ZAMĚŘENO NA PŘÍRODU

MILITARY LIFE FOR NATURE

Restoration of sand steppes at Pánov

Case study of the Military LIFE for Nature project implemented between 2016–2022

Beleco, z.s. 2022 | Authors: Lenka Dvořáková
Pavel Marhoul
Jiří Koptík
Marta Kotecká Misíková

ORGANIZÁTOR | ORGANIZER

S FINANČNÍ PODPOROU
WITH FINANCIAL SUPPORT FROM

Ministerstvo životního prostředí

PARTNEŘI | PROJECT PARTNERS

Ministerstvo životního prostředí

www.beleco.cz/militarylife
LIFE15 NAT/CZ/001028

Vydáno s podporou programu LIFE Evropské unie a Ministerstva životního prostředí ČR.
Nemusí vyjadřovat stanoviska Evropské unie ani Ministerstva životního prostředí.

Published with the support of the European Union LIFE programme and the Ministry of the Environment of the Czech Republic. The views expressed are not necessarily those of the European Union or the Ministry of the Environment of the Czech Republic.

CONTENTS

INTRODUCTION

Military areas are comparable in importance to the most valuable Czech protected areas; mainly due to the occurrence of nowadays rare non-forest habitats, such as dry grasslands, heathlands, wetlands or even sand dunes. These habitats have been preserved here due to the absence of urbanization and industrial agriculture, as well as due to the army activities. The activities of soldiers in the field unintentionally simulated natural processes for many decades – the so-called disturbances, which otherwise disappeared from the cultural landscape. Disturbances generally disrupt the established state of the ecosystem, prevent the gradual overgrowth of the landscape and thus ensure the constant restoration of non-forest habitats. Infantry, heavy vehicles, and exploding ammunition shaped the landscape just like herds of large ungulates, natural landslides, windthrows, and fires once did.

The aim of the Military LIFE for Nature project was to provide management of five biologically extremely valuable sites in the Czech Republic, which were formed in the past by military training: Načeratický kopec near Znojmo, Pánov near Hodonín, Blšanský chlum, and Mašovická střelnice together with Havranické vřesoviště. For this purpose, four management methods were selected, which are being introduced in the Czech nature conservation: heavy and military equipment activity, motocross, free grazing of sheep and goats and grazing of „wild“ horses. The advantage of these approaches is, on the one hand, that they make it possible to create much-needed heterogeneity in the environment. On the other hand, they can also be effective in large areas, such as military areas, often at relatively low financial costs, especially with the involvement of local communities. The project also sought to raise public awareness of the natural significance of abandoned military areas and the involvement of local people in the management of these sites.

Pánov, also called Hrubá louka by the locals, is one of the last remnants of the so-called Moravian Sahara – a landscape of sand dunes and solitary trees – which was artificially forested in the 19th century. Soldiers used Pánov at the end of the 19th century; in the 20th century, a tank training ground was established here. Heavy equipment and military training protected the Pánov steppes and sand areas from overgrowth and helped competitively weak plant species that require partially exposed soil to survive. Local specific psammophyte communities are unique in the Czech Republic. There are not only many rare plants, but also a number of critically endangered insect species and a large colony of bee-eaters nesting in the sand walls. After the end of the army‘s activities in the 1990s, Pánov sand areas began to quickly overgrow with self-seeding woody plants, wood small-reed, and various invasive plants. The aim of the Military LIFE project was therefore to restore rare habitats and, together with local interest groups, try to set up a long-term sustainable concept of future management.

The Military LIFE for Nature project was launched in September 2016 with a five-and-a-half-year implementation period. Its main researcher was the professional conservation organization Beleco. The company Wetland, which specializes in environmental protection projects, has taken on the role of project partner in carrying out extensive remediation interventions in Pánov. Other partners in the project were the organization Česká krajina, which provided grazing of wild horses in Mašovice and Havraníky, and the Ministry of the Environment of the Czech Republic.

This document was created at the very end of the project and is intended to serve as a case study in order to record and share important information about the initial state, course, and results of the conservation management at Pánov. Emphasis is placed on retrospective evaluation of measures and transfer of experience gained, which can be used in the protection of similar areas in the future. We thank the European Union‘s LIFE programme and the Ministry of the Environment of the Czech Republic for their support of the entire project and the publication of this case study.

Historical development

Pánov is one of the largest and most important sand areas in the Czech Republic. The presence of open, in the past grazed, sand areas has a long-term continuity and is documented on historical maps from at least the 17th century. However, this non-trophic area had probably been used for grazing since the Middle Ages, and it is possible that unique psammophyte communities of plants and animals have been preserved here since the Ice Age (Losík J. 2012).

Pánov was probably used to train the army during the reign of Maria Theresa, but a permanent military garrison was only stationed in Hodonín in 1883. First, there were various cavalry and artillery units (the bare nature of the area from this period can be seen on map 1). In the 1950s, several mechanized regiments gradually operated here. Virtually the entire training ground at that time was furrowed by trenches, and despite relatively little traffic and due to slow succession, also networks of unpaved roads. In 1958, 4th Mechanized Rifle Regiment was deployed here, staying until 1991. The training activities were similar to those in the 1950s, consisting of infantry activities – its movements, the creation of trenches. A specialized training ground for driver skill training was located in the eastern part; due to the sandy base it was a paved area. The unit was armed with OT-64 armoured personnel carriers, of which it had approximately 170. During the training, however, only about 17 transporters accompanied by several tanks and lorries drove at the training ground at the same time. In 1994, the 4th Mechanized Rifle Regiment was abolished, and although 71st Mechanized Battalion operated in Hodonín barracks until 1997, military activities at the training ground were no longer taking place.

In 2005, Pánov became part of the newly declared SAC Hodonínská doubrava. Two years later, it became the property of the town of Hodonín. In connection with the change of owner, efforts began to appear to use the area for various purposes (golf course, photovoltaic power station), which, however, did not merge with the nature conservation interests (Losík J. 2012). In 2012, Pánov was finally granted the status of a specially protected site, and a Nature Monument with the subject of protection of psammophilous vegetation was declared, covering an area of 86.8 ha. A protection zone was established on another 9 ha.

Natural conditions

Pánov Nature Monument (with the local name Hrubá louka) is located north of Hodonín, where it connects to the district of Pánov. It is a triangle-shaped area wedged between the forest stands of Hodonínská doubrava. It is located at an altitude of approximately 200 m above sea level. From a geological point of view, it is a slightly undulating dune formed by Pleistocene windblown sands, while only some depressions reveal underlying clays and marls. Shallow lakes naturally form in these depressions, which, in combination with the sand dunes, give the whole area a unique character.

The presence of open, previously grazed sand areas has a long-term continuity. The most biologically valuable is the occurrence of populations of species associated with the free substrate or very sparse xerothermic grasslands. Rare, species-rich Pannonian sand steppes are spread especially in the southern half of the site (this is one of the last two sites in the Czech Republic where this type of vegetation occurs in larger areas; Losík J. 2012). In disturbed places with a suitable base, there are no less important habitats of open grasslands of continental dunes with grey hair-grass and bent-grass. Not only many rare plant species, but also many endangered invertebrate species are associated with these habitats. For some of them, the last remnants of windblown sands in the Hodonín region are their last place of occurrence in the Czech Republic. The threat to these habitats and species is the spread of competitively strong species of grasses and herbs, such as wood

small-reed (*Calamagrostis epigejos*) and invasive goldenrod species (*Solidago canadensis*, *S. gigantea*). And also the advancing overgrowth of self-seeding shrubs, such as aspen (*Populus sp.*), pines (*Pinus sp.*), as well as invasive false acacia (*Robinia pseudoacacia*), whose litter adversely changes soil conditions to the detriment of steppe species.

