows that not only existing standards need updating, but also completely new ones must be added. There, a new set of measures caused by the return of large carnivores to a large area in the Czech Republic needed to be implemented in the field. Similarly, standardisation of fire management is assumed to be necessary in the future (as a supplement to the already published SPPK D 02 006 standard titled Disturbance Management on Non-forest Areas) if the presently discussed amendment to the Nature Conservation and Landscape Protection Act is approved, enabling the burning of vegetation in the selected cases.

Standards and costs of common measures

Ten years ago, NCA CR also started to produce documents named Costs of Common Measures (CCM), at the time titled Pricelists of Common Measures of the NCA CR. The reason was the adoption of a new Administrative Procedure Code and the 2010 ruling of the Constitutional Court, which helped to put into effect agreements on farming methods with landowners according to Article 68 of the Nature Conservation and Landscape Protection Act, to implement measures for the improvement of the natural environment, and to refrain from selected activities in the form of public contracts (PEŠOUT & ŠMÍDOVÁ 2012). Until then, all measures had been assigned in the form of services and the price was determined in accordance with public procurement regulations. According to the farming agreements, however, contributions were paid pursuant to Article 69. Therefore the mentioned Pricelists of Common Measures was compiled, based on averages of supplier prices at that time, which secured a comparable payments for implementing similar measures across various regions. Based on a recommendation of the Czech Republic Supreme Audit Office, the experience was later taken over by the Ministry of the Environment of the Czech Republic to ensure comparable practice in areas not falling

Box 1 What is a Nature and Landscape Management Standard?

A nature and landscape management standard is a recommendation setting output parameters and providing a technical description of procedures for particular activities commonly implemented in nature and landscape management, incl. properties of materials, products and definitions. The standards are developed in collaboration with academic institutions and the Nature Conservation Agency of the Czech Republic (NCA CR) publishes them only after expert/technical and public reviews. Therefore, elaboration of standards provides the widest possible professional consensus is achieved. Standards are freely available to the public and are updated with increasing knowledge (PEŠOUT & ŠTĚRBA 2013).


AGENTURA OCHRANY PŘÍRODY A KRAJINY ČESKÉ REPUBLIKY
Fakulta životního prostředí
ČZU ČESKÁ ZEMĚDĚLSKÁ UNIVERZITA V PRAZE

STANDARDY PÉČE O PŘÍRODU A KRAJINU

PÉČE O VYBRANÉ TERESTRICKÉ BIOTOPY | PASTVA | SPPK D02 003: I. REVIZE 2021 (TECHNICKÁ NOVELA)

ŘADA D

Pasture/Grazing

Weide

Tento standard obsahuje definice technických a technologických postupů při péči o travní společenstva pomocí pastvy.

Související zdroje:
Zákon č. 114/1992 Sb., o ochraně přírody a krajiny, v platném znění.
Zákon č. 156/1998 Sb., o hnojivech, pomocných půdních látkách, pomocných rostlinných přípravcích a substrátech a o agrochemickém zkoušení zemědělských půd (zákon o hnojivech), v platném znění.
Zákon č. 246/1992 Sb., na ochranu zvěře proti týrání, v platném znění.
Zákon č. 254/2001 Sb., o vodách a o změně některých zákonů (vodní zákon), v platném znění.
Nařízení vlády č. 75/2007 Sb., o podmínkách poskytování plateb za přírodní znevýhodnění v horských oblastech, oblastech s jinými znevýhodněními a v oblastech Natura 2000 na zemědělské půdě.
Nařízení vlády č. 262/2012 Sb., o stanovení znevýhodněných oblastí a náhrnm programu.
Vyhláška č. 208/2004 Sb., o minimálních standardech pro ochranu hospodářských zvířat, v platném znění.
Vyhláška č. 377/2013 Sb., o skladování a způsobu používání hnojiv, v platném znění.
Vyhláška č. 395/1992 Sb., kterou se provádějí některá ustanovení zákona České národní rady č. 114/1992 Sb., o ochraně přírody a krajiny, v platném znění.

Zpracování standardu:
Pro AOPK ČR zpracovala v r. 2013 – 2015 Fakulta životního prostředí, Česká zemědělská univerzita v Praze.
Technická novela 2021: AOPK ČR

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Ilustrace:
Ing. Jan Gaisler

Dokumentace ke zpracování standardu je dostupná v knihovně AOPK ČR.

13 -01- 2021
Standard schválen dne .....

Agentura ochrany přírody a krajiny ČR
Kaplanova 1931/1
148 00 Praha 11 - Chodov

RNDr. František Pelc
Ředitel AOPK ČR

Title page of D 02-003 Standard: Grazing

Tab. 1 Current state of development of nature conservation and landscape management standards © Pavel Štěrba

standard (Code and name)		** year of publication	**
Series A Arboristical standards			
SPPK A 01 001	Assessment of woody tree state	2018	
SPPK A 01 002	Woody plant protection during building and development	2017	
SPPK A 02 001	Planting trees	2021*	
SPPK A 02 002	Pruning trees	2015*	
SPPK A 02 003	Planting and pruning shrubs	2014	
SPPK A 02 004	Crown security binding and other stabilising systems	2019	
SPPK A 02 005	Cutting/felling trees	2018	
SPPK A 02 006	Protecting trees against lightening strike	2016	
SPPK A 02 007	Modification of woody plant habitats	2020	
SPPK A 02 008	Establishing and managing woody plant growths	UP	
SPPK A 02 009	Special tree measures/treatment	2019	
SPPK A 02 010	Tree management near public transport infrastructure	2020	
SPPK A 02 011	Tree management near public technological infrastructure	2018	
Series B Water in the landscape			
SPPK B 02 001	Pool building and restoration	2014	
SPPK B 02 002	Restoring water regime in peat-bogs and springs	UP	
SPPK B 02 003	Restoring small watercourses and their floodplains	UP	
SPPK B 02 004	Management of watercourses incl. riparian growths	UP	
SPPK B 02 005	Extensive fishpond management	UP	
SPPK B 02 006	Fish ladders/Fish passes	2014	
SPPK B 02 007	Building and restoration small water bodies in nature-friendly way	UP	
Series C TSES and landscape elements			
SPPK C 01 001	TSES functioning assessment	UP	
SPPK C 01 002	Designing TSES (plans and projects)	UP	
SPPK C 02 001	Forming biocentres and biological corridors	UP	
SPPK C 02 002	Forming landscape and interactive elements	UP	
SPPK C 02 003	Planting fruit woody plants in the agricultural landscape	2016	
SPPK C 02 004	Management TSES components incl. landscape and interactive elements	UP	
SPPK C 02 005	Management of fruit woody plant plantings	2016	
SPPK C 02 006	Establishment and management of fruit sort genepool plots	2018	
SPPK C 02 007	Grasslands	2018	
Series D Selective terrestrial habitat management			
SPPK D 02 001	Restoring grassland communities using subnational seed mixtures	2017*	
SPPK D 02 002	Restoring long-term unmanaged grassland communities incl. elimination of self-sowing encroaching woody plants	UP	
SPPK D 02 003	Grazing	2021*	
SPPK D 02 004	Mowing	2017	
SPPK D 02 005	Measures to improve forest growth species composition	2014	
SPPK D 02 006	Disturbance management on non-forest areas	2018	
SPPK D 02 007	Eradication of the selected plant invasive alien species incl. subsequent site management	2016	
SPPK D 02 008	Eradication of the selected animal invasive alien species incl. subsequent site management	UP	
Series E Special species protection measures			
SPPK E 02 001	Installing and operating mobile seasonal barriers along roads to protect amphibians	2020	
SPPK E 02 002	Permanent measures to provide landscape permeability for amphibians	2021	
SPPK E 02 003	Measures to provide landscape permeability for Eurasian otters and other small mammals	UP	
SPPK E 02 004	Measures for mitigating injuries of birds and other animals on overhead power lines	UP	
SPPK E 02 005	Managing trees as a rare species habitat	UP	
SPPK E 02 006	Livestock protection against large carnivore attacks	2021	
SPPK E 02 007	Measures for mitigating injuries of birds on glass and reflection spaces	UP	
Series F Visitor infrastructure			
SPPK F 01 001	Monitoring visitor attendance in Specially Protected Areas	UP	
SPPK F 02 001	Fixing paths/trails and side-by-side log paths/trails	UP	
SPPK F 02 002	Vantage points/lookouts and overcoming height differences (steps, ladders, handrails, *etc.*)	UP	
SPPK F 02 003	Footbridges and small bridges	UP	
SPPK F 02 004	Marking and labelling paths, trails, roads and cycleways/bikeways	UP	
SPPK F 02 005	Marking borders of Specially Protected Areas and Memorial/Veteran Trees	UP	
SPPK F 02 006	Information signs and signboards	UP	
SPPK F 02 007	Rest facility equipment (benches, shelter roofs, sheds, summer-houses, gazebos, *etc.*)	UP	

* – updated edition published; **UP** – under preparation; **TSES** – a multilevel national ecological network (local, sub-national, national/international) consisting of biocentres (core areas), biological corridors and interactive elements.

under the NCA CR administration. Since then, the Ministry has issued CCMs every year. They are updated according to experience of State Nature Conservancy authorities and from practice in the comment process. Exceptionally (for new, formerly not commonly implemented measures) a CCM is compiled in another way (e.g. by targeted survey or research).

As the standards are developed and published, they are gradually linked to the CCMs. Its aim is to standardise activities in procedure, conditions and materials traceable in the CCMs and conversely. For example, once the arboriculture standard (SPPK A 02 002) was published, the structure and names of measures in the relevant part of the CCM were completely changed to be consistent with the published standard. In the different chapters of the current version of CCM (2021) also the related standards are mentioned.

Standards and activity code lists

The standards are gaining in importance because of the introduction of active adaptive management (AM) in Specially Protected Areas (Pešout & Knižátková 2020). A prerequisite for continuously updated administration and management is the necessary digitisation of the entire AM cycle from planning, setting targets and their prioritisation, administration and implementation to monitoring the state of the subject of conservation and assessing how well management and conservation goals have been achieved. A tool making this possible is a unified nature conservation information system, which has currently been under preparation (Zárybnický *et al.* 2020). This approach requires unification of the different code lists, such as the code list of nature and landscape

management activities (see Box 2), in order to make clear what activities are meant by a certain term. The nature and landscape management standards serve as a basis for elaborating such code lists.

Standardisation must not limit individual approaches

The objective of the standards is not only to unify terms in the communication among designers, investors, suppliers, the State/Public Administration and experts and technical institutions, but also to achieve the required quality in nature and landscape management. The standards are based on examples of good practice, therefore respecting them should guarantee correct and appropriate implementation of a project.

At the same time, however, it must be stressed that each measure has to be considered individually, taking into account specific local conditions. It is possible or rather certain that conditions and procedures set in a standard will have to be altered in the particular cases. In such a situation, thoughtless insisting on consistent application of the standard is one of the mistakes made in applying standards. On the other hand, a decision to deviate from the standard procedure must be made consciously, and in internal NCA CR practice also described and justified. Documentation of an aberrant procedure is not only important for a particular situation, but it also (especially when repeated) is an incentive to update the standard. It is moreover important in the checking payments from subvention programmes/subsidy schemes guaranteed by the Ministry of the Environment of the Czech Republic.

Standards should thus – whether for convenience or caution – not make the land manager or another supplier or work assessor stop considering or even ignore specific conditions at the implementation site and so make less effort in setting the parameters of the measure as targeted and tailored as possible to achieve the best possible result.

The standards in nature and landscape management can only support the appropriate implementation of the measures, but they alone cannot ensure adequate quality. Therefore, they should be handled as a utility or a tool, not as a law. ■

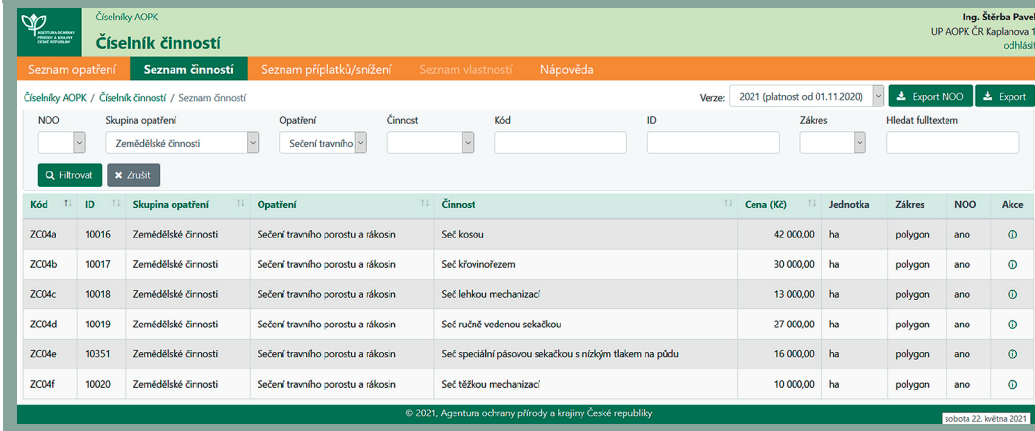
The list of references is attached to the online version of the article at www.casopis.ochranaprirody.cz.

Box 2 Code List of Nature and Landscape Management Activities

The Nature Conservation Agency of the Czech Republic (NCA CR) has for a long time been documenting implemented nature and landscape management measures, including maps, in the Nature Conservation Information System (ZÁRYBNICKÝ *et al*. 2020). For this purpose, a multilevel code list of management activities (category of measures – measure – activity) is used. The activity code list is uniform not only in the implemented management, but also in management planning (a necessary step to prepare the digitisation of management plans), and at the same time it serves to monitor management and to assess the effectivity of the management implemented, making it a cornerstone of the adaptive management cycle.

The code list currently includes a total of 498 different nature and landscape management activities.

Each activity in the list is assigned the usual price (basic price and possible surcharges/reductions) from the Costs of Common Measures (CCM). The interconnection of activity code lists and CCMs is a significant step forward, opening further data processing and analyses. CCMs as they are now available (*e.g.* https://www.mzp.cz/cz/naklady_obvyklych_opatreni_mzp) are an export from the NCA CR's Nature Conservation Information System, of which CCMs are an integral part.



Example of unified code list of activities linked to costs of common measures (Filter: Category of measures – Farming activities, Measure – Grassland and reedbed mowing).

Standard D 02-003 Grazing was amended in 2021. Grazing on Štítarský kopec Hill sub-national Territorial System of Ecological Stability (TSES) biocentre/core area carried out by the Czech Union for Nature Conservation, Libosváry Local Chapter. © Pavel Pešout

Ecosystem Restoration of Brown Coal Open-pit Mines

Pavel Pešout, Michal Porteš, Kateřina Černý Pixová,
Markéta Hendrychová, Petr Kříž & David Lacina

Mineral and rock mining carried out for centuries has had significantly negative impacts on the landscape and the environment in the Czech Republic. By size, the most extensive destruction in the whole country has been caused by surface open-pit brown coal mining in the Krušné hory/Ore Mountains Foothills Basin, also known as the North Bohemian Basin. More than 400 km^2 have been affected by mining and by related infrastructure and industry there. Nowadays, when a termination of active brown coal mining termination in the Sokolov and Most Basins[1] has been in sight, the future use of the closed quarries is being discussed extensively. Experts have long been aware of the great scientific significance of abandoned non-reclaimed excavations and spoil heaps. Therefore the question of applying ecosystem restoration to the above post-industrial habitats has been even more urgent than ever before.

Figure 1 The mosaic morphology of brown coal spoil heaps is determined by the way they were established and conditions the diversity of habitats created on them. A part of the Radovesice spoil heaps left to natural succession. © Markéta Hendrychová

Remediation and reclamation plans have been compiled for all large brown coal open-pits or quarries. The more progressive ones allow for leaving 10% of the area to spontaneous succession (Fig. 2). In the remaining area, costly technological (hydrological, agricultural or silvicultural) reclamation will take place. The Most-Ležáky and Chabařovice quarries have been remediated and reclaimed this way. In other ones (*e.g.* the Vršany and Czechoslovak Army Mine – CSA quarry) already a significant area of spoil heaps has been technologically reclaimed and new ones are planned.

Scientific importance of post-mining area

Scientific research into non-reclaimed spoil heaps and active quarries in the past decade has revealed an extraordinary biological potential of these sites. The brown coal mining areas in the Ústí Region, often referred to as the lunar landscapes, are in fact very species-rich, which is especially true in the case of spoil heaps. The different succession stages on them provide valuable habitats for a range of endangered or extinct wild animal and plant species which are rapidly disappearing from the landscape or have already vanished. Surface mines are refugia for these species in the altered agricultural landscape (see *e.g.* Hendrychová *et al.* 2008, Vojar *et al.* 2012, 2018, Šálek 2012, Tichánek & Tropek 2016, Hendrychová & Bogusch 2016, Vicentiny *et al.* 2018, Beran *et al.* 2018a, 2018b).

The importance of post-mining areas for biodiversity can be well illustrated on birds of which we have detailed information. The Tawny pipit (*Anthus campestris* – see Box 1), Northern wheatear (*Oenanthe oenanthe*) and many other legally protected or rare bird species nest in the mining areas, often in high densities. The numbers of some species in the large quarries of the Most area even match estimations of nesting populations for the entire country. Other species nest strictly in large quarries only or have the majority of their population or the only large population there. In general, large quarries are important source populations for many farmland birds, which are among the most endangered and most rapidly declining groups of the vertebrates all over Europe.

The main reasons why brown coal surface mines are so interesting to biota include:

- sufficiently large areas of sparsely vegetated or bare habitats;
- continuous formation of communities in primary succession stages;
- absence of large-scale use of chemicals and therewith sufficiency of food;
- bedrock variety creating a mosaic of substrates of different trophy, including phytotoxic spots where succession is blocked for a long time;
- different site ages; due to the long duration of mining, plots in various stages of succession can be found in particular parts of a quarry;
- waterlogging: thanks to the bedrock and various technological interventions in this type of the environment, a varied range of waterlogged plots are found there, from completely dry to arid through intermittently wet areas and shallow pools to larger and deeper water bodies.

Comparison of reclaimed plots and plots left to spontaneous development

The target of financially demanding technological reclamation is to create a cultural forest, agricultural land, a lake with a regulated water level, a recreation area, *etc.* (Pecharová *et al.* 2011). The result is an artificial landscape very poor in biodiversity. Including already inundated residual excavations (Lake Most and Lake Milada), non-productive habitats supporting a generally functional landscape and giving priority to ecological or nature conservation functions (tree rows, hedgerows, baulks, forest margins, spontaneously developing spots, sands, wetlands, *etc.*) cover less than 9% of reclaimed brown coal quarries and spoil heaps in the Most Basin (Hendrychová *et al.* 2020). However, reclaimed landscapes are often unstable, requiring long-term or even permanent finances for maintenance.

Ecological restoration applying natural processes allows for gradual colonisation of post-mining areas by pioneer species and subsequently further stages of succession, with which other ecological/functional groups of species (guilds) are associated. Since the onset of individual succession stages in time and space depends on local conditions (subsoil, trophy, slope, humidity, *etc.*), which are very variable in a post-mining area (see above), a diverse mosaic is created, from areas lacking vegetation or partly covered by herbs or shrubs to completely closed habitats with a developed shrub layer and scattered trees. Moreover, many ecotones are found in such environments. Early succession stages in cultural landscapes attract, for example, some pollinating insects (Tscharntke *et al.* 2002). An important feature of ecological restoration is its low cost (see Box 3).

Today we have the opportunity to assess and compare areas left to spontaneous development with technologically reclaimed ones at many sites. Numerous surveys have repeatedly confirmed that ecological restoration allows for development of extraordinarily valuable

BOX 1 The Tawny Pipit: Flagship Species of Large Surface Brown Coal Mines

Due to its specific habitat requirements (low vegetation, sparsely vegetated plots), the Tawny pipit (*Anthus campestris*) has disappeared from the entire Czech Republic, except for populations capable of reproduction preserved in the surface brown coal mines of the Ústí Region. Regular monitoring since 2009, including colour marking, has shown that the Czech population counts up to 200 nesting pairs and is fully dependent on active mining and regular creation of communities in the initial stage of succession (Beran 2020).

The Tawny pipit is a cryptically coloured species with a limited voice expression, living covertly. It is therefore very demanding to monitor it. © Michal Porteš

In the past decade, the bionomics of tawny pipit has been intensive studied (geolocation, predation, acoustic activity, nest site fidelity, genetic data, habitat requirements at different types of soil heap surfaces) (Briedis *et al.* 2016, 2020). The studies were a part of a project from the Technology Agency of the Czech Republic, during which also certified management methods were prepared and suitable habitats for tawny pipit and northern wheatear were created in actively mined areas (Beran *et. al.* 2018a, 2018b). The Tawny pipit thus serves as an indicative and umbrella species in the area of large surface brown coal mines.

Figure 2 Brown coal mining in the Czechoslovak Army Mine (CSA quarry) will finish within five years. Large areas, particularly in the NW part of the Krušné hory/Ore Mountains foothills, have not yet been technologically reclaimed. In cooperation with the Czech University of Life Sciences Prague, the Nature Conservation Agency of the Czech Republic has delineated an extensive area which should be left to ecological restoration. © Markéta Hendrychová

habitats inhabited by endangered species at incomparably lower creation and maintenance costs (Bejček & Tyrner 1980, Hodačová & Prach 2003, Hendrychová 2008, Tropek & Řehounek 2011, Jongepierová *et al.* 2018). From the pedogenetic point of view, non-reclaimed parts of spoil heaps are not far behind in qualitative features compared to the technologically created anthrosoils. Some spontaneously created woodlands show a higher biological soil activity and more efficient decomposition of dead organic matter, while they can also produce more timber, usually around the 25th year of development (Frouz *et al.* 2008, 2015).

Looking for the target use of large quarries

The completed technological, hydrological, silvicultural and agricultural reclamations (*e.g.* Most-Ležáky, now Lake Most) have raised the question of their economic effectivity. It is not just that their implementation is extremely expensive (paid by the mining company), but also its subsequent maintenance is costly (paid by the State). For example in the case of the Most excavation, annual maintenance costs amount to an average of CZK 15 million (EUR 0.6 million), of which raising the water level fallen by evaporation costs CZK 8–10 million a year (EUR 0.3–0.4 million). Future revenues from recreation and sales of land for economic use and development can be expected, but even though many years have passed since the lake was created, a solution for cost-effective use has still been sought. Lake Milada is in a similar situation. There, an architectural-urbanistic-landscaping competition has been started. This experience logically asks for a more sustainable solution for the remaining quarries.

In 2017, the Government of the Czech Republic stated that no target state has been determined for the currently intensively mined brown coal areas, where extensive water bodies are planned according to the current remediation and reclamation plans. It has therefore imposed to explore possibilities of effective exploitation, taking into account operation costs and simultaneously the revenues from their potential development.

Lake and yacht landscape?

In visualisations, the new post-mining 'lake landscape' looks fascinating. It is however questionable whether spontaneous inundation of the excavations or pumping water into them from nearby water pipes after mining and the subsequent control of the water level is realistic.

Current studies[2] show that it is hard to establish a long-term stabilised lake water level when only inflow from the respective catchment is considered. Moreover, just a small change in the flow rate may cause considerable deviations in level in the future. The assessment included a modelling of flow rates, precipitation and temperature[3] for three time levels: the present, the year 2050 and the year 2100. For the initial filling of the lakes, the Ohře River (the Bílina stream was excluded for its insufficient water quality and quantity) was considered as the water source, provided a minimum residual flow rate and water withdrawal downstream is guaranteed. It was demonstrated that this source for the initial filling of the lakes has a sufficient capacity and is reliable. The time (years or decades) it will take to fill the lakes will depend on *e.g.* the time schedule of mining termination, *i.e.* whether to fill the lakes successively or parallel to the mining.

Controlling the water level achieved by initial filling, without the need of further water pumping *(e.g.* from the Ohře River) to compensate for evaporation, was shown to be sustainable in the case of the lakes considered at the sites of Bílina and Libouš (possibly connected with the Nechranice water works). Also the level of Lake Milada, which is supplied with groundwater

BOX 2 Memorandum of Cooperation to Identify Suitable Sites for Ecological Restoration after Termination of Brown Coal Surface Mining

The Nature Conservation Agency of the Czech Republic (NCA CR), together with Ústí Fuel Plant Company, State Enterprise and the Czech University of Life Sciences Prague, have declared their will to cooperate on identifying suitable sites for ecological restoration.

Two cooperation objectives were formulated in the joint Memorandum of Cooperation signed 3 September 2019 (NCA CR 2019):

1. **Finding a sufficiently large post-mining area suitable to establish a Specially Protected Area of national importance, where the conservation target would be maintaining natural processes, preparing its protection and proposing a long-term monitoring scheme.**

2. **Identifying smaller areas with concentrated natural values, suitable for ecological restoration and proposing a method of preserving them.**

Already in 2019, a joint working group, consisting also of representatives of mining companies of the Sev.en Energy AG energy group, was established to fulfil the objectives of the Memorandum and started to work.

from overflow wells, should be sustainable. The study assessed the lake considered in the CSA as unusable for water management, as it would only be a part of a water management system with demands for controlling its own balance (compensation for evaporation). For the hydrologically reclaimed site of Most it was confirmed that the water level is unsustainable under the current climate conditions. The current water level will have to be maintained by pumping water there also in the future[4]. Neither for the lake considered at the site of Vršany a solution for a stabilised water level was found in any of the examined ways.

Placing solar power plants in post-mining areas?

Lately, in addition to hydrological reclamation, efforts have been made to use post-mining areas for energetic and other purposes in order to increase the proportion of carbon-free energy sources. In 2020, the potential of reclaimed areas was assessed, including the water level of lakes considered to be used for installing photovoltaic power plants (PVP). It was verified that building these facilities in areas of future reclaimed areas may provide a very significant power potential (maximum production estimated at 4.0–6.8 TWh/yr). Specifically in the CSA, the estimated PVP capacity is 0.66–1.04 GW[5].

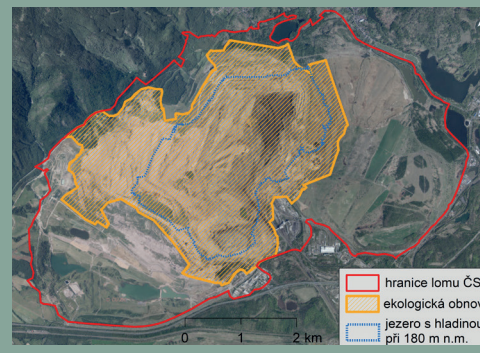
Also the use of these areas for building pumped storage power plants is being discussed. Although the economic assessment is positive in the case of the CSA and Lake Milada, it is necessary to carry out a nature and the landscape impact assessment before a decision is made to work out these plans seriously.

Ecological restoration is a solution

Although a wider application of ecological restoration has repeatedly been proposed by the Nature Conservation Agency of the Czech Republic (NCA CR), scientific institutes and non-governmental organisations, these proposals have mostly only been included in strategic documents. The Implementation Plan of the Strategic Framework Czech Republic 2030 states the necessity to protect near-natural restoration sites in disturbed areas. This is clarified in the National Biodiversity Strategy of the Czech Republic 2016–2025, which states that it is very appropriate to leave strongly disturbed or completely destroyed ecosystems (*e.g.* surface mining areas) to spontaneous succession combined with suitable management interventions. Near-natural restoration is also mentioned in regional strategies of the Ústí Region.

BOX 3 Applying Spontaneous Succession as an Effective Tool of Ecological Restoration of the Czechoslovak Army Mine (CSA Quarry)

The study by this name summarises the most important scientific knowledge for the application of natural and controlled succession in the reclamation of brown coal surface mines and spoil heaps. It specifically presents the possibilities of applying succession in the Czechoslovak Army Mine (CSA quarry) in two possible ways.



The size of the area suitable for spontaneous development in the CSA quarry is 12.72 km^2, covering approx. 44% of the quarry (6.03 km^2, *i.e.* 21%, when filling the lake to a level of 180 m a.s.l.). © Markéta Hendrychová

One assumes the construction of a lake according to the current remediation and reclamation plan with a water level of 180 m a.s.l. and leaving the remaining half to natural succession, whereas the other alternative even allows for leaving the entire area of the quarry to succession supported by water spontaneously flowing into the area up to a naturally sustainable level. Both alternatives are compared with the current reclamation plan: they provide a direction which is significantly cheaper (saving CZK hundreds of millions to billions), more efficient, to be implemented immediately at a low risk, at the same time having a higher potential for further sustainable use of the area of a considerably higher quality even with regard to climate change. The study emphasises that applying succession to restore an extensive area would – besides a considerable improvement of environmental quality and a contribution to nature conservation in the region – open an enormous potential for scientific research and tourist education and is at the same time in agreement with all applicable strategies at various levels, including the concepts of further socio-economic development of the Ústí Region (HENDRYCHOVÁ *et al.* 2020).

Figure 3 Some parts are being left to spontaneous succession in reclamation, but these are only small areas. The photo shows an area left to natural restoration at the Pokrok spoil heap. © Markéta Hendrychová

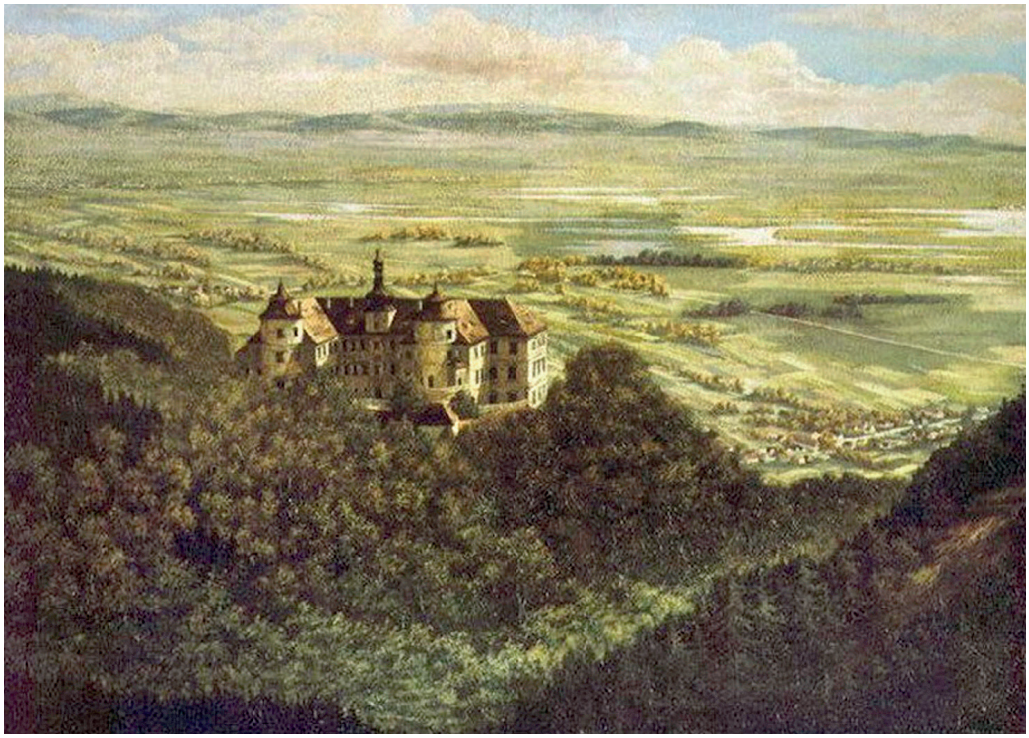


Figure 4 Komořany Lake, which used to cover the site of today's Czechoslovak Army Mine (CSA quarry), started to be drained systematically in 1835 (Pecharová *et al.* 2011). This picture postcard of the Jezeří Castle shows the state of Komořany Lake around 1880. Source: Archive of the Regional Museum in Most.

Figure 5 Habitats with blocked succession are the most interesting from the nature conservation point of view. They will long host rare early-succession species requiring bare substrates. © Markéta Hendrychová

In the planning and implementation of specific practical measures, ecological restoration has so far only been applied on a small scale, experimentally. In 2018, the NCA CR therefore started to negotiate actively with the Ústí Fuel Plant Company, State Enterprise and Sev.en Energy AG energy group about delimiting larger areas for spontaneous development in the CSA and Vršany quarries. In the end, further steps were agreed and decided on (see Box 2).

The first aim of the agreement was to select sites extraordinarily valuable for biodiversity and to exclude them temporarily from technological reclamation plans. As agreed, the NCA CR will prepare proposals to register them as Significant Landscape Elements. In updated remediation and reclamation plans, the mentioned sites should then be destined for ecological restoration or special restoration management (blocking certain succession stages).

