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Hrabůvka quarry

A potential refuge of rare species

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Project overview

Title:	Hrabůvka quarry: a potential refuge of rare species
Contest: (Research/Community)	Research
Quarry name:	Hrabůvka



Hrabůvka quarry: a potential refuge of rare species

Jana Růžičková, Lenka Harmáčková, Michal Hykel, Ondřej Popelka & Vojtěch Taraška

Abstract

The main aim of this project was to conduct a biological survey in Hrabůvka quarry with an emphasis to south part of the quarry premises called Bobroviště. Specifically, this area is composed of various habitats, including forests, open soils, ruderal habitats and a sewage water body. Based on our findings, we suggest appropriate interventions or changes in management to support and enhance local biodiversity. Our results showed that species composition of plants and animals in the quarry premises is characterized mostly by common species (with only few plant taxa exception) without any specific habitat requirements. We found that the most botanically valuable habitats in Bobroviště are the forest fragment and the spring with its immediate vicinity. Since wetland habitats became valuable in the respect of climate changes in the last few years, we suggest creating new ponds and a littoral zone in the sewage water body to enhance biodiversity of this area and consequently increase water retention in the landscape.

Introduction

Mining areas are often perceived by the public as a scar on the landscape. However, in many cases a mosaic of various habitats in different successional stages is often created during mining. Such habitats may act as secondary refuges for many rare and/or threatened species that almost disappeared from urbanized and simplified agricultural landscape (Beneš *et al.* 2003, Ottonetii *et al.* 2006, Topp *et al.* 2010, Heneberg *et al.* 2012, Harabiš and Dolný 2015, Trnka and Rada 2015). Hrabůvka quarry and its immediate surroundings could be composed of biologically valuable habitats with a potential occurrence of threatened species. This quarry could be an important source of biodiversity that could spread from it. The aim of this project is therefore (i) to carry out a zoological and botanical survey and, on its basis, (ii) to suggest environmental management to support and enhance biodiversity within quarry premises with focus on southern abandoned part, called Bobroviště. Furthermore, we want (iii) to design an educational display board that will present the biological values to the public, thus raising awareness of the benefits of mining areas for biodiversity in the landscape.

Methods

Hrabůvka quarry is situated approximately 5 km to the north-west from the town of Hranice na Moravě (GPS: 49.577N, 17.697E, Olomouc region, Czech Republic). The mined raw material is a building stone, Culmian

greywacke, and the mining processes have been carried since 1890. The high potential for the quarry's biodiversity is based on its surroundings which consist of a mosaic of forests, ruderal habitats and arable fields. Meadows are represented to a lesser extent. In addition, the quarry is located at the intersection of the Carpathian and Hercynian biogeographical regions (Culek et al. 2013) amidst an important biocorridor. We expect that local biodiversity can be driven by these factors and that it can be enriched with both Carpathian and Hercynian species together.

Based on a previous agreement with the organizers of QLA and the manager of the quarry, our survey was focused especially on the abandoned area called Bobroviště (area of 320 × 150 m, GPS: 49.575N, 17.702E) in the southern part of the quarry premises. It is located between a reclaimed spoil tip on the north and a four-lane highway on the south with an adjacent aqueduct. Bobroviště seems to represent a fragment of the semi-natural forests occurring in the wider surroundings (Fig. 1, all figures and tables are in Appendix of this report) and some parts were probably formed by spontaneous succession after the landscape intervention during the highway building between 2004 and 2008. A sewage water pond was built here; it does not have a littoral zone and is strongly eutrophic, surrounded mostly by the nitrophilous semi-ruderal vegetation. From this pond, a drainage channel runs along the highway. There is also a spring that does not go dry even during the hottest summer days and creates a small shallow pond in its immediate vicinity. The presence of perennial wetland herb species confirms a relatively stable water conditions at this place at least during several last years. Moreover, open and ruderal patches exist in Bobroviště as well due to relatively recent landscaping along the highway. These environmental conditions create a diverse habitat mosaic in a relatively small area. However, for better understanding of the overall biodiversity composition in the focused area, we conducted intensive botanical and zoological surveys in Bobroviště, as well as in the quarry itself (i.e. the stone mining areas) and its close surroundings.

Biological surveys were carried out from March to August 2018 by standard floristic, phytosociological and zoological methods. Botanical survey was performed in the actual mining area and its closest vicinity. Additionally, we performed botanical inventory in the future mining area. The study area was divided into 20 homogenous plots (Fig. 2). For each of the plots, all taxa of the vascular plants were recorded.

