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2. Project overview

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Prize category: (select all appropriate)	<input type="checkbox"/> Education and Raising Awareness <input checked="" type="checkbox"/> Habitat and Species Research <input checked="" type="checkbox"/> Biodiversity Management <input type="checkbox"/> Student Project <input type="checkbox"/> Beyond Quarry Borders

Gravel pit Hulín: towards the harmony among diverse interest

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Abstract: Various approaches may be employed to post-mining area restoration. Currently, many restoration projects aim to enhance regional biodiversity by creation of biologically valuable habitats in abandoned gravel pits. To succeed, it is, however, necessary to take the existing regional diversity into consideration. Our project aimed to evaluate biodiversity in the Gravel Pit Hulín and its surroundings, including former gravel pit in Kvasice which enabled us to compare biodiversity in an excavated and abandoned gravel pit. We performed an inventory survey focused on several animal and plant systematic groups. Additionally, we did an ecological analysis of vegetation and ground beetle community. According to our findings, Gravel Pit Hulín is an important biodiversity centre. Sand excavation is not in contradiction to the interests of nature protection; by contrast, many valuable habitats are created as a consequence of mining activities. Many rare and endangered species meets suitable environmental conditions in the mining area. Yet, there is a major potential to further enhance biodiversity in the gravel pit by implementation of suitable measures. Proposals of these measures are presented in this project. In the proposals we also take notice of humans as an integral part of the landscape. We suggest a nature trail accompanied by educational boards, providing information on both, mining process and natural value of the mined area. Thus, our project suggests not only restoration treatments but also a way how to find a harmony among different interests: sand excavation, nature protection and public use of the area.

1. Introduction

Although the gravel mining usually has a major impact on landscape it is not always in conflict with aims of the nature conservation in a cultural landscape (Řehounek et al. 2015, Trávníček 2016 in press). The mining activities often result in creation of valuable habitats. Restoration of the area is necessary after the mining is finished. In modern restoration projects, it is often possible to employ a spontaneous succession, which can be alternatively driven by acceleration, inhibition, regression or other mechanisms (e.g. artificial sowing of desirable species, elimination of undesirable species – mainly invasive). Another possibility, less convenient for the nature conservation, is a technical restoration, usually consisting in afforestation with cultural woody-plants. The number of restoration projects employing a spontaneous succession has recently increased. An environmental character of the surroundings must be, however, taken into consideration (Řehounek et al. 2015). Besides conventional aims of many restoration projects, it is important to take notice of humans, who are an integral part of the landscape.

2. Aims

Measured suggested for biodiversity enhancement should result from the knowledge of existing biological diversity in the area. Thus, our aim was **(1)** to evaluate biodiversity of the Gravel Pit Hulín and its surroundings on the basis of an inventory of selected organism groups; **(2)** to find out what habitats created as a consequence of the mining activities are most valuable in the matter of biodiversity; **(3)** to assess the most convenient ways of restoration (spontaneous succession, agricultural or forestry recultivation) for biodiversity support, **(4)** to suggest treatments supporting biodiversity in the gravel pit and **(5)** to enable its employment for recreational purposes in the same time. We put great emphasis on a harmonically incorporation of the gravel pit into its surrounding landscape, as well as creation of habitats allowing for migration of conservation-important species from the vicinity.

3. Study area

The area is situated in Haná region, in alluvium of the Morava River. It belongs to the West-Carpathian biogeographical subprovince, Kojetínský bioregion (Culek et al. 2005). Climatically, the area is classified as the warm area T2 (Quitt 1975). Gravel Pit Hulín is located south-west of town Hulín (Zlínský region). It is surrounded by cultural landscape of Haná agricultural region and it borders on a floodplain forest and a large fishpond complex in Natural Park Záhlinické rybníky. Among other biologically valuable localities in the vicinity, we can mention e.g. wetland Special Area of Conservation (SAC) Skalka or the alluvial valley of the Morava River.

Excavation of quaternary sands has been processed under the groundwater level since the end of 70th of 20th century. Part of the gravel pit has already been restored to an agricultural land. Former sludge deposits (made up from small-grained clay particles) represent interesting habitats. Current Restoration Plan intends to renew an agricultural land and create a lake on the area of the gravel pit. The area is also included into the Sanitary protection zone (PHO II) and the Protected area of natural water accumulation and it is likely to be used as a drinking water source.

4. Methods

We performed our survey from April to September 2016. Area of interest was divided into eight studied areas (designated by one or two-letter abbreviation, see appendix 1 and 2). In detail, we examined the area of Gravel Pit Hulín (area H) and Gravel Pit Kvasice (area K), where sand was excavated by similar method until 1984. For this purpose, both areas were further divided into smaller units – sectors and plots (designated by another one letter, resp. digit added to the abbreviation of area, see appendix 1 and 2). Some other areas were divided into sectors too.

A thorough botanical inventory was performed in Gravel Pit Hulín (area H) and Kvasice (area K). This enables us to compare a currently mined area with a gravel pit where mining was terminated. An inventory focused on important plant species was carried out in the vicinity (all other areas). Zoological inventory in the Gravel Pit Hulín focused on dragonflies, ground beetles, orthopterous, arachnids and birds. In addition, we made a brief inventory of other animal groups, e.g. butterflies, hymenopterous insect, amphibians and reptiles (we focused chiefly on conservation-important species). The survey was performed by standard floristic and faunistic methods (entomology: pitfall traps, sweep netting, beating, individual sampling; birds observation: point count method). Our data were supplemented with other sources: Šálek (2007), Faunistic database CSO (<http://www.birds.cz/avif>). Flow cytometry was employed for the determination of some problematic taxa (genus *Batrachium*). Maps were created in QGIS 2.4.0-Chugiak (QGIS Development Team 2014).

Following indicators were used to compare a biological value of studied plots: number of conservation-important and invasive taxa, average number of species per 25 m², Dragonfly biotic index (DBI, Simaik & Samways 2008) and number of species weighted by their red list category (appendix 3, figure 12). Species listed in a relevant red list (macromycetes – Holec & Beran 2006; vascular plants – Grulich 2012; bryophytes – Kučera et al 2012; animals – Plesník et al. 2003, Farkač et al. 2005, Řezáč et al. 2015) were considered conservation-important (or conservation-valuable); for animals, list of specially protected species (regulation 395/1992 Sb., issued by the Ministry of Environment) was additionally taken into account. Invasive species were recognized according to the Catalogue of alien plants (Pyšek et al. 2012). For abbreviations of conservation status of all systematic groups see appendix 8.

We used ground beetles for assessment of biological value of former sludge deposits. For that purpose, we studied their species diversity, environmental requirements (Hůrka et al. 1996) and conservational value. Furthermore, we studied the response of this group to the type of management on the plots where agricultural restoration had been done. Pitfall traps were distributed on the plots, so that they would represent them as much as possible (3-9 traps/plot; see appendix 1, figure 8). In total, we placed 43 traps. The pitfall catch was collected approximately once a three weeks.

We used phytosociological relevés for vegetation study in the Gravel Pit Hulín and Kvasice (and several biologically valuable places in surroundings). The relevés were distributed on the plots, so that they would represent the studied plots as well as possible (1-5 relevés/plot; see appendix 1, figure 8 and 9). We used the Braun-Blanquet cover-abundance scale (Westhoff & Van Der Maarel 1978). Depending on the purpose, the area of a relevé was set to 25m² (study of succession) or 100 m² (study of forest vegetation in Kvasice). In total, we took 62 relevés (43 in area H, 16 in area K and three in other areas, see appendix 4, table 5).

We analysed the influence of the environmental factors on the ground beetles and vegetation by multivariate methods in program Canoco for Windows 4.5 (ter Braak & Šmilauer 2002). Unimodal methods were selected on the basis of the gradient length in DCA (Lepš & Šmilauer 2000). Species data were transformed by logarithmic transformation. We used forward selection with Monte Carlo permutation (1000 permutations) to select suitable variables. Phytosociological relevés were classified in program Juice (Tichý 2002).

5. Results

Biological inventory

In order to perform our survey, each member of the team visited the Gravel Pit Hulín about 15 times. All taxa found in both gravel pits are listed in appendix 9. Comments on some interesting records are given in appendix 10.

Macromycetes: Thirty-one species were found in the Gravel Pit Hulín. Most species occurred at plots covered with woody-plants (HE1, HE2, HA3). Wood-decaying and mycorrhizal species prevailed. Three red list species were found in the vicinity of the gravel pit.

Bryophytes: Forty-seven bryophyte species were found in the Gravel Pit Hulín (four liverworts and 43 mosses). Common species of non-forest habitats and bare soil prevailed. Forest species and epiphytes occur on the oldest sludge deposit (HE1). Three of the noted species are included in the red list. A mountain species *Dicranella cerviculata* was surprisingly recorded at this lowland locality.

Vascular plants: In total, five hundred and fifteen taxa were found in Gravel Pit Hulín. Out of them, 58 were included in the red list and 30 in the list of invasive species. In Gravel Pit Kvasice, three hundred and sixty-four taxa were found in total; thirty-two of them were endangered and 19 invasive. Additional 40 endangered and two invasive species were recorded in the other areas; these invasive species were *Ambrosia artemisiifolia* (sector LA) and *Impatiens glandulifera* (area K, and sectors LA,PB). The most conservation-valuable taxa in the Gravel Pit Hulín are: *Batrachium baudotii* (C1), *Crepis setosa* (C1), *Batrachium rionii* (C2), *Senecio sarracenicus* (C2), *Scutellaria hastifolia* (C2), *Verbascum blattaria* (C2). The most valuable findings in the vicinity were: *Lathyrus palustris* (C1), *Taraxacum vindobonense* (C1), *Cerastium dubium* (C2), *Viola stagnina* (C2), *Sium latifolium* (C2), *Stellaria palustris* (C2), *Althaea officinalis* (C2) a *Dianthus superbus* (C2). The most valuable plots (from the floristic point of view) in Gravel Pit Hulín are HF6 (banks of the lake in the haven) and HA2 (semi-cultural, mesophilous to wet meadow on a restored land). On the other hand, the less valuable plots are HD3 (a ditch with dominance of *Calamagrostis epigejos*) and HG4 (non-mowed vegetation of *Solidago gigantea*), see appendix 3.

Arachnids: In Gravel Pit Hulín we recorded a total of 65 species, mostly characterized by common species of non-forest, damp, open and disturbed habitats (e.g. *Thanatus striatus*, *Eratigena agrestis*). Interesting record was wolf spider *Pardosa nebulosa*, which is currently known only from two localities in the Czech Republic.

Dragonflies and damselflies: We recorded a total of 17 species in Gravel Pit Hulín. Artificial aquatic habitats such as gravel pits usually habit only eurytopic species. Therefore, interesting records were 6 red-listed species (one protected by CZ and EU legislation). We suppose that most of these species were not indigenous but dispersed from surrounding wetlands. However, we found *Stylurus flavipes* (EN) exuviae on the bank of gravel pit. This is the evidence of the habitat use by this species and also that gravel pit provides some suitable habitats for dragonflies (mainly sand bottom). We also observed several adults and larvae in newly formed pool on waste pond. In compare with Kvasice gravel pit, we found more species in Hulín and also more valuable dragonfly communities according to DBI (appendix 3, figure 24).

Grasshoppers and crickets: We recorded a total of 25 species. This high number represents more than 25% of CZ orthopterans. Interesting records were *Eumodicogryllus bordigalensis* and *Ruspolia nitidula* (CR). Very rare is also the occurrence of *Pteronemobius heydenii* at western bank of gravel pit (HC1).

Ground beetles: We recorded a total of 67 species in Gravel Pit Hulín (four red-listed, six protected by CZ legislation). The most valuable records we consider the occurrence of psammophilous *Cylindera areanria* and *Harpalus flavescens* (NT) (waste pond HE1, HE3), hygrophilous *Pterostichus gracillis* (VU) and *Nebria livida* (NT). Interesting finding was also *Cylindera germanica* (VU).

Other invertebrates: Interesting records on the waste ponds were earwig *Labidura riparia* (EN) and several species of cuckoo wasps (Chrysididae). From CZ protected species we found *Mantis religiosa* (VU), *Xylocopa violacea* and butterflies *Apatura ilia* and *Lycaena dispar* (also protected by EU legislation). We recorded also some alien and invasive species: treehopper *Stictocephalia bisonia*, ladybug *Harmonia axyridis* and Zebra mussel, *Dreissena polymorpha* in gravel pit lake.

Amphibians and reptiles: In Gravel Pit Hulín area we recorded two species of „green water frogs“ *Pelophylax esculentus* (NT) and *P. ridibundus* (NT). Two species of „brown water frogs“ *Rana temporaria* (NT) and *R. dalmatina* (NT) we recorded in southern part of gravel pit (in the ecotone of forest and stream, B3, B4). In depressions (A2, A3) we commonly found *Bombina bombina* (EN). Reptiles were represented by grass snake *Natrix natrix* (LC) and abundant lizard *Lacerta agillis* (NT). Except *R. temporaria*, all of these species are protected by CZ legislation. According to EU legislation are protected all species except *N. natrix*. Šálek (2007) reports from Gravel Pit Hulín in addition *Pelobates fuscus*, *Bufo bufo*, *B. viridis* and *Hyla arborea*. We assume that these species in gravel pit could be still present (but not detected during our survey).

Birds: In Gravel Pit Hulín, 73 bird species were recorded (28 red-listed). An important finding is a nesting colony of *Riparia riparia* (NT). The bird nesting islands are very favourable for *Sterna hirundo* (EN). On the reed-vegetation at a sludge deposit (HE3) a single pair of *Circus aeruginosus* (VU) was nesting. Besides common passerines, *Oriolus oriolus* was nesting at plot HE1. During the spring migration we also observed *Asio flammeus* at plot HA2 and several wader species (e.g. *Tringa glareola*, *Charadrius dubius*, *Philomachus pugnax*.) on the border of plots HA2 and HG2. Interestingly, *Gallinago gallinago* (EN) was regularly observed in the nesting time on a wetland at plot HA2 (dried out in summer). We also observed a successful reproduction of *Lanius colurio* and two pairs of *Saxicola rubetra*. According to Šálek (2007) and faunistic database of CSO, many other bird species inhabit the gravel pit. The database includes 52 additional species. Out of all the species (our observations and CSO), fifty-five species are included in red list.

In Kvasice, only 30 species were observed (according to CSO additional 31 species were observed in 2016). Probably nesting of *Alcedo atthis* was recorded there. Twenty-three of these 60 species are included in the red list. Out of all the species (our observations and CSO), twenty-three species are included in red list.

Quantitative analysis

Ground beetles communities: Species composition of waste ponds (HE1–HE4) reflected their specific habitat conditions (given their history and age). Based on our findings, we can not conclude that some of these waste ponds were more valuable (in terms of a total number of species and presence of conservation-important species, appendix 3, figure 21 and 22). At the oldest waste pond (HE1) were recorded common forest species and migrants from the agricultural area. Species composition on this locality was represented by adaptable species of natural habitats (e.g. protected *Carabus ullrichii*, *C. scheidleri*). The other waste ponds dominated by species typical for artificial and disturbed habitats (appendix 3, figure 23). The highest number of species we recorded on the waste pond HE3, formed mainly by reed, but also by disturbed habitats. These disturbed patches are created by heavy machinery and provides suitable conditions for some protected species (e.g. *Cicindela campestris*, *Brachinus crepitans*). On the open waste ponds with a sandy substrate (HE2, HE4), we recorded tiger beetle *Cylindera arenaria* (protected species which currently uses secondary habitats such as waste ponds). In the southern part of the reclaimed area, we found a relatively common species of grasslands. According to our results, most species prefer managed hay meadows (HB2, HA2, HG2). In compare with managed areas where we recorded 36 species, on unmanaged areas with high *Solidago* cover (HA3, KB2) we found only 25 species. Based on CCA, we can not conclude that the ground beetles avoided areas overgrown by *Solidago* (appendix 5, figure 34 and 35).

Phytosociological analysis: Results of the ordination analysis show that succession is influenced chiefly by soil texture and moisture.

On loamy soils, species-poor ruderal communities with predominant invasive species (*Solidago gigantea*, *Erigeron annuus*), establish in the early-succession stage (appendix 4, figure 26, 27 and 28). Nevertheless, more valuable vegetation of wetland species develops on places with moist soil (relevé HA3-1, appendix 4). Succession may further lead to formation of biologically valuable secondary forests (HE1) or, contrary, forests with dominance of invasive woody species (KA3). The direction of the succession probably depends on diaspores supply. Some of the plots were transformed to a meadow, instead of leaving them to spontaneous succession. These plots are botanically much more valuable. Many endangered plant species occur there, while cover of invasive species is rather low.

Succession on the sludge deposits with sandy soils results in formation of extremely species-poor communities. Secondary birch forests with dominant *Calamagrostis epigejos* (on dry or mesophilous places) or *Phragmites australis* (on wet places) in undergrowth represent the oldest successional stage (appendix 3). Succession is inhibited on places with stagnant water occupied by reed-beds.

In 2016, water level decreased in the lake, which enabled us to study a vegetation of exposed bottoms, emerged in the littoral zone (appendix 4, figure 29 and 30). Cover of species characteristic of valuable littoral communities, including some conservation valuable species, correlated with the slope of the banks. The most valuable communities were formed on just slightly sloping banks, while invasive species dominated on steep slopes (appendix 4, figure 31 and 32). Besides sloping, a soil texture had an influence on the species composition; these two variables were, however, strongly correlated. Yet it can be concluded that sandy and clay soils are more suitable for many conservation valuable species.

6. Discussion

General part

In contrast to the sand pits in South Bohemia (Řehouňková et al. 2012) or South Moravia (Skoupá & Kalous 2014), psamophyte vegetation is missing in the Gravel Pit Hulín. It results from the fact, that this type of vegetation has never met suitable environmental conditions in the whole region. Few psamophyte species found during our inventory were certainly (*Dysphania botrys*, *Salsola tragus*) or probably (*Vulpia myuros*, *Filago arvensis*) introduced. Conservation important species are represented mainly by species of nutrient-rich habitats (wet alluvial meadows, floodplain forests, wetland scrubs), which are typical of this region, as our inventory in the vicinity shows. Approaches to restoration applied in South Bohemia and South Moravia are not necessarily the most suitable in the landscape of Haná region. When preparing plans of restoration and post-mining treatments, it is important to take into consideration biodiversity of the surrounding landscape.

Our floristic data allow us to compare three thoroughly surveyed areas in Central Moravia. A survey in Gravel Pit Tovačov was performed in 2014-2015 (Ševčík et al. 2014, Trávníček 2016, in press). Another two areas, Gravel Pit Hulín and former Gravel Pit Kvasice, were surveyed in 2016 (within this project). Highest number of vascular plant taxa were found in Hulín (515), followed by Tovačov (510) and Kvasice (368). Low number of taxa found in the latter results from absence of early-successional habitats, created and periodically renewed as a consequence of mining activities (rejuvenation). Relatively higher plant species diversity (number of species / area size) in the Gravel Pit Hulín, if compared to Tovačov, is probably caused by a connection to an extraordinarily species-rich area. As for endangered species, the Gavel Pit Hulín is the richest area with 58 red

list taxa, compared to Tovačov with 44 taxa and Kvasice with 38 taxa. Another conservation-important species are likely to immigrate to the gravel pit from the surroundings, if convenient post-mining treatments will be done. Highest number of invasive species was found in the Gravel Pit Hulín, as well. However, the difference (between Gravel Pit Hulín and Tovačov) in number of invasive species is significantly lower than the difference in number of endangered species. Moreover, our data from the Gravel Pit Kvasice show, that number of both endangered and invasive species decrease after mining activities are finished.

Also in terms of dragonfly species diversity, Hulín gravel pit was more valuable than Kvasice. In compare with Kvasice, we found more species in Hulín and also more valuable dragonfly communities according to DBI. However, most of these dragonfly species were probably not indigenous but rather dispersed from surrounding wetlands. Low quality of Kvasice gravel pit for dragonflies is caused by absence of littoral zone (steep banks) and by high tree cover (dragonflies prefer open and sunny habitats). Previous survey (Šálek 2007) found large populations of dragonflies on pools in waste ponds (e.g. HE3), however currently these pools does not exist. Own observations in the HF6 area shown that dragonflies and amphibians are able to quickly habit these pools, if they are formed again. Suitable conditions for dragonflies in the gravel pit lake occurs especially in microhabitats with a sandy bottom. However, larger littoral zone in the lake should provide another environmental conditions not only for these species but also for other invertebrates, amphibians and birds.

Not many species of aquatic birds nest in gravel pit Hulín because of lack of littoral vegetation. Artificial nesting islands and high steep banks are valuable, in the latter we found nesting of *Riparia riparia*. However, opportunity for nesting of larger colonies of this species is not so high, because walls of banks are too low and accessible to predators. For waders, extensive wet areas on the fields and meadows are important, as it was in the spring on the boundary of areas HA2 and HG2. Gravel pit has a high potential for aquatic birds, especially for wintering, and after appropriate reclaiming its value will increase. It is all about creating permanently waterlogged littoral zones with gradual shorelines and small islands or exposed areas at larger distances from banks. It is also appropriate to conserve wet meadows and nesting sites for *Riparia riparia*.

On the ground of our survey we suggest that the highest potential for biodiversity enhancement consists in development of the littoral zone. After the water level decreased in 2016, large space of a bare soil emerged, where we could study initial succession. Depending on the slope and soil texture, a mosaic of ruderal communities and the exposed bottoms vegetation established on the banks of the lake. Too steep slopes on the banks may lower biodiversity of a mining area for long time, as can be demonstrated on the Gravel Pit Kvasice. Thus, we recommend modification of the banks in currently mined gravel pits, so that they would support these valuable habitats. This requires making the slopes milder, with maximum sloping of 5 degrees (appendix 6, figure 36), and create deep bends on the lake. Long, slowly declining bank would not be eroded by water and it would enable a littoral vegetation to arise. When the water level decreases, vegetation of exposed bottoms might be periodically renewed. As this treatment is somewhat space-demanding, this could be solved by alternation of a steep slopes and shallow bends along the bank (appendix 6, figure 37). Part of the lake could be dammed with the ground excavated within the beds creation, or steep slopes could be raised in order to create nesting sites for *Riparia riparia*; these slopes would be maintained due to water erosion.

We compared restored plots with those where spontaneous succession was allowed. Our results show that spontaneous succession is desirable only at nutrient-poor sludge deposits, where it leads to formation of valuable habitats for bird nesting (reed-beds) and insect. Rare and endangered ground beetle species were found at all kinds of sludge deposits; thus, none of them can be considered more valuable than the others. We assume that similar conclusions could be done for other insect species. Therefore, we suggest alternation of wet and dry sludge deposits. If there is a lack of space, it would be also possible to periodically renew the old sludge deposits by harvesting and repeated filling. This treatment would maintain current biodiversity of the sludge deposits, including disturbances, supporting biodiversity in the gravel pit as well. Our suggestions of suitable treatments are given in following chapter.

Invasive plant species predominate in the initial successional stages on loamy soils; thus, these habitats have only limited botanical value. From the zoological point of view, these initial stages can be considered valuable. Ongoing succession may lead to formation of biologically valuable secondary forests or, by contrast, a vegetation with predominance of invasive woody species. For that reason, we recommend to modify these plots to wet meadows or afforest them with native tree species.

In our opinion, public use of the abandoned mining areas is an important part of restoration projects. Use of former gravel pits is usually joined with fishing, swimming and water sports. Gravel Pit Hulín will probably become a drinking water source and its public access will be limited in this case. Yet we suggest some measures which combine a recreational use with interests of nature protection. Attractiveness of the locality could be improved by a nature trail, resp. a natural cycle route with educative boards and a birdwatching tower. It is necessary to prevent a disturbing of water birds and maintain high quality of water. Thus we suggest delimitation of a quiet zone with suitable places for bird nesting (e.g. reed-beds). If our suggestions are implemented, these habitats will be created mainly in south-east part of the gravel pit. In this zone, fishing and swimming should be banned. Water sports should be banned in whole area, regarding the water bird nesting.

Visitors will be directed to the north-west bank of the lake, where natural beaches could be created. The nature trail (cycle route) would lead along the north-west bank of the lake. A plan of the cycle route, a proposal of the educative boards content and their arrangement are given in appendix 7.

Proposals of measures for biodiversity enhancement

1. Plots after restoration, sectors HA, HB, HC, HG, HI

HA1, HB1: A ruderal vegetation with some species of exposed bottoms established here after the water level declined in 2016. Although the slope of the banks is rather small, steep edges were formed by water erosion at several places. Formation of littoral zone is restricted at these places; however, they provide suitable places for *Riparia riparia* nesting. Thus, we suggest creation of steep slopes and shallow bends on plot HA1 according to (appendix 6, figure 37). As plots HB1 and HB2 differ only slightly in their altitude, it would be possible to raze the erosional edge and make a gradual transition between meadow and littoral vegetation (appendix 6, figure 36).

HC1: The banks have not been restored yet. They are mostly constituted of steep, sandy-loam places covered by ruderal vegetation. A few species of the exposed bottoms occur at more suitable places. This plot is an important habitat of *Pteronemobius heydenii*. Restoration of the banks should be performed consecutively, so that its population would not be damaged. We suggest the same kind of restoration as used for plot HA1. By contrast, its realization should be divided into at least three successive years. Monitoring of the population of *P. heydenii* at old and newly recultivated places would be desirable during the restoration works.

HG1: Banks of the lake were consolidated with stones under previous restoration. A combination of steep slopes of the banks and an inconvenient soil texture prevented from formation of any littoral zone. As a result, ruderal plant species prevail there. We consider this kind of restoration the less suitable for biodiversity support. Instead, we recommend creation of steep slopes and shallow bends, as described for plots HA1 (see above or in appendix 6 figure 37).

HA2: This area was covered by ground, later a grass seed mixture was used to sow the ground (appendix 6, table 6) with shallow cultivation. However, divots were not crushed completely and thus, seeds did not fully germinate. The plot is currently covered by species-poor meadow, where invasive species (*Calamagrostis epigejos*, *Solidago gigantea*) predominate. Yet, some species of wet meadows get into wet places. Many rare plant species of wet meadows occur at the plot, especially in flooded depressions made by agricultural vehicles. Rovněž z hlediska zoologického je tato plocha hodnotná. There is a serious potential for spreading of species naturally occurring at wet meadows near Záhlinice (e.g. *Viola stagnina*, *Taraxacum vindobonense*, *Stethophyma grossum*).

This plot is valuable for animal diversity, as well. We recorded several protected ground beetle species there. Flooded depressions created by agricultural vehicles are often inhabited by frogs (e.g. *Bombina bombina*). Thus, we do not recommend any substantial changes. Current management (mowing two times a year) is most suitable. It is important to maintain the extensive form of agriculture (manuring is not acceptable). An important task is a restriction of invasive species *Calamagrostis epigejos* and *Solidago gigantea*. Their abundance should decrease as a result of mowing. Alternatively, experimental sowing of a *Rhinanthus* species, a hemiparasite of grasses, could be done in order to suppress *Calamagrostis* population. Another possible measure is a mosaic mowing, with 5-10 % of the area skipped in spring, which enables seed maturing of many species and in the same time provides suitable habitats for insect. Regular moving of agricultural vehicles would be desirable at the margins of the meadow. We suggest extending of the grassland vegetation up to the edge of the lake.

HA3: Woody species were planted at a part of this plot (forest was damaged by beaver and re-newed in 2010). The rest of the plot was left for spontaneous succession. Currently, the plot is covered by a mosaic of planted or spontaneously spread woody plants (*Salix* sp., *Populus alba*, *Acer negundo*) and species-poor non-forest vegetation with *Solidago gigantea*. A few red list species found at this plot are restricted to wet places.

Relatively low number of ground beetle species was recorded at this plot. We assume, that other insect species avoid these habitats even more (e.g. butterflies). Various frog species (*Bombina bombina*, *Rana* sp., *Pelophylax* sp.) plentifully occur in flooded depressions near the banks of the lake. The only biologically valuable habitats are those with wetland vegetation or autochthonous woody-plants. We recommend to create a mosaic of wetland habitats, small water lagoons and willow carrs.

Vegetation of non-native *Acer negundo* should be cut. Periodically flooded pools for amphibians should be dugged near the bank of the lake. The meadow parts should be sown with regional grass seed mixture with deep cultivation (places with valuable wetland species must be avoided from this treatment). Subsequently, the same management would be applied as for plot HA2.

HB2: This plot was originally transformed to a permanent grassland with *Festuca arundinacea*. It was sown with grass seed mixture with shallow cultivation in 2013. Divots were not crushed and seeds did not germinate. Fewer endangered plant species grow there, compared to plot HA1. Nevertheless, there is a potential to create a valuable habitat at this plot too. It would be desirable to sow the ground with a regional seed mixture with deep cultivation. Alternatively, the plot could be transformed to a pasture, which could provide suitable conditions for other important species.

HG2, HG3: These plots were sown with grass seed mixture with deep cultivation in 2015. Germination was successful and now there is grassland vegetation with dominant *Lolium perenne*. Furthermore, there are many wet places with rare plant species. In a part of the area a vegetation of reed-bed and willows remained. It is convenient for bird nesting. We suggest the same management as for HA2, with maintaining of the reed and willow vegetation.

HC2: A ruderal herb community currently predominates at this plot. However, typical tree species of floodplain forests were recently planted there. Thus, we do not recommend any considerable changes. Additional trees could be planted, so that this plot would come into direct contact with the floodplain forest in the south of the gravel pit, which would enable migration of desirable herb species.

HI: It is a transferred bed of the Němčický brook. The way of restoration is very inappropriate: too deep and insufficiently diversified bed does not allow a natural modelling of the shores and thus development of valuable vegetation. The brook currently lacks water. We can not estimate, whether this is a consequence of dry climate or the inconvenient restoration. We suggest broadening of the bed and creation of small water pools retaining water for at least some longer time.

2. Sludge deposits – sector HE, HF1

HE1: This sludge deposit was covered by ground in 1989. Most of its surface is covered by secondary forest with conservation-valuable plant species (e.g. *Pulmonaria mollis* C3, *Silene baccifera* C3). The species composition in wet parts resembles the species composition of floodplain forests. Drier parts are rather mesophilous to xerophilous. As for ground beetles, mainly common species of natural habitats were found there (e.g. *Carabus ullrichii* and *C. scheidleri*, both protected by law). Thus, the communities at this plot are biologically valuable and there is further potential for migration of rare species from the surroundings (above all from the floodplain forests). For that reason we suggest employing of spontaneous succession at this plot. In eastern part of the sludge deposit there is a grassland vegetation with dominance of *Calamagrostis epigejos*. We recommend transformation of this plot to a meadow with management similar as for HA2. Alternatively, it could be left for spontaneous succession, leading to afforestation.

HE2: This sludge deposit has been left for spontaneous succession since 1995. A species-poor birch forest with invasive *Calamagrostis epigejos* grows there. Cover of the herb layer is low, bare sandy soil accounts for a major part of the surface. These places are, according to our findings, inhabited by rare psamphilous insect (e.g. *Cylindera arenaria*, *Labidura riparia*). In 2016 part of the sludge deposit was harvested and a steep sandy slope was created as a result. This habitat represents a new habitat at this plot, which could be favourable to e.g. hymenopterous insect. Further harvesting may be beneficial, but following conditions must be met: area of the harvested surface should not exceed ¼ of the total area of the sludge deposit within one year (in order to prevent destruction of the insect populations) and at least ½ of the surface of the sludge deposit should remain in current altitude (to maintain the xerophilous habitats).

HE3: This sludge deposit is covered mainly with uniform reed vegetation, a bare soil occurs on a landfill. The highest number of ground beetle species was recorded at this plot, which is a result of its habitat heterogeneity (wet reed-bed, regularly disturbed warm landfill). As a consequence of the disturbances caused by mining activities, further suitable places are created for conservation-valuable insect species. Reed-bed in the north of this plot serves as a nesting place for birds (e.g. *Acrocephalus* sp., *Circus* sp.). For that reason we recommend to maintain the reed vegetation. As a measure leading to biodiversity enhancement, we suggest digging of water pools (at least on the margin of the sludge deposit, depending on technical possibilities; not to be done in bird nesting period). Implementation of this measure would lead to creation of valuable habitats for water invertebrates and wetland plants. A proposal is given in appendix 6, figure 39. If further filling of the sludge deposit is necessary, we recommend maintaining of the landfill on the altitude no more than 1 m above the water level. Small water pools should be dug, as well. The plot lies next to the plot HE1, where spontaneous succession led to formation of a valuable secondary forest. Thus, this approach could be applied to plot HE3 too.