Direct remnants of military activities are mainly limited to old trenches and characteristic concrete dragon's teeth. In the southern part of the territory, there is still a military observation tower and an elongated building of former classrooms, albeit in poor condition. The area is no economic use, but a number of recreational and sports activities take place on it or in its immediate vicinity. In the east, there is a go-kart track at the border of the protected area, and in the southwest, there is a sports shooting range, which in the past served the army as a shooting range for handguns. There is an active motocross track in the protected area itself. In addition, the area is used for paintball, airsoft, and similar activities.

Species important from the conservation point of view

The dominant vegetation on Pánov is psammophilous grasslands developing in a gradient from open areas with dominant grey hair-grass (*Corynephorus canescens*) to species-rich Pannonian sand steppes. Open sand grasslands with grey hair-grass develop in disturbed places and are characterized by low cover and a large proportion of competitively weak species, such as wingstem spurry (*Spergula pentandra*), drooping brome (*Bromus tectorum*), small cudweed (*Filago minima*), common stork's-bill (*Erodium cicutarium*), and others. The Pannonian sand steppes have a higher cover and a significantly richer species spectrum. Of the important taxa, there are the festuca species *Festuca vaginata subsp. dominii*, dwarf everlast (*Helichrysum arenarium*), the sedge species *Carex stenophylla*, sheep's bit scabious (*Jasione montana*), woolly buttercup (*Ranunculus illyricus*), Spanish catchfly (*Silene otites*), rush skeletonweed (*Chondrilla juncea*), early star-of-Bethlehem (*Gagea bohemica subsp. bohemica*), the Gagea species *Gagea pusilla*; also, lichens of the genus Cladonia are abundant. A rich population of branched plantain (*Plantago arenaria*) and locally the amaranth species *Polycnemum arvense* are developing in severely disturbed places. There are rare occurrences of pheasant's eye (*Adonis vernalis*), purple milk-vetch (*Astragalus danicus*), and night-scented stock (*Hesperis tristis*). Shallow steppe lakes are a unique phenomenon on Pánov. Historically, aquatic and wetland plants have been reported in the area, such as white water-lily (*Nymphaea alba*), caltrop (*Trapa natans*), sea milkwort (*Glaux maritima*), the sedge species *Carex secalina*, and others. As a result of overgrowing the area with self-seeding woody plants, the lakes disappeared and have been restored only within the implementation of the Military LIFE for Nature project. The vegetation of the lakes is currently developing; of the important species, the bladderwort (*Utricularia vulgaris*) has reappeared so far, which has a large population in the lake in the central part of the site.

The entomological significance of Pánov is still extraordinary, despite the documented disappearance of some important species. The community of psammophilous beetles is particularly representative. Ground and tiger beetle species (*Harpalus flavescens*, *H. melancholicus*, *H. picipennis*, *H. servus*), the click beetle species *Drasterius bimaculatus*, the scarab beetles *Anoxia pilosa* and *Polyphylla fullo*, the weevil species *Coniocleonus turbatus*, *Lixus neglectus*, *Mecinus ictericus*, and *Mecinus pirazzolii*, the leaf beetles *Cassida seladonia* and *Chrysolina limbata*, and other species. An important species of xylophages is the jewel beetle species *Poecilonota variolosa*. The most important species of diurnal butterflies – grayling butterfly (*Hipparchia semele*) and tree grayling (*Hipparchia statilinus*) – disappeared during the 1990s. For tree grayling it was the last site in the Czech Republic; the grayling butterfly had its last site in Moravia. At present, there are still dryad butterfly (*Minois dryas*) and false grayling (*Arethusana arethusa*), purple-shot copper (*Lycaena alciphron*); of the nocturnal species here there is a large population of spurge hawk-moth (*Hyles euphorbiae*); the prominent moth species *Drymonia velitaris* is regularly recorded.

The fauna of grasshoppers, locusts, and crickets is also significant. In the past, there were the locust species *Celes variabilis*, the locust species *Oedaleus decorus*, and the slant-faced grasshopper species *Chorthippus dichrous*, now all extinct in the Czech Republic. The bush cricket species *Montana montana* still lives here, in one of its two remaining sites in the Czech Republic. A significant expansion of the species spectrum of grasshoppers by wetland species has been taking place since 2019, when the wetland in the central part of the site was restored. The littoral part of the wetland was gradually settled by Cepero's groundhopper (*Tetrix ceperoi*) and the groundhopper species *Tetrix bolivari*, the pygmy mole cricket species *Xya variegata*, the cricket species *Pteronemobius heydenii*, the bush cricket species *Ruspolia nitidula*, and the band-winged grasshopper species *Mecostethus parapleurus* and *Aiolopus thalassinus*.

The restored wetland is also associated with an increase in the number of amphibians that reproduce here. Fire-bellied toad (*Bombina bombina*), green toad (*Bufotes viridis*), common toad (*Bufo bufo*), tree frog (*Hyla arborea*), and common spadefoot toad (*Pelobates fuscus*) live here.

From an ornithological point of view, the most important nesting species are nightjar (*Caprimulgus europaeus*), hoopoe (*Upupa epops*), a large population of bee-eater (*Merops apiaster*), and woodlark (*Lullula arborea*).

Table 1 shows the selection of the most conservation-important species found at the site since 2010 (see Table attachments). Only species listed in the CR (critically endangered) and EN (endangered) categories of the relevant red lists and specially protected species included in the KO (critically endangered according to Czech law) category are included.

Important stakeholders

Landowners:
- Town of Hodonín – the dominant owner of land in the project site

Residents:
- The settlement of Pánov and the settlement committee

Specially protected area (SPA) administration:
- Regional Office of the South Moravian Region, detached workplace Hodonín

Interest groups:
- Motocross Hodonín Pánov
- Pánov Archery Range
- Pánov Paintball Park
- Moravská tanková Sahara, an association, organizer of Tank Days in Pánov
- South Moravian branch of the Czech Ornithological Society, Gašpar Čamlík – monitoring of Pánov bee-eater population and the nesting wall

INITIAL STATE

With the end of military activities, disturbances disappeared from the area; these were crucial for the prosperity of local sand communities. As a result of the absence of any use, succession (the process of natural development of communities towards forest stands) gradually began to prevail. Overgrowth by self-seeding woody plants was further accelerated by local conditions: the trees spread easily from the surrounding forest stands. In addition, they prospered thanks to the moisture of the pools in clay depressions. Self-seeding plant outbreaks developed here then spread in all directions and merged. Thus, a large part of the steppes and dunes were relatively quickly covered by continuous tree stands, including invasive false acacia. The litter of foliage and needles has enriched the soil with large amounts of nutrients and changed its chemistry in an undesirable direction. In addition, due to symbiosis with tuberous bacteria, false acacia enriched the soil with nitrogen. Due to the accumulation of dead biomass and nutrients in the soil, competitively strong grass species, mainly wood small-reed, began to gain ground in large areas, as well as various invasive herbs such as giant goldenrod and Canadian goldenrod.