For collecting ground-dwelling arthropods, we used pitfall traps (plastic cups) with 4% formaldehyde as a preservation solution. 11 traps were located in Bobroviště in various microhabitats, such as a forest, a meadow, and open sandy soils, to cover all presented habitats. Traps were exposed for 3 months, from May to July, and checked monthly. We especially focused on ground beetles (family Carabidae), one of the most abundant groups of ground-dwelling arthropods, which are often used as bioindicators of habitat quality (Altieri 1999). For other invertebrates we used vegetation sweeping and beating, individual collection, or a direct observation. Birds were recorded by point counting (direct observation or voice recognition) and net trapping. Occurrence of other vertebrates was mainly detected by the direct observation and signs, such as foot prints and excrements.

Nomenclature of the vascular plants was unified according to Danihelka et al. (2012). We have assigned a conservation status to each of the recorded species according to the Czech Red Lists of vascular plants (Grulich 2012), invertebrates (Hejda et al. 2017), vertebrates (Chobot and Němec 2017). Moreover, for animals, a list of specially protected species (regulation 395/1992 Sb., issued by the Ministry of Environment of the Czech Republic) and species listed in The Habitats Directive (adopted by EU in 1992 as Council Directive 92/43/EEC) was additionally considered (no plant species included in the list were found). List of abbreviations of conservation statuses is provided in Table 1.

Results

All recorded species of plants and animals are listed in the appendix (Tables 2-4). Here, we provide a commentary on the selected groups and/or species.

Plants

In total, 322 taxa were recorded in the surveyed area (Table 2). Out of them, 7 were included in the Czech Red list of vascular plants and 16 in the list of invasive taxa. The most abundant Red-listed species was *Filago arvensis* (C3), which was common in the mining area and its closest vicinity. It typically grew in the initial successional stages. The other Red-listed species recorded in the mining area was *Cota tinctoria* subsp. *subtinctoria* (C4b). Some more conservation-valuable taxa occurred mainly in the forest and meadow habitats in the future mining areas on the eastern border of the quarry, and in Bobroviště. These were: *Hieracium levicaule* (C3), *Corydalis solida* subsp. *solida* (C4a), *Neottia nidus-avis* (C4a), *Abies alba* (C4a) and *Pilosella cymosa* (C4a). On the other hand, invasive species reached a high abundance in the mining area as well (e.g. *Arrhenatherum elatius*, *Acer negundo*, *Erigeron annuus*, *Impatiens parviflora*).

In the mining area, vegetation was missing from most of the surface because of the mining activity. In the places with low level of disturbance, species-poor ruderal communities dominated with a frequent occurrence of the invasive taxa. More valuable communities were developed only on wet sites and dumps of small-grained particles. Especially on the dumps we recorded interesting communities with some thermophilous species (e.g. *Turritis glabra*, *Filago arvensis*, *Cota tinctoria*).

On the other hand, valuable habitats were present in the future mining area, mainly a semi-natural beech forest in the northeast part and an oak forest in the northwest part. In the area of our interest, Bobroviště, a secondary mixed forest represented the main vegetation type, probably influenced by the tree planting. Mainly nitrophilous semi-ruderal plant species occurred in the herb layer; nevertheless, some interesting grove and forest species were also found there (i.g. *Polygonatum multiflorum*), including a mycotrophic bird's nest orchid (*Neottia nidus-avis*). A water spring with an adjacent shallow pond was also located to this plot, where a fragmentary wetland community developed (with dominant *Typha latifolia*). Although only the common wetland herb species grew there (*Typha latifolia*, *Ranunculus sceleratus*, *Rorippa palustris*), they seriously contributed to the total

biodiversity of the surveyed area. Bobroviště has a strong potential to be enriched with more species by the nearby aqueduct with similar (better developed) vegetation, which may serve as a diaspore source. In addition, wetland habitats have become valuable in the landscape in the last years, with respect to the climatic change and extremely dry weather in the Czech Republic.

Animals

During our survey in Bobroviště, we recorded 496 individuals of ground beetles in 41 species (Table 3). The community composition was characterized mostly by common species of forests and open habitats. Only two species belonged to Czech Red-list of invertebrates: *Chlaenius tristis* (NT) and *Cylindera germanica* (NT). In total, six species were protected by Czech legislation, namely *Brachinus crepitans*, *B. expulso*, *Carabus scheidleri*, *C. ullrichii*, *Cicindela campestris* and *C. germanica*. This mixture of common and relatively abundant open, forest and generalist species showed that the habitat quality of Bobroviště is not higher than the surrounding agricultural and forest landscape. *C. germanica* is the species of fallow lands and meadows (Hůrka 1996) and it was recorded at the border of the reclaimed area and in open soils near the highway. On the other hand, *C. tristis* is a ground beetle of wet habitats and we found this species near the sewage water pond.