Another objective is to determine an extensive area affected by mining (5–10 km^2 in size) to be left to spontaneous development and pursuant to the national legislation to be designated a Specially Protected Area where the specific subject of protection will be the protection of natural processes. For several reasons, an area in the CSA was identified as the most appropriate. First of all, still large areas with ongoing spontaneous succession escaped from technological reclamation and possessing high biodiversity and inhabited by endangered species are found there (see Fig. 1). An important reason is the fact that most of the land in this quarry is owned by the State, so no problems with ownership relations will arise. A third reason is the low percentage of temporarily excluded agricultural and forest land, because Lake Komořany covers most of the area (see Fig. 6). Of course also the soon expected termination of mining in the CSA was taken into consideration. The NCA CR therefore requested the Czech University of Life Sciences Prague to prepare a feasibility study for the CSA, which confirmed the feasibility and high efficiency of ecological restoration there (see Box 3). Its conclusions are transferrable to other sites, *e.g.* the Vršany quarry.

Background documents elaborated by the NCA CR in cooperation with partners have been incorporated into a document submitted to the Czech Republic Government session by the Ministry of the Environment of the Czech Republic. After decades of debate, ecological restoration has thus become an equivalent restoration option for extensive post-mining areas. It offers the Czech Republic an opportunity to implement its commitments under the EU Biodiversity Strategy for 2030 (EC 2020, Pešout 2020) and an appropriate contribution to the UN *Decade* on *Ecosystem* Restoration, proclaimed in 2019 (UN 2019, Plesník 2019). The NCA CR now has to define the extent of the territory to be restored by spontaneous processes more precisely, while taking into account other interests and conditions, in collaboration with

Figure 6 In the Vršany quarry, areas have been selected which should not be technologically reclaimed but left to spontaneous development or specifically managed.

state enterprises Ústí Fuel Plant and Ohře River Basin, mining company Sev.en Energy AG and the relevant municipalities. ■

The list of references is attached to the online version of the article at www.casopis.ochranaprirody.cz.

Notes:

[1] The government should decide on this in 2021, based on a recommendation of the so-called Coal Board. It will most probably provide for the termination of active mining in 2036–2038.

[2] Study of integral water management balance for the inundation of residual excavations after complete termination of brown coal mining in the Ústí Region (Czech Technical University Prague, November 2020); Analysis and assessment of alternatives of interconnected water management systems for completed hydrological reclamations (**Water Management Development and Construction Company, May** 2020).

[3] The studies did not include (due to uncertainties) hydrogeological tributaries and leakage.

[4] In the period until 2050, the average supplement will amount to 810 thousand m^3 annually, then until 2100 to 1,331 thousand m^3.

[5] Analysis verifying the feasibility of solar energy parks in reclaimed areas and areas to be hydraulically reclaimed (Deloitte Advisory, May 2020)

Grassing of Zone I in the Moravian Karst Protected Landscape Area

Taťána Halešová & Marie Kotyzová

The Moravský kras/Moravian Karst (central Moravia) is the most important karst area in the Czech Republic. In addition to underground karst phenomena, we can also find surface aboveground karst phenomena there, which include sinkholes and limestone pavements. All these karst phenomena are legally protected. The uniqueness of the area is also confirmed by the only internationally protected underground wetland in the Czech Republic, which is the Podzemní Punkva/Punkva Subterranean Stream Wetland of International Importance (Ramsar Site). The karst environment needs our protection, not only below the surface but also at ground level, from where nitrates and pesticides from intensively managed karst plateaus enter the underground areas. These substances pollute groundwater, which is used as a source of drinking water and harbours a lot of animals. Changes in management around the sinkholes and above the caves implemented in 2019 and 2020, resulted not only in positive shifts in the agricultural landscape, but they also significantly contributed to improving the quality of drip water that seeps down to the caves through the soil and rocks.

New declaration of the Moravský kras/Moravian Karst Protected Landscape Area

In April 2019, the Moravský kras/Moravian Karst Protected Landscape Area (PLA) was declared by Government of the Czech Republic Decree No. 83/2019 Gazette, making it the youngest PLA in the Czech Republic. In addition to the change in borders and new, more specified protective conditions, delimitation of nature protection zones also changed (Decree of the Ministry of the Environment of the Czech Republic No. 84/2019 Gazette). Protection zone I was delimited above the caves (100 m on each side) and around the sinkholes (30 m from a sinkhole edge). According to the Czech Geological Survey, the protection zone should prevent topsoil runoff from fields into sinkholes and seepage or soak of fertilizers and pesticides into caves. Historically, karst plateaus were farmed because there was flat terrain, unlike the steep cliffs and karst valleys. Karst plateaus are characterized by the occurrence of sinkholes, which used to be ploughed up to the edge and thus there was erosion into sinkholes. There are caves in some sinkholes, and topsoil containing fertilizers and pesticides went straight into the caves.

Figure 1 The area sown with alfalfa/lucerne grass mixture on the Harbeš Plateau. © Stanislav Koukal

Communication with farmers

Negotiations with farmers regarding the grassing of arable land in zone I began in 2017, when the Ministry of the Environment of the Czech Republic introduced the intention of a new declaration of the Moravský kras/Moravian Karst PLA to representatives of municipalities, affected large agricultural enterprises, and forest enterprises. During 2017 and 2018, a number of negotiations about the zoning proposal took place with farmers. Each farmer who had newly proposed arable land in zones I and II received a list of affected land parcels and map data. In addition to meetings with individual farmers, meetings and seminars were also held on the issue. Farmers did not submit any comments on the zoning proposal. After the declaration of the Moravský kras/Moravian Karst PLA, specific

steps leading to grassing were discussed, such as a geodetic survey of zone I, marking with stakes, composition of grass mixtures, and dates for grassing. In order to enable a gradual change of management in zones I and II, it was also agreed to submit applications for an exemption from Act 114/1992 Gazette on Nature Conservation and Landscape Protection, as amended later, for intensive farming and the application of fertilizers and biocides.

The change in management in zones I and II affected four large agricultural holdings and eleven private farmers. In the smaller zone II, it is a matter of excluding some pesticides with a long half-life (increased penetration into groundwater). For restrictions due to nature conservation (long-term exclusion of arable land from production), farmers are entitled to compensation for losses, which is determined by expert opinion.

Grassing Zone I

A total of 114 hectares of arable land was grassed. 11 hectares were grassed with Bromion subnational/regional grass mixture, sowing 20 kg/ha (90% grass, 16 species; 5% clover, 16 species; 5% herbs, 53 species), 64 ha with Živa species-enriched grass mixture, sowing 30 kg/ha (95% grasses, 10 species; 5% clover, 6 species), and 39 ha with alfalfa/lucerne grass mixture (70% alfalfa/lucerne; 30% grass, 3 species). The Nature Conservation Agency of the Czech Republic (NCA CR) contributed to the purchase of a regional and species-enriched grass mixture from the Landscape Management Programme. From the interim results of the NCA CR study entitled Monitoring of above-ground and soil biota of karst plateau grasslands in selected areas of Zones I and II of the Moravský kras/Moravian Karst PLA (implemented by Zemědělský výzkum, s.r.o/Agricultural Research Ltd. Troubsko, in cooperation with the Institute of Soil Biology of the Academy of Sciences of the Czech Republic České Budějovice, the Mendel University Brno, and the Masaryk University Brno), it is obvious that the areas with a species-enriched grass mixture sown in the spring were significantly weedy; after mowing, the weed species receded, and in the autumn the vegetation was already stratified. A total of 13 of the 16 sown species grew. The regional mixture showed slower vegetation development. Of the species sown, significantly fewer species germinated than in areas sown with a species-enriched mixture. A total of 7 species grew from the mixture. The reason is a high proportion of species with dormant seeds. Several rare and endangered plant species also appeared among flowering plants, such as the Night-flowering catchfly (*Silene noctiflora*), Field madder (*Sherardia arvensis*), Small bugloss (*Lycopsis arvensis*), Cut-leaved crane's bill (*Geranium dissectum*), and the Scarlet pimpernel (*Anagallis arvensis*).

Figure 2 Land surveying of Zone I by staff of the State Land Office. © Leoš Štefka

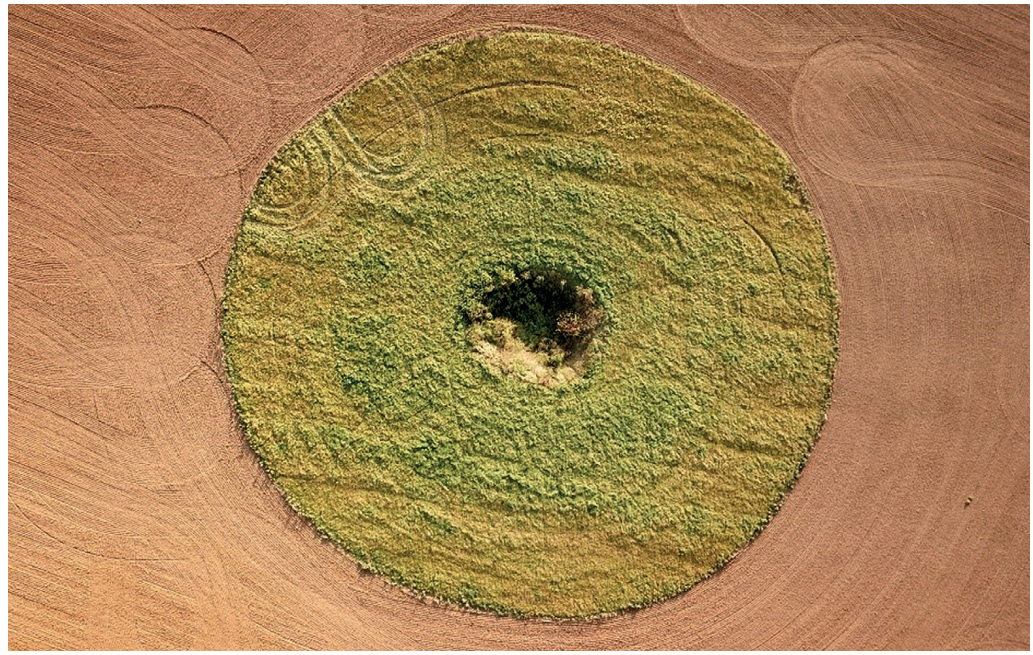


Figure 3 Grassed zone I around the sinkhole. © Stanislav Koukal

TACR TH03030178 project

Thanks to cooperation with the Research Institute of Plant Production, Public Research Institution, and ALS Czech Republic Certified Laboratories Ltd., within the TACR project "New methods of risk assessment of plant protection products against non-target organisms: Evaluation of xenobiotic soil load on organisms", the necessary information was obtained on soil pollution, active streams and, in particular, drip water in the Amatérská jeskyně/Amateurs Cave and the Harbeš Cave. This information significantly helped in negotiating with farmers and convincing the public about the importance of grassing zone I above the caves and around the sinkholes. This is a four-year project, which was launched in 2018. For three years now, monthly

Figure 4 Grassing the sinkhole at the municipality of Šošůvka in autumn 2019 and its state in summer 2020. © Leoš Štefka

sampling and analysis of soil and water samples for nitrate and pesticide concentrations has been underway in the north of the Moravský kras/Moravian Karst, where there was a change in management on karst plateaus. The obtained results will be further processed into a certified map of pesticide occurrence and will also serve as a model for the correct demarcation of the protection zone. The general objective of the project is to incorporate current approaches into the principles for evaluation and authorization of plant protection products.

Nitrate concentrations in the Amatérská jeskyně/Amateurs Cave have been around 115 mg/l on average since 2018, thus doubling the limit for drinking water. The highest nitrate concentration measured was in September 2018, when it reached 171 mg/l. The results of drip water analyses in the Harbeš Cave (under the Společňák Sinkhole) show high pollution, especially with nitrogenous substances and pesticides, nitrate concentrations average having been 140 mg/l. The highest nitrate concentration measured in the Harbeš Cave was in October 2019, when it reached 210 mg/l. The reduction of nitrogenous substances in drip water after the change of management has not yet had a significant effect. However, the measurement results show that nitrate concentrations in drip water under permanent grassland meet the public health limit for drinking water (50 mg/l). We expect that in 2021 there was also a gradual reduction of nitrate concentration under the newly grassed arable land as a result of reduction of agricultural activity in the area. Three-year monitoring of nitrates in drip water is shown in Fig. 1.

An important part of the TACR TH03030178 project is monitoring pesticides in the selected areas of Moravský kras/Moravian Karst PLA zones I and II, and monitoring the transfer of these substances from soil to drip water. The most significant pesticides found in the Harbeš Cave, which we encountered throughout the whole sampling period (2018–2020), mainly include triazine pesticides and their metabolites, chloridazon and its metabolites, chloroacetanilide pesticides and their metabolites, and azole pesticides and their common metabolite 1,2,4-triazole. The presence of the original active substances terbuthylazine, atrazine, metazachlor, epoxiconazole and others is no exception in this limestone area. Monitoring pesticides in drip water in the Harbeš Cave is shown in Fig. 2.

The levels of pesticides in drip water under arable land regularly exceeded the permitted limit for groundwater (0.5 µg/L). Concentrations of some individual pesticides and their metabolites exceeded the permitted limits several times. The “average” arable land sample in 2018 and 2019 contained 27 and for drip water 29 detectable pesticides and their metabolites. The change in management was significantly reflected in the reduction of concentrations of some pesticides and their metabolites. In the Harbeš Cave in 2020, there was a significant decrease in the total amount of pesticides measured and the absence of certain groups of pesticides, *e.g.* azole and amide pesticides, was also found there. Above all, there was a significant decrease in triazine pesticides and chloridazon metabolites. In the Amatérská jeskyně/Amateurs Cave, the total decreased to the 0.5 µg/L limit level. The pesticide totals in drip water in the Harbeš Cave and the Amatérská jeskyně/Amateurs Cave are shown in Fig. 3.

Figure 5 Grassing with a sub-national/regional and species-enriched grass mixture above the Amatérská jeskyně/Amateurs Cave. © Stanislav Koukal

Beneficial solution

Grassing above the caves and around the sinkholes has contributed not only to the protection of the karst underground and water from pollution, but also to differentiation in the agricultural landscape. Green islands on arable land

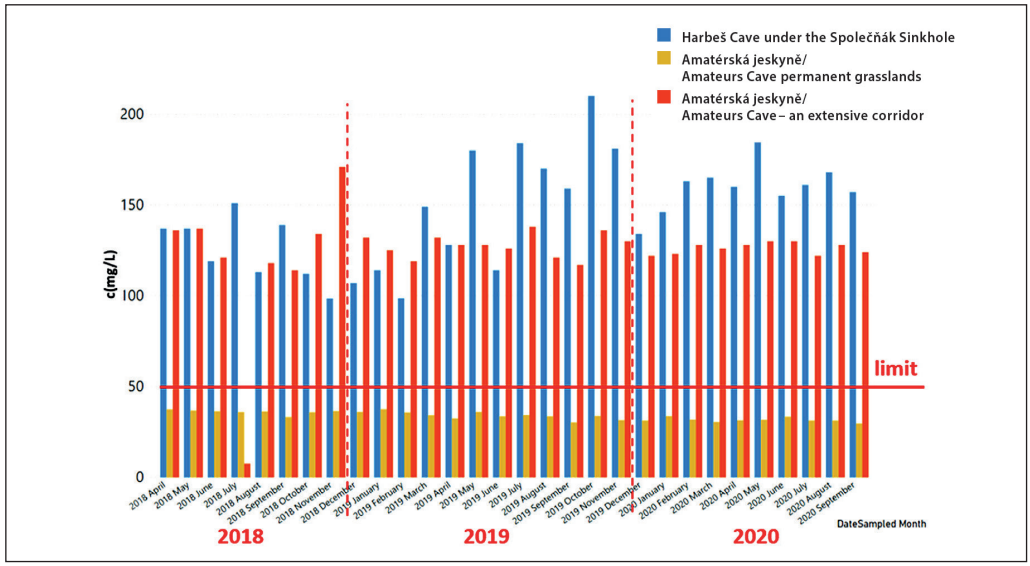


Figure 6 Monitoring nitrates in drip water in the Harbeš Cave and the Amaterská jeskyně/Amateurs Cave in 2018–2020. © Taťána Halešová

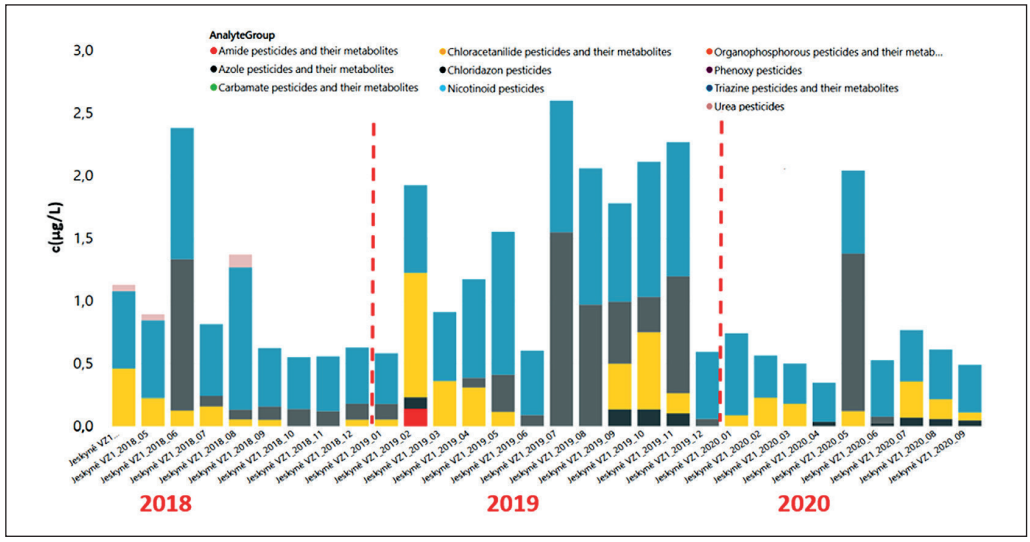


Figure 7 Monitoring pesticides in drip water in the Harbeš Cave in 2018–2020. © Taťána Halešová

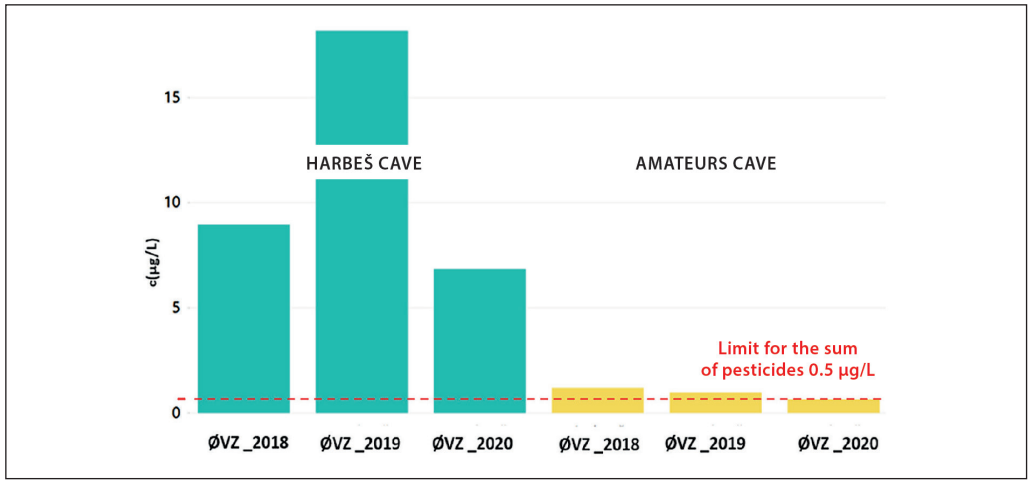


Figure 8 Average of the sum of pesticides in drip water (the Harbeš Cave and Amatérská jeskyně/Amateurs Cave) below arable land in 2018–2020. © Taťána Halešová

Figure 9 Collection of drip water in the Harbeš Cave. © Marie Kotyzová

have thus become home to many animals and various species of plants, including rare and endangered weed plants which have been irretrievably disappearing from farmland. We will gradually learn about the positive changes caused by grassing not only from the TACR TH03030178 project, but also from the four-year NCA CR study (popfk-043/73/20) "Monitoring of above-ground and soil biota of grasslands of karst plateaus in the selected areas of Moravský kras/Moravian Karst PLA zones I and II".

Acknowledgements

Grassing of zone I of the Moravský kras/Moravian Karst PLA would not be possible without the great cooperation from farmers in the Moravský kras/Moravian Karst PLA, support from colleagues at the Moravský kras/Moravian Karst PLA Administration, NCA CR South Moravia Regional Office and NCA CR's Headquarters, cooperation with the Moravský kras/Moravian Karst PLA rangers, Bílé Karpaty/White Carpathians Mts. PLA Administration, Institute of Plant Production, Public Research Institution, ALS Czech Republic Certified Laboratories Ltd., State Land Office in Blansko, Central Institute for Supervising and Testing in Agriculture Brno, State Agricultural Intervention Fund Blansko, Agrostis trávníky/Lawns Ltd., and all the others who have helped us to implement this great change in the agricultural landscape within the Landscape Protection Programme. ■

Experience in Training Shepherd Dogs Guarding Livestock

František Groessl

Shepherd dogs guarding livestock are rightly recommended as the most effective measure against grey wolves (*Canis lupus*) attacking livestock. Farmers are often criticized for hesitating to acquire shepherd dogs. However, few people can imagine the long and challenging journey to a reliable working shepherd dog.

Slovak Cuvac named Ares is a sought-after companion in the herd. © František Groessl

Wolves are near

Among its other activities, our organization, Libosváry, a Local Chapter of the Czech Union for Nature Conservation, has been maintaining a number of biologically valuable sites in the Domažlice and Tachov regions in western Bohemia by grazing sheep, goats, and yaks for over 20 years. Thus, we had watched the rapid spread of grey wolves in neighbouring Germany with growing concern. In 2018, their permanent occurrence of the canid predators was confirmed in our areas of activity. We did not want our animals to appear on the wolf's diet.

If we used free grazing under the constant supervision of a shepherd, we would use our rich experience with cattle dogs. Unlike shepherd dogs, they are easily-manageable, they can actively manipulate a herd on human command and, at the same time, they are very good and brave guardians (*e.g.* the Beauceron, Briard or Bouvier breeds).

For organizational and economic reasons, we graze within electric fences without the presence of a shepherd, only with regular daily inspections. Therefore, shepherd dogs working independently are the only suitable solution for us to maximize the effectiveness of preventive "anti-wolf" measures.

Selecting dogs

The task of the shepherd dogs is **only** to accompany and guard the herd, not to manipulate it! You cannot buy a reliable shepherd dog; you must educate it and be prepared for the fact that it is 100% usable only after reaching the age of two to three. In addition, there is a relatively high risk (up to 50%) that the dog lacks the required talent or that its upbringing will fail.

Three years ago, there was no real breeding of working shepherd dogs in the Czech Republic. There were only breeders who bought a few sheep or goats to go with the dogs. Therefore, they were still more or less family dogs who, at best, had met with considerably domesticated and appropriately cheeky sheep and goats in the backyard. We certainly cannot talk about independent work of shepherd dogs there, least of all guarding from wolves.

We were deciding whether to buy one dog or two. One puppy will stick to the sheep more easily because it will have no other chance. However, there is a higher risk that it will play with sheep and chase them more often because it will be bored. In the case of two puppies, there is a risk that they will not develop a strong enough relationship with the guarded animals because it will be enough for them to have each other. However, they can play together and not disturb the sheep unnecessarily. Puppies born in a herd have a better starting position. They will not experience a "culture shock" as they do not have to cope with a radical change of conditions – minimal contact with humans and a number of, from their point of view, strangely behaving animals. However, the subsequent upbringing is exactly the same as for puppies from regular breeding.

A shepherd dog guards the herd all year round in any weather. © František Groessl

We also had to decide on the size of the breed; we did not want large dogs that could look over our 90-cm-high electrical fences and scare passers-by. We also considered the length of the coat; the shorter it is, the easier it is to care for it. On the other hand, we have animals outside all year round and we graze in areas with a high incidence of stinging insects, where longer hair is an advantage.

By far the most available breeds for us were the Slovak Cuvac and the Sharplaninac. We chose the Cuvac with the knowledge that they have no longer been working dogs, but social dogs. Puppies born in a herd of sheep were not available, so we bought two puppies of the same age from regular breeding.

Difficult beginnings

The advice on how to raise a shepherd dog is very diverse: from "raise a puppy in the family and take it on a lead to the sheep several times a day" to "throw a puppy in a sheep hut and do not pay attention to it, except for feeding." Because we need independent shepherd dogs, it is by far the most difficult to solve the problem of how to raise such a dog when you can spend only a minimum of time with it. Otherwise, the puppy would prefer human society to the animals it is supposed to protect in the future.

We have carefully studied all available publications on shepherd dog training. We chose a procedure that seemed logical to us. We placed the puppies in a pen with several curious lambs. They had a kennel which the lambs could not get to. We covered a part of the pen to motivate puppies and lambs to spend as much time together as possible in the summer heat. The pen stood on a pasture with a herd of sheep with other lambs. The only shade was right next to the pen, so these animals also went to rest with the puppies, although separated by a fence in the pen.

As the puppies grew, we gradually changed the lambs for calm adult sheep, as the puppies played with the lambs more and more like with their siblings. If we did not address this, we would encourage inappropriate behaviour (pulling wool or ears and chasing sheep). At first, the puppies had respect for the adult sheep. As the puppies got bored in the pen, they were trying the patience of adult sheep as well.

From the beginning, we carefully and almost constantly checked what was happening in the enclosure and later in the herd from a distance, using binoculars or a camera placed on a fence. We did so both to prevent the dogs becoming too familiar with us, and to have an overview of the situation. After each feeding, the puppies played for about an hour and a half, then fell asleep and we could walk away. As soon as we noticed that the dogs were starting to dominate the sheep, we exchanged the sheep for others.

From the fourth month, we got the dogs used to the electric fence and started to release them into the big pasture. **We took great care to ensure that the dogs absolutely respect the electric fence and do not test the possibilities of**

Shepherd dogs with a herd in the Veský Mlýn Natural Monument, the Český les Mts. Protected Landscape Area. © František Groessl

jumping over it. Among other things, we taught them to walk on a lead, travel by car, endure a visit to the vet, *etc.*

We gradually added more sheep and goats. Some were afraid of the dogs, others were chasing them. The puppies found that, with some animals, it is good to keep out of the way, while they wanted to chase the more timid ones. There we had to intervene and correct this inappropriate behaviour. The puppies were very fond of the old ram, a male goat, and several sheep, with whom they made a real friendship.

If we could not provide continuous remote supervision for organizational or time reasons, we locked the dogs in a spacious enclosure of electric wire inside the pasture. However, we tried to do so as little as possible. We placed water for the animals and salt licks near this enclosure so that the animals and dogs were at least in visual contact. Constant remote surveillance does not mean that one is constantly standing at the enclosure, thinking one has better things to do, and waiting for the dogs to misbehave again. With regard to the dog's daily rhythm and weather, at every free moment we simply briefly checked the current situation on the pasture so that the animals did not notice us. In hot weather it was about two hours a day, in bad weather much more (min. 4–5 hours of net time per day).

A very rugged pasture is ideal, where the dogs always have something to do or examine. We did not have any problems with inappropriate behaviour of dogs on such types of pastures. Straight, well-arranged, and even small pastures are a nightmare when it comes to raising shepherd dogs. Boredom is a curse. In 90% of cases, Ares (the Cuvac) started with inappropriate behaviour, and sometimes Ursa (the Sharplaninac) joined in; if Ursa started, Ares always joined.

The most important issue has been to recognize the start of problems in time. If the guarded animals are grazing spread out across the pasture, everything is ok. However, if the herd is together, or there are tufts of wool across the pasture, it means that the dogs have been chasing the animals or trying to play with them. Both situations are wrong and need to be addressed immediately. However, shouting at dogs that you did not catch just in the act is illogical, and will only undermine the dog's trust in humans. In our direct physical presence, we had to solve the problem of chasing animals only twice. It was enough to warn the dogs verbally and it was over. It was effective to watch the herd whilst hidden, so that the animals would not know about us. And as soon as a dog is about to do something naughty – clap loudly. The dog immediately stops and went to guard. If the dogs were too misbehaved for several days in a row, we moved the whole herd with the dogs to another pasture. In the new environment, the animals have other thoughts. If we only followed the manuals and excluded animals that are afraid of dogs, or the dogs had a "hunting" interest in them, we would be left with only 2 old rams, a male goat, 2 female goats, and 3 sheep out of 200 animals.

We also used electric training collars, which allowed us to correct inappropriate dog behaviour at distances over 1 km, which mostly guaranteed that dogs would not know about us. Of course, we first introduced the dogs to the collars, and only then used them in practice. Except for two cases, an audible signal was enough to interrupt the unwanted behaviour. **BUT! These collars should only be used by very experienced hands.** It is important to have a thorough knowledge of dog behaviour and a perfect overview of what is happening in the pasture. It happened to us several times that what from a distance looked like chasing was different in reality. For example, a dog ran to guard the fence and coincidentally a confused sheep ran in front of him. If the dog were punished at this point, it would be an unforgivable mistake. Improper use of these collars will easily make the dog a neurotic psychopath, completely unsuitable for herd protection. So, training collars do not belong in the hands of a choleric person!

According to the literature, it often happens that young inexperienced dogs kill and eat new-born lambs. However, Ares and Ursa licked the lambs and kids and adopted them, unless the mother

drove them away. It also happened that the young went with dogs, tried to drink from them and ignored their own mothers. Therefore, we just had to first let the dogs lick and sniff the new-born lambs and kids, and then lock them in a small enclosure with the mother for a few days so that it was clear to them who the mother was and where the milk was. At present, this is no longer a problem. The sheep and goats themselves make sure that the young do not follow the dogs in the first days. When they are older and start being put into kindergartens, they can easily entrust them to dogs. We let the dogs eat the placentas, so they do not attract red foxes and ravens.

First encounters with wolves

Although the dogs were only less than a year old, we decided to use them to guard a herd in the Český les Mts. (western Bohemia). It had its advantages; the dogs learned to cope with changes (new environment, different pastures, long-distance transport). But also disadvantages; in remote places (up to 45 km from the base) it was not possible to constantly check the dogs and herd by commuting. Fortunately, it was very hot weather, so the dogs were napping near the herd during the day and it was not necessary to constantly keep an eye on them. From the evening until the morning, one of us stayed at the site to check the dogs' behaviour and also to intervene immediately if wolves came. They actually appeared several times at the fence at Pleš. The dogs cooperated perfectly. As the wolves circled the enclosure each from one side, the dogs also parted and accompanied them with menacing barks. We watched everything whilst hidden so we could drive the wolves away if they tried to attack the dogs. If this happened, the young dogs could have a bad experience (wolves would force them to retreat or flee) and thus be unreliable as herd guardians in the future.

Initially, for practical reasons, we set up a tent for the night near the enclosure. That spoiled the dogs a bit. They did not spend time among the sheep, but near the tent. They even guarded it from the sheep and did not allow them to approach it. So we moved the tent out of the dogs' viewing angle and fed them on the opposite side of the enclosure. Two seasons in a small tent were very exhausting for us. That's why this year we built a small mobile home which, in addition to incomparable comfort, has windows that allow a view of the surroundings. One does not have to climb out of the tent with every dog alarm and find out what is going on. Because we have verified that the dogs guard reliably, it is not necessary to get up for every wolf visit. We just listen to see if the herd is calm and leave everything to the dogs.

The puppies spent the first weeks with lambs in a pen. © František Groessl

Each dog is different

Both dogs were three years old in 2021. Ares is very attentive and quite spontaneous; he actively seeks the company of guarded animals, and they also like him. If he was guarding himself, we are not entirely sure that he would not retreat from the wolves if they climbed the fence. Ursa is much calmer, she has a more reserved relationship with the guarded animals and they do not seek her company either. However, she is completely uncompromising in guarding and she would engage in direct physical confrontation with the wolves without hesitation if they attacked the herd. Ares watches and chases away large birds if their flight level drops below 25 m. Ursa is not interested in birds until they land in the pasture, but otherwise she is an avid hunter. She hunts rodents in the pastures and, when she has the opportunity, destroys bird nests. Ares hunts only very exceptionally.

Shepherd dogs in the countryside

In order to prevent conflicts with misbehaving tourists who do not respect the warning signs, in enclosures along busy tourist routes we lock the dogs in a pen at the far end of the pasture during the day and only release them at night.

Before the fences were built, we walked through the area of the future pasture to drive out the game. They get used to the dogs guarding the herd very quickly and appear at the enclosures no later than the third day. It often happens that doe or fallow deer graze only 10 m from a dog who barks at them behind the fence. The deer very quickly understands that the dog behind the fence does not pose a risk and ignores it.

