

Final Project Report (to be submitted by 30th September 2016)

1. Contestant profile

▪ Contestant name:	Marcin Sikora
▪ Contestant occupation:	
▪ University / Organisation	Natura i Człowiek Association
▪ E-mail:	
▪ Phone (incl. country code):	
▪ Number of people in your team:	12

2. Project overview

Title:	The active protection of the bees together with 3D-nature visualization of Górażdże Limestone Quarry
Contest:	Poland
Quarry name:	Górażdże
Prize category: (select all appropriate)	<input checked="" 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

Abstract

From economic point of view the importance of the bees is significant and difficult to evaluate. It is estimated that approximately 70% of cultivated plants rely on cross pollination, for which presence of the bees is essential. Apart of profits like crop yield and bee products these insects play an important role in almost all ecosystems on our planet. They are key species, which means, that from their presence the flowering plants are dependent. Such plants shape the environment for other flora and fauna species. However, a constant and great decrease of bee species richness and numbers is observed since over half a century. That is why seeking and creating places for bees protection is nowadays a necessity. One of perfect alternatives are post mining areas, which can create great conditions for their survival, thanks to corresponding reclamation process and maintaining the areas. During 2014 QLA the performed inventory of bee fauna 22 bee species (Apoidea) were found. Their food base included 39 flower plant species. This year observations, including wasp fauna (Vespoidea) resulted with 46 bee species, 7 wasp species and 35 plant species, on which insects foraged. Amongst found bees they were protected species, rare and threatened in European scale like shrill carder bee *Bombus sylvarum* and broad-banded nomad *Nomada signata*. It shows remarkable natural potential of the mining area for protection of these important insects.

In this QLA edition, apart of flora and fauna surveys we focused on active protection actions, aerial photos and 3D visualization of surveyed area.

The active protection included enrichment of existing grassland habitats with native food plant species for the bees. The seed mixes were composed to simultaneously be the food base and help in reclamation process by initiating soil creation process. Also, the constructions providing nesting places for different kind of bees were placed on the Quarry area. For honey bee a traditional log hive was made. Wooden boxes were prepared for other social bees - bumblebees, which in nature nest mainly in rodent burrows. The biggest construction for solitary bees - bee hotel was placed near Kamień Śląski reserve. Storey construction out of different natural materials brings also great educational value.

Basing on our knowledge and experiences we decided in this QLA edition to become familiar with natural wonders of the Górażdże Limestone Quarry to wider group of people. The habitat measurements using aerial photos and laser scanning gave opportunity to create Geoportal, which is available on Natura i Czowiek Association web page from September 2016. It allows all interested visitors on interactive movements on surveyed areas and presents the most important results in descriptive and graphic form.

1. AIMS OF THE STUDIES

Due to interdisciplinary character of our project the following aims were determined:

1. To define the species richness of pollinating insects (Apoidea) and predatory ones from Aculeata group. Moreover the inventory of food plant species for these insects. The continuation of surveys from 2014 QLA edition should give a database to compare the condition of Apoidea population throughout seasons.
2. The active protection actions to secure the right food base and nesting places for the bees according to reclamation requirements. The first step is to enrich the Quarry area with native species of flower plants and grass. The second aspect of active protection is to set appropriate constructions on the Quarry area as a refuges and nesting sites for bees and other useful insects.
3. The field surveys with GPS and geodetic devices in order to provide precise measurement data of the Quarry area and to combine them with fauna and flora researches. This will be the base to create the interactive Geoportal as a tool to present the researches result in simple and interesting way.