HE4: Vegetation is still missing on major part of this sludge deposit, with exception of the wet margins covered by reed-bed. Two interesting invertebrate species, *Cylindera arenaria* and *Harpalus flavescens*, were recorded here. We recommend vertical diversification of the plot, ensuring simultaneous presence of terrain depressions with high moisture together with dry sandy microhabitats for psamphilous insect. This may be achieved for example by harvesting of a part of the surface, as done at plot HE2.

HF6: At this plot, sloping of the banks is very mild and their surface is regularly disturbed. As a result, the most valuable vegetation occurs at this plot. A small water pool with just slightly sloping banks has arisen around the sludge feeder. Several rare species grew there, e.g. *Cyperus fuscus* (C3), *Batrachium rionii* (C2). On a bare wet soil near to the bucket elevator, a critically endangered plant species *Batrachium baudotii* (terrestrial form) was recorded. Dragonfly nymphs were observed in the pool, which shows the high speed of their dispersal, probably from near wetlands (e.g. Záhlinické rybníky). This is a good example of how sludge deposits could be used for creation of littoral zone with water lagoons. According to our suggestion (see appendix 6 figure 38), filling of the sludge deposit should be finished when parts of the sludge deposit are still under water. Water pools may be dugged on the sludge deposit margins, accessible even for machinery. These pools represent a convenient habitat for amphibians and wetland plants. A large reed-bed would establish in the central part, which would be a suitable nesting place for birds. Habitats created as described here could be left to spontaneous succession; nevertheless, occasional disturbances by harvesting and re-filling would be desirable.

Connecting of the area to TSES

The area of the Gravel Pit Hulín represents an important biodiversity centre. The measures we suggest should lead to further increasing of biological value of this area. For that reason it would be desirable to incorporate the area in current Territorial system of ecological stability (TSES), which already comprises of Natural Park Záhlinické rybníky and Gravel Pit Kvasice. This would give rise to a large biologically valuable area with wide range of habitats, some of which are already rare in the cultural landscape of Haná region. Němčický brook and Stonáč brook could be utilized as a regional biocorridors in order to connect the area of the gravel pit to the TSES-network.

7. Conclusions

A high number of species was found in the Gravel Pit Hulín within most of surveyed taxonomical groups. This is evidence that the Gravel Pit Hulín is an important regional biodiversity centre. Properties of the species diversity are, however, more important than the number of species. Our results show that mining activities support both invasive and endangered species. A vast amount of habitats arisen as a consequence of mining are suitable for rare species and simultaneously facilitate propagation of the invasive plants. Yet it is possible to conclude that positive influence of mining prevails over the negative, regarding the diversity properties. The most important conclusions from our survey are following:

- In the case of agricultural restoration of the post-mined areas by means of their transformation to meadows, a correct kind of sowing and subsequent extensive management are important to enhance biodiversity. If these conditions are not fulfilled, these places become biologically valueless, covered only by invasive species.
- Despite different environmental conditions and age of these plots, all of them may be considered biologically valuable.
- Biologically valuable habitats (e.g. sludge deposits) are not always colonized by conservation important species; the reason may be absence of appropriate species in the region. This fact should be taken into consideration when restoring ecosystems.
- Biodiversity in the Gravel Pit Hulín could be significantly increased by development of large littoral zone, which is almost missing to date.

A proposal of treatments is given which would significantly enhance biodiversity of the Gravel Pit Hulín and simultaneously allow its use for recreational and educational purposes after mining is finished. An emphasis is put on harmonically incorporation of the gravel pit into the surrounding landscape.

Acknowledgement

We are grateful to following experts for determination of taxonomically problematic groups: Z. Hradílek (bryophytes), Z. Egertová (macromycetes), J. Prančl (*Batrachium*, *Callitriche*), Z. Kaplan (*Potamogeton*, *Batrachium*, *Ceratophyllum*), R. J. Vašut (woody plants, especially *Salix*, *Populus*), M. Hroneš (*Viola*, *Salix*), M. Dančák (above all Poaceae), J. Chrtěk (*Pilosella*), R. Řepka (*Carex*), M. Veselý (Carabidae), O. Machač (arachnids), J. Vidlař (birds), S. Rada (orthopterans). We further thank to M. Oulehlová (herbarium service), H. Kočvarová (assistance by field works), M. Sochor (information about localities), V. Pluhař (information about localities), P. Batoušek (information about localities). We also thank K. Lorek, P. Reich, P. Bardoun, H. Michalíková and K. Botková for consultations and information about the project. We thank to M. Duchoslav for his help with statistical analysis and I. Hujíčková for text alignment. Last but not least we thank to the Českomoravský štěrk company for reposing their trust in our project and for provided financial support.

List of appendices

Appendix 1: Maps.....	1
Appendix 2: A description of the plots and sectors.....	8
Appendix 3: Biodiversity indicators.....	10
Appendix 4: Phytosociological analysis.....	15
Appendix 5: Analysis of ground beetles communities.....	23
Appendix 6: Proposal of treatments.....	25
Appendix 7: Proposal of the nature trail with educational boards.....	28
Appendix 8: Categories of conservation statuses according to various red lists.....	30
Appendix 9: Results of inventory survey.....	31
Appendix 10: Comments on selected finds.....	60
Appendix 11: References.....	65

List of figures

Figure 1: Map of the region of interest divided into studied areas.....	1
Figure 2: Map of the Gravel Pit Hulín (area H) – divided into sectors.....	2
Figure 3: Map of the Gravel Pit Hulín (area H) – divided into plots.....	2
Figure 4: Map of the Gravel Pit Kvasice (area K) – divided into sectors.....	3
Figure 5: Map of the Gravel Pit Kvasice (area K) – divided into plots.....	4
Figure 6: Map of the studied areas L, Z, P – divided into sectors.....	5
Figure 7: Map of the interesting floristic findings in the Gravel Pit Hulín (area H).	5
Figure 8: Distribution of the phytosociological relevés and pitfall traps in the Gravel Pit Hulín (area H).	6
Figure 9: Distribution of the phytosociological relevés and pitfall traps in the Gravel Pit Kvasice (area K).	7
Figure 10: The total number of vascular plant taxa in the gravel pit Hulín, Kvasice and Tovačov.	10
Figure 11: The percentage (%) of endangered and invasive vascular plant taxa in the gravel pit Hulín, Kvasice and Tovačov.	10
Figure 12: Number of vascular plant taxa weighted by their red list category in the gravel pit Hulín, Kvasice and Tovačov.	10
Figure 13: The number of vascular plant taxa/total area in the gravel pit Hulín, Kvasice and Tovačov.	11
Figure 14: The total number of vascular plant taxa on particular plots of the Gravel Pit Hulín.	11
Figure 15: The percentage (%) of endangered and invasive vascular plant taxa on particular plots of the Gravel Pit Hulín.	11
Figure 16: Number of vascular plant taxa weighted by their red list category on particular plots of the Gravel Pit Hulín.	12
Figure 17: The total number of vascular plant taxa on particular plots of the Gravel Pit Kvasice.....	12
Figure 18: The percentage (%) of endangered and invasive vascular plant taxa on particular plots of the Gravel Pit Kvasice.	12
Figure 19: Number of vascular plant taxa weighted by their red list category on particular plots of the Gravel Pit Kvasice.	13
Figure 20: Average number of vascular plant taxa in phytosociological relevés (25 m ²) on particular plots of the Gravel Pit Kvasice and Hulín.....	13
Figure 21: Total number of Carabidae species on the sludge deposits.	13
Figure 22: Number of conservation important Carabidae species on the sludge deposits.....	14
Figure 23: The total number of Carabidae species on the sludge deposits based on their bioindicating value. ..	14
Figure 24: Comparison of gravel pit Hulín and Kvasice according to number of dragonfly species and dragonfly biotic index.....	14
Figure 25: DCA of all relevés with passively projected environmental variables.	15
Figure 26: DCA based on relevés of area 25m ² excluding relevés of the littoral zone (species and passively projected environmental variables are shown).	16
Figure 27: DCA based on relevés of area 25m ² excluding relevés of littoral zone (samples and passively projected environmental variables are shown).	17
Figure 28: DCA based on relevés of area 25m ² excluding relevés of littoral zone (attribute plots of samples according to the cover of the most frequent invasive species).	17
Figure 29: RDA of the response of species composition on the slope the banks (species are shown).	18
Figure 30: RDA of the response of species composition on the slope the banks (samples are shown).	19
Figure 31: RDA of the response of species composition on the slope the banks (attribute plots of samples according to the cover of the <i>Cyperus fuscus</i> and <i>Bolboschoenus laticarpus</i>	19
Figure 32: RDA of the response of species composition on the slope the banks (attribute plots of samples according to the cover of the invasive species).....	20
Figure 33: CCA analysis of Carabidae species composition on sludge deposits.	23

Figure 34: CCA analysis of Carabidae species response on environmental variables.....	23
Figure 35: Generalized additive model of Carabidae species response to <i>Solidago</i> cover.....	24
Figure 36: Recommended modification of the banks.....	25
Figure 37: Alternative recommendation of the modification of the banks.....	26
Figure 38: Proposal of treatments for sludge deposits currently used.....	26
Figure 39: Inappropriate and appropriate management of waste pond HE3.....	27
Figure 40: Maps of the nature trail.....	28

List of tables

Table 1: Correlation of environmental variables with the first three ordination axes for DCA analysis of all relevés.....	15
Table 2: Correlation of environmental variables with the first three ordination axes for DCA analysis of relevés of area 25m ² excluding relevés of littoral zone.....	17
Table 3: Report of the RDA analysis of the response of species composition on the slope the banks.....	20
Table 4: Result of classification of the phytosociological relevés by the Expert system for Vegetation of the Czech Republic.....	20
Table 5: List of relevés.....	21
Table 6: Species composition of the grass seed mixture used on plot HA2, HB2 and HG2.....	27
Table 7: Categories of conservation statuses according to various red lists.....	30
Table 8: List of macromycetes in the Gravel Pit Hulín (area H).....	31
Table 9: List of bryophytes in the Gravel Pit Hulín (area H).....	32
Table 10: List of vascular plant taxa in the Gravel Pit Hulín (area H) and Kvasice (area K).....	33
Table 11: List of endangered vascular plant taxa in the surroundings areas (L,P,S,T,Z,ST).....	50
Table 12: Localization of endangered vascular plant taxa in the Gravel Pit Hulín (area H).....	51
Table 13: Localisation of endangered vascular plant taxa in the Gravel Pit Kvasice (area K).....	53
Table 14: Localisation of endangered vascular plant taxa in the surroundings areas (L,P,S,T,Z,ST).....	53
Table 15: List of Araneae and Opiliones in the Gravel Pit Hulín (area H).....	55
Table 16: List of dragonflies and damselfies (Odonata) in the Gravel Pit Hulín and Kvasice (area H and K).....	56
Table 17: List of Orthoptera in the Gravel Pit Hulín (area H).....	57
Table 18: List of ground beetles (Carabidae) in in the Gravel Pit Hulín (area H) and Kvasice (area K).....	57
Table 19: List of birds (Aves) in the Gravel Pit Hulín (area H).....	58

Appendix 1: Maps.



Figure 1: Map of the region of interest divided into studied areas.

The areas are labelled according to their abbreviations used in the text. For verbal delimitation of the areas see appendix 2.

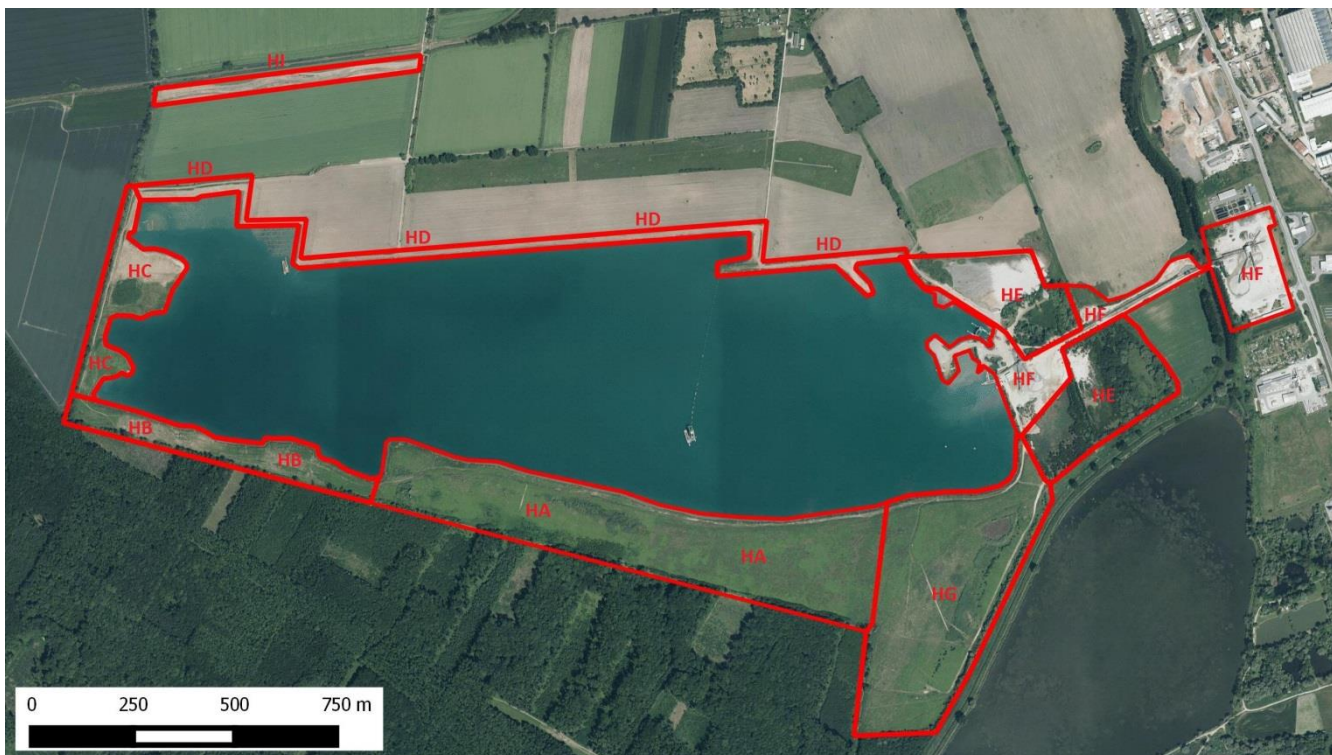


Figure 2: Map of the Gravel Pit Hulín (area H) – divided into sectors.

The sectors are labelled according to their abbreviations used in the text. For verbal delimitation of the sectors see appendix 2.

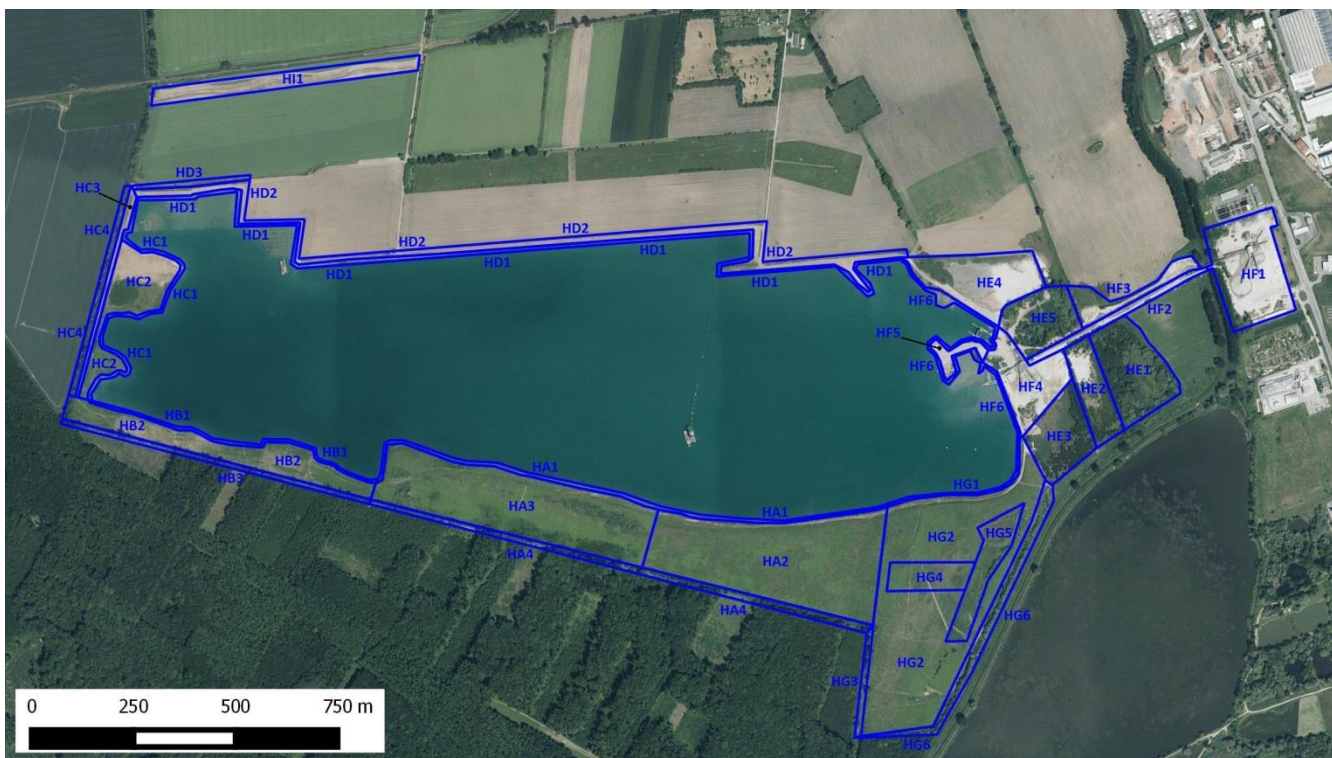


Figure 3: Map of the Gravel Pit Hulín (area H) – divided into plots.

The plots are labelled according to their abbreviations used in the text. For verbal delimitation of the plots see appendix 2.

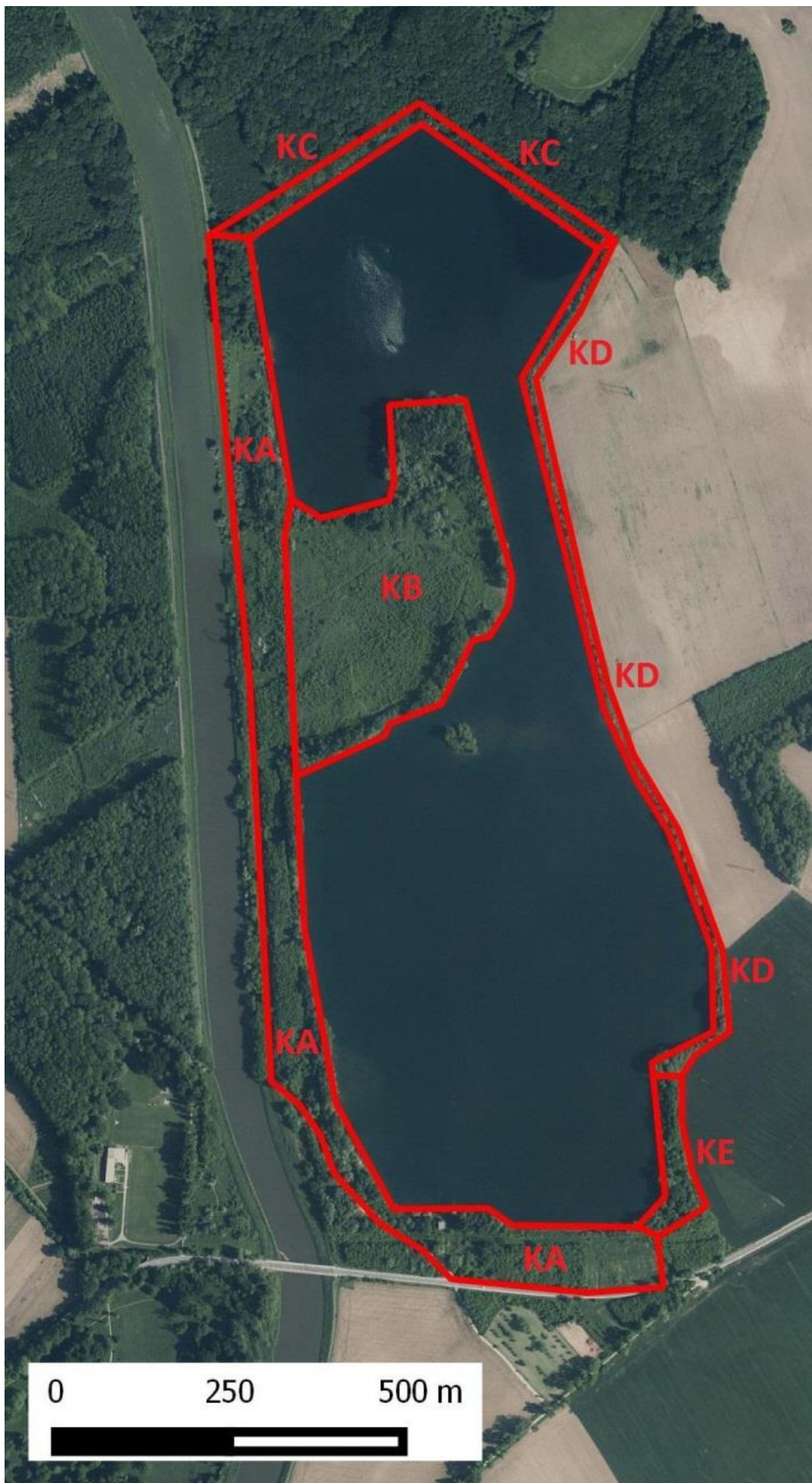


Figure 4: Map of the Gravel Pit Kvasice (area K) – divided into sectors.

The sectors are labelled according to their abbreviations used in the text. For verbal delimitation of the sectors see appendix 2.



Figure 5: Map of the Gravel Pit Kvasice (area K) – divided into plots.
The plots are labelled according to their abbreviations used in the text. For verbal delimitation of the plots see appendix 2.

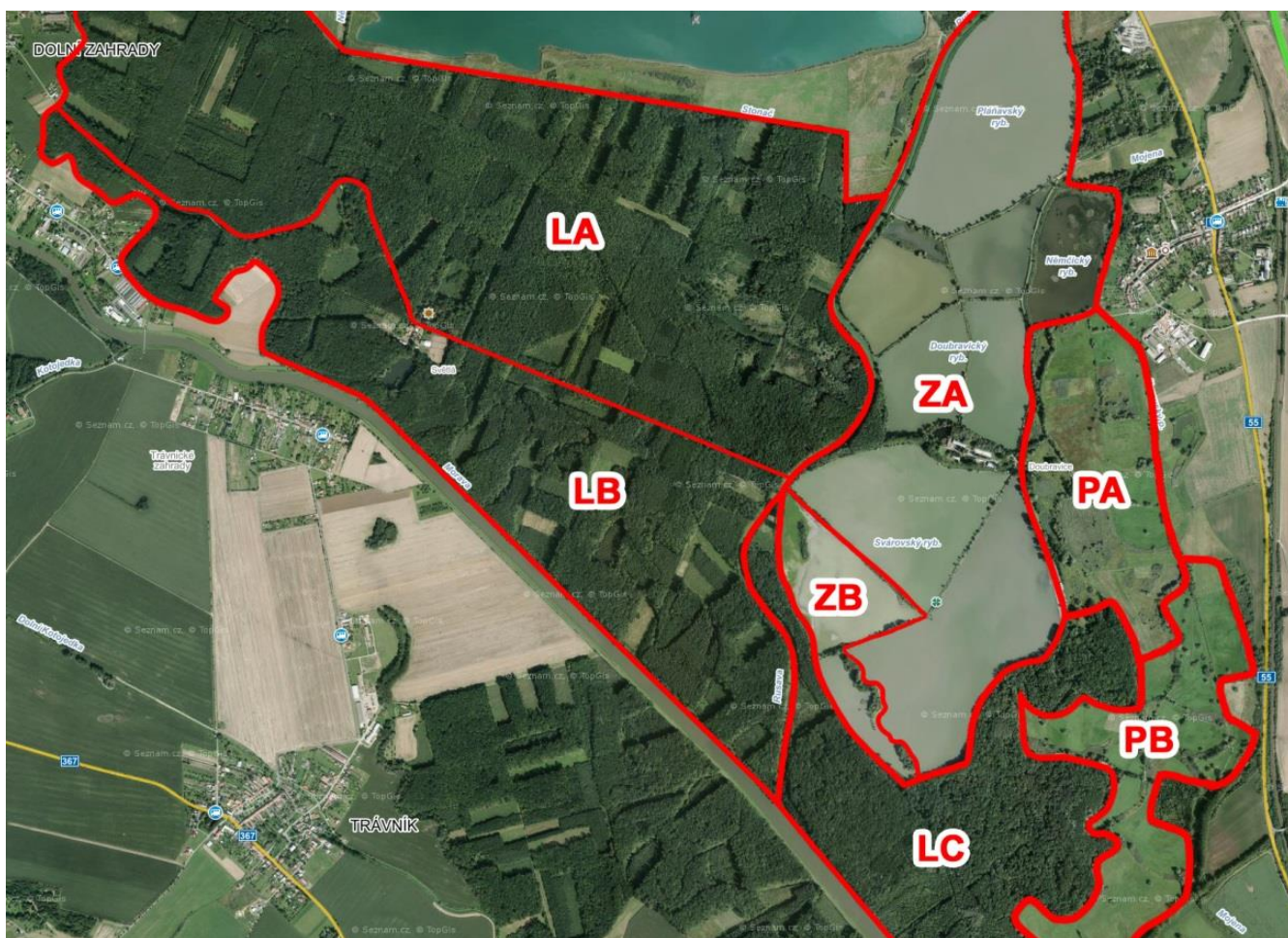


Figure 6: Map of the studied areas L, Z, P – divided into sectors.

The sectors are labelled according to their abbreviations used in the text. Area of the Gravel Pit Hulín and Kvasice is not shown. For verbal delimitation of the sectors see appendix 2.

Legend

- ★ *Batrachium baudotii* (C1)
- ★ *Crepis setosa* (C1)
- ☆ *Populus nigra* (C1)
- *Rumex stenophyllus* (C2)
- *Salsola tragus* (C2)
- *Scutellaria hastifolia* (C2)
- *Senecio sarracenicus* (C2)
- *Verbascum blattaria* (C2)
- *Veronica agrestis* (C2)
- *Bolboschoenus yagara* (C3)
- *Centaureum pulchellum* (C3)
- *Dysphania botrys* (C3)
- *Euphorbia palustris* (C3)
- *Filago arvensis* (C3)
- *Hyoscyamus niger* (C3)
- *Lotus tenuis* (C3)
- *Pulmonaria mollis* (C3)
- *Silaum silaus* (C3)
- *Silene baccifera* (C3)
- *Stellaria neglecta* (C3)
- *Thalictrum lucidum* (C3)
- *Veronica catenata* (C3)
- *Vulpia myuros* (C3)
- group I
- group II
- group III
- group IV

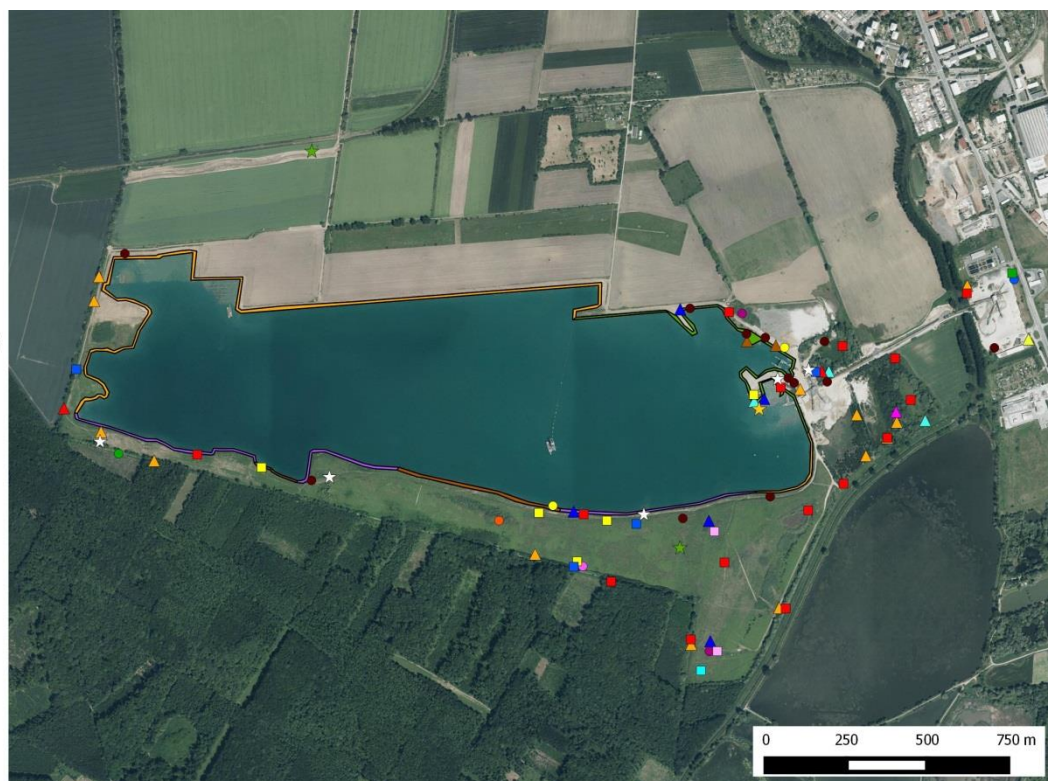


Figure 7: Map of the interesting floristic findings in the Gravel Pit Hulín (area H).

All species in red list category C1-C3 found in the gravel pit are presented. **Group I:** *Batrachium circinatum*, *B. rionii*, *Cyperus fuscus*, *Epilobium parviflorum*. **Group II:** *Batrachium circinatum*, *B. rionii*, *Bolboschoenus yagara*, *Cyperus fuscus*, *Epilobium parviflorum*. **Group III:** *Batrachium circinatum*, *B. rionii*, *Bolboschoenus yagara*, *Epilobium parviflorum*. **Group IV:** *Batrachium circinatum*, *B. rionii*, *Epilobium parviflorum*.

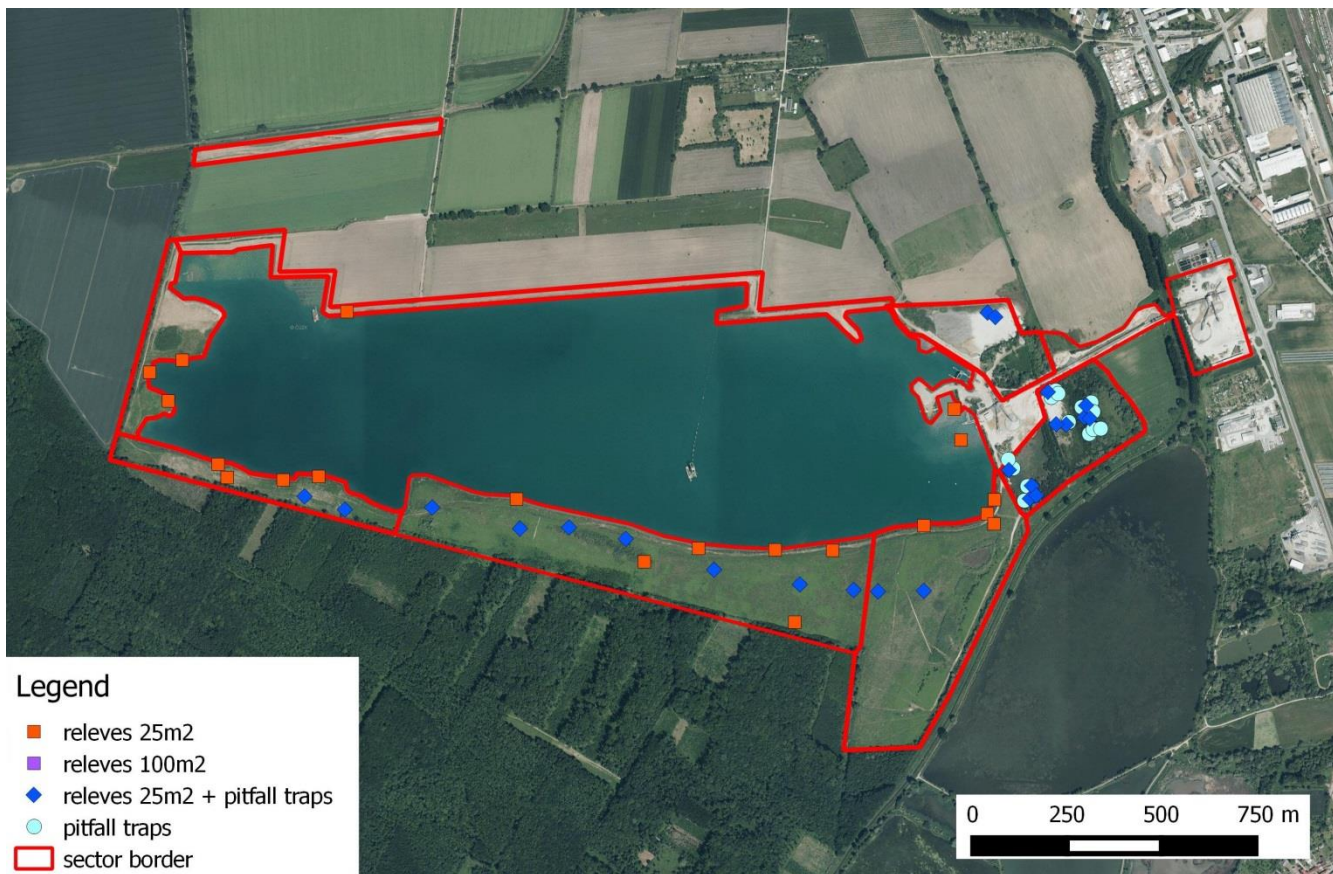


Figure 8: Distribution of the phytosociological relevés and pitfall traps in the Gravel Pit Hulín (area H).