To conclude

Although we sometimes see wolves in the beam of a headlight watching the herd or walking around the enclosure, we have had no attacks or losses. Shepherd dogs are by far our most valuable and expensive animals. Although their acquisition was by 80% financed from the Operation Programme Environment, we invested a huge amount of time in them. With the arrival of wolves, as well as herding dogs, the time and organizational demands of grazing have increased dramatically. It is not possible to use strangers (volunteers, other members of the Local Chapter) to inspect animals and maintain fences in a herd guarded by shepherd dogs. The dogs simply would not allow them to enter the enclosure without our presence.

So far, we have only added shepherd dogs to the herd of sheep and goats at sites most endangered by wolves. If wolf territories increase and we have to protect all our herds (including cattle), we will need a minimum of 14 shepherd dogs on active duty. Such a situation would already exceed the existing financial, personnel, and organizational capacities of our organization and force us to radically change the grazing system. ■

Management Agreements: An Important Tool for Cooperation with Landowners and Land Managers in Nature Conservation

Pavel Pešout

Ten years ago, the Nature Conservation Agency of the Czech Republic (NCA CR) began to conclude agreements on management through public contracts, setting up both management measures to be implemented and providing landowners or tenants with a subsidy/subvention. Consequently this practice has been step-by-step applied also by other State Nature Conservancy authorities, particularly Regional Offices. At present the agreements on management are one of the principal and commonly used tools in cooperation with land managers. The NCA CR is currently taking active steps to further expand the type of cooperation with landowners, our most important partners in practical nature conservation.

Concluding agreements on land management for nature conservation, and agreements on management in protected areas, and paying a financial contribution for its implementation has been enshrined in the Nature Conservation and Landscape Protection Act (NCLPA) since its approval, *i.e.* for thirty years (Article 68, para 2 and Article 69). However, the absence of general legislation on the concept of public contracts had long been an obstacle to its application in practice. This occurred only in the Administrative Procedure Code (Act No. 500/2004 Gazette), with effect from 1 January 2006. A fundamental change was also the decision of the Constitutional Court of 2010[1], providing a detailed interpretation of Articles 68 and 69 of the NCLPA (Hůlková 2010). Despite the fact that the legal literature is reserved for some parts of the Constitutional Court's Plenary decision (Vomáčka *et al.* 2018), it undoubtedly is a breakthrough in many respects and remains essential for the implementation of practical measures for nature conservation.

In 2018, the Nature Conservation Agency of the Czech Republic signed a public agreement with the town of Domažlice (western Bohemia) on management of municipality forests which, *inter alia*, make up the majority of the Čerchovské hvozdy National Nature Reserve. It is a comprehensive agreement formulating the principles of management, quantifies the level of compensation costs for loss caused by management difficulties, and includes an agreement on the implementation of measures to improve the condition of objects of protection in this part of the Český les Mts. Protected Landscape Area. © Jiří Sladký

In order for the NCA CR to be able to pay financial contributions, it was necessary to clarify compliance with budgetary rules (Act No. 218/2000 Gazette on Budgetary Rules and on Amendments to Some Related Acts) and some other changes (for more details, see Pešout & Šmídová 2012). What is the situation after almost ten years of concluding and signing public agreements?

A challenging journey to agreements

The rules for concluding agreements were step-by-step established. When setting up the process, the NCA CR used the relevant interpretation of the Ministry of the Environment of the Czech Republic[2]; however, in order to ensure compliance with the budgetary rules, they had to build the entire system from scratch. The first step was to distinguish between commonly assigned activities in nature conservation and landscape protection and to determine the usual costs for their implementation. Today, the result are unified code lists of activities in nature conservation and landscape protection linked to costs of common measures and consequently for planning and documenting

the interventions having been made in nature and the landscape (Pešout & Štěrba 2021 and this issue). Without the implementation of these demanding steps, the concluding public contracts (in particular the provision of financial contributions for the implementation of measures) would be difficult and complicated, with the risk of inefficient use of public funds[3]. The standardization of activities also makes it possible to develop data support tools (Zárybnický *et al.* 2020), which further facilitates the planning and signing agreements and their documentation in particular.

How many agreements have been signed with land managers?

Public contracts with landowners and land users have become a commonly used form for agreement on practical measures in Specially Protected Areas, as well as providing a payment for their implementation. Unfortunately, multi-annual agreements have been less common so far, although they save time and effort on administrative steps for both the NCA CR and the land manager. They are designed in such a way that unless there is a need to change the management of the objects of protection, or the budgetary possibilities of the NCA CR do not change, or there is a change on the part of the land user, there is no need to re-negotiate the activities covered by the agreement and sign a contract every year.

At present, the NCA CR concludes and signs over 1,100 agreements per year and around one hundred agreements are signed as long-term (up to ten years). The number of public contracts has been growing every year (see Figure 1).

The NCA CR is also gradually developing agreements on the management method in protected areas, to which no financial contribution is tied, *e.g.* agreements on non-intervention forests and their monitoring signed with the Forests of the Czech Republic, State Enterprise (Hort *et al.* 2008).

Comprehensive management agreements – all on one single paper only

The highest type of agreement with the landowner is the so-called comprehensive management agreement (Pešout *et al.* 2013). Its aim is to formulate clear rules and conditions for management by the owner or user. These are long-term agreements, usually for five to ten years. The comprehensive agreement includes three main parts:

Part I: Agreement on the management method
This part of the agreement sets a voluntary obligation by the landowner (land user) to manage the land so that the object(s) of protection in the particular Specially Protected Area are kept in the same state or their condition improves. The NCA CR undertakes to continuously inform the owner about the state of the area, its changes, newly identified occurrences of specially protected and valuable species, *etc.* The parties agree in detail on the management principles, *i.e.* under what conditions the individual measures will be implemented, using specific technologies, materials and procedures, and to what deadlines. If necessary, the intensity of management, *etc.* can be differentiated spatially and temporally (*e.g.* year-on-year).

Part II: Agreement on the method of financial compensation for management difficulties
There, the NCA CR declares to the landowner (land user) the amount of financial compensation for the difficulties in agricultural, forestry or fishpond management, due to restrictions for nature conservation (Article 58 of the NCLPA) beyond the scope included in the first part of the agreement. However, it is often not possible to quantify the exact amount of losses for several years in advance, not even by the landowner; in these cases, the calculation is described in detail in the agreement. The conclusion of the agreement does not replace the legal obligation to apply for losses every year; however, the repeated providing a number of annexes is eliminated (*e.g.* an extract from the Land Cadastre).

Part III: Agreement on management of specially protected areas.
In this part of the comprehensive agreement, the NCA CR agrees with the landowner (land user) on the implementation of practical measures in the field, usually resulting from the Specially Protected Area's Management Plan, and on the amount of the financial contribution provided (pursuant to Article 69 of the NCLPA). This part of the contract includes the so-called termination provisions, where the NCA CR can notify, within a contractually stipulated deadline, that it does not have finances for the implementation of the agreed management for that year available in its budget. Then it is up to the landowners to decide whether they implement the measures on their own accord or whether it will not be implemented in the relevant year.

Of course, the agreement does not have to include all three parts described above, but it is an advantage for both nature conservationists and land managers to find a consensus and conclude a comprehensive agreement. Despite the laborious process of preparation and negotiation, the result is always a time and economic saving, and better possibility of prioritization. Most importantly, there is a higher degree of understanding; firstly by the land manager, about the needs to ensure the existence of objects of protection, and secondly by the State Nature Conservancy authority, about the land manager's abilities.

The first comprehensive management agreement is from 2013 (Pešout *et al. l.c*). Since then, the NCA CR has concluded and signed several of them, for example with the town of Domažlice (see photo).

When does the NCA CR sign agreements outside land under its administration?

The NCA CR is authorized by the Ministry of the Environment of the Czech Republic to coordinate

NEW NCA CR METHODOLOGY: "COMMUNICATION WITH LANDOWNERS AND LAND USERS IN SPECIALLY PROTECTED AREAS"

The methodology (Farkač *et al.* 2021) focuses on good practice in establishing and maintaining fair communication and building long-term partnerships between State Nature Conservancy representatives and landowners/managers. It was elaborated by experts from the Charles University Environment Centre (CUEC) and the Nature Conservation Agency of the Czech Republic (NCA CR.) The text of the methodology is based on the experience of managers and NCA CR staff.

In its first part, the methodology focuses on the general principles of communication valid (not only) in nature conservation; it is mainly building mutual trust and partnership approach to landowners and users. It also points out the importance of understanding the interests and limitations of the other party, as well as a clear presentation of nature conservation interests and the required measures. The second part deals with the division of landowners and users into groups with similar interests, as well as a similar approach to nature conservation and land management. The division into groups also serves as a guide for nature conservationists in preparing for negotiations with the relevant partners. The last part presents the legislative regulations which State Nature Conservancy authority staff uses when planning and providing management for Specially Protected Areas, and the practical experience of the NCA CR in concluding public agreements with landowners and land users. The text of the methodology is enlivened by stories from the practice of NCA CR staff from negotiations with various landowners or managers. The methodology also includes references to Czech and foreign literature for those interested in a deeper study of the topics.

Martina Kobyláková & Eva Sochová

As an example of a comprehensive agreement, the Nature Conservation Agency of the Czech Republic signed a public contract in 2018 with the town of Domažlice on management in municipality forests. The picture shows the then Mayor of Domažlice, Miroslav Mach (right) and NCA CR Director František Pelc. © Pavel Pešout

and ensure the implementation of action plans/recovery programmes across the whole Czech Republic's territory for the most threatened species. Some of the sites of these species are located outside land managed by the NCA CR. Therefore, a type of public agreement was sought there which would express the divided competence among the State Nature Conservancy authorities.

The result is a three-way comprehensive management agreement. This was signed for the first time in cooperation with the Regional Office of the Central Bohemian Region, and an enlightened owner, F. Kinský Dal Borgo. It aimed at forest management in the Dománovický les Nature Reserve, included in the Action Plan/Recovery Programme for the Scarce fritillary butterfly (*Euphydryas maturna*) – *cf.* KRÁSA & PAVLÍČKO (2014). In the contract, the Regional Office acts as a locally appropriate State Nature Conservancy authority, and the NCA CR as an intervener who guarantees the payment of compensation for losses caused by difficulties of forestry management and ongoing professional support.

More management agreements

A significant increase in the percentage of management agreements within the Specially Protected Area management is one of the main aims of the integrated LIFE project "One Nature", of which the NCA CR is a co-researcher. As part of the project activities, the capacity of the NCA CR Regional Branches has been strengthened, consultations and training sessions have been underway, a methodology for cooperation with landowners and land users has been developed for State Nature Conservancy authority staff (see Box 1), information tools are being modified (ZÁRYBNICKÝ *et al.* 2020), *etc.* The main obstacles preventing the conclusion of agreements on a larger scale have also been identified, such as an unjustified worry that the owner loses the right to compensation if a management agreement is signed, or that the owner faces penalties for non-compliance with the contract. All unjustified concerns are explained in more detail in the mentioned methodology.

Conclusion

Management agreements arise from the mutual communication of the owner (user) of the land and the State Nature Conservancy authority. By discussing them, and subsequently signing them, a long-lasting commitment has been fulfilled which is repeated in a number of strategic documents on nature conservation and landscape protection, namely to implement nature conservation and landscape protection with the participation of landowners and land managers. Nature conservation is becoming clearer, more understandable, and predictable for partners. The comprehensive and long-term agreements on management measures in Specially Protected Areas have proved successful and therefore, it is necessary to develop this instrument further.

Acknowledgements

I would like to thank my colleagues Klára Čámská and Paula Filipová for their comments on the draft of the article. ■

The list of references is attached to the online version of the article at www.casopis.ochranaprirody.cz.

Notes:

[1] Decision of the Constitutional Court Pl. ÚS 8/08 on the restriction of ownership rights pursuant to Article 68 of Act No. 114/1992 Gazette on Nature Conservation and Landscape Protection (256/2010 Coll.) of 8 July 2010.

[2] Communication of the State Administration and the Nature Conservation and Landscape Protection Section of the Ministry of the Environment of the Czech Republic regarding the implementation of measures to improve the natural environment pursuant to Article 68 of Act No. 114/1992 Gazette on Na ture Conservation and Landscape Protection, as amended later, Ministry of the Environment of the Czech Republic Bulletin No. 7/2014/8, entering into force 1 December 2014.

[3] The costs of common measures (activities) are used as a tool to ensure the comparability of payments provided for similar activities in different regions and from different financial sources (subvention programmes/subsidy schemes). However, if the State Nature Conservancy authority is aware of a supplier who is able to implement the measure at a lower rate, the land owner/user is offered adequately lower support under the agreement. If they do not agree with it, the NCA CR will conclude a management contract with the selected cheaper supplier. Although the land owner/user has priority in ensuring the management of the Specially Protected Area, at the same time the NCA CR must proceed with due diligence and in accordance with budgetary rules and therefore cannot spend more than is necessary to implement the measures in the field.

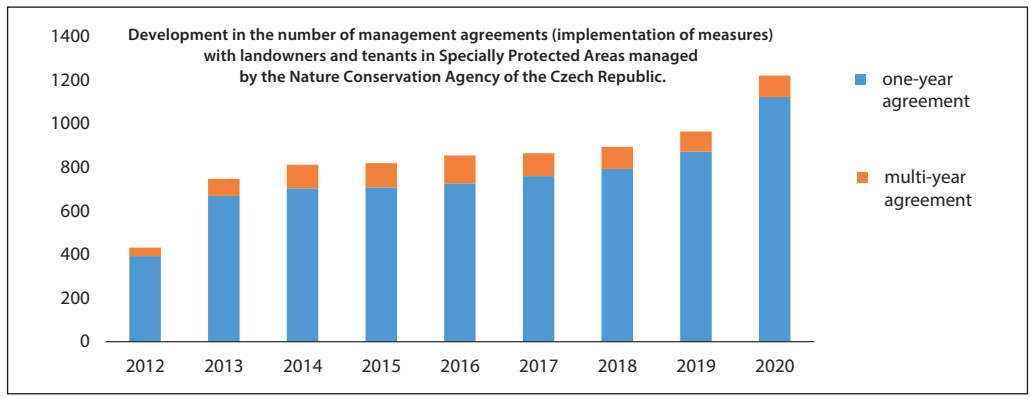


Figure 1 Development in the number of management agreements (implementation of measures) with landowners and tenants in Specially Protected Areas managed by the Nature Conservation Agency of the Czech Republic. © Klára Čámská

Shall We Go for Krkonoše/Giant Mts. Black Grouses with a Computer?

Jiří Flousek, Dušan Romportl & Vladimír Zýka

Yes, this is possible. Although computer modelling will not save the Black grouse, its outputs can significantly help in planning various practical measures in the field, regulating tourists at high-risk sites, and educating visitors. Habitat modelling, which uses the possibilities of geo-information technologies, remote sensing data, and advanced spatial analysis methods (*e.g.* Hirzel & Le Lay 2008, Elith & Leathwick 2009), is applied significantly in the study of ecological requirements of (not only) animal species. These methods, technologies, and data allow extensive analyses of the relationships between the occurrence of species of interest and relevant environmental factors (*e.g.* Franklin 2010, Guisan *et al.* 2017). A common approach is to model the current or potential occurrence of species (*e.g.* Thuiller *et al.* 2004, Hirzel *et al.* 2006, Basille *et al.* 2008); the aim is to determine the landscape potential for their permanent or temporary occurrence and to evaluate the significance of individual environmental factors for their spatial expansion. Thus, habitat modelling is currently one of the most widely used approaches in conservation biology (*e.g.* Huck *et al.* 2010, Basille *et al.* 2013, Guisan *et al.* 2013).

Black grouse (*Tetrao tetrix*). © Zdeněk Patzelt

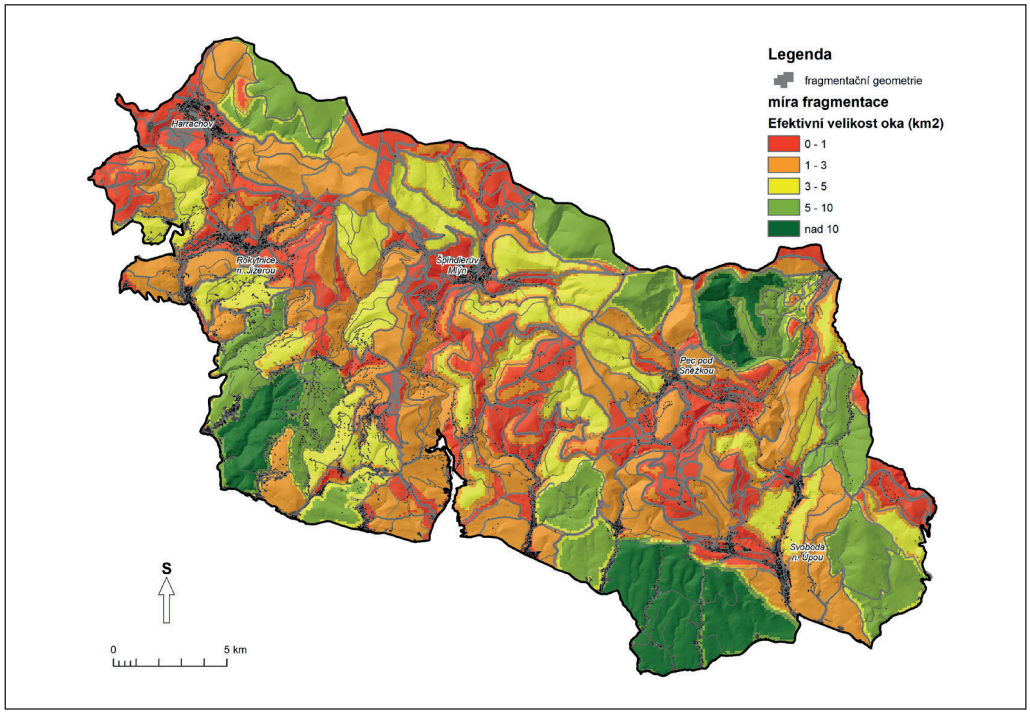


Figure 2 Degree of fragmentation of the Krkonoše/Giant Mts. National Park and its buffer zone (the redder the colour, the higher the fragmentation of the area). Source: ZÝKA & ROMPORTL 2018

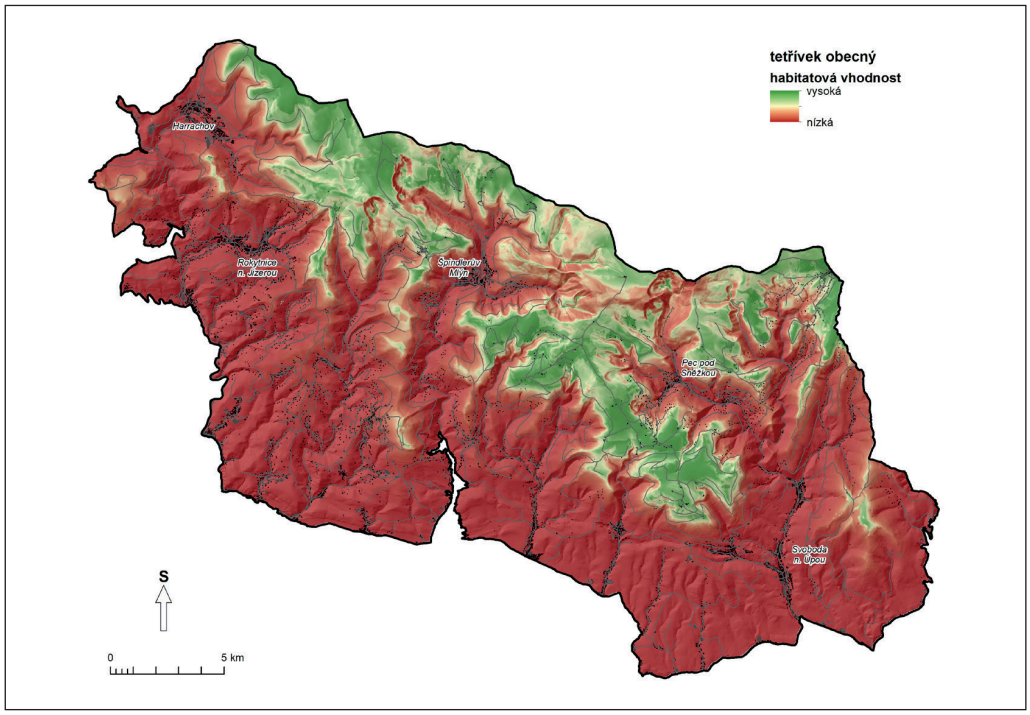


Figure 3 Continuous habitat model of the Black grouse in the Krkonoše/Giant Mts. National Park (the greener the colour, the more suitable the habitat). Source: ROMPORTL & ZÝKA 2018

Some necessary information to begin

The Krkonoše/Giant Mts. National Park (KRNAP, East Bohemia) is a vulnerable protected area with an extreme number of visitors (3.8 million people, or 11.9 million visiting days, in 2018) and a significant concentration of anthropogenic activities of all types, which penetrate even into areas with a predominance of natural and semi-natural habitats. The current development of local landscape use and, in particular, the intensity of recreational pressure on the area cause a high degree of fragmentation by anthropogenic elements (Fig. 1); these create significant barriers in terms of permeability and usability of the landscape for wildlife.

The Black grouse (*Tetrao tetrix*) is a species directly threatened by intensive human use of the landscape and its fragmentation. Suitable habitats for black grouses have still been there; however, their occupancy is significantly limited by disruptive effects of forestry or agriculture, building development, tourist infrastructure, and a dense road network.

The second largest population of the Black grouse in the Czech Republic survives in the Krkonoše/Giant Mountains and the jIzerské hory/Jizera Mountains (FLOUSEK 2019). However, with 80–100 lekking males in 2020, it is approaching the survival limit. In the Krkonoše/Giant Mts. alone, their number has fallen by more than half in the last 20 years. The main problem is not the lack of suitable habitats, but especially the area fragmentation and the negative impact of recreational activities (e.g., PATTHEY et al. 2008, ARLETTAZ et al. 2013, FORMENTI et al. 2015).

How did we proceed?

We used the MaxEnt method for habitat modelling (PHILLIPS *et al.* 2006, MEROW *et al.* 2013). The environmental variables included factors describing the basic abiotic gradients of the environment (altitude, vertical heterogeneity of the relief), habitat characteristics (derived from the Consolidated Layer of Ecosystems of the Nature Conservation Agency of the Czech Republic and the CzechGlobe – Global Change Research Institute of the Czech Academy of Sciences – see HÖNIGOVÁ & CHOBOT 2014), and anthropogenic disturbance factors expressed by distance from built-up areas, ski resorts (cable cars, lifts, ski slopes), and the road network. In addition, all roads were divided into three categories according to the intensity of traffic of pedestrians, cyclists, and motor vehicles – low, medium, and intensively used (for classification, data from automatic field counters and expert estimates of the KRNAP Administration field workers were used).

To model the connectivity of black grouse habitats, we chose the so-called least cost path (BEIER & NOSS 2008). Its principle presupposes at least a basic knowledge of the environment in which the organism moves. Simply put, the method seeks the easiest way to the objective, *i.e.* the connection of predefined core areas or stepping stones. The Circuitscape programme (MCRAE & SHAH 2011) and Linkage Mapper tool (MCRAE & KAVANAGH 2011) were used for the calculations.

Data from the area mapping of lekking black grouse throughout the KRNAP area during the spring of 1998–2017 served as the input basis for all evaluations (mapping according to the standard methodology, mostly at three-year intervals; a total of 1,480 records). The data gathered in this way show us the preference of males when choosing a lek, but they only partially indicate the nesting environment. Here we have been helped by published studies which show that black grouse nests are found and young are raised within a radius of 100–1500 m from the lek (e.g., Cayford *et al.* 1989, Zawadska *et al.* 2015, Scridel *et al.* 2017). With regard to the high fragmentation of the natural environment in the Krkonoše/Giant Mountains, we worked with the lower limit of this range, and in the preparation of the habitat model we evaluated habitats from a circle with a radius of 500 m from each lekking male.

Published data were again used to evaluate the sensitivity of black grouse to various types of disruption. Various sources indicate the flight initiation distance/alert distance of the Black grouse in a range from 30 to 1000 m (most often 50–500 m), depending on the season (the biggest mainly during lekking, the smallest during egg incubation, often different individual reactions during raising the young or wintering), on previous experience of disturbed birds, or on the type and factor of disruption (*e.g.* Currie & Elliott 1997, Zeitler 2000, Ruddock & Whitfield 2007, Tost *et al.* 2020). The impacts of the disruptive effect of the road network were therefore assessed in stages – low-used roads were given an escape distance of 50 m, medium-used roads 200 m, and for intensively-used roads, two alternatives were used – 200 or 500 m.

When assessing the connectivity of black grouse subpopulations, we counted on the average movements of adult males and females up to 1 km, or 5 km (*e.g.* Caizergues & Ellison 2002, Waren & Baines 2002, Marjakangas & Kiviniemi 2005), and on the stated audibility of black grouse lekking to a distance of 3 km (Hjorth 1970).

Habitat model

The habitat model shows the association of the Black grouse in the Krkonoše/Giant Mountains to the ridges of the mountains on the tree line and above it (subalpine and alpine grasslands with scattered dwarf mountain pine growths), open or non-stratified forest stands with clearings, to montane and subarctic peat-bogs and other natural and secondary treeless areas (Fig. 2). Based on the outputs of the habitat model, the core areas of black grouse occurrence were defined according to their occupancy during mapping in 2017 (Fig. 3).

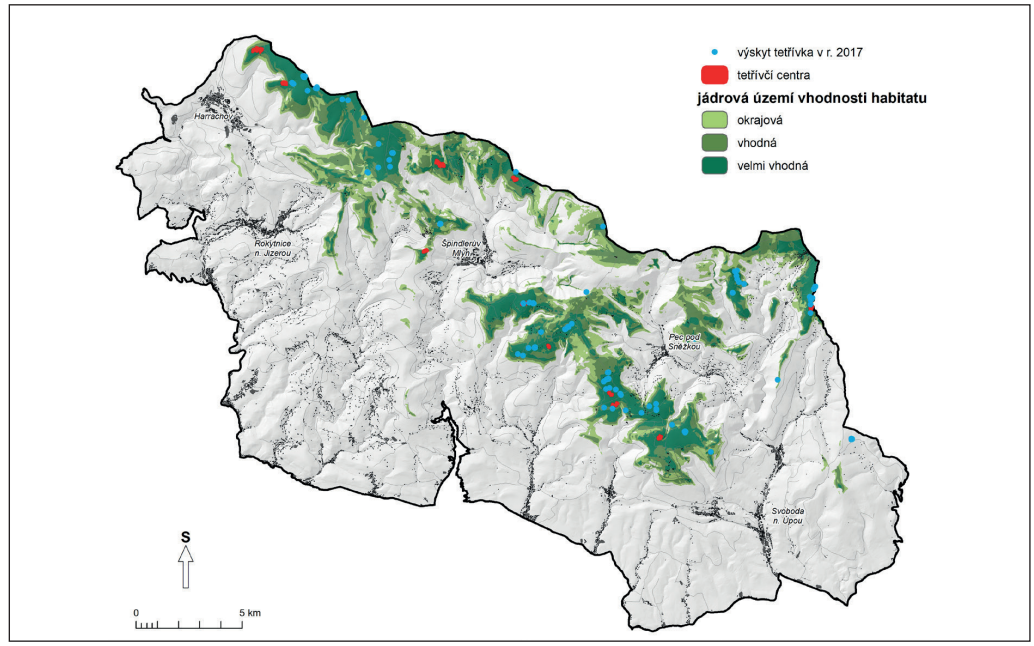


Figure 4 Core areas of suitable black grouse habitats without the disturbing effect of road network and ski resorts (so-called grouse centres, which the KRNAP Administration created in the autumn of 2018 to increase the supply and interconnection of grouse habitats, are marked in red; in 2020, black grouse were lekking on seven of them, but their occurrence has already been proven in all of them). Source: Romportl & Zýka 2018

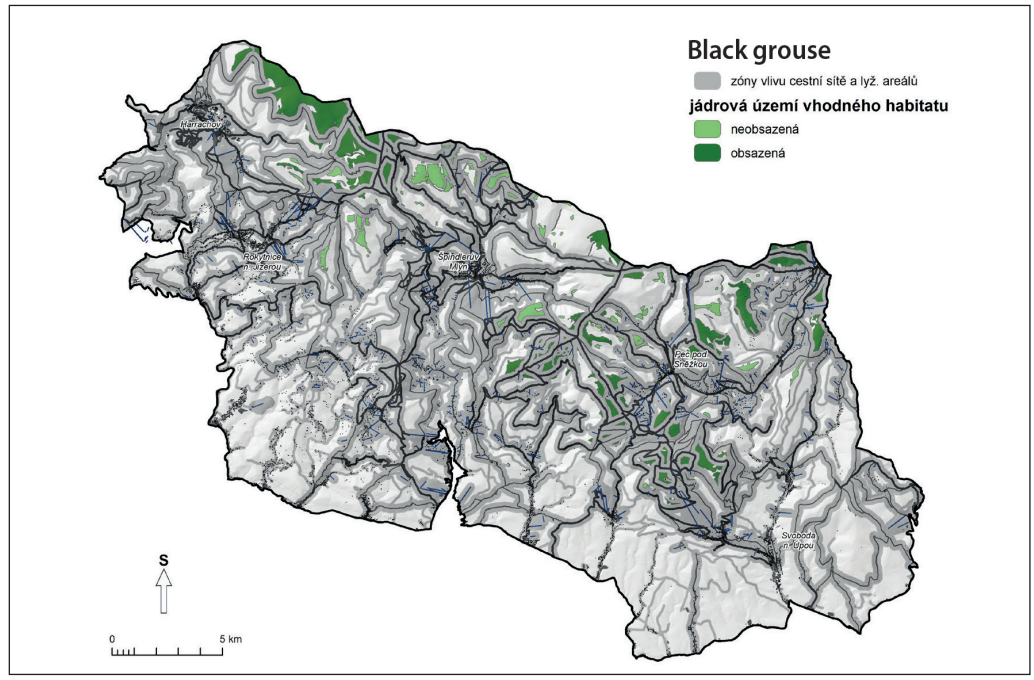


Figure 5 Core areas of suitable black grouse habitats (occupied/unoccupied in 2017) taking into account the influence of road network and ski resorts (real variant: graded disturbing effect of low-medium-intensively used roads up to a distance of 50-200-200 m from them). Source: Romportl & Zýka 2018

However, the model thus prepared evaluates the real impact of various human activities in a very limited way – movement of people on hiking and skiing trails and bike paths, operation of ski resorts and cable cars, and year-round movement of service vehicles on roads. In particular, the dense road network is an essential element that limits the occurrence of the Black grouse on potentially suitable areas. Therefore, other models were

Table

Table 1 Changes in the area and spatial structure of the core areas of Krkonoše/Giant Mts. Black grouse suitable habitat at different intensities of the influence of anthropogenic activities and elements. Source: ROMPORTL & ZÝKA 2018

The scope of the core area	Total area (in hectares)	Number of patches	Average size of a patch (in hectares)
Overall supply of suitable habitats	6,616	133	49.7
Realistic supply (variant 50-200-200 m)	2,214	72	30.7
Pessimistic supply (variant 50-200-500 m)	1,089	46	23.6

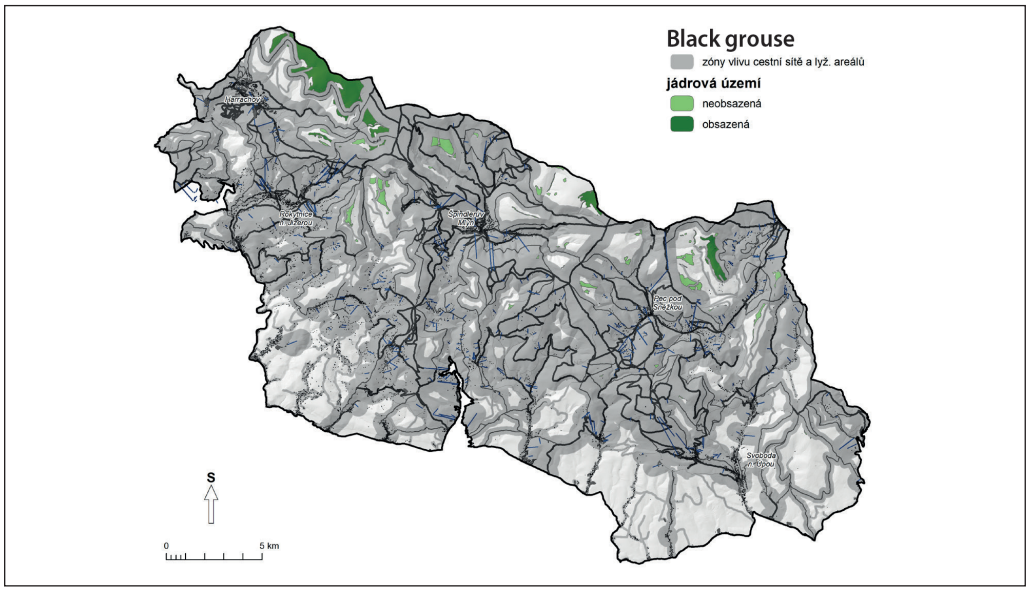


Figure 6 Pessimistic variant of Figure 5 (disturbing effect of low-medium-intensively used roads up to a distance of 50-200-500 m from them). Source: ROMPORTL & ZÝKA 2018

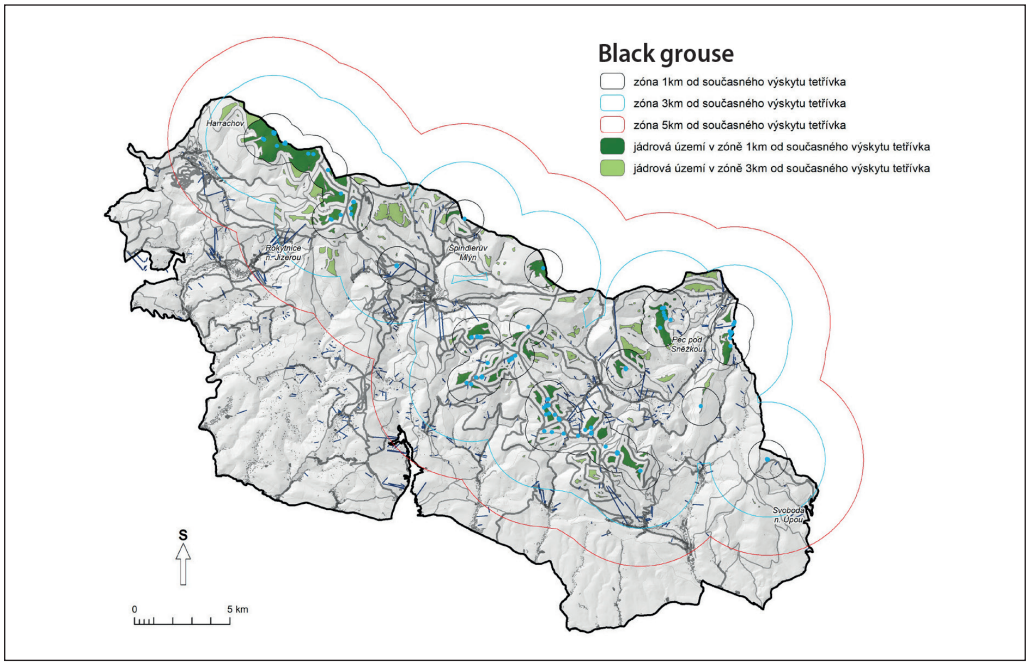


Figure 7 Core areas of suitable grouse habitats in various zones of their availability (real variant of influence of road network 50-200-200 m according to Fig. 5; availability zones 1-3-5 km). Source: ROMPORTL & ZÝKA 2018

prepared according to the expected disturbing influence of low-medium-intensively used roads – in variants of 50-200-200 m for individual categories of intensity (realistic variant) and of 50-200-500 m (pessimistic variant) (Fig. 4 and 5).

