Fragments of Successes from the Landscape of Changes and Stability: the Český kras/ Bohemian Karst under Protection of the Protected Landscape Area for a Half a Century

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In 2022, half a century has passed since the colourful limestone landscape nor far from Prague was declared as Protected Landscape Area (PLA). The Český kras/Bohemian Karst is a textbook of changes in nature from the sea with trilobites almost half a billion years ago, to the current overgrowing the landscape and decline in rare species. In contrast to mountainous and remote protected areas, the nature and the landscape have been co-created and shaped by humans over many thousands of years there, and it would be incorrect to consider nature conservation without humans, land managers, and visitors. The article presents half a century of rapid social changes as well as changes in the landscape and nature in this picturesque, dynamic and at the same time in some aspects stable area. Stable with respect to the fact which phenomena have been preserved under the title of the PLA, particularly by recovery and replacement of traditional management.

Decades after the end of mining, the Alkazar quarry in the Berounka River Valley has become a habitat for steppe and rock species, as well as sought-after landscape scenery/character.

Geology and geomorphology – basis of the landscape

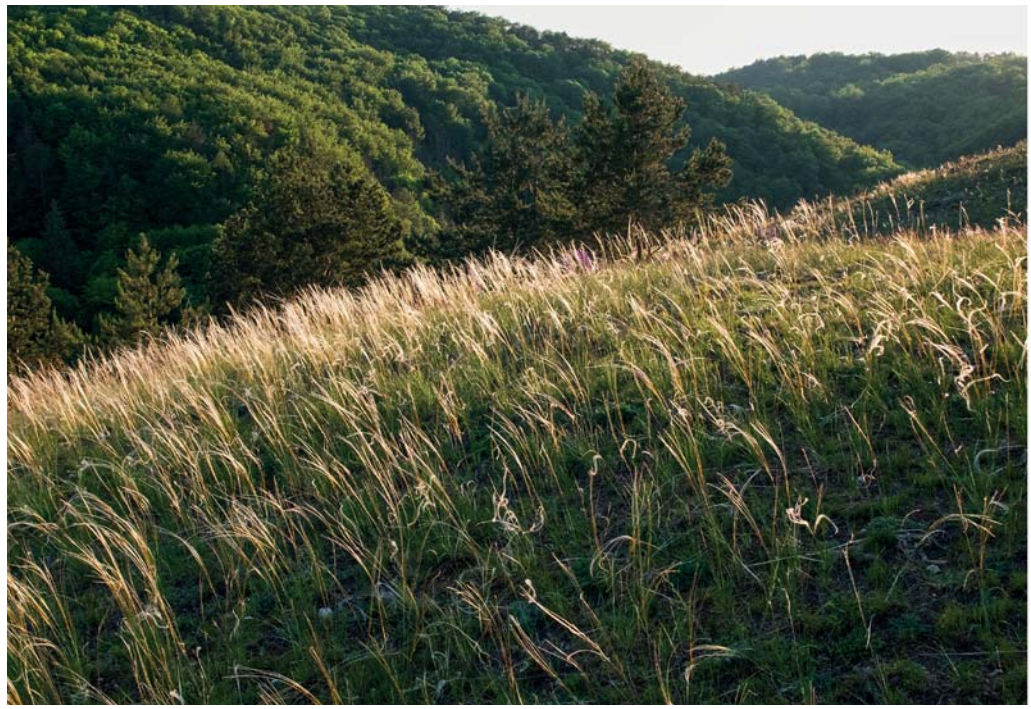
The gorges of the Berounka River and its tributaries have been furrowed over the last million years; these are mainly Palaeolithic limestones with complex and complete succession of beds and famous fossils. The landscape of ravines and plains was created, which has no equivalent elsewhere in Bohemia. Rocks with caves and rock steppe vegetation are the most important and typical element for the PLA (those interested in the details of how the Český kras/Bohemian Karst is the "Key to the Czech Landscape" are referred to the book of the same title ŽÁK *et al.* 2014).

Rocks are also changing; the numerous quarries are an often discussed nature conservation issue and, at the same time, a key phenomenon for geological research. It was possible to concentrate mining in areas approved before establishing the PLA, where valuable phenomena had already been destroyed. Mining continues at depth, which has less impact on distant views of the landscape, and quarries move towards relatively less-valuable areas (fields and ordinary forests). Simultaneously, it was possible to protect the valuable edges of the mining areas with the help of newly declared nature reserves. Nevertheless, continued mining is a source of controversy. Hundreds of former quarries are no longer mined; quarries and landfill, sometimes overgrown and sometimes managed by targeted grazing and clearing woody plants, are integrated into the landscape and become important habitats for rare species.