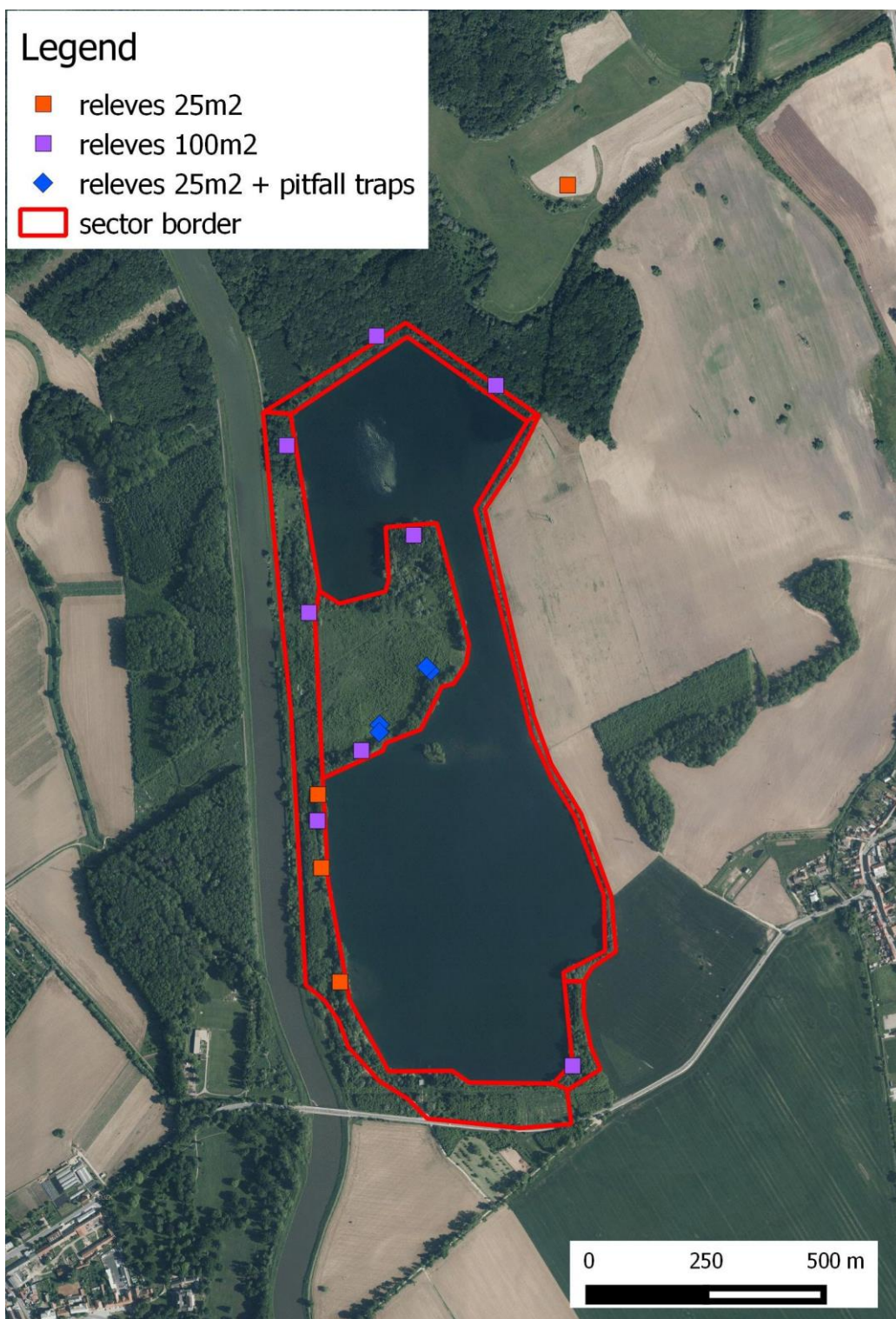


Figure 9: Distribution of the phytosociological relevés and pitfall traps in the Gravel Pit Kvasice (area K).

Appendix 2: A description of the plots and sectors.

Each of the investigated plot was designated by a code corresponding to three hierarchical units: area (the first letter) – sector (the second letter) – plot (a digit).

H: Gravel Pit Hulín

HA: sector comprised of the part of the area covered with overburden (finished in 1994)

HA1: littoral zone (between the lake and the erosion edge of the bank)

HA2: plot sowed with the grass seed mixture with shallow cultivation, mowed twice a year, with tree plantation along the bank of the lake

HA3: trees planted on a part of the plot, the rest of the plot left to spontaneous succession

HA4: bed of the Stonáč brook

HB: sector comprised of the part of the area covered with overburden (finished in 2010)

HB1: littoral zone (between the lake and the erosion edge of the bank)

HB2: plot originally restored to a grassland with *Festuca arundinacea*, sowed with a grass seed mixture with shallow cultivation in 2013, mowed twice a year, with tree plantation along the bank of the lake

HB3: bed of the Stonáč brook

HC: sector comprised of the part of the area covered with overburden, largely covered with tree plantation in 2015

HC1: littoral zone (between the lake and the erosion edge of the bank)

HC2: fenced off tree plantation

HC3: plot between the fenced off tree plantation and the bed of the Stonáč brook; expected to become a dike separating two lakes in the future

HC4: bed of the Němčický brook

HD: currently or prospectively mined parts of the area

HD1: littoral zone (between the lake and the erosion edge of the bank)

HD2: plot between the littoral zone and the edge of the field

HD3: wet ditch in the north-west of the sector

HE: sludge deposits and places covered with landfill

HE1: the oldest sludge deposit, covered with landfill in 1989

HE2: sludge deposit filled in 1995, partly harvested in 2016

HE3: sludge deposit filled in 1999

HE4: sludge deposit filled in 2013

HE5: plot covered with landfill (overburden) in 1995-2000

HF: sector comprised of material storage and transportation routes

HF1: place of storage in the eastern part of the sector

HF2: conveyor belt and the road alongside

HF3: wet ditch along the conveyor belt

HF4: place of storage in the western part of the sector

HF5: haven (excluding the littoral zone)

HF6: littoral zone on the eastern bank of the lake (between the lake and the erosion edge of the bank), newly established sludge deposit (still being filled)

HG: sector comprised of the part of the area covered with overburden (finished in 1988)

HG1: littoral zone (between the lake and the erosion edge of the bank)

HG2: plot sowed with the grass seed mixture with deep cultivation, mowed twice a year, with tree plantation along the bank of the lake

HG3: bed of the Stonáč brook and its left tributary in the eastern part of the sector

HG4: non-sowed plot with predominant *Solidago gigantea*

HG5: wetlands with reed-bed and willows

HG6: bed of the left tributary of the Stonáč brook

HI: transferred bed of the Němčický brook

K: Gravel Pit Kvasice

KA: western and eastern part of the area, left to spontaneous succession

KA1: littoral zone in the southern part of the sector (between the lake and the erosion edge of the bank)

KA2: grassland in the south-eastern part of the sector

KA3: spontaneously developed secondary forest

KA4: grasslands in the northern part of the sector

KA5: forest in the northern part of the sector – probably partly planted and partly spontaneously developed

KA6: littoral zone in the north part of the sector (between the lake and the erosion edge of the bank)

KB: peninsula formed as a consequence of mining activities

KB1: littoral zone (between the lake and the erosion edge of the bank)

KB2: spontaneously developed secondary forest

KB3: pool

KB4: periodically mowed places under the high-voltage power lines

KC: natural floodplain-forest to the north of the gravel pit, arisen before the mining activities, but influenced by them

KC1: littoral zone (between the lake and the erosion edge of the bank)

KC2: floodplain-forest in the surroundings of the gravel pit

KD: eastern bank of the lake, surrounded by fields

KD1: littoral zone (between the lake and the erosion edge of the bank)

KD2: plot between the littoral zone and the edge of the field

KE: forests in the south-eastern part of the area – a probably spontaneously developed forest and a spruce forest plantation

KE1: littoral zone (between the lake and the erosion edge of the bank)

KE2: forests in the south-eastern part of the area

L: floodplain forest between the Gravel Pit Hulín and Kvasice

LA: floodplain forest in the vicinity of the Gravel Pit Hulín, with the south border on the “Planorbis” nature trail

LB: middle part of the floodplain forest, delimited by the “Planorbis” nature trail in the north, the Rusava brook in the east and the Morava river in the south

LC: floodplain forest in the vicinity of the Gravel Pit Kvasice

P: The Přední louky meadows (wet meadows south from village Záhlinice)

PA: northern part

PB: southern part

S: Nature monument Skalky u Hulína

T: Nature monument Tlumačovská tůňka

ST: Nature monument Stonáč

Z: The Záhlinické rybníky fishponds

ZA: The Záhlinické rybníky fishponds excluding the eastern part of the Svárovský fishpond

ZB: eastern part of the Svárovský fishpond

Appendix 3: Biodiversity indicators.

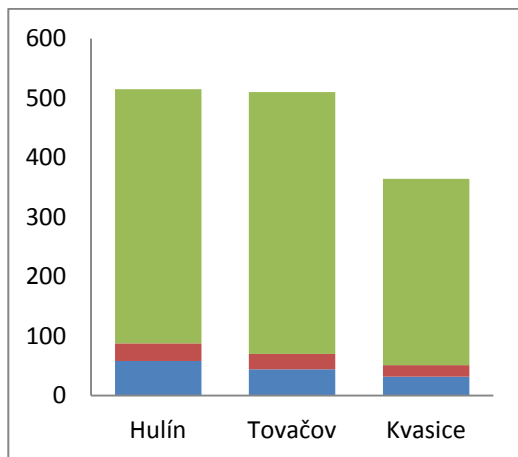


Figure 10: The total number of vascular plant taxa in the gravel pit Hulín, Kvasice and Tovačov.
Blue = endangered taxa, **red** = invasive taxa, **green** = other taxa.

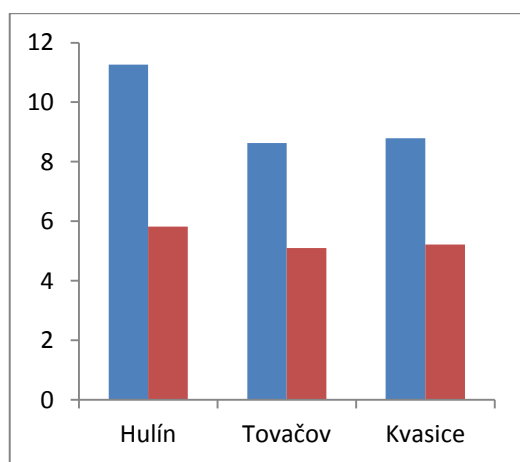


Figure 11: The percentage (%) of endangered and invasive vascular plant taxa in the gravel pit Hulín, Kvasice and Tovačov.
Blue = endangered taxa, **red** = invasive taxa.

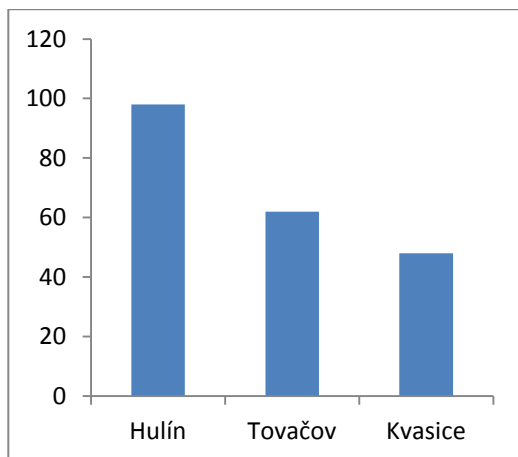


Figure 12: Number of vascular plant taxa weighted by their red list category in the gravel pit Hulín, Kvasice and Tovačov.
 Following weights were used: C1 = 4, C2 = 3, C3 = 2, C1 = 1, others = 0.

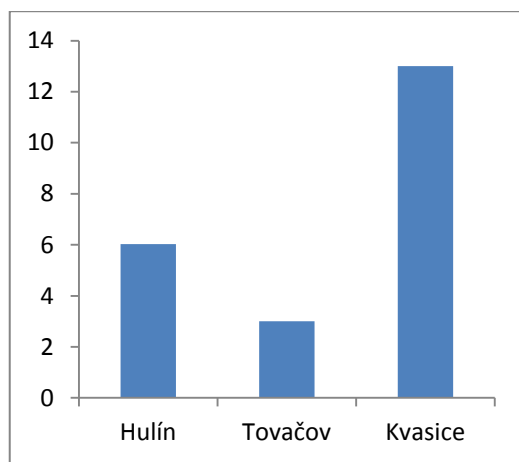


Figure 13: The number of vascular plant taxa/total area in the gravel pit Hulín, Kvasice and Tovačov.
(total area of the gravel pit = area under inventory survey [ha] excluding the body of water)

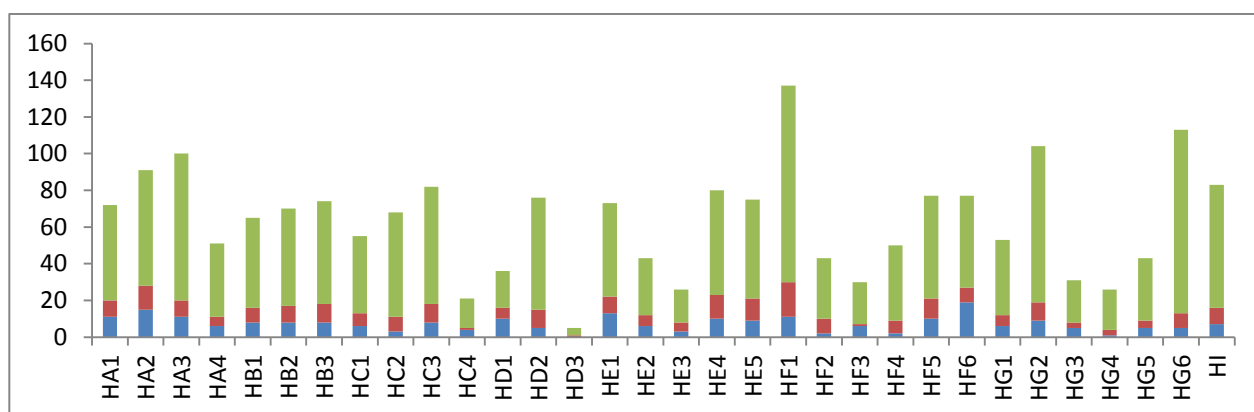


Figure 14: The total number of vascular plant taxa on particular plots of the Gravel Pit Hulín.
Blue = endangered taxa, red = invasive taxa, green = other taxa.

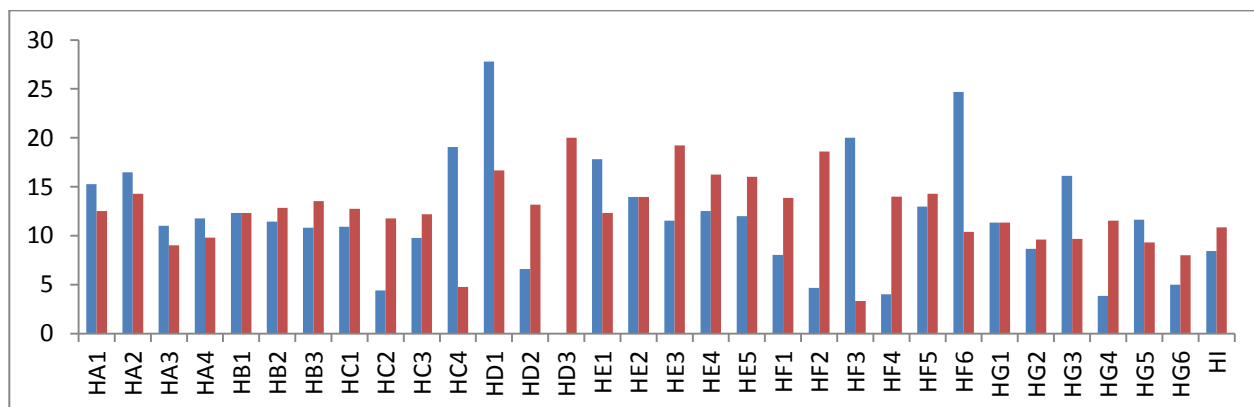


Figure 15: The percentage (%) of endangered and invasive vascular plant taxa on particular plots of the Gravel Pit Hulín.
Blue = endangered taxa, red = invasive taxa.

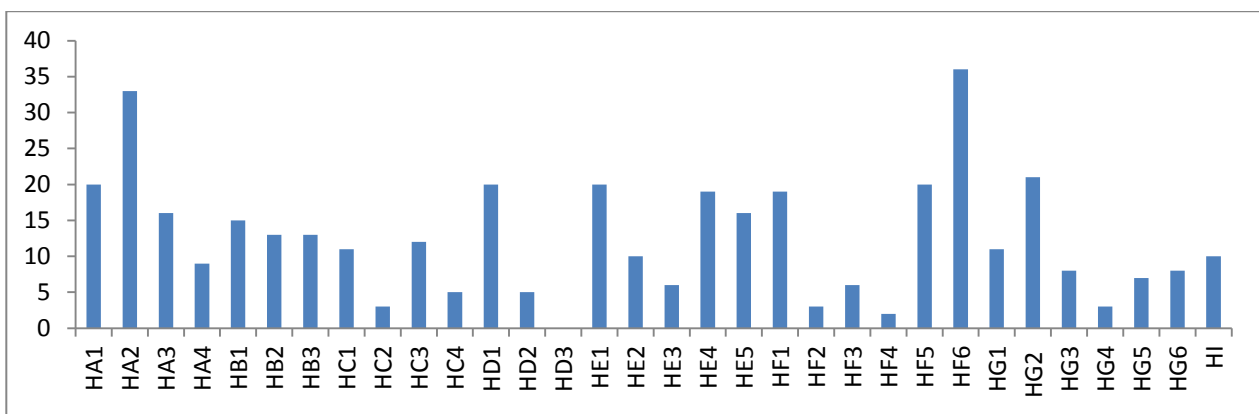


Figure 16: Number of vascular plant taxa weighted by their red list category on particular plots of the Gravel Pit Hulín.

Following weights were used: C1 = 4, C2 = 3, C3 = 2, C1 = 1, others = 0.

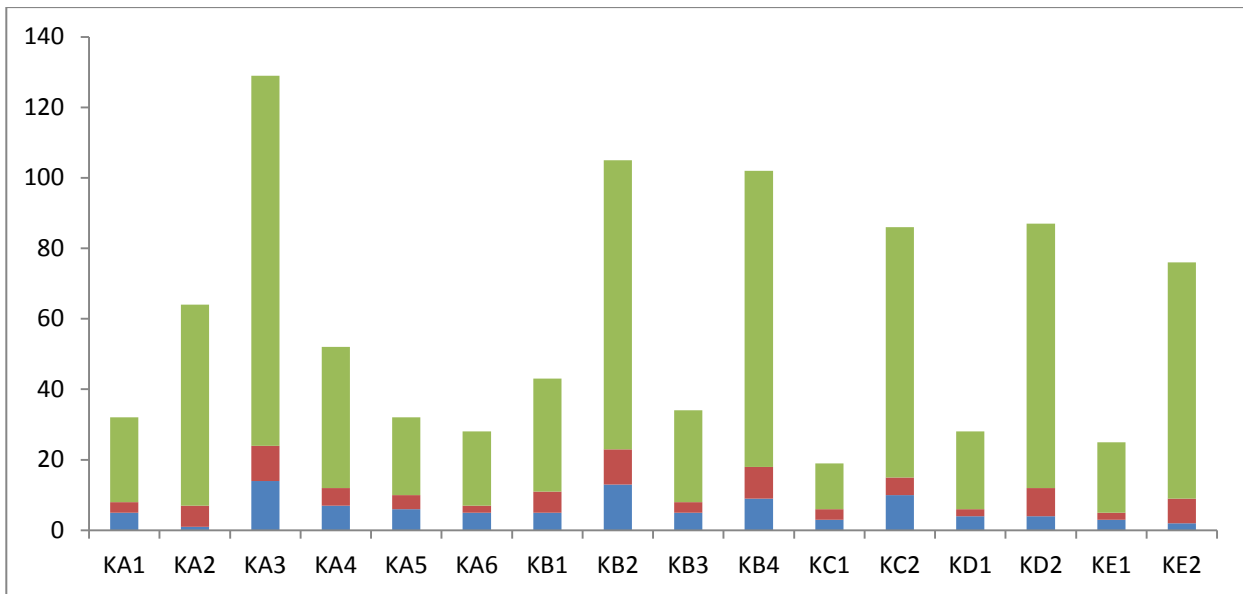


Figure 17: The total number of vascular plant taxa on particular plots of the Gravel Pit Kvasice.

Blue = endangered taxa, red = invasive taxa, green = other taxa.

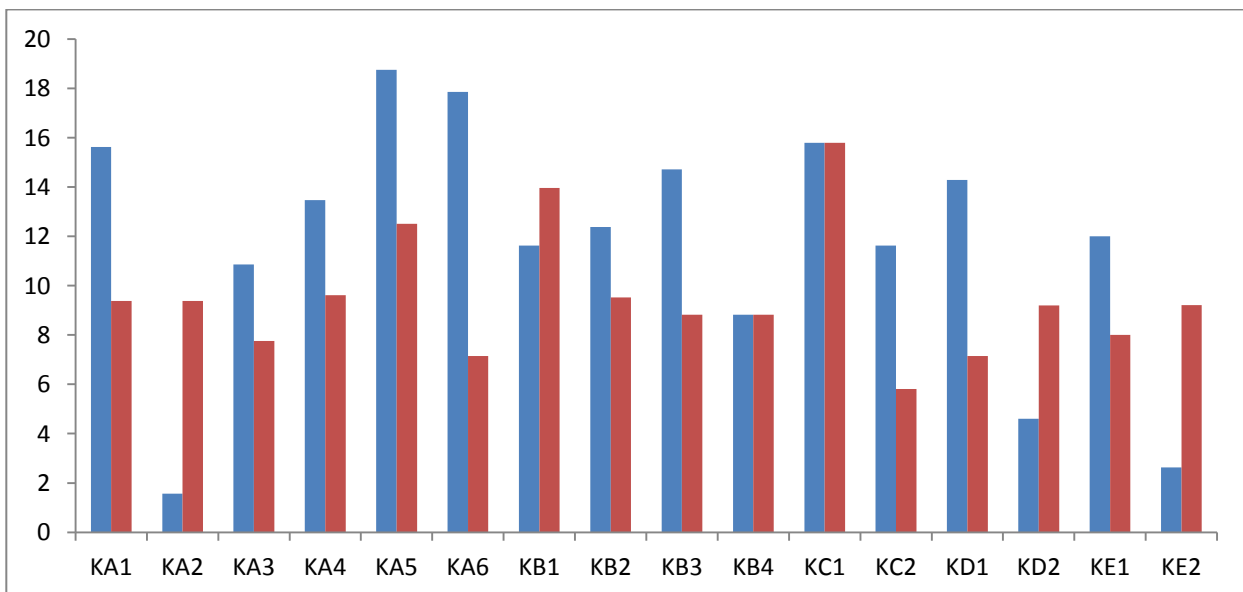


Figure 18: The percentage (%) of endangered and invasive vascular plant taxa on particular plots of the Gravel Pit Kvasice.

Blue = endangered taxa, red = invasive taxa.

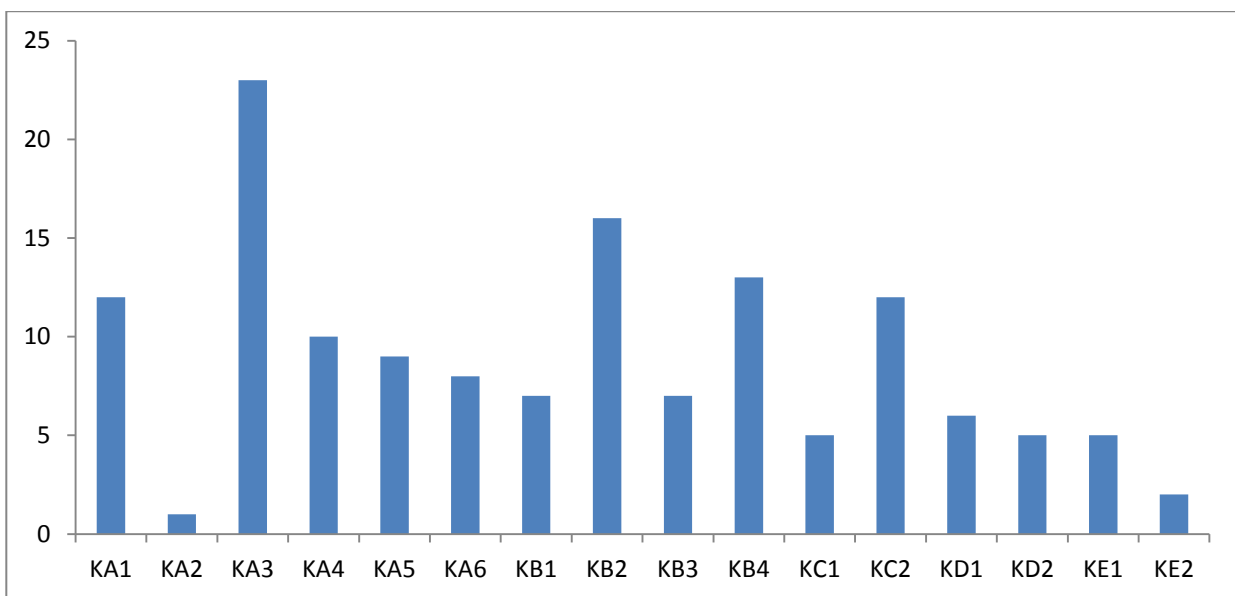


Figure 19: Number of vascular plant taxa weighted by their red list category on particular plots of the Gravel Pit Kvasice.

Following weights were used: C1 = 4, C2 = 3, C3 = 2, C1 = 1, others = 0.

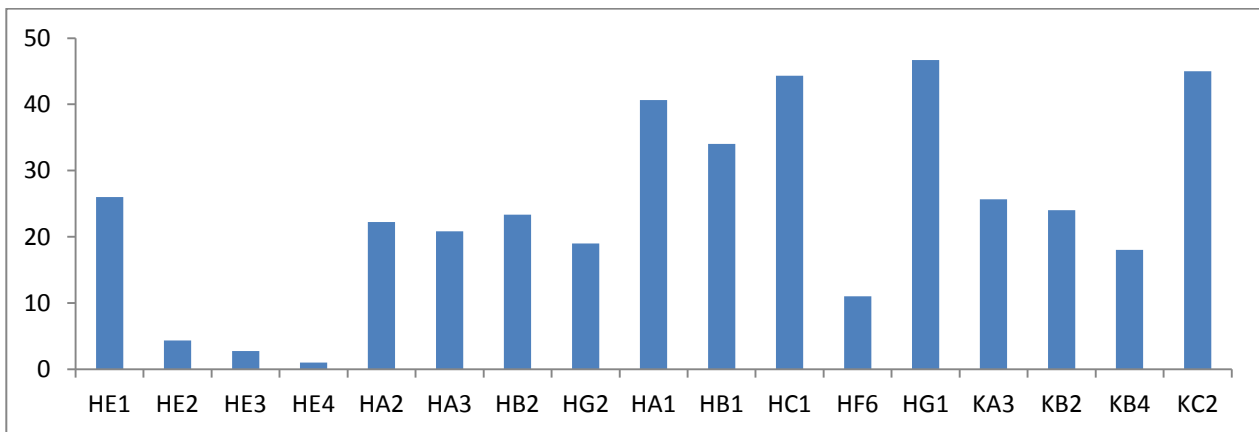


Figure 20: Average number of vascular plant taxa in phytosociological relevés (25 m²) on particular plots of the Gravel Pit Kvasice and Hulín.

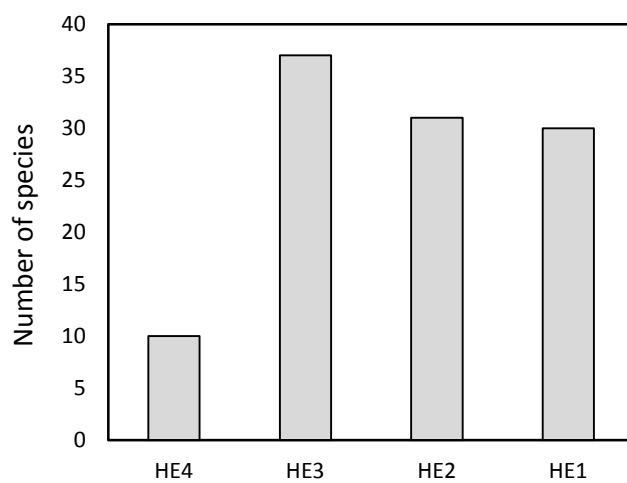


Figure 21: Total number of Carabidae species on the sludge deposits.

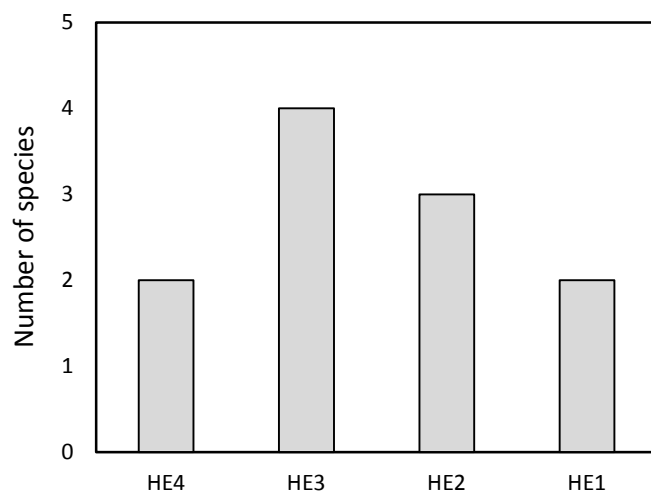


Figure 22: Number of conservation important Carabidae species on the sludge deposits.