During the spring, we found *Gammarus fossarum*, a bio-indicating species of clean waters, and in the adjacent shallow pond several species of water heteropterans (*Gerris lacustris*, *Hydrometra stagnorum* and *Nepa cinerea*). The occurrence of dragonfly *Aeshna mixta* larvae showed that this water body likely does not dry during summer. On the other hand, we found only highly tolerant larvae of Culicidae, Chironomidae and Stratiomyidae (Diptera) in the sewage pond. Of the other invertebrates with affinity to the aquatic environment, 11 species of dragonflies and damselflies were recorded in the study area. The drainage channel along the highway provided opportunities for only a few common species. On the contrary, a freshly emerged adult of red-listed *Orthetrum coerulescens* (NT) was observed on the meadow before the quarry entrance. This species is very rare in the region and we assume that its larval development occurred in the channel (with appropriately created coastal vegetation) on the adjacent aqueduct. Thus, this species likely did not make its larval development in Bobroviště. We also observed adults of three species (*Anax imperator*, *A. parthenope* and *Libellula depressa*) and exuviae of *Sympetrum sanguineum* and *Lestes sponsa* in a small pond in the middle of the mining area. Some of these species are relatively good fliers, thus their occurrence in such pond were not particularly surprising, as they came from the wider surroundings. The finding of exuviae suggests that this pond existed for a year at least. However, it can be presumed that the pond will disappear with continued mining operations.

We recorded 35 species of birds (Table 4) with most of them found during the majority of the visits, indicating their breeding affinity to the area. Species with documented breeding in the Bobroviště area were: *Sitta europaea*, *Phylloscopus collybita*, *Erithacus rubecula*, *Turdus pilaris*, *T. merula*, *Falco tinnunculus*, *Garrulus glandarius*, *Dendrocopos major*, *Emberiza citrinella*, *Poecile palustris*, and *Sturnus vulgaris*. One pair of mallards (*Anas platyrhynchos*) successfully nested on the eutrophic sewage water body in Bobroviště. Some species were detected only once during the spring migration, such as *Streptopelia turtur* and *Motacilla cinerea*. The mining area

itself was not inhabited by any bird species with the exception of tree patches inside the quarry and around its edges. There, we recorded e.g. *Phylloscopus trochilus*, *Cyanistes caeruleus*, and *Buteo buteo*. Many other species not found in these localities inhabited the close village, but did not protrude into the quarry or Bobroviště (e.g. *Serinus serinus*, *Passer domesticus*, *Carduelis chloris*). On the other side of the highway also nested a pair of kestrels (*Falco tinnunculus*) in the installed nest box. Interestingly, on one occasion we recorded an inter-specific feeding of woodpecker nestlings (*Dendrocopos major*) by nuthatches (*Sitta europaea*). Out of all the observed bird species, four are Red-listed: *Ardea cinerea* (NT), *Circus aeruginosus* (VU), *Ficedula albicollis* (NT) and *Hirundo rustica* (NT) and two species are protected by the Czech law (*C. aeruginosus*, *H. rustica*).

From 11 recorded species of other vertebrates (amphibians, reptiles and mammals), six were directly observed in the area (*Rana dalmatina*, *Lacerta agilis*, *Vulpes vulpes*, *Capreolus capreolus*, *Lepus europaeus* and *Sciurus vulgaris*), while for the rest we found only signs of late (e.g. foot prints in the mud for boars *Sus scrofa*, excrements for martens *Martes martes*) or former activity (e.g. a burrows of badger *Meles meles* and trees cut by beavers *Castor fiber*, which were, however, probably no longer in active use). From this list, four species are Red-listed (*R. dalmatina*, *L. agilis*, *S. vulgaris*, *L. europaeus*) and four protected by Czech legislation (*R. dalmatina*, *L. agilis*, *S. vulgaris*, *C. fiber*).

Discussion

Hrabůvka quarry is located on the transition between two different biogeographical regions and within the mosaic of semi-natural forests and arable fields. However, contrary to the findings in other quarries, sand and gravel pits (e.g. Popelka et al. 2017), our results showed that plant and animal species composition in the mining area (quarry itself and Bobroviště as well) is characterized mostly by common species without any specific habitat requirements. These species also often occur in wider surroundings. There are only few exceptions in the plant taxa, e.g. *Neottia nidus-avis* (C4a), *Euphorbia dulcis* and *Polygonatum multiflorum*, all found exclusively in Bobroviště within the surveyed area. Only few red-listed species and by Czech legislation protected species were recorded there (e.g. *C. germanica*, *R. dalmatina*, *L. agilis*). Thus, from the zoological point of view, the current habitat quality of Bobroviště and Hrabůvka quarry is not as high as we anticipated. According to the plant community composition, a part of Bobroviště represents a relatively valuable forest fragment.

