

Final Project Report (to be submitted by 20th September 2018)

Instructions:

- Document length: maximum 10 pages, excluding the first two pages of this document, the cover page and the last page on project tags.
- We welcome the submission of Annexes (i.e. bachelor or master thesis, references, species lists, maps, drawings, pictures) to further HeidelbergCement's understanding and future use of your findings, however they will not be reviewed by the Jury, and we kindly ask for these to be sent separately to the National Coordinators.
- Please use the attached template for species data collected during the project and submit with the project report.
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- To be validated, your file must be uploaded to the [Quarry Life Award website](#) before **20th September 2018** (midnight, Central European Time). To do so, please log in, click on 'My account' / 'My Final report'.
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- **You should not publish additional private information in your final report (e.g.: address, day of birth, email-address, phone number), just complete the categories we ask for below under "Contestant profile".**

The final reports should comprise the following elements:

For research stream projects:

- Abstract (0,5 page)
- Introduction :
 - For projects that are building upon a previous project, write a summary of actions that were already completed in the previous project.
 - Project objectives
- Methods: a detailed description of the methods used during the project is required.
- Results: the results of the project should be outlined and distinguished from the discussion.
- Discussion:
 - Results should be analysed and discussed with reference to region/country taking into account other publications.
 - Outline the added value of the project for science and for the quarry / company.
 - Recommendations and guidance for future project implementation and development on site is requested. Where possible, please mention the ideal timing and estimated costs of implementation.
- Final conclusions: a short summary of results and discussion.

1. Contestant profile

▪ Contestant name:	Kai Schütte
▪ Contestant occupation:	Biologist
▪ University / Organisation	University of Hamburg
▪ Number of people in your team:	6

2. Project overview

Title:	Quarries as stepping stones and corridors for bees and wasps
Contest: (Research/Community)	Research
Quarry name:	Wiepenkathen

Quarries as stepping stones and corridors for bees and wasps

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Period of the project: January – September 2018

Quarry Life Award – Category Research – Quarry Wiepenkathen, Lower Saxony, Germany



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Abstract

Bees (Apoidea) and wasps (Chrysididae, Crabronidae, Mutillidae, Pompilidae, Sphecidae, Tiphiidae, Vespidae) were collected in the mining site "Wiepenkathen" in the county of Stade in Lower Saxony from the middle of April until the beginning of September. This was realised by using Malaise traps (stationary net traps) in order to collect at six different locations equipped with potential breeding sites (steep slopes and break-off edges). Additionally, from the beginning of July until the beginning of August, three pan traps in blue, yellow and white were used respectively at five locations for the collection of blossom-visiting species. The standardised traps were emptied once a week. Furthermore, during the whole period, there was a weekly check regarding the potential hatching places and feeding plants for bees and wasps using insect nets. Until presentation of the final report, it was possible to identify 135 species of bees and wasps. Among the bees, ten species could be accounted for that are listed in the Red List of Lower Saxony as endangered to critically endangered. The possible function of the quarry as stepping stone and corridor is discussed for some of the rare inventoried species exemplary. A total of 150 plant species were inventoried at the six potential breeding sites which were investigated. In order to raise the available flowering plants and thus the feeding resources for bees, a certified regional mix of seeds was disseminated at various locations on an area covering one hectare. 50% of the plant species contained in the mix of seeds could not be located at the potential hatching places. Additional hatching places in the form of break-off edges and pits with vertical and horizontal structures, consisting of sand and clay were established. Recommendations are issued regarding the promotion of the diverse fauna of bees and wasps which were established during the project as well as recommendations concerning the treatment and development of the mining site in general as well as with regard to the renaturation plan. Young researchers are qualified through the project by involving two master projects focussing on species knowledge of the diverse group of bees and wasps.