2. SURVEY TEAM

Natura i Człowiek Association (faunistic i floristic researches, the active protection actions): M. Sikora (coordinator), A. Sikora, P. Michołał, I. Lis, M. Cierpisz;

GEO IT Specialists Student Organization, Wrocław University of Life Science (field measurements, aerial photographs and 3D visualisation of the area): A. Nadolny, Ł. Guźniczak, M. Lubański, M. Karpina, P. Kubiś, A. Turbańska;

Nicolaus Copernicus University in Toruń (faunistic consultations): prof. dr hab. T. Pawlikowski

3. AREA OF SURVEYS



LEGEND:

- - area of surveys
- - bee hotel and log hive
- 1** - number of surveyed area

The habitats surveys were conducted on the Górażdże Limestone Quarry, Gogolin community, 22km east-south from Opole. The mining area is divided on two parts: western and eastern one. On the western part the surveyed Area no 1 is nested, while on eastern part: Areas no 2 and 3.

The Area no1 covers about ok 6000 m². It includes reclaimed escarpment, and the plots beneath and above it. On the slope the xerothermic grasslands were restored, and afforestation was carried out. On this area the dominant plants are low growing species of grasses and legumes. On the bottom part of the escarpment the strip of expansive plants is well established.

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The Area no 2 covering over 11000 m², placed in western part of the Quarry is mainly striped out of topsoil, due to future mining works. Between it and a forest the stripes with mainly high grasses and bushes are established. The Area no 3 covering approx. 5000 m² is nested in centre of eastern part of the Quarry. It is the most varied habitat amongst all surveyed, with stripe of low growing grasses herbaceous plants and legumes and woodlot with herbaceous habitat on the upper part.

4. METHODS

4.1. Fauna and flora research

The field observations were conducted during April-September 2016 period, at least once a month. In total, 7 visits were performed during this time. In order to determine species composition and abundance of aculeates the 30-minute observation methods were used. The observations were conducted between 10am-4pm in favourable weather conditions: sunny weather light wind and temperatures 15°C or higher. During observations the insects were counted, classified to species, and their food plants recorded as well.

The bumblebees were determined intravitaly, basing on field identification keys. The questionable specimens of bees were caught using entomological net, chilled down in tourist fridge, photographed and released.

4.2. Field measurements, aerial photographs and 3D visualisation of the area

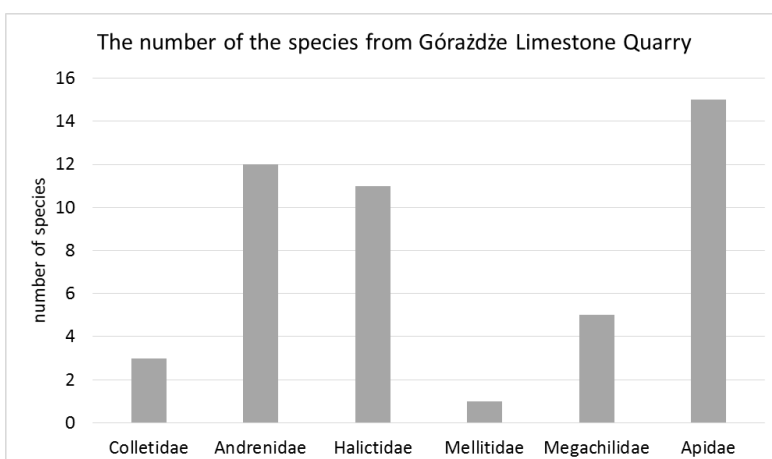
The surveyed areas were measured using geodetic stations and GPS devices in monthly intervals, from April to September. The geographical coordinates were recorded using Garmin eTrex HCx device.

The aerial photographs of surveyed habitats were taken during two days, in windless conditions, using Aibot X6 (hexacopter) drone. Nikkor 24-85 f/3.5-4.5 VR lens attached to body Nikon D800, aperture priority, ISO 250-400, f/8 aperture number and 16,7 MP resolution were the settings of taken photos. For each habitat dron needed to have 2-3 flights, 8-10 minutes each.

For accurate coordinates of photopoints DNSS technology was used. The taken photos were merged together in form of dot cloud using software processing. Such dot point was transformed by ArcGis program into 3D TIN models, based on triangles system. The models gained texture in form of real colours. Moreover, the models were marked with active protection actions together with bee and plant species occurrence. Also, video animations of surveyed habitats were created.