In this current state of Bobroviště, we see the potential for the enhancement of the local biodiversity in the water sources, i.e. the sewage water pond and the spring with the adjacent shallow pond. Most of the streams and rivers in the Czech Republic are regulated, thus their natural processes of water circulation are restricted or completely disappeared. Water is drained as quickly as possible out of the landscape. Moreover, summers in the last years are getting warmer and drier without enough precipitation. These conditions lead to overall drought in the country. For longer retention of water in the landscape we therefore suggest to build several small ponds in Bobroviště. Damming the spring stream into two parts (in approx. 10 and 15 m distance from the spring) by soil, stones or concrete blocks would create a system of ponds (Fig. 3). Our survey revealed that the water in the spring

is clean with the occurrence of bio-indicating *Gammarus fossarum*. Thus, new ponds could be occupied by various species of sensitive water invertebrates and amphibians. However, it is important to keep the surface of the new ponds and their immediate surrounding in the sunlight; otherwise they will not be utilized by the target species. Likely, it will be necessary to cut down several trees nearby. With consideration that only three pairs of hollow nesting species of birds (*Sitta europaea*, *Poecile palustris*, *Dendrocopos major*) were recorded in Bobroviště in the close vicinity of the spring (and thus the expected clearing), taking down the surrounding trees should not heavily affect their population. However, it would be still advisable to keep these trees with apparent hollows. Chopped trees should be utilized into variously long logs and used for building a loggery. Loggeries are important for enhancing biodiversity of xylophagous beetles and other insects for which they represent a suitable habitat for development of larvae.

Water in the sewage pond is strongly eutrophic and occupied only by highly tolerant species such as larvae of Culicidae, Chironomidae and Stratiomyidae. Littoral zone is completely absent and banks are covered by nitrophilous semi-ruderal vegetation. The water body itself attracts also other species of water invertebrates such as *Dytiscus marginalis*, but these larvae cannot finish their development in the pond due to the adverse environmental conditions. Larvae migrate (we recorded them in pitfall traps located nearby) to find another potential pond. However, the non-existence of other suitable ponds is fatal for the larvae. The most appropriate solution for the sewage water treatment and thus the improvement of the environmental conditions is to build a root zone wastewater treatment system. We are deeply aware that the space requirements for building such treatment are large (the size of the filter tank should be at least 5 m² per capita; Vymazal 2004) and building costs are not in the competence of the quarry nor the entire company, but should be in the interest of the adjacent municipality that damps there its sewers (Hrabůvka village, approx. 320 inhabitants). Therefore, we propose an alternative option in the form of modeling of banks of the sewage pond to create a shallow littoral zone. This could support the occurrence of littoral plant species, such as *Phragmites australis* and *Typha latifolia*, which are also used in the root zone wastewater treatment system, and other associated plant and animal communities. These landscaping practices should be done during winter months (December – February) to avoid unwanted interference in the development of target species.

Our detailed data of the occurrences of plants and animals in the quarry premises and its surroundings obtained by this project can be used, for example, as a basis for EIA process (eventual expansion of mining) or future conservation projects. Moreover, our suggestions for interventions and management practices may help to enhance the biodiversity in Hrabůvka quarry and will lead to the improved environmental conditions in the focused area. Therefore, the quarry could become a refuge of rare and threatened species in the future. Additional educational board highlighting the benefits of mining areas for the biodiversity should be introduced to the public after interventions leading to the creation of ponds and loggery. We are open for further cooperation with HeidelbergCement group to help with coordination of landscaping practices and to create this education board for public audience.

Final conclusions

We presumed that Hrabůvka quarry could serve as a refuge for rare species, but (i) our survey conducted in Bobroviště revealed that this area is occupied mainly by common plant and animal species. Most of the species are abundant also in the wider surroundings of the quarry. Nevertheless in Bobroviště, we see the biological value of this area in the forest fragment together with the spring and its immediate vicinity. Moreover, (ii) we suggest creating new ponds and to make littoral zone in the sewage water body to enhance biodiversity of this area and to increase the water retention in the landscape. Finally, (iii) our intended education board which will highlight the potential of quarry premises for biodiversity should be introduced to the public audience after the execution of our proposed interventions.

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Appendix

Figure 1: The habitat mosaic in Bobroviště.

Figure 2: Map of the Hrabůvka quarry.

Figure 3: Proposed interventions in Bobroviště.

Table 1: List of abbreviations of conservation statuses.

Table 2: List of recorded plants in the Hrabůvka quarry.

Table 3: List of recorded invertebrates in the Hrabůvka quarry.

Table 4: List of recorded vertebrates in the Hrabůvka quarry.