Introduction

Natural dry locations characterised by nutrient-poor and dry soil, belong to the most species-rich habitats in the middle of Europe (Pretscher & Sander 2002). Also, mining sites with their traits as anthropogenic created, climatic favourable conditions, nutrient-poor soils, are known for their high biodiversity. They are compensation habitats of landscape elements rarely to be found nowadays, such as break-off edges at rivers and dunes which offer the living basis for many endangered animals and plants. In times of continuous loss of biodiversity (CBD 2010) and scientifically proven insect perishing (Hallmann et al. 2017) political need for action in order to protect insects and especially bees as an important provider of our ecosystem has been established and was integrated in the coalition treaty of 2018. These developments require that dry and very species rich artificial sites are also maintained for the protection of the fauna of bees and wasp and are not filled and flooded after terminating the mining processes (Krauss et al. 2009). It is necessary to establish an adopted management of dry locations as a means of habitat protection in order to ensure a suitable habitat for a maximum number of specialised species

and bees and wasps in general, and this in a sustainable and long-term way. Furthermore, mining sites can assume a network function between dry locations like dry grasslands having similar characteristics and which are still naturally given or they can rather serve as stepping stone in order for adapted species to expand and to facilitate a genetic exchange between dispersed populations. In Germany there are 585 Wildbienen (Scheuchl & Schwenninger 2015) and 634 aculeate wasps (Schmid-Egger 2011, Dathe et al. 2001). In Lower Saxony 734 species could be found when putting both groups together, 355 bees and 379 aculeate wasps (Theunert 2011). The suitability of bees as indicators, especially for dry locations is generally accepted (Westrich 1990). The aculeate wasps complement the broad spectre of indicators from generalists to specialists. Both groups as a combination are highly qualified to make assumptions regarding the habitats in question. Many species of bees and wasps show a limited period of flight in the course of the year so that is often possible to distinguish between spring, summer and autumn species and to anticipate a changing spectre of species during the whole vegetation period when doing research.

The different claims of bees can also be found in their feeding resources. Polylectic species collect pollen on a number of different plant families, whereas oligolectic (specialized on food) bee species only collect pollen providing for their brood on plants of one specific family or rather genus or, rarely, on one species, albeit the fact that other flowering plants are available (Westrich 1989).

The other aculeata in our research project, apart from the bees, here designated as aculeate wasps or just wasps, contain the Chrysididae (jewel wasps), Mutillidae (velvet ants), Pompilidae, Sphecidae, Tiphiidae and Vespidae. They are, for the most part, dependent on animal proteins in order to raise their hatch, although when they are adult they also live on pollen and nectar (Witt 2009).

Project objectives

- Compilation of a species list as complete as possible of bees (Apoidea) and wasps (Chrysididae, Crabronidae, Mutillidae, Pompilidae, Sphecidae, Tiphiidae, Vespidae). ✓
- Determination of the species which have adapted to the specific location and who use the mining site as habitat, stepping stone or corridor. ✓
- Evaluation of the food range and hatching site range. ✓
- Comparison with other regional inventories (z.B. Goldbeck 1998, Hamburg 2017) and known dissemination of species discovered in Lower Saxony. ✓
- Installation of hatching habitats. ✓
- Improvement of food resources. ✓
- Management of existing habitats. ✓
- Recommendations for maintenance and development measures. ✓
- Qualification of young researchers, especially with regard to their knowledge about the species of the very diverse group of bees and wasps. ✓

Material and methods

Malaise traps (fig.1) and pan traps (fig.2) were used for standardised collection. The Malaise traps which resemble tents, are used in order to capture insects. If flying insects get into the lower and darker part of the trap, they use to fly up towards the lighter and upper part of the trap, where they are preserved in a capturing container/jar (fig. 4). Plastic jars with a volume of two liters that were varnished with blue, yellow and white UV-colours were used as pan traps (fig. 2). The colours are meant to imitate blossoms and mainly attract insects which are looking for blossoms. Those insects are captured in a special liquid and later preserved.



Abb. 1: Malaise trap at one site at Wiepenkathen.