Steppes and forest-steppes

From the point of view of living nature, forest-free steppe fragments are the most valuable. The rugged karst landscape, with permeable limestones and south-facing slopes, has always been perfect for the survival of xerophytes and heliophytes and their communities. The European feather grass (*Stipa pennata*), pasqueflowers, yellow sunroses (*Helianthemum* spp.) – they are part of the westernmost islands of Eurasian continental steppes and relicts of the forest-free Ice Age (*i.e.*, in principle, a similar phenomenon to the well-known cloudberry, also now as the Nordic berry (*Rubus chamaemorus*), and tundra in the Krkonoše/Giant Mts.). Numerous southern European species have joined the continental species which, on the other hand, have their northern-most occurrences on warm karst rocks.

There are several types of steppes in the Český kras/Bohemian Karst – from rock steppes to broad-leaved grasslands on deeper soils, which have been disappearing the fastest, to forest-steppes. All in an unprecedentedly fine and colourful mosaic intermingling with thermophilic oak forests. The blurred boundary between forest and forest-free areas are important; it is becoming increasingly evident that quite a few of the rare and declining species need some ecotone type to live there.



Feather grass steppes – forest-free islands on southern slopes and rock tops (Radotínské údolí/Radotín Valley Nature Reserve and Special Area of Conservation under the EU Habitats Directive). © Jindřich Prach

To understand the dynamics of communities and to plan management, it is important to realize that we cannot explain the diversity and richness of the Český kras/Bohemian Karst by natural conditions alone. We find the answer in history and archaeology, as with all sites/areas at lower altitudes within reach of core, warm, and intensively populated areas. It is half a day's walk from the Polabí/Elbe River Basin, Hořovická kotlina/Hořovice Basin, and the territory of Prague to the karst – not only for today's tourists, but also for prehistoric hunters and herders. As evidenced by numerous archaeological findings, in caves, on surface settlements, and in the mounds of gords on the hills, there has never been a shortage of people in the area, even though the karst plains are barren. From the research so far, we can still only see hints of what the landscape looked like in agricultural prehistory. It must have been significantly influenced by humans, to a large extent open, grazed and mosaic-like, resembling a park (we infer from snail communities from the correspondingly old scree layers under the slopes and from mammal communities documented in bones from cave fillings).

Steppe heliophytes have lived there for seven millennia together with humans, and humans have preserved their habitats through landscape management. This implies the necessity of an active approach to nature conservation; targeted forest-free area management.

Grazing management

Steppe grasslands in the Český kras/Bohemian Karst, as well as forest-steppes on the forest soils, had been used as pastures in the past and thus prevented overgrowing by woody plants. However, grazing was gradually reduced from the 1930s until it finished completely in the 1950s. The steppes were overgrowing, their area was shrinking. Since the 1980s, management mainly consisting of clearing invasive and expansive trees (acacia, ash, shrubs) and occasional mowing could not by itself prevent the accumulation of old grass and turf thickening, *i.e.* gradual degradation.

Goat and sheep grazing has therefore been recommended in management plans since the 1990s. Regular grazing of steppe vegetation, initially only on former pastures outside the forest, had started in the Český kras/Bohemian Karst on Zlatý kůň/Golden Horse Hill and Pání hora Hill in 2004, covering an area of about 15 ha. Between 2008 and 2010, it was also possible to start grazing management on forest-steppe sites in the Karlštejn National Nature Monument (NNM), located on the forest land fund, on the basis of permission for a deviating procedure in special

Landscape changes in the Český kras/Bohemian Karst in the last half century on aerial photographs of the same area in the 1950s and now. The upper right corner is outside the Protected Landscape Area, and without territorial protection; satellite development has become very widespread there (the municipality of Bubovice). In the lower left corner and in the middle of the photos, overgrown forest steppes are visible, where the last remaining unvegetated areas are managed by conservation grazing and host rich populations of the Pyramidal orchid. In the bottom right of the photos, part of the landscape altered by the quarry and landfill is shown.

purpose forests to fulfil the management plan (grazing in the forest and stocking reduction below 0.7 is allowed); this was issued by the Cadastral Office of the Central Bohemian Region after agreement with Lesy České republiky/ Forests of the Czech Republic State Enterprise and the municipality of Srbsko. Since 2010, grazing management has been gradually extended to other areas in the Karlštejn NNM, Koda NNM, Kotýz NNM, Kobyla Nature Reserve, and other areas in the zone I of the Český kras/Bohemian Karst PLA. Thanks to the activities of the Pražská pastvina/Prague Pasture association, since 2017 grazing has also been implemented at sites in the Radotínské údolí/Radotín Valley (Nature Reserve and surroundings), Zmrzlík Natural Monument, and the Cikánka I. NNM on the outskirts of Prague. Other significant areas in the PLA are leased and grazed by herders, who otherwise provide management at core sites in the neighbourhood, with the support of agricultural subsidies/subsidiary schemes.