Figure 1: The habitat mosaic in Bobroviště: the forest fragment (top left, top right), the sewage water body (middle left), the meadow with solitary willows (middle right), ruderal habitats created by landscaping during the building of the adjacent highway (bottom left, bottom right).

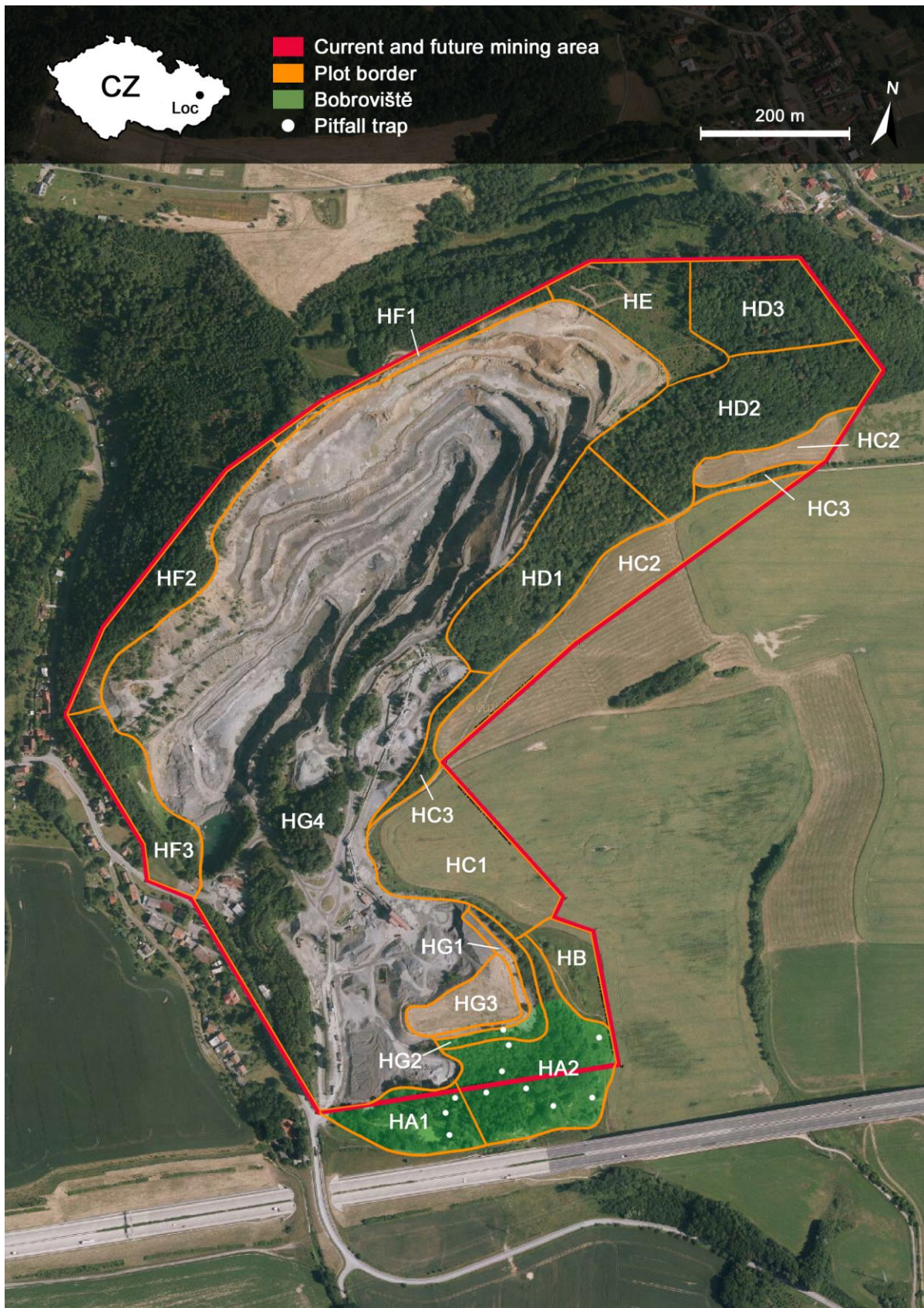


Figure 2: Map of the Hrabůvka quarry divided into plots used for the botanical survey (HA1-HG4). Bobroviště is highlighted by green color.



Figure 3: Proposed interventions in Bobroviště. The sewage water body with littoral vegetation, new ponds with the position of loggery and clear cut area is displayed.

Table 1: List of abbreviations of conservation statuses used in Table 2-4.