A whole area maps were purchased from Polish National Geodetic and Cartographic Resource.

5. THE FAUNISTICAL AND BOTANICAL SURVEYS OF THE QUARRY AREA



5.1. Bees of the surveyed areas

On the Quarry area in 2016 46 bee species were recorded. The species represent all six families of Poland. The systematic affiliation of Michener monograph (2000) was used. The list of species from the Quarry area can be found in Attachment no 1.

Polyester bees – Colletidae

According to many researchers it is the most primitive family of the bees, which is proved by two-lobular tongue, similar to digger wasps. Those are solitary bees, and their unique feature is that inside of their hollowed, underground nests is coated with cellophane-like secretion.

47 species are native to Poland. In the Quarry 3 species were found and only on Area no 1. These pollinators prefer sandy soils and forage mainly on willows.

Mining bees – Andrenidae

All Andrenidae are solitary and ground nesting bee species. They occur mainly in early and late spring period. 100 species are native to Poland, while on the Quarry area 12 species were found. Andrenidae were present on all surveyed areas. The most common was the mining bee *Andrena vaga* – very rare species on British Isles.

Halictids– Halictidae

They are short-tongued species, which are mainly solitary, but can live in ground nest aggregations. There are 107 species native to Poland. On the Quarry area 11 species were found. They are hard to distinguish, so their affiliation was mainly determined to genus level.

Two observed genus: *Halictus* and *Lassioglossum* are bees nesting mainly in the ground. They transport pollen on hairs of their legs. Third genus blood bee - *Sphecodes* is a cuckoo bee which lays their eggs to nests of other bees.

Melittid bees - Melittidae

This is the smallest family on the world in terms of species. They are very often food specialized and nest underground. In Poland 11 species are native. In the Quarry 1 species was found: *Dasygaster altercator*. This species is easy to distinguish, because it has got very long hairs on its legs, to transport pollen.

Leaf-cutter bees – Megachilidae

These bees are very characteristic, as they carry their pollen on abdominal hairs. They nest in ground as well as in wood, hollow plant stems, shells, build their nests in walls, coating them with plant fluff. 90 species are native to Poland, while in the Quarry 5 species were observed.

Hoplitis leucomelana – is a bee species only once recorded on British Isles; *Coelioxys* sp. is a parasiting species with characteristically elongated abdomen, which lays eggs to the nests of other bees.

Bees – Apidae

The biggest and most variable bees family. They are extremely important for economy pollinating many plants, important for human beings. Also their importance in nature is significant, while some of them pollinate flowers unavailable for other bees. 130 species are native to Poland , while 15 were found in the Quarry area. It was the most ubiquitous family of the bees in Górażdże Limestone Quarry.

Nomada signata is a parasiting bee, which lays its eggs in nests of other bees. The species is on Red List of Threatened Species with LC status (Least Concern). It is also on Red Lists Of Great Britain and Slovenia.

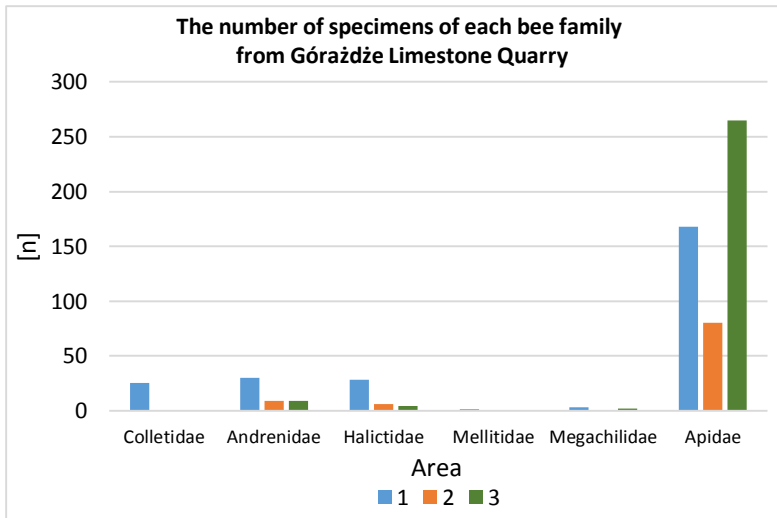
Hairy-footed flower bee *Anthophora plumipes* was found on all surveyed areas. This solitary bee nests in clay and is strictly protected in Poland.