Abb. 2: Pan traps at a break-off edge at Wiepenkathen.

We installed six malaise traps at six locations of the mining site which were close to potential hatching habitats (fig. 3). Those traps were continuously placed from April 12 until September 6, 2018 and emptied once a week (see appendix for exact dates of emptying). We used 70% Ethanol as collection and preservation liquid for the six traps and used 500ml per trap. The pan traps were placed in blue, yellow and white at five locations from July 6 until August 9, 2018, and were emptied once a week. As a collection liquid we used a mixture of Ethylenglykol and water in a relation of 1:1, which is able to heavily slow down or rather prevent complete evaporation.

Additionally, bees and wasps were collected on a weekly basis, using insect nets of different sizes (\varnothing 30, 40 cm) via sighting and vegetation wiping. If on-sight identification was possible, species names and further dates were noted and the animal was released.

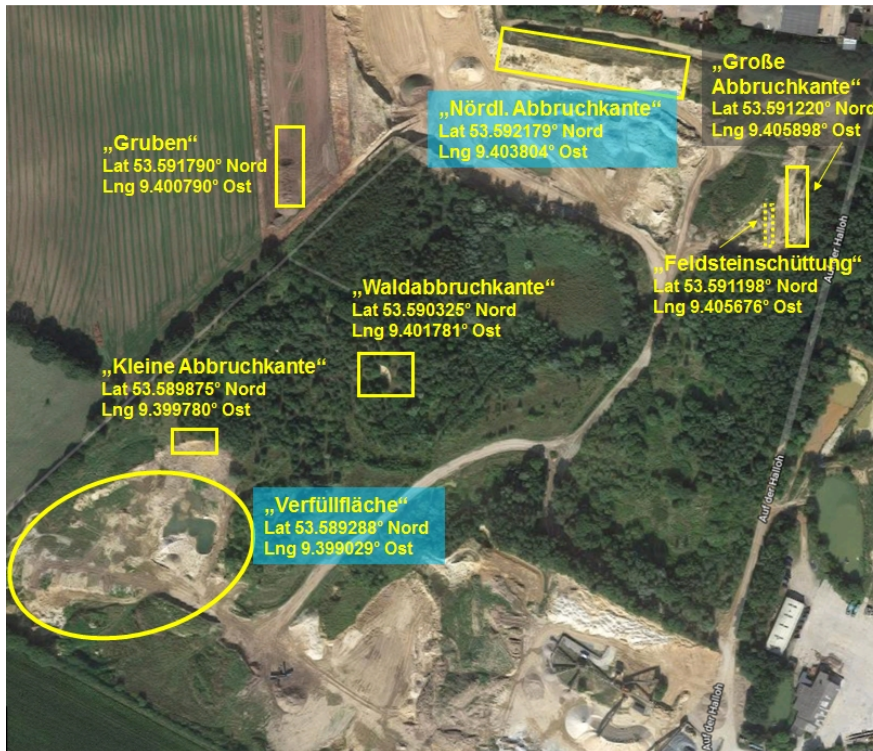


Fig. 3: Sites of the installed pan traps and malaise traps (yellow squares and dots) and the site that was inventoried with insect nets („Verfüllfläche“). Adapted from Bilder © 2018 Google, Kartendaten © 2018 GeoBasis-DE/BKG (©2009), Google.

Preparation, Identification, Analysis and Nomenclature

In the laboratory, bees and wasps were separated from the remaining contents of the traps and further preserved in alcohol. In order to identify the bee species, they were mostly pinned and dissected. For the males, the genital was dissected in order to improve identification (fig. 5). For the identification of bees and wasps we used the vast identification literature, indicated with a * in the literature references. Furthermore, we consulted the voucher collection of the researchers involved. The voucher specimens of this project are in the researchers' collections in the zoological institute of the University of Hamburg.