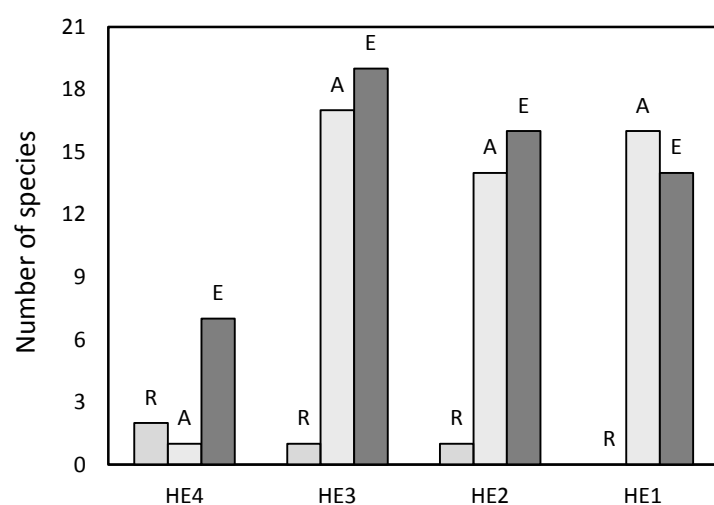


Figure 23: The total number of Carabidae species on the sludge deposits based on their bioindicating value. **R (relict)** = species with the narrowest ecological amplitude, **A (adaptable)** = species of natural habitats, **E (eurytop)** = species without specific requirements on the environmental quality (usually species of artificial habitats).

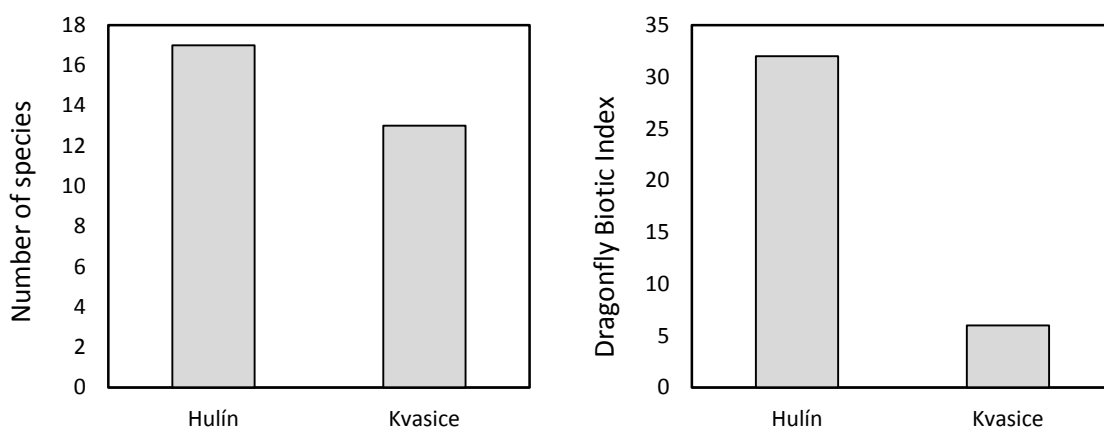


Figure 24: Comparison of gravel pit Hulín and Kvasice according to number of dragonfly species and dragonfly biotic index.

Appendix 4: Phytosociological analysis

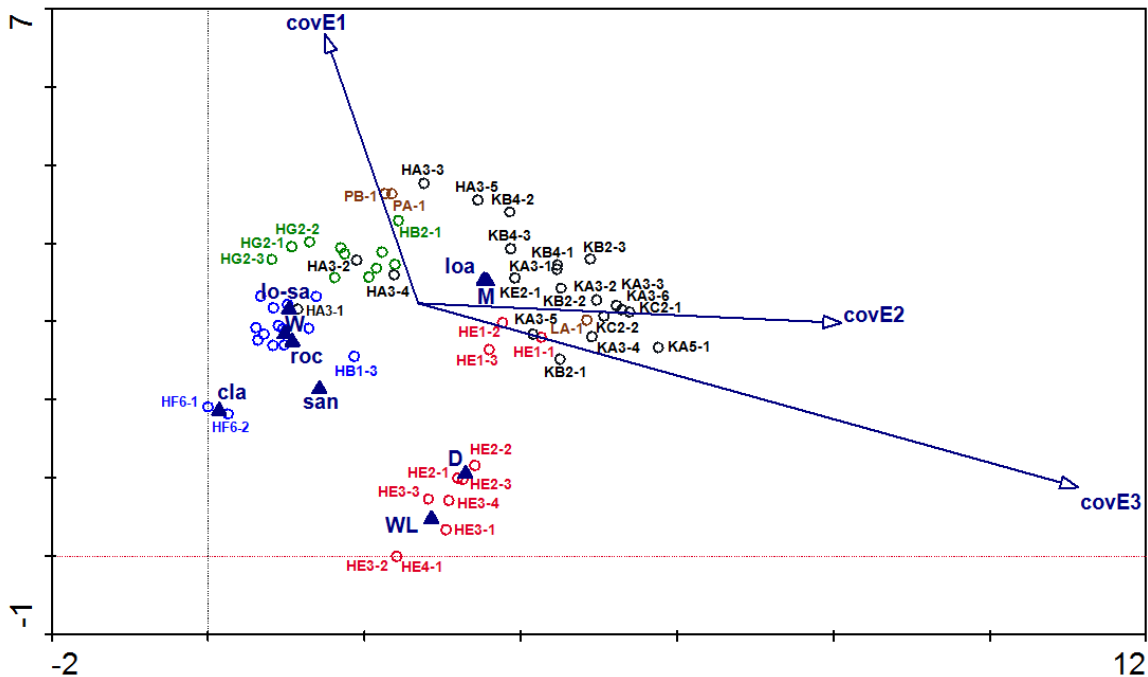


Figure 25: DCA of all relevés with passively projected environmental variables.

Vegetation cover: covE1 = cover herb layer, covE2 = cover shrub layer covE3 = cover tree layer; **moisture regime:** WL = waterlogged, M = mesophilous, W = wet, D = dry; **soil texture:** cla = clayey, loa = loamy, lo-sa = loamy-sandy, roc = rocky, san = sandy; **nospe** = number of species; **samples:** blue circle = relevés from littoral zone, green circle = relevés from mowing plots, red circle = relevés from sludge deposits, brown circle = relevés from surroundings of Gravel Pit Hulín and Kvasice, black circle = other relevés.

Table 1: Correlation of environmental variables with the first three ordination axes for DCA analysis of all relevés.

	CovE3	CovE2	CovE1	WL	W	M	D	san	loa	roc	cla	lo-sa
axis 1	0.8952	0.5760	-0.1211	0.0085	-0.7274	0.7068	0.0408	-0.2490	0.6868	-0.3059	-0.2061	-0.3966
axis 2	-0.1737	-0.0016	0.2951	-0.3062	-0.3709	0.4944	-0.3219	-0.4757	0.5199	-0.2058	-0.2439	-0.0409
axis 3	0.0589	-0.4324	0.5574	0.0296	-0.2799	0.2671	0.0169	-0.0857	0.2450	-0.1222	-0.1059	-0.1209

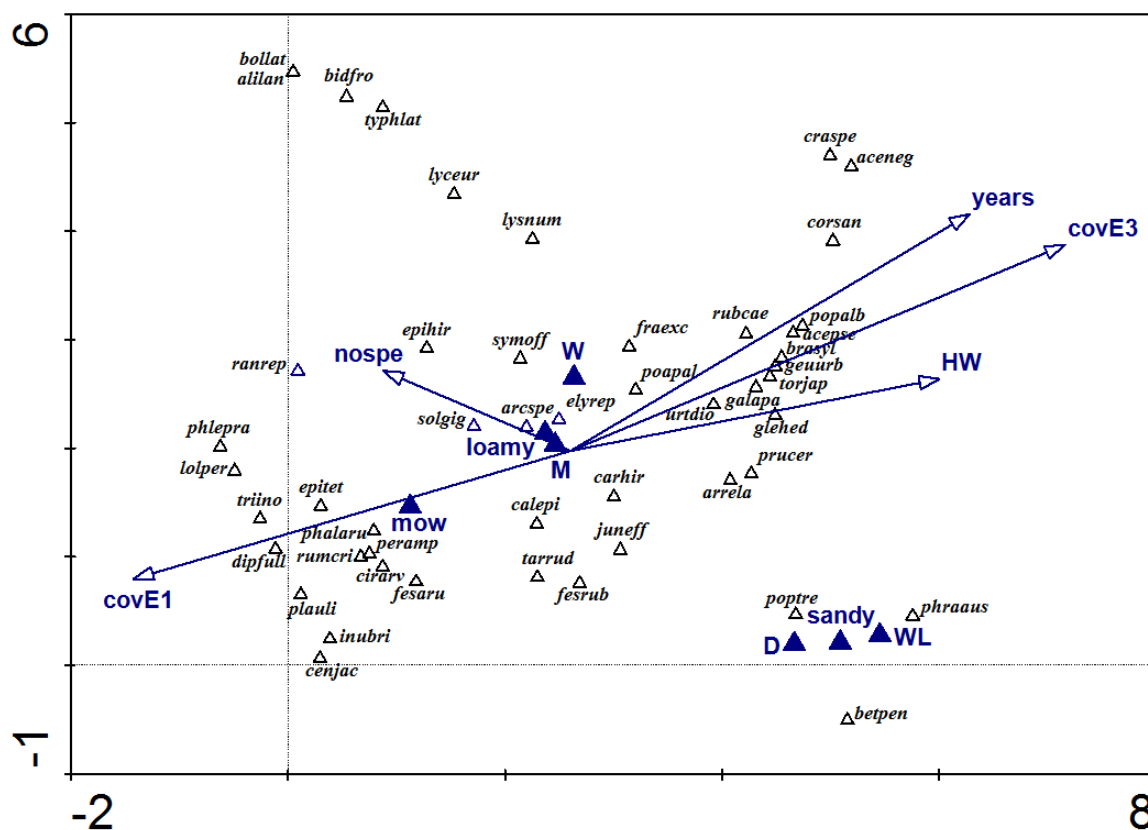


Figure 26: DCA based on relevés of area 25m² excluding relevés of the littoral zone (species and passively projected environmental variables are shown).

Vegetation cover: covE1 = cover herb layer, covE3 = cover tree layer; **moisture regime:** WL = waterlogged, M = mesophilous, W = wet, D = dry; **soil texture:** loamy, sandy; **management:** mow = mowing; **HW** = height above the water (lake) level in the summer; **nospe** = number of species; **taxon:** aceneg = *Acer negundo*, acepse = *Acer pseudoplatanus*, alilan = *Alisma lanceolatum*, arcspe = *Arctium* sp., arrela = *Arrhenatherum elatius*, betpen = *Betula pendula*, bidfro = *Bidens frondosa*, bollat = *Bolboschoenus laticarpus*, brasyl = *Brachypodium sylvaticum*, calepi = *Calamagrostis epigejos*, carhir = *Carex hirta*, cenjac = *Centaurea jacea*, cirarv = *Cirsium arvens*, corsan = *Cornus sanguinea*, craspe = *Crataegus* species, dipfull = *Dipsacus fullonum*, elyrep = *Elymus repens*, epihir = *Epilobium hirsutum*, epitet = *Epilobium tetragonum*, fesaru = *Festuca arundinacea*, fesrub = *Festuca rubra*, fraexc = *Fraxinus excelsior*, galapa = *Galium aparine*, geuurb = *Geum urbanum*, glehed = *Glechoma hederacea*, inubri = *Inula britannica*, juneff = *Juncus effusus*, lolper = *Lolium perenne*, lyceur = *Lycopus europaeus*, lysnum = *Lysimachia nummularia*, peramp = *Persicaria amphibia*, phalaru = *Phalaris arundinacea*, phlepra = *Phleum pratense*, phraaus = *Phragmites australis*, plauli = *Plantago uliginosa*, poapal = *Poa palustris*, popalb = *Populus alba*, poptre = *Populus tremula*, prucer = *Prunus cerasifera*, ranrep = *Ranunculus repens*, rubcae = *Rubus caesius*, rumcric = *Rumex crispus*, solgig = *Solidago gigantea*, symoff = *Symphytum officinale*, tarrud = *Taraxacum* sect. *Taraxacum*, torjap = *Torilis japonica*, triino = *Tripleurospermum inodorum*, typhlat = *Typha latifolia*, urtdio = *Urtica dioica*.

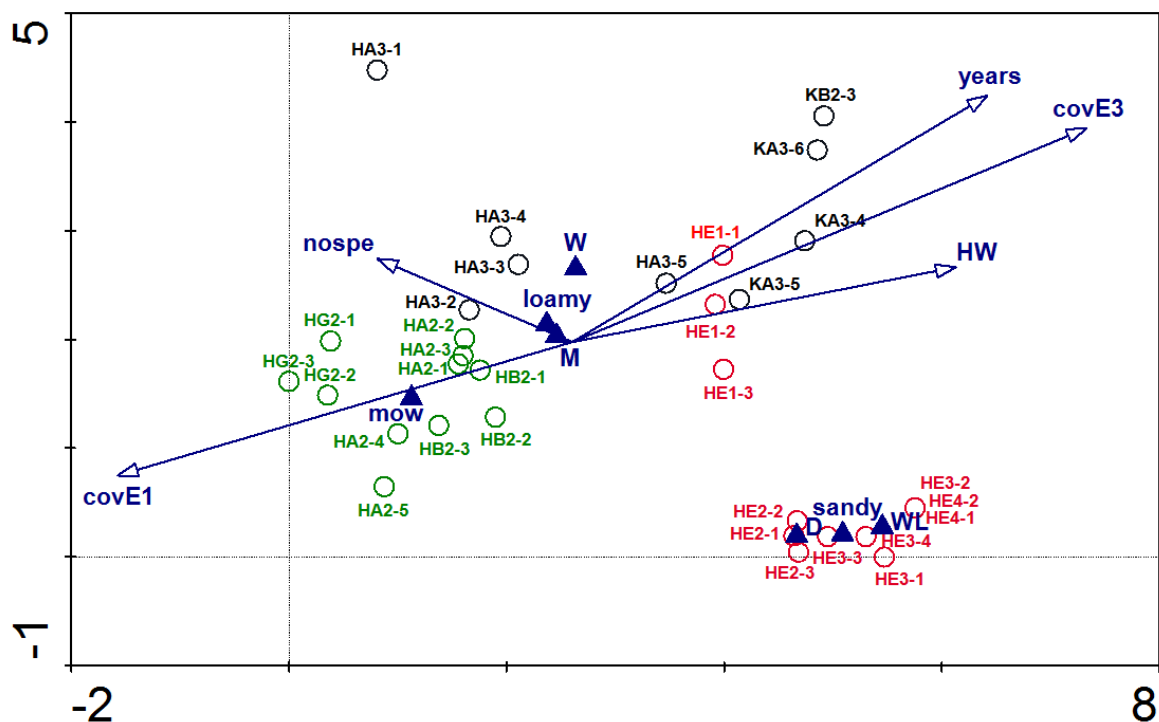


Figure 27: DCA based on relevés of area 25m² excluding relevés of littoral zone (samples and passively projected environmental variables are shown).

Vegetation cover: covE1 = cover herb layer, covE3 = cover tree layer; **moisture regime:** WL = waterlogged, M = mesophilous, W = wet, D = dry; **soil texture:** loamy, sandy; **management:** mow = mowing; **HW** = height above the water (lake) level in the summer; **nospe** = number of species; **samples:** greens circle = relevés from mowing plots, red circle = relevés from sludge deposits, black circle = other relevés.

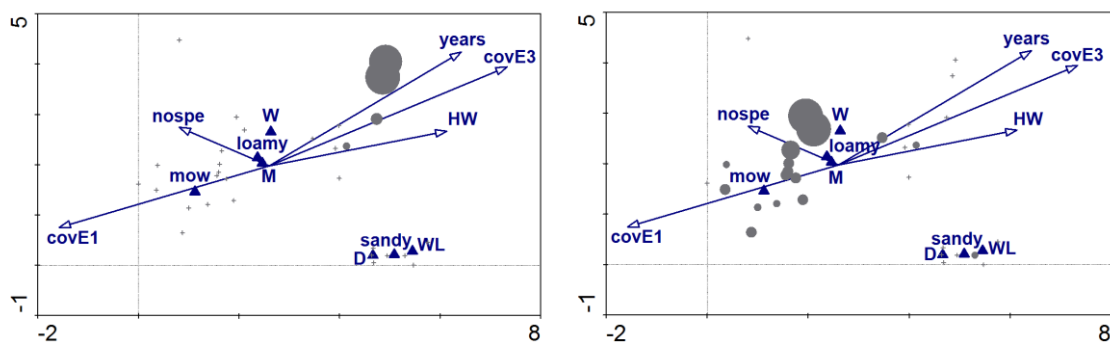


Figure 28: DCA based on relevés of area 25m² excluding relevés of littoral zone (attribute plots of samples according to the cover of the most frequent invasive species).

Invasive species used in the plots: *Acer negundo* (on the left), *Solidago gigantea* (on the right). **Vegetation cover:** covE1 = cover herb layer, covE3 = cover tree layer; **moisture regime:** WL = waterlogged, M = mesophilous, W = wet, D = dry; **soil texture:** loamy, sandy; **management:** mow = mowing; **HW** = height above the water (lake) level in the summer; **nospe** = number of species.

Table 2: Correlation of environmental variables with the first three ordination axes for DCA analysis of relevés of area 25m² excluding relevés of littoral zone.

	covE3	covE2	covE1	nospe	HW	WL	W	M	D	years	sandy	loamy	mow
axis 1	0.7797	0.6331	-0.6822	-0.2758	0.5718	0.2395	0.0049	-0.2378	0.2315	0.6377	0.4589	-0.4589	-0.7804
axis 2	0.3753	0.3045	-0.2588	0.0714	0.1699	-0.2331	0.1707	0.1561	-0.3264	0.3982	-0.5326	0.5326	-0.4440
axis 3	-0.0769	0.4563	-0.3526	-0.1598	-0.4900	-0.0744	-0.0332	-0.0339	0.1607	0.2575	0.0444	-0.0444	-0.0327

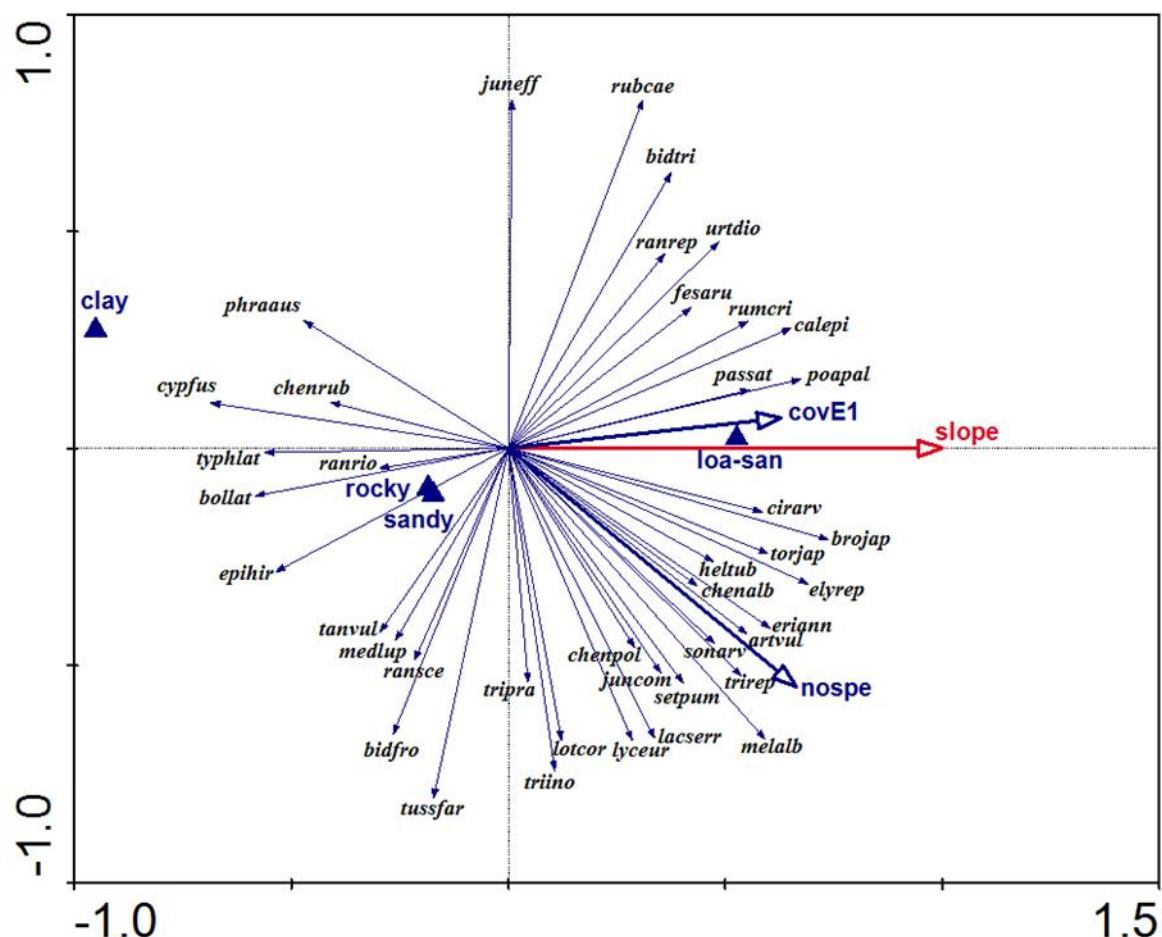


Figure 29: RDA of the response of species composition on the slope the banks (species are shown).

Passive variables: covE1 = cover herb layer; **soil texture:** sandy, rocky, clay = clayey, loa-san = loamy-sandy; **nospe** = number of species, **taxon:** Artvul = *Artemisia vulgaris*, bidfro = *Bidens frondosa*, bidtri = *Bidens tripartita*, bollat = *Bolboschoenus laticarpus*, brojap = *Bromus japonicus*, calepi = *Calamagrostis epigejos*, cirarv = *Cirsium arvense*, cypfus = *Cyperus fuscus*, elyrep = *Elymus repens*, epihir = *Epilobium hirsutum*, eriann = *Erigeron annuus*, fesaru = *Festuca arundinacea*, heltub = *Helianthus tuberosus*, chenalb = *Chenopodium album*, chenpol = *Chenopodium polyspermum*, chenrub = *Chenopodium rubrum*, juncom = *Juncus compressus*, juneff = *Juncus effusus*, lotcor = *Lotus corniculatus*, lyceur = *Lycopus europaeus*, medlup = *Medicago lupulina*, melalb = *Melilotus albus*, passat = *Pastinaca sativa*, phraaus = *Phragmites australis*, poapal = *Poa palustris*, ranrep = *Ranunculus repens*, ranrio = *Btarachium rionii*, ransce = *Ranunculus sceleratus*, rubcae = *Rubus caesius*, rumcri = *Rumex crispus*, setpum = *Setaria pumila*, sonarv = *Sonchus arvensis*, tanvul = *Tanacetum vulgare*, torjap = *Torilis japonica*, triino = *Tripleurospermum inodorum*, triptra = *Trifolium pratense*, trirep = *Trifolium repens*, tussfar = *Tussilago farfara*, typhlat = *Typha latifolia*, urtdio = *Urtica dioica*.

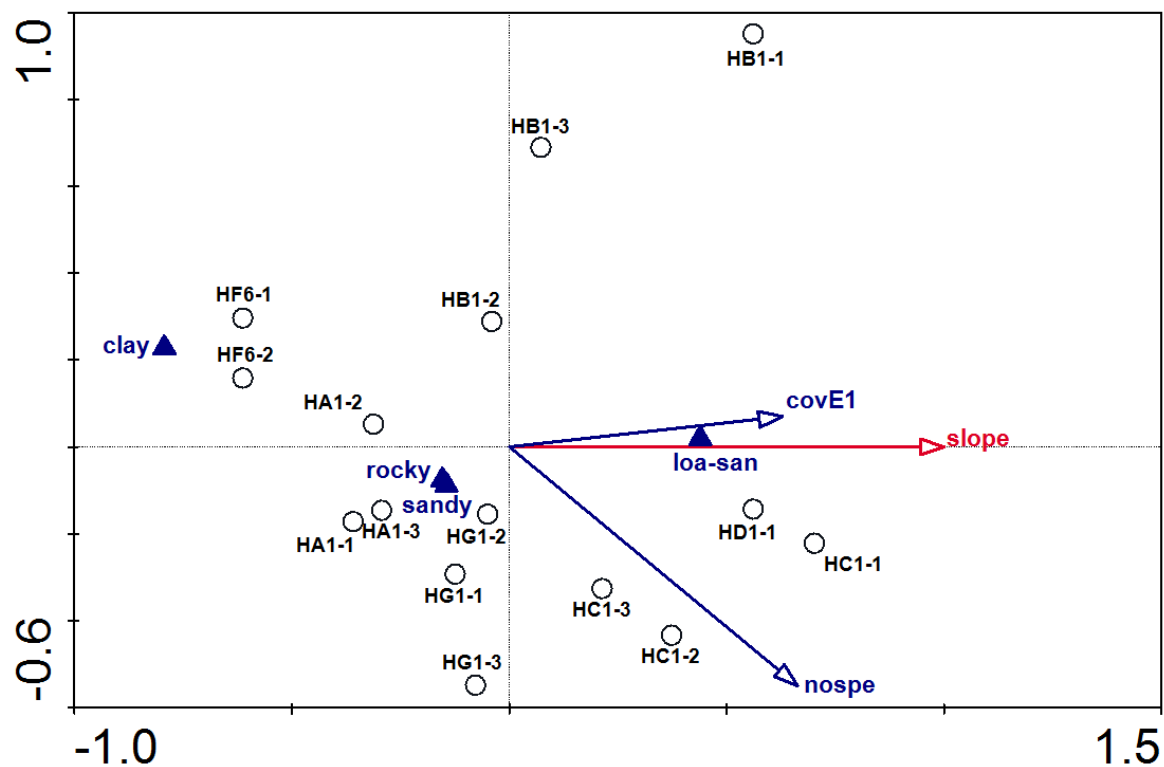


Figure 30: RDA of the response of species composition on the slope the banks (samples are shown).
Passive variables: covE1 = cover herb layer; **soil texture:** loamy, sandy, rocky, clay = clayey, loa-san = loamy-sandy; **nospe** = number of species.

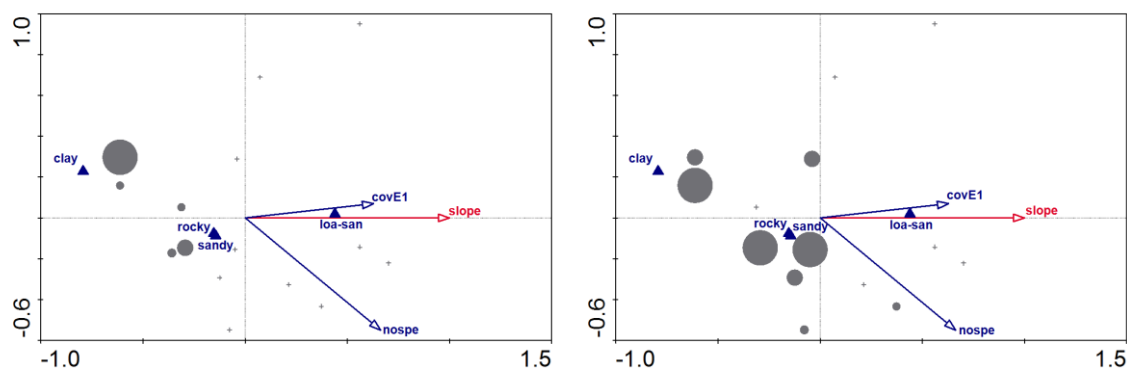


Figure 31: RDA of the response of species composition on the slope the banks (attribute plots of samples according to the cover of the *Cyperus fuscus* and *Bolboschoenus laticarpus*).
Species used in the plots: *Cyperus fuscus* (on the left), *Bolboschoenus laticarpus* (on the right); **Passive variables:** covE1 = cover herb layer; **soil texture:** loamy, sandy, rocky, clay = clayey, loa-san = loamy-sandy; **nospe** = number of species.

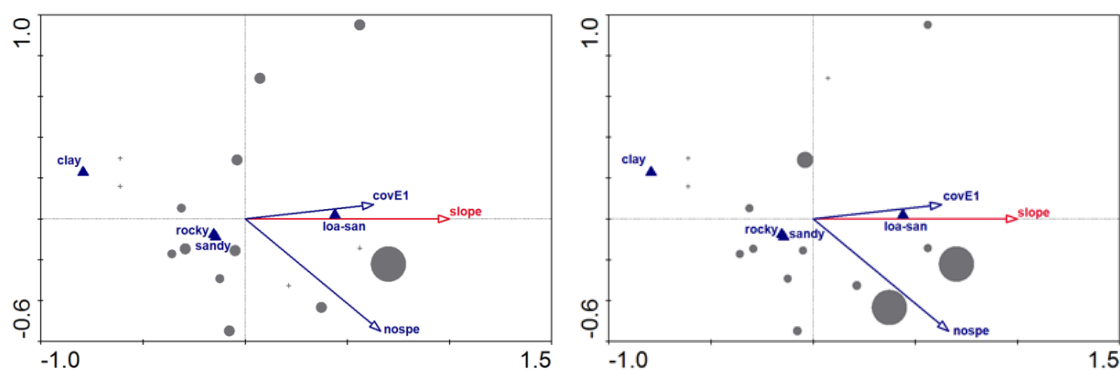


Figure 32: RDA of the response of species composition on the slope the banks (attribute plots of samples according to the cover of the invasive species).

Invasive species used in the plots: *Solidago gigante* (on the left), *Erigeron annuus* (on the right). **Passive variables:** covE1 = cover herb layer; **soil texture:** loamy, sandy, rocky, clay = clayey, loa-san = loamy-sandy; **nospe** = number of species.