The availability of a suitable habitat is not limited only by its isolation or degree of fragmentation by barriers of various types, but also by the dispersive abilities of the Black grouse. Therefore, an analysis of the availability of suitable habitat fragments at distances of 1, 3, and 5 km was also performed. Further "fragmentation" of core areas according to this criterion showed only a very limited supply of functional habitats (Fig. 6).

The analysis shows that black grouse (with average movements of up to 1 km) in the western, central, and eastern Krkonoše/Giant Mountains can already be isolated from each other. The situation could be more optimistic for females (with average movements of up to 5 km), where there has been still a realistic chance of their movements, at least along the Czech-Polish state border, within the entire mountain range. The audible range of black grouse lekking (3 km), especially important for female flights between leks, is not bad either; however, given the level of noise pollution in the area and the sensitivity of the Black grouse to noise, the actual audibility distance is likely to be significantly lower.

When quantifying the impact of different degrees of the above-mentioned disturbing influences on the size and character of the core areas distribution, we find a fundamental degradation of suitable habitats. Of their total area of over 6,600 hectares, two-thirds are negatively affected by the anthropogenic structures in their vicinity. In the case of the pessimistic variant, where the maximum range of disturbing effects of 500 m from intensively used roads is considered, the total area of a suitable environment is reduced to less than 1,100 hectares. The spatial structure of isolated patches of core areas is similarly significantly affected; their number is declining and the average patch size is also decreasing (Tab. 1). This increases the migration distances for the necessary movement of black grouses between suitable sites, and thus reduces the overall connectivity of habitats and subpopulations. In addition, the average patch size of 24 hectares has already been close to the minimum size of a continuous suitable habitat needed for black grouse nesting, which is stated to be around 20 ha *(e.g.* DECOUT & SIGNER 2010, PATTHEY *et al.* 2012).

Interconnection of core areas

The steps described above subsequently made it possible to model the connectivity of black grouse habitats – where optimal black grouse

routes can lead so that they can move at least between adjacent patches of the core areas.

The connectivity model was developed in two variants, which reflect the current state and the potential for possible interconnection of suitable habitat sites. The model of the current state of connectivity (Fig. 7) represents a possible interconnection of patches that were occupied by black grouses during mapping in 2017. It captures the current state of the population, fragmented into several larger or smaller subpopulations, which are in many cases more than 3 km apart. The proposed movement corridors describe the most probable lines of interconnection of core areas; however, without a detailed field investigation it is not possible to determine their real permeability for black grouse.

The potential connectivity model (Fig. 8) is based on all core areas of a suitable black grouse habitat (see Fig. 3). Its output shows a more positive picture of the degree of potentially suitable habitat interconnection, where a significant part of movement corridors does not exceed 1 km in length and only a few are longer than 3 km. Again, it is necessary to take into account the real permeability of the corridors, which can be fundamentally affected by numerous disruptive activities in the area.

In any case, both models suggest that the Black grouse is a species very sensitive to a decrease in connectivity in the area (and an increase in its degree of fragmentation), and therefore is a suitable umbrella species to protect the interconnectedness of natural elements in areas of its occurrence (*cf. e.g.* KURKI *et al.* 2000, GEARY *et al.* 2015).

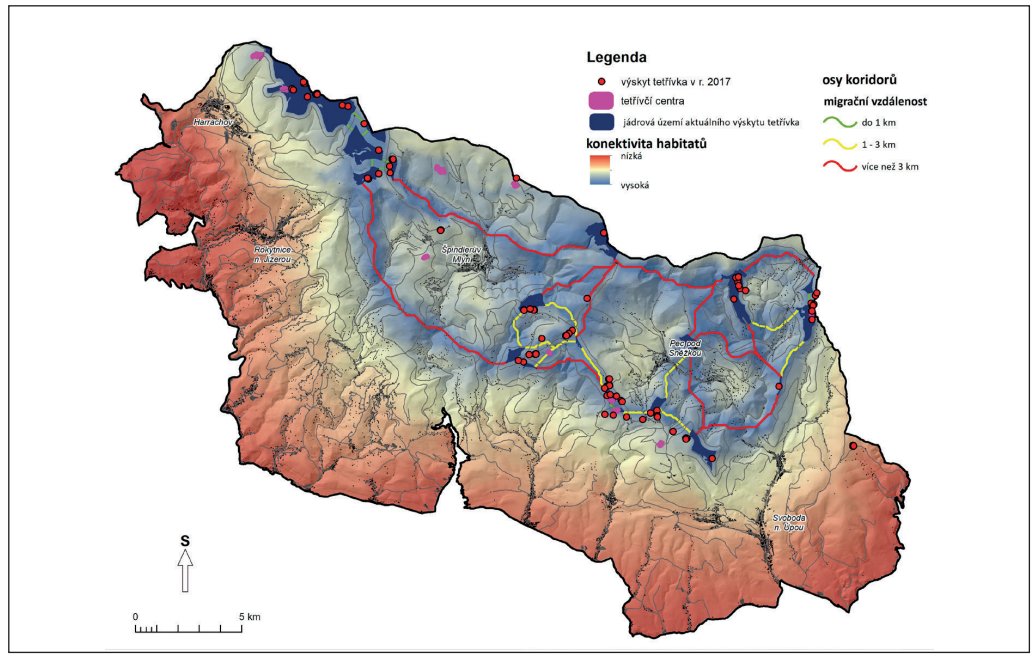


Figure 7 Model of connectivity of suitable black grouse habitat core areas – current state (as of 2017). Source: ROMPORTL 2018

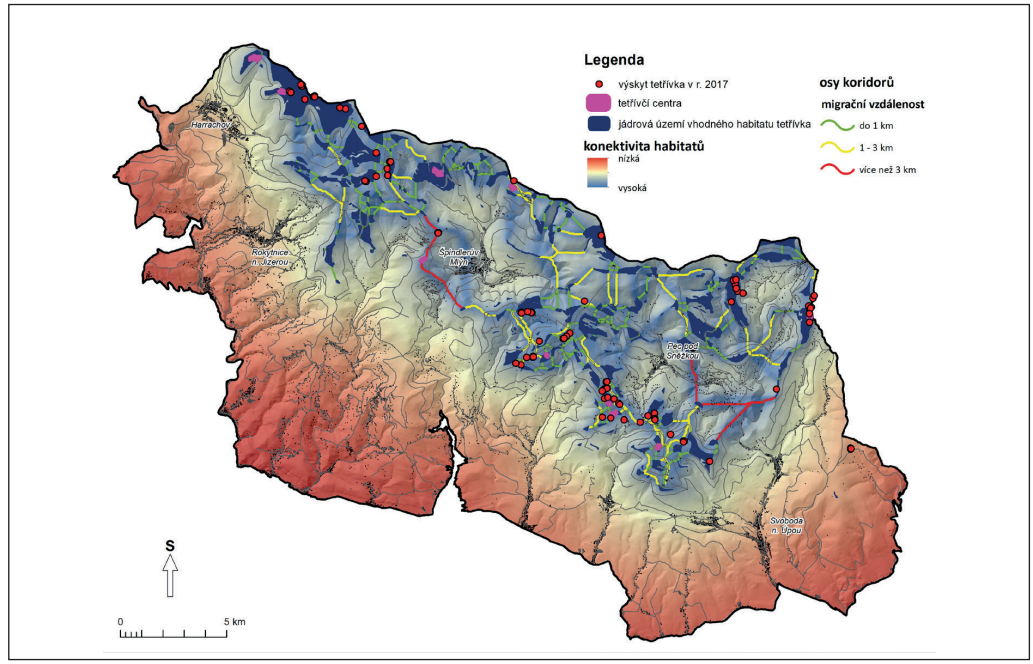


Figure 8 Model of connectivity of suitable black grouse habitat core areas – potential state. Source: ROMPORTL 2018

Conclusion

The Krkonoše/Giant Mts. National Park is not the only place in our country where a similar approach is used to protect the Black grouse. Habitat models for all grouse species are processed for Šumava/Bohemian Forest Mts. National Park; according to the Krkonoše/Giant Mts. experience, data from Jizerské hory/Jizera Mountains Protected Landscape Area are evaluated as well. As a result, we should have the entire territory of the Krkonoše/Giant Mts.-Jizerské hory/Jizera Mts. black grouse population covered, including the Polish part of both mountain ranges.

The resulting recommendation of Krkonoše/Giant Mts. modelling is clear and just trivial for a well-functional national park: ***To maintain a viable black grouse population in the Krkonoše/Giant and the Jizerské hory/Jizera Mountains, it is sufficient to consistently protect the interconnection of areas with habitats suitable for this species and not allow further fragmentation of the area by disruptive structures and activities.*** However, it is necessary to realize that the mere movement of people off the marked paths into the places where the Black grouse has still been living is a disruptive activity that devalues suitable habitats.

(*Models of fragmentation, habitats, and connectivity for the KRNAP territory were prepared within the project MaGICLandscapes – Managing Green Infrastructure in Central European Landscapes, Reg. No. CE 897.*) ■

The list of references is attached to the online version of the article at www.casopis.ochranaprirody.cz.

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MaGICLandscapes

Temporarily Unmown Grass Strips – A Hope for Productive Meadow Insects?

Petr Šípek, Tomáš Jor & Lukáš Eršil

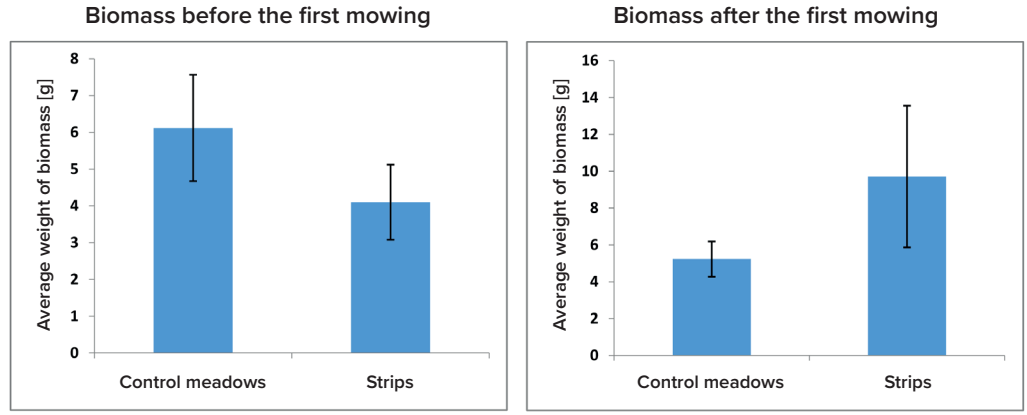
The agri-environmental-climate measures (AECM) announced by the Ministry of Agriculture of the Czech Republic are intended to support management methods mitigating the negative effects of intensive farming on the landscape and its inhabitants, including insects. Despite their productive nature, permanent grasslands are an important landscape component hosting a wide range of invertebrates. The right balance of production practices and compensatory measures can make a significant contribution to maintaining the diversity of grassland organisms and the ecosystem services they provide. The Nature Conservation Agency of the Czech Republic (NCA CR) has therefore commissioned a study on the effects of temporarily unmown grass strips on the diversity and abundance of meadow organisms. The aim of the study was to verify whether the retained parts of grass stands have a positive effect on the biota on common managed meadows of various sizes.

Herb-rich unmown strip. © Petr Šípek

The decline in insect populations has long been connected only with species associated with threatened habitats. Recently, the phenomenon of global insect decline and loss has come to the forefront of the interest of professionals and the general public (Hallmann *et al.* 2017, Sánchez-Bayo & Wyckhuys 2019, Seibold *et al.* 2019). Although there has still been debate about the extent to which these "alarmist" reports are data-based (*e.g.* Didham *et al*. 2019, Wagner 2019), the "insect-clearing" of the landscape seems to be a real phenomenon and the decline also affects the hitherto abundant and common species of the cultural landscape (Basset & Lamarre 2019, Habel & Schmitt 2018, Harvey *et al.* 2020, Wagner 2020, Hallmann *et al.* 2021). There are many reasons for the decline in and loss of insects, including some economically valuable and irreplaceable pollinators: habitat loss, chemical and light pollution, climate change, as well as new and invasive alien species. In Central Europe, however, it is necessary to look for causes mainly in the structure of the landscape and the way it is used. One of the main threatening factors/drivers is the unification of the environment due to industrial use of the landscape.

Apart from pastures, the most important insect habitats in the agricultural landscape are mainly permanent grasslands for hay production. These meadows are harvested by machine, two to three times a year (depending on climatic conditions), while the mowing dates are set by a government decree and are linked to the payment of subsidies. One-off machine mowing has an impact on insects in several ways. Almost everyone will immediately think of bees, bumblebees, and butterflies that lose their food. In the case of mobile species, it may not be so bad; the Western honeybee (*Apis mellifera*) will simply look for another source of food. Small solitary bees, often tied to specific plant species as a source, are significantly worse off. For their offspring, mowing the meadow is basically an existential question, as in a few hours, their home becomes literally a green desert. Butterfly caterpillars are in a similar situation. For this reason, the Danube clouded yellow (*Colias myrmidone*) has relatively recently become extinct in the Czech Republic. In addition, machine mowing also directly kills invertebrates. One mowing of a meadow kills 40% of locusts and grasshoppers, another 40% is killed by baling hay. A direct link between mowing type and population size was demonstrated on the last surviving population of the Larger saw-tailed bush cricket (*Polysarcus denticauda*) in the Jičín region, which was momentarily resurrected by the diversification of the mowing regime before the farm concerned returned to its original management model due to administrative barriers

Figure 2 Unmown grass strips (marked by an arrow) can also be an important landscape feature. Agricultural landscape near the village of Vlastibořice (District of Turnov), photo from June 2019. Source: Mapy.cz, Seznam.cz



Amount of biomass captured on control meadows and meadows with strips before and after the first mowing. © Tomáš Jor

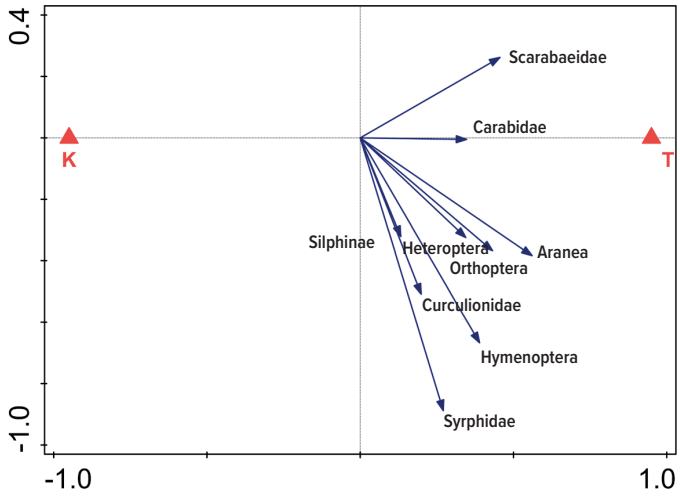
(*e.g.* Konvička *et al.* 2008, Humbert *et al.* 2010, Marhoul 2012).

Although most Central European grassland communities have been converted to productive agroecosystems, their importance for preserving global biodiversity and ecosystem functions within the landscape cannot be underestimated. Current grassland ecosystems are substitute habitats for now extinct Central European savannah species (Dostál *et al.* 2014). In addition, over the centuries of specific management, unique ecosystems have emerged which can also be surprisingly very species-rich (Batáry *et al.* 2007). At present, the grassland ecosystems of temperate zones are among the most endangered biomes in the world (Habel *et al.* 2013, Tökök *et al.* 2016) which logically also applies to their inhabitants (e.g. Reif *et al.* 2008, Van Swaay & Warren 1999, Franzén & Johannesson 2007, Wagner *et al.* 2021).

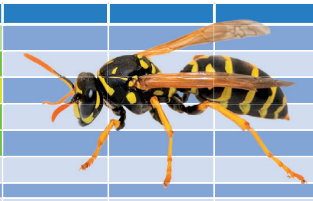
How did the research proceed?

The actual implementation of the study took place on the basis of an assignment created in cooperation between the NCA CR and the Ministry of the Environment of the Czech Republic. A total of 100 research plots were used located on 22 farm meadows in the so-called open landscape area near the Český ráj/Bohemian Paradise Protected Landscape Area.

The meadows were selected according to the assignment from three different size categories: meadows with an area of 1–5 ha, meadows with an area of 5–12 ha, and meadows with an area of more than 12 ha. Half (11) of the meadows were experimental, *i.e.* strip mowing was introduced there, leaving approximately 5–10% of the area unmown (Fig. 2). The other half (11) was mown in the classic blanket manner. Each plot consisted of a set of three types of traps designed to capture invertebrates. Specifically, it was one



RDA ordination diagram showing the relationship of the studied groups to meadows with strips (T) or without strips (K). The direction of the arrow shows the preferred environment, the length of the arrow the strength of the preference. © Tomáš Jor



Total biomass	↑			
Biomass without traps	↑*			
Biomass the first collection	↓**			
Biomass the second collection	↑*			
Outside the strip/strip (T – meadows)	↑*			
Size	0			
Taxon	Diversity	Abundance	Diversity(2-4)	Abundance (2-4)
Lepidoptera	0	↑	na	na
Coleoptera: Carabidae	↑	↑	↓	0
Coleoptera: Curculionidae	↑	↓	↑	↓
Coleoptera: Scarabaeidae	↑*	↑	↑	↓
Coleoptera: Silphinae	↑	↑	↑	↑
Hymenoptera: Aculeata	↑*	↑	↑	↑
Syrphidae	↑	↑	↑	↑
Heteroptera	↑	0	↑	0
Orthoptera	↑	↓	na	na
Aranea	↑↓*	↑**	↑	↑

Summary of study results: changes in collected biomass, species richness, and abundance of groups depending on the type of mowing in the first year of research. © Tomáš Jor

window trap measuring 1.5 × 1 m, three ground traps (plastic cup with a volume of 500 ml) with fixation, and ten 200 ml yellow cups to catch pollinators. Due to the vegetation, yellow traps were always placed on wooden poles 1 m high. The collections themselves were always made before mowing and a week after mowing on each meadow, thanks to which it was possible to evaluate the effect of mowing on meadow invertebrate communities. A total of four collections were carried out, the first in May and the last at the turn of August and September after the second hay harvest. All material was fixed in 75% ethanol at collection. Diurnal butterflies were monitored twice a season by the transect method (observation per unit of time) in sunny and wind-free weather. All material thus collected was subsequently weighed in the alcohol state on analytical balances, according to the methodology given in HALLMAN *et al.* (2017). Subsequently, species were determined in nine selected groups of invertebrates: ground beetles (Carabidae); scavengers (Silphidae); scarab beetles (Scarabaeidae); weevils (Curculionidae); stinging bees and wasps (Hymenoptera: Aculeata), true bugs (Heteroptera); hoverflies (Syrphidae); grasshoppers, locusts, and crickets (Orthoptera); diurnal butterflies (Lepidoptera: Papilionoidea); and spiders (Araneae).

The last two collections were excluded from analyses of the meadow strip effect on invertebrate biomass, as 2018 was very dry and the meadows turned into "yellow (no longer green) deserts" after mid-July, which had a major impact on the biodiversity of captured organisms. The main reason was that the vegetation was largely non-grown on a large part of the meadows and it was difficult to judge from these data whether the weather or the type of mowing had a greater effect. However, data from all collections were included in species diversity analyses to determine the cumulative effect of unmown strips on invertebrates.

What are the results?

Based on the analysis of the total collected biomass of insects and arachnids, it is clear that the strips have a clear positive effect on the number of captured invertebrates. In the first collection, there is a statistically significant higher amount of biomass in the control meadows (Wilcoxon test, p = 0.00397). However, after the first mowing in

Machine mowing has a negative effect on spiders as well (Goldenrod crab spider *Misumena vatia*). © Petr Šípek

Machine mowing also endangers grasshoppers, locusts, and crickets (Large marsh grasshopper *Stethophyma grossum*). © Petr Šípek

2018, the situation changed dramatically. Suddenly, more invertebrates were collected in the meadows with strips (Wilcoxon test, p = 0.00695).

The fact that the strips served as islands of life in the production meadows in the first year of the project is also evidenced by the evidence that the biomass of invertebrates captured on the experimental areas located in the strips was significantly higher than that obtained in the same meadows in traps outside the strip. The effect of the strips was also independent of the experimental meadow size. The strip-mown meadows were not only richer in total number of individuals (biomass), but also in that of captured species (species richness). Individual monitored groups entered the RDA (redundancy analysis) and instead of the traditionally used abundance, total number of species in the studied meadows was used there. The model testing the effect of unmown strips resulted in a clearly positive effect on the number of species for meadows mown in parts.

It is obvious that all the monitored groups have a greater relationship to the experimental strip meadows. However, from the dispersion of individual vectors on the second (vertical) axis of the diagram, it is clear that the overall biodiversity of invertebrates is affected by many other factors (humidity, isolation, herb richness, *etc.*).

The complete results are summarized in the following table (Table), which shows both the overall results concerning the analyses of captured biomass and also those describing the identified diversity and abundance for individual studied groups. In the year that management was introduced, the unequivocally positive effect of strip mowing on diversity was found with scarab beetles, bees and wasps, and spiders. Moreover, a strong positive effect of strips on the number of individuals was also recorded in spiders. Like all biological systems, meadow (agro-) ecosystems are very complex and comprehensive, as demonstrated by the decreases in abundance of some groups in the experimental plots.

What to say in conclusion?

If we look at almost any literature focused on invertebrate diversity in the production/working landscape today, we will find that everything is not quite right. This is mainly due to a significant change in landscape management over the last 100 years. Due to agriculture, diversity has disappeared from the landscape. In the past, there were dozens of various patches of land belonging to different owners on a few hectares that formed a diverse heterogeneous landscape mosaic; after the merging of land parcels/plots, we no longer find such a mosaic. Thanks to landscape diversity, even in a managed landscape,

Heath fritillary (*Melitaea athalia*) sucks on betony (*Betonica officinalis*). © Petr Šípek

the organisms still had the opportunity to move to places that were relatively suitable for them. Also, there used to be a difference in the speed of individual agricultural activities. What a farmer did with the scythe for half a week, today the tractor can do it in less than two hours and on an even larger area. This fact radically affects meadow communities, and we should take a certain moral obligation to support these organisms.

From the results presented above, it is quite clear that the maintained meadow strips could be the method that will help improve the situation of invertebrates in the open landscape, similarly to Specially Protected Areas (see the study from the Babiččino údolí/Grandmother's Valley National Nature Monument– Čížek *et al*. 2012). Their positive effect manifested itself in the very first year of mowing adjustment. They provide animals with an indispensable source of food, even when mowing the remaining part of the meadow. The strips also very often create a missing refuge in which organisms can hide from bad weather. In many insect species, the role of such a refuge is even more crucial for larval development; for example, due to the relatively large impact of mowing on the microclimate at a site, which is absolutely essential for the development of, *e.g.* many species of caterpillars. Radical changes usually have a lethal effect on them. A very important factor is also that unmown strips are a relatively easy and cheap method. At present, according to AECM rules, the retained strips are only mandatory for meadows with a size of more than 12 hectares; due to the negative trend in insect populations, it is necessary to extend this measure to smaller areas as well.

Management recommendations within AECM

If we could choose, we would recommend promoting such way of management that would lead to the spread of strip refuges in the landscape, regardless of meadow size. It is important that unmown areas are in the form of strips and that the strips are maintained to the greatest extent, even during the winter.

As with other biodiversity-supporting measures, it is clear that there is no universal solution. In order to maximize the effectiveness of the measures, it would be necessary to support diversity in the location of strips (both in the middle and on the edges) which, on the other hand, may not be readily accepted by agricultural entities/enterprises and control bodies, such as the State Agricultural Intervention Fund (SAIF). One solution could be an expansion of the subsidy according to the degree of heterogeneity of the implemented measures (*e.g.* such as in Switzerland). At the same time, however, AECM must not increase the administrative burden on the stakeholders concerned. ■

The list of references is attached to the online version of the article at www.casopis.ochranaprirody.cz.

Monitoring Non-native and Invasive Alien Species in the Czech Republic

Karel Chobot, Jan Pergl & Tomáš Görner

Invasive alien species (IAS), together with natural ecosystem fragmentation, degradation, destruction and loss, growing natural-resource consumption, environmental pollution and climate change, are among the main negative factors threatening native species and the biodiversity of native ecosystems. In addition, they can cause high economic damage/financial costs or adversely affect human health. Due to the ability of IAS to spread, an isolated approach to their management at the level of individual regions or countries is usually not effective; we need a targeted and tailored strategy that transcends national borders. Therefore, Regulation (EU) No 1143/2014 of the European Parliament and of the Council on the prevention and management of the introduction and spread of invasive alien species was adopted in the European Union, which was transposed into the Czech Republic's legal order by amending Act No. 114/1992 Gazette on Nature Conservation and Landscape Protection, and other laws related to the issue, entering into force January 1, 2022.

The Box tree moth (*Cydalima perspectalis*). © Karel Chobot

Looking for invasive alien species

Following the adoption of the Regulation, a list of IAS of EU concern (the Union list) has been created; it currently includes 66 species and is gradually being updated. Pursuant to the Regulation, invasive species are considered to be non-native species whose introduction and spread threatens biodiversity and related ecosystem services, or has a negative impact on them. It is therefore a sub-group of introduced non-native species in the Czech Republic. The Regulation and the Amendment to the Nature Conservation and Landscape Protection Act speak mainly of IAS. A very important component of prevention and regulation, which are the main topics of the Regulation, is IAS monitoring. However, for nature conservation purposes, it is advisable to monitor a wider group of species, *i.e.* non-native, already established and potentially invasive in the future, or those that have been only just settling in the Czech Republic or are newly introduced there. It is therefore advisable for the monitoring scheme to give priority to monitoring those species that are defined by legislation, but also to be prepared for monitoring other ones. In the Amendment to the Act, Article 13f is devoted to monitoring. In its two paragraphs, it describes the two necessary points of the information base on IAS control.

Two paragraphs, two topics

The first paragraph of the Article entrusts the Nature Conservation Agency of the Czech Republic (NCA CR) with monitoring the IAS occurrence and distribution across the country. It should also be informed about found occurrences by Public/State Administration bodies or an authorized person, in accordance with the Forest Act, and then publish all the collected data on its website. The NCA CR also gathers information from public institutions and the public. The second paragraph mentions the analysis of how IAS listed on the Union list spread, which, according to the law, is provided by the Ministry of the Environment of the Czech Republic Based on the analyses, the Ministry updates the action plans (practical measures aimed at regulating and controlling unintentional introductions). Both topics are interrelated; spread analysis must be based on knowledge of distribution, and, retrospectively, it can influence monitoring methods and the selection of priority areas. It is also important whether the target is an invasive species in the Czech Republic, invasive species from the Union list, or a wider group of non-native species. According to the law and Regulation, these analyses and action plans only apply to species on the Union list. That is, the list which includes only species originating outside the EU, and which reflects the history of political negotiations at the EU level (due to which knotweeds *Reynoutria* spp. and the American mink *Neovison vison* have not been included in the Union list). Therefore, in the case of the Czech Republic, it does not include a number of species that are considered significant in terms of negative impacts. So, let us summarize the current situation of monitoring IAS in the Czech Republic.

Mapping + monitoring = surveillance

In the established interpretation of terms, "surveillance" can be understood as combinations (or spectrum) of mapping and monitoring activities. The aim of mapping is to find out the current distribution of the phenomenon in a specified level of detail, monitoring aims to repeatedly observe trends (population, qualitative), or other detailed parameters on permanent plots. Repeated mapping is actually monitoring; monitoring the species at its all known sites also fulfils the function of mapping. Both basic principles of surveillance are necessary for correct analyses, or for fulfilling obligations, *e.g.* from the EU Habitats Directive, which also introduced the obligation to monitor the species and habitats listed in the annexes. Based on the latter example, the formulation of obligations in relation to IAS can be expected in the future. To begin with, we should remember that a specialized and unified scheme of detailed and comprehensive IAS monitoring in the Czech Republic has not yet been established. So have we been mapping and monitoring IAS today?

We have lists

The basic element of monitoring is the knowledge of the occurrence in the area, and so for IAS, the existence of lists of these species. At the European level, the DAISIE Database of Non-Native Species in Europe, covering more than 11,000 items, has played this role. Today, the EASIN platform can be used at a European scale, bringing together almost all European databases of non-native species, including those focused only on certain regions (NOBANIS, ESENIAS). There are over 2,000 non-native species in the Czech Republic, and the proportion of IAS among them is up to 15%, such as at the EU level. We have these data from two basic lists of non-native species in the Czech Republic. The first is the *Catalogue of alien plants of the Czech Republic* (Pyšek *et al.* 2012) and the other is the *Catalogue of alien animal species in the Czech Republic* (Šefrová & Laštůvka 2005), both of which are scheduled to be updated in 2022. Other lists are based on these studies – Black, Grey, and Watch Lists of non-native species (Pergl *et al.* 2016), which used and summarized the relatively long tradition of studying non-native species in the Czech Republic; it includes not only a simple list of species but also the information on their distribution, spreading and pathways, and environmental and socio-economic impact. We can say that we know what species we should monitor in an ideal situation. These are not just species from the Union list, but also those important for our Central Europe and those have been occurring in neighbouring countries and could be potentially introduced to the Czech Republic.