At the time of the beginning of the Military LIFE for Nature project in 2015, Pánov had been without systematic use, maintenance, and nature conservation management for over 20 years. About 60% of the area was covered with woody plants, mostly stratified tree stands. In wetter places this was aspen in particular, with pines and false acacia elsewhere. The sand steppes persisted mainly in the southern part; however, on most of their area they were severely degraded by extensive homogeneous stands of wood small-reed, goldenrod, and other expansive plants. Communities associated with the exposed sand substrate have survived only on the last small fragments, where there have been disturbances due to motocross. Populations of psammophilous invertebrates were generally declining; a number of conservation-important species have already disappeared from the see (see Species important from the conservation point of view) and others were in imminent danger of local extinction.

Fig. 1: Initial state of Pánov at the beginning of the project – a large part of the original sand steppes receded under the pressure of self-seeding woody plants. The stratified tree stands changed the microclimate, contributed to the extinction of lakes, enriched the soil with undesirable nutrients from its litter, and contributed to the loss of biodiversity of herbaceous communities. (Photo: Beleco, 2017)

Before the declaration of the Nature Monument, motocross activities were not regulated and focused mainly on the central part of the training ground. After the creation of the protected area, the nature conservation authority tried to regulate the riding into the two tracks, which were to be used alternately. Thus, a new track was built in the southern part of the site. Wider use of disturbances for management of the site was not expected.

Fig. 2: Extensive homogeneous stands of invasive goldenrod species (Solidago gigantea and S. canadensis) in the degraded habitats of Pánov. (Photo: Beleco, 2019)

MEASURES OUTSIDE THE PROJECT

A necessary prerequisite for the protection of target sand habitats and their restoration was the implementation of extensive remediation interventions consisting of the removal of self-seeding woody plants in selected areas of Pánov, followed by removing stumps to reduce regrowth and removing accumulated nutrients by scraping off the top layer of substrate. Due to the fact that the trees were owned by the town of Hodonín, the harvest was provided upon agreement with the municipal administration, which also used the harvested wood. Felling took place in three stages, always outside of the growing season, from 2017 to 2019 (see map 2). Only selected individual trees or their groups were left, especially aspens and birches, which provided an important habitat for some rare xylophagous insect species associated with these tree species. In addition to insects, this step was also beneficial for endangered bird species inhabiting the forest-steppe landscape – nightjar, woodlark, hoopoe, and bee-eater. On a broader scale, the retention of solitary trees has contributed to the creation of the intended fine and colourful mosaic of habitats.

The selection of specific trees was continuously consulted with Ing. Martin Škorpík (Podyjí National Park Administration, Znojmo) and Mr. Jindřich Procházka (Hodonín), who are experts in the target insect species. The excavated trunks and stems were removed from the site at the end of each stage. In total, self-seeding trees were removed on 24 ha and false acacia on 6 ha (as part of additional intervention).

Fig. 3: Felling of self-seeding woody plants in Pánov in order to restore the rare sand steppes. (Photo: Beleco, 2017)

The project activities followed the felling of self-seeding trees carried out by the town of Hodonín. First, stumps left after self-seeding trees were removed. Subsequently, the upper layer of the substrate was removed on the same areas and on selected parts of the forest-free area with heavily ruderalized grassland. The restoration of the target sites was supported by heavy machinery movement. Contrary to the original assumptions, significant effort had to be made to eliminate regrowth of self-seeding and invasive woody plants.

Stump removal

The removal of stumps was provided by the project partner, the company Wetland, which specializes in the implementation of nature conservation projects. Stumps were removed in areas where self-seeding trees were cut (see map 1), immediately after harvesting. They were removed by a tracked excavator equipped with a special device – a stump grinder. The removed stumps were placed in temporary piles and removed from the site by the end of each stage at the latest. A total of about 30,000 stumps on an area of 30 ha were removed in this way. Despite the large number of stumps and the considerable volume of mass, no serious complications occurred during the implementation of the measures.

Fig. 4: Removing stumps on Pánov using a tracked excavator and special accessories. (Photo: Beleco, 2017)

Substrate removal

Substrate removal was also provided by the company Wetland. This measure was necessary in places where the self-seeding trees and their stumps were removed because the soil there was too eutrophicated by litter and accumulation of nutrients, which would complicate the restoration of the target habitats. In addition, the topsoil was removed in selected areas of forest-free land where the grassland was already heavily degraded by wood small-reed. This type of measure, combined with vehicle movement or mulching, has proven to be the most effective in combating wood small-reed compared to mere mulching, heavy equipment movement, or harrowing. Although topsoil removal is the most intrusive method, it does not have a significant negative impact on herbaceous communities when removing source outbreaks on already degraded grasslands without conservation-important species, and measures can be targeted selectively and locally.

The removal was performed by a tracked excavator. In the case of felled areas, it was carried out simultaneously with the removal of stumps, or immediately after it, in three stages, always at the end of the growing season and outside it. In terrain depressions in places where there were shallow pools in the past, the layer of removed substrate was 10–15 cm. Towards the edges of the self-seeding tree groups, the humus layer thinned and thus the depth of the removed soil was lower (about 5 cm). The relief of the site was kept during the removal of the substrate. In the case of interventions aimed at wood small-reed, selectively smaller areas were removed at places of its most advanced expansion throughout the whole project. In total, the upper substrate was removed from 31 ha (see map 3).

The removed substrate was stored in three places on the edges of the site and modelled into a flat area. After storage, the development of vegetation was monitored, especially with regard to the presence of undesirable species, and the areas were regularly mown twice a year. Heavy metal soil load analyses performed on two mixed samples at the site did not show that the set limits were exceeded in any of the monitored parameters.

Fig. 5: Removal of the top layer of soil degraded by the rotten litter from self-seeding woody plants. (Photo: Beleco, 2017)

Removal of wood small-reed

Continuous wood small-reed stands were removed by scraping off the substrate (see previous measures). The efficiency was increased by heavy vehicle movement and mulching, together with the removal of regrowth. Mulching was carried out in the summer (before the seeds ripen), when the small-reed wood was weakened, and the intervention was the most effective. A total of 14 ha of land were treated in this way.

Regrowth removal

Intensive regrowth of woody plants proved to be the biggest complication in the project implementation. In the first phase (2017–2018), invasive trees, especially false acacia, were felled using so-called high stump felling (stump height about 1–1.2 m). The measure was based on the experience of Podyjí National Park Administration at the time. The principle of this method is the removal (breaking) of the regrowth, which the stumps form in their top part. Multiple intervention gradually weakens the tree until it dies. In practice, however, this method proved to be extremely demanding in terms of personnel capacity and time. After one season of regular removal, no signs of reduced stump vitality were observed. For these reasons, false acacia stumps, as well as native self-seeding trees, were removed by an excavator. In the following seasons, the root regrowth was eliminated by spraying herbicide on the leaves. The method is highly effective – trees of heaven were removed in the same way.