The European honeybee *Apis mellifera* is the third most common species in the Quarry area, probably due to beekeepers nearby. However, in 2014 the swarm was found on the Quarry area, which was looking for the nesting site. This species is used widely for pollination as well as for wax and honey production.

The most commonly recorded were bumblebees genus *Bombus*, just like in 2014. They are closely related to honeybee, living in annual colonies with queen and workers. In Poland there are 27 legally protected bumblebee species and 9 species of cuckoo bumblebees.

On the Quarry area 8 bumblebee species were recorded. The most common was red-tailed bumblebee *B. lapidarius*, then buff- and white-tailed bumblebee *B. terrestris/ B. lucorum* (counted together due to difficulties in distinguishing them in field conditions), common carder bee *B. pascuorum*. The rarer bumblebees were: small garden bumblebee *B. hortorum* with tongue reaching 25 mm (Area no 1) and shrill carder bee *B. sylvarum* (Area no 3) which is less frequent in Poland and almost extinct in Great Britain. Moreover, 3 cuckoo bumblebee species were recorded in the Quarry. They overtake bumblebee nest and lay their own eggs. Cuckoo bumblebees are good indicators of bumblebees stable populations.

5.2. The bees number on each surveyed area



The highest number of the bee species and specimens and the highest was recorded on Area no 1. The representants from all the families were present there. The most ubiquitous was the Apidae family– 65%, and then 10% for Colletidae, Andrenidae, Halictidae, and small share of Megachilidae and Melitidae. This area is rich in bee fauna probably due to sloppy and sandy escarpment, perfect for solitary nesting bees. The food source is the restored xerothermic grassland area.

Area no 2 was the habitat with the lesser number of bee species and specimens. The Apidae family dominates here (86%), small share of Andrenidae (10%) and Halictidae (6%). The area with removed to spoil level, ready for mining works. The bees foraged mainly on the edges near the forest.

The Area no 3 with clear dominance of Apidae - 95%, and low share of Megachilidae, Halictidae and Andrenidae. The restored in 2012 xerothermic grassland is food source for social bees, mainly bumblebees.

5.3. The food tapes of the bees

The food tape is a sequence of following, flowering plants, which provide food for the bees through vegetation season. On the Quarry area the bees visited 35 plant species in total. The detailed description of the plants may be found in Attachment no 3.

During surveys the most visited plants were determined on each research site. These species might be used in future reclamation process. The inventory of place where the most visited plants occurred may be found in Attachment no 11,12 and 13.

On Area no 1 bees were visiting 17 flowering plant species (Attachment no 4). The biggest share of visits had kidney vetch 31,3%, willow 19,7%, birdsfoot trefoil 10,7%, dandelion 8,2%. The biggest number of bee species visited kidney vetch and red clover, which are legumes. These species offer attractive pollen food for bees, especially for bumblebees.

On Area no 2 bees visited the biggest number of flowering plants (18), despite their lowest numbers of bees specimens (Attachment no 5). This indicates dispersion of the bees on less attractive plant species. The mostly visited were hemp-agrimony 27,2%, marsh thistle 13,6% and giant goldenrod 9,9%. The biggest number of the bees visited hemp-agrimony and marsh thistle.

The Area no 3 was site where bees visited the lesser number of flowering plant species – 13 (Attachment no 6). The biggest share of visits was for creeping thistle 37,8%, viper's bugloss 20% and birdsfoot trefoil 16,4%. The biggest number of bee species were visiting creeping thistle and birdsfoot trefoil. .