Grazing brings numerous organizational problems, *e.g.* the need to move fences and herds in a timely manner according to the most important target species, whether it is plants and their flowering and reproduction, or ensuring the development of insects on specific plots during a given season. There has been still much to learn there. In recent years in particular, the problem is that weather fluctuations cannot be guaranteed in a contract, while natural science needs and the economic-legal framework are not in unison.

Currently, over 70 ha of steppe grasslands are regularly grazed every year in the Český kras/Bohemian Karst. In addition to sheep and goat grazing, pony and cattle grazing has recently started at selected sites. Grazing contributes to the improvement of the steppe site condition, which is manifested, *e.g.* in the increase in the Small pasque flower (*Pulsatilla pratensis*) and Pyramidal orchid (*Anacamptis pyramidalis*) populations.

Butterflies and beetles preserved through grazing

On carefully grazed areas (especially under the management of the Třesina conservation association) it has been possible to preserve a thriving population of the otherwise disappearing or already locally extinct Grayling (*Hipparchia semele*). For its development, the butterfly needs short-grazed fescue stands adjacent to plots with insolated tree trunks and plots with nectar. In other words, a previously common intricate landscape mosaic which is not possible to be created with modern management and whose absence is the reason for the disappearance of many other, less explored organisms. Less fortunate were the Hermit (*Chazara briseis*) and the dusky meadow brown (*Hyponephele lycaon*) butterflies, which have widely become extinct in the decades since declaring the PLA there. Grazing also supports important species of dung beetles (*Onthophagus lemur, Onthophagus illyricus, Sigorus porcus, Planolinus fasciatus*, and *Euoniticellus fulvus* having been confirmed in the area recently, the latter after more than 50 years). The thermophilous *Sisyphus schaefferi* is very abundant. However, the restoration of grazing is not a panacea; for example, the iconic Horned dug beetle (*Copris lunaris*) and *Gymnopleurus geoffroyi* disappeared from the Český kras/ Bohemian Karst not long after declaration of the PLA.

Forests

Open thermophilic forest-steppe oak forests are another fundamental phenomenon of the Český kras/Bohemian Karst. In a delicate mosaic, it changes into the above-mentioned steppes and shadier forests, especially oak-hornbeam forests, islands of calcareous beech forests, and ravine forests. Positive changes have also taken place in Český kras/Bohemian Karst forests since declaration of the PLA. In the 1970s, species composition of forests was marked by the long-term intensification of forest management. Coniferous trees, of which only the European silver fir (*Abies alba*) and Scots pine (*Pinus sylvestris*) can be considered native, represented 35% when the PLA was established. Of deciduous trees, oak (*Quercus* spp.) dominated with 38.2% and the European hornbeam (*Carpinus betulus*) with 14.4%. The transformation of the species composition in forest stands was one of the priority nature conservation goals. Not only thanks to long-term efforts, but also in recently due to extremely dry years, the Norway spruce (*Picea abies*) and the European larch (*Larix decidua*) have almost completely disappeared from the Český kras/Bohemian Karst forests. The non-native Austrian pine (*Pinus nigra*) still grows on about 5% of the forest area, and the total proportion of conifers has decreased to the current level of about 11%.

Changes in the forest in the Karlštejn National Nature Reserve – aerial photographs of the same area of forest stands (about 0.5 x 0.5 km) in the 1950s and now. In the sparse thermophilic oak forest in the lower half of the pictures, there used to be a rich population of the Elder-flowered orchid ((*Dactylorhiza sambucina*); today, individual plants occasionally appear. In the upper half of the photos, strips of former often-cleared coppice forests with standard trees are shown; today, it is a continuous stand. Given that the plot is owned by the Nature Conservation agency of the Czech Republic, active forms of management are being renewed there. Aerial photographs © The Czech Office for Surveying, Mapping and Cadastre, https://ags.cuzk.cz/archiv)

The Český kras/Bohemian Karst holds national primacy in the delimitation of non-intervention forest areas. The very first agreement with Lesy České republiky/Forests of the Czech Republic State Enterprise on leaving the forests to spontaneous development was signed in 2004. Part of the Karlštejn NNR – Doutnáč Hill, covering an area of 65 ha, has been a model non-intervention site since then. Regular monitoring and evaluation of changes in the forest habitat takes place there, and data obtained are used to understand natural processes in lowland forests.