Table 3: Report of the RDA analysis of the response of species composition on the slope the banks

Axes	1	2	3	4
Eigenvalues	0.189	0.172	0.130	0.107
Species-environment correlations	0.876	0.000	0.000	0.000
Cumulative percentage variance of species data	18.9	36.1	49.1	59.8
Test of significance of first canonical axis	F-ratio = 3.030		P-value = 0.004	

Table 4: Result of classification of the phytosociological relevés by the Expert system for Vegetation of the Czech Republic.

relevés	Cocktail classification	Most similar associations		FPFI (10 - 100 %)
	Name of association	Association code	Name of association	
HA1-1	-	MCC12	Tripleurospermo inodori-Bolboschoenetum planiculmi	38.4
		MCA03	Typhetum latifoliae	37.2
HA1-2	-	MBA01	Rumici maritimi-Ranunculetum scelerati	28.8
		MAA02	Cyperetum micheliani	28.8
HA1-3	Cyperetum micheliani	MAA02		
HA2-1	-	MCC12	Tripleurospermo inodori-Bolboschoenetum planiculmi	16.0
HA2-2	-	MCC12	Tripleurospermo inodori-Bolboschoenetum planiculmi	15
		MCH03	Caricetum gracilis	13.7
HA2-3	-	MCC12	Tripleurospermo inodori-Bolboschoenetum planiculmi	11.2
HA2-4	-	MCC12	Tripleurospermo inodori-Bolboschoenetum planiculmi	23.1
		MAC03	Pulicario vulgaris-Menthetum pulegioidis	18.1
HA2-5	-	MCC12	Tripleurospermo inodori-Bolboschoenetum planiculmi	28.3
		MAC02	Cerastio-Ranunculetum sardosi	21.5
HA3-1	Phalarido arundinaceae-Bolboschoenetum laticarpi	MCA10		
HA3-2	Rudbeckio laciniatae-Solidaginetum canadensis	XCB09		
HA3-3	-			
HA3-4	Rudbeckio laciniatae-Solidaginetum canadensis	XCB09		
HA3-5	-	MCA04	Phragmitetum australis	26.6
		MCA09	Typhetum shuttleworthii	14.4
HB1-1	-	MCC12	Tripleurospermo inodori-Bolboschoenetum planiculmi	25.3
		MBA02	Bidentetum tripartitae	25.3
HB1-2	-	MCC12	Tripleurospermo inodori-Bolboschoenetum planiculmi	40.4
		MCA10	Phalarido arundinaceae-Bolboschoenetum laticarpi	37.4
HB1-3	-	MCA04	Phragmitetum australis	33.9
		MCC12	Tripleurospermo inodori-Bolboschoenetum planiculmi	25.5
HB2-1	Convolvulo arvensis-Elytrigietum repens	XCC01		
HB2-2	-	MCA04	Phragmitetum australis	30.7
		MCC12	Tripleurospermo inodori-Bolboschoenetum planiculmi	15.4
HB2-3	-	MCC12	Tripleurospermo inodori-Bolboschoenetum planiculmi	25.9
		MAC02	Cerastio-Ranunculetum sardosi	15.0
HC1-1	Melilotetum albo-officinalis	XCB01		
HC1-2	Setario pumilace-Echinochloetum cruris-galli	XBF01		
HC1-3	Setario pumilace-Echinochloetum cruris-galli	XBF01		

HD1-1	Setario pumilace-Echinochloetum cruris-galli	XBF01							
HE1-1	-	KBD03	Sambuco nigrae-Aceretum negundo						18.2
		KBD01	Sambucetum nigrae						16.2
HE1-2	-	KBD03	Sambuco nigrae-Aceretum negundo						19.2
		KBE01	Chelidonio majoris-Robinetum pseudoacaciae						14.5
HE1-3		KBD03	Sambuco nigrae-Aceretum negundo						20.0
HE2-1	-	MCA04	Phragmitetum australis						22.6
HE2-2	-	MCA04	Phragmitetum australis						22.6
HE2-3	-	MCA04	Phragmitetum australis						22.6
HE3-1	Phragmitetum australis	MCA04							
HE3-2	Phragmitetum australis	MCA04							
HE3-3	Phragmitetum australis	MCA04							
HE3-4	Phragmitetum australis	MCA04							
HE4-1	-	MCA04	Phragmitetum australis						22.4
HE4-2	-	MCA04	Phragmitetum australis						22.4
HF6-1	-	MCA03	Typhetum latifoliae						29.5
		MCA10	Phalarido arundinaceae-Bolboschoenetum laticarpi						27.0
HF6-2	-	MCA10	Phalarido arundinaceae-Bolboschoenetum laticarpi						36.7
		MCA03	Typhetum latifoliae						29.9
HG1-1	-	MCA10	Phalarido arundinaceae-Bolboschoenetum laticarpi						44.5
		MCC12	Tripleurospermo inodori-Bolboschoenetum planiculmi						36.6
HG1-2	Phalarido arundinaceae-Bolboschoenetum laticarpi	MCA10							
HG1-3	Setario pumilace-Echinochloetum cruris-galli	XBF01							
HG2-1	Lolietum perennis	TDC03							
HG2-2	Lolietum perennis	TDC03							
HG2-3	Lolietum perennis	TDC03							
KA3-1	Sambuco nigrae-Aceretum negundo	KBD03							
KA3-2	-	KBD03	Sambuco nigrae-Aceretum negundo						27.1
		KBB06	Carpino betuli-Prunetum spinosae						21.6
KA3-3	Sambuco nigrae-Aceretum negundo	KBD03							
KA3-4	-	KBD03	Sambuco nigrae-Aceretum negundo						19.1
		LBA05	Pruno padi-Fraxinetum excelsioris						11.8
KA3-5	-	KBD03	Sambuco nigrae-Aceretum negundo						36.4
		LBA07	Fraxino pannonicae-Ulmetum glabrae						16.8
KA3-6	Sambuco nigrae-Aceretum negundo	KBD03							
KA5-1	-	LBA06	Ficario verna-Ulmetum campestris						23.1
		LBA05	Pruno padi-Fraxinetum excelsioris						22.2
KB2-1	-	MCA04	Phragmitetum australis						27.6
		LBA07	Fraxino pannonicae-Ulmetum glabrae						23.8
KB2-2	Sambuco nigrae-Aceretum negundo	KBD03							
KB2-3	Sambuco nigrae-Aceretum negundo	KBD03							
KB4-1	Sambuco nigrae-Aceretum negundo	KBD03							
KB4-2	Rudbeckio laciniatae-Solidaginetum canadensis	XCB09							
KB4-3	Rudbeckio laciniatae-Solidaginetum canadensis	XCB09							
KC2-1	-	KBD03	Sambuco nigrae-Aceretum negundo						26.9
		LBA07	Fraxino pannonicae-Ulmetum glabrae						26.8
KC2-2	-	LBA07	Fraxino pannonicae-Ulmetum glabrae						33.7
		KBB05	Rhamno catharticae-Cornetum sanguineae						28.3
KE2-1	Sambuco nigrae-Aceretum negundo	KBD03							
PA-1	Scirpo sylvatici-Cirsietum cani	TDF07							
PB-1	-	MCC12	Tripleurospermo inodori-Bolboschoenetum planiculmi						13.6
		MCB01	Astero pannonici-Bolboschoenetum compacti						13.1
LA-1	-	LBA07	Fraxino pannonicae-Ulmetum glabrae						25.0
		KBE01	Chelidonio majoris-Robinetum pseudoacaciae						20.5

Table 5: List of relevés.

relevés	relevés area (m ²)	altitude	water table depth	moisture regime	soil texture	succession age	slope (degree)	management	number of species
HA1-1	10 x 2.5	186	0.5	wet	sandy	1	6.2	no	43
HA1-2	10 x 2.5	186	0.5	wet	sandy	1	6.7	no	35
HA1-3	10 x 2.5	186	0.5	wet	sandy	1	6.9	no	44
HA2-1	5 x 5	188	2.5	mesophilous	loamy	22	0	mowing	14
HA2-2	5 x 5	188.5	3	mesophilous	loamy	22	0	mowing	17
HA2-3	5 x 5	188.5	3	mesophilous	loamy	22	0	mowing	19
HA2-4	5 x 5	188	2.5	mesophilous	loamy	22	0	mowing	28
HA2-5	5 x 5	188	2.5	mesophilous	loamy	22	0	mowing	33
HA3-1	5 x 5	188	2.5	wet	loamy	22	0	no	20
HA3-2	5 x 5	187.5	2	mesophilous	loamy	22	0	no	24

HA3-3	5 x 5	187.5	2	mesophilous	loamy	22	0	no	17
HA3-4	5 x 5	188	2.5	mesophilous	loamy	22	0	no	17
HA3-5	5 x 5	188	2.5	mesophilous	loamy	22	0	no	26
HB1-1	10 x 2.5	186	0.5	wet	loamy-sandy	1	16	no	30
HB1-2	10 x 2.5	186	0.5	wet	loamy-sandy	1	9.6	no	38
HB1-3	10 x 2.5	186	0.5	wet	rocky	1	10.8	no	34
HB2-1	5 x 5	187.5	2	mesophilous	loamy	6	0	mowing	31
HB2-2	5 x 5	188	2.5	mesophilous	loamy	6	0	mowing	20
HB2-3	5 x 5	188	2.5	mesophilous	loamy	6	0	mowing	19
HC1-1	10 x 2.5	186	0.5	wet	loamy-sandy	1	17.5	no	45
HC1-2	10 x 2.5	186	0.5	wet	loamy-sandy	1	14	no	54
HC1-3	10 x 2.5	186	0.5	wet	loamy-sandy	1	12.3	no	34
HD1-1	10 x 2.5	186	0.5	wet	loamy-sandy	1	16	no	40
HE1-1	5 x 5	193	7.5	mesophilous	loamy	27	0	no	23
HE1-2	5 x 5	193	7.5	mesophilous	loamy	27	0	no	22
HE1-3	5 x 5	193	7.5	mesophilous	loamy	27	0	no	33
HE2-1	5 x 5	190	4.5	dry	sandy	22	0	no	4
HE2-2	5 x 5	190	4.5	dry	sandy	22	0	no	5
HE2-3	5 x 5	190	4.5	dry	sandy	22	0	no	4
HE3-1	5 x 5	188	2.5	wet	sandy	19	0	no	2
HE3-2	5 x 5	187.5	2	waterlogged	sandy	19	0	no	1
HE3-3	5 x 5	188	2.5	wet	sandy	19	0	no	4
HE3-4	5 x 5	187.5	2	waterlogged	sandy	19	0	no	4
HE4-1	5 x 5	189	3.5	mesophilous	sandy	3	0	no	1
HE4-2	5 x 5	189	3.5	mesophilous	sandy	3	0	no	1
HF6-1	10 x 2.5	186	0.5	wet	clayey	1	3.5	no	9
HF6-2	10 x 2.5	186	0.5	wet	clayey	1	3.5	no	13
HG1-1	10 x 2.5	186	0.5	wet	rocky	28	8.7	no	42
HG1-2	10 x 2.5	186	0.5	wet	rocky	28	9.5	no	52
HG1-3	10 x 2.5	186	0.5	wet	rocky	28	9.2	no	46
HG2-1	5 x 5	187.5	2	mesophilous	loamy	1	0	mowing	20
HG2-2	5 x 5	188	2.5	mesophilous	loamy	1	0	mowing	21
HG2-3	5 x 5	187.5	2	mesophilous	loamy	1	0	mowing	16
KA3-1	10 x 10	185	4	mesophilous	loamy	32	0	no	32
KA3-2	10 x 10	190	9	mesophilous	loamy	32	0	no	26
KA3-3	10 x 10	200	19	mesophilous	loamy	32	0	no	30
KA3-4	5 x 5	185	4	mesophilous	loamy	32	0	no	16
KA3-5	5 x 5	185	4	mesophilous	loamy	32	0	no	31
KA3-6	5 x 5	185	4	mesophilous	loamy	32	0	no	19
KA5-1	10 x 10	202	21	mesophilous	loamy	.	0	no	27
KB2-1	10 x 10	195	14	mesophilous	loamy	32	0	no	29
KB2-2	10 x 10	194	13	mesophilous	loamy	32	0	no	36
KB2-3	5 x 5	185	4	mesophilous	loamy	32	0	no	7
KB4-1	5 x 5	189	8	mesophilous	loamy	.	0	no	19
KB4-2	5 x 5	188	7	mesophilous	loamy	.	0	no	22
KB4-3	5 x 5	187	6	mesophilous	loamy	.	0	no	13
KC2-1	10 x 10	190	9	mesophilous	loamy	.	0	no	40
KC2-2	10 x 10	195	14	mesophilous	loamy	.	0	no	50
KE2-1	10 x 10	185	4	mesophilous	loamy	32	0	no	47
LA-1	10 x 10	189	.	mesophilous	loamy	.	0	mowing	33
PA-1	5 x 5	185	.	mesophilous	loamy	.	0	mowing	34
PB-1	5 x 5	185	.	mesophilous	loamy	.	0	no	21

Appendix 5: Analysis of ground beetles communities

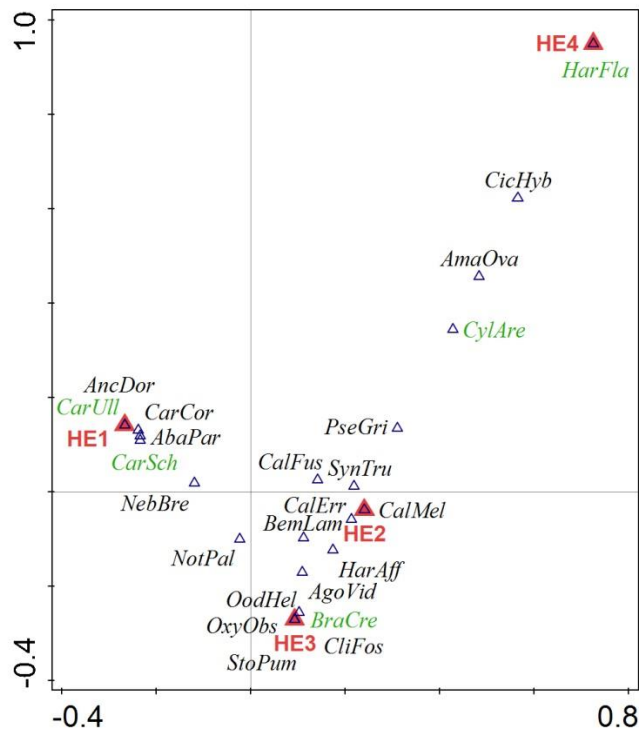


Figure 33: CCA analysis of Carabidae species composition on sludge deposits.

Only 25 species are shown according to the highest weight to axes. Test of all axes was significant ($p=0.002$). Conservation-important species are marked green. Species composition of waste pond HE4 was the most different.

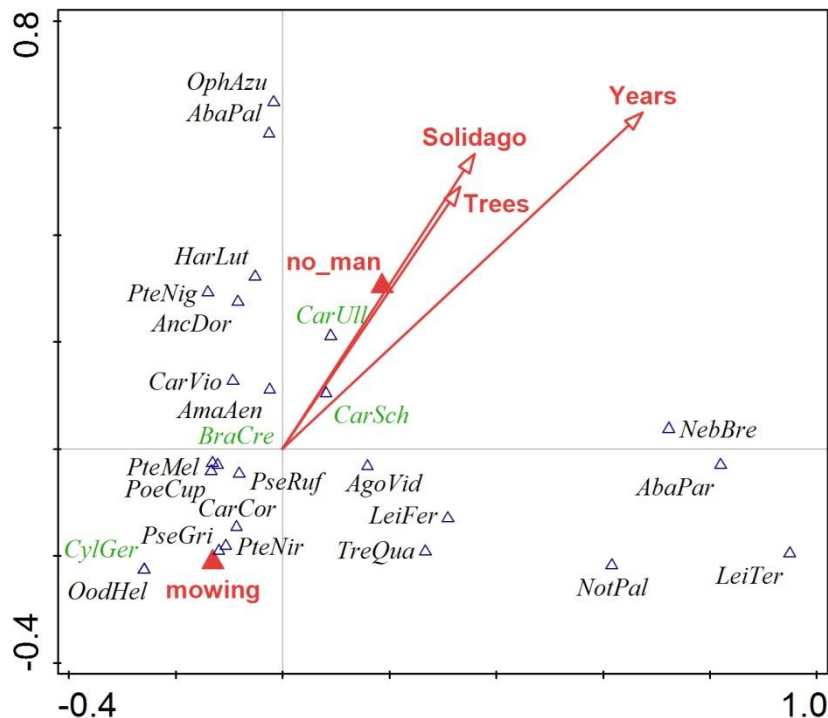


Figure 34: CCA analysis of Carabidae species response on environmental variables.

mowing ($p=0.002$), **no management** ($p=0.002$), **age of vegetation** (Years, $p=0.002$), **tree cover** ($p=0.528$) and **Solidago gigantea cover** ($p=0.75$). Test of all axes was significant ($p=0.002$). Conservation-important species are marked green.

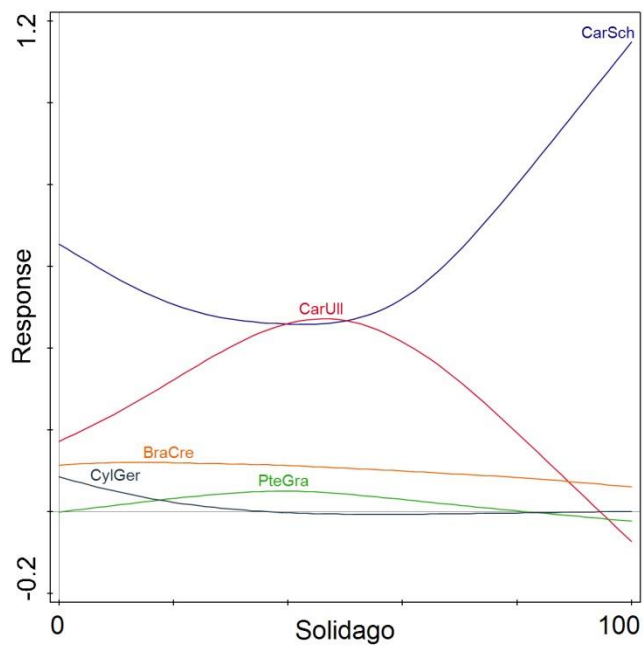
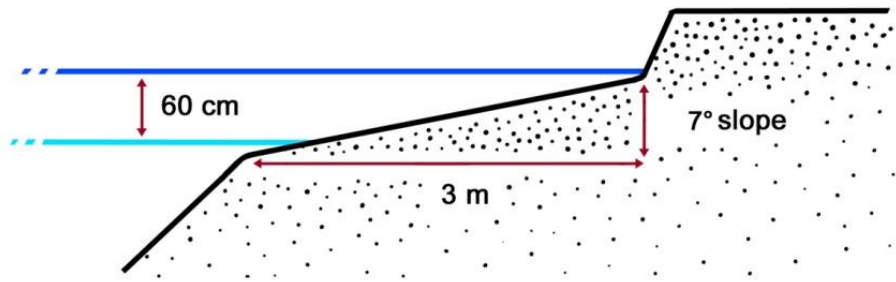


Figure 35: Generalized additive model of Carabidae species response to *Solidago* cover.

Only conservation-important species are shown: *Cylindera germanica* ($p=0.149$), *Brachinus crepitans* ($p=0.9$) and *Pterostichus gracilis* ($p=0.154$) are rather unresponsive to *Solidago* cover, *Carabus scheidleri* ($p=0.584$) occurs more abundant in areas with the highest *Solidago* cover, *C. ullrichii* ($p=0.23$) was the most abundant in areas with medium *Solidago* cover.

Appendix 6: Proposal of treatments

2016



Proposed modification

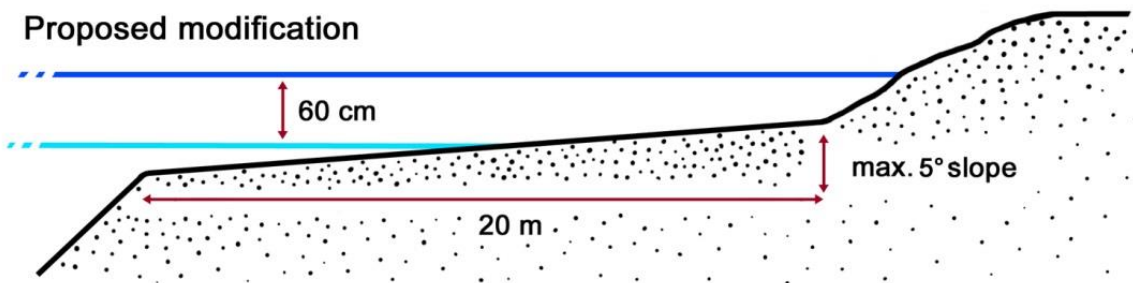


Figure 36: Recommended modification of the banks.

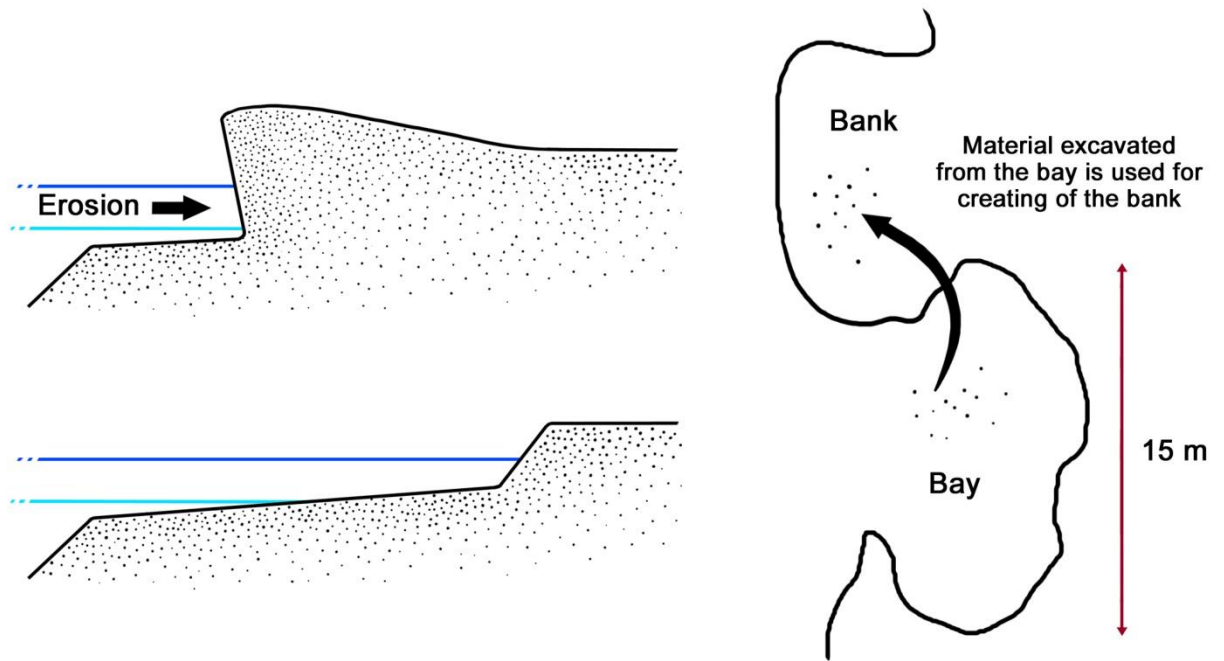


Figure 37: Alternative recommendation of the modification of the banks.

Alternation of steep slopes and shallow bays. The excavated ground can be used for damming of the body of water or for making the shores higher. High shores could serve as a nesting place for *Riparia riparia*. Periodical renewal would be ensured by water erosion.



Figure 38: Proposal of treatments for sludge deposits currently used.



Figure 39: Inappropriate and appropriate management of waste pond HE3

Presence of pools increases biodiversity of area (map source: mapy.cz).

Table 6: Species composition of the grass seed mixture used on plot HA2, HB2 and HG2.

taxon	(%)
<i>Festuca pratensi</i> Preval	20
<i>Lolium perenne</i> Talon	25
<i>Poa pratensis</i> Balin	12
<i>Phleum pratense</i> Kaba	23
<i>Alopecurus pratensis</i> Talope	20

Appendix 7: Proposal of the nature trail with educational boards

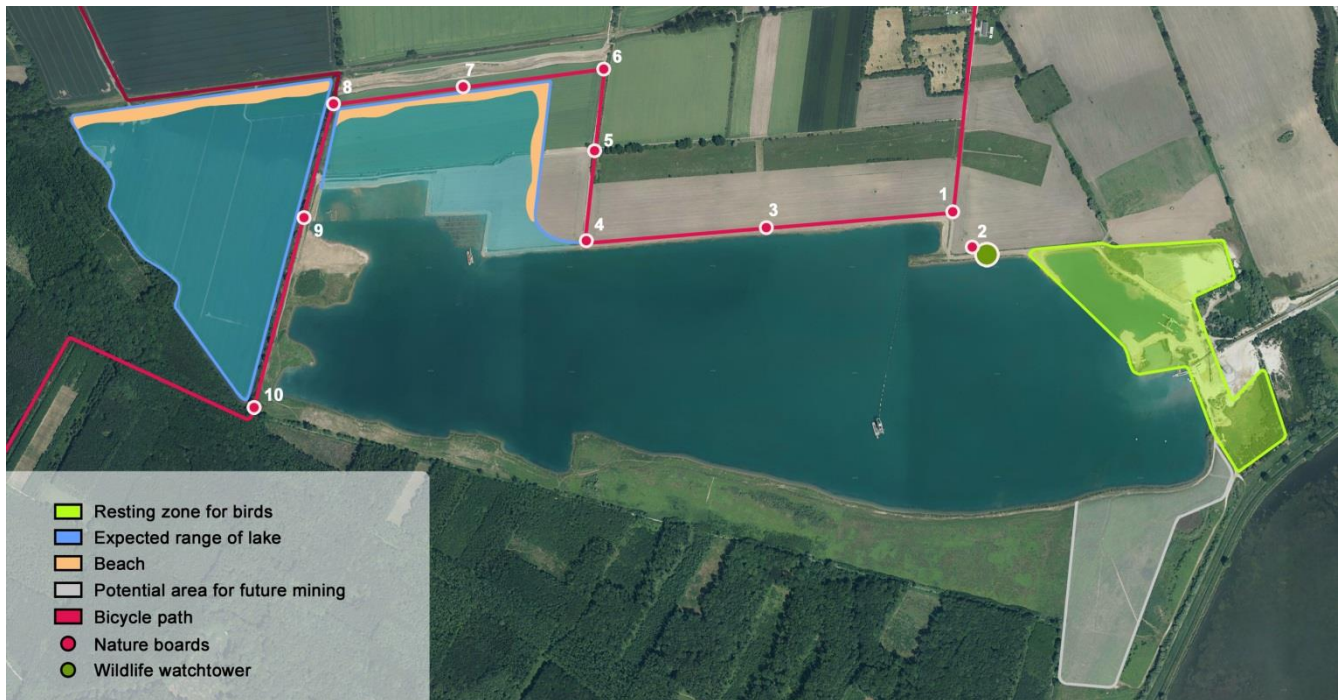


Figure 40: Maps of the nature trail

Educational trail in Gravel Pit Hulín

Difficulty: the lowest level

The educational trail would inform the visitors at 10 information panels about the gravel origin and mining, which would be from the general viewpoint and also the gravel pit Hulín qualities. The visitors would have possibility to learn something about biologically interesting facets in the gravel pit Hulín vicinity. The trail would be situated on cycling trail going along the north-western part of the gravel pit Hulín and with three kilometres length in total.

The suggested information panels:

1. What is the origin of gravel deposit?
 - a. The origin of gravel deposits. The floodplain of great rivers. The Tertiary and the Quaternary river terraces. The air-blown sands.
 - b. The gravel deposits in Haná region – geology of the area, the reconstruction of river network and river terraces.
 - c. The interested area properties, a map with mining surfaces in Hulín surroundings.
 - d. The processes of gravel storing and qualitative differences.
2. Terns
 - a. General characteristic of terns and familiarization with several tern species occurring in the Czech republic.
 - b. Past of tern population dynamics. Why are they decreasing and what is the function of concrete islands?
3. The past and the presence of the mining
 - a. When did people begin to mine and why; the general overview? For which purposes did people mine in the past and what does influence the present mining?
 - b. The mining past of the Hulín surroundings.
 - c. Non-metallic minerals – building material, stone, sandy gravel
4. How and what do people use to mine in gravel pit?
 - a. How do people know that they can mine?
 - b. dredging
 - c. The topsoil taking and storing before the mining, removing and transport of overburden.
 - d. dredger (bucket dredger, clamshell dredger and pump dredger), transport self-unloading barges, conveyor systems, distribution tapes and other techniques
5. The mining production and its utilization
 - a. Why do people mine? What do we mine? For what do we use the extracted material?
 - b. The division of mining products: sand, gravel, sandy gravel
 - c. the production of concrete, mortar and plasters, the utilization for road stabilization and so on
6. The description of lake originated from mining

- a. the picture with lake from the side with short descriptions. What is situated where, from which depth is it taken? How is it transported? Where is it spread?
7. The mining termination in the gravel pit and the following ecological renewal
 - a. natural succession, spontaneous succession, controlled succession, and human management
 - b. How does the new water surface formed from the gravel pit enrich the surroundings landscape?
 - c. Is it better to leave the place for spontaneous succession or is it better to change the place as it used to be before the mining (concerning mostly the open-pit mining)?
8. Invasive plant species in the gravel pit vicinity
 - a. What kind of invasive plant species can we see in the surroundings of gravel pit Hulín and how do these plant species change their vicinity?
 - b. In which kind of habitat do the invasive plant species grow, from where did they spread and how did they spread? Why do they spread in our country? Why are they so successful in our country? How can we influence their propagation around?
9. Invasive animal species in the gravel pit vicinity
 - a. Which species can we meet in the surroundings of gravel pit Hulín? How do they change their vicinity?
 - b. In which kind of habitat do the invasive animal species live, from where did they come and how did they come? Why do they spread in our country? Why are they so successful in our country? How can we influence their propagation around?
10. The gravel pit or the fishpond?
 - a. What is the difference between gravel pit and fishpond? What are advantages/disadvantages of gravel pit/fishpond? What is the origin of the gravel pit and what is the origin of fishpond?
 - b. How is the gravel pits and fishponds economically utilize?
 - c. The comparison of abiotic conditions at gravel pit and fishpond.
 - d. The differences of species biotic composition between gravel pits and fishponds.

Inspiration: Braunová (2013).

Appendix 8: Categories of conservation statuses according to various red lists.

Table 7: Categories of conservation statuses according to various red lists.

source	abbreviation	explanation
Grulich 2012 (Red list of vascular plants)	C1	Critically threatened
	C2	Endangered
	C3	Vulnerable
	C4	Lower risk
Regulation 395/1992 Sb. (Conservation status by Czech legislation)	KO	Critically threatened
	SO	Strongly threatened
	O	Threatened
Farkač et al. 2005 (invertebrates), Holec & Beran 2006 (macromycetes), Kučera et al. 2012 (bryophytes), Plesník et al. 2003 (vertebrates), Řezáč et al. 2015 (arachnids)	CR	Critically endangered
	EN	Endangered
	VU	Vulnerable
	NT	Near threatened
	LC	Least concern
	RE	Extinct in CZ
	DD	Data deficient
	NE	Not evaluated

Appendix 9: Results of inventory survey

Table 8: List of macromycetes in the Gravel Pit Hulín (area H)

RL CZ = category of endangered by Holec & Beran 2006 (see appendix 8).

Taxa	RL CZ	HA2	HA3	HA3	HD1	HE1	HE1 HE2	HE1 HE2 HE3	HE2 HE3	HE2 HE3	HE3	LA	LA LB	LB	ZA
<i>Agaricus</i> sp.									*						
<i>Agaricus sylvicola</i>												*			
<i>Amanita muscaria</i>								*							
<i>Amanita rubescens</i>									*						
<i>Ascobolus denudatus</i>												*			
<i>Auricularia auricula-judae</i>												*			
<i>Byssomerulius corium</i>												*			
<i>Calloria neglecta</i>												*			
<i>Chalciporus piperatus</i>									*						
<i>Clitopilus</i> sp.						*									
<i>Coriolopsis gallica</i>														*	
<i>Coriolopsis trogii</i>			*												
<i>Cyanoboletus pulverulentus</i>												*			
<i>Cyathus olla</i>		*													
<i>Daedaleopsis confragosa</i>				*		*									
<i>Dendrothele acerina</i>												*			
<i>Hortiboletus engelii</i>												*			
<i>Hymenochaete rubiginosa</i>												*			
<i>Hypholoma fasciculare</i>												*			
<i>Hypoxylon cercidicola</i>													*		
<i>Inocybe</i> sp.									*						
<i>Jafnea semitosta</i>														*	
<i>Kretzschmaria deusta</i>														*	
<i>Kuehneromyces mutabilis</i>														*	
<i>Lacrymaria lacrymabunda</i>												*			
<i>Lactarius cf. mammosus</i>									*						
<i>Lactarius helvus</i>						*									
<i>Lactarius plumbeus</i>						*					*				
<i>Laetiporus sulphureus</i>															*
<i>Leccinum cf. holopus</i>									*						
<i>Leccinum scabrum</i>									*						
<i>Leccinum versipelle</i>							*								
<i>Leptosphaeria acuta</i>												*			
<i>Lycoperdon</i> sp.											*				
<i>Morchella semilibera</i>	NT											*			
<i>Mutinus ravenelii</i>											*				
<i>Mycena acicula</i>												*			
<i>Mycena galericulata</i>														*	
<i>Mycena haematopus</i>														*	
<i>Mycena inclinata</i>												*			
<i>Mycena speirea</i>												*			
<i>Nectria cinnabarina</i>												*			
<i>Octospora gemmicola</i> var. <i>tetraspora</i>					*										
<i>Octospora ithacaensis</i>												*			
<i>Olla scrupulosa</i>			*												
<i>Panellus stipticus</i>												*			
<i>Parasola kuehneri</i>												*			
<i>Paxillus involutus</i>							*				*				
<i>Peniophora limitata</i>													*		
<i>Pezoloma marchantiae</i>												*			
<i>Phellinus igniarius</i>				*											
<i>Pluteus aurantiorugosus</i>	VU											*			
<i>Pluteus cervinus</i>														*	
<i>Polyporus alveolaris</i>	EN													*	
<i>Polyporus ciliatus</i>						*									
<i>Polyporus squamosus</i>														*	
<i>Postia subcaesia</i>												*			
<i>Rhytisma acerinum</i>												*			
<i>Russula aeruginea</i>						*									
<i>Russula</i> sp. div.										*					
<i>Scleroderma citrinum</i>						*									

<i>Scleroderma verrucosum</i>								*			
<i>Scutellinia legaliae</i>										*	
<i>Schizophyllum amplum</i>				*							
<i>Schizophyllum commune</i>		*									
<i>Stereum subtomentosum</i>				*							
<i>Thelephora terrestris</i>					*						
<i>Trametes hirsuta</i>				*							
<i>Trametes versicolor</i>										*	

Table 9: List of bryophytes in the Gravel Pit Hulín (area H)

RL CZ = category of endangered by Kučera et al. 2012, (see appendix 8).