The regrowth of indigenous trees, especially aspen, proved to be very intense, even though the stumps of these trees were removed. Aspens also regrew very well from the thin roots that remained in the ground after the stump was uprooted. Aspen regrowth was eliminated by a combination of military equipment movement and repeated mulching on more continuous, easily accessible areas. This intervention, carried out in two consecutive seasons and repeated twice a year, significantly reduced the vitality of the regrowth, but did not eliminate it completely. Targeted movement of vehicles to places with regrowth led to their elimination, but it was necessary to apply intensive movement at these places. During the project, the regrowth was removed on most of the areas, leaving only some localized outbreaks, which will be the target of the vehicle movement in the future management.

Fig. 6: The result of intensive military movement which was used at Pánov to suppress wood small-reed and aspen regrowth. (Photo: Beleco, 2020)

Military equipment movement

Military equipment movement on project site was intended as the main method of long-term maintenance of the quality of the target sites after the end of the project. During the implementation of the project, the disturbance effect of movement was used mainly for the elimination of unwanted vegetation on the restored areas (root regrowth of self-seeding woody plants, small-reed wood, Canadian goldenrod, etc.). Some parts of the project site were temporarily (during the project implementation) excluded from the vehicle movement (see map 4). These are the parts where at the beginning of the project there were the best quality stands of target habitat types and also known places of occurrence of some important taxa. The preserved grasslands in these areas served as source populations for the restored areas.

Movement was provided by tracked vehicles (tank and/or infantry fighting vehicles, IFV). A total of 870 hours of movement were completed.

Fig. 7: Military equipment movement has contributed, among other things, to the emergence and development of ephemeral water bodies. (Photo: Beleco, 2020)

Throughout the project, vegetation and entomological monitoring took place of the impacts of restoration measures on communities of interest and plant and animal species. The starting point for the evaluation is the data obtained in the first year of monitoring, which was completed in October 2017. Subsequently, monitoring was repeated every year, based to the methodology described below. The obtained data are currently being processed. The monitoring results will help both to optimize the implemented measures for the future, and contribute to general knowledge about the use of individual management measures.

Vegetation monitoring

Within vegetation monitoring, three mutually complementary methods of data collection were applied:

1. **Monitoring of target habitats:** 3 transects 20 to 60 m long were fixed in the area and placed on the basis of subjective selection on a gradient from the optimal habitat to the degraded habitat. Based on the on-site calibration, an indication group of species was determined. In the regular network of squares 0.5 m x 0.5 m (n = 63), the presence or absence of species was determined and the status of the area was recorded as optimal or degraded. Every two years, the ratio of optimal and degraded areas was evaluated.

2. **Phytocoenological images:** 18 images were fixed in the area. Each image was fixed in the corners with a metal mark. The cover of individual species was estimated on the Braun-Blanquet nine-member scale; the total cover, living vegetation cover, old grass cover and moss layer cover was recorded.

3. **Vegetation maps:** vegetation maps were made in the first and last year of the project (2017 and 2021) in the form of an outline of habitat extension boundaries. Habitats were recorded in accordance with the updated Habitats Catalogue.

Entomological monitoring

The model groups of monitoring were spiders (Araneae), true bugs (Heteroptera), butterflies and moths (Lepidoptera), and selected families of beetles: ground and tiger beetles, weevils, leaf beetles (Coleoptera: Carabidae, Curculionidae, Chrysomelidae) and Hymenoptera: Aculeata. Data collection was ensured by a combination of methods: pit traps, sweep netting, light traps and time-lapse images of diurnal butterflies, and Moericke (yellow) pan traps.

A total of 16 pairs of pit traps were installed 10 m apart in selected parts of the area (see map 4). Pit traps were exposed three times during the growing season (first half of May, mid-June, August) for 10 days each time. The fixing medium was alcohol vinegar. At each of the pairs of traps, the surrounding vegetation was swept (always 100 times), a light trap for one night was installed here, and a time-lapse image was taken for the registration of diurnal butterflies. The collection of data on butterflies and moths (time-lapse image for the registration of diurnal butterflies and light traps) was installed also separately (without reference to other methods) in the second half of July.

From the very beginning, the Military LIFE for Nature project in Pánov aimed at restoring already overgrown and degraded sand habitats. Its main benefit was the reopening of these habitats, the restoration of their oligotrophic character, and thus enabling the restoration of their psammophilous communities. The priority for the hitherto preserved, botanically valuable sand steppe habitats was to keep them in a stable condition so that they could serve as a source of seeds and animals of the protected species inhabiting the newly restored areas. Therefore, disturbance management has not been applied to these habitats to a significant extent, although it will certainly be desirable for their conservation in the future.

In the first years, the target species of sand grasslands began to spread successfully to the restored habitats, where trees were cut down, stumps removed, and the topsoil was removed; for example, the critically endangered campion species *Silene viscosa* or grey hair-grass. Intensive disturbance intervention (topsoil removal) has also led to a recovery of the critically endangered *Polycnemum arvense* after more than 40 years, in a promising population of several dozen individuals.

During the project, the occurrence or support of some important animal species was also restored at Pánov. Nightjar has returned here as a nesting species. Currently, two to three pairs probably nest in the area. Regular monitoring of moths has shown a significant increase in the spurge hawk-moth population. At the beginning of the project, only individuals were captured within the monitoring; between 2020 and 2021, there was a significant increase in the population.

The above species are indicators of changes that occur at the site as part of the project. Similar population changes can be expected for other species of plants and animals with similar habitat requirements. The removal of woody plants led to the restoration of shallow steppe lakes (probably by eliminating the transpiration of water by woody plants). In particular, the lake (wetland) in the central part of the former training ground is becoming a very important habitat for wetland organisms. Two years after its emergence, important species have appeared here (reproduction of several species of amphibians, the emergence of a species-rich community of wetland Orthoptera, the resumption of the occurrence of critically endangered common bladderwort, and others).

The population growth of spurge hawk-moth

Project period	2017	2018	2019	2020	2021
Number of individuals	4	1	5	11	34

The resulting scope of individual measures

	Result
Activities outside the project	
Removal of self-seeding woody plants	30 ha
Project activities	
Stump removal	30 ha
Substrate removal	31 ha
Removal of wood small-reed	14 ha
Military equipment movement	870 hours of movement

Fig. 8: The final state of Pánov – a fine forest-steppe mosaic with a wide range of habitats from exposed sands and steppe grasslands to spinneys providing shade, combined with ephemeral ponds and wetlands. (Photo: 2021)

Fig. 9: After the initial remediation measures, some parts of Pánov looked like a lunar landscape. However, their thorough implementation was necessary for the success of the subsequent restoration management. (Photo: Beleco, 2017)

Fig. 10: Interesting sparse grasslands have begun to form in the humus-depleted areas, where a number of typical psammophilous plant species grow, such as grey hair-grass (Corynephorus canescens) and the campion species Silene viscosa. (Photo: Beleco, 2018)

Fig. 11: One of the competitively weak species benefiting from intense disturbances of the soil surface is the inconspicuous amaranth species Polycnemum arvense. This critically endangered species appeared in the northern tip of the area after the removal of self-seeding woody plants and is found here every year. (Photo: Beleco, 2020)

Fig. 12: One of the most important representatives of Pánov flora is the early star-of-Bethlehem (Gagea bohemica), which forms here a small population in psammophilous grasslands, which are irregularly disturbed by heavy machinery. (Photo: Beleco, 2017)