It is not only conservative nature conservation that makes sense. In previously intensively managed forests in particular, imitating former management methods is a way of effective active nature conservation. Returning to coppice forest with a short rotation period helps to preserve the previously abundant wild animal and plant species of open canopy middle forests. Through gradual negotiations with owners of State and private forests, the current area with the aim of re-introducing coppice management has reached 43 ha, with interventions currently being implemented on 7.6 ha.

Iconic plants show change, problems, and relative stability

The rarest and, at the same time, the most monitored plant is the Austrian dragonhead (*Dracocephalum austriacum*), a rare and disappearing species at a pan-European level. In the PLA, it occurs at eight sites, where we count hundreds of plants in total. We have sufficient information about the plant from detailed monitoring (T. Dostálek, Institute of Botany, Academy of Sciences of the Czech Republic Průhonice near Prague), and we can generalize the findings and use them for planning the management of other similar long-lived plants limited in the seedling stage. Between 2003 and 2013, the number of individuals increased and the situation appeared promising. In the dry years since 2015, however, there has been a decrease, and the decrease became critical after the extremely dry year of 2018, when the populations reached roughly a quarter of their original number, from hundreds to tens of plants per site. For nature conservation, the confluence of impacts – the well-intentioned opening of sites and drought – is instructive and a warning. Previously, it was clear that they thrive, bloom profusely, and produce clumps in the sunny parts of the sites, and wither away in the shaded ones. Therefore, conservationists started to clear bushes locally. Unexpectedly dry years followed, when old clumps generally did not survive in sunny, extremely dry places. Plants in the marginal, more shaded parts of the sites were preserved. So clearly, in the longer term, this is a species bound to a mosaic of habitats, and its needs and management needs cannot be simplified if we do not understand processes on a scale of decades or centuries. A regional action plan/recovery programme was developed for the species, which includes, *inter alia*, establishing replacement populations in botanical gardens that separately keep the gene pool from individual populations. Sowing and planting are carried out on replacement sites, where management is ensured, and they are not as extremely dry as the original sites.

Despite the apparent decline in the Austrian dragonhead to roughly a third over almost 20 years of monitoring, it can be stated that conservation under the Nature Conservation Agency of the Czech Republic (NCA CR) – Český kras/Bohemian Karst PLA Administration is relatively successful; occurrences in the Český kras/Bohemian Karst PLA are still among the richest within the species´

European distribution ranges, while on the other two sites in the Czech Republic it has become extinct.

It is more complicated with open forest species. Specialized insects, such as butterflies, had become extinct immediately after management changes, the decline in long-lived plants is only considered under the heading of PLA, and the trend is clearly not going to be reversed anytime soon. Orchids, the ones we know from meadows in other areas, grew in the Český kras/Bohemian Karst on grassy patches in open oak forests. In recent decades, the Common fragrant orchid (*Gymnadenia conopsea*) has become extinct at both sites, the Elder-flowered orchid (*Dactylorhiza sambucina*) has been declining, with a few individuals remaining at a few micro-sites. Everything is an obvious consequence of forest stratification, forest undergrowth, and litter. So far, the preservation of the Early purple orchid (*Orchis mascula*) has been successful; the respective areas in thermophilic oak forest are mowed, raked, and the plants are monitored in detail. The numbers of the flowering pyramidal orchids has increased at sites with management grazing. In the turf of a forest-steppe, which had been thinned out by the dry years, several specimens of the Burnt orchid (*Neotinea ustulata*) have appeared again. We are unsure about the decline in sites of the Ladybells (*Adenophora liliifolia*), which was previously apparently associated with a mosaic of low forest cycling on a landscape spatial scale, although its abundance is increasing at sites that are purposefully fenced and specially managed.