Taxa	RL CZ	HA1	HA4	HB1	HB3	HD1	HE1	HE2	HE3	HF5	HF6
<i>Amblystegium serpens</i>			*		*						
<i>Atrichum undulatum</i>							*	*			
<i>Barbula unguiculata</i>				*						*	*
<i>Brachytheciastrum velutinum</i>								*			
<i>Brachythecium albicans</i>							*	*			
<i>Brachythecium campestre</i>	LC									*	
<i>Brachythecium rutabulum</i>								*			
<i>Bryum</i> sp.				*							
<i>Bryum argenteum</i>		*		*							*
<i>Bryum dichotomum</i>		*		*		*					
<i>Bryum klinggraeffii</i>											*
<i>Bryum moravicum</i>							*				
<i>Bryum violaceum</i>										*	
<i>Cephaloziella divaricata</i>									*		
<i>Ceratodon purpureus</i>							*	*			*
<i>Dicranella cerviculata</i>								*			
<i>Dicranella heteromalla</i>							*	*			
<i>Dicranella staphylina</i>							*				
<i>Dicranella varia</i>		*								*	
<i>Drepanocladus aduncus</i>			*		*						
<i>Eurhynchium angustirete</i>							*				
<i>Fissidens exilis</i>							*				
<i>Fissidens taxifolius</i>							*				
<i>Funaria hygrometrica</i>		*		*		*					*
<i>Hypnum cupressiforme</i> var. <i>cupressiforme</i>							*				
<i>Leskea polycarpa</i>							*				
<i>Lophozia excisa</i>	LC							*			
<i>Marchantia polymorpha</i> subsp. <i>polymorpha</i>			*		*	*					
<i>Nyholmia obtusifolia</i>							*				
<i>Orthotrichum affine</i>							*				
<i>Orthotrichum diaphanum</i>							*				
<i>Orthotrichum pallens</i>							*				
<i>Oxyrrhynchium hians</i>											*
<i>Physcomitrella patens</i>	LC									*	
<i>Platygyrium repens</i>							*				
<i>Pohlia nutans</i>							*				
<i>Polytrichum formosum</i>								*			
<i>Polytrichum juniperinum</i>							*				
<i>Polytrichum piliferum</i>								*			
<i>Pylaisia polyantha</i>							*				
<i>Riccia fluitans</i>			*		*						
<i>Sciuro-hypnum populeum</i>							*				
<i>Syntrichia papillosa</i>							*				
<i>Syntrichia ruralis</i> var. <i>ruralis</i>							*				
<i>Tortula truncata</i>							*				
<i>Ulotia bruchii</i>							*				

Nomenclature by Danihelka et al. 2012, **RL CZ** = category of endangered by Grulich 2012, (see appendix 8). **status** = status by Pyšek et al. 2012, **Tov.** = presence of taxon in the Gravel Pit Hulín

33

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taxa	RL CZ	status	Tov.	HA1	HA2	HA3	HA4	HB1	HB2	HB3	HC1	HC2	HC3	HC4	HD1	HD2	HD3	HE1	HE2	HE3	HE4	HE5	HF1	HF2	HF3	HF4	HF5	HF6	HG1	HG2	HG2	HG3	HG4	HG5	HG6	HI	KA1	KA2	KA3	KA4	KA5	KA6	KB1	KB2	KB3	KB4	KC1	KC2	KD1	KD2	KE1	KE2			
		nat																																																					
<i>Hypericum hirsutum</i>			*		*			*	*																					*				*												*			*						
<i>Hypericum perforatum</i>			*	*	*			*				*				*		*		*	*	*	*	*	*	*	*	*	*	*	*		*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
<i>Hypericum tetrapterum</i>			*	*																																*																			
<i>Hypochoeris radicata</i>			*	*				*			*				*				*					*				*	*						*							*								*					
<i>Chaerophyllum aromaticum</i>																						*																																	
<i>Chaerophyllum bulbosum</i>			*		*													*																	*			*	*	*	*	*		*	*	*	*	*	*	*	*	*	*		
<i>Chaerophyllum temulum</i>			*		*	*			*									*																				*		*		*		*		*		*	*	*	*	*	*		
<i>Chelidonium majus</i>		arch nat	*															*	*												*						*				*		*		*		*		*		*		*		
<i>Chenopodium album</i> agg			*																																												*								
<i>Chenopodium album</i> agg.			*	*				*			*					*		*			*						*		*	*	*	*	*	*	*		*														*			*	
<i>Chenopodium ficifolium</i>			*													*					*				*																														
<i>Chenopodium polyspermum</i>			*	*				*								*			*				*				*	*	*	*	*				*		*									*									
<i>Chenopodium rubrum</i>																											*																												
<i>Impatiens glandulifera</i>		neo inv	*																																												*								
<i>Impatiens parviflora</i>		neo inv	*		*	*		*		*								*	*	*		*														*				*			*												
<i>Inula britannica</i>			*	*	*						*					*											*				*						*									*									
<i>Inula conyzae</i>			*																																																			*	
<i>Inula helenium</i>		neo nat																																															*						
<i>Inula salicina</i> subsp. <i>salicina</i>		C4a																*																										*		*									
<i>Iris pseudacorus</i>			*	*	*	*		*		*				*																*					*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
<i>Juglans nigra</i>		neo cas	*					*																																															
<i>Juglans regia</i>																		*																				*	*															*	
<i>Juncus articulatus</i>			*	*			*	*		*					*												*									*	*				*			*							*				
<i>Juncus bufonius</i>			*	*			*	*		*					*			*		*			*		*		*	*	*	*					*		*																		
<i>Juncus compressus</i>			*	*	*	*	*	*		*					*																				*	*																			
<i>Juncus conglomeratus</i>																		*																																					
<i>Juncus effusus</i>			*	*	*	*	*	*	*	*	*	*	*	*				*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
<i>Juncus inflexus</i>			*	*	*	*	*	*		*					*			*							*		*		*		*				*		*				*			*				*		*					
<i>Juncus tenuis</i>		neo nat	*	*	*																																*			*		*			*					*			*		
<i>Juniperus cf. chinensis</i>																		*																																					
<i>Knautia arvensis</i>			*															*																													*								
<i>Lactuca serriola</i>		arch nat	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*		*		*		*	*	*	*	*	*	*		*		*		*		*		*		*		*		*		*		*		*		
<i>Lamium album</i>		arch nat	*									*							*				*				*											*				*			*				*		*		*		
<i>Lamium amplexicaule</i>		arch nat																			*																																		
<i>Lamium maculatum</i>			*	*	*	*	*	*	*	*								*	*			*							*		*				*		*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
<i>Lamium purpureum</i>		arch nat	*								*							*	*	*			*	*	*		*		*		*				*		*		*																
<i>Lapsana communis</i>		arch	*	*	*	*	*	*	*	*								*				*													*		*		*		*		*		*		*		*		*		*		

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taxa	RL	CZ	status	Tov.	HA1	HA2	HA3	HA4	HB1	HB2	HB3	HC1	HC2	HC3	HC4	HD1	HD2	HD3	HE1	HE2	HE3	HE4	HE5	HF1	HF2	HF3	HF4	HF5	HF6	HG1	HG2	HG2	HG3	HG4	HG5	HG6	HI	KA1	KA2	KA3	KA4	KA5	KA6	KB1	KB2	KB3	KB4	KC1	KC2	KD1	KD2	KE1	KE2																	
<i>Pinus mugo</i>																								*																																														
<i>Plantago lanceolata</i>				*	*	*				*				*			*					*	*	*	*		*	*	*		*						*	*		*	*	*					*																							
<i>Plantago major</i>				*		*	*			*				*			*					*	*	*	*		*	*	*		*								*	*		*	*		*	*	*	*	*	*	*	*	*	*	*															
<i>Plantago media</i>																																																				*																		
<i>Plantago uliginosa</i>				*	*	*	*		*			*					*				*		*	*		*			*		*					*	*																																	
<i>Poa angustifolia</i>				*			*	*						*						*			*	*	*		*	*	*		*							*	*		*		*	*	*	*	*	*	*	*	*	*	*	*	*															
<i>Poa annua</i>				*					*	*		*		*						*		*	*	*	*		*	*	*		*							*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*															
<i>Poa compressa</i>				*	*	*				*			*	*			*					*	*	*	*	*	*	*	*	*	*								*													*																		
<i>Poa nemoralis</i>				*																			*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*														
<i>Poa palustris</i>				*	*	*	*		*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*												
<i>Poa pratensis</i>				*		*	*							*																							*			*	*			*								*				*														
<i>Poa trivialis</i>				*	*		*		*			*	*	*	*	*	*	*			*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*												
<i>Poa x figertii</i>																								*																																														
<i>Poa x intricata</i>																								*																																														
<i>Polygonum aviculare</i> agg.				*	*	*	*		*	*		*	*	*	*	*	*	*		*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*												
<i>Populus alba</i>				*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*												
<i>Populus nigra</i>	C1t	aut			*	*				*												*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*												
<i>Populus nigra</i> agg.				*		*						*				*						*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*												
<i>Populus tremula</i>				*		*								*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*												
<i>Populus x canadensis</i>		neo	inv	*		*						*																																																										
<i>Populus x canescens</i>				*		*								*		*			*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*												
<i>Portulaca oleracea</i> subsp. <i>oleracea</i>		arch	inv	*																			*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*												
<i>Potamogeton crispus</i>				*																								*																*				*		*		*		*		*		*												
<i>Potamogeton nodosus</i>	C3			*																																			*			*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*												
<i>Potamogeton pusillus</i>				*												*												*											*													*		*		*		*												
<i>Potamogeton trichoides</i>	C3		lit	.																																																																		
<i>Potentilla anserina</i>				*	*	*	*		*			*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*												
<i>Potentilla reptans</i>				*	*	*	*		*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*												
<i>Potentilla supina</i> subsp. <i>supina</i>				*	*			*				*				*												*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*												
<i>Prunella vulgaris</i>				*	*							*							*			*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*												
<i>Prunus avium</i>				*								*				*			*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*												
<i>Prunus cerasifera</i>		arch	inv	*	*			*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*												
<i>Prunus domestica</i>		arch	nat																																																								*											
<i>Prunus mahaleb</i> subsp. <i>mahaleb</i>	C4b											*																																																										
<i>Prunus padus</i> subsp. <i>padus</i>				*																																																																		
<i>Prunus spinosa</i>				*					*			*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*												
<i>Pulmonaria mollis</i>	C3			*								*							*				*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*												
<i>Pulmonaria obscura</i>				*			*		*			*				*			*				*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*												
<i>Pyrus pyraister</i>	C4a																																																																					
<i>Quercus robur</i>				*					*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*</																				

taxa	RL	CZ	status	Tov.	HA1	HA2	HA3	HA4	HB1	HB2	HB3	HC1	HC2	HC3	HC4	HD1	HD2	HD3	HE1	HE2	HE3	HE4	HE5	HF1	HF2	HF3	HF4	HF5	HF6	HG1	HG2	HG2	HG3	HG4	HG5	HG6	HI	KA1	KA2	KA3	KA4	KA5	KA6	KB1	KB2	KB3	KB4	KC1	KC2	KD1	KD2	KE1	KE2																																																																	
<i>Quercus rubra</i>			neo inv	*			*							*																									*					*																																																																										
<i>Ranunculus acris</i> subsp. <i>acris</i>				*																																																																																				*		*				*		*																						
<i>Ranunculus auricomus</i> agg.				*																																																																																														*			*																	
<i>Ranunculus repens</i>				*	*	*	*	*	*		*	*																				*		*		*	*		*	*		*	*		*	*		*	*		*	*		*																																																																
<i>Ranunculus sceleratus</i>				*	*			*	*		*	*				*	*										*			*	*	*	*														*																																																																							
<i>Reynoutria japonica</i> var. <i>japonica</i>			neo inv			*																																																																																				*																												
<i>Reynoutria sachalinensis</i>			neo inv																				*		*		*		*		*																																																																																							
<i>Reynoutria x bohemica</i>			neo inv		*																			*		*		*																																																																																										
<i>Rhamnus cathartica</i>				*																			*		*		*																				*		*		*		*		*		*		*		*		*		*																																																					
<i>Ribes rubrum</i>			neo nat																																																													*																																																						
<i>Ribes uva-crispa</i>																																																																	*																																																					
<i>Robinia pseudoacacia</i>			neo inv	*																																																																																																																		
<i>Rorippa amphibia</i>																							*		*		*																				*				*																																																																			
<i>Rorippa palustris</i>				*	*				*			*					*										*						*					*																																																																																
<i>Rorippa</i> sp.																							*														*	*																																																																																
<i>Rorippa sylvestris</i>				*	*	*	*		*				*										*			*				*	*						*				*											*																																																																		
<i>Rorippa x armoracioides</i>																							*				*		*		*		*		*																																																																																			
<i>Rosa agrestis</i>	C4b																																																														*	*		*																																																				
<i>Rosa canina</i>				*	*	*				*				*			*		*	*	*	*	*	*	*		*	*				*					*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*																																																												
<i>Rosa canina</i> subsp. <i>corymbifera</i>																																																															*																																																							
<i>Rosa dumalis</i> subsp. <i>subcollina</i>				*																																																													*																																																					
<i>Rubus armeniacus</i>			neo nat																																																																																																																			
<i>Rubus bifrons</i>				*																			*		*		*																				*				*																																																																			
<i>Rubus caesius</i>				*		*		*	*	*	*		*	*	*	*			*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*																																																									
<i>Rubus clusii</i>																							*												*																																																																																			
<i>Rubus dollnensis</i>				*																																																																																																																		
<i>Rubus flos-amygdalae</i>				*																																																													*																												</																									

[illegible]

taxa	RL	CZ	status	Tov.	HA1	HA2	HA3	HA4	HB1	HB2	HB3	HC1	HC2	HC3	HC4	HD1	HD2	HD3	HE1	HE2	HE3	HE4	HE5	HF1	HF2	HF3	HF4	HF5	HF6	HG1	HG2	HG2	HG3	HG4	HG5	HG6	HI	KA1	KA2	KA3	KA4	KA5	KA6	KB1	KB2	KB3	KB4	KC1	KC2	KD1	KD2	KE1	KE2					
			nat																																																							
<i>Setaria viridis</i> subsp. <i>viridis</i>			arch	*																				*	*														*																			
<i>Silaum silaus</i>	C3												*										*																										*									
<i>Silene baccifera</i>	C3			*			*		*	*			*	*					*	*	*			*			*					*					*							*				*			*							
<i>Silene latifolia</i>		arch	nat	*	*				*		*	*	*			*		*	*	*	*	*	*	*	*	*	*	*	*		*					*		*	*												*		*	*				
<i>Silene noctiflora</i>	C4a	arch	nat	*					*		*	*						*				*									*				*		*																					
<i>Sinapis arvensis</i>		arch	nat	*	*	*		*	*	*		*	*	*						*	*		*	*	*	*				*				*	*	*																						
<i>Sisymbrium altissimum</i>		neo	nat																								*																															
<i>Sisymbrium loeselii</i>		neo	inv															*	*	*															*																							
<i>Sisymbrium officinale</i>		arch	nat	*																															*																							
<i>Sisymbrium strictissimum</i>		neo	nat																																			*		*		*				*												
<i>Sium latifolium</i>	C2b																																																									
<i>Solanum decipiens</i>		neo	nat																				*																																			
<i>Solanum dulcamara</i>			*	*		*	*	*	*		*				*				*	*	*		*	*								*		*								*				*		*			*							
<i>Solanum nigrum</i>		arch	nat																				*					*																														
<i>Solidago canadensis</i>		neo	inv	*									*						*			*																																				
<i>Solidago gigantea</i>		neo	inv	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
<i>Sonchus arvensis</i>		arch	nat	*	*														*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
<i>Sonchus asper</i>		arch	nat	*	*			*		*		*			*				*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
<i>Sonchus oleraceus</i>		arch	nat	*															*	*			*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
<i>Sorbus aucuparia</i>			*								*																													*															*			
<i>Sparganium erectum</i>			*																																			*				*				*			*									
<i>Sparganium erectum</i> subsp. <i>microcarpum</i>																																						*				*																
<i>Spergularia rubra</i>			*																								*																															
<i>Spiraea</i> cf. <i>vanhoutei</i>																							*																																			
<i>Spiraea</i> x <i>pseudosalicifolia</i>													*			*																																										
<i>Spirodela polyrhiza</i>																																																										
<i>Stachys palustris</i>			*	*				*	*										*							*					*						*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
<i>Stachys sylvatica</i>			*																								*														*			*			*											
<i>Stellaria holostea</i>																																																										
<i>Stellaria media</i>			*			*								*	*				*	*			*			*											*	*		*			*			*			*									
<i>Stellaria neglecta</i>	C3		*																	*	*			*													*																					
<i>Stellaria pallida</i>		arch	inv	*																		*																																				
<i>Stellaria palustris</i>	C2b																																																									
<i>Stuckenia pectinata</i>			*			*			*																*	*									*												*			*								

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48

taxa	RL	CZ	status	Tov.	HA1	HA2	HA3	HA4	HB1	HB2	HB3	HC1	HC2	HC3	HC4	HD1	HD2	HD3	HE1	HE2	HE3	HE4	HE5	HF1	HF2	HF3	HF4	HF5	HF6	HG1	HG2	HG2	HG3	HG4	HG5	HG6	HI	KA1	KA2	KA3	KA4	KA5	KA6	KB1	KB2	KB3	KB4	KC1	KC2	KD1	KD2	KE1	KE2																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
			nat																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
Veronica polita			arch	*	*				*											*									*							*																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
Veronica scutellata	C4a		nat																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
Veronica serpyllifolia																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								

Table 11: List of endangeret vascular plant taxa in the surroundings areas (L,P,S,T,Z,ST)

Nomenclature by Danihelka et al. 2012, **RL CZ** = category of endangered by Grulich 2012, (see appendix 8). **status** = status by Pyšek et al. 2012, **Tov.** = presence of taxon in the Gravel Pit Hulín

taxa	RL CZ	status	Tov.	LA	LB	LC	PB	S	T	ZA	ZB	ST	PA
<i>Aethusa cynapium</i> subsp. <i>elata</i>	C4a		*	*		*							
<i>Agrimonia procera</i>	C3							*					
<i>Allium angulosum</i>	C3						*						*
<i>Allium oleraceum</i>				*									
<i>Althaea officinalis</i>	C2t							*					
<i>Ambrosia artemisiifolia</i>		neo inv		*									
<i>Arctium nemorosum</i>	C4a			*	*								
<i>Asperugo procumbens</i>	C3	arch nat		*									
<i>Barbarea stricta</i>	C3						*						
<i>Batrachium rionii</i>	C2b							*			*		
<i>Bolboschoenus laticarpus</i>	C4a		*								*		
<i>Butomus umbellatus</i>	C4a		*					*			*		
<i>Cardamine matthioli</i>	C4a			*			*						*
<i>Carex buekii</i>	C4a		lit.	*	*	*	*			*			
<i>Carex disticha</i>	C4a						*						*
<i>Carex otomana</i>	C4a		*			*	*						
<i>Carex otrubae</i>	C4a			*				*					*
<i>Carex pendula</i>	C4a			*									
<i>Carex riparia</i>	C4a		*	*	*	*	*	*		*	*	*	*
<i>Elodea canadensis</i>		neo nat	*				*						
<i>Fraxinus angustifolia</i>	C4a		*	*		*				*			*
<i>Fraxinus pennsylvanica</i>		neo inv		*									
<i>Galium boreale</i> subsp. <i>boreale</i>	C4a			*			*					*	
<i>Galium elongatum</i>	C4a					*							
<i>Galium mollugo</i>	C4b			*									
<i>Galium rivale</i>	C4a		*	*	*	*	*	*		*			*
<i>Galium wirtgenii</i>	C4b						*						
<i>Geranium sibiricum</i>		neo nat								*			
<i>Hemerocallis fulva</i>		neo cas		*									
<i>Hottonia palustris</i>	C3				*	*	*						
<i>Hydrocharis morsus-ranae</i>	C2b						*						
<i>Impatiens glandulifera</i>		neo inv	*	*			*						
<i>Inula salicina</i> subsp. <i>salicina</i>	C4a			*			*						
<i>Juglans nigra</i>		neo cas	*	*									
<i>Lotus tenuis</i>	C3												*
<i>Myosotis caespitosa</i>	C4a		*				*	*					*
<i>Myosotis sparsiflora</i>	C4a		*		*	*					*		
<i>Petasites hybridus</i>				*									
<i>Potamogeton trichoides</i>	C3		lit.						*				
<i>Pulmonaria mollis</i>	C3						*						
<i>Quercus rubra</i>		neo inv	*	*									
<i>Reynoutria japonica</i> var. <i>japonica</i>		neo inv		*				*					
<i>Rubus armeniacus</i>		neo nat					*	*					
<i>Rubus occidentalis</i>		neo cas						*					
<i>Scrophularia umbrosa</i>	C4a												*
<i>Scutellaria hastifolia</i>	C2b			*			*						
<i>Senecio erraticus</i>	C3												*
<i>Senecio sarracenicus</i>	C2b		lit.				*			*			*
<i>Silaum silaus</i>	C3			*			*						*
<i>Silene baccifera</i>	C3		*		*	*	*			*	*		
<i>Sium latifolium</i>	C2b						*						
<i>Solidago canadensis</i>		neo inv	*					*					
<i>Solidago gigantea</i>		neo inv	*				*						
<i>Stellaria neglecta</i>	C3		*	*		*							
<i>Stellaria palustris</i>	C2b						*						*

taxa	RL CZ	status	Tov.	LA	LB	LC	PB	S	T	ZA	ZB	ST	PA
<i>Taraxacum copidophyllum</i>	C3												*
<i>Taraxacum paucifolium</i> Trávn. et al. ined.													*
<i>Taraxacum vindobonense</i>	C1t												*
<i>Thalictrum lucidum</i>	C3		*	*			*						
<i>Trifolium fragiferum</i>	C3												*
<i>Ulmus laevis</i>	C4a		*	*	*	*							
<i>Ulmus minor</i>	C4a		*		*								
<i>Verbascum blattaria</i>	C2b					*							
<i>Verbascum densiflorum</i>	C4a							*					
<i>Verbena officinalis</i>	C3	arch nat		*									
<i>Veronica maritima</i>	C3			*									
<i>Veronica scutellata</i>	C4a					*							*
<i>Vicia dumetorum</i>	C4a		*		*	*					*		
<i>Viola stagnina</i>	C2t			*			*						

Table 12: Localization of endangered vascular plant taxa in the Gravel Pit Hulín (area H)
Nomenclature by Danihelka et al. 2012, RL CZ = category of endangered by Grulich 2012, (see appendix 8).

RL CZ	taxon	plot
C1b	<i>Batrachium baudotii</i> (*)	HF6 (49°17'59"N, 17°28'09"E)
C1t	<i>Crepis setosa</i> (*)	HA2 (49°17'44"N, 17°27'59"E); HI (49°18'20"N, 17°26'57"E)
C1t aut	<i>Populus nigra</i>	HA2 (49°17'47"N, 17°27'53"E); HA3 (49°17'48"N 17°27'05"E); HB3 (49°17'49"N, 17°26'29"E); HE4 (rare); HF5 (rare)
C2b	<i>Batrachium rionii</i>	HA1 (scattered); HB1 (e. g. 49°17'48"N, 17°26'55"E; 49°17'47"N, 17°26'59"E); HC1 (rare); HD1 (49°18'06"N, 17°27'41"E); HF6 (e. g. 49°18'07"N, 17°28'04"E; 49°18'03"N, 17°28'13"E); HG1 (scattered)
C2b	<i>Scutellaria hastifolia</i>	HA2 (49°17'46"N, 17°27'52"E; 49°17'41"N, 17°27'44"E); HC3 (49°17'56"N, 17°26'24"E); HE5 (49°18'03"N, 17°28'18"E)
C2b	<i>Senecio sarracenicus</i>	HA1 (ca 49°17'46"N, 17°27'44"E); HA4 (49°17'40"N, 17°27'49"E); HB2 (49°17'49"N, 17°26'44"E); HE1 (49°18'05"N, 17°28'29"E; 49°18'01"N, 17°28'32"E); HE2 (49°17'57"N, 17°28'29"E); HE3 (49°17'52"N, 17°28'23"E); HE4 (49°18'08"N, 17°28'03"E); HE5 (ca 49°18'06"N, 17°28'21"E); HF1 (ca 49°18'12"N, 17°28'39"E); HF5 (49°18'01"N, 17°28'12"E); HG3 (49°17'35"N, 17°28'02"E); HG4 (49°17'43"N, 17°28'06"E); HG5 (49°17'49"N, 17°28'18"E); HG6 (ca 49°17'39"N, 17°28'16"E)
C2b	<i>Verbascum blattaria</i>	HA2 (49°17'41"N, 17°27'44"E; ca 49°17'46"N, 17°27'37"E; ca 49°17'46"N, 17°27'47"E); HB2 (49°17'48"N, 17°26'54"E); HF5 (49°18'00"N, 17°28'08"E)
C2b aut	<i>Rumex stenophyllus</i> (*)	HG2 (49°17'34"N, 17°28'05"E; 49°17'46"N, 17°28'04"E)
C2t	<i>Salsola tragus</i> (*)	HF1 (49°18'14"N, 17°28'46"E)
C2t	<i>Veronica agrestis</i> (*)	HG2 (49°17'32"N, 17°28'04"E)
C3	<i>Batrachium circinatum</i>	HA1 (scattered); HB1 (commonly, e. g. 49°17'48"N, 17°26'55"E); HC1 (scattered); HD1 (e. g. 49°18'08"N, 17°27'20"E; 49°18'06"N, 17°27'41"E); HF6 (e. g. 49°18'03"N, 17°28'13"E); HG1 (scattered)
C3	<i>Bolboschoenus yagara</i> (*)	HA3 (e. g. 49°17'45"N, 17°27'31"E); HC1 (e. g. 49°17'55"N, 17°26'29"E); HD1 (e. g. 49°18'06"N, 17°27'08"E); HF6 (49°17'56"N, 17°28'17"E; 49°18'01"N, 17°28'09"E); HG1 (scattered)
C3	<i>Centaurium pulchellum</i> (*)	HA2 (49°17'41"N, 17°27'44"E)
C3	<i>Cyperus fuscus</i> (*)	HA1 (scattered); HB1 (scattered); HD1 (49°18'08"N, 17°27'57"E); HF6 (commonly)
C3	<i>Dysphania botrys</i> (*)	HF1 (49°18'14"N, 17°28'46"E)
C3	<i>Epilobium parviflorum</i>	HA1 (scattered); HB1 (e. g. 49°17'47"N, 17°26'59"E); HC1 (scattered); HD1 (49°18'08"N, 17°27'57"E); HF6 (e. g. 49°18'02"N, 17°28'13"E; 49°17'59"N, 17°28'09"E); HG1 (e. g. 49°17'53"N, 17°28'18"E)
C3	<i>Euphorbia palustris</i>	HB3 (49°17'48"N, 17°26'32"E)
C3	<i>Filago arvensis</i> (*)	HA1 (49°17'47"N, 17°27'39"E, rare); HE4 (49°18'05"N, 17°28'12"E)
C3	<i>Hyoscyamus niger</i> (*)	HE4 (49°18'08"N, 17°28'05"E, rare); HG2 (49°17'34"N, 17°28'05"E)

C3	<i>Lotus tenuis</i>	HA2 (49°17'47"N, 17°27'59"E); HA3 (ca 49°17'47"N, 17°27'02"E); HD1 (49°18'08"N, 17°27'57"E; 49°18'08"N, 17°26'30"E); HE4 (ca 49°18'06"N, 17°28'09"E); HE5 (49°18'06"N, 17°28'18"E); HF1 (49°18'07"N, 17°28'44"E); HF2 (49°18'02"N, 17°28'19"E); HF5 (ca 49°18'02"N, 17°28'14"E); HF6 (49°18'02"N, 17°28'13"E; 49°18'06"N, 17°28'06"E); HG2 (49°17'50"N, 17°28'12"E)
C3	<i>Pulmonaria mollis</i>	HE1 (49°17'59"N, 17°28'30"E)
C3	<i>Silaum silaus</i>	HC3 (49°17'52"N, 17°26'23"E); HE5 (49°18'03"N, 17°28'18"E)
C3	<i>Silene baccifera</i>	HA4 (49°17'42"N, 17°27'37"E); HB2 (49°17'50"N, 17°26'29"E); HB3 (ca 49°17'48"N, 17°26'38"E); HC3 (49°18'03"N, 17°26'26"E); HC4 (ca 49°18'05"N, 17°26'26"E); HE1 (ca 49°17'59"N, 17°28'30"E); HE2 (49°17'59"N, 17°28'24"E; 49°17'57"N, 17°28'29"E); HE3 (49°17'55"N, 17°28'26"E); HF1 (49°18'13"N, 17°28'39"E); HF5 (49°18'01"N, 17°28'15"E); HG3 (ca 49°17'34"N, 17°28'02"E); HG6 (49°17'39"N, 17°28'15"E)
C3	<i>Stellaria neglecta</i>	HF1 (ca 49°18'08"N, 17°28'49"E)
C3	<i>Thalictrum lucidum</i>	HE1 (ca 49°17'59"N, 17°28'35"E); HE5 (49°18'03"N, 17°28'18"E); HF5 (49°18'00"N, 17°28'08"E)
C3	<i>Veronica catenata</i>	HA1 (ca 49°17'47"N, 17°27'42"E); HD1 (49°18'08"N, 17°27'57"E); HF6 (ca 49°18'00"N, 17°28'10"E); HG2 (49°17'47"N, 17°28'03"E; 49°17'35"N, 17°28'05"E)
C3	<i>Vulpia myuros</i> (*)	HE4 (49°18'05"N, 17°28'12"E); HF6 (49°18'06"N, 17°28'06"E)
C4a	<i>Aethusa cynapium</i> subsp. <i>elata</i>	HB3 (ca 49°17'48"N, 17°26'37"E)
C4a	<i>Atriplex prostrata</i> (*)	HD2 (49°18'04"N, 17°26'49"E)
C4a	<i>Bolboschoenus laticarpus</i>	HA1 (scattered); HF3 (49°18'07"N, 17°28'26"E; 49°18'07"N, 17°28'26"E);
C4a	<i>Bolboschoenus planiculmis</i> (*)	HA1 (scattered); HB1 (scattered); HF3 (e. g. 49°18'07"N, 17°28'25"E; 49°18'07"N, 17°28'26"E); HF6 (e. g. 49°18'07"N, 17°28'04"E; 49°17'56"N, 17°28'17"E); HG1 (scattered); HG2 (49°17'47"N, 17°28'03"E)
C4a	<i>Bromus japonicus</i> (*)	scattered in: HA1; HA2; HA3; HB1; HB2; HC1; HC2; HC3; HD1; HD2; HE4; HE5; HF1; HF6; HG1
C4a	<i>Carex otrubae</i>	HA3 (ca 49°17'44"N, 17°27'31"E); HE1 (rare); HG5 (rare); HI (rare)
C4a	<i>Carex riparia</i>	HA3 (e. g. ca 49°17'44"N, 17°27'31"E); HA4 (scattered); HB3 (scattered); HC3 (rare); HC4 (scattered); HD2 (rare); HE1 (49°18'04"N, 17°28'28"E); HE3 (rare); HE5 (rare); HF3 (49°18'06"N, 17°28'24"E); HF6 (49°18'01"N, 17°28'09"E); HG5 (scattered)
C4a	<i>Centaurium erythraea</i>	HA2 (acattered); HA3 (rare); HG5 (e. g. 49°17'49"N, 17°28'18"E)
C4a	<i>Cerastium lucorum</i>	HA4 (49°17'44"N, 17°27'08"E)
C4a	<i>Cornus mas</i> (*)	HD2 (49°18'08"N, 17°26'28"E); HI (rare)
C4a	<i>Crepis foetida</i> subsp. <i>rhoeadifolia</i> (*)	HA1 (49°17'47"N, 17°27'39"E , rare); HF6 (49°18'06"N, 17°28'06"E, rare)
C4a	<i>Epilobium lamyi</i>	HA2 (scattered); HB2 (rare); HC2 (scattered); HE1 (scattered); HE4 (scattered); HF1 (scattered); HF4 (scattered); HF5 (e. g. 49°18'00"N, 17°28'08"E); HF6 (scattered); HG2 (scattered); HI (rare)
C4a	<i>Euphorbia exigua</i> (*)	HE4 (49°18'08"N, 17°28'05"E, rare)
C4a	<i>Fraxinus angustifolia</i>	HA3 (rare); HA4 (scattered); HB3 (scattered); HF5 (rare); HG3 (scattered); HG6 (e. g. 49°17'32"N, 17°28'10"E)
C4a	<i>Galega officinalis</i> (*)	HF5 (49°18'01"N, 17°28'12"E)
C4a	<i>Galium boreale</i> subsp. <i>boreale</i>	HC3 (scattered)
C4a	<i>Galium elongatum</i>	HA3 (49°17'46"N, 17°27'25"E); HC4 (49°18'05"N, 17°26'26"E)
C4a	<i>Galium rivale</i>	scattered in: HA2; HA3; HA4; HB2; HB3; HC4; HD2; HE1; HG6
C4a	<i>Inula salicina</i> subsp. <i>salicina</i>	HE1 (49°18'01"N, 17°28'32"E)
C4a	<i>Loranthus europaeus</i> (*)	HC3 (49°17'52"N, 17°26'23"E)
C4a	<i>Myosotis sparsiflora</i>	HB1 (rare); HB3 (scattered); HE2 (scattered); HF1 (rare); HF3 (rare); HG3 (scattered)
C4a	<i>Scrophularia umbrosa</i>	HG3 (49°17'34"N, 17°28'02"E)
C4a	<i>Silene noctiflora</i> (*)	HB2 (scattered); HC1 (rare); HC2 (scattered); HE4 (49°18'08"N, 17°28'05"E); HG2 (e. g. 49°17'34"N, 17°28'05"E); HG5 (49°17'37"N, 17°28'11"E); HI (rare)
C4a	<i>Ulmus laevis</i>	rare in: HA2; HA3; HB2; HG6
C4a	<i>Ulmus minor</i>	HC3 (49°17'56"N, 17°26'24"E)
C4a	<i>Verbascum densiflorum</i>	HE1 (rare); HE2 (rare); HE5 (scattered); HF1 (rare); HF2 (scattered); HF4 (scattered); HF5 (scattered); HG2 (rare); HI (rare)
C4b	<i>Myosotis palustris</i> subsp. <i>palustris</i> (*)	HI (49°18'19"N, 17°26'54"E)
C4b	<i>Prunus mahaleb</i> subsp. <i>mahaleb</i> (*)	HE1 (49°18'03"N, 17°28'27"E)
C4b	<i>Rosa agrestis</i> (*)	HE1 (49°18'05"N, 17°28'29"E); HE2 (49°17'57"N, 17°28'29"E); HE5 (49°18'05"N, 17°28'16"E)

C4b	<i>Taraxacum amaurolepis</i> (*)	HF1 (scattered)
C4b	<i>Taraxacum melanostigma</i> (*)	HA2 (49°17'42"N, 17°27'47"E)
(*) - taxon nebyl v území nalezen mimo oblast H (hulinská štěrkovna)		

Table 13: Localisation of endangered vascular plant taxa in the Gravel Pit Kvasice (area K)
Nomenclature by Danihelka et al. 2012, **RL CZ** = category of endangered by Grulich 2012, (see appendix 8).