5.4. Wasps of the surveyed areas

Vespoidea is a superfamily of insects within the suborder Apocrita aculeata. These animals play a very important role in the flow of matter and energy in ecosystems. They prey on insects, mainly flies and eat decaying food - fruits and meat. Therefore they are useful reducing numbers of harmful insects and thus prevent the transmission of a various diseases.

On the Quarry area 7 Vespoidea species, belonging to 5 families were found (Attachment no 2). The most numerous was Vespidae family. Among the insects encountered in this family, 2 species of wasps are social: European wasp *Vespula germanica* and paper wasp *Polistes nimpha*. Both build nests made of chewed wood pulp. However, European wasps shield their nest with paper spherical layer, while paper wasps nests are open. The solitary wasp representing Vespidae family was potter wasp *Eumenes pedunculatus*, which builds its nests in form of clay pots attached to stones.

The other encountered species are: *Pompilius vaticus* and scoliid wasp *Scolia sexmaculata* - species of solitary wasps, hunting and paralyzing beetles; *Tiphia femorata* - solitary wasp species preying on spiders; *Cerceris rybensis* – digger-wasp preying on Halictidae bees. The identified species of scoliid wasp is a rare insect associated with xerothermic habitats. In Poland, its presence was confirmed only on few sites.

6. THE BEES ACTIVE PROTECTION ACTIONS

6.1. Flower rich grassland

The conditions on the Quarry area like alkaline pH, high degree of insolation and low level of groundwater enable reclamation process in order to create xerothermic grasslands. In 2012 one of QLA projects aimed the reclamation support of grassland biocenosis, which allowed us to undertake bee surveys on initial habitats of the Quarry. Such areas can be additionally boosted with pollen and nectar rich plant species. This will increase the nature potential for this important group of insects, and will become added value for reclamation process.

The seed mixes of native polish plants were sown on the grasslands in east and west parts of the Quarry. In order to create the mixes 20 plant species were used, amongst them 4 species of grasses. Mix no 1 (Attachment no 7) included 10 flower plant species and 4 grass species was introduced on grassland in west part of the Quarry. The experiment field was established on total area of 200m², two squares 10x10m each. Mix no 2

(Attachment no 8) included 11 flower plant species and the same grass species, like in mix no 1. This mixture was applied on an area in east part of the Quarry, with the same plots dimensions like in mix no 1. The mix no 3 (Attachment no 9) is composed only with flowering species. The mix was sown in the east part of the Quarry, on 20m long section of the bank. The bank is a top part of steep escarpment. The sown area was approximately 40m².

The seeds were combined with sand and then sown by hand crosswise for even seeds distribution. The sowing process was applied during still weather on 22nd of May 2016. Right before sowing larger stones were removed and top soil was treated with rakes. The grass seeds and legume seeds were purchased in seed farms, while rest of the seeds was collected from semi-natural habitats in Lower Silesia region. The description of all used plant species is included in Attachment no 10.

During seed mixes arrangement the area specificity and protection values for bees were mainly taken into consideration. Thus, such factors were important: the period of blooming to provide uninterrupted source of pollen and nectar through whole vegetation season; the colour and shape of the flowers to fulfill demanding of specialized insects and finally the type of food offered by the plants to provide source of pollen and nectar. The introduced plants were also chosen in matters of soil creation process. All grasses species are suitable for extensive use. The selected species are also drought-resistant, and by turfing the soil they protect it from the aftermaths of erosion. The biggest part within mixes had leguminous species which have got positive impact on soil fertility via nitrogen fixing ability. This spectacular phenomenon is possible due to symbiotic bacteria within nodules in legume root systems. Also important feature of legume species was strong and well-developed root system. It drains and scarifies soil, simultaneously binding it, which is especially important for steep surfaces. What is most important: those species are often used on post-industrial sites during biological part of reclamation process.