Source	Abbreviation	Explanation
Grulich 2012 (Red list of vascular plants)	C1	Critically threatened species
	C2	Endangered species
	C3	Vulnerable species
	C4	Lower risk
Decree no. 395/1992 Sb. (Conservation status by Czech legislation)	KO	Critically threatened
	SO	Strongly threatened
	O	Threatened
Hejda et al. 2017, Chobot & Němec 2017 (Red list of invertebrates and vertebrates)	CR	Critically endangered
	EN	Endangered
	VU	Vulnerable
	NT	Near threatened
	LC	Least concern
	RE	Extinct in CZ
	DD	Data deficient
	NE	Not evaluated

Table 2: List of recorded plants in the Hrabůvka quarry. Nomenclature by Danihelka et al. 2012, RL CZ = category of threatened species by Grulich 2012, status = status by Pyšek et al. 2012.

Taxa	CZ Red list	status	HA1	HA2	HB	HC1	HC2	HC3	HD1	HD2	HD3	HE	HF1	HF2	HF3	HG1	HG2	HG3	HG4
<i>Abies alba</i>	C4a								*	*	*		*	*					
<i>Acer campestre</i>				*				*											
<i>Acer negundo</i>		inv neo					*												*
<i>Acer platanoides</i>									*		*				*				*
<i>Acer pseudoplatanus</i>									*	*	*		*						*
<i>Actaea spicata</i>				*															
<i>Aegopodium podagraria</i>			*	*											*				
<i>Aesculus hippocastanum</i>		nat neo													*				
<i>Agrostis sp.</i>			*								*								*
<i>Agrostis stolonifera</i>																		*	
<i>Achillea millefolium agg.</i>			*	*			*	*					*	*	*		*	*	*
<i>Ajuga genevensis</i>					*			*											*
<i>Ajuga reptans</i>			*	*			*												
<i>Alchemilla sp.</i>							*												
<i>Alisma plantago-aquatica</i>																			*
<i>Alliaria petiolata</i>					*						*		*	*	*				
<i>Allium oleraceum</i>				*															
<i>Allium sp.</i>										*									
<i>Alnus glutinosa</i>			*																
<i>Alopecurus aequalis</i>				*															
<i>Alopecurus pratensis</i>					*														
<i>Anagallis arvensis</i>		nat ar			*	*									*				*
<i>Anemone nemorosa</i>			*						*										
<i>Anthoxanthum odoratum</i>							*									*			

<i>Galeobdolon montanum</i>				*			*	*	*		*			
<i>Galeopsis pubescens</i>												*		*
<i>Galinsoga quadriradiata</i>														*
<i>Galium aparine</i>				*	*	*		*	*	*	*	*		
<i>Galium mollugo</i> agg.					*	*							*	*
<i>Galium odoratum</i>				*			*	*	*		*			
<i>Galium verum</i>							*					*		
<i>Geranium columbinum</i>							*							
<i>Geranium robertianum</i>				*	*		*	*	*	*	*	*		*
<i>Geum urbanum</i>				*	*	*		*		*	*	*		
<i>Glechoma hederacea</i>				*		*		*				*		
<i>Gymnocarpium dryopteris</i>											*			
<i>Hedera helix</i>				*	*			*						
<i>Helianthus tuberosus</i>				*									*	*
<i>Heracleum sphondylium</i>				*		*			*			*		
<i>Hieracium cf. levicaule</i>												*		
<i>Hieracium cf. murorum</i>										*				
<i>Hieracium laevigatum</i>														*
<i>Hieracium lachenalii</i>											*	*		
<i>Hieracium murorum</i>				*	*			*			*	*		
<i>Hieracium sabaudum</i>												*		
<i>Hieracium</i> sp.														*
<i>Holcus lanatus</i>						*	*							*
<i>Humulus lupulus</i>									*					*
<i>Hylotelephium maximum</i>				*	*		*			*	*			
<i>Hypericum maculatum</i>					*								*	
<i>Hypericum perforatum</i>				*	*	*	*		*	*	*	*	*	*
<i>Chaerophyllum aromaticum</i>												*		
<i>Chaerophyllum</i> sp.				*										
<i>Chaerophyllum temulum</i>								*						
<i>Chelidonium majus</i>				*			*	*	*		*			

Table 3: List of recorded invertebrates in the Hrabůvka quarry. CZ § = regulation 395/1992 Sb (issued by the Ministry of Environment of the Czech Republic), RL CZ = category of threatened species by Hejda et al. 2017, EU § = The Habitats Directive (adopted by EU in 1992 as Council Directive 92/43/EEC).