We know quite a lot

However, interest in non-native and invasive alien species does not come with the EU regulation or the amendment to the act. The above-mentioned tradition of research on non-native species in our country (internationally important and recognized) together with the long-term interest in IAS from the ranks of conservationists and phytosanitary experts are behind the fact that we have already had good knowledge of many species. The current overall state of knowledge of the IAS occurrence is essentially fragmentary, both at the species level and at the spatial and temporal ones. IAS and their mapping are a topic of projects and partial activities limited by time, capacity or area. This should change with the implementation of Article 13f of the amended Nature Conservation and Landscape Protection Act, and it should therefore be comprehensive and systematic for at least some IAS.

Non-native species in the Species Occurrence Database

The long-term effort of the NCA CR to centralize all available data on species diversity within the Nature Conservancy Species Occurrence Finding Data Database, shortly known as the Species Occurrence Database (SOD; https://portal.nature.cz) has, in fact, gradually been summarizing these data in the database. At the same time, data have already been published in the SOD applications (SOD Filter, Species Cards).

Due to distributing access rights/permissions for access and data entry into the SOD to the relevant State Nature conservancy authorities, the structure pursuant to Article 13f has been prepared and functional. Simply said, the most comprehensive dataset on IAS distribution and numbers in the Czech Republic has regularly been published, updated and enhanced.

These data are based on several extensive sources. Of the total number (as of 19 November

Table 1 Summary of sources processed in the SOD (excluding habitat mapping data) with more than 1,000 records on the occurrence of non-native species in the Czech Republic.

Source	Number of records
CHYTRÝ M. *et al.* (2013) Česká národní fytocenologická databáze/ Czech National Phytosociological Database.	17,964
FALTYS Vladimír (2015) Personal findings.	14,864
ANDĚRA M. *et al.* (1995 – 2009) Atlas rozšíření savců v České republice/Atlas of the distribution of mammals in the Czech Republic. National Museum, Prague.	9,280
DANIHELKA J. (2005) Kompletní inventarizace flory území rozšíření CHKO Pálava/Comprehensive survey on flora within the enlargement of the Pálava/Pavlov Hills Protected Landscape Area (today's Dolní Morava/ Lower Moravia Biosphere Reserve).	6,930
Various authors (2017) Botanický inventarizační průzkum KRNAP a jeho OP z let 2006–2014/Survey on flora of the Krkonoše/Giant Mts. National Park and its buffer zone in 2006–2014.	6,442
JONGEPIER J. W. (2011) Biodiversity. Project of the Council of the Government of the Czech Republic for Research & Development.	5,158
iNaturalist (2021) Data Czech Republic 2020 (iNaturalist.com).	4,120
Forest Management Institute (2016) Databáze lesnické typologie/ Database of Czech Forest Classification System (as of 2016).	3,986
Czech Anglers Union (2004) Czech Anglers Union. Questionnaires in 2004.	3,873
BERCHOVÁ K. (2016) Ohrožení biotopů soustavy Natura 2000 invazními druhy/Threatening habitats of EU Natura 2000 network by invasive alien species (Mon EVD v Natura 2000, EEA-CZ02-OV-1-024-2015 Project).	2,759
POPELÁŘOVÁ M., WOLFOVÁ J. & WOLF P. (2009) Mapování flóry v CHKO Beskydy v letech 2006–2009 (síťové mapování)/Flora mapping in the Beskydy/Moravian-Silesian Beskids Mts. Protected Landscape Area in 2006–2009 (grid mapping).	2,684
NĚMEC R. *et al.* (2020) Mapování cévnatých rostlin Podyjí/Vascular plant mapping in the Podyjí/Thaya River Basin.	2,630
iNaturalist (2020) Data Czech Republic August 1, 2018 – December 31, 2019 (iNaturalist.com).	2,407
Central Institute for Supervising and Testing in Agriculture (2015) Monitoring zaplevelení. Metodika a vyhodnocení: Průzkum výskytu a rozšíření plevelů v ČR v roce 2014/Monitoring weed distribution and infestation. Methods and assessment: Survey on weed occurrence and distribution in the Czech Republic in 2014.	1,857
Koniklec/Pasqueflower Ecocentre, charitable trust. (2015) Monitoring vybraných invazních rostlin Prahy a blízkého okolí/Monitoring the selected invasive alien plants in Prague and its vicinity.	1,398
MAREK M. (2013) Terénní šetření 2005–2013 – Květena hradů, zámků a zřícenin, včetně okolí do cca 100 m/Field survey 2005–2013. Flora of castles and ruins including their vicinity up to approx. 100 meters	1,257
ŠPRYŇAR P. & MAREK M. (2001) Květena pražských chráněných území/Flora in Prague Specially Protected Areas.	1,192
GRULICH V. (1997) Atlas rozšíření cévnatých rostlin Národního parku Podyjí/Thayatal/Atlas of vascular plant distribution in the Podyjí/Thaya River Basin National Park. 297 pp.	1,074
Czech Society for Ornithology (2014) Bird Fauna Database – AVIF.	1,054
GREMLICA T. *et al.* (2011) VaV SP/2d1/141/07 Rekultivace a management nepřírodních biotopů v České republice/Non-natural habitat restoration and management. Project of the Council of the Government of the Czech Republic for Research & Development.	1,033

2021) of 603,540 data on non-native species in the SOD (which is 2% of the total number of data), two thirds (399,390) are based on data gathered during habitat mapping (3% of the number of species records gathered by habitat mapping). Habitat mapping is, to a large extent, also a systematic mapping of IAS occurrence. On each mapped segment of a semi-natural habitat, the occurrence of vascular plant non-native species is also recorded. From a strictly objective point of view, this extensive data set is fragmentary: it does not consider animals or fungi, it is limited to preserved segments within the landscape, *i.e.* often ignoring the centres of occurrence of non-native species in disturbed habitats. The remaining data largely compensate for these shortcomings (see Table 1 for a list of the biggest sources). But again, strictly objectively, these are not systematic activities. Although data sources include subnational grid mappings of the large-size Specially Protected Areas (*i.e.* National Parks and Protected Landscape Areas, PLAs), imports from large databases (Czech National Phytosociological Database; FMI Database of Czech Forest Classification System; Avif Ornithological Database; CISTA Weed Database), data from the public from iNaturalist and BioLog apps, and the results of projects aimed at IAS or specific non-natural habitats; these activities are always limited in area or species.

If we limit ourselves to the species of the Union list, *i.e.* a *de facto* arbitrary subset of the data, the numbers are logically lower and the share of data is also different. Thanks to habitat mapping, 22,856 data were gathered (these are only plant species). Among other activities, the SOD include 23,347 data on Union list species (both plants and animals). In terms of time, there is an increase in the number of data collected. Up to 1999 the SOD included 72,158 data, 222,257 data from 2000–2009, and 313,187 findings since 2010. Although biological invasions are a dynamic phenomenon, the increase in the number of data is mainly due to the combination of higher efficiency of data collection and processing and also its targeting; after all, it concerns data in general, not just data on non-native species. On the other hand, for nature conservation, new or newly verified data are needed, or even negative findings (there are very few of them in the SOD) reflecting, *e.g.* successful interventions and measures.

However, some data have still been missing in the SOD file. The outputs of the monitoring economically important non-native species carried out by the Central Institute for Supervising and Testing in Agriculture were only imported partially and once; in the future, the data exchange should be more intensive. The data still lack exports of the occurrence of invasive tree species captured by forest management plans collected by the Forest Management Institute (FMI). It is the actual authorized person according to the Forest Act and the import of the data into the SOD will be carried out in the near future. The SOD has also not yet received data from an interesting citizen science project of the Research Institute of Plant Production aimed at general public – Najdi.je. A number of other scattered data published and hidden in grey literature have been waiting to be included into the SOD, which is, *inter alia*, one of the aims of the DivLand project consortium, in which the NCA CR participates.

Even so, the amount of SOD data makes it possible to present a very good overview of the current distribution in the resolution of the basic grid mapping for a number of non-native species (Central European mapping network KFME, 10' × 6', approximately 11 × 12 km). Thus, the Species Cards (https://portal.nature.cz/karty-druhu) captures the spread of important invasive plant species well, thanks to habitat mapping and other sources; thanks to the systematic mapping of vertebrates, it captures the spread of invasive species of mammals and reptiles, and thanks to the combination of conspicuousness and belonging to a group with a higher

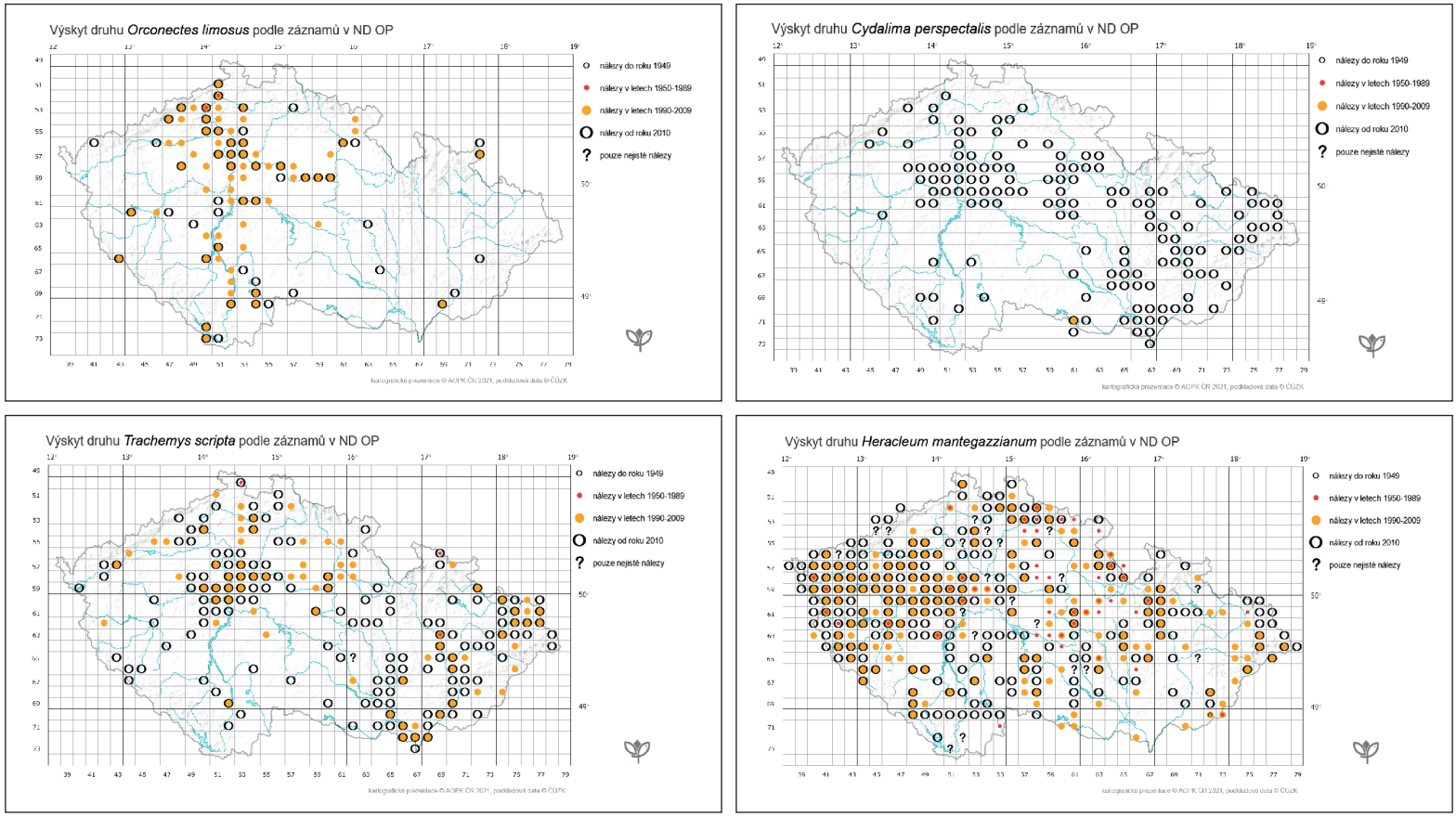


Figure 1 Grid maps of distribution of the selected non-native species, well represented in SOD: the Spinycheek crayfish (*Orconectes limosus*), an invasive species of crayfish, a major vector of crayfish plague pathogen, therefore also relatively intensively monitored. The Box tree moth (*Cydalima perspectalis*), a visually striking pest of box stands, an example of high spreading dynamics. The Pond slider (*Trachemys scripta*), today the most common representative of turtles in Czech Republic's nature, with an increasing number of sites inhabited. The Giant hogweed (*Heracleum mantegazzianum*), a symbol of biological invasions in the Czech Republic, with an expanding distribution range within the country.

number of specialists, it captures *e.g.* some species of butterflies and crayfish (*cf.* Fig. 1).

We want to know more

Everything can be improved. Gaps and shortcomings in the data have already been indicated; overall and more frequently updated data on a wider range of species have been still missing. Due to the fact that no funds were found in the State Budget for monitoring IAS, *i.e.* a new legal obligation of the state, based on its experience in systematic mapping, the NCA CR prepared a proposal for an extensive project Mapping and monitoring IAS within the Operational Programme Environment, *i.e.* from the EU funds.

The aim of the project is to establish a long-term functional system for collecting current and detailed data on the occurrence of the selected IAS and the topical data collection during the project implementation. The system aims to provide up-to-date information on the state of invasive alien species in the Czech Republic on a much more detailed scale than before and across the whole country's territory. This would not only meet the legislative requirements, but would also provide detailed and up-to-date data that can be used for practical management. The project should focus on mapping species from the Union list, as well as on other non-native species important for nature conservation. The current set of practical methodologies for a wide range of species (Pergl *et al.* 2016a) will be used as a basic background for methodological settings in the context of area-wide mapping.

Due to the relatively high costs and complexity of the project for field work, area-wide mapping will be based on the following basic principles. In the open landscape (excluding PLAs and small-size Specially Protected Areas), IAS will be mapped in units of 1st order mapping grid (approx. 5.5 × 6 km) and on the basis of a survey of potentially affected areas (*e.g.* brownfields, linear green belts along roads, or watercourses); within large-size Specially Protected Areas (PLAs), in units of 2nd order grid (3 × 3 km, or finer), and within small-size Specially Protected Areas by regular monitoring of the entire site. The whole Czech Republic (with the exception of Prague, National Parks, and military domains/areas) will be mapped by new NCA CR employees; in addition, the project will fund a number of studies contributing to greater efficiency and detail of mapping (*e.g.* prediction models of spread, satellite data analysis, eDNA analyses, genetic analyses of pathogens) and trying to actively involve the general public through citizen science and other projects aimed at non-native species.

If the project succeeds and is supported, a significant increase in data in the SOD can be expected – even up to a ten per cent share. The data will be available for further research. For example, lists of non-native species tend to be updated, just as Red Lists of Threatened Species are updated, so it will be possible to respond to new knowledge gained, *inter alia*, by mapping IAS. However, this is not the main outcome; thanks to mapping, data will be obtained for more effective nature conservation field measures, especially if its objective is to eradicate or prevent the spread of invasive alien species at the specific sites. ■

The list of references is attached to the online version of the article at www.casopis.ochranaprirody.cz.

Show Caves as Important Hibernacula of Bats in the Czech Republic

Jiří Šafář & Martin Koudelka

The International Union of Speleology (*UIS*) has declared 2021 as the International Year of Caves and Karst (IYCK). Unique phenomena in our landscape have therewith received deserved attention. Of more than 2,460 karst caves in the Czech Republic, 14 are show caves. All of them are fully legally protected according to national law and in addition, most of them are also protected as important bat hibernation sites (hibernacula) at the European level pursuant to the European Union's legislation, namely the Habitats Directive. An important pillar of nature conservation is regular monitoring of Specially Protected animal species, and this also is the case in caves.

Fig. 1. Entrance of the Nicová Cave in the Sloup-Šošůvka cave system, where the largest bat hibernation site of the Moravian Karst is situated. © Jiří Šafář

Significance of monitoring

Long-term monitoring of bats has been performed according to a unified method at all known hibernation sites of importance, with emphasis on minimal disturbance of hibernating animals, since the 1990s. The data gathered substantially help determining changes in distribution and abundance of bats, including a possible clarification of the causes of these changes. The monitoring is coordinated and carried out by members of the Czech Bat Conservation Society (CBCS), in collaboration with the Nature Conservation Agency of the Czech Republic and other volunteers, also in show caves and operated by the Czech Cave Administration. Only the specific Zbrašov Aragonite Caves are unsuitable for bat hibernation with regards to the high temperature (14–16 °C) and relatively high concentrations of carbon dioxide (CO_2) in some parts. The remaining caves, however, belong to the largest bat hibernation sites in the Czech Republic.

These are the following caves (in descending order by number of hibernating individuals – average over the past ten years): the Javoříčko Caves 5,417; Sloup-Šošůvka Caves 2,282; Na Pomezí Caves 902; Na Turoldu Cave 638; Balcarka Cave 268; Koněprusy Caves 260; Kateřina/Catherine Cave 242; Punkva Caves 149; Výpustek Cave 148; Na Špičáku Cave 137; Chýnov Cave 99; Mladeč Caves 50; and the Bozkov Dolomite Caves 25. Except for the last one, all mentioned caves are Sites of Community Importance (SCI) within the EU Natura 2000 network, under which bats are a subject of protection.

Between 2011 and 2020, each year 12–14 bat species were recorded in show caves in the Czech Republic. Over the entire period, 16 species hibernated there. The highest species richness (15 species) was recorded in the Sloup-Šošůvka Caves, but 5 species, each represented by a single specimen, hibernated there only once. Due to the very similar temperature (mostly 7–9 °C) and air humidity in all the caves, it is not a great surprise that three species dominate, *i.e.* the Lesser horseshoe bat (*Rhinolophus hipposideros*), Greater mouse-eared bat (*Myotis myotis*) and the Geoffroy's bat (*Myotis emarginatus*) there. However, this statement does not apply in full, because the Geoffroy's bat does not hibernate in show caves in Bohemia, and in the Chýnov Cave the Lesser horseshoe bat is even completely missing.

The proportion of animals from hibernating sites in show caves in comparison with other regularly monitored sites in the Czech Republic can be regarded as very significant for the three dominant species, as can be seen from Tab. 1. More than a third (35.6%) of lesser horseshoe bats and nearly a third (30.4%) of Geoffroy's bats hibernate at only 14 sites! However, the show caves have small significance for other species important in

Europe, *e.g.* the Barbastrelle (*Barbastella barbastellus*), Bechstein's bat (*Myotis bechsteinii*) and the Pond bat (*Myotis dasycneme*).

In the Czech Republic, really rare hibernators in the show caves recorded in the monitoring period were *Myotis bechsteinii* (15 individuals), the Serotine bat *Eptesicus serotinus* (8 individuals), the Northern bat *E. nilssonii* (8 individuals), *Myotis dasycneme* (2 individual), and truly sporadically also the Parti-coloured *Vespertilio murinus* and *Pipistrellus pipistrellus* (only one individual each).

Wat about development trends?

Trends in the development of bat population sizes in show caves in the Czech Republic cannot be generalised. Only three caves, Na Turoldu, Balcarka and Výpustek, showed a permanent increase in numbers of hibernating animals during the monitoring period. This was in all three cases linked to the growing Lesser horseshoe bat's numbers. Generally, the largest number of animals was counted in 2017 (11,478 individuals, 13 species), but surprisingly only three caves, Chýnov, Javoříčko and Mladeč, reached their maximum in that year. How to explain the fact? The number of hibernating bats is influenced by many factors, the most important being possibly inappropriate interventions in maternity colonies. All three most numerous hibernating species usually form such colonies in the attics of buildings. A less important factor is subnational/regional climate conditions, which significantly influence food supply in the time of birth and rearing the young.

Similarly, the influence of visitors on bat populations in the winter season cannot be clearly assessed because the conditions vary from cave to cave. In the Na Špičáku and Na Turoldu caves, where most hibernating animals are practically within reach of visitors, the presence of people can be very disruptive. In the Javoříčko Caves, about two thirds of the bats stay at the visitor route/path, even though they could choose a place away from it. However, most of them are at a great distance from the visitors and the site is moreover, due to difficult access in winter, not much sought after by visitors. On the other hand, in the Punkva and Mladeč caves, most hibernators are found off the visitor route/path, so that they are practically not disturbed.

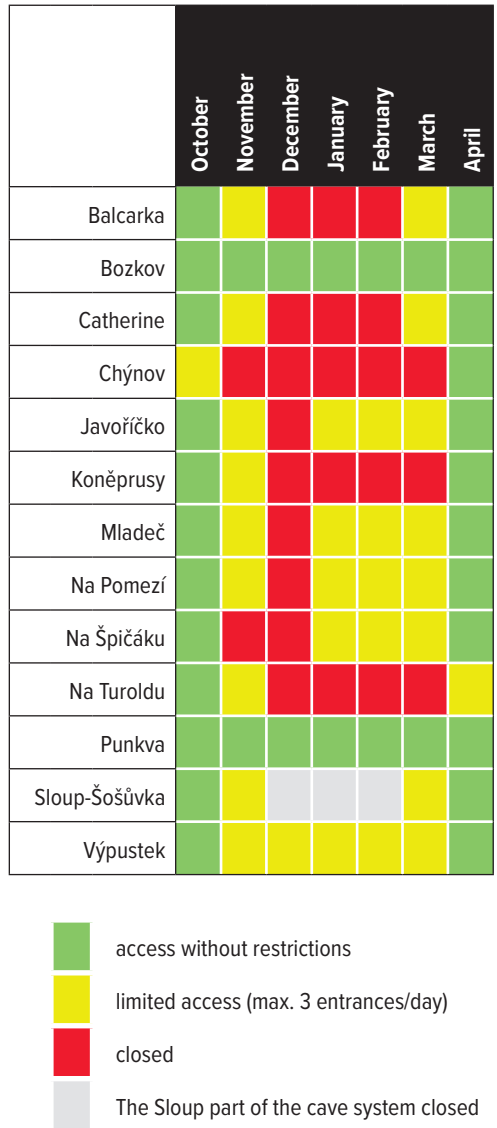
Main results

So does cave access in winter affect the size of bat populations? It may have – somewhere more, elsewhere less. Do caves need to be closed to visitors completely in the winter? Some need to be, other ones not. Each site needs to be assessed individually according to its dimensions, potential number of visitors in the time of bat hibernation, and possibilities of alternative shelters. Only in winter can regular visitors come 'within reach' of these very interesting animals, develop a positive relationship with them and understand their important role in the ecosystem. They can spread the acquired information and ideas further on and therewith also help protect rare animals which we pay a visit in their dormitories. ■

Tab. 1 – Numbers of the selected bat species at hibernating sites in show caves in the Czech Republic (data CBCS 2011–2019)

	Accessible caves		Other hibernating sites monitored in the Czech Republic	
Species	Total number over the period	Proportion (%)	Total number over the period	Proportion (%)
Rhinolophus hipposideros	73,611	35.6	133,362	64.4
Myotis myotis	12,114	14.2	73,207	85.8
Myotis emarginatus	4,405	30.4	10,093	69.6
Barbastella barbastellus	698	2.4	28,485	97.6

Tab. 2 – Current opening times of show caves during bat hibernation in the Czech Republic



Protection of hibernating sites

According to current legislation, not only bats but also sites inhabited by them are protected. Applying this regulation is especially important with hibernating sites/hibernacula, where the animals are particularly vulnerable. The following measures must also be taken in show caves:

- **Secure caves entrances in a way allowing bats to fly in and out.**
- **Perform prolongation of caves (especially by means of small shot firing) and surveys outside the hibernation period (May–October), taking into account the climate situation and particularly the presence of animals at the site.**
- **Perform reconstruction work at visitor routes/paths predominantly outside the hibernation period, especially if connected with increased noise and air pollution in the cave.**
- **Eliminate lampenflora, in English also known as lamp-flora, outside the hibernation period (May–October).**
- **Focus educational activities by tourist guides on the importance of bats and emphasise the importance and uniqueness of each site.**

Necessity to Introduce a New System for Financing Nature Conservation in sub-Saharan Africa

František Pelc & Petr Zahradník

The European Union has been aware of the specific geo-political status of Africa and its extraordinary importance for protection and conservation of biodiversity including natural ecosystems as well as of need to support sustainable economic prosperity there. The European Green Deal states: "The EU will launch a "NaturAfrica" initiative to tackle biodiversity loss by creating a network of protected areas to protect wildlife and offer opportunities in green sectors for local populations." The article aims at proposing possible measures to meet the above high ambition.

How has African protected area management been financed?

Well-managed protected areas (PAs) in sub-Saharan Africa play a key role for maintaining biodiversity and local and global ecosystem services/nature's contributions to people and for economic prosperity development of local communities and regions. The number of large-size PAs has been exceeding 7,800 there and they cover 17% of the continent in various biomes, particularly savannas, rain forests, high mountains, wetlands, semi-arid areas). The share of the whole country's territory covered by PAs and their quality in various sub-Saharan African countries is presented in Table 1. Natural habitat degradation has generally been alarming across the continent: in addition, PA management has been to a great extent insufficient. The fact is indicated by decline in areas covered by natural ecosystems and in population sizes of threatened species as well as by increase in biodiversity loss rate, both occurring not rarely within PAs. Except of some countries, namely the Republic of South Africa, Rwanda, Kenya, PA management is strongly underfinanced, reaching only dozens

The Mikumi National Park in Tanzania in 2020 © František Pelc

or small hundreds of USD per km^2. The basal minimum values of PA appropriate financing was set by experts as USD 1,000 – 2,000/km^2 (LINDSEY *et al.* 2018). Although the number and its interpretation is always worth of discussion and it is clear that it reflect socio-economic parameters of individual countries or regions neighbouring PAs, as a clue for strategic thoughts is sufficient. For other approaches applied in this article minimum of USD 1,000/km^2 is taken into account. As an average, only 10 – 20% of necessary costs are financed in African PAs. In addition, inner structure of financing has been quite variable and it is shared among the Government/State, non-governmental organisations (NGOs) and other bodies. The contribution of the Government/State varies in a wide range between less than 10% up to almost 100%, reaching an average of approx. 60%. In total PA financing, the share of NGOs funding (*e.g.* African Park up to USD 76 million, African Wildlife Foundation USD 34 million, David Sheldrick Wildlife Trust USD 3.5 million, all data *per annum*) has also been quite variable (between 0 and more than 90%), having been approx. 30% as an average (LINDSEY *et al. l.c.*). Data on the selected African countries area summarised in Table 2. The COVID-19 pandemic accompanied by decrease in income from ecotourism has just exposed the extent of lack of funds for appropriate PA management and the instability of such funding (WAITHAKA 2020). The pandemic contributed to decrease in GDP of the respective countries by up to 10% (ALU 2020). Ecotourism significantly contributes to national/state budgets in foreign currencies (WORLD BANK 2018, PLANET TRACKER 2020) and at the same it is one of preconditions for providing PAs with management, enhancing involvement of local communities and indigenous people, economic prosperity of whole regions and as it has been highlighted a financial source for PA management (Table 3). The up-to-date system of providing finances for PAs in sub-Saharan Africa is in the vast majority insufficient and for the future unsustainable.

Table 1 Percentage of the country's territory covered by protected areas and that covered by effective protected areas in the selected sub-Saharan African countries (UNEP-WCMC & IUCN 2020)

Country	Share of the country's territory covered by protected areas (%)	Share of the country's territory covered by reasonably managed protected areas (%)
Republic of Congo	42	10
Zambia	41	16
Tanzania	38	12
Namibia	38	16
Guinea	36	6
Benin	30	10
Botswana	29	19
Togo	28	7
Zimbabwe	27	6
Senegal	25	6
Côte d'Ivoire	23	6
Malawi	23	12
Gabon	22	11
Mozambique	22	5
Chad	21	12
Equatorial Guinea	19	12
Ethiopia	18	3
Central African Republic	18	6
Niger	17	16
Guinea-Bissau	17	16
Uganda	16	7
South Sudan	16	9
Ghana	15	1
Nigeria	14	2
Democratic Republic of Congo	14	7
Egypt	13	8
Kenya	12	5
Rwanda	9	9
Mali	8	8
South Africa	8	5
Cameroon	33	---

Proposals for Change in Financing African nature conservation

Below there are proposals for principles designated for making financing nature conservation and protected areas in sub-Saharan Africa more effective and stable. The European Union's Green Deal (2019) sets up general intentions to improve protection, conservation and sustainable use of natural ecosystems, paying special attention to African continent. For reasonable implementing them, it is necessary to make financing more robust, thus to ensure conservation and sustainable use of natural ecosystems generally and particularly within PAs through its well-balanced diversification and stabilization. Therefore, the existing and newly formulated financial tools are proposed to be suitably and properly used: they are divided into five mutually interconnecting areas.

1. Contributory payments to countries for ecosystem services/nature's contributions to people in protected areas

Within the proposed fund for supporting ecosystem services there also is a sub-program aiming at reaching effective PA management, *i.e.* USD 1,000/km^2/year. From a point of view of attractiveness for the individual countries as well as effectivity of the support the structure of the contribution should be agreed. It is recommend to allocated three quarters of the contribution for activities in the particular PA and one quarter for decision of the beneficiary country. Moreover, there should be terms that the remaining part of necessary funds should be provided from other sources (*e.g.* NGOs, private bodies, state/national budget). The aim of the

Table 2 Annual finances spent per 1 km² of protected area by the Government/State and NGOs in the selected sub-Saharan countries (LINDSEY *et al.* 2018)

Country	USD total	USD spent by Government/State	USD spent by NGOs
South Africa	3,014	3,014	?
Rwanda	2,006	245	1,960
Kenya	1,688	1,435	82
Chad	753	?	753
Malawi	690	6	681
Benin	557	54	498
Uganda	418	332	85
Burkina Faso	370	207	164
Zimbabwe	241	235	?
Botswana	200	189	11
Tanzania	176	41	54
Namibia	166	123	35
Mozambique	135	4	121
Central African Republic	128	29	84
Democratic Republic of Congo	116	?	116
Zambia	116	70	46
Nigeria	103	58	45
Ethiopia	63	45(?)	35
Senegal	47	31	16
South Sudan	45	9	4
Niger	43	26	17
Angola	34	?	34
Cameroon	21	12	9

support is to improve PA management and to provide a contribution to ensure maintaining ecosystem services/nature's contributions to people in the respective natural ecosystems or as the case may be support to establishing new PAs. Main activities to be supported from the fund include engagement of local communities in elimination of human-wildlife conflicts, anti-poaching actions, maintenance, salaries and development of the basic infrastructure, compensation of damages, *etc.*

2. Contributory payments to countries for ecosystem services/nature's contributions to people outside protected areas

For reducing large-size extensive destruction of the selected natural ecosystems producing global and sub-global ecosystem services/nature's contributions to people (rainforest, deciduous forest and savannas of various types, wetlands, *etc.*) and for involvement countries in the above activities payment per 1 km² is proposed which is not ring-fenced or assigned except of avoiding activities aiming at destructions of the habitats which have been supported. Monetary assessment of ecosystem services/nature's contributions to people has been for a long time studied, therefore the financial flow should be interpreted only as a contribution for their provisioning. In this context, adjustment has to stimulate interest to generally prefer providers of ecosystem services/nature's contributions to people to activities degrading and destroying them and at the same time interest to introduce or improve enhanced protection and conservation, *e.g.* in PAs. Financial amount of the support should definitely be further debated and it should reflect the potential of a financial source. Nevertheless, in the context to the proposal under 1. Contributory payments to countries for ecosystem services/nature's contributions to people in protected areas (see above) it should be considerably lower than USD 250/km²/year, maybe USD 100/km²/year. Prime example can be provided by natural ecosystem rich Zambia where miombo woodlands and other natural landscapes (open savannas and wetlands) have been still covering approx. 500,000 km², *i.e.* two thirds of the country's territory (VOLLESEN & MERRET 2020). In this case when applying the above proposed charge the total contribution to protect and to conserve natural ecosystems and ecosystem, services/nature's contributions to people related to them there would reach EUR 50 million/year. Checking and controlling system would be based on remote sensing, namely satellite imagery.