6.2. Log hive for honey bee

Virtually for ages, the European honey bee (*Apis mellifera* L.) has accompanied human beings. In nature, this species establishes its nests in rock cracks, and wooden, rotted trees. Since 10th century people started to keep the bees in distinctively hollowed chambers in living tree or massive logs. This method of beekeeping was called “bartnictwo”.

We decided to implement this traditional form of beekeeping on Górażdże Limestone Quarry area. To achieve that our team hollowed the oak log, found on the Quarry area. The log measured 130cm tall, with diameter ranging from 65 cm in the bottom to 75 cm on the top of the log. The hollowing process called “dzianie” was based on jottings of last “bartnicy” from Białowieża primeval forest. During hollowing our team used traditional tools like “piesznia”(spear-like tool, with angled blade), “ciosło”(axe-like tool called adze) and “skobliczka”(the sleeve-shaped tool with handle used to even inner surface of “barć”). The modern toll- a chainsaw was used in order to simplify the hollowing process. The longitudinal opening, “zatwór” is placed in front of the log and closed by wooden beam, called “dłużyca”. The opening is used to check the healthiness of honey bee colony. The hole placed on a side, so called “oko” (eye) is used as the entry for the bees. The roof is made out of small planks, which protects the log from rain. All natural cracks and crevices in the log were sealed with clay.

The log hive after dry out will be hanged on a selected tree in May 2017. It is a time of a year, when bees swarm and seek a new place to exist.

6.3. Nesting boxes for bumblebees

Bumblebees (*Bombus*), in order to exist, need two crucial elements: food in form of pollen and nectar and suitable places to establish their nests. Depending on species, bumblebees build their nests in rodents burrows, under stones, in bushes or birds tree hollows. The presence of dried leaves, straws, parts of plants, fur hairs etc. is crucial in such a places for insulating and coating the bumblebee nest. Moreover, the interesting aspect of bumblebees is scent correlation, since bumblebees prefer places steeped with scent of previous occupiers. For that reason, the boxes available on the market are reluctantly settled by bumblebees.

5 hand-made nesting places in form of wooden boxes were placed on the Quarry area in May 2016. The wooden boxes measure approximately 20x25x15cm each. The most important element of the construction seems to be the nests filling. The natural mouse nest was imitated, filling it with sheep wool. Additionally, the nest was finished with dry grass straw to the very top in order to prevent hornets (*Vespa crabro*) from nesting. The entrance with diameter of 20mm is placed just over the bottom of the box. Moreover, each box has got opened top in order to control potential established colony. The biggest advantage of such a box is that it can be used by bumblebees through few seasons.

6.4. The wild bees hotel

Amongst almost 470 bee species recorded in Poland the vast majority are the solitary bees. It means that males and females do not lead social life. The nests, built by females, are only for hatching the eggs in them. After that adult solitary bees usually do not look after their offspring. Such bees are remarkable architects, founding their nests in unexpected places, using various materials. Therefore, during construction of "bee hotel", the attention has to be paid to variety of used materials in order to invite and shelter more useful insects.

The hotel was constructed in the end of June/ beginning of July. It was situated in east part of the Quarry, nearby Kamień Śląski Reserve and a plot of planted fruit trees (from another, this year QLA project). The construction allocation is important for two reasons: to provide food for the bees and to guarantee the adequate pollination of fruit trees nearby.

The construction process started from assembling the wood frame, made out of pallets. During following survey visits the construction was progressively complemented with various nesting materials. The hotel is mostly filled by miscellaneous wooden logs with drilled holes, ranging in diameter from 2 to 8 mm. Numerous bee species nest in wood and stalks. Once wood is rotted, it will be also used by cells drilling species. The box and pots filled with clay were placed in the construction, since the biggest group of the Quarry bees build their nests in the ground. The insects need also material to coat and fulfil their nests. For such reasons, other pots and containers were filled in with desiccated plants, grass straws, cones and dried moss. The entire construction is interspersed by stones and sticks, which make it stable and create even more space for the other useful animals. The materials like wooden pallets, clay and reed were collected from the Quarry area to fully use the potential of this space.