Species	CZ §	CZ Red list	EU §
Oligochaeta			
<i>Lumbricus terrestris</i>			
Gastropoda			
<i>Helix pomatia</i>			
<i>Succinea putris</i>			
<i>Fruticicola fruticum</i>			
<i>Cepaea nemoralis</i>			
<i>Cepaea hortensis</i>			
Diplopoda			
<i>Ommatoiulus sabulosus</i>			
<i>Polydesmus complanatus</i>			
<i>Megaphyllum unilineatum</i>			
<i>Glomeris sp.</i>			
<i>Unciger foetidus</i>			
Chilopoda			
<i>Lithobius forficatus</i>			
<i>Geophilus flavus</i>			
Arachnida			
<i>Misumena vatia</i>			
<i>Xysticus cristatus</i>			
<i>Ixodes ricinus</i>			
<i>Araneus diadematus</i>			
<i>Nuctenea umbratica</i>			
<i>Argiope bruennichi</i>			
<i>Araneus angulatus</i>			
<i>Araniella cucurbitina</i>			
<i>Phalangium opilio</i>			
<i>Pardosa lugubris</i>			
<i>Pardosa amentata</i>			
Crustacea			
<i>Gammarus fossarum</i>			
<i>Oniscus asellus</i>			
<i>Armadillidium vulgare</i>			
Odonata			
<i>Calopteryx splendens</i>			
<i>Platycnemis pennipes</i>			
<i>Coenagrion puella</i>			
<i>Pyrrhosoma nymphula</i>			
<i>Ischnura elegans</i>			
<i>Lestes sponsa</i>			
<i>Anax imperator</i>			
<i>Anax parthenope</i>			
<i>Aeshna mixta</i>			
<i>Libellula depressa</i>			
<i>Orthetrum coerulescens</i>		NT	
<i>Sympetrum sanguineum</i>			
Orthoptera			
<i>Pholidoptera griseoaptera</i>			
<i>Tettigonia viridissima</i>			
<i>Tettigonia cantans</i>			
<i>Tetrix subulata</i>			
<i>Chorthippus parallelus</i>			
<i>Omocestus viridulus</i>			
<i>Euthystira brachyptera</i>			

Dermaptera*Forficula auricularia**Chelidura acanthopygia***Hemiptera***Gerris lacustris**Miris striatus**Capsodes gothicus**Elasmucha grisea**Aelia acuminata**Carpocoris**purpureipennis**Graphosoma lineatum**Palomena viridissima**Aphis fabae**Aphrophoraalni**Lygaeus equestris**Spilostethus saxatilis**Pyrrhocoris apterus**Nepa cinerea**Eurygaster maura**Hydrometra stagnorum**Coreus marginatus**Rhynocoris iracundus***Coleoptera (ex.****Carabidae)***Galeruca tanaceti**Meligethes aeneus**Malachius bipustulatus**Paederus littoralis**Ocypus sp.**Phyllotreta undulata**Altica oleracea**Nicrophorus vespillo**Mordelidae**Amphimallon solstitiale**Phyllobius sp.**Labidostomis longimana**Chrysolina fastuosa**Chrysomela populi**Silpha obscura**Oiceoptoma thoracicum**Cantharis rustica**Cantharis fusca**Rhagonycha fulva**Dorcus parallelipipedus**Dytiscus marginalis**Adalia bipunctata**Propylea**quatuordecimpunctata**Coccinella**sempunctata**Calvia**quatuordecimguttata**Harmonia axyridis**Oedemera femorata**Oedemera podagrariae**Oedemera virescens**Leptura quadrifasciata**Leptura maculata**Calamobius filum*

<i>Agapanthia villosviridescens</i>			
Carabidae			
<i>Abax ovalis</i>			
<i>Abax parallelepipedus</i>			
<i>Amara aenea</i>			
<i>Amara plebeja</i>			
<i>Anchomenus dorsalis</i>			
<i>Badister lacertosus</i>			
<i>Bembidion lampros</i>			
<i>Bembidion properans</i>			
<i>Brachinus crepitans</i>	○		
<i>Brachinus explodens</i>	○		
<i>Calathus erratus</i>			
<i>Calathus fuscipes</i>			
<i>Carabus coriaceus</i>			
<i>Carabus hortensis</i>			
<i>Carabus intricatus</i>			
<i>Carabus scheidleri</i>	○		
<i>Carabus ullrichii</i>	○		
<i>Carabus violaceus</i>			
<i>Cicindela campestris</i>	○		
<i>Cylindera germanica</i>	○	NT	
<i>Drypta dentata</i>			
<i>Elaphrus cupreus</i>			
<i>Harpalus affinis</i>			
<i>Harpalus distinguendus</i>			
<i>Harpalus tardus</i>			
<i>Chlaenius nitidulus</i>			
<i>Chlaenius tristis</i>		NT	
<i>Microlestes minutus</i>			
<i>Nebria brevicollis</i>			
<i>Notiophilus palustris</i>			
<i>Ophonus azureus</i>			
<i>Panagaeus cruxmajor</i>			
<i>Platinus assimilis</i>			
<i>Poecilus cupreus</i>			
<i>Pseudoophonus griseus</i>			
<i>Pseudoophonus rufipes</i>			
<i>Pterostichus melanarius</i>			
<i>Pterostichus nigrita</i>			
<i>Stomis pumicatus</i>			
<i>Syntomus truncatellus</i>			
<i>Trechus quadristriatus</i>			
Neuroptera			
<i>Chrysoperla carnea</i>			
Hymenoptera			
<i>Bombus terrestris</i>	○		
<i>Bombus lapidarius</i>	○		
<i>Sphex funerarius</i>			
<i>Lasius fuliginosus</i>			
<i>Lasius niger</i>			
<i>Formica sp.</i>	○		
<i>Myrmica rubra</i>			
<i>Vespa crabro</i>			
<i>Vespula vulgaris</i>			
<i>Polistes dominula</i>			
<i>Apis mellifera</i>			
Diptera			
<i>Clitellaria ephippium</i>			