Status of threat

Details regarding the bees' level of threat were extracted from the Red List of Lower Saxony (Theunert 2011) and of Germany (Westrich et al. 2011). The details regarding the status of wasps in Germany were taken from Schmid-Egger 2011. No publication on threat level of the wasps of Lower Saxony is available.



Fig. 4: Content of malaise traps containing several hundred insects.



Fig. 5: A mounted male of *Andrena flavipes* with a dissected genital preparation for unequivocal identification.

Results

Faunistic Collection

It was possible to identify 135 bees and wasps at the mining site in Wiepenkathen for the final report. The 58 species of bees belong to the families of Colletidae (8 species), Andrenidae (9 species), Halictidae (12 species), Melittidae (3 species), Megachilidae (10 species) und Apidae (16 species).

The aculeate wasps, with 77 identified species, belong to the families of Chrysidae (jewel wasps), Crabronidae (digger wasps), Mutillidae (velvet ants), Pompilidae (spider wasps), Sphecidae (sand wasps), Tiphiidae (tiphiid wasps) und Vespidae. The 135 scientific species names can be found on the submitted species list.

The focus of the project report is on the species qualified as threatened (tab. 1), of which dissemination and habitat claims are discussed exemplarily. Apart from the bees, we mainly found honey bees (*Apis mellifera*) in the blossom-rich areas of the mining site.

Botanic Collection

In the Wiepenkathen mining site a whole of 147 plant species could be identified in the proximity of the six breeding habitats that we investigated (see attached species list). The species range is not distributed evenly at the different locations which makes it possible that different bees and wasps specialized on specific feeding plants, can also be found and were thus recorded. Two of the plant species collected ("Deutsches Filzkraut", "Geflecktes Habichtskraut") are on the Red List of Lower Saxony (Garve 2004). Half of the plants of the mix of seeds distributed on one hectare (Feldraine und Säume, 10% Gräser/ 90% Kräuter & Leguminosen/HK 1 / UG1 - Nordwestdeutsches Tiefland, www.saaten-zeller.de) contained species which were not inventoried within the collection. Additionally, a small-size heath land was included, whose relevance for bees and development options is being discussed.

Table 1: Number of endangered bees species found in the research area and wasps according to the Red Lists of Lower Saxony and Germany (there is no Red List of wasps in Lower Saxony).

Threat status	Red List Lower Saxony	Red List Germany	
	bees	bees	wasps
0: extinct	-	-	-
1: critically endangered	3	-	-
2: endangered	3	-	1
3: vulnerable	4	3	3
G: possibly threatened	2	1	1
V: near threatened	1	4	-
Total of threatened species (0, 1, 2, 3, G)	10	4	4

Discussion

Species inventory and comparison of the mining site Wiepenkathen

As shown by other perennial works on bees and/or wasps inventories in a specific area, the complete inventory of a species' population within one period of flight is not possible (Drewes 1998, Riemann & Homann 2005). Thus, for the mining site in Wiepenkathen we also have to take into account possible additional species, apart from the collected 135 species and further collected material in the context of the research projects, which will have to be examined again.

It is planned to illustrate the value of (rarely found) natural habitats for rare and endangered bees based on the example of the "Vierbindige Furchenbiene" (*Halictus quadricinctus*) and other species. Afterwards, it is envisaged to critically discuss plans for renaturation. The structures originated from the extraction, especially those steep slopes and vertical banks oriented southwards, which mostly consist of sand and clay, are climatically preferred warmer breeding habitats of many bees and wasps. Some species, such as the "Vierbindige Furchenbiene" are preferably bound to these habitats (Amiet & Krebs 2012). Distribution of this species in Lower Saxony is limited to a few localities in the southeast and northeast. Our findings in Wiepenkathen are the first proof in the northeastern part of Lower Saxony of this species, which is listed in the Lower Saxony Red List as a species threatened with extinction. There is no proof of this species in the mining site "Goldbeck" which is at a distance of 26 kilometers beeline, although it shows similar habitats and was examined on a large scale some 20 years ago (Drewes 1998). Likewise, the species has so far not been determined within the context of the Red List for Hamburg (Schmidt-Egger 2017). There are three species of leafcutterbees, the "Rosen-Blattschneiderbiene" (*Megachile centuncularis*), the "Platterbsen-Mörtelbiene" (*Megachile ericetorum*) and the "Bunte Blattschneiderbiene" (*Megachile versicolor*) showing similar distribution patterns some 15 years ago (Theunert 2003). More specifically, there were single findings in northeastern Lower