RL CZ	taxon	plot
C1t aut	<i>Populus cf. nigra</i>	KA1 (49°15'05"N, 17°28'36"E); KA3 (49°14'51"N, 17°28'46"E); KA4 (ca 49°15'29"N, 17°28'30"E); KA5 (rare); KB2 (49°15'25"N, 17°28'39"E)
C2b	<i>Batrachium rionii</i>	KA1 (49°15'05"N, 17°28'36"E)
C2b	<i>Verbascum blattaria</i>	KA3 (49°14'51"N, 17°28'46"E); KB4 (49°15'24"N, 17°28'39"E)
C3	<i>Agrimonia procera</i>	KA3 (49°15'17"N, 17°28'34"E; 49°15'20"N, 17°28'30"E); KB4 (e. g. 49°15'19"N, 17°28'34"E)
C3	<i>Batrachium circinatum</i>	KA1 (e. g. 49°15'05"N, 17°28'36"E); KA6 (49°15'28"N, 17°28'31"E); KC1 (scattered); KD1 (scattered); KE1 (e. g. 49°14'57"N, 17°29'03"E)
C3	<i>Epilobium parviflorum</i>	KA6 (49°15'29"N, 17°28'31"E)
C3	<i>Euphorbia stricta</i>	KB3 (49°15'26"N, 17°28'43"E)
C3	<i>Lemna trisulca</i>	KB3 (49°15'26"N, 17°28'43"E)
C3	<i>Potamogeton nodosus</i> (*)	KA1 (e. g. 49°14'52"N, 17°28'58"E); KA6 (49°15'28"N, 17°28'31"E); KB1 (e. g. 49°15'21"N, 17°28'49"E; 49°15'30"N, 17°28'44"E); KC1 (scattered); KD1 (scattered); KE1 (scattered)
C3	<i>Silaum silaus</i>	KC2 (rare)
C3	<i>Silene baccifera</i>	KA3 (e. g. 49°14'52"N, 17°28'52"E); KB4 (49°15'24"N, 17°28'43"E); KC2 (49°15'40"N, 17°28'33"E); KD2 (ca 49°15'36"N, 17°28'53"E)
C3	<i>Stellaria neglecta</i>	KA3 (49°15'02"N, 17°28'37"E)
C4a	<i>Aethusa cynapium</i> cf. subsp. <i>elata</i>	KB2 (rare)
C4a	<i>Arctium nemorosum</i>	KA3 (49°15'27"N, 17°28'29"E)
C4a	<i>Carex buekii</i>	KA3 (49°15'23"N, 17°28'29"E); KA4 (scattered); KA5 (scattered)
C4a	<i>Carex otomana</i>	KA3 (e. g. 49°15'25"N, 17°28'32"E); KA5 (scattered); KB2 (e. g. 49°15'16"N, 17°28'45"E; 49°15'14"N, 17°28'40"E; 49°15'29"N, 17°28'42"E); KC2 (49°15'41"N, 17°28'43"E); KE2 (scattered)
C4a	<i>Carex riparia</i>	KA3 (scattered); KA5 (rare); KB1 (scattered); KB2 (e. g. 49°15'29"N, 17°28'42"E); KB3 (scattered); KC2 (scattered)
C4a	<i>Centaurium erythraea</i>	KA4 (scattered); KB4 (e. g. ca 49°15'19"N, 17°28'34"E)
C4a	<i>Dianthus armeria</i> (*)	KB2 (49°15'14"N, 17°28'39"E)
C4a	<i>Epilobium lamyi</i>	scattered in: KA4 ; KB4
C4a	<i>Fraxinus angustifolia</i>	KA5 (scattered); KC2 (rare)
C4a	<i>Galium rivale</i>	scattered in: KA1 (e. g. 49°15'05"N, 17°28'36"E); KA2 ; KA3 ; KA4 ; KA6 ; KB1 ; KB2 ; KB3 ; KB4 (e. g. ca 49°15'19"N, 17°28'34"E); KC2 ; KD2 ; KE1 ; KE2
C4a	<i>Galium cf. spurium</i> (*)	KD2 (49°15'04"N, 17°29'07"E)
C4a	<i>Inula salicina</i> subsp. <i>salicina</i>	KB2 (rare); KB4 (e. g. ca 49°15'19"N, 17°28'34"E)
C4a	<i>Myosotis sparsiflora</i>	KA3 (e. g. 49°14'59"N, 17°28'37"E); KB2 (scattered); KB4 (scattered); KC2 (scattered)
C4a	<i>Neottia nidus-avis</i> (*)	KC2 (rare)
C4a	<i>Pyrus pyraeaster</i> (*)	KA4 (49°15'30"N, 17°28'30"E)
C4a	<i>Scrophularia umbrosa</i>	KA6 (rare); KB1 (49°15'30"N, 17°28'44"E); KC1 (scattered); KD1 (e. g. 49°15'36"N, 17°28'52"E)
C4a	<i>Ulmus laevis</i>	rare to scattered in: KA3 ; KA4 ; KA5 ; KB2 ; KB4 ; KC2
C4a	<i>Ulmus minor</i>	KC2 (rare)
C4a	<i>Vicia dumetorum</i>	KA3 (rare); KB2 (49°15'26"N, 17°28'40"E); KB3 (49°15'26"N, 17°28'40"E); KD2 (northern part)
C4b	<i>Salix triandra</i> subsp. <i>amygdalina</i> (*)	KD1 (49°15'06"N, 17°29'06"E)
(*) - taxon nebyl v území nalezen mimo oblast K (kvasická štěrkovna)		

Table 14: Localisation of endangered vascular plant taxa in the surroundings areas (L,P,S,T,Z,ST)
Nomenclature by Danihelka et al. 2012, **RL CZ** = category of endangered by Grulich 2012, (see appendix 8).

RL CR	taxon	plot
C1t	<i>Lathyrus palustris</i>	PB (49°16'20"N, 17°28'40"E)
C1t	<i>Taraxacum vindobonense</i>	PA (ca 49°16'48"N, 17°28'59"E)
C2b	<i>Batrachium rionii</i> (*)	S (ca 49°17'47"N, 17°29'02"E); ZB (ca 49°16'36"N, 17°28'19"E)

C2b	<i>Cerastium dubium</i>	PB (49°15'54"N, 17°28'54"E)
C2b	<i>Hydrocharis morsus-ranae</i>	PB (49°16'20"N, 17°28'41"E; 49°16'17"N, 17°29'01"E)
C2b	<i>Scutellaria hastifolia</i> (*)	LA (ca 49°17'35"N, 17°26'49"E); PB (49°16'11"N, 17°29'07"E)
C2b	<i>Senecio sarracenicus</i> (*)	PA (ca 49°17'02"N, 17°28'58"E; ca 49°17'04"N, 17°28'42"E; ca 49°16'50"N, 17°29'01"E; 49°16'58"N, 17°28'45"E); PB (ca 49°16'26"N, 17°29'18"E; 49°16'05"N, 17°29'11"E; 49°16'14"N, 17°29'07"E; 49°16'07"N, 17°28'58"E; 49°16'20"N, 17°28'41"E; 49°16'45"N, 17°29'19"E; 49°16'36"N, 17°29'20"E; 49°16'29"N, 17°29'20"E); ZA (ca 49°17'09"N, 17°28'38"E; ca 49°17'22"N, 17°28'39"E; ca 49°17'14"N, 17°28'16"E)
C2b	<i>Sium latifolium</i>	PB (ca 49°16'19"N, 17°28'47"E)
C2b	<i>Stellaria palustris</i>	PA (49°16'58"N, 17°28'45"E; ca 49°16'59"N, 17°28'51"E); PB (49°16'20"N, 17°28'54"E)
C2b	<i>Verbascum blattaria</i> (*)	LC (49°15'37"N, 17°28'25"E)
C2t	<i>Althaea officinalis</i>	S (49°17'50"N, 17°28'51"E)
C2t	<i>Dianthus superbus</i>	S (49°17'50"N, 17°28'52"E)
C2t	<i>Viola stagnina</i>	PB (49°15'54"N, 17°28'54"E); LA? (<i>Viola</i> cf. <i>stagnina</i> : 49°18'12"N, 17°25'59"E)
C3	<i>Agrimonia procera</i>	S (49°17'50"N, 17°28'49"E)
C3	<i>Allium angulosum</i>	PA (ca 49°17'04"N, 17°28'42"E; ca 49°16'46"N, 17°29'05"E; ca 49°16'50"N, 17°29'01"E); PB (ca 49°16'26"N, 17°29'18"E; ca 49°16'20"N, 17°29'02"E; ca 49°16'19"N, 17°28'47"E; 49°15'47"N, 17°28'52"E)
C3	<i>Asperugo procumbens</i>	LA (49°17'13"N, 17°26'43"E)
C3	<i>Barbarea stricta</i>	PB (49°16'11"N, 17°29'07"E)
C3	<i>Ceratophyllum submersum</i>	S (49°17'39"N, 17°28'54"E)
C3	<i>Dipsacus pilosus</i>	LA (49°16'57"N, 17°27'43"E; 49°17'20"N, 17°26'40"E); LC (ca 49°16'01"N, 17°28'27"E); PB (49°16'20"N, 17°28'41"E)
C3	<i>Epilobium parviflorum</i> (*)	S (ca 49°17'43"N, 17°28'57"E; ca 49°17'47"N, 17°29'02"E)
C3	<i>Equisetum pratense</i>	LC (49°16'10"N, 17°28'18"E)
C3	<i>Euphorbia palustris</i> (*)	PB (49°16'01"N, 17°29'09"E; 49°16'09"N, 17°28'52"E)
C3	<i>Euphorbia stricta</i>	LA (49°17'38"N, 17°26'51"E); LB (49°16'56"N, 17°27'12"E)
C3	<i>Hottonia palustris</i>	LB (49°16'57"N, 17°27'33"E); LC (ca 49°16'13"N, 17°28'32"E); PB (49°16'14"N, 17°29'02"E)
C3	<i>Lemna trisulca</i>	LC (49°16'45"N, 17°27'48"E); PB (49°16'14"N, 17°29'02"E)
C3	<i>Lotus tenuis</i> (*)	PA (ca 49°16'50"N, 17°29'01"E)
C3	<i>Potamogeton trichoides</i>	T (49°15'08"N, 17°29'29"E)
C3	<i>Pulmonaria mollis</i> (*)	PB (ca 49°16'20"N, 17°29'02"E)
C3	<i>Senecio erraticus</i>	PA (ca 49°17'02"N, 17°28'58"E; ca 49°16'46"N, 17°29'05"E; ca 49°16'50"N, 17°29'01"E)
C3	<i>Silaum silaus</i> (*)	LA (49°18'12"N, 17°25'59"E); PA (ca 49°17'02"N, 17°28'58"E; ca 49°17'04"N, 17°28'42"E; ca 49°16'59"N, 17°28'51"E); PB (ca 49°16'20"N, 17°29'02"E; 49°16'05"N, 17°29'11"E; 49°16'26"N, 17°29'07"E; 49°16'09"N, 17°28'52"E)
C3	<i>Silene baccifera</i> (*)	LB (scattered); LC (ca 49°16'01"N, 17°28'27"E); PB (49°16'20"N, 17°28'41"E); ZA (49°16'54"N, 17°27'52"E; ca 49°17'14"N, 17°28'16"E; 49°17'27"N, 17°28'28"E); ZB (ca 49°16'37"N, 17°28'14"E)
C3	<i>Stellaria neglecta</i> (*)	LA (49°16'57"N, 17°27'43"E; 49°17'16"N, 17°26'35"E); LC (ca 49°15'45"N, 17°28'28"E)
C3	<i>Taraxacum copidophyllum</i>	PA (ca 49°16'48"N, 17°28'59"E and scattered on another places)
C3	<i>Thalictrum lucidum</i> (*)	LA (49°18'12"N, 17°25'59"E); PB (49°16'12"N, 17°29'05"E)
C3	<i>Trifolium fragiferum</i>	PA (ca 49°17'02"N, 17°28'58"E)
C3	<i>Verbena officinalis</i>	LA (49°17'51"N, 17°25'51"E)
C3	<i>Veronica catenata</i> (*)	near PB (49°15'41"N, 17°29'28"E)
C3	<i>Veronica maritima</i>	LA (49°18'12"N, 17°25'59"E)
C4a	<i>Aethusa cynapium</i> subsp. <i>elata</i> (*)	LA (49°17'12"N, 17°26'46"E); LC (ca 49°15'51"N, 17°28'40"E)
C4a	<i>Arctium nemorosum</i>	LA (49°17'46"N, 17°26'28"E); LB (49°16'52"N, 17°27'10"E)
C4a	<i>Bolboschoenus laticarpus</i> (*)	ZB (ca 49°16'36"N, 17°28'19"E)
C4a	<i>Butomus umbellatus</i>	S (ca 49°17'49"N, 17°28'57"E; ca 49°17'46"N, 17°28'51"E); ZB (ca 49°16'36"N, 17°28'19"E; 49°16'48"N, 17°27'59"E)
C4a	<i>Cardamine matthioli</i>	LA (49°18'12"N, 17°25'59"E); PA (ca 49°16'59"N, 17°28'51"E); PB (49°15'54"N, 17°28'54"E);
C4a	<i>Carex buekii</i>	LA (49°17'10"N, 17°27'20"E and on another places); LB (scattered); LC (ca 49°15'51"N, 17°28'40"E and on another places); PB (49°16'05"N, 17°29'11"E;); ZA (ca 49°17'09"N, 17°28'38"E)

C4a	<i>Carex disticha</i>	PA (49°16'58"N, 17°28'45"E); PB (49°16'11"N, 17°29'07"E; ca 49°16'19"N, 17°28'48"E)
C4a	<i>Carex otomana</i>	LC (49°16'07"N, 17°28'20"E); PB (49°16'20"N, 17°28'40"E)
C4a	<i>Carex otrubae</i> (*)	LA (49°17'25"N, 17°27'32"E); PA (ca 49°16'59"N, 17°28'51"E); S (ca 49°17'43"N, 17°28'57"E)
C4a	<i>Carex pendula</i>	LA (49°16'55"N, 17°27'47"E)
C4a	<i>Carex riparia</i> (*)	LA (ca 49°17'35"N, 17°26'49"E; 49°18'12"N, 17°25'59"E; and on another places); LB (scattered); LC (49°15'59"N, 17°28'52"E; ca 49°16'01"N, 17°28'27"E; and scattered on another places); PA (ca 49°16'59"N, 17°28'51"E and on another places); PB (49°16'01"N, 17°29'09"E; 49°16'12"N, 17°29'05"E; 49°16'29"N, 17°29'20"E); S (ca 49°17'40"N, 17°28'52"E; ca 49°17'50"N, 17°28'49"E); ST (49°18'27"N, 17°25'32"E); ZA (ca 49°17'09"N, 17°28'38"E); ZB (ca 49°16'37"N, 17°28'14"E)
C4a	<i>Cerastium lucorum</i> (*)	LA (49°17'16"N, 17°27'52"E and on another places); LC (ca 49°15'51"N, 17°28'40"E); S (ca 49°17'50"N, 17°28'49"E)
C4a	<i>Fraxinus angustifolia</i> (*)	LA (ca 49°17'35"N, 17°26'49"E; 49°17'10"N, 17°27'20"E); LC (ca 49°15'51"N, 17°28'40"E); PA (ca 49°17'04"N, 17°28'42"E; 49°17'02"N, 17°28'53"E); ZA (49°17'15"N, 17°28'02"E)
C4a	<i>Galium boreale</i> subsp. <i>boreale</i> (*)	LA (49°18'12"N, 17°25'59"E); PB (ca 49°16'19"N, 17°28'48"E); ST (ca 49°18'26"N, 17°25'42"E)
C4a	<i>Galium elongatum</i> (*)	LC (49°15'59"N, 17°28'52"E)
C4a	<i>Galium rivale</i> (*)	LA (49°17'12"N, 17°26'46"E; 49°17'10"N, 17°27'20"E; 49°17'25"N, 17°27'32"E; 49°17'38"N, 17°26'51"E; ca 49°17'35"N, 17°26'49"E; 49°17'32"N, 17°27'00"E; and on another places); LB (49°16'52"N, 17°27'10"E); LC (ca 49°15'57"N, 17°28'19"E); PA (ca 49°17'02"N, 17°28'58"E; ca 49°17'04"N, 17°28'42"E; 49°16'58"N, 17°28'45"E; ca 49°16'59"N, 17°28'51"E); PB (49°16'01"N, 17°29'09"E; 49°16'12"N, 17°29'05"E; 49°16'20"N, 17°28'41"E; 49°16'45"N, 17°29'19"E); S (ca 49°17'50"N, 17°28'49"E); ZA (ca 49°17'22"N, 17°28'39"E; ca 49°17'09"N, 17°28'38"E; 49°17'17"N, 17°28'27"E)
C4a	<i>Inula salicina</i> subsp. <i>salicina</i> (*)	LA (ca 49°16'59"N, 17°27'32"E, very rare); PB (ca 49°16'31"N, 17°29'06"E)
C4a	<i>Lavatera thuringiaca</i>	ZA (49°17'27"N, 17°28'09"E)
C4a	<i>Myosotis caespitosa</i>	PA (ca 49°16'59"N, 17°28'51"E); PB (49°16'20"N, 17°28'41"E); S (ca 49°17'40"N, 17°28'52"E; ca 49°17'46"N, 17°28'51"E; ca 49°17'43"N, 17°28'57"E);
C4a	<i>Myosotis sparsiflora</i> (*)	LB (scattered); LC (ca 49°15'51"N, 17°28'40"E; ca 49°15'57"N, 17°28'19"E); ZB (ca 49°16'37"N, 17°28'14"E)
C4a	<i>Scrophularia umbrosa</i> (*)	PA (49°16'58"N, 17°28'45"E)
C4a	<i>Ulmus laevis</i> (*)	LA (ca 49°16'59"N, 17°27'32"E and on another places); LB (scattered); LC (ca 49°15'51"N, 17°28'40"E and on another places);
C4a	<i>Ulmus minor</i> (*)	LB (scattered)
C4a	<i>Verbascum densiflorum</i> (*)	S (ca 49°17'47"N, 17°29'02"E)
C4a	<i>Veronica scutellata</i>	PA (ca 49°17'02"N, 17°28'58"E); PB (49°16'20"N, 17°28'41"E; 49°15'54"N, 17°28'54"E);
C4a	<i>Vicia dumetorum</i>	LB (49°16'52"N, 17°27'10"E); LC (ca 49°16'01"N, 17°28'27"E); ZB (ca 49°16'36"N, 17°28'19"E)
C4b	<i>Galium cf. mollugo</i>	LA (ca 49°17'35"N, 17°26'49"E)
C4b	<i>Galium wirtgenii</i>	PB (49°16'26"N, 17°29'07"E)
(*) - nalezeno i v oblasti H (hulínská štěrkovna)		

Table 15: List of Araneae and Opiliones in the Gravel Pit Hulín (area H)
RL CZ = category of endangered by Řezáč et al. 2015, (see appendix 8).

species	family	RL CZ
Araneae		
<i>Agelena labyrinthica</i> (Clerck, 1757)	Agelenidae	
<i>Agroeca brunnea</i> (Blackwall, 1833)	Liocranidae	
<i>Antistea elegans</i> (Blackwall, 1841)	Hahniidae	
<i>Anyphaena accentuata</i> (Walckenaer, 1802)	Anyphaenidae	
<i>Alopecosa pulverulenta</i> (Clerck, 1757)	Lycosidae	
<i>Araniella cucurbitina</i> (Clerck, 1757)	Araneidae	
<i>Arctosa leopardus</i> (Sundevall, 1833)	Lycosidae	
<i>Clubiona</i> sp.	Clubionidae	
<i>Clubiona stagnatilis</i> Kulczyński, 1897	Clubionidae	
<i>Dictyna uncinata</i> Thorell, 1856	Dictynidae	

<i>Drassodes lapidosus</i> (Walckenaer, 1802)	Gnaphosidae	
<i>Drassyllus pusillus</i> (C. L. Koch, 1833)	Gnaphosidae	
<i>Ebrechtella tricuspidata</i> (Fabricius, 1775)	Thomisidae	
<i>Enoplognatha ovata</i> (Clerck, 1757)	Theridiidae	
<i>Eratigena agrestis</i> (Walckenaer, 1802)	Agelenidae	
<i>Evarcha arcuata</i> (Clerck, 1757)	Salticidae	
<i>Heliophanus auratus</i> C. L. Koch, 1835	Salticidae	
<i>Larinioides sclopetarius</i> (Clerck, 1757)	Araneidae	
<i>Larinioides suspicax</i> (O. P.-Cambridge, 1876)	Araneidae	
<i>Linyphia triangularis</i> (Clerck, 1757)	Linyphiidae	
<i>Mangora acalypha</i> (Walckenaer, 1802)	Araneidae	
<i>Metellina segmentata</i> (Clerck, 1757)	Tetragnathidae	
<i>Micaria pulicaria</i> (Sundevall, 1831)	Gnaphosidae	
<i>Misumena vatia</i> (Clerck, 1757)	Thomisidae	
<i>Neriere clathrata</i> (Sundevall, 1830)	Linyphiidae	
<i>Nuctenea umbratica</i> (Clerck, 1757)	Araneidae	
<i>Oedothorax apicatus</i> (Blackwall, 1850)	Linyphiidae	
<i>Ozyptila praticola</i> (C. L. Koch, 1837)	Thomisidae	
<i>Parasteatoda lunata</i> (Clerck, 1757)	Theridiidae	
<i>Pardosa agrestis</i> (Westring, 1861)	Lycosidae	
<i>Pardosa amentata</i> (Clerck, 1757)	Lycosidae	
<i>Pardosa lugubris</i> (Walckenaer, 1802)	Lycosidae	
<i>Pardosa nebulosa</i> (Thorell, 1872)	Lycosidae	CR
<i>Pardosa pullata</i> (Clerck, 1757)	Lycosidae	
<i>Philodromus</i> sp.	Philodromidae	
<i>Phlegra fasciata</i> (Hahn, 1826)	Salticidae	
<i>Phrurolithus festivus</i> (C. L. Koch, 1835)	Phrurolithidae	
<i>Pirata hygrophilus</i> Thorell, 1872	Lycosidae	
<i>Piratula latitans</i> (Blackwall, 1841)	Lycosidae	
<i>Pisaura mirabilis</i> (Clerck, 1757)	Pisauridae	
<i>Porrhomma microphthalmum</i> (O. P.-Cambridge, 1871)	Linyphiidae	
<i>Singa nitidula</i> C. L. Koch, 1844	Araneidae	
<i>Synageles venator</i> (Lucas, 1836)	Salticidae	
<i>Tetragnatha extensa</i> (Linnaeus, 1758)	Tetragnathidae	
<i>Tetragnatha pinicola</i> L. Koch, 1870	Tetragnathidae	
<i>Thanatus striatus</i> C. L. Koch, 1845	Philodromidae	
<i>Theridion varians</i> Hahn, 1833	Theridiidae	
<i>Tibellus oblongus</i> (Walckenaer, 1802)	Philodromidae	
<i>Titanoeca quadriguttata</i> (Hahn, 1833)	Titanoecidae	
<i>Trachyzelotes pedestris</i> (C. L. Koch, 1837)	Gnaphosidae	
<i>Trochosa ruficollis</i> (De Geer, 1778)	Lycosidae	
<i>Xerolycosa miniata</i> (C. L. Koch, 1834)	Lycosidae	
<i>Xysticus cristatus</i> (Clerck, 1757)	Thomisidae	
<i>Xysticus ulmi</i> (Hahn, 1831)	Thomisidae	
<i>Zilla diodia</i> (Walckenaer, 1802)	Araneidae	
<i>Zelotes subterraneus</i> (C. L. Koch, 1833)	Gnaphosidae	
<i>Zodarion rubidum</i> Simon, 1914	Zodaridae	
<i>Zora spinimana</i> (Sundevall, 1833)	Miturgidae	
Opiliones		
<i>Astrobus laevipes</i> (Canestrini, 1872)	Sclerosomatidae	
<i>Lacinius dentiger</i> (C. L. Koch, 1848)	Phalangidae	
<i>Lacinius ephippiatus</i> (C. L. Koch, 1835)	Phalangidae	
<i>Phalangium opilio</i> Linnaeus, 1761	Phalangidae	
<i>Rilaena triangularis</i> (Herbst, 1799)	Phalangidae	
<i>Nemastoma lugubre</i> (Müller, 1776)	Nemastomatidae	
<i>Trogulus nepaeformis</i> (Scopoli, 1763)	Trogulidae	

Table 16: List of dragonflies and damselflies (Odonata) in the Gravel Pit Hulín and Kvasice (area H and K)
RL CZ = category of endangered by Farkač et al. 2005, (see appendix 8).

species	family	CZ §	EU §	RL CZ	Hulín	Kvasice	DBI
<i>Aeshna cyanea</i> (Müller, 1764)	Aeshnidae				*		0
<i>Aeshna affinis</i> Vander Linden, 1820	Aeshnidae			VU	*		5
<i>Aeshna mixta</i> Latreille, 1805	Aeshnidae				*	*	1
<i>Anax imperator</i> Leach, 1815	Aeshnidae					*	0
<i>Anax parthenope</i> (Sélys, 1839)	Aeshnidae			VU	*		3
<i>Calopteryx splendens</i> (Harris, 1782)	Calopterygidae				*		0
<i>Calopteryx virgo</i> (Linnaeus, 1758)	Calopterygidae					*	1

<i>Chalcolestes viridis</i> (Vander Linden, 1825)	Lestidae								*	1
<i>Coenagrion puella</i> (Linnaeus, 1758)	Coenagrionidae								*	0
<i>Crocothemis erythraea</i> (Brullé, 1832)	Libellulidae								*	1
<i>Enallagma cyathigerum</i> Charpentier, 1840	Coenagrionidae								*	0
<i>Erythromma viridulum</i> (Charpentier, 1840)	Coenagrionidae								*	3
<i>Ischnura elegans</i> (Vander Linden, 1820)	Coenagrionidae								*	0
<i>Lestes sponsa</i> (Hansemann, 1823)	Lestidae								*	0
<i>Libellula depressa</i> Linnaeus, 1758	Libellulidae								*	0
<i>Orthetrum cancellatum</i> (Linnaeus, 1758)	Libellulidae								*	0
<i>Orthetrum albistylum</i> (Sélys, 1848)	Libellulidae								*	2
<i>Platycnemis pennipes</i> (Pallas, 1771)	Platycnemididae								*	0
<i>Sympetrum meridionale</i> (Sélys, 1841)	Libellulidae								*	8
<i>Sympetrum sanguineum</i> (O. F. Müller, 1764)	Libellulidae								*	0
<i>Sympetrum striolatum</i> (Charpentier, 1840)	Libellulidae								*	3
<i>Stylurus flavipes</i> (Charpentier, 1825)	Gomphidae	SO	annex IV						*	7

Table 17: List of Orthoptera in the Gravel Pit Hulín (area H)
RL CZ = category of endangered by Farkač et al. 2005, (see appendix 8).

species	family	RL CZ	A1	A2	A3	A4	B1	B2	C1	C2	C4	D	D3	E1	E2	E5	E6	G2
<i>Chorthippus albomarginatus</i> (De Geer, 1773)	Acrididae			*	*			*		*								*
<i>Chorthippus apricarius</i> (Linnaeus, 1758)	Acrididae																	*
<i>Chorthippus biguttulus</i> (Linnaeus, 1758)	Acrididae			*	*			*		*	*	*	*		*		*	*
<i>Chorthippus brunneus</i> (Thunberg, 1815)	Acrididae									*		*	*					*
<i>Chorthippus dorsatus</i> (Zetterstedt, 1821)	Acrididae			*	*			*		*	*		*	*		*		*
<i>Chrysochraon dispar</i> (Germar, 1834)	Acrididae			*														*
<i>Conocephalus dorsalis</i> (Latreille, 1804)	Tettigoniidae		*									*						*
<i>Conocephalus fuscus</i> (Fabricius, 1793)	Tettigoniidae		*	*	*	*	*	*	*	*		*				*		*
<i>Eumodicogryllus bordigalensis</i> (Latreille, 1804)	Gryllidae									*	*	*	*					
<i>Gryllotalpa gryllotalpa</i> (Linnaeus, 1758)	Gryllotalpidae									*		*				*		
<i>Leptophyes albovittata</i> (Kollar, 1833)	Tettigoniidae				*	*												
<i>Metrioptera bicolor</i> (Philippi, 1830)	Tettigoniidae									*								
<i>Meconema thalassinum</i> (DeGeer, 1773)	Tettigoniidae																	
<i>Oecanthus pellucens</i> (Scopoli, 1763)	Gryllidae									*								
<i>Oedipoda caerulea</i> (Linnaeus, 1758)	Acrididae														*			
<i>Phaneroptera falcata</i> (Poda, 1761)	Tettigoniidae				*													
<i>Pholidoptera griseoaptera</i> (De Geer, 1773)	Tettigoniidae		*	*		*	*			*								*
<i>Pseudochorthippus montanus</i> (Charpentier, 1825)	Acrididae			*	*			*										
<i>Pseudochorthippus parallelus</i> (Zetterstedt, 1821)	Acrididae			*	*			*										
<i>Pteronemobius heydeni</i> (Fischer-Waldheim, 1853)	Gryllidae	DD							*									
<i>Roeseliana roeselii</i> (Hagenbach, 1822)	Tettigoniidae			*	*			*		*	*		*	*				*
<i>Ruspolia nitidula</i> (Scopoli, 1786)	Tettigoniidae	CR				*				*								
<i>Tettigonia viridissima</i> Linnaeus, 1758	Tettigoniidae																	
<i>Tetrix subulata</i> (Linnaeus, 1758)	Tetrigidae																	*
<i>Tetrix tenuicornis</i> (Sahlberg, 1891)	Tetrigidae		*															