Fig. 13: Remains of quality psammophilous grasses, which were not affected by the growth of self-seeding woody plants or competitively strong plants, served as a refuge and a source of biodiversity for the newly restored habitats. (Photo: Karel Šimeček, 2016)

Fig. 14: The critically endangered campion species Silene viscosa is an unmissable element of the best-preserved psammophilous grasslands. It prefers more stratified types of vegetation, which are not so often disturbed. However, it soon appeared in areas with removed turf, which are adjacent to the preserved steppe vegetation. (Photo: Beleco, 2021)

Fig. 15: Soon after the removal of the self-seeding woody plants, water began to return to the site spontaneously. A wetland was created in the central part, which spreads into the landscape every spring, creating large shallow sunlit littorals. A rich wetland community is established here, including the critically endangered common bladderwort (Utricularia vulgaris). (Photo: 2019)

Fig. 16: The re-emergence of pools and wetlands also meant development for amphibians, including the tree frog (Hyla arborea). (Photo: Beleco, 2020)

Fig. 17: The activities of motorists on the motocross track have restored the sand dunes beyond expectations, also thanks to the great interest of the drivers and frequency of use. However, the intensity of movement needs to be regulated in the future, not only with regard to fauna and flora, but also to local residents. (Photo: Beleco, 2021)

Fig. 18: The critically endangered bush cricket species Montana montana is the most important species of Orthoptera on the site. Pánov is one of the two known sites of the species in the Czech Republic. (Photo: Beleco, 2017)

Fig. 19: During the bird nesting period, from mid-March to August, rides on the motocross track are prohibited and its edges are occupied by a bee-eater (Merops apiaster), which digs nesting burrows in the loose substrate and brings the young out of the nest. (Photo: Beleco, 2020)

Fig. 20: Even before the start of the project, the Regional Office of the South Moravian Region also built a nesting wall, which was immediately occupied by bee-eater (Merops apiaster) and sand martin (Riparia riparia) colonies. The abundance of colonies grew every year during the project. Its status is monitored by the South Moravian branch of the Czech Ornithological Society. (Photo: Karel Šimeček, 2017)

Fig. 21: Within the project, a facility for tourists was built and a new educational panel about the natural values of Pánov and their management was installed. (Photo: Beleco, 2020)

Fig. 22: As part of negotiations with the locals, a guided excursion was held, where the public was introduced to the scientific significance of Pánov and the significance of the interventions carried out. (Photo: Karel Šimeček, 2017)

Fig. 23: Volunteers from the Brontosaurus Movement also helped to take care of the Pánov sand grasslands. In particular, they plucked goldenrod invasive species (Solidago gigantea and S. canadensis) by hand in botanically valuable habitats where the use of intensive disturbance measures was not desirable. (Photo: Adam Dvořák, 2020)

Fig. 24: In 2021, when Pánov and other parts of Hodonín were drastically hit by a tornado, the help of volunteers at the Pánov Natural Monument was redirected to cleaning up after the tornado. Several lorries of waste, mainly roofing, polystyrene and other building material, was collected and removed from the area. Beleco employees also took part in the cleaning. (Photo: Lenka Dvořáková, 2021)

Basic approach:

- Maintaining the open character of the site will be ensured by the movement of various types of vehicles implemented outside the growing season.
- It would be desirable to supplement the vehicle movement by livestock grazing during the growing season. The introduction of grazing will be the focus of the follow-up project.

Specifying conditions:

Vehicle movement:

- In 2021, an agreement was concluded between the town of Hodonín (as the owner of land in Pánov Nature Monument) and the Regional Office of the South Moravian Region (as the administrator of the protected area) to set the regime of motocross activities at the site. Riding is possible on specified days of the week in the period from 15 August to 15 March and are coordinated by the appointed motocross coordinator.
- Motocross takes place on two permanent tracks located in the southern and central part of the area and freely in the field on various parts of the Nature Monument (enduro rides).
- Modifications to the tracks are only possible with the consent of the nature conservation authority.
- At the beginning of each motocross season, the nature conservation authority, in cooperation with professional contractor and the motocross coordinator, will determine the priority areas for free riding, with emphasis on successively advanced areas and places with invasive plants (wood small-reed, goldenrods, etc.).
- Apart from motocross activities, military vehicle movement and other types of movement (one-off coordinated events, etc.) are welcome in the area. These activities take place outside the motocross regime and are regulated individually by the Regional Office of the South Moravian Region and the town of Hodonín.
- In the winter, it is desirable to direct the movement (especially of military equipment) to the littoral vegetation of the local pools.

Fig. 25: The motocross track at Pánov is also used to train the Czech national team at the Dakar Rally. (Photo: Beleco, 2019)

Other activities:

- It is necessary to control the regrowth of self-seeding and invasive trees removed during the project, and in the case of their re-emergence, they should be eliminated by spraying a suitable herbicide.

Grazing:

- The animals will be present at the site all year round.
- The actual grazing will take place when the vehicle movement is not carried out (from mid-March to August or September).
- In the remaining period, the animals will be placed in a permanent enclosure with an area of up to 5 ha, built on a suitable place on the former training ground.
- Mobile grazing will take place – a certain part of the training ground (5–10 ha) will be temporarily fenced with mobile fences. After grazing, the fence will be moved to another place. The reason for this grazing method is not to block the whole area and to allow access to public and vehicles.
- The grazing herd will be composed of several species of animals. The basis will be cattle and horses in total up to 10 animals. In the future, it would be appropriate to supplement the herd with sheep and possibly a donkey. The reason for the multi-species composition of the herd is the different way of grazing and different food preferences for individual species. Placid breeds/individuals will be selected for the herd that will be easy to handle and will not endanger the environment.

SUMMARY

- The long period since the army left the former training ground in the mid-1990s to the launch of the LIFE project in 2016 without regular care and management interventions has led to a very strong development of self-seeding tree species and invasive species of herbs and grasses, especially wood small-reed and goldenrod of the Solidago genus. The seed bank of undesirable species is very rich and is a source of constant renewal of populations of these species.
- Controlled vehicle movement is a suitable way of management for the open habitats of the former Pánov training ground. The movement effectively prevents the development of tree species and also lead to a decrease in undesirable invasive species. However, for practical reasons, they cannot affect all places with the occurrence of undesirable species, e.g. near the trees and in the undergrowth of the groves.
- In order to speed up the restoration of the original vegetation after a long period of ruderalization, it would be very appropriate to supplement the vehicle movement by grazing livestock.
- Disposal of false acacia, tree of heaven, and other invasive trees is desirable by a more technically demanding method of injecting the herbicide into pre-prepared holes. Removal by simple cutting (whether on a low or high stump) without the use of herbicide, followed by manual disposal of the regrowth, is extremely laborious and time-consuming.

Acknowledgements:

We would like to thank all the project partners for their cooperation, especially the company Wetland which took the necessary extensive remediation measures at Pánov. Many thanks also go to the town of Hodonín for its support and cooperation throughout the project and for providing work that was not part of the project but was a prerequisite for its successful implementation. It was mainly the felling of overgrowth trees before the start of project measures at Pánov and the removal of concrete elements that remained there after military activities and endangered the safety of visitors to Pánov. We would also like to thank the Regional Office of the South Moravian Region, which was very accommodating to the project team.