3. Establishing new European/European Union Official Development Assistance (ODA) scheme for sustainable ecotourism

Ecotourism in sub-Saharan PAs and financial flows related to it are of utmost importance for nature conservation and socio-economic development because it generates income to public and private budgets, particularly through entrance fees, accommodation, boarding and guide services. At the same time it engages local people in nature conservation awareness, acceptance and implementation, also generating jobs in the sector itself as well as in other follow-up services and activities (see Table 3). Before the COVID-19 pandemic at least 3.6 million people worked in ecotourism in Africa: the sector generated more than USD 29 billion annually there. Tourism helps sub-Saharan governments justify protecting wildlife habitat, creates revenue for state wildlife authorities, generates foreign exchange earnings, diversifies and strengthens local economies, and contributes to food security and poverty alleviation. It generates 40% more full-time jobs per unit investment than agriculture and employs proportionally more women than other sectors (LINDSEY *et al.* 2020). Ecotourism facilities are often connected with other activities influencing nature conservation. For example, the iSamangaliso Wetland Park covering 3,600 km² in Kwazulu-Natal in the Republic of South Africa was established under difficult socio-economic conditions (the landscape threatened by mineral extraction) and is visited by more than 500,000 visitors annually, earns USD 1.6 million generated by tourism and provides 1,600 direct and 6,000 indirect jobs (The World Bank 2018). The Ol Pejeta Conservancy in Kenya is connected with 14 ecotourism facilities generating 1,000 jobs (ALU 2020). PAs without ecotourism facilities are mostly paper parks. The ODA in this field has for a long time been insufficient in volume, poorly effective and unsystematic.

Therefore, a sophisticated model of support should be elaborated, *e.g.* trough establishing the specific programme within EU funds aimed at ODA with well-defined and measurable target on number of newly established facilities in PAs, *e.g.* 500 or 1,0000 supported facilities. With respect to model investment into a single facility

of approx. EUR 0.25–0.5 million the volume of medium-term allocated finances will be neither low nor astronomical (roughly EUR 125–500 million).

For stabilising its operations and income generated by it ecotourism services should support raising middle-class and educative programmes on reducing future disturbances and lability in incomes and in future to support environmentally friendly local and long-distance traffic. A certain part of incomes from these services where infrastructure is supported from ODA shall be directly returned to PA management.

4. Providing minimum basic contribution by metropolitan states/mother countries for PA management

Involvement of governmental authorities in nature conservation is necessary and can be indicated by various ways, *i.e.* by credible allocation of a part of the public budgets for PA and natural habitat management. Moreover, analyses from various countries suffer from sharp methodological and other differences. With only a few exceptions, governments spend for PA management annually only dozens or small hundreds of USD per km^2 (LINDSEY *et al.* 2018). Despite various economic turbulences the aim should be to allocate at least 20–30% of real costs for sufficient PA management, *i.e.* USD 100–300 km^2/year. Another elementary precondition for stabilising PA sustainable financing is to meet at least the basic parameters of PA establishing and functioning (*e.g.* declaring a PA by a legal instrument, delineation on a map, active management, management plan elaboration and implementation, *etc.*).

5. Using contributions from NGOs

Non-governmental organisations (NGOs) play an important, irreplaceable and in some countries, *e.g.* in Malawi, dominant role in financing PA management (see Table 2). Moreover, they should not bear for a long time providing PAs with funds. In future they should particularly implement specific projects including preparation of establishment of new PAs and serving as a flexible reserve for medium-term deficits and shortfalls of financial resources as needed. Thus, the total volume of fund to be provided by them should not sharply differ from the current one.

General financial context of support from the European Union's budget

The EU's financial support to developing countries has for a long time been displaying a relative generosity but at the same time considerable fragmentation of its management and of subsidiary tools. Only the recently launched EU long-term budget, also known as the 2021–2027 Multiannual Financial Framework (MFF) has fundamentally clarified it, has provided it with unified structure and management and has newly aimed at issues which were previously not covered by the financial support. The main tool for financing the support has been the Neighbourhood, Development and International Cooperation Instrument – Global Europe (NDICI – Global Europe). Within its framework most of up to date used partial tools of the support have been merged.

Within NDICI – Global Europe there are EUR 79.5 billion allocated for 2021–2027 which is by comparison only a few EUR billion less than within the largest nonrecurring programme for financing science, research and innovation worldwide – Horizon Europe, thus highlighting the fact that funds available for NDICI – Global Europe are not within the MMF negligible. When comparing the amount of money with similar characteristics of the support used in 2014 – 2020 the funds available for that purpose has been increased by 12%.

The most important part of the above funds is geographically delineated: NDICI for sub-Saharan Africa has EUR 39.18 at disposal, aims at 17 United Nations Sustainable Development Goals (SDGs) and it includes, inter alia, priorities such as environment and climate change, inclusive and sustainable economic growth and decent employment or eradicating poverty.

Within the priority Environment and climate change, four thematic areas can be supported. The first is targeted on disaster risk reduction where support aims at the eradication of poverty caused, *inter alia*, by climate change, promoting environmental and social resilience and at elaboration and implementation of specific strategies, plans and activities. The second area deals with supporting ecosystems and biodiversity conservation and is divided into geographical tools where there is for each country in relation to the identified needs "a financial envelope", thematic programmes which include the selected priority topics to be implemented in a transboundary way, and Public-Private Partnership projects where in addition to the EU funds private capital enters. The third and fourth area highlight sustainable forestry and effective water resource conservation and management.

Finances allocated for implementing inclusive economic growth can be used for supporting micro, small and medium-sized enterprises (SMEs), stimulating the creation of decent jobs, enhancing public and private infrastructure, supporting

Table 3 The selected African countries and share of their GDP covered by international tourism in 2018 (Planet Tracker 2020, Waugh *et al.* 2020)

Top 16 sub-Saharan African countries with percentage of their GDP covered by international tourism in 2018		
Country	**% GDP in 2018**	**Income from international tourism in 2018 (USD million)**
Seychelles	38	611
Cabo Verde	27	524
Sao Tome and Principe	17	72
Mauritius	15	2,161
Kenya	10	1.540
Gambia	10	168
Madagascar	6	879
Rwanda	6	528
Tunisia	6	2,320
Ethiopia	4	3,548
Tanzania	4	2,465
Uganda	4	1,044
Botswana	3	575
Namibia	3	488
South Africa	3	9,789
Zambia	3	742

The Ruaha National Park in Tanzania in 2020 © František Pelc

renewable energy, sustainable agriculture and digital economy and solving public health, social and economic consequences of the crisis caused by the COVID-19 pandemic. Laos for that purpose involvement of private capital is not only allowed but also very welcomed.

The authors can state that in the article mentioned and proposed areas for targeting financial support to sub-Saharan Africa are directly compatible with the possible support from the EU funds. The first two areas fit directly in the thematic issue on ecosystems and biodiversity conservation, while the third area can be implemented *e.g.* by elaboration and implementation of business strategies aiming at ecotourism including business plan and a feasibility study with the first thematic area within environment and climate change. The fourth area should become an integrated part of the project financing where a certain minimal co-financing by the country on territory of which the project is being implemented is supposed; usually an interest of the particular country in reaching the required results has been strengthened. Using NGO funds together with the EU ones has not been common yet, moreover the former can be a private source contributing to financing the project there. Thus, it is important to in advance assess whether the private capital expects from its engagement also some return on and realistically consider whether such a return is achievable.

The European Commission's activities in 2022

It is possible that due to efforts towards implementing the EU Green Deal and other activities carried out in both the EU and across the world the European Commission will in 2022 recommend to double the amount of external financing biodiversity conservation and to significantly involve in financing fighting climate change in developing countries and in countries most severely threatened by climate change.

Presidency of the Czech Republic in the Council of the European Union

In the second half in 2022 the Czech Republic shall preside over the Council of the European Union. During the term, it should aim at providing and implementing thematic priorities significant for both future of the EU as a whole as well as for the Presidency itself. Among the priorities there should be those focusing on strengthening EU influence all over the world. Within it, it would be meritorious if some of the partial activities also include projects typologically based on the proposal described in the article. It would be desired to implement a small and controlled number of the projects as pilot ones. At the same it would also be praiseworthy to elaborate methodological guidelines to implement the idea in a greater scale.

Nowadays, the Czech Republic has been EU Member State the 18th year. Since 2004, it has received from the EU budget almost CZK trillion (EUR 41 billion) in net profit, *i.e.* after subtraction of the payment/contribution to the EU budget required from each Member State. The funds also has helped the country to approach 95% of the average EU Member States measured by gross domestic product per capita inn purchasing power parity. It is about time to avoid considering the use of the EU funds only in rather self-centeredness way and begin to think of others who can be more in need in this respect. If the Czech Republic is successful in this issue its image as well as that of the whole EU in sub-Saharan Africa undoubtedly increase.

Just to sum up

Up-to-date providing finances for iconic and famous protected areas in sub-Saharan Africa is in the vast majority insufficient and for the future unsustainable, particularly when taking into account necessity of more effective biological diversity conservation, reducing negative climate change impacts and necessary sub-national and local development and prosperity. The authors suggest to cover costs for appropriate management of protected areas through (1) payments to African countries for ecosystem services/nature's contributions to people provided by these protected areas; (3) establishing a new EU's ODA (Official Development Assistance) scheme aiming at sustainable ecotourism; (4) securing the minimum basic contribution from metropolitan states (or "mother countries") for the protected area management and (5) using various financial support from NGO, in appropriate and realistic shares, *e.g.* 30-50% (1), 1-10% (3), 10-30% (4), a 0-40% (5). At the same time (2) introducing payments for ecosystems services/nature's contributions to people from the non-reserved landscape, *i.e.* outside protected areas is also proposed. The model supposes voluntary agreements with the individual African countries on the proposed issues and that the COVID-19 pandemic is temporary and that after some time it will be in a reasonable way controlled by public health institutions worldwide. ■

The list of references is attached to the online version of the article at www.casopis.ochranaprirody.cz.

Summary of 2021 Issues

On Nature in the Czech Republic

Nožířová R.: The Králický Sněžník Mts. National Nature Reserve – 30 Years since its Declaration

In the Králický Sněžník Mts. territorial protection had begun on the Polish side. In 1954, the Śnieżnik Kłodzki Nature Reserve was established on the Králický Sněžník northern slope aiming at landscape protection and vegetation conservation and covering 181.24 hectares. Consequently, the Snieznicki Park Krajobrazowy/Landscape Park was declared across 28,800 hectares. The first efforts to protect and conserve natural values on the Czech side did not appear before the half of the 20th century. Only in December

1990, the National Nature Reserve (NNR) was established also in the Czech Republic and unique patterns of the area have been maintained there. Despite a dynamic development very close to the NNR and current building a watchtower on the Polish side the author believes that the Králický Sněžník Mts. remarkable natural values shall be preserved for the future generations.

Rothröckl T. & Hubený P.: The Šumava/Bohemian Forest Mts. and Podyjí/Thaya River Basin – 30 Years of National Parks as Seen by their Directors

Three decades ago, two seemingly geographically disparate worlds were established. Only time told that they have much in common. Both the National Parks actually harbour ecosystems located along the elevation gradient typical for the Czech Republic as a whole. The Podyjí/Thaya River Basin starts at 220 m a.s.l. and reaches 536 m a.s.l. while the lowest point of the Šumava/Bohemian Forest Mts. is situated at 560 m a.s.l.

and rises up to 1,378 n a.s.l. In cold ravines within the Dyje/Thaya River valley, organisms living on the Šumava/Bohemain Forest Mts. tops also occur, on screes of the Podyjí/Thaya River Basin there are small natural Norway spruce forests and European beech growths on slopes highly similar to those in the Šumava/Bohemian Forest Mts. The historical turnaround in 1989 had allowed to declare National Parks close to the border and to establish real cooperation with neighbouring National Parks, namely the Thayatal and Bayerischer Wald/Bavarian Forest Mts. NPs. It also provided natural and cultural values at previously marginalized sites and often forgotten areas with comprehensive protection and conservation including those for remarkable biological diversity and natural processes. “We are grateful to offer to people a performance of this national theatre of nature unbound,” say both Directors of the National Parks.

Zajíček P.: The Štramberk Karst – a Jewel of Nature near a Picturesque Town

In Moravia, the majority of karst areas consists of limestones and marbles created in the Paleozoic Era, except of isolated islets of the Mesozoic limestones occurring in eastern and southern Moravia. The latter also include the Štramberk Karst with some remarkable caves. In the best-known of them, the Šipka/Arrow Cave, the first evidence of settlement of Neanderthals on the Czech Republic’s territory was found. Within the Štramberk Karst, four small-size Specially Protected Areas have been declared, namely

the Šipka/Arrow National Nature Monument, Kamenárka Nature Monument (NM), Vaňův kámen NM and the Štramberk NM. The area is criss-crossed by a network of visitor and educational trails. Due to picturesqueness of the historical town of Štramberk which is not intrusive among the natural sites, the Štramberk Karst is one of the most beautiful sites in Moravia.

Reiterová L.: What is New in Flora of the Podyjí/Thaya River Basin and Thayatal National Parks?

In 2019–2020 a grid mapping of flora was conducted in the Podyjí/Thaya River Basin (Czech Republic) and Thayatal (Austria) National Parks. After 25 years which have passed by since the finishing data gathering in the course of the first floristic mapping led by Vít Grulich, comprehensive data on the occurrence of all vascular plants across the whole Podyjí/Thaya River Basin National Park including its buffer zone is available. Both mappings were carried out in the same system of mapping grid: thus, the data from them is well comparable. The floristic mapping again confirmed a huge importance of efforts to maintain the highest possible diversity in habitat types within the National Park: in croft of each municipality, on every patch of field or of forest, in a valley and

on a plateau, in the warm western part of the National Park as well as in the cold eastern one. The Podyjí/Thaya River Basin National Park has fully entitled to be furthermore listed as a prestige Important Plant Area of Europe.

Hromas J.: The Ledové sluje/Ice Caves – An Extraordinary Phenomenon of the Podyjí/Thaya River Basin

The Czech Republic does not abound with occurrence of ice-covered caves. There are some caverns where ice is formed in winter but they are ice-free in summer, particularly in pseudokarst sandstone holes or volcanites. The Naděje/Hope Cave in the Lužické hory/Lusatian

Mts. as well as a system of abyssal caves in the Dyje/Thaya River Valley near the town of Vranov, called the Ledové sluje/Ice Caves (South Moravia) can be – to be treated with reserve – considered as ice-covered caves, incorrectly called ice ones. Macroclimatic conditions within holes, narrow entrance exposure and shading allow to form ice cover there, *e.g.* needle ice, icicles or ground ice, displaying patterns of statistic, dynamic and static-dynamic caves. In some holes, ice remnants survive all-year round: they are perennial. In the Ledové sluje/Ice Caves, 19 bat species have been recorded and due to high number of bats it was confirmed that the site is a unique bat roost of the Central European importance.

Ambrozek L.: The Landscape of Cooperation – Forty Years of the Bílé Karpaty/White Carpathians Mts. Protected Landscape Area

What will you recall if you hear the collocation "the Bílé Karpaty/White Carpathians Mts."? Only a century ago, it was the most **out-of-the-way** place in what is now the Czech Republic left by people emigrating for America to seek employment; nowadays it has been a popular destination for more and more visitors from the whole country. Meadows full of orchids, wine cellars near the municipality of Petrov and the town of Strážnice, old service/sorb trees (*Sorbus domestica)*, the Horňácko/Upper Moravian Slovakia region folk culture, the Moravian Kopanice region with the Goddesses of Žítková, a virgin forest below the top of Mt. Velká Javořina/Great Maple Forest, a beech forest in the Vlára Pass, the well-preserved landscape in Southern Moravian Wallachia around the municipality of Nedašov are probably best-known. The article complements

the above picturesque mosaic of natural beauties with a fragment on cooperation between the State Nature Conservancy and local people which is necessary to effectively and successfully protect, conserve and manage nature there. A charming beauty of the Bílé Karpaty/White Carpathians Mts. landscape and its natural treasure jointly formed by humans have been able to win recognition also abroad. In 1996, the Bílé Karpaty/White Carpathians Mts. were declared UNESCO Biosphere Reserve and since 2000, they have been a holding area of the European Diploma for Protected Areas awarded by the Council of Europe.

Mačát Z.: Fishponds and Pools as Important Refugia of Species Richness and Diversity – An Example Given by the Podyjí/Thaya River Basin

Although the Podyjí/Thaya River Basin National Park (NP) is primarily seen as an important island of various rather dry to xerothermic terrestrial habitats, forming together by a comprehensive mosaic a unique system freshwater ecosystems are a significant NP's part. The course of the Dyje/Thaya River is a region's real backbone that formed the NP's current geomorphological shape. Moreover, by their size, marginal wetland ecosystems significantly complement the mosaic of habitat patches. From a wider point of view of the adjacent landscape, they act as important refugia for more sensitive and demanding species and communities/assemblages: thus, they are typical local biodiversity hotspots. Such sites harbour completely crucial habitats for survival of or stabilizing populations in a lot of rare species, particularly plants or invertebrates. Therefore, the Podyjí/Thaya River Basin National Park

Administration tries to maintain high-quality water ecosystems, to build new wetlands and to restore degraded or disturbed ones.

Čížková P. & Hubený P.: Which Forest Is Formed by Spontaneous Processes in the Šumava/Bohemian Forest Mts.?

On more than one thousand permanent monitoring plots in the non-intervention area of the Šumava/Bohemian Forest Mts. National Park, patterns of forest natural regeneration have been studied since 2008. It seems that species composition of the natural regeneration responds to that of long-term grown stands, even if it the latter died during disturbance. Thus, the significant dominance of the Norway spruce (*Picea abies*) and temporary strong proportion of the Rowan or Mountain-ash (*Sorbus aucuparia*) shortly after disturbance have been maintained there. The forest natural regeneration patterns have not been indicating any changes in the spontaneous species composition in the forest caused by climate change. Nevertheless,

the data gathered correspond to the species composition in Šumava/Bohemian Forest Mts. primary/virgin forests reported in the 19th century and suggest stabilized higher proportion of the Norway spruce for more than two centuries. It also should be mentioned that natural regeneration patterns do not respond to forestry or vegetation ecology/geobotany models of the expected natural species composition of the forest. At some artificially reforested clearings, a rapid arrival of the natural regeneration and taking the lead role in forming the species composition of the future growth by it is described, again with the conspicuous dominance of the Norway spruce and the Rowan.

Krejča F.: Karst Phenomena in the Šumava/Bohemina Forest Mts. Area

In the Šumava/Bohemian Forest Mts. region, it is difficult to find any typical karst areas, *e.g.* extensive cave systems or magnificent underground spaces with extraordinary dripstone ornamentation. To be honest, there is no karst cave in the Šumava/Bohemian Forest Mts. National Park registered in the Unified Files of Speleological Objects of the Czech Republic database. Therefore, it would be rather better to spread the interest also to the Šumava/Bohemian Forest Mts. Protected Landscape Area and its vicinity. On the other hand, just due to their rarity and often atypical conditions of forming and developing these karst phenomena are more interesting and from a technical/expert point of view, they are of the invaluable importance. The article presents the most remarkable among such phenomena.

Malíček J., Trunečková L. & Hlaváček R.: Uranium Spoil Heaps near the Town of Příbram as a Part of Cultural Landscape Heritage and a Threatened Flora Habitat

Uranium spoil heaps in the surroundings of the town of Příbram (Central Bohemia) are a dominant landscape element and important habitat for many organisms. They are very extreme in abiotic conditions – erosion on steep slopes, high temperatures and aridity of dark substrates, low level of nutrients, high level of metals, radioactivity, *etc*. Moreover, spoil heaps harbour a suitable habitat for many rare plant and lichen species usually missing in the adjacent agricultural landscape. They are a unique example of primary succession and spontaneously developing vegetation. Uranium spoil heaps also serve as a local hot-spot and habitat for weak competitors, colonists of early succession stages and substrate specialists, such as lichens on rocks enriched by metals. Some lichen species have one of their few sites of occurrence in the Czech Republic just there. Currently, restoration of the Příbram's spoil heaps has been intensively discussed. It is supported by Czech law policy that requires a restoration of all mining sites. However, many of them, including the uranium spoil heaps near Příbram, display high value and potential in nature conservation and landscape protection.

Patzelt Z.: Sandpits and Quarries as a Challenge for Nature Conservation

Mineral resource mining is usually supposed to be harmful for nature and the landscape. Nevertheless the presumption is not definitely correct always and everywhere. Rocks and wetlands are among the most valuable natural sites in the Czech Republic: their inaccessibility for predators, grazers and browsers has allowed undisturbed wild plant and animal development there. Species diversity at such sites is also caused by dynamic instability and long-term presence of open non-forested habitats with varied and manifold succession stages. Particularly most of wetlands have disappeared from the landscape or more precisely they were rashly and indiscreetly destroyed by humans.

Therefore, it is not by chance that a lot of rare species have been finding substitute alternative habitats for surviving and living in abandoned mining and excavation sites. In the Nature Conservancy Central Register run by the Nature Conservation Agency of the Czech Republic (https://drusop.nature.cz), there are a lot of dozens of former sandpits and quarries which have become a Specially Protected Area. If nature conservationists and mining companies cooperate, *e.g.* sandy gravel mining can join effective tools for landscape management and threatened species protection and conservation.

Jarošek J.: The Poodří/Odra River Basin Protected Landscape Area after Thirty Years

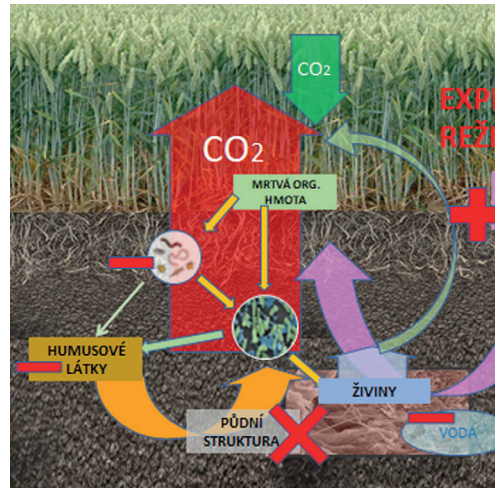
In 2021 we have been celebrating 30 years since establishing the Poodří/Odra River Basin Protected Landscape Area (PLA) situated in the Moravian-Silesian Region. The Odra River having been on and on waving in multiple meanders is a real PLA's backbone. In the last years the extremes of the in total drier weather have been expressed themselves – many flows beneficial for nature have been missing there. Moreover, greater floods sometimes show the importance of the floodplain and its ability to retain water. Forests cover only less than 10% of the PLA's territory, but the landscape is completed by greenery outside forests optically increasing the woody plant proportion in the landscape and providing it with an appearance of the English landscape garden, also called the English landscape park. Many fishponds have been currently better managed and cooperation with fishermen is good. The PLA's uniqueness resulted in including the Poodří/Odra River Basin into the global List of Wetlands of International Importance under the Ramsar Convention, also known as Ramsar Sites. The PLA was established to protect, conserve and manage the from a nature conservation point of view valuable landscape in the Odra River floodplain and it does not serve only nature conservationists or farmers, fishpond managers, hunters/gamekeepers, tourists... It serves to a different extent all. The PLA's current state is a good resultant of the development lasting for centuries.

Hendrychová M., Bogusch P., Weisová K. & Šálek M.: What Attract Rare Invertebrates to Brown Coal Spoil Heaps?

Since the highest boom in surface brown coal mining below the Krušné hory/Ore Mts. a lot of good has happened. An area larger than 1,200 km^2 has been biologically and technologically restored and at least CZK 20 billion (EUR 0.8 billion) have been spent there. Moreover, less is sometimes more: it seems that it is optimal to combine technological restoration and natural succession. The pattern is definitely true for rare wild animal species. Results of entomological surveys and inventories show that presence of a fine-grain mosaic of various habitats including shrubbery and flower-rich meadows is important for the high species diversity and the occurrence of rare and threatened species. How the outputs of studies on orthopterans inhabiting brown coal spoil heaps suggest, in addition to soil feature diversity and presence of terrain unevenness, species diversity of grassed sites/patches is also crucial.

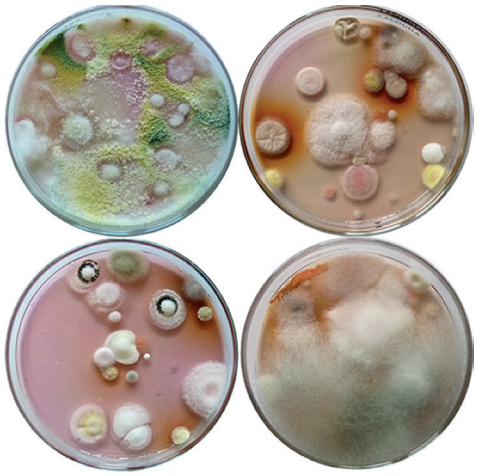
Miko L.: Soil as Biodiversity Hotspot, Namely that of Small Soil Arthropods

If we should give examples of really species-rich ecosystems, most probably tropical coral reefs or some types of tropical rainforests or gallery forests are mentioned. In any case, these are ecosystems quite far abroad, beyond the borders of not only the Czech Republic, but also our continent. Moreover, even under our conditions there is an ecosystem which is just as good as the above famous examples from abroad and which has been from a point of view of biological diversity rather looked through, probably because thousands of species inhabiting it can only rarely be watched by the naked eye and because they are mostly of microscopic size. Such a hotspot being right up ahead or next door is healthy and well-functioning soil, in the Czech Republic the most appropriately soils in deciduous broad-leaved or mixed forests. Occurrence of some species, total species richness and number of soil organisms are at the same time an excellent indicator of the state of the soil environment and indirectly also of the above-ground ecosystem which can be found on the respective soil surface. Therefore, studies on soil organisms have possible importance also for applied and field ecology, biodiversity conservation, environmental protection as well as agricultural practice or assessing and evaluating the state of selected sites/areas.



Nováková A.: Soil Fungi – An Important Component of Soil Microbiota

Microedaphon is a very important, essential and necessary component in all soils. It includes microscopic animals, the surface soil layer (topsoil) is inhabited by autotrophic organisms (algae and cyanobacteria, also called blue-green algae), chemotrophic ones (some archaea and bacteria) and particularly heterotrophic organisms, *i.e.* actinobacteria and fungi. Heterotrophic fungi and bacteria are an ecological/functional group of decomposers, being of a huge importance in cycle of carbon and other elements in nature. Their decomposing activity is crucial for life on earth, because they participate in decomposing dead organic matter of plant, animal and microbial origin and its activity produces humus substances, which are essential for soil fertility. By step-by-step decomposition of the substances, chemical elements necessary for plant growth are released



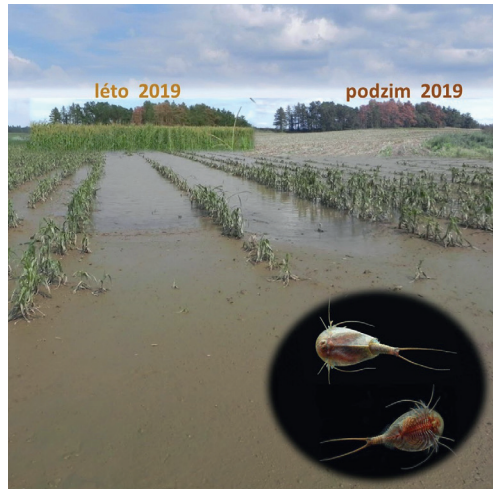
into soils. Therefore, soil protection and conservation should also aim at conserving and maintaining the living constituent of the soil – edaphon.

Tuf I.H. & Machač O.: Soil Full of Predators

The soil environment is inhabited by a very broad range of various organisms with different feeding strategies. Particularly medium- and large-size species of soil fauna are often considered from a point of view of the feeding strategy to be predators. The predators' role in ecosystems as well as their relationship with other organisms in food webs have been indeed known and studied for a long time. Nevertheless soil is the environment considerably different from forest or African savanna and ways under which soil predators function and operate display specific patterns. The specificities can help to explain soil biota species diversity and at the same time soil organisms' ability to share together without great difficulties the same space. The diversity and abundancy of (not only) soil predators often indicate the state of the respective above-ground habitat. Thus, studies on soil predators can provide useful inputs into assessing and evaluating the above-ground habitat. And vice versa, studies on soil communities/assemblages clearly suggest that soil protection is worth remembering in nature conservation efforts.

Záhora J.: A Rain Trap

There has been an awareness among the general public of the fact that soil and the soil environment quality are directly linked with the landscape's ability to retain water. As climate change has been progressing also in the Czech Republic, change in distribution of precipitation has been becoming increasingly pronounced when abrupt heavy or even extreme rainfalls are followed by long and repeated droughts, the latter becoming quite chronic in Central Europe. Thus, a drier year can cause at the same time above-average cereal harvest as well as drying forest located only a few of hundreds of meters near to within the same landscape. Water infiltration has been becoming slower with continuing rainfall. On the surface of degraded topsoil, a turbid and muddy mixture of soil mineral components, *i.e.* sand, dust and clay, is created. Due to consequent drying out, cracking and repeated filling, soil capillaries are ruptured. Thus, non-intentional but sophisticated protection of topsoil against evaporation is functioning, called the rain trap. Paradoxically, drying-out pools and poodles can allow branchiopods to survive in such landscape. The question is how to provide the sites/areas with appropriate management.



Zajíček P.: The Mladeč Caves – 110 Years since Becoming a Show Cave

The Mladeč Caves (central Moravia) which became a part of the Třesín National Nature Monument have been in recent times, *i.e.* in almost two centuries, undergoing a lot of changes. Nevertheless, underground space under Třesín Hill had been used by humans as early as in the Early Stone Age. The remarkable caves were rediscovered in the first half of the 19th century. For long decades they were devastated by a lot of unorganized visits. The caves' importance was appreciated by researchers only after archaeological surveys carried out by Josef Szombathy in 1881–1883. Consequent many-years' research has confirmed that the caves are the northernmost settlement of the oldest *Homo sapiens sapiens* populations, *i.e.* Cro-Magnon people in Europe. Moreover, they had been for a long time unknown because entrances were sometime in the past naturally buried. Thus, the Mladeč Caves were rediscovered during limestone excavation and quarrying there only in 1828 (according to some sources in 1815). The entrance into underground space was secured and finally, the Mladeč Caves became a show cave officially in 1911.

Kuča K., Kučová V. & Horáček J.: The Great Spa Towns of Europe as a World Heritage

In July 2021 eleven spa towns located in seven European countries were inscribed in the UNESCO World Heritage List as a new World Heritage Site under the title of the Great Spa Towns of Europe. Thus the property consists of Františkovy Lázně, Karlovy Vary, Mariánské Lázně (the Czech Republic), Baden (Austria), Bad Ems, Bad Kissingen,

Baden-Baden (Germany), Spa (Belgium), Montecantini Terme (Italy), Vichy (France) and Bath (the United Kingdom). The intention to nominate spa testimony into the List appeared about in 2000 independently of each other both in the Czech Republic and in Belgium and Germany. From 2011 the most important European spa towns elaborated the common transnational serial nomination, initially for 16, after technically based reduction finally for 11 towns. Each of them is very specific by some features and at the same time as a whole they fully meet the criteria of the outstanding universal value, thus presenting both the tradition and present of European thermal spa sector based on using mineral springs (the nomination did not cover climatic and seaside spas). The specific features of the spa towns include not only urban typology with high proportion of parks, specific types of public buildings and highly presentable and impressive architecture, but also the adjacent therapeutic landscape. Walks in spa parks and forest parks equipped with a lot of small buildings and facilities have been part and parcel of cure/course of treatment and active leisure. Including the cultural often picturesque landscape in the nomination mostly required enlargement of protected monument zones in the towns concentrated so far in built-up areas there. In 2018, three large spa conservation areas replacing previous small heritage conservation areas were established in the Czech Republic, too. Thanks to co-operation between Departments of Heritage Conservation and of Nature Conservation extensive buffer zones were delineated in Karlovy Vary and Mariánské Lázně. In these zones, there is synergistic effect caused by activities of heritage conservation and nature conservation and landscape protection, because the heritage conservation areas as well as their buffer zones are largely located within the Slavkovský les Protected Landscape Area, also harbouring some small-size Specially Protected Areas. At the national level, the spa testimony as a part of world heritage can become another topic in expert/technical co-operation and strengthen collaboration between both the sectors at the governmental and sub-national level.

Plesník J., Hušek J. & Pelc F.: The Jizerskohorské bučiny/Jizera Mountains Beech Forest National Nature Reserve – A Part of the World Heritage Treasury

Since July 2021 the Jizerskohorské bučiny/Jizera Mountains Beech Forest National Nature Reserve has been the UNESCO World Heritage Site (WHS) becoming a new component of the serial WHS *Ancient and Primeval Beech Forests of the Carpathians and Other Regions of Europe*. The very first natural WHS in the Czech Republic is located in the country's northern part (Liberec Region, northern Bohemia), close to the Czech-Polish border. The Jizerskohorské bučiny/Jizera Mountains Beech Forest National Nature

Reserve (NNR) harbours the largest continuous European beech (*Fagus sylvatica*) forest in the whole Czech Highlands. The NNR is the most strictly protected category of the Specially Protected Areas in the Czech Republic. In 1999 the Jizerskohorské hory/Jizera Mountains Beech Forest NNR (9.5 km^2) was established by merging 7 small-size Specially Protected Areas into a single one, now consisting of six segments. In addition, it is a part of the Jizerské hory/Jizera Mts. Protected Landscape Area Zone I and of the EU Natura 2000 network. By 1960, only selective logging was applied there because due to geomorphological conditions, the terrain is permeable only with huge difficulties in some parts of the NNR. Moreover, since 1960, the core area has not been managed, having been left to spontaneous development. The WHS property and its protection buffer sub-zone cover the largest NNR's segment. The NNR's buffer zone (17.5 km^2) surrounding all the six core areas has been slightly managed, *e.g.* by selective logging since that time. It forms, together with other five core areas, the WHS' landscape conservation buffer sub-zone.