Table 18: List of ground beetles (Carabidae) in in the Gravel Pit Hulín (area H) and Kvasice (area K).
RL CZ = category of endangered by Farkač et al. 2005, (see appendix 8).

species	CZ §	RL CZ	A2	A3	B2	E1	E2	E3	E4	G3	Kvasice
<i>Abax parallelepipedus</i> (Piller & Mitterpacher, 1783)			*	*		*	*	*			*
<i>Abax parallelus</i> (Duftschmid, 1812)				*		*	*				
<i>Agonum viduum</i> (Panzer, 1797)			*	*	*	*	*	*		*	*
<i>Amara aenea</i> (De Geer, 1774)			*	*	*	*	*	*		*	*
<i>Amara familiaris</i> (Duftschmid, 1812)						*					
<i>Amara fulva</i> (O.F. Müller, 1776)				*			*				
<i>Amara gebleri</i> Dejean, 1831							*				
<i>Amara ovata</i> (Fabricius, 1792)			*				*		*		
<i>Amara similata</i> (Gyllenhal, 1810)							*				
<i>Anchomenus dorsalis</i> (Pontoppidan, 1763)				*		*					
<i>Anisodactylus binotatus</i> (Fabricius, 1787)			*	*		*	*	*		*	*
<i>Badister lacertosus</i> Sturm, 1815				*		*	*				
<i>Bembidion biguttatum</i> (Fabricius, 1779)						*				*	
<i>Bembidion lampros</i> (Herbst, 1784)			*	*	*	*	*	*		*	
<i>Bembidion quadrimaculatum</i> (Linnaeus, 1761)							*				
<i>Bembidion varium</i> (Olivier, 1795)							*				
<i>Brachinus crepitans</i> (Linnaeus, 1758)	O		*	*				*		*	
<i>Broscus cephalotes</i> (Linnaeus, 1758)							*				

<i>Calathus erratus</i> (C. R. Sahlberg, 1827)					*	*	*		
<i>Calathus fuscipes</i> (Goeze, 1777)					*	*	*	*	*
<i>Calathus melanocephalus</i> (Linnaeus, 1758)						*			
<i>Carabus coriaceus</i> Linnaeus, 1758					*	*			*
<i>Carabus granulatus</i> Linnaeus, 1758					*	*			*
<i>Carabus scheidleri</i> Panzer, 1799	O				*	*	*	*	*
<i>Carabus ullrichii</i> Germar, 1824	O				*	*	*		*
<i>Carabus violaceus</i> Linnaeus, 1758					*	*	*	*	*
<i>Chlaenius nigricornis</i> Fabricius, 1787						*	*		
<i>Cicindela campestris</i> Linnaeus, 1758	O						*		
<i>Cicindela hybrida</i> Linnaeus, 1758						*		*	
<i>Clivina fossor</i> (Linnaeus, 1758)					*		*		
<i>Cylindera arenaria</i> (Füssli, 1775)	O					*		*	
<i>Cylindera germanica</i> (Linnaeus, 1758)	O	VU				*		*	
<i>Drypta dentata</i> (Rossi, 1790)					*				
<i>Europhilus micans</i> (Nicolai, 1822)							*		
<i>Harpalus affinis</i> (Schränk, 1781)					*	*	*	*	*
<i>Harpalus distinguendus</i> (Duftschmid, 1812)					*		*		
<i>Harpalus flavescens</i> (Piller & Mitterpacher, 1783)		NT					*		
<i>Harpalus luteicornis</i> (Duftschmid, 1812)					*	*			
<i>Leistus ferrugineus</i> (Linnaeus, 1758)					*	*	*	*	*
<i>Leistus terminatus</i> (Hellwig in Panzer, 1793)							*		*
<i>Loricera pilicornis</i> (Fabricius, 1775)					*				
<i>Nebria brevicollis</i> (Fabricius, 1792)					*	*	*		*
<i>Nebria livida</i> (Linnaeus, 1758)		NT			*				
<i>Notiophilus biguttatus</i> (Fabricius, 1779)					*				
<i>Notiophilus palustris</i> (Duftschmid, 1812)					*	*	*		*
<i>Omophron limbatum</i> (Fabricius, 1776)					*				
<i>Oodes helopioides</i> (Fabricius, 1792)							*	*	
<i>Ophonus azureus</i> (Fabricius, 1775)					*				
<i>Ophonus melletii</i> (Heer, 1837)								*	
<i>Oxypselaphus obscurus</i> (Herbst, 1784)					*	*	*		
<i>Panagaeus cruxmajor</i> (Linnaeus, 1758)					*	*			*
<i>Poecilus cupreus</i> (Linnaeus, 1758)					*	*	*	*	
<i>Pseudoophonus griseus</i> (Panzer, 1797)					*	*	*	*	*
<i>Pseudoophonus rufipes</i> (De Geer, 1774)					*	*	*	*	*
<i>Pterostichus diligens</i> (Sturm, 1824)					*				
<i>Pterostichus gracilis</i> (Dejean, 1828)		VU			*		*		
<i>Pterostichus macer</i> (Marsham, 1802)					*	*	*	*	*
<i>Pterostichus melanarius</i> (Illiger, 1798)					*	*	*	*	*
<i>Pterostichus niger</i> (Schaller, 1783)					*		*	*	*
<i>Pterostichus nigrita</i> (Paykull, 1790)					*	*		*	*
<i>Pterostichus oblongopunctatus</i> (Fabricius, 1787)					*	*	*		
<i>Pterostichus ovoideus</i> (Sturm, 1824)							*		
<i>Pterostichus strenuus</i> (Panzer, 1797)					*		*		
<i>Stomis pumicatus</i> (Panzer, 1796)							*		
<i>Syntomus truncatellus</i> (Linnaeus, 1761)					*	*	*	*	
<i>Trechus quadristriatus</i> (Schränk, 1781)					*	*	*	*	*
<i>Trichocellus placidus</i> (Gyllenhal, 1827)								*	

Table 19: List of birds (Aves) in the Gravel Pit Hulín (area H).

RL CZ = category of endangered by Plesnik et al. 2003, (see appendix 8).

species	family	CZ §	EU §	RL CZ	wetland species	nesting	wintering	migration
<i>Acrocephalus palustris</i> (Bechstein, 1798)	Acrocephalidae				*	*		*
<i>Acrocephalus scirpaceus</i> (Hermann, 1804)	Acrocephalidae				*	*		*
<i>Acrocephalus schoenobaenus</i> (Linnaeus, 1758)	Acrocephalidae				*	*		*
<i>Actitis hypoleucos</i> (Linnaeus, 1758)	Scolopacidae	SO		EN	*	*		*
<i>Alauda arvensis</i> Linnaeus, 1758	Alaudidae					*		*
<i>Alcedo atthis</i> (Linnaeus, 1758)	Alcedinidae	SO	annex I	VU	*	*		
<i>Anas platyrhynchos</i> Linnaeus, 1758	Anatidae				*	*		
<i>Anthus trivialis</i> (Linnaeus, 1758)	Motacillidae					*		*
<i>Apus apus</i> (Linnaeus, 1758)	Apodidae	O				*		*
<i>Ardea cinerea</i> Linnaeus, 1758	Ardeidae			NT	*	*	*	
<i>Asio flammeus</i> (Pontoppidan, 1763)	Strigidae	SO	annex I	VU		*	*	*
<i>Aythya ferina</i> (Linnaeus, 1758)	Anatidae				*	*	*	
<i>Buteo buteo</i> (Linnaeus, 1758)	Accipitridae					*		*
<i>Carduelis cannabina</i> (Linnaeus, 1758)	Fringillidae					*	*	

<i>Carduelis carduelis</i> (Linnaeus, 1758)	Fringillidae					*			
<i>Certhia</i> sp.	Certhiidae					*			
<i>Charadrius dubius</i> Scopoli, 1786	Charadriidae			VU		*			
<i>Chlidonias niger</i> (Linnaeus, 1758)	Laridae	KO	annex I	CR		*			*
<i>Chroicocephalus ridibundus</i> (Linnaeus, 1766)	Laridae			VU		*		*	
<i>Circus aeruginosus</i> (Linnaeus, 1758)	Accipitridae	O	annex I	VU		*			
<i>Coccothraustes coccothraustes</i> (Linnaeus, 1758)	Fringillidae					*			
<i>Columba palumbus</i> Linnaeus, 1758	Columbidae					*			*
<i>Corvus cornix</i> Linnaeus, 1758	Corvidae					*			
<i>Cuculus canorus</i> Linnaeus, 1758	Cuculidae					*			
<i>Cyanistes caeruleus</i> (Linnaeus, 1758)	Paridae					*			
<i>Delichon urbica</i> (Linnaeus, 1758)	Hirundinidae			NT		*			*
<i>Dendrocopos major</i> (Linnaeus, 1758)	Picidae					*			
<i>Dryocopus martius</i> (Linnaeus, 1758)	Picidae		annex I	LC		*			
<i>Egretta alba</i> (Linnaeus, 1758)	Ardeidae	SO	annex I			*			
<i>Emberiza citrinella</i> Linnaeus, 1758	Emberizidae					*			
<i>Emberiza schoeniclus</i> (Linnaeus, 1758)	Emberizidae					*		*	*
<i>Erethacus rubecula</i> (Linnaeus, 1758)	Muscicapidae					*			*
<i>Falco tinnunculus</i> Linnaeus, 1758	Falconidae					*			
<i>Fringilla coelebs</i> Linnaeus, 1758	Fringillidae					*		*	*
<i>Gallinago gallinago</i> (Linnaeus, 1758)	Scolopacidae	SO		EN		*			*
<i>Garrulus glandarius</i> (Linnaeus, 1758)	Corvidae					*			
<i>Hippolais icterina</i> (Vieillot, 1817)	Acrocephalidae					*			*
<i>Hirundo rustica</i> Linnaeus, 1758	Hirundinidae	O		LC		*			*
<i>Lanius collurio</i> Linnaeus, 1758	Laniidae	O	annex I	NT		*			
<i>Larus cachinnans/michahellis</i>	Laridae			VU		*		*	*
<i>Locustella luscinioides</i> (Savi, 1824)	Locustellidae	O		EN		*			*
<i>Luscinia megarhynchos</i> Brehm, 1831	Muscicapidae	O		LC		*			*
<i>Motacilla alba</i> Linnaeus, 1758	Motacillidae					*			
<i>Oriolus oriolus</i> (Linnaeus, 1758)	Oriolidae	SO		LC		*			*
<i>Parus major</i> Linnaeus, 1758	Paridae					*			
<i>Passer domesticus</i> (Linnaeus, 1758)	Passeridae			LC		*			
<i>Passer montanus</i> (Linnaeus, 1758)	Passeridae			LC		*			
<i>Phasianus colchicus</i> Linnaeus, 1758	Phasianidae					*			
<i>Philomachus pugnax</i> (Linnaeus, 1758)	Scolopacidae					*			*
<i>Phoenicurus ochruros</i> (S. G. Gmelin, 1774)	Muscicapidae					*			*
<i>Phylloscopus collybita</i> (Vieillot, 1817)	Phylloscopidae					*			*
<i>Phylloscopus trochilus</i> (Linnaeus, 1758)	Phylloscopidae					*			*
<i>Pica pica</i> (Linnaeus, 1758)	Corvidae					*			
<i>Picus canus</i> Gmelin, 1788	Picidae		annex I	VU		*			
<i>Picus viridis</i> Linnaeus, 1758	Picidae			LC		*			
<i>Podiceps cristatus</i> (Linnaeus, 1758)	Podicipedidae	O		VU		*		*	
<i>Poecile palustris/montanus</i>	Paridae					*			
<i>Remiz pendulinus</i> (Linnaeus, 1758)	Remizidae	O		NT		*			*
<i>Riparia riparia</i> (Linnaeus, 1758)	Hirundinidae	O		NT		*			*
<i>Saxicola rubicola</i> (Linnaeus, 1766)	Muscicapidae	O		VU		*			*
<i>Serinus serinus</i> (Linnaeus, 1766)	Fringillidae					*		*	*
<i>Sterna hirundo</i> Linnaeus, 1758	Laridae	SO	annex I	EN		*			*
<i>Streptopelia decaocto</i> (Frivaldszky, 1838)	Columbidae					*			
<i>Streptopelia turtur</i> (Linnaeus, 1758)	Columbidae					*			*
<i>Sturnus vulgaris</i> Linnaeus, 1758	Sturnidae					*		*	*
<i>Sylvia atricapilla</i> (Linnaeus, 1758)	Sylviidae					*			*
<i>Sylvia borin</i> (Boddaert, 1783)	Sylviidae					*			*
<i>Sylvia communis</i> Latham, 1787	Sylviidae					*			*
<i>Tringa erythropus</i> (Pallas, 1764)	Scolopacidae					*			*
<i>Tringa glareola</i> Linnaeus, 1758	Scolopacidae					*			*
<i>Tringa ochropus</i> Linnaeus, 1758	Scolopacidae	SO		EN		*		*	*
<i>Turdus merula</i> Linnaeus, 1758	Turdidae					*			
<i>Vanellus vanellus</i> (Linnaeus, 1758)	Charadriidae			VU		*			*

Appendix 10: Comments on selected finds

Macromycetes

***Jafnea semitosta*.** A species native in North America. It was found in Austria in 1996, which was the first record in Europe. It was probably introduced together with the eastern black walnut (*Juglans nigra*). In 2010 it was found in the Czech Republic in Zlodějský háj, in the Hodonín region (Antonín & Moravec 2010). Záhlinické rybníky is its second known locality in the Czech Republic. This population is very abundant.

***Morchella semilibera*.** A spring species, occurring in open broad-leaf forests, groves, floodplain-forests, parks and gardens. Mostly under the ash, alder, poplar or willow trees.

***Octospora ithacaensis*.** A small bryoparasitic fungus, growing on *Marchantia polymorpha*. Although the host liverwort is a common species, the fungus is known from only a few localities in Europe. In the Czech Republic, it was recorded in 2014 for the first time (Egertová et al. 2014) at two localities: in the castle park Buchlovice and in the Natural Park Záhlinické rybníky, in the vicinity of pheasantry. The species became extinct at the later locality due to nettle expansion after abandoning of the pheasantry. Since the time a new locality was found in Olomouc.

***Pezoloma marchantiae*.** Inoperculate ascomycete fungus growing on *Marchantia polymorpha*. Found on the same places as *Octospora ithacaensis*. The first records of this species were made by prof. J. Velenovský (in 1924 and 1934), who erroneously considered it a new species. Further localities were not found until 2014.

***Scutellinia legaliae*.** A *Scutellinia* species with spherical spores with characteristic ornament of spines 3-5 µm high. While it has been collected on 42 localities in Slovakia, it has not yet been published from the Czech Republic (Glejdura 2016). Yet, several localities have been recently found here.

***Mutinus ravenelii*.** A conspicuously colourful gasteroid fungus, originally described from North America. In Europe, it was found in Germany in 1943 for the first time. It has spread out to all Europe since the time, but it is not copious anywhere. It grows in forests, parks, gardens and meadows.

***Pluteus aurantiorugosus* (VU).** A saprotrophic gilled fungus, growing on deadwood of broad-leaf trees, especially beech, oak, hornbeam, ash, maple and elm. It is conspicuous by its scarlet cap and yellowish stipe.

***Polyporus alveolaris* (EN).** On the territory of the Czech Republic, it is copious only in floodplain-forests in Moravia and Silesia. It occurs at many microlocalities in the Natural Park Záhlinické rybníky.

Bryophytes

***Physcomitrella patens*, (LC-att).** A small, annual moss, growing exclusively on a bare soil. In the surveyed area it was found at only one locality, which cannot be localized, as the plant was collected unwittingly and determined later, under microscope. The distribution of the species was described on the basis of herbaria collections by Pospíšil (1989). Till the beginning of 90th of the 20th century, only ca. 30 localities were known, mostly historical. Thus, the species was considered very rare in the Czech Republic and was designated a critically endangered species in the Preliminary list of endangered bryophytes of the Czech Republic (Váňa 1995). However, many new localities were found later. For that reason, it was classified in a lower category (LR-nt) in the Red list (Kučera & Váňa 2003). Currently, it is classified in category least concerned - attention (LC-att). It is regularly found in the Morava lowlands on bare soil. Here it occurs on sand, which is not usual and it shows a potential to expand to the new habitat.

***Brachythecium campestre*, (LC-att).** A middle-size moss species with insufficiently known ecology and distribution. Literary sources are not reliable, as they use various taxonomic concepts. On the basis of recent findings it is considered rather heliophilous species of bare soils and synanthropic habitats. It occurs at foothills or lower mountains (Kučera 2010).

***Lophozipsis excise*, (LC-att).** According to Váňa & Hubáčková (1992), it is a scattered liverwort, occurring in lower altitudes, growing on bare and sandy soil. It has not been known from the Hulín region; the nearest localities lie in the region of Zlín, Přerov and Prostějov.

***Dicranella cerviculata*.** This species is not endangered in the Czech Republic. However, it is a mountain species and, therefore, its occurrence in the Hulín region is noteworthy. Although it sometimes inhabits peat bogs in relatively lower altitudes, it has never been found in lowland. Its presence here might be connected with flood in 1997, when spores of the moss could be brought from mountains to the Morava lowland.

Vascular plants

1. Interesting floristic findings in Gravel Pit Hulín

***Batrachium baudotii*, (C1).** This water-crowfoot species was found in area H. Several clumps of terrestrial form grew at the bare wet soil in the haven near to the bucket elevator (plot HF6). To our knowledge this is the first report of the species in Central Moravia (J. Prančl, pers. comm.); it has been known from South Moravia and Bohemian region of Polabí and Podbořany (see <http://botany.cz/cs/batrachium-baudotii>). The occurrence of this species is probably benefited by mining activities (resulting in creation of suitable habitats in the haven).

***Crepis setosa*, (C1).** In area H, two single individuals were found at two different plots. According to literature (Kaplan & Kirschner 2004), this species formerly occurred in Haná region near Olomouc; however, it has not been confirmed since decades. The most suitable habitats for this species are semi-open grasslands or fallow land. The species has not been recorded outside area H.

***Populus nigra*, (C1).** This rare woody-plant species grows with certainty at several places in the area of the Gravel Pit Hulín (area H). A full-grown tree can be found at plot HB3. Additional young individuals are likely to occur at some plots not mentioned in the list, because they are just hardly distinguishable from a hybrid species *P. x canadensis* (a special dendrological inquiry would be necessary). Several individuals morphologically corresponding to *P. nigra* were found in the Gravel Pit Kvasice too.

***Batrachium rionii*, (C2).** This species copiously occurs in the Gravel Pit Hulín (area H) in the submerged form in shallow water (often together with *B. circinatum*) and in terrestrial form at wet bare soil on the banks of the lake. This species was further found in the vicinity (area S and ZB) and rarely in the Gravel Pit Kvasice (area K). The occurrence of the species is obviously supported by mining activities, creating suitable habitats with suppressed competition of other herb species. In Haná region this species is rare (not found in the Gravel Pit Tovačov).

***Scutellaria hastifolia*, (C2).** This species was found at three plots (HA2, HC3 and HE5). There is a strong population at two microlocalities at plot HA2. Current management of this plot (agricultural machinery crossing the meadow and thus creating wet terrain depressions) is very convenient for this rare plant species. Outside of Hulín, the species was found in area LA and PB; it forms, however, substantially smaller populations there. It is a nearly extinct species in Central Moravia, with only few localities near Kroměříž.

***Senecio sarracenicus*, (C2).** This species can be sparsely found at many places of the Gravel Pit Hulín (area H). It meets suitable environmental conditions especially at wet places on the edges of shrubs and groves. Moreover, abundant and viable populations of this species were found at several places in the vicinity (area PA, PB, ZA); it is, however, missing in the Gravel Pit Kvasice (area K). The species is nowadays very rare in Haná region (extinct in the Gravel Pit Tovačov).

***Verbascum blattaria*, (C2).** This species grows at three Plots (HA2, HB2, HF5) in the Gravel Pit Hulín (area H), with the most rich population at Plot HA2 (where agricultural machinery regularly cross and create wet terrain depressions). Outside this area, a smaller population was found in the Gravel Pit Kvasice (area K) and one single individual was recorded next to the road along Moravia river on the edge of area LC.

***Rumex stenophyllus*, (C2).** This species was found at only one Plot (HG2) in the Gravel Pit Hulín, where it occurs on a meadow at two places in wet terrain depressions (with *Bolboschoenus* sp.). This habitat resembles localities from regions where the species is considered autochthonous (e.g. South Moravia, South Slovakia, Hungary). To date, the species has been known from only purely anthropogenic habitats (sediment basins of sugar factories – cf. Trávníček & Dančák 2011) in Haná region. The species has not been recorded outside area H.

***Salsola tragus*, (C2).** One single individual was found at plot HF1, on a heap of sand transported from a South-Moravian sand pit (probably Božice); the plant had been obviously brought with the sand. Part of the heap with the plant was taken away in late summer and thus the plant disappeared.

***Veronica agrestis*, (C2).** A few microlocalities of the species lie in south part of plot HG2. The most suitable habitats for this species are fallow lands or road margins, with occasional disturbances (loosening) of the soil. It is a rare species in Haná region, we did not find it outside area H.

***Batrachium circinatum*, (C3).** A copious species in the Gravel Pit Hulín, where it forms viable, strikingly flowering populations (often with *B. rionii*). Especially submerged form was observed (terrestrial form only rarely). Submerged form was noted in the Gravel Pit Kvasice, as well. Another abundant population in Haná region can be found in the Gravel Pit Tovačov.

***Bolboschoenus yagara*, (C3).** This species meets suitable conditions predominantly on the banks of the lake in area H. We did not find the species outside area H, nor in the Gravel Pit Kvasice (no species of the genus was found there). Thus, we assume that the occurrence of the species is strongly related with mining activities, resulting in creation of early-succesional habitats on wet soil). The species was not found in the Gravel Pit Tovačov.

***Centaureum pulchellum*, (C3).** This species prefers wet places with limited competition of other herb species; in the Gravel Pit Hulín, it finds such habitats in semi-open vegetation in south part of plot HA2, where it sparsely grows. Surprisingly, the species was not recorded in the litoral zone, where it could meet suitable conditions as well. It was not recorded outside area H. It is a rare species in Haná region; rarely found in the Gravel Pit Tovačov.

***Cyperus fuscus*, (C3).** An abundant and viable population was observed in the Gravel Pit Hulín, especially around the haven, where suitable conditions are ensured by mining activities. This species was not found outside area H (nor in area K), but there is a comparably rich and viable population in the Gravel Pit Tovačov. This confirms the importance of mining activities for the species. In Haná region, the species is rare; populations outside mined gravel pits are less abundant and stable.

***Dysphania botrys*, (C3).** Several tens of individuals found on (or around) a heap of sand transported from a South-Moravian sand pit (probably Božice) at plot HF1; the plant had been obviously brought with the sand. Although a part of the population was destroyed by grabbing sand from the heap, some individuals remained at the locality, they probably shed seeds and the species could spread in the future. Similarly, the species was brought to the Gravel Pit Tovačov, where it was found primarily around a heap of sand from South Moravia. This species is rare in Haná region and its occurrence is mostly related with industrial activities (e.g. sand pit in Brodek u Prostějova).

***Epilobium parviflorum*, (C3).** This species was found in many places in the Gravel Pit Hulín (area H), predominantly on wet semi-bare soil along the banks of the lake, where suitable conditions are assured by mining activities. Although it was found in another places in the region (area S, K), its populations outside area H are much smaller. A sparse species in Haná region, known from the Gravel Pit Tovačov.

***Euphorbia palustris*, (C3).** The species occurs only in one place in the Gravel Pit Hulín at plot HB3. It is a characteristic species of wet places on the edges of floodplain forests, shrubs and reed-beds or wet terrain depressions on meadows. It occupies similar habitat in area PB. Several more localities are known from the south of Haná region, but their abundances decline (the species recently disappeared among others from area LA, along the railway Kroměříž-Hulín).

***Filago arvensis*, (C3).** The species grows sporadically in area H, at two plots (HA1, HE4). It requires a loose, permeable (sandy) soil, at least slightly enriched with nutrients. We can not reject, that it has reached the area just a short time ago and it will expand in the future. Mining activities support formation of suitable habitats (except for the nutrient-poor sludge lagoons). The species was not found outside area H. It sparsely occurs in Haná region, e.g. in the Gravel Pit Tovačov (with more abundant population).

***Hyoscyamus niger*, (C3).** In the studied area, this species is a typical archaeophyte, growing on loosen, nutrient-rich soil. It was, however, found in only two places (plot HE4, HG2) with only several individuals. It is unlikely to expand, as the predominant habitats in the gravel pit do not provide optimal conditions for this species. It was not found in the vicinity; it sparsely occurs in Haná region.

***Lotus tenuis*, (C3).** This species was found in many places in area H. It occurs mainly in early-successional stages of vegetation on wet soils, which often result from mining; thus, the species is strongly supported by mining activities. For this reason it was found only rarely in the vicinity (area PA) and it lacks in abandoned gravel pit in Kvasice. It was not found in the Gravel Pit Tovačov, neither. It is a rare species in Haná region.

***Pulmonaria mollis*, (C3).** The species was found in shrubs in only one place at plot HE1. One more locality was found in the vicinity (area PB). The species used to be more frequent in the region, where it grew in mesophilous grasslands and adjacent shrubs; declining probably due to landscape eutrophication. Its distributional changes are hardly predictable. The species is more frequent mainly in south-east part of Haná region, adjacent to the Moravian Gate.

***Silaum silaus*, (C3).** In the Gravel Pit Hulín, this species was found at only two plots (HC3, HE5). In the vicinity, it occurs mainly on mesophilous to wet alluvial meadows, adjacent to floodplain forests; the species was quite copiously recorded at these habitats in area LA, PA, PB and, more rarely, on the edge of the Gravel Pit Hulín (area K). The species could potentially find suitable conditions on the meadows in south part of the Gravel Pit Hulín; nevertheless, it currently does not occur there. It can be still considered rather sparse species in Haná region (not found in the Gravel Pit Tovačov).

***Silene baccifera*, (C3).** This species occurs in many places in area H, similarly to *Senecio sarracenicus* (both species are native and conservation-valuable members of *Senecion fluvialis* community). Moreover, it was recorded in other areas (LB, LC, PB, ZA, ZB) and in the area of the Gravel Pit Kvasice (K). It is quite copious species in Haná region, mainly in the Moravia valley. It was found in Gravel Pit Tovačov, as well.

***Stellaria neglecta*, (C3).** In the Gravel Pit Hulín, the species was found at only one plot (HF1). It is probably an accidental (and temporary) occurrence, caused by immigration from surroundings of the gravel pit. The species was found around wet forest roads in areas LA, LC, and in shrubs in area K. It could further expand in the Gravel Pit Hulín, mainly in wet shrubberies. It is species with sparse distribution in Haná region; rarely it occurs in the Gravel Pit Tovačov too.

***Thalictrum lucidum*, (C3).** The species was found at three plots (HE1, HE5, HF5) in the Gravel Pit Hulín; its populations are, however, rather small. It is a typical species of wet meadows, bordering on floodplain forests and shrub margins. Although it was recorded in two places in the vicinity (LA, PB), it is surprisingly rare in the studied area. It is a rare to sparse species in Haná region, rarely found in the Gravel Pit Tovačov, as well.

***Veronica catenata*, (C3).** In the Gravel Pit Hulín, this species occurs in several places on the banks of the lake and in wet depressions on the recultivated plot HG2. This is in accordance with the ecological requirements of the species, which typically grow on wet places with regular disturbances. Thus, this species is at least partly supported by mining activities. During our survey the species was not found outside area H; it was, however, observed in area PB in the previous years (Trávníček, unpubl.). This year we recorded the species in a wet terrain depression on a field to the west of Tlumačov. A sparse species in Haná region (but not found in the Gravel Pit Tovačov).

***Vulpina myuros*, (C3).** A species with only two records in the Gravel Pit Hulín, at two adjacent plots (HE4, HF6). It requires a loose, permeable (sandy) soil. We can not reject, that the species has reached the area only short time ago, and it could expand in the future. Mining activities are certainly beneficial, as they create suitable habitats of young successional stages. The species was not found outside area H. A strong population within Haná region occurs in the Gravel Pit Tovačov.

Spiders (Araneae)

***Pardosa nebulosi* (CR).** Species of the muddy banks of large rivers, secondary also occurs in old brick and sand pits. It is very rare in the CZ, firstly discovered in 2010 in Hodonín. In gravel pit Hulín, we found this species on the western and northern banks of the lake.

Dragonflies and damselflies (Odonata)

***Stylurus flavipes* (§ SO, EN).** Palaearctic species with the center of distribution in Eastern Europe. In the CZ occurs rarely (e.g. lower reaches of the river Morava and Thaya). This species uses mainly lowland large rivers (up to several meters deep) and prefers meandering, natural rivers with little pollution. Due to its habitat preferences is finding of exuviae in gravel pit Hulín unique. Features of the gravel pit bottom and riparian vegetation corresponds with large rivers habitats.

***Sympetrum meridionale* (EN).** Mediterranean species occurring mainly in North Africa and Southern Europe. In the Czech rep. it was previously rare, however especially in warm areas it's spreading. This species uses warm pools with rich littoral vegetation (e.g. smaller ponds, oxbow lakes). Therefore we do not expect that this species is indigenous in the gravel pit Hulín area.

Earwigs (Dermaptera)

***Labidura riparia* (EN).** Worldwide distribution but rare and retreating in the CZ. Species occurs in light sandy soils of riverbanks and silt, also secondary in sand. In gravel pit Hulín, We found it in waste pond E3.

Grasshoppers and crickets (Orthoptera)

***Eumodicogryllus bordigalensis*.** Thermophilic species of steppes and forest steppes, in the CZ inhabits also abandoned sand pits and brickworks. In CZ mostly occurs in the southern regions of Moravia. Population in the western and northern part of the gravel pit Hulín is the second well-known and the strongest in Central Moravia.

***Pteronemobius heydenii* (DD).** wetland species occurs in floodplains of major rivers. In the CZ this species were missing for a long time. Recently, rare recordings come only from southern Moravia. Therefore, finding of reproducing population on the western bank of the lake (C1 area) was very surprising. For this reason, we recommend to monitor populations of this species during our proposed reclamations of C1 area and perform work gradually over at least three years.

***Ruspolia nitidula* (CR).** species of wetlands, wet meadows, marshes and waterlogged neighborhood ponds and pools. These habitats are especially important for the development of nymphs, adults disperse to large distances and can be found even in atypical biotopes. Recently, the species spreads to new locations, but its occurrence in Central Moravia is quite rare.

Ground beetles (Carabidae)

***Carabus ullrichii* (§ O).** Species of Central and Southeastern Europe. Indigenous in deciduous forests, but also occurs in non-forest habitats like gardens, orchards, meadows and fields from the lowlands to the foothills. In Moravia, species is relatively common, in Bohemia rarer.

***Carabus scheidleri* (§ O).** Central European species of woods, fields, meadows and pastures. In the CZ, its occurrence is very common.

***Cylindera germanica* (§ O, VU).** Euro-siberian species occurs locally in the CZ especially in the lowlands on the edges of fields, pastures and fallow lands, secondary also in quarries and dumps. Species was recorded on the waste pond E2 and the meadow G3.

***Cylindera arenaria* (§ O).** Southern European species originally inhabits in sandy and gravel sediments of rivers. In the CZ, species is rare and occurs mainly in secondary habitats such as sand pits, which provide favorable conditions, like on waste ponds E2 and E4, where we found this species.

***Harpalus flavescens* (NT).** Rare species of drift sands and sand pits with Euro-caucasian distribution. We recorded it on waste pond E4.

***Nebria livida* (NT).** Euro-siberian species, rare in the CZ. It occurs on sunlit sandy to gravelly shores of water bodies, eg. Water dam, exposed shorelines.

***Pterostichus gracilis* (VU).** hygrophilous species of wetland vegetation. Found on the meadow A2 and waste pond E2.

Appendix 11: References

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Flora:

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- ☒ Grassland
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- ☐ Open areas of rocky grounds
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- ☐ Screes
- ☒ Shrubs & groves
- ☒ Soil
- ☒ Wander biotopes
- ☒ Water bodies (flowing, standing)
- ☒ Wetland

Stakeholders:

- ☐ Authorities
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