We would like to thank to all parties involved: Josef Večerka, Vratislav Zpěvák, Moravská tanková Sahara, Vojenská technika Brno, and the South Moravian Branch of the Czech Ornithological Society with its head, Gašpar Čamlík, for their cooperation. We are equally grateful to the ornithologist Karel Šimeček for the photos and expert explanations provided to the public and Zuzana Veverková for her help with entomological monitoring and for connecting with local parties.

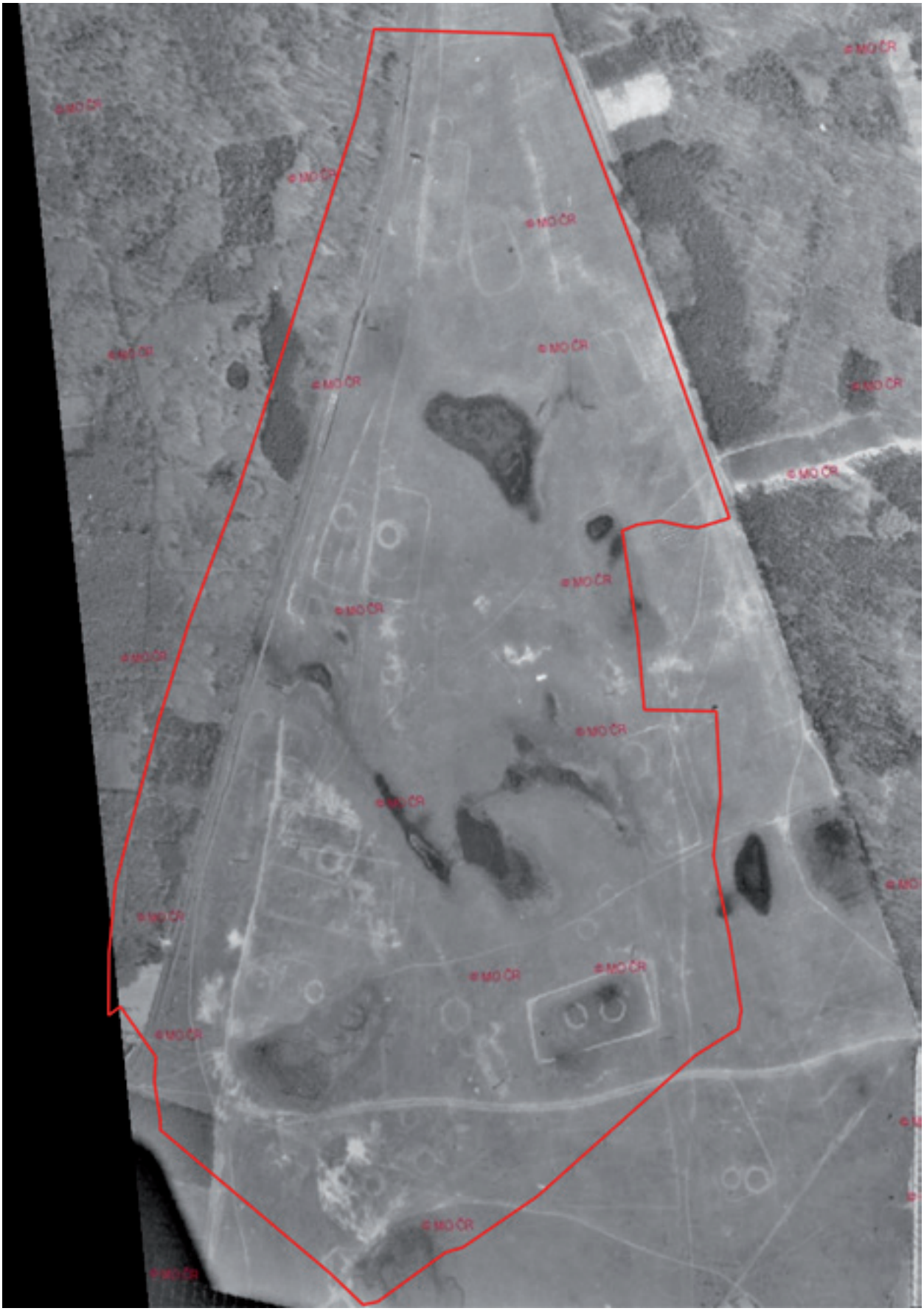
We would also like to thank Pánov settlement committee and all the inhabitants of Pánov for their understanding and patience, leading a stimulating discussion, seeking consensus and contributing to the direction of the future management of Pánov. Last but not least, we thank the volunteers from the Brontosaurus Movement for their help in protecting Pánov steppes and also for their help in clearing the consequences of the tornado in 2021.

REFERENCES

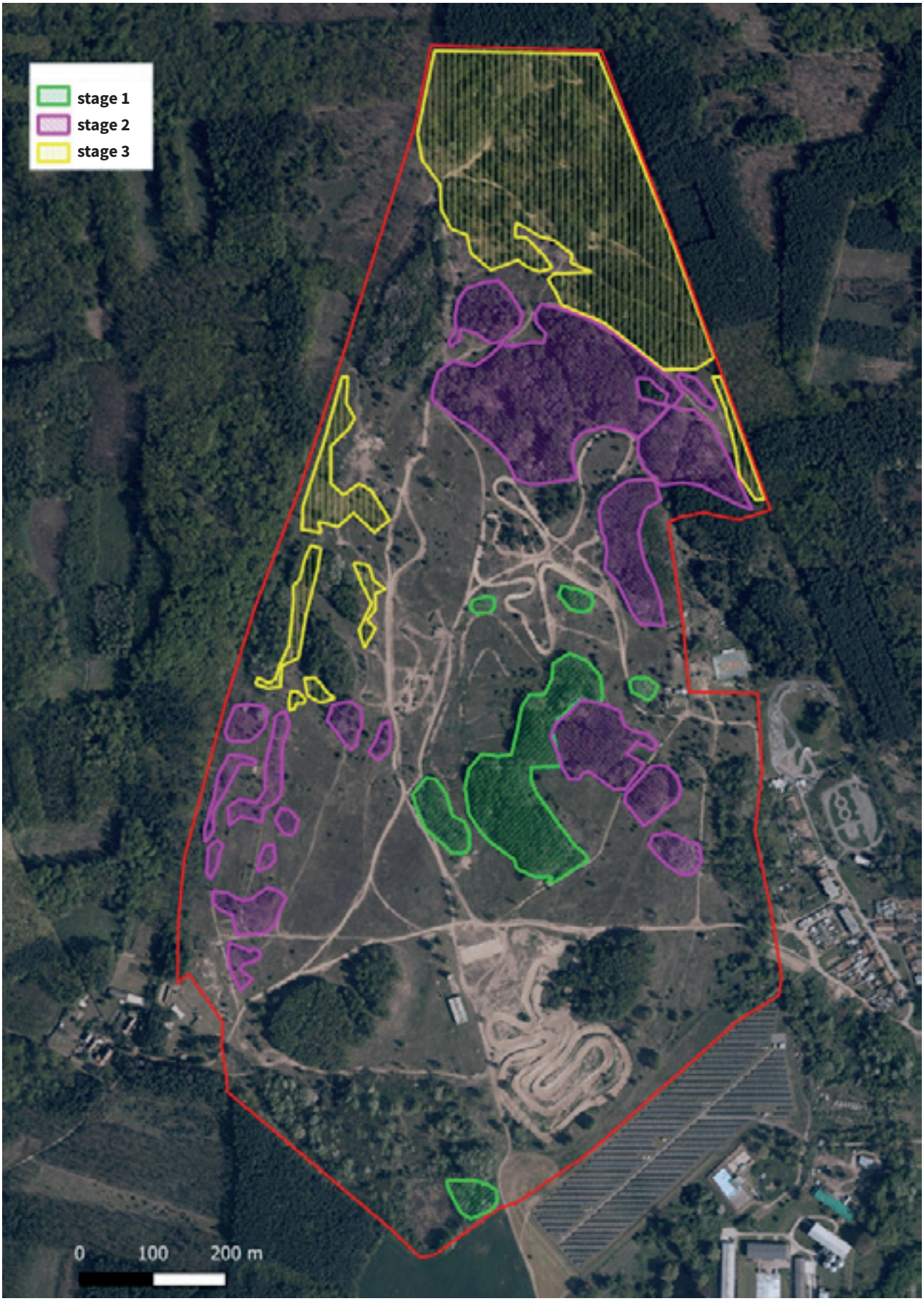
Beleco – results of site monitoring within the Military LIFE for Nature project