The Jizerskohorské bučiny/Jizera Mountains Beech Forest displays a huge variety of old-growth characteristics which is consistent with previously reported studies on primary old-growth forests that have never been managed or have been unmanaged for even longer time periods. It has developed, contrary to other sites in the Subatlantic-Hercynic Beech Forest Region, on granites and granodiorite. The fact has significantly influenced the unique patterns in fungi, plant and animal communities (species composition, community structure, functionality *etc.*) and their natural habitats. The site shows very rich geomorphology with a high concentration of rock formations, particularly within the top parts of mountain ranges. The NNR's Management Plan for 2021–2030 tries to maintain and enhance exceptionally valuable natural ecological and evolutionary processes there.

Nature & Landscape Management

Halešová T. & Kotyzová M.: Grassing the Zone I in the Moravský kras/Moravian Karst Protected Landscape Area

The Moravský kras/Moravian Karst (Central Bohemia) is the most important karst area in the Czech Republic. In addition to underground karst phenomena, there also are aboveground ones including limestone

pavements or sinkholes. The uniqueness of the area is confirmed by the only internationally protected underground wetland in the Czech Republic, *i.e.* the Podzemní Punkva/ Punkva Subterranean Stream Wetland of International Importance/ Ramsar Site. The karst habitats need not only underground protection, but also that on the surface where particularly nitrates and pesticides from intensively used karst plateaux penetrated from. The substances contaminate groundwater used as a drinking water source and harbouring a lot of animals. Changes in management around sinkholes and above caves implemented in 2019–2020 resulted not only in positive shifts in farmland but they also significantly contributed to enhancing dripwater quality entering caves by leakages through the soil and rocks.

Pešout P., Porteš M., Černý Pixová K., Hendrychová M., Kříž P. & Lacina D.: Ecosystem restoration of brown coal open-pit mines

Mineral and rock mining carried out for centuries has had significantly negative impacts on the landscape and the environment in the Czech Republic. By size, the most extensive destruction in the whole country has been caused by surface open-pit brown coal mining in the North Bohemian Basin: more than 400 sq km have been affected by mining and by related infrastructure and industry there. Nowadays, when active brown coal mining termination in the Most and Sokolov Basins has been very close, there has been a discussion on future use of the closed mines and ecosystem restoration application for the above post-industrial habitats has been even more urgent than ever before. Remediation and restoration plans have been elaborated for all the brown coal open-pits. We have been currently able to assess and to compare sites/

areas left to spontaneous succession with those having been restored by technical reclamation. Many studies repeatedly confirmed that natural succession allows development of extraordinarily valuable habitats inhabited by threatened species, in addition having incomparably lower input costs and subsequent maintenance expenses. Background documents elaborated by the Nature Conservation Agency of the Czech Republic in cooperation with partners have been incorporated into a document submitted to the Czech Republic Government session by the Ministry of the Environment of the Czech Republic. After decades, the ecosystem restoration has become an equivalent alternative to reclamation of extensive parts in the post-mining landscape.

Stejskal R. & Ponikelský J.: Stool Forests in the Podyjí/Thaya River Basin Are again Coming Alive

The article presents the first experience in coppice forest restoration at two model sites in the Podyjí/Thaya River National Park (South

Moravia), namely the Hnanice and Popice stool forests, in 2016–2021. These are overaged stool forests on habitats of acid and thermophilous oak forests and Hercynian oak-hornbeam forests. The rotation period is set for time being at 40 years while regeneration component size ranges between 0.25–0.5 hectares. Up to the present day, there have been in total 12 fellings: in addition to keeping reserved trees including biologically valuable hollow trees, all standing and lying dead wood is left there. At the same time, pine growths are restored there and foci of invasive woody plants, particularly the Black locust (*Robinia pseudoacacia*), are eradicated. Oak stool shoot growing rate is more than one meter per year: thus, clearings have to be fenced. Spaces among spouting stumps are filled by self-seeding woody plants – pioneering birches, aspens, willows or pines. Valuable broadleaved deciduous trees, *e.g.* cherry, rowan or pear trees have been regenerating and the shrub layer is formed there. On almost all clearings, low number of invasive black locusts and Alianthus trees have appeared. The first five years of the coppice forest regeneration in the Podyjí/Thaya River Basin National Park suggest that the targeted and regular management can enhance the growths even in the short term and can lay down the spatio-temporal mosaic typical for stool forests.

Görner T.: The Marbled Crayfish for the third time, this time again in Prague

One of the so far popular aquarium arthropods unfortunately now and then illegally released into a water reservoir by an irresponsible keeper. The author is speaking about the Marbled crayfish (*Procambarus virginalis*), native to the Eastern United States. Due to its

popularity among aquarists and high risk to native crayfish species when released into the wild the crustacean is listed among the invasive alien species of European Union concern. The first species' confirmed occurrence in the Czech Republic was in a water body in Přátelství/Friendship Park in Prague (the Prosek city district) in 2015, the second case was reported from an artificial water reservoir on the Radovesice bank spoil after surface open-pit lignite/brown coal miming near the town of Bílina (northern Bohemia) a year later. The most recently, in 2020, almost 400 marble crayfish individuals of size between 2–13 centimetres including females with eggs had been captured in Prague, namely in the Dolní Chabry city district, during only

four days. Bare fishpond bottom was consequently treated by lime: the procedure would eradicate the rest of crayfish. In the winter 2020/2021 season, the fishpond was dry and just the winter weather would support the eradication. Checks have not anymore proved the Marble crayfish occurrence at the site.

Kozel J.: From the World of Forest Solitary Settlements into the World of Nature

During thirty years since the declaration of the Šumava/Bohemian Forest Mts. National Park, there have been a lot of changes. They include changes in societal demands for National Park functions, technical/expert opinions on ecosystem management there and legal rules as well in ecosystems themselves. In the case of Šumava/Bohemian Forest Mts. NP, there was extraordinarily stormy development accompanied by a series of disputes and technical/expert and political conflicts. Due to the above events, forest communities and their management have also significantly changed there. In the early 1990s, in the nation-wide context the Šumava/Bohemian Forest Mts. forests had been relatively undisturbed; moreover they were to some extent influenced by clear felling/cutting system linked to the age-class forest and partiality for game-keeping and hunting. At present, on approx. one third of the NP, there has been undisturbed development of forest communities having been monitored and studied. On the remaining NP's territory, a current active regeneration management is applied using natural disturbances in forest ecosystems to improve their state and causing conditions for enhancing species diversity and ecosystem resistance/resilience. A feedback from monitoring the individual elements of the management is helpful not only for Specially Protected Areas and delivers the idea of lessons learnt from nature in forest and landscape management outside nature reserves which the first protected areas had been established in the Czech Republic with.

Roučková R.: The Šumava/Bohemian Forest Mts. Meadows and Pastures

Meadows and pastures are the species-richest ecosystems in the Šumava/Bohemian Forest Mts. nature. They were created and maintained by human hard-working. The most important meadow habitats in the Šumava/Bohemian Forest Mts. include: mountain heats and moors; short-grass matgrass grasslands; oatgrass, thistle and moor-grass meadows as well as meadow peat-bogs and spring areas with many typical species. The most important changes in the secondary forestless landscape had begun after the World War II when the German ethnic population was deported and a large part of the Šumava/Bohemian Forest Mts. was located behind the Iron Curtain. Thus, a traditional management by local people providing Šumava/Bohemian Forest Mts. meadows and pastures with landscape and species diversity was disrupted. At present the Šumava(Bohemian Forest Mts. meadows and pastures are threatened by natural/ecological succession as well as by pressured from developers. The Šumava/Bohemian Forest Mts. National Park Administration provides approx. a half of the secondary forestless area with management based mostly on contracts. A special attention is paid particularly to sensitive habitats and species, *e.g.* to the Bohemian Early Gentian (*Gentianella praecox* subsp. *bohemica*), Hairy stonecrop or Purple stonecrop (*Sedum villosum) and the Varnished hook-mass (Hamatocaulis vernicosus*).

Bufková I.: Looking Back at Water or Twenty Years of Restoration in the Šumava/Bohemian Forest Mts.

In the Šumava/Bohemian Forest Mts., restoration has begun significantly later than in other parts of the Czech Republic. The greatest problem in the Šumava/Bohemian Forest Mts. has been drainage. Its real extent became clear only during mapping in the first half of the 1990s. It was found that on the National Park's territory approx. 70% of peat-bogs had been once drained. In other wetlands, about a half of their area had been also drained. In the late 1990s, the restoration efforts were crowned by elaborating a long-term strategy called "Programme on Šumava/Bohemian Forest Mts. Peat-bog and Wetland Restoration". The article summarizes the long-term efforts in that issue and shows how methods applied at the Šumava/Bohemian Forest Mts. can serve as good practice examples. The key measure in the drained wetlands are removing drainage channels/ditches: the channels/ditches should be filled and left to be overgrown by vegetation before wooden barriers break-up. The partial sub-basin should be restored. Since the very beginning the LIFE project has significantly contributed to restoration measure improvement there.

Pešout P. & Štěrba P.: Standardization in Nature Conservation and Landscape Management

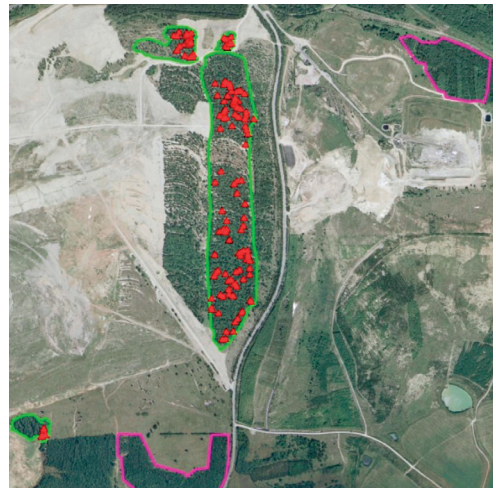
The Nature Conservation Agency of the Czech Republic has been for ten years

elaborating together with academic institutions standards in nature conservation and landscape protection. Almost 30 such standards have been published yet and approx. the same number has been under preparation. Up-to-date experience shows that the concept of standardization in various activities has proved successful and has fulfilled its purpose: standards are used by designers, planners, project implementers, evaluators of application for a subsidy/subvention/grant and they are also applied in the State/Public Administration performance. Thus, the standards at present have been serving as a background for establishing unified code lists of activities in nature conservation and landscape protection linked with costs of usual measures and consequently for planning and

documenting the interventions having been made in nature and the landscape. Moreover, they are sometimes misapplied. The standards in nature conservation and landscape protection can only support the appropriate implementation of the measures: therefore, they should be handled as a utility or a tool, not as a law.

Frouz J.: Ecological Restoration of Mining Sites, Organic Matter Accumulation and Ecosystem Functioning Restoration

Special attention has been recently paid to abandoned mineral resource mining sites which provide a broad range of rare and threatened species with a suitable substitute alternative habitat. The article deals with question how beneficial are sites/areas left to spontaneous development in comparison with those restored artificially. The author preliminarily summarizes that production and other ecosystem functions



under self-seeding woody plant growths are in many cases comparable with the outputs gathered under restoration plantings. The latter usually show a rapid improvement in the parameters studied in the beginning, but later the rate in restoring the individual parameters and processes slows down. On the other hand, sites/areas left to spontaneous succession usually display slower start, but in older sites/areas the studied parameters of area's restoration can reach the comparable results.

Šafránek J.: Old Environmental Burdens in České Švýcarsko/ Bohemian Switzerland

It could come as a surprise, but there have been various environmental burdens/loads/damages also in Bohemian-Saxon Switzerland. As early as before the World War I, there had been difficulties caused by quarrying, as it was alerted by associations for landscape embellishment about. Finally, the quarrying along the Labe/Elbe River was

prohibited in the 1940s. After the World War II, bigger dumps or landfills of particularly municipal waste appeared there. In addition, near factories or garrisons dumps of hazardous waste were created. In the České Švýcarsko/Bohemian Switzerland National Park, old exploratory deposit and hydrogeological wells have been causing other troubles. Unfortunately, some of them have reached a state of disrepair and not all have been properly disposed; therefore they can pose a serious threat to underground water sources. The article presents ways how the old environmental burdens are removed in České Švýcarsko/Bohemian Switzerland.

Pešout P.: Management Agreements – An Important Tool for Cooperation with Landowners and Managers in Nature Conservation

Ten years ago, the Nature Conservation Agency of the Czech Republic (NCA CR) began to conclude agreements on management through public contracts setting up both management measures to be implemented

and providing landowners or tenants with a subsidy/subvention. Consequently this practice has been step-by-step applied also by other State Nature Conservancy Authorities, particularly Regional Offices. At present the agreements on management are one of the principal and commonly used tools in cooperation with land managers. The NCA CR currently carries out active steps towards further basic enlargement of the type of cooperation with landowners, our most important partners in practical nature conservation. The comprehensive and long-term agreements on management measures in Specially Protected Areas have proved

successful and it is necessary to develop this instrument further.

Stejskal R.: Targeted Application Methods or a New/Old Tool for Controlling Invasive Alien Woody Plants: Management of Invasive Alien Woody Plant Young Individuals

Management of invasive alien woody plant young individuals is often underestimated in nature conservation practice. Main efforts regularly aim at eradication of old trees while young individuals are unnoticed or eliminated by methods with uncertain effects. Nevertheless, early, appropriate and correct measure can prevent a lot of difficulties related to developing a biological invasion at valuable sites/areas. This contribution is a continuation of the recently published article (*Ochrana přírody*, *76*, *5*, *15-19*, *2020*)

and presents less known eradication measures having been over recent years tested in the Podyjí/Thaya River Basin National Park (South Moravia). They particularly include using herbicide when partially removing bark. The method can be preferred as selective management of invasive alien woody plants at from a point of view of nature conservation valuable sites/areas with preserved vegetation and important species occurrence. At other sites and particularly at sources of high young individual density spraying on leaves can be applied.

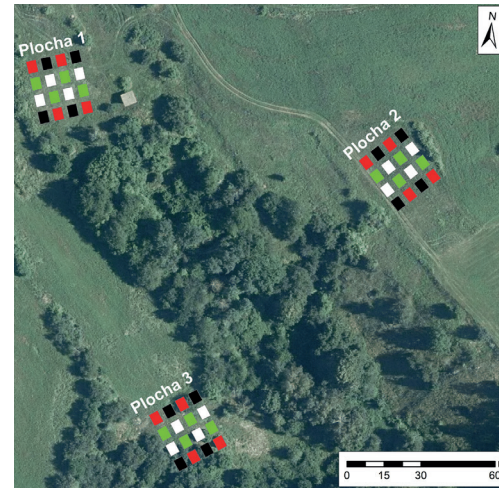
Groessl F.: Experience in Training Shepherd Dogs Guarding Livestock

Shepherd dogs guarding livestock are rightly recommended as the most effective tool against grey wolves attacking livestock.

Farmers are often criticized that they hesitate to obtain a shepherd dog. Hardly anybody is able to realize a long and hard way to get a well-working and fully operating shepherd dog. The author, a practitioner, describes in detail the period of approx. two years of training of the shepherd dogs by the exact examples of two shepherd dog breeds. Possible difficulties and pitfalls of the procedure are summarized and recommendations on how to as well as can be carry out shepherd dog rearing and training are also presented in the article.

Hamřík T. & Košulič O..: Prescribed Burning as an Effective Conservation Management Tool to Support Steppe Habitat Biodiversity

In some regions, returning to traditional farming in grasslands is not feasible, or the implementation of such conservation management is high-cost. The small-scale prescribed burning can be a suitable low-cost substitute for uneconomical management measures such as grazing or mowing. Experiment carried out by the authors shows that prescribed burning reduces accumulated plant biomass and creates open soil surface with sparse vegetation, thus providing microhabitats that support xerothermic spider species. The authors also found that prescribed burning achieves more favourable results than does traditional mowing in xeric grassland. Unlike the mown patches, the burnt ones display relatively tall vegetation, which offers a refuge for vegetation-dwelling spiders. Therefore, the authors suggest that one-time prescribed burning could be performed as a tool of restoring recently homogeneous xeric grasslands that had been abandoned from the former traditional farming. Nevertheless, the prescribed burning needs to be implemented



by well-trained conservation managers who have proper knowledge of the given habitats, with the assistance of firefighters to avoid possible negative effects.

Pešout P.: Authentication of Vegetation Burning in the Czech Republic

Fire has been among the oldest helpers to managers. In some parts of the world with less developed agriculture this is still the case. In the Czech Republic, using fire in nature management has been very much reduced, vegetation burning having been fully prohibited. Such an approach is basically correct when taking into account the carbon footprint. Definitely it is not right to reintroduce postharvest remnant burning on the field. Nevertheless, in some specific cases, *e.g.* during secondary heathland restoration, using burning is helpful or even just necessary. The Nature Conservation Agency of the Czech Republic in cooperation with the Fire Rescue Service of the Czech Republic has been elaborating a detailed and in-depth

methodology on applying the prescribed burning. The document will include instructions for conservation planning and parameters for selecting suitable plots/sites and timing, set down risk assessment procedure and steps to eliminate such risks, provide instructions for organizing interventions including their planning and scheduling, identify the conditions for fire preventing measures and will describe ways how to negotiate the issue with stakeholders and to communicate it to the general public. In the methodology, attention will also be paid to procedure for securing the plot/site after burning, proposing monitoring activities and assessing the intervention.

Nature Conservation Legislation

Mana V.: Bad Laws Are the Worst Sort of Tyranny

The quote of British conservative statesman Edmund Burke (1729–1797) definitely is an appropriate introduction to an essay on the new Building Act. Laws are like guns. they can protect people but they can be dangerous for them, too. Sometimes a purposively

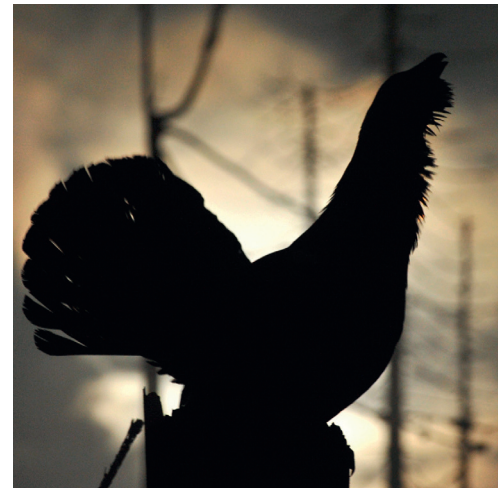
written law can turn against those who elaborated it and lobbied for it. Only the coming years shall show who the new Building Act will serve: whether it will be providing a quicker way to higher profits for financial groups and developers or to modernize the public infrastructure and to implement the European Green Deal in the Czech Republic. Moreover it also is possible that the current proposal shall become a legislative monster after having been approved by the Parliament, thus not helping anything but only damaging everywhere.

Vlasáková L.: Lead and Wetlands. What Results from the Newly Adopted European Commission's Regulation?

Wild animal poisoning is among the principal problems in global nature conservation. Many studies dealing with the topic have demonstrated that lead in gunshot poses the significant risk of poisoning particularly to waterbirds consuming spent shot mistaking it for food or the grit they need for their gizzards. Some international multilateral treaties and agreements to which the Czech Republic became a Party have been for a long time trying to handle the issue. Some years ago, the European Commission (EC) had begun to seriously deal with the issue. At the beginning of 2021, the EC adopted a new regulation under REACH, the EU's framework regulation for the use of chemicals. The regulation entered into force on February 15, 2021 and sets a period of two, three years respectively for the introduction of ban on the use of lead gunshot in wetlands and at 100 metres around them. In the Czech Republic, the ban on the use of lead gunshot for hunting waterfowl in wetland has been in place since December 31, 2010.

Mlčoch S. & Tuháček M.: Thirty Years between Scylla and Charybdis or Some Notes on the Legal Framework for Management in the Šumava/ Bohemian Forest Mts. National Park

For legal regime of the Šumava/Bohemian Forest Mts. National Park, adopting Governmental Regulation No. 163/1991 Gazette and Act No. 114/1992 Gazette on Nature Conservation and Landscape Protection, as amended later (hereinafter the Nature Conservation and Landscape



Protection Act, NCLPA) had been crucial. The last important amendment to the NCLPA by Act No. 123/2017 Gazette newly modified also an issue of the above NP's public attendance. The fact is related to visitors' security which was in 2205–2008 in detail handled by the District Court at Prachatice and the Regional Court in České Budějovice/Budweis in the case of fatal injury caused by natural tree falling in the most strictly protected area. For nature conservation and landscape protection relatively favourable verdicts of the courts in this issue were meantime disrupted by new amendment to the Civil Code which has not explicitly stated a duty to prevent damages also to health and to the environment. On the contrary, amendments to Article 19 of the Forest Act and Article 64 of the NCLPA highlight that persons entering into forest, nature respectively should pay attention to their own security. National Park Administrations have in any case to check risk areas, to alert visitors to the risk and if need be to prohibit enter of the public into a threatened site and carefully consider both the legal interest in human health and the public interest in nature conservation.

Begič T. & Mazancová E.: Six Months of Implementing the Linear Building Act in Practice

In the Czech Republic, on January 1, 2021 the amendment to the Linear Building Act came into force providing a lot of substantial changes in both linear building permitting procedure and "ordinary" building administrative work. The Act on Nature Conservation and Landscape Protection has been also influenced. When implementing the amendment into practice, due to imperfections in its text, some lack of clarity and inconsistencies raised. The article presents various

explanations and a shift in applied practice affecting the State Nature Conservancy authorities which have not been analysed in previous articles. The amendment did not caused only changes in linear building permitting as it can be seemed at first glance; by modifying some legalities of the Code of Administrative Procedure and of the Building Act, there are changes influencing a lot of procedures carried out by the State Nature Conservancy authorities when issuing binding opinions. The main questions discussed by the authors include "the legal fiction of approval" and "the legal fiction of binding opinion on felling woody plants – yes or not?".

Říha C., Konopásek Z., Prach J. & Obermajer J.: Construction Activities in Protected Landscape Areas: An Outline of the Current State and an Analysis of What Existing Leaflets for the Public Say

In the Czech Republic, the purpose of Protected Landscape Areas is not only to protect, conserve and manage nature, but also to preserve the landscape's values. The

landscape is shaped, among others, by the appearance of buildings and settlements. Construction activities should therefore be aimed at respecting the local historical and cultural forms. In short, the landscape should retain its specific character and provide a pleasant impression and perception on both residents and visitors. The question remains how to fulfil the public interest as effectively as possible while being simultaneously perceived by citizens as a welcome service to the state, and not a senseless restriction. In the article, the authors present the first phase of an applied research project, in which a team of sociologists, urban planners, architects and conservationists critically explores and co-shapes the reality of decision making, *i.e.* the complex trajectory from regulation to practice.

Jelínková J.: Strengthening Powers of Forest Guard and Nature Guard as a Part of Anti-IAS Amendment

As a part of the so-called Anti-Invasive Alien Species (IAS) amendment to Act No. 114/Gazette on Nature Conservation and Landscape Protection, as amended later, and some other laws, on June 2, 2021 the Chamber of Deputies of the Czech Republic passed amendments strengthening powers

of Nature Guard and Forest Guard. The most important changes include completing Forest Guard powers by allowing it to make audio/sound, visual or similar recordings, under the conditions set by the Act to stop a vehicle or to detain a person. Moreover, the powers are not the same in various guards. Thus, it is no more than desired to complete all of them as soon as possible with power to make audio/sound, visual or similar recordings. The authority to make such recordings in relation to guards' activities, particularly to document lawless behaviour/misconduct, is of great importance also because the guards, contrary to the Police of the Czech Republic and municipality polices are not endowed with coercive or compulsory means.

Trojanová K. & Šíma J.: Presenting the So-Called Anti-Invasive Alien Species Amendment to the Act on Nature Conservation and Landscape Protection

On 8 October, 2021 Act No. 364/2021 Gazette which changes some laws in relation to implementing the European Union's legislation on invasive alien species (IAS) was published in the Gazette/Collection of Laws/Statute Book of the Czech Republic. The above piece of legislation called also the anti-IAS Amendment was elaborated by the Ministry of the Environment of the Czech Republic due to duty to respond to Regulation (EU) No. 1143/2014 of the European Parliament and of the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species within the Czech Republic's rule of law. The Act's primary purpose is to set down the competence, procedural and sanction system allowing effective implementation of the EU's directly applicable in controlling IAS. Setting down pro-

cedures towards adopting measures to avoid or eliminate the introduction of new IAS on the Czech Republic's territory and to reduce IAS having been spreading there is also important.

Flousek J., Romportl D. & Zýka V.: Shall We Go for Krkonoše/Giant Mts. Black Grouses with a Computer?

In studying ecological requirements of (not only) wild animal species, habitat modelling

has been significantly applied using geoinformatics technologies, data gathered by remote sensing techniques and spatial analysis advanced methods. It aims at setting the landscape potential for permanent or temporary occurrence of such animal species and at assessing importance of individual environmental factors/drivers for their spatial distribution. Thus, habitat modelling currently is among the approaches often applied in conservation biology. The article deals with modelling factors related to the Black grouse (*Lyrurus tetrix*) occurrence in the Krkonoše/Giant Mts. (East Bohemia). The final recommendation feom the modelling is clear and for well-functioning National Park just trivial: to maintain the viable Black grouse population in the Krkonoše/Giant Mts. and Jizerské hory/Jizera Mts. by thoroughgoing protection and conservation of connectivity among sites/areas with habitats suitable for the above species and by avoiding further landscape fragmentation by disturbing structures and activities is just enough.

Research, Surveys and Data Management

Škorpík M.: Research on Podyjí/Thaya River Basin Nature in the Light of the last 30 years

Act No. 114/1992 Gazette on Nature Conservation and Landscape Protection, as amended later, obliges National Park (NP) Administrations not only to manage their territory, but also to conduct inventories, surveys, documentation and cooperation with scientific and research bodies. A long time before introducing territorial protection, research had been sporadic in the Podyjí/Thaya River Basin. Study on the Ledové sluje/Ice Caves pseudokarst near the town of Vranov and their microclimate described by Anton Roth in 1863 is one of the oldest. In 1897, Adolf Oborny made good use of the knowledge of the Podyjí/Taya River Basin in book Flora of the Znojmo Region (Flora des Znaimer Kreises), The changes occurred after 1989 and after declaring the Podyjí/Thaya River Basin NP in 1991. In 1990 Vojen Ložek restored research on molluscs and he crowned it by monography entitled Molluscs of the Podyjí/Thaya River Basin (1999). More extensive projects have been step-by-step implemented, *e.g.* a geological map of the Podyjí/Thaya River Basin NP and the Thayatal NP (1992) elaborated by the Czech Institute of Geology. Mapping of natural habitats and plant and animal species protected by the European Union's legislation was completed,

the Podyjí/Thaya River Basin Site of European Importance (pursuant to the above act the term for Site of Community Importance, SCI under the European Union's Habitats Directive) and the Podyjí/Thaya River Basin Bird Area (pursuant to the above act, the term for Special Protection Area, SPA under the EU Birds Directive) were declared there. Research on dipterans carried out by the Czech University of Life Sciences Prague is highly remarkable, the project on butterflies in both the bilateral NPs implemented by Jan Šumpich (National Museum Prague) is also highly admirable: research on birds and bats should be mentioned, too. Since 1998, research results have been published in peer-reviewed journal Thayensia issued in cooperation with the South Moravian Museum Znojmo.

Kaděra M.: Conspicuous is not an Equivalent of Knowledge

Nature can be effectively protected, conserved and managed using detailed knowledge. In the case of threatened wild animals, it is necessary to know both their habitats and trophic relations in food webs and due to usual population numbers and external factors also the level in which they have been endangered. Although some of them are highly visible in their habitats, such necessary knowledge is made more difficult by their bionomics. Thus, nature conservationists should increase field activities and arm themselves with **patience. For example, blister beetles from the family Meloidae have been for many years one of the most endangered beetle taxa/groups, because habitats inhabited by most of their hosts, mainly hedgerows and grassy strips at field margins, have been declining in the Czech Republic's landscape. Necessity to**

maintain in the landscape not only blister beetles, but also other visible, often critically endangered organisms (due to their less known trophic interactions, they have been avoiding effective conservation measures) should be considered as a particularly urgent task by nature conservationists. If nature conservationists underestimate specific trophic relations in such species, their efforts to conserve them will result in disappointed hopes. Similarly, "trophically hidden" species in other taxa/groups should also be targeted.

Belotti E. & Bufka L.: Thirty Years of Monitoring the Eurasian Lynx (*Lynx lynx*) in the Šumava/Bohemian Forest Mts.

The protected Bohemian-Bavarian-Austrian (BBA) Eurasian lynx (*Lynx lynx*) population arose from the reintroduction of a few tens of individuals in the 1980s, and has still been small, isolated and frail. The Eurasian lynx is an elusive species, mostly nocturnal and

occurring naturally at very low densities. The best method to study the ecology of such species (*e.g.* habitat and spatial requirements, diet composition, interactions with natural prey) is telemetry, which was used in the Šumava/Bohemian Forest Mts. approximately between the 1990s and 2013. Lynx individuals can be safely identified based on their coat pattern. Thus, camera-trapping (*i.e.* monitoring by camera-traps) is instead the best method to long-term monitor an entire population. If a sufficiently large part of the population's distribution area is appropriately covered with camera-traps for sufficiently long, it is possible to monitor individual survival, subadult migration after the dissolution of family groups or reproduction events. This altogether allows obtaining reliable estimates of population size and status.

Hubený P.: Naturalness as a Nature Conservation Tool?

Conservation of the mostly forested Šumava/Bohemian Forest Mts. National Park has been since its beginning linked with assessment of forest naturalness level. At the time of establishing the National Park only proven preserved primary/virgin forests had been considered as natural. For remaining forest which had been dominating there, their species composition was a main naturalness criterion. It was compared with "natural forest species composition" model made by comparison of primary/virgin forest species composition in the adequate habitats across the whole Czech Republic. In 2000, the models led to significant reassessment of the natural forest species composition concept. In the 2000s, attention was paid to "naturalness" of trees according to age class and their appearance. Scientific knowledge over the course of time casted doubt

upon the forestry model based on species composition. Genetics broke the myth on determination of naturalness according to tree age or appearance. At present, the forest naturalness has been assessed according to traits showing level of natural driver effects on growth structure, dead wood amount and natural regeneration ability.

Šípek P., Jor T. & Eršil L.: Temporarily Unmown Grass Strips – A Hope for Productive Meadow Insects?

Agri-environment Climate Schemes (AECS) managed by the Ministry of Agriculture of the Czech Republic aim at support to management mitigating negative intensive agriculture effects on the landscape and its inhabitants including insects. Therefore, the Nature Conservation Agency of the Czech Republic commissioned a study on effects of temporarily unmown grass strips on diversity and abundance in meadow organisms. It should test whether parts of grass growths left positively affect biota on common

managed productive meadows of various sizes. The study's results clearly show that grass strips left would be a method helping to improve the state of invertebrates within the open landscape. Their positive effect was visible even in the first year of the changed mowing. The unmown strips are at the same time a relatively easy and cheap measure. At present, the strips left according to the AECS requirements have been obligatory only for meadows larger than 12 hectares. Moreoover, due to negative trends in insect populations, it is necessary to support the approach also in less extensive areas/plots.

Procházka J., Skořepa L. & Dvořák V.: The European Spruce Bark Beetle – A Keystone Species for Occurrence of Many Rare Beetles in Šumava/Bohemian Forest Mts. Forests

The European spruce bark beetle (*Ips typographus*) is considered to be a keystone species in mountain spruce forests because

by its activity it influences a lot of organisms: among them, saproxylic beetles should be mentioned. Bark beetle plagues/outbreaks positively affect threatened beetle taxa through providing new opportunities for latter by increasing dead wood availability at various decay stages and with various insolation intensity. The endangered beetle *Peltis grossa* is a typical example: in 2018, the species came back to the Šumava/Bohemian Forest Mts. National Park and consequently has been extensively spreading to areas disturbed by bark beetles. The stag beetle *Ceruchus chrysomelinus* also profits from the recent situation: thus. the Šumava/Bohemian Forest Mts. population is among the most numerous in the Czech

Republic. The longhorn beetle *Ropalopus ungaricus* uses the favourable conditions, namely opening forest growths for its food woody plant which is the Sycamore (*Acer pseudoplatanus*). In the Šumava/Bohemian Forest Mts. the remarkable insect species was found after more than 60 years. Huge amount of decaying spruce wood after bark beetle plagues/outbreaks also supports one of the rarest beetle in Europe, the longhorn beetle *Tragosoma depsarium*, having n the Šumava/Bohemian Forest Mts .the only viable population in the Czech Republic.