Saxony, various finding localities in southeastern Lower Saxony, partly on the East Frisian Islands and isolated findings in the interior of the federal state between the islands and the southeastern finding localities. In the northern interior of Lower Saxony there are no known finding before 2003, so that one can assume that these species of leafcutter bees have spreaded and are using the mining site Wiepenkathen as a stepping stone.

Measures of maintenance, development and renaturation

The present heath land, which is limited to a few square meters (*Calluna vulgaris*) is located in an area where no further extraction is executed. It is recommendable to maintain and enlarge the sandy area by extracting the surrounding bush vegetation as well as the growing trees such as pines and birches. The renaturation plan does not take into account the heath land and it is planned to do a reforestation at the location. We recommend to reconsider this measure and to maintain and enlarge the heath land. Periodical extraction of the growing trees (mainly birches, willows, pines) as well as extraction of the surrounding birch populations can preserve the food habitat as well as sandy horizontal hatching habitat which is so valuable for bees and wasps. The heath which blooms late in the course of the year represents a valuable source of pollen in a season in which the food offer for bees diminishes drastically; she is also the main food source of some species, such as the the “Heidekraut-Seidenbiene” (*Colletes succinctus*) or the “Heidekraut-Herbstsandbiene” (*Andrena fuscipes*), which so far we were not able to account for. It is possible that the low food availability of heath pollen plays a role in this context so that it seems conceivable that by a targeted promotion of heath plants it could be possible to establish a sufficient food basis for other endangered species. In this context, it is also advisable not to place hives for honey bees within the immediate proximity of the mining site because the honey bees could become food competitors for the bees, are mostly the competitively stronger group and can suppress and replace oligolectic species.

The ongoing extraction continues to guarantee the succession of habitats in the medium-term. Thus, it is also to be assumed that south-oriented sand and clay break-off edges continue to be created by the extraction activities, providing valuable hatching habitats in different succession rates on a short- and medium-term basis.

In the mining site Wiepenkathen and in mining sites in general, valuable and very species-enriched dry-locations containing nutrient-poor soils are created anthropogenically during extraction. Within renaturation, it will be possible to maintain these locations in the medium term; with suitable maintenance measures even on a long-term basis. In the renaturation plan for the mining site Wiepenkathen it is scheduled and partly already executed to reforest larger areas, apply nutrient-rich soil and refill or align sand and clay break-off edges. Sandy areas are planned for some lower situated areas, in which they are possibly highly influenced by ground- and seepage water and where they do not have the characteristics of dry localities.

It is recommendable to reconsider and adapt these measures in order to also offer bees and wasps a long-term habitat, focusing on the determined endangered species.

Summarizing, the following recommendations for the promotion of bees and wasps can be issued:

1. Preservation and promotion of the naturally existing food offer, e.g. via seed cultivation of regional flowering plants (already executed) and focused planting of food plants for food specialists as well as the maintenance (executed short-term) and enlargement of the heath land.
2. Preservation and creation of further southern-oriented sand and clay break-off edges. Alignment and filling can destroy the hatching habitats of many bees and wasp species.
3. Creation of horizontal, non-compressed dry habitats, consisting of sandy, nutrient-poor soils in the higher situated areas, in order to facilitate water draining. It would thus be possible to allow for the development of species-enriched dry grasslands. This habitat does not exist in the mining site of Wiepenkathen or rather is highly under-represented.