Goat grazing is the main management tool for preserving the varied mosaic of steppes and forest-steppes in the Český kras/Bohemian Karst Protected Landscape Area. © Jindřich Prach

The grayling (*Hipparchia semele*), a declining or extinct butterfly elsewhere, remains in the Český kras/Bohemian Karst thanks to management interventions, especially grazing. © Lucie Hrůzová

Vertebrates

Vertebrates mainly "read" the landscape on a larger spatial scale; therefore, a relatively small PLA in the populated landscape is not so special in terms of vertebrates. In recent decades, the Fire salamander (*Salamandra salamndra*) populations have been relatively prosperous, as well as the Dice snake (*Natrix tessellata*) in the Berounka River Valley, and the number of the steppe Smooth snake (*Coronella austriaca*) habitats has been increasing. It is worth mentioning the confirmation of the appearance of three new species of bats, namely the Soprano pipistrelle (*Pipistrellus pygmaeus*), Alcathoe bat (*Myotis alcathoe*), and the Savi's pipistrelle (*Hypsugo savii*), apparently related to more detailed research and genetic analysis as well as climate change.

During the existence of the PLA, the occurrence of 123 bird species has been confirmed: there is new nesting of the Black stork (*Ciconia nigra*), European bee-eater (Merops apiaster), Montagu's harrier (*Circus pygargus*), and Savi's warbler (*Locustella luscinioides*). On the other hand, the European roller (*Coracias garrulous*) and two species of shrikes, the Lesser grey shrike (*Lanius minor*) and the Woodchat shrike (*Lanius senator*), can be considered completely extinct species. Among the mammals, the European beaver (*Castor fiber*) and the Eurasian otter (*Lutra lutra*) are increasing, and there is a problem with the European mouflon (*Ovis orientalis musimon*) destroying unique vascular plants, the botanical subjects of protection. All this corresponds to general trends in the surrounding countryside and in the Czech Republic as a whole.

Urbanism – development and the landscape

Due to the proximity of the capital city and the growing interest of urban residents in "living in nature", the PLA is exposed to very strong interest in new construction. In terms of the landscape, "keeping construction under control" is relatively

successful, and the traditional appearance of the landscape, including settlements, has still been visible in the PLA compared to other parts of Central Bohemia, which are quickly becoming a suburb of Prague. Weekend house cottage development had occurred there even before the declaration of the PLA; in the first years of the PLA's existence, weekend house cottages were still being built, but over the past 20 years further permission has almost stopped and the extent of weekend house cottage development has remained stable for many years. Although the scope of development in total has increased significantly over the 50 years of the PLA's existence, the trend is significantly lower compared to the rest of the Central Bohemian Region, mainly thanks to the active participation of the NCA CR (PLA Administration) in the municipal planning process.

Cradle and laboratory of natural science research

The PLA is essential from the point of view of natural science research; the variety of abiotic and living nature as well as the proximity of Prague make the area a destination for generations of scientists, university excursions, and all types of enthusiasts. The common name Český kras/Bohemian Karst itself was introduced 100 years ago by the quirky naturalist Jaroslav Petrbok. The Český kras/Bohemian Karst serving as a model area for the study of broader scientific questions can be found on the pages of leading scientific journals. Cooperation with the scientific community is welcomed by nature conservation; formalities such as placing devices or taking samples in the NNR are negligible due to the widely applicable results that scientific research of all types brings to subsequent better understanding and planning of nature conservation.

Preserving for future generations

Today, human reshaping of the planet (co-creation or destruction) has been faster and faster. It manifests itself in the local landscape, as we have shown in the examples, while local phenomena contribute to the whole like a fragment in a mosaic. So how to summarize 50 years of nature conservation in the Český kras/Bohemian Karst PLA? An old timer can complain that much has disappeared and is disappearing, in both within the PLA and outside of it. The conservationist can be happy that much is being preserved and that under the NCA CR – PLA management the decline has been slower, as we showed in the positive examples. Quite a few rare species only survive in somewhat sustainable populations within the PLA. This is to some extent due to the varied and extreme natural conditions (they would be there even without conservation), but many directly depend on traditional management and its restoration, or its imitation and implementation. As for the traditional landscape scenery/character, the PLA clearly does better than the surrounding landscape, *i.e.* other parts of the periphery of Prague. Even a non-expert can see the persistent qualities of nature and the landscape within the PLA, as evidenced by the increase in interest in the area among tourists. Due to the thousands of years of shaping of the landscape and nature by people, visitors generally do not disturb the protected phenomena there. Let us believe that the Český kras/Bohemian Karst will continue to prosper in cooperation among conservationists, land managers, scientists, and many others, and that the basic phenomena will be preserved for future generations. ■

The Pyramidal orchid (*Anacamptis pyramidalis*); the only sites of occurrence of this orchid in Bohemia are managed on the Český kras/Bohemian Karst pastures. © Jindřich Prach

The gorge of the Berounka River with limestone rocks is the core of the Českýkras/Bohemian Karst Protected Landscape Area. © Jindřich Prach