7. VISUALISATION OF AREA OF THE ACTIONS

In order to present the nature wonders in Górażdże Limestone Quarry we created Geoportal. It is a compilation of our surveys and GEO-IT measurements. The 3D visualisation of the area allows to interactive movements on surveyed plots and present the most essential observations in verbal and graphic form. The Geoportal is available on Natura i Człowiek Association web page in "Geoportal" section. Because it is beta version all features are only presented with Google Chrome.

By clicking on "START" button we can have a glimpse on Górażdże Limestone Quarry position in form of zooming in Google Earth. By clicking on next button "ISOK" we have a chance to see two animations of The Quarry area. The first one is based on "ISOK" system and contains surveyed areas together with hypsometry (height above sea level). The second animation, based on Google Earth shows terrain and Quarry infrastructure, but also surveyed areas. Further, we have buttons, respectively „1”, „2” and „3”. These are the surveyed areas. By clicking on them we see short 3D animation and then tags appear in colours: green (plants), red (insects) and grey (others like active protection actions or reclamation suggestions). By pointing on it we see a description in polish and english and by clicking on it we can see a photo. The last button is named "HOTEL". By clicking on it we see the area where the bee hotel and the log hive are positioned, in form of grey tag. The description is shown by pointing on it and photo gallery is presented by clicking on the tag.

Our aim is to create a specific and comprehensive database about inanimate and animate nature of the Quarry. That is why, in the future the Geoportal will be supplemented, and it's interface - rearranged and developed. Such solution could be successfully implemented in all quarries, belonging to Heidelberg - Cement all over the world. This would allow to gather natural data in one place, in easy understandable form.

8. RECLAMATION RECOMMENDATIONS TOWARDS THE FAUNA AND FLORA PROTECTION

Taking into account the principles of insular biogeography theory it is necessary to sustain the mosaicity of habitats for efficient wildlife functioning. This implies, that various types of Quarry habitats, like xerothermic grasslands, ponds, forests are able to operate as a whole when they are connected by wildlife corridors. It enables relocation of flora and fauna, which is essential to maintain habitats in fine condition.

The active protection actions, undertaken by NiC Association, incorporated in biological reclamation process, should be continued even after the contest is finished. Thanks to employees and management staff of Górażdże Limestone Quarry it was possible to make preliminary bee fauna studies, later extended over aculeata group and to carry out the active protection actions. We believe that close cooperation and willingness to brave actions will contribute to creation of unique type of habitats. These habitats will be used not only by people, but in particular by flora and fauna.

For that reasons, counting on help and support from Górażdże Limestone Quarry we propose following actions:

1. The extensive use of grassland areas.

The extensive use means the maintaining of grassland sites in form, which protects its organisms and prevents from secondary succession. These areas have to be cut at least once a year. The best time is the end of vegetation season- in September. The cut hay needs to be left for about two weeks and then removed from the plot. Such treatment allows seeds to mature and fall on the ground. Moreover, removing remains prevents

euthropication and preserve the existence of legume plants in the habitat. By leaving 10-20% of area unmown (each season different part) we provide food sources for pollinators as well as refuges for other animals, i.e. mantis prayers for breeding. The extensive usage decreases maintaining costs by less frequent mowing. We propose gradual implementation of such actions on different areas of the Quarry.

2. Seed bank

A vast range of flowering plant species may be found on the Quarry area, mainly on grasslands. The potential of such territories might be additionally used by seeds collecting and relocate it on different parts of the Quarry. We suggest to harvest seeds from areas, where they are common and available and sow them in places prepared for biological part of reclamation. Also, the areas with removed topsoil for mining purposes, in few years perspective can serve wildlife purposes. It will help to prevent erosion process by turfing biological inactive areas. Moreover, it will create the place for many flora and fauna species.