Outlook

The detailed assessment, analysis and description of the inventory of the six sites at the quarry Wiepenkathen is carried out by two master students from our project team. Furthermore they will compare in their thesis the different inventory methods of malaise traps, pan traps and netting as well as seasonal fluctuations of the period of flight and the abundance of species.

As it is impossible to make a complete inventory of bees and wasps within a year (see Drewes 1998) it was agreed with the managing director that it will be possible to conduct further thesis projects in the quarry. In the context of our collecting permit for bees, wasps and other invertebrates that was issued by the regional nature-conservation authority we are obligated to share our species lists with the “Niedersächsischen Landesbetrieb für Wasserwirtschaft, Küsten- und Naturschutz (NLWKN)”. They will be added to their species recording programme and available for Red List updates and other scientists. In the course of our own research we will use the results for a comparison with other inventories we have carried out in Schleswig-Holstein (Pinneberg), Hamburg and in Northeastern Lower Saxony (Pevestorf) to analyse possible migration paths of bees and wasps in Northern Germany.

Final conclusion

Until the deadline of this report 135 species of bees and wasps were identified for the quarry of Wiepenkathen. With this number the quarry has a high diversity of aculeata in its current state with the existing habitats. The occurrence of ten species that are listed in the Red List of Lower Saxony as endangered to critically endangered, and that are known from few localities in the federal state only, proves that the quarry Wiepenkathen provides a suitable habitat and can act as a stepping stone and corridor for dispersal.

The ongoing and further planned mining activities ensure the preservation and creation of species rich dry habitats in the medium term. Nonetheless it is advised to create additional southwards directed vertical banks, horizontal and not compacted sandy dry grasslands and additional flower strips, for example more heath lands to increase the breeding habitats and food resources especially for the threatened species we have found.

The present plan for restauration of the quarry with filling, flattened embankments, nutrient-rich soils, reforestation and flooding needs to be reconsidered necessarily because these actions will take away the living conditions of the surveyed bees and wasps. When mining is finished and the planned restauration measures are implemented it is not expected that the current diverse bee and wasp fauna will be preserved.

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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"/> Beyond quarry borders <input checked="" type="checkbox"/> Biodiversity management <input type="checkbox"/> Cooperation programmes <input type="checkbox"/> Connecting with local communities <input type="checkbox"/> Education and Raising awareness <input type="checkbox"/> Invasive species <input type="checkbox"/> Landscape management <input checked="" type="checkbox"/> Pollination <input checked="" type="checkbox"/> Rehabilitation & habitat research <input checked="" type="checkbox"/> Scientific research <input type="checkbox"/> Soil management <input checked="" type="checkbox"/> Species research <input type="checkbox"/> Student class project <input type="checkbox"/> Urban ecology <input type="checkbox"/> Water management <p>Flora:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Trees & shrubs <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 checked="" type="checkbox"/> Insects <input type="checkbox"/> Fish <input type="checkbox"/> Mammals <input type="checkbox"/> Reptiles <input type="checkbox"/> Other invertebrates <input type="checkbox"/> Other insects <input type="checkbox"/> Other species 	<p>Habitat:</p> <ul style="list-style-type: none"> <input checked="" type="checkbox"/> Artificial / cultivated land <input type="checkbox"/> Cave <input type="checkbox"/> Coastal <input checked="" type="checkbox"/> Grassland <input type="checkbox"/> Human settlement <input type="checkbox"/> Open areas of rocky grounds <input type="checkbox"/> Recreational areas <input checked="" type="checkbox"/> Sandy and rocky habitat <input type="checkbox"/> Screes <input type="checkbox"/> Shrub & groves <input type="checkbox"/> Soil <input type="checkbox"/> Wander biotopes <input type="checkbox"/> Water bodies (flowing, standing) <input type="checkbox"/> Wetland <input type="checkbox"/> Woodland <p>Stakeholders:</p> <ul