Hendrychová M., Šálek M., Novák J. & Krkošková N.: How Do Birds Do in the Post-mining Landscape?

The landscape formed in northern Bohemia after brown coal surface mining displays a lot of specific characteristics positively influencing, *inter alia*, bird communities. Rapidly changing habitat on spoil heaps is an excellent laboratory for studying various ecological-ornithological topics. Birds well

indicate habitat quality; therefore, bird communities can be used to evaluate restoration success which also includes support to biological diversity. The results of research highlight the importance of successional patches/sites and encourage to maintain a mosaic of patches/sites differing in age with various management or more precisely, involving non-restored patches/areas into the post-mining landscape, similarly *e.g.* to Germany. As far as planting shrubs, preferred habitat selection for nesting in birds is better met by native shrubs. To enhance breeding success in birds due to lower predation rate establishing more extensive close-to-nature and semi-natural growths on spoil heaps is more appropriate.

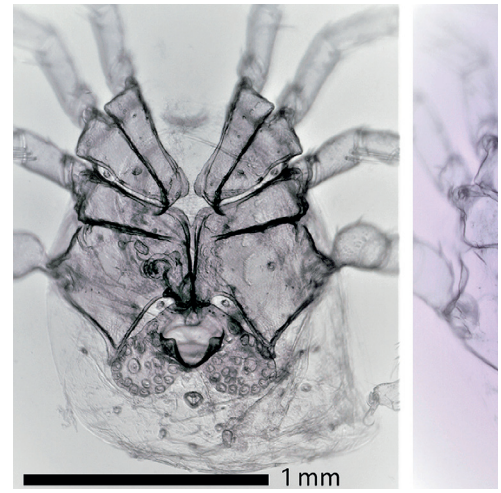
Kaprová K. & Neumannová B.: Updating the Methodology on Woody Plant Evaluation by the Nature Conservation Agency of the Czech Republic for 2021

The Nature Conservation Agency of the Czech Republic (NCA CR) has been for a long time cooperating with research authorities in developing approaches, procedures and methods to evaluate nature and the landscape. The article presents the results of the research project aiming at evaluation of

woody plants growing outside forests which resulted in a comprehensive revision of the NCA CR's methodology. The main new issues in woody plant evaluation procedure include new solitary woody plant categorization, explicit taking into consideration of invasiveness when evaluating both the solitary woody plants and woody plant growths and more precise differentiation of values in dry and decaying trees with respect to their biological potential. In the sum of all such changes, in comparison with the last edition of the methodology, there is a modest increase in the value of most of solitary woody plants and woody plant growths cut.

Punčochář P.: Water Mites in Some Fishponds in the Czech Republic in 2020 Compared to Findings of Dr. Karl Thon Published in 1900

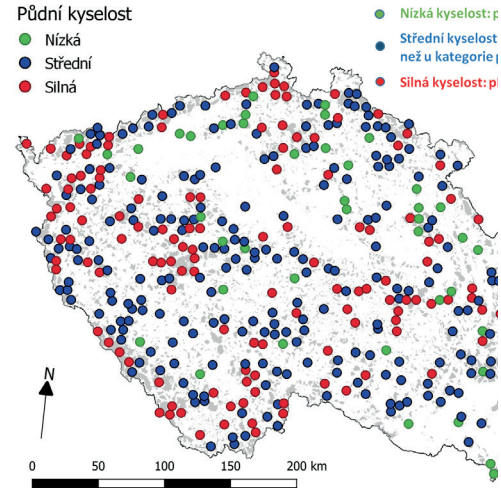
Water mites (Hydrachnidia, Parasitengona, Arachnida, Acari) are less known among the general public. The aquatic organisms follow the complicated life cycle; therefore, their occurrence and diversity can be used for assessing biological communities inhabiting water ecosystems. The article briefly presents history of research on water mites and compares their species composition in



some fishponds in the Czech Republic found in 2020 with findings published in 1900. The results suggest that water mite diversity in fishponds has not decreased which is a positive finding when taking into account the published data on declines in many insect and other taxa species gathered by studies on biodiversity during the last decades.

Šantrůčková H.: Where Are We with Forest Soils in the Czech Republic

There is an awareness among all of us of necessity to protected managed soils. People negatively perceive large-scale forest dying and complain about Norway spruce plantations/monocultures as well as on the European spruce bark beetle (*Ips typographus*) plague but only few of them interlink the disaster with soils which feed trees. The study having been conducted shows that most of forest soils are very acid and nutrient poor. The acidity should be decreased and put back to soils the ability to capture and retain nutrients available for plants. This



can be reached through increasing forest stand species diversity, increasing proportion of plant species producing favourable composition of litter, leaving dead biomass as much as possible just in forest growths and through supporting species-rich communities/assemblages of soil organisms which decompose plant biomass and give nutrients back into soils.

Kysela M., Konvička M., Pokorný J., Ričl D. & Sedláček O.: Ray of Hope for the Rock Grayling (Hipparchia alcyone)

The Rock Grayling (*Hipparchia alcyone*) is among the most threatened butterfly species in the Czech Republic. Its distribution is concentrated in a narrow strip in Central Bohemia following the Vltava River. The core of its occurrence is just in the Vltava River canyon in open woods or groves with Sheep fescue (*Festuca ovina*) undergrowth. In 2019, only two specimens had been recorded from the whole area of occurrence. The fact initiated huge monitoring efforts in the whole area of Rock Grayling's recent occurrence. It was found that the Rock Grayling has been still inhabiting a lot of sites there: thus, there has been hope for its survival. Moreover, an ongoing transformation of forests and woods which can provide the Rock Grayling as well as other organisms both with a threat and a challenge.

Čížek L., Drag L. & Hauck D.: Situation in the Alpine Longhorn Beetle in the Ralsko Upland

In 2020, the Alpine longhorn beetle (*Rosalia alpina*), also known as the Rosalia longhorn, population size in the Slatinné vrchy/Fen Hills Site of European Importance (pursuant to Act No. 114/1992 Gazette on Nature Conservation and Landscape Protection, as amended later, the term for Site of Community Importance, SCI under the European Union's Habitats Directive) and in the Malý and Velký Bezděz/Little and Big Bezděz National Nature Reserve (NNR) was estimated by mark-recapture method. The study is a continuation in monitoring carried out in 2008, 2009 and 2015: 935 individuals were marked and there have been 233 recaptures there. In the NNR, the population size estimation is one-half of that from the past years and a sharp decline in beetle's numbers cannot be excluded there. In the Slatinné vrchy/Fen Hills there has been sharp increase in abundance compared to the past years caused by high amount of wood from windfalls. Unfortunately, this is the Alpine longhorn beetle's swansong at the site. Therefore, it is desirable to stop felling in beech growths, to begin to replace conifers by beech trees and to introduce acers into the growths. In addition, climate change has been worsening the conditions for the European beech. In the NNR lack of rainfall caused drying up in the growths. Suitable old beech trees are disappearing, the forest is becoming thicker, young beech trees shadow old ones. Thus, it is necessary to make the growths less thick and to trimming the trees there. In addition, other adjacent sites should also by prepared by appropriate management. In the Slatinné vrchy/Fen Hills, there have been only fragments of the beech forest left. Functional connectivity among the sites, provided by a system of rows of trees or alleys, ideally consisting of trimmed trees, is also very important. The Alpine longhorn beetle's future in the Ralsko Upland and thus in Bohemia as a whole is uncertain and particularly we have it in our hands.

Chobot K., Pergl J. & Görner T.: Monitoring Non-native and Invasive Species in the Czech Republic

Invasive alien species (IAS) are, together with natural ecosystem fragmentation, degradation, destruction and loss, growing natural-resource consumption, environmental pollution and climate change, one of the most important drivers threatening native species themselves as well as other native ecosystem biodiversity. In addition, they also can cause huge economic damages/financial costs and negatively affect human health. Due to IAS' ability to spread, managing them only within the single country or region has been mostly ineffective. Therefore, the targeted and tailored strategy across the country's borders is desirable. Thus, Regulation (EU) No. 1143/2014 of the European Parliament and of the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species was adopted within the European Union was transposed into the Czech Republic's legislation by amendments to Act No. 114/1992 Gazette on Nature Conservation and Landscape Protection as well as marginally to other laws related to the issue, coming into force 1 January, 2022. In view of the fact that no finances for monitoring IAS, *i.e.* for the new legal duty will not be available for the State Budget, the Nature Conservation Agency of the Czech Republic has prepared, based on its experience in IAS systematic mapping, a proposal of the extensive project on mapping, inventorying and monitoring invasive alien species across the country to be funded from the Operational Programme Environment (OPE), *i.e.* from the EU funds.

Šafář J. & Koudelka M.: Show Caves as Important Hibernacula of Bats in the Czech Republic

Of more than 2,460 karst caves, 14 are show caves in the Czech Republic. All of the later are fully protected by national law and in addition, most of them are also protected as important hibernacula at the European level by the European Union's legislation. Monitoring occurrence of Specially Protected wild animal species is one of the pillars of wildlife protection and conservation and it is the same for caves, too. Since the 1990s, long term bat monitoring has been carried out by unified methodology in all the known more important hibernacula, aiming at minimal disturbance to animals. In 2011–2020, 12–14 bat species were found in the show caves in the individual years. In total, 16 bat

species hibernated there during the above period. The highest species richness, namely 15 species, was reported from the Sloup-Šošůvka Caves (the Moravský kras/Moravian Karst, central Moravia), although five species spent winter there only once and in addition, it was the single individual only.

The Nature Conservation History

Zajíček P.: Jan Knies

160 years ago, an important Moravian teacher, researcher and explorer Jan Knies was born. He became famous thanks to writing some volumes of the publication *The Moravian History and Geography* and his archaeological and paleontological research carried out in many karst areas and at other sites in Moravia should also be

mentioned. His findings and other exhibits and showpieces were presented to the public in a small karst museum built on a plat owned by him at the township of Sloup in the Moravský kras/Moravian Karst. He left the outputs of his research, documentation and describing activities in a lot of articles, reprints, brochures and popular science/non-fiction publications. In addition to the above *The Moravian History and Geography*, the most significant contributions made by Jan Knies include a comprehensive article on the Punkva River and its karst tributaries published in 1909 and presenting a detailed map of supposed underground streams in the Moravský kras/Moravian Karst.

Pešout P.: Jan Roubal, a Pioneer in Conservation of Czech and Slovak Nature

In nature conservation Jan Roubal, a high-school teacher born at the township of Chudenice (West Bohemia), has been better known in Slovakia than in the Czech Republic. His extraordinary scientific activities in

entomology, particularly studies on beetles (*Coleoptera*) and typical bugs (*Heteroptera*) have been many times described, assessed and published, most recently and in a comprehensive manner in monography by Stanislav Benedikt and Pavel Bezděčka in 2010. Moreover, Roubal's contribution to nature conservation has not been published in *Ochrana přírody/Nature Conservation Journal* yet, except of a short note written by Jaroslav Veselý, one of the founders of nature conservation and landscape protection in the former Czechoslovakia, in 1956. Celebrating the 140 anniversary of the birth of Jan Roubal, the article pays off this debt. Jan Roubal passed away on October 23, 1971 and is buried in his hometown Chudenice.

Diviš T., Kovařík K. & Soukup M.: History of Nature Guards/Rangers in the Šumava/Bohemian Forest Mts. National Park and Protected Landscape Area

The article deals with history of nature guard/ranger service development in the Šumava/Bohemian Forest Mts. area. Although in a recent, but quite deep-rooted collocation the National Park is placed before the Protected Landscape Are (PLA), the order of their establishment is just opposite: the same is correct for nature guard/ranger service which had begun to be formed in relation to declaring the most extensive protected area in the Czech Republic. The term "nature guard/ranger" is for many people – if not a synonym – at least a name inherently linked to nature conservation. Despite the fact that at the time of declaring the Šumava/Bohemian Forest Mts. PLA, the term had not been included in the legislation, all persons from various branches of activities who contributed to preserving the unique nature heritage there should be called nature guards/rangers. In spite of the fact that nature conservation has

to be based on principles and approaches of the whole society, hundreds of volunteers and professionals have had an unforgettable share in that and their efforts should be very much appreciated.

Pešout P.: Jan Svatopluk Procházka – A Cofounder of Modern Czech Nature Conservation

Among unjustly overlooked personalities in nature conservation, there are also is Jan Svatopluk Procházka, founder and the very first lecturer in nature conservation in Prague universities and the spirit of Czech

nature conservation movement in the first third of the 20th century. In his time the most important promoter of nature conservation is remembered by the article on the occasion of the 130th anniversary of his birth. Due his huge knowledge in various branches of study and international horizon J.S. Procházka step-by-step reached a new holistic approach to nature conservation. He formulates applied nature conservation as a multi-disciplinary biology-based branch with broad involvement of communication, education and public awareness (CEPA), and he also describes differences between "modern nature conservation" and "older movement for natural monument protection".

Zajíček P.: 200 Years since the Birth of Jaroslav Wankel

200 years ago, Jindřich Wankel, M.D., physician, researcher and polymath was born. He is considered to be the father of Moravian archaeology. He discovered a unique sanctuary/shine in the Býčí skála/

Bull Rock Cave (the Moravský kras/Moravian Karst area, central Moravia). In 1972–1873 Wankel carried out the systematic and comprehensive research on sediments in entrance part of the cave called The Hall, making his greatest archaeological discovery there. The extensive site was dated to the Hallstatt Period (800–450 B.C.). With his collaborators, he also discovered, described and documented a lot of caves in the Moravský kras/Moravian Karst area. In addition, Wankel wrote many popular science publications. The list of his activities, outputs, findings and discoveries would fill up a whole book. He published the results of his research as well as discoveries in many technical articles and papers in various journals, mostly in German.

Focusing on the Public

Komancová B.: The Public Helps to Identify Remarkable Trees in the Brdy Highlands

Pursuant to Act No. 114/1992 Gazette on Nature Conservation and Landscape Protection, as amended later, extraordinarily significant trees, their groups /clusters and alleys can be declared by a decision taken by the State Nature Conservancy authority as Memorial/Veteran Trees. Although the exact criteria for selecting Memorial/Veteran Trees have not been set yet, it is assumed that these are individuals with magnificent size or age, prominent landscape dominants/landmarks, historically valuable woody plants or extraordinarily valuable introduced woody plants. The public can participate in identifying such trees in the Brdy Highlands (Central Moravia) through a simple mapping application. To date, about 18 months after making a database accessible to the public,

more than 140 trees of various species and sizes have been gathered. Mapping remarkable trees has been continuing in the Brdy Highlands Protected Landscape Area – and the readers are welcomed also contribute to these efforts.

Kala L. & Kos J.: Visitor monitoring in the Podyjí/Thaya River Basin National Park in Normal Times and in Times of Coronavirus

How many people walk along trails and paths there and has been the Podyjí/Thaya River Basin National Park (NP) also tending towards the fate as Mt. Sněžka, Pravčice Gate/Prebischtor, Mt. Praděd or Pustevny Saddleback which have been rather avoided by nature lovers due to high number of visitors? The answer is provided by outputs of long-term visitor monitoring scheme which was introduced also into the Podyjí/Thaya River Basin National Park in 2010 and had been inspired by such monitoring in the České Švýcarsko/Bohemian

Switzerland National Park. The outputs suggest that the Podyjí/Thaya River Basin NP attendance by visitors was entirely minimal from October to March. Moreover, this has been in recent years true only for the NP's central and western parts while due to development in wine-growing and making tourism wine-growing and making municipalities in the eastern part of the NP are visited also in winter. There has been a clear trend in the visitor number: in 2011–2019 it increased in total by 27%. In 2020, the unambiguously highest load of visitors was recorded in the NP's thirty-year history: the number even multiplied. Whether this is a temporary fluctuation related to the global COVID-19 pandemic it at this moment is very difficult to say. Nevertheless the NP's Administration staff shall know it from numbers gathered by visitor monitoring using automatic counting system, the technology recording a jump in temperature caused by passing of a visitor, which shall be also continuing in the future.

Kučerová M.: The Šumava/Bohemian Forest Mts. National Park is the Best Open-air Classroom

During 30 years of its existence, the Šumava/Bohemian Forest Mts. National Park has succeeded in building a very broad and diverse offer of environmental communication, education and public awareness programmes. Four environmental education centres display a common trait: they teach children as well as adults to perceive beauties and uniqueness of Šumava/Bohemian Forest Mts. nature, to listen to nature and to learn from it. Children from kindergarten and elementary schools can come there and participate in educational programmes also in visitor centres which are together with information centres are of key importance for communication with visitors. For better understanding of Šumava/Bohemian Forest Mts. nature, the NP Administration publishes a lot of didactic materials. In September 2021, a wheelchair accessible classroom called the Forest Workshop shall be launched. Numbers of visitors both in information centres and visitor centres have been increasing. For future projects, it is necessary to direct the offer to sites with lower visitor attendance and to develop user-friendly activities how to behave well in nature.

Zajíček P.: Show Caves in the Czech Republic in the Era of COVID

Humans have been suffering from the COVID-19 pandemic, negatively influencing economy, companies, individuals as well as social and cultural life. Waves of measurements against the disease have been also troubling 14 show caves in the Czech Republic. Moreover, the Cave Administration of the Czech Republic's staff and visitors to the underground spaces have been successfully overcoming the troubles and difficulties. In addition to ordinary tours in 2021 a lot of interesting side events have been organised in show caves. Research and survey activities have been continuing as well as cultural events and building particularly new visitor centres in the Český kras/Bohemian Karst (Central Bohemia) and near the Chýnov Cave (South Bohemia). Thus, under such conditions, the Cave Administration of the Czech Republic can consider the "COVID season" successful.

International Nature Conservation

Pavlíčko A.: A Look into Myanmar: Rediscovered Nature which Will Not Last Long

Contrary to Thailand frequently visited by tourists, more and more accessible Vietnam and recently popular Cambodia, Myanmar has been maintaining not only from Central European persons a magnificent magic of mysterious and in the past forbidden country in Southeast Asia with ancient Buddhist tradition. Although it mostly is located in the Oriental biogeographical region, also known as the Sino-Indian ones, the northern region is a part of the Palearctic, namely of the Himalayas. While lowlands, *e.g.* along the Irrawaddy River, are densely populated by humans, borderlands, such as the Nat Ma Taung National Park, have been still displaying natural character. The coastal zones, *e.g.* on the Mergui Archipelago, have been affected by the increasing tourism industry, pollution and eutrophication. How long will be Mayanmar's nature for a long time closed to the rest of the world able to resist the growing globalization pressure has been a burning question.

Plesník J. & Pelc F.: Forests in the World: Current State, Changes and an Outlook

According *to The State of the World's Forests 2020* report, published by the FAO, the world has a total forest area of 4.06 billion hectares (ha), which is 31% of the total land area. More than half of the world's forests is in only five countries – the Russian Federation, Brazil, Canada, the U.S.A. and China. Earth has lost a net area of 178 million ha of forest since 1990, which is an area about the size

of Libya. Moreover, the rate of net forest loss declined from 7.8 million ha per year in the decade 1990–2000 to 4.7 million ha per year in 2010–2020. Contrary to common consideration Africa had the highest annual rate of net forest loss in 2010–2020, at 3.9 million ha, followed by South America, reaching 2.6 million ha there. The rate of net forest loss has increased in Africa in each of the three decades since 1990, but it has declined substantially in South America, too, however, to about half the rate in 2010–2020 compared with 2000–2010.

An estimated 420 million ha of forest has been lost worldwide through deforestation since 1990, but the rate of forest loss has also declined significantly. In the most recent five-year period (2015–2020), the global annual rate of deforestation was estimated at 10 million ha, down from 12 million ha in 2010–2015. It is necessary to say that data provide information on deforestation, not on forest degradation. There is an estimated 726 million ha of forest in protected areas worldwide. Of the six world regions, South America has the highest share of forests in protected areas, at 31%. The area of forest in protected areas globally has increased by 191 million ha since 1990, but the rate of annual increase slowed in 2010–2020. The planet still has at least 1.11 billion ha of primary forest.

Plesník J.: The United Nations Fundamental Report: Making Peace with Nature Should not be Too Much Postponed

On February 18, 2021, United Nations Secretary-General António Guterres launched the first UNEP synthesis report entitled *"Making Peace with Nature: A scientific blueprint to tackle the climate, biodiversity and pollution emergencies"* based on evidence from global environmental assessments, *inter alia*, reports by the Intergovernmental Panel on Climate Change (IPCC), the Intergovernmental Science-Policy Platform for Biodiversity and Ecosystem Services, the UNEP's Global Environment Outlook report and research on zoonotic diseases such as COVID-19. Unlike past U.N. reports that focused on one issue and avoided telling leaders actions to take, the facts-based document combines three intertwined environment issues, making it clear that there is no time for linear thinking or tackling problems one at a time. It first provides an Earth diagnosis of current and projected human-induced environmental change, by putting facts and interlinkages in perspective, including by using smart infographics. In building on this diagnosis, the report identifies the shifts needed to close gaps between current actions and those needed to achieve sustainable development. Authors detail our reliance on natural capital for livelihoods, prosperity, health and well-being, and outlines how that value is unevenly distributed. Moreover, while humanity depends on the Earth and its ecosystems and draws benefit from nature, this dependence is not accounted for in current economic and financial systems. The report of reports concludes that world can transform its relationship with nature and tackle the climate, biodiversity and pollution crises together to secure a sustainable future and prevent future pandemics.

Záhorová L.: Dominica Has Been Remaining the Pearl of the Lesser Antilles even after Devastating Hurricane Maria

The Lesser Antilles, islands in the eastern Caribbean Sea, are located in the tropics and are regularly devastated by tropical cyclones. In addition, due to climate change there has been an increase in their number and intensity over the last twenty years. Thanks to its location, volcanic origin, tropical climate with stable temperature and humidity, presence of more than 360 brooks and rivers with a lot of waterfalls and high elevation range Dominica, similar to other island in the region, harbours very species-rich nature, in addition displaying a high percentage of endemic taxa. Approx. 60% of the island has still been covered by natural vegetation while on about a fifth of the Dominica's territory protected areas have been declared. The island is often called the Pearl of the Lesser Antilles and it has been maintaining such character despite devastating effect of hurricanes.

Bečka P.: The Bayerischer Wald/ Bavarian Forest Mts. National Park – the Oldest German National Park

Establishment of the Bayerischer Wald/ Bavarian Forest Mts. National Park in 1970 had been the beginning of a unique story. For the first time in Germany, such an extensive area was set aside and step-by-step left to natural process protection and conservation. At present, the Bayerischer Wald/Bavarian Forest Mts. National Park covers 24,250 hectares and from 2027, the motto "Leave Nature Alone" shall be main approach across 75% of the NP's territory. Moreover, the way to spontaneous non-intervention development was not easy there. The general public, experts and politicians debated ahead of twenty years the issues that have been also known from history of declaring the non-intervention natural zones in the neighbouring Šumava/Bohemian Forest Mts. National Park. But there has been a huge difference there. The Bayerischer Wald/Bavarian Forest Mts. National Park Administration stood up all the time for this approach and did not change it.

In addition, it was always supported by its founder, the Free State of Bavaria. Therefore, the Bayerischer Wald/Bavarian Forest Mts. National Park nowadays has been providing an excellent example for other areas and thanks to natural processes underway the National Park has been changing back to wilderness, following its own natural patterns.

Zajíček P.: The Zolushka Cave – An Underground Treasure of Moldova

For a long time hidden, more than 90 kilometres long cave labyrinth called Zolushka (Cinderella) was discovered during gypsum excavation in a surface quarry almost on the border between Moldova and Ukraine. It is the third longest cave in gypsum all over the world. A rugged system of remarkably modelled underground corridors is largely located in Ukraine; moreover, it's the only entrance is situated in Moldova. Because Moldovan authorities consider making the Zolushka a show cave, they asked through the Czech Development Agency experts from the Cave Administration of the Czech Republic (CACR) for assessing the intention. Thus, four CACR staff members visited Moldova in autumn 2019. The main outputs of their expertise include a lot of recommendations how to implement the intention to make the Zolushka Cave a show cave in practice.

Plesník J. & Hanel L.: Marine Biological Diversity Needs More than Protected Areas¨

The global ocean covers over 70% of earth's surface, offers more than 95% of the living space on the planet and provides a huge range of ecosystem services to enhance human well-being. Nevertheless, humans have impacted 87–90% of ocean's surface. The global ocean ecosystem is negatively affected by various drivers, *e.g.* overfishing, marine and coastal habitat degradation, destruction and loss, climate change, acidification, contamination with various elements or substances, plastics and noise pollution, eutrophication, resource exploitation including sea-bed mining or invasive alien species impact, often acting synergistically. On the other hand, a healthy ocean could, with 30% of it protected effectively, deliver 20% of the carbon emission reductions needed to achieve the Paris climate agreement's warming limit of 1.5 °C above pre-industrial levels; 40 times more renewable energy than was generated in 2018; 6 times more sustainable seafood; 12 million jobs; and USD 15.5 trillion in net economic benefits. This can be reached by holistic integrated management combining management of effective networks of protected areas, ideally no-take ones, and various measures for reasonable temporal and spatial regulation of resource exploitation including fisheries and applying the ecosystem approach. Negotiating an international legally binding instrument under the United Nations Convention on the Law of Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction, *i.e.* in deep seas, is also of great importance.

Pelc F. & Zahradník P.: Necessity to Introduce a New System for Financing Nature Conservation in sub-Saharan Africa

The European Green Deal states: The EU will launch a "NaturAfrica" initiative to tackle biodiversity loss by creating a network of protected areas to protect wildlife and offer opportunities in green sectors for local populations. The article aims at proposing possible measures to meet the above high ambition. According to the authors up-to-date providing finances for iconic and famous protected areas in sub-Saharan Africa is in the vast majority insufficient and for the future unsustainable. The authors suggest to cover costs for appropriate management of protected areas with payments to African countries for ecosystem services/nature's contribution to people provided by these protected areas, to establish a new EU's ODA (Official Development Assistance) scheme aiming at sustainable ecotourism, to secure the minimum basic contribution from metropolitan states (or "mother countries") for the protected area management and to use various financial support from NGOs. At the same time introducing payments for ecosystems services/nature's contributions to people from the non-reserved landscape, *i.e.* outside protected areas is also proposed. The model supposes voluntary agreements

with the individual African countries on the proposed issues.

Plesník J.: Financial Costs Caused by Invasive Alien Species: Estimations versus Reality

Invasive alien species (IAS) can negatively impact the environment including its biological diversity, human health and socio-economy. Mainly due to continuing globalization, rates of IAS introduction and establishment are increasing and show no sign of abating. The economic costs caused by IAS are di-

verse and complex and include damages and losses as well as expenditures invested for avoiding or reducing the impacts of biological invasions through prevention, control and eradication. Based on data from InvaCost database the recently published report on the global economic costs over the last 50 years concludes that IAS are responsible for a minimum of USD 1.288 trillion (2017 USD) in damages. Taken together, studies from 13 countries and 6 supra-national regions estimate global realized and potential economic impacts of biological invasions at around USD 2.3 trillion in 1960–2020. Total costs of IAS in Europe summed to USD140.20 billion (or EUR 116.61 billion) between 1960 and 2020, with the majority (60%) being damage-related and impacting multiple sectors. The costs remain strongly underestimated because they do not cover some ecosystem types, taxa and regions. Moreover, it is clear that the economic impacts of biological invasions around the world, in Europe and within the EU are really huge and are steadily rising over time. In addition, damage costs are an order magnitude higher than management expenditures. ■

BioLog

http://biolog.nature.cz

Species recording is a crucial source of data for nature conservation. The recording needs to be effective, precise and comfortable. Recent technologies are suitable environment to do so. The BioLog Android application by Czech Nature Conservation Agency, serves as an effective way to collect records in the field or just while hiking in nature. BioLog provides an offline notepad for your observations of animals, plants or fungi in the nature of Central Europe.

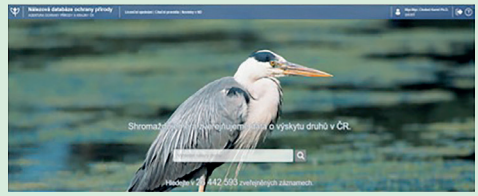
The application enables automated localisation (via Google maps) and recording in structured form, which is possible to be imported into Species Occurrence Database of NCA (https://portal.nature.cz/nd) or to be exported.

BioLog could be used as a hint source for species search or species local distribution atlas, from the opposite side. Through filtering of Species Occurrence Database via the Around Me function you can get the records collected near to your position on the screen. Your new records through BioLog can then easily enrich this distribution atlas.

The app is connected to the Species Occurrence Database and therefore collected records could be used in wide spectrum of conservation practice based on species presence: as a ground of administrative issues, for management of the specific areas, for assessments on local and regional levels.

Species Occurrence Database

https://portal.nature.cz/nd



Species Occurrence Database is a valuable information resource for experts and all interested in species in Czechia. It is a central species data repository on the national level.

Database encompasses more than 30 million of localised and dated records of 24 thousand species. Three quarters of data are of plants, animals are making a fourth quarter, fungi and lichens do not reach one percent of the data volume. Most of the data are results of expert research and monitoring, but the involvement of public in the citizen science project shows a growing trend.

Former intention to build a database for expert and official use made the growing public interest and open data policy outdated. The data (except of sensitive records) are today available under the Creative Commons License for any registered user.

Public are grid maps of species distribution (available at https://portal.nature.cz/karty-druhu), which are generated on a day-to-day basis on the actual state of database, the published knowledge is very recent. The grid maps enable the comparison with published and digitized species distribution atlases. Data are available also in BioLog, the Android app in Around Me function.

Full records are accessible through Filter (at: https://portal.nature.cz/ nd), the main gate to the database: just put the species name or other conditions. If you are interested what species you can find in your home municipality (if it is in Czechia), just try to search...

NATURE
CONSERVATION AGENCY
OF THE CZECH REPUBLIC

NATURE IS OUR HERITAGE AND THE FUTURE

The Nature Conservation Agency of the Czech Republic (NCA CR) is a governmental body established in 1995. The NCA CR's main aim is to protect, conserve and manage nature and the landscape on the whole territory of the Czech Republic. The NCA CR directly manages 24 Protected Landscape Areas (PLAs, IUCN Category V) and 132 National Nature Reserves and National Nature Monuments (small-size Specially Protected Areas of at least national importance) outside National Parks and PLAs (IUCN categories Ia, III, IV) across the country.

The NCA CR's range of activities includes inter alia:

- PerformingState/Public Administration in nature conservation and landscape protection in the particular areas, namely the Protected Landscape Areas, as the Public Authority;
- Monitoring the status of, changes and trends in the selected natural habitats and their types and populations of specially protected wild plant and animal species;
- Technical and expert support to other State/ Public Administration authorities including methodological and expert activities;
- Carrying out inventories, surveys, monitoring and research for nature conservation and landscape protection;
- Running the Nature Conservancy Central Register and the central governmental documentation on nature conservation and landscape protection;
- Managing the Nature Conservancy Species Occurrence Database (in May 2021, there are more than 28 million records, thus being the most comprehensive database on species occurrence in the country);
- Implementation of practical conservation measures in the field to conserve nature and to protect landscape in the 24 Protected Landscape Areas and 132 National Nature Reserves and National Nature Monuments on the whole Czech Republic's territory;
- Developing & implementing specially protected species action plans & recovery programmes;
- Administration of national subvention programmes/subsidy schemes as well as of some European Union funds serving to conserve nature, protect the landscape and to mitigate climate change or to adapt to it;
- Payment of financial compensations for loss of property in agriculture, forestry and fishpond management;
- State property management in the Czech Republic's Specially Protected Areas including purchasing and exchanging new land;
- Communication with, education of and public awareness among the general public and the target groups;
- International cooperation in nature conservation and landscape protection: the NCA CR is the Czech Republic CITES Scientific Authority, European Topic Centre on Biological Diversity (ETC/BD) partner, IUCN, EUROPARC Federation and ENCA member and National Focal Point of the CBD SBSTTA and Clearing-House Mechanism (CHM) and of the IPBES.

The NCA CR consists of Headquarters based in Prague and of 14 Regional Branches. As of May 1, 2022, it has 680 staff members, of them 563 with university degree and 49 with Ph.D. degree.

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