3. Wildlife corridors

In terms of wildlife on the Quarry area the reclamation actions should consider additional natural features. On eastern part of the Quarry we suggest optional plantings, which will be simultaneously wildlife corridor and dust protecting area (Attachment no 14). Such corridor would connect isolated, surveyed area with plot of planted fruit trees, the wild bees hotel and escarpment, which will be reclaimed in the future. Roadsides should be planted with biennial and perennial plant species both drought-resistant and bee-attracting. Such barriers would limit road dust transfer on neighbouring areas, converted into herbaceous habitats.

4. The control of expansive species.

The valuable, natural habitats should be especially monitored in terms of invasive species. Based on our own observations we conclude for quick and efficient actions to be taken on the western Quarry area, where xerothermic grasslands were restored. In less than two years mix of goldenrods and wood small-reed divided the area in two parts. The best solution is cutting the expansive plants two, three times a year, before they bloom and produce seeds. With such a frequency of treatments goldenrods and wood small-red will disappear from the area after five years.

5. Monitoring of undertaken actions.

Performed actions should be monitored after the QLA contest end. It might include i.e. examination and maintenance of log hive, bumblebee nest boxes and wild bees hotel. Moreover, the sown plants should be investigated, because the process of flowers introduction might be time-consuming. However, appropriate agro-technical treatments will help created habitats to survive the competition with expansive species.

6. Creating „bee „ hot spots.

Despite the fact, that afforestation is the main direction of reclamation, we propose partial changes of it. On the areas excluded from mine works the obvious pro natural solution would be creating mid-forest meadows – natural hot spots. The areas, approx. 500m² each should be rich in flower plant species, which attract bees. Thus hot spots within rather poor forest landscape will be ideal for pollinators and additionally, will enable them to travel beyond the Quarry area.

To be kept and filled in at the end of your report

<p>Project tags (select all appropriate):</p> <p>This will be use to classify your project in the project archive (that is also available online)</p>	
<p>Project focus:</p> <ul style="list-style-type: none"> <input checked="" type="checkbox"/> Biodiversity management <input checked="" type="checkbox"/> Cooperation programmes <input checked="" type="checkbox"/> Education and Raising awareness <input checked="" type="checkbox"/> Endangered and protected species <input type="checkbox"/> Invasive species <input checked="" type="checkbox"/> Landscape management - rehabilitation <input checked="" type="checkbox"/> Rehabilitation <input checked="" type="checkbox"/> Scientific research <input type="checkbox"/> Soil management <input type="checkbox"/> Urban ecology <input type="checkbox"/> Water management <p>Flora:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Conifers and cycads <input type="checkbox"/> Ferns <input checked="" type="checkbox"/> Flowering plants <input type="checkbox"/> Fungi <input type="checkbox"/> Mosses and liverworts <p>Fauna:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Amphibians <input type="checkbox"/> Birds <input type="checkbox"/> Dragonflies & Butterflies <input type="checkbox"/> Fish <input type="checkbox"/> Mammals <input type="checkbox"/> Reptiles <input type="checkbox"/> Spiders <input checked="" type="checkbox"/> Other insects <input type="checkbox"/> Other species 	<p>Habitat:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Cave <input type="checkbox"/> Cliffs <input type="checkbox"/> Fields - crops/culture <input type="checkbox"/> Forest <input checked="" type="checkbox"/> Grassland <input type="checkbox"/> Human settlement <input checked="" type="checkbox"/> Open areas of rocky grounds <input type="checkbox"/> Recreational areas <input type="checkbox"/> Screes <input type="checkbox"/> Shrubs & groves <input type="checkbox"/> Soil <input type="checkbox"/> Wander biotopes <input type="checkbox"/> Water bodies (flowing, standing) <input type="checkbox"/> Wetland <p>Stakeholders:</p> <ul style="list-style-type: none"> <input checked="" type="checkbox"/> Authorities <input checked="" type="checkbox"/> Local community <input checked="" type="checkbox"/> NGOs <input checked="" type="checkbox"/> Schools <input checked="" type="checkbox"/> Universities