Losík J. (2012): Plán péče o přírodní památku Pánov na období 2012–2021. 46 pp.
Dostupné na: http://drusop.nature.cz

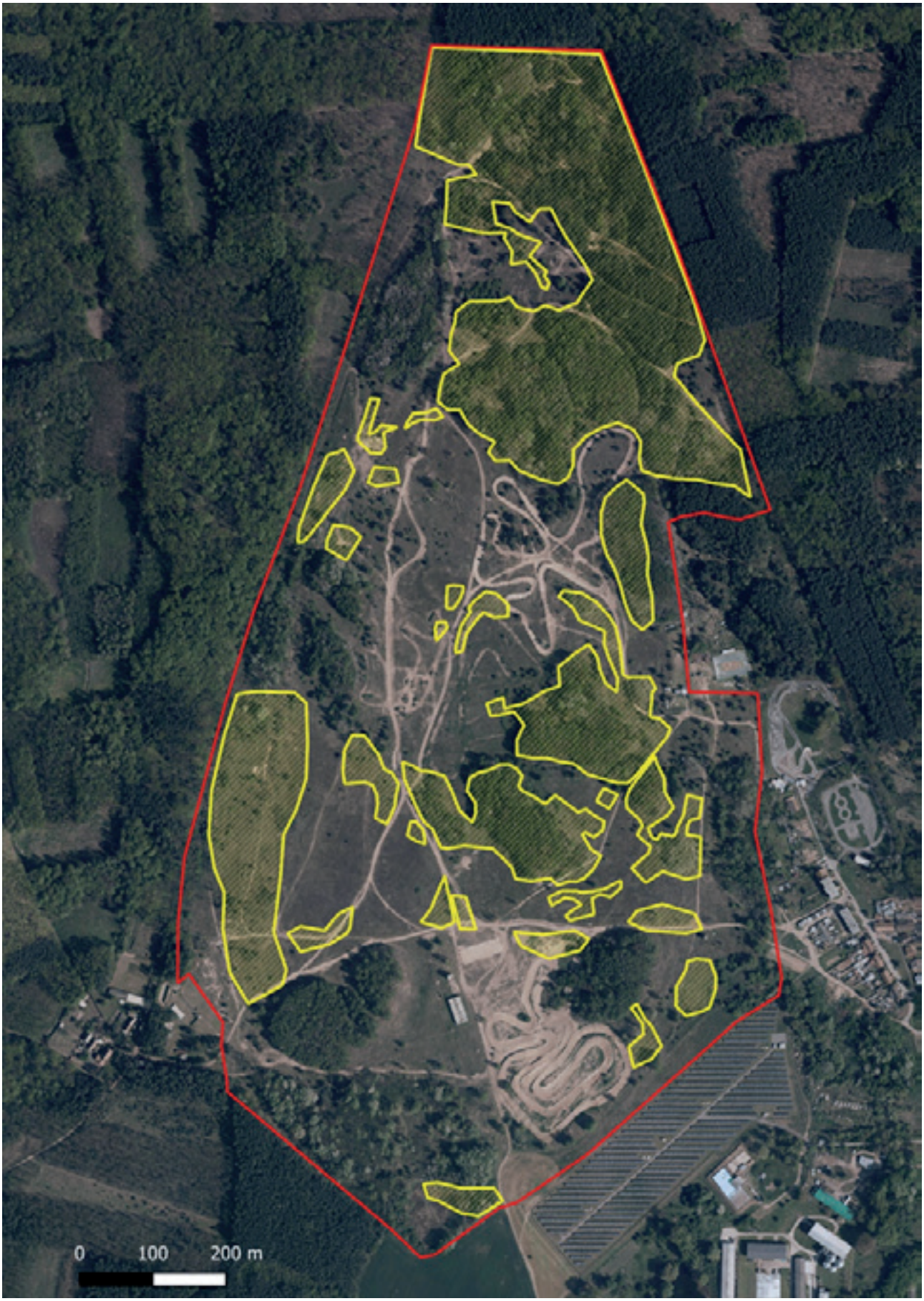
NDOP AOPK ČR (accessed 1. 2. 2022)



Map 1: Aerial survey image of Pánov from 1938. The boundaries of the current Nature Monument are indicated by a red line. The completely bare character of the area with disturbed sand grasslands is evident. (Created by Beleco)