Calliphora vicina
Lucilia caesar
Lipoptena cervi
Ectophasia crassipennis
Culex pipiens
Sarcophaga carnaria
Musca domestica
Simulium sp.
Chironomus plumosus
Syrphidae
Rhagoletis cerasi
Tipula oleracea
Mecoptera
Panorpa communis
Trichoptera
Limnephilidae
Lepidoptera
Vanessa atalanta
Aglais io
Araschnia levana
Pieris rapae
Pieris napi
Anthocharis cardamines
Pieris brassicae
Euclidia glyphica
Autographa gamma
Chiasmia clathrata
Cucullia verbasci
Polyommatus icarus
Celastrina argiolus
Maniola jurtina
Coenonympha pamphilus
Argynnis paphia
Camptogramma bilineata
Euplagia quadripunctaria
Tyria jacobaeae
Yponomeuta cagnagella
Pyrgus malvae
Erynnis tages
Thymelicus sylvestris
Ochlodes sylvanus
Orgyia antiqua
Ematurga atomaria
Chrysoteuchia culmella
Crambus lathoniellus
Gonepteryx rhamni

VU

Table 4: List of recorded vertebrates in the Hrabůvka quarry. CZ § = regulation 395/1992 Sb (issued by the Ministry of Environment of the Czech Republic), RL CZ = category of threatened species by Chobot & Němec 2017, EU § = The Habitats Directive (adopted by EU in 1992 as Council Directive 92/43/EEC).

Species	CZ §	CZ Red list	EU §
Amphibia			
<i>Rana dalmatina</i>	SO	NT	annex IV
Reptilia			
<i>Lacerta agilis</i>	SO	VU	annex IV
Aves			
<i>Sitta europaea</i>			
<i>Phylloscopus collybita</i>			
<i>Phylloscopus trochilus</i>			
<i>Erithacus rubecula</i>			
<i>Turdus pilaris</i>			
<i>Turdus philomelos</i>			
<i>Columba palumbus</i>			
<i>Streptopelia turtur</i>			
<i>Anas platyrhynchos</i>			
<i>Buteo buteo</i>			
<i>Motacilla alba</i>			
<i>Motacilla cinerea</i>			
<i>Turdus merula</i>			
<i>Ficedula albicollis</i>		NT	annex I
<i>Circus aeruginosus</i>	O	VU	annex I
<i>Sylvia atricapilla</i>			
<i>Sylvia curruca</i>			
<i>Fringilla coelebs</i>			
<i>Falco tinnunculus</i>			
<i>Phoenicurus ochruros</i>			
<i>Garrulus glandarius</i>			
<i>Carduelis carduelis</i>			
<i>Pica pica</i>			
<i>Dendrocopos major</i>			
<i>Emberiza citrinella</i>			
<i>Poecile palustris</i>			
<i>Parus major</i>			
<i>Cyanistes caeruleus</i>			
<i>Sturnus vulgaris</i>			
<i>Hirundo rustica</i>	O	NT	
<i>Ardea cinerea</i>		NT	
<i>Passer domesticus</i>			
<i>Passer montanus</i>			
<i>Carduelis chloris</i>			
<i>Serinus serinus</i>			
Mammalia			
<i>Castor fiber</i>	SO		annex II, IV
<i>Microtus arvalis</i>			
<i>Meles meles</i>			
<i>Talpa europaea</i>			
<i>Martes martes</i>			annex V
<i>Vulpes vulpes</i>			
<i>Myodes glareolus</i>			
<i>Sus scrofa</i>			
<i>Capreolus capreolus</i>			
<i>Sciurus vulgaris</i>	O	DD	
<i>Lepus europaeus</i>		NT	