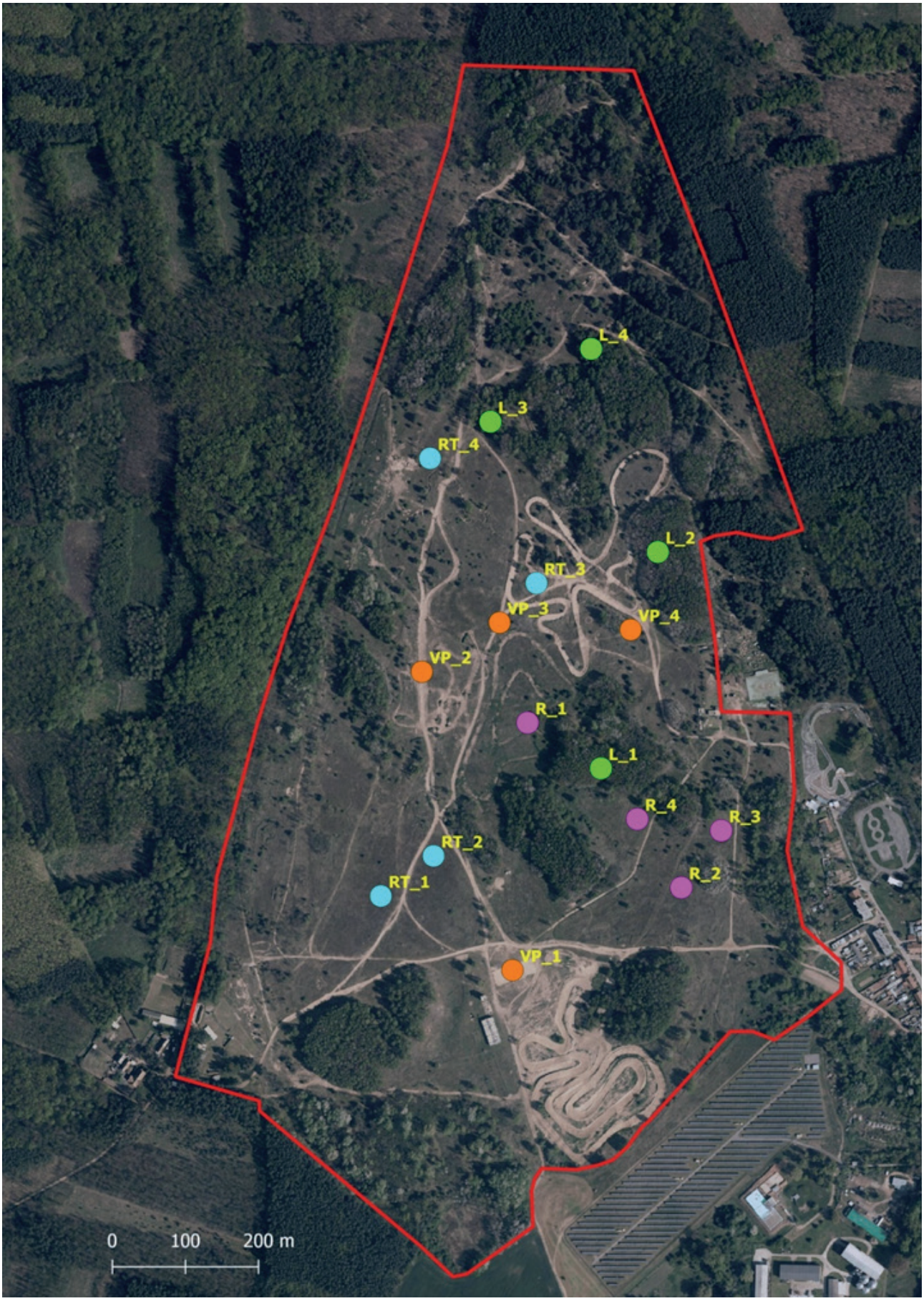


Map 2: Aerial image of Pánov (initial state) showing the extent of self-seeding woody plant reduction and subsequent removal of stumps. The trees were removed during the dormant period: (1) at the beginning of 2017, (2) 2017/2018, (3) 2018/2019. (Created by Beleco)



Map 3: Aerial image of Pánov (initial state) showing the total extent of topsoil removal. (Created by Beleco)

Map 4: Aerial image of Pánov (initial state) showing the extent of areas excluded from heavy machinery movement (at least for the duration of the project). (Created by Beleco)



Map 5: Aerial image of Pánov with the marked location of entomological traps throughout the project. Trap codes reflect different combinations of compared managements in terms of their impact on invertebrate model groups: RT = sparse grasslands, L = forest, R = ruderal, VP = free land. (Created by Beleco)

TABLE ATTACHMENTS

Table 1: Selection of the most conservation-important species found on Pánov since 2010. Only species listed in the CR (critically endangered) and EN (endangered) categories of the relevant red lists (RD) and specially protected species (SPS) included in the KO (critically endangered according to Czech law) category are included

Latin name	English name	Family	RD	SPS
Plants				
Carex stenophylla	sedge sp.		VU*	KO
Festuca vaginata subsp. dominii	Festuca sp.		EN	
Helichrysum arenarium	dwarf everlast		EN	SO*
Polycnemum arvense	amaranth species		CR	
Plantago arenaria	branched plantain		EN	
Silene viscosa	campion sp.		CR	
Utricularia vulgaris	bladderwort		CR	KO
Leaf hoppers				
Hephathus achilleae			CR	
Ommatidiotus dissimilis			EN	
Psammotettix provincialis			EN	
Mantises				
Mantis religiosa	European mantis		VU*	KO
Grasshoppers, locusts, & crickets				
Montana montana	bush cricket species		CR	
Beetles				
Anoxia pilosa	scarab beetle sp.	Scarabaeidae	CR	SO*
Cassida seladonia		Chrysomelidae	CR	
Coniocleonus turbatus		Curculionidae	EN	
Drasterius bimaculatus		Elateridae	EN	
Chrysolina limbata		Chrysomelidae	CR	
Lixus neglectus		Curculionidae	EN	
Mecinus ictericus		Curculionidae	EN	
Mecinus pirazzolii		Curculionidae	EN	
Notorhina muricata		Cerambycidae	CR	
Ocypus mus		Staphylinidae	EN	
Omaloplia ruricola		Scarabaeidae	EN	
Protaetia affinis		Scarabaeidae	EN	
Philonthus nitidicollis		Staphylinidae	EN	
Rhabdorrhynchus echii		Curculionidae	EN	

Latin name	English name	Family	RD	SPS
Hymenoptera				
Aporinellus sexmaculatus	spider hunting wasp sp.	Pompilidae	EN	
Dasylabris regalis	velvet ant species	Mutillidae	EN	
Eumenes sareptanus	wasp sp.	Vespidae	CR	
Lestica alata	wasp sp.	Crabronidae	EN	
Meria tripunctata	thynnid wasp species	Tiphiidae	EN	
Osmia cornuta	European orchard bee	Megachilidae	EN	
Seladonia seladonia		Halictidae	RE*	
Sphecodes cristatus	parasitic sweat bee sp.	Halictidae	EN	
Stenodynerus xanthomelas	wasp sp.	Vespidae	EN	
Tachysphex austriacus	square-headed wasp sp.	Crabronidae	CR	
Tiphia minuta	beetle-killing wasp	Tiphiidae	EN	
Tiphia unicolor	flower wasp sp.	Tiphiidae	EN	
Butterflies and moths				
Drymonia velitaris	prominent moth sp.	Notodontidae	CR	
Hyles euphorbiae	spurge hawk-moth	Erebidae	EN	O*
Lasiocampa trifolii	grass eggar	Lasiocampidae	EN	
Amphibians				
Bombina bombina	fire-bellied toad		EN	SO*
Bufotes viridis	green toad		EN	SO*
Birds				
Caprimulgus europaeus	nightjar		EN	SO*
Dendrocopos syriacus	Syrian woodpecker		EN	SO*
Emberiza calandra	corn bunting		VU*	KO
Lullula arborea	woodlark		EN	SO*
Merops apiaster	bee-eater		EN	SO*
Upupa epops	hoopoe		EN	SO*

**RE = regionally extinct, VU = vulnerable, O = endangered according to Czech law, SO = very endangered according to Czech law*

Restoration of sand steppes at Pánov – case study of the Military LIFE for Nature project

Obnova písčitých stepí na lokalitě Pánov – případová studie projektu Military LIFE for Nature

Lenka Dvořáková, Pavel Marhoul, Jiří Koptík
& Marta Kotecká Misíková
Beleco, z.s., Praha, 2022

Graphic design:
Ivana Bartůňková, www.ibart.cz

Czech proofreading by:
Markéta Dušková

Translation by:
Mark and Zuzana Sixsmith, www.environmentalenglish.co.uk

Published by:
Beleco, z.s., Na Zátorce 10, 160 00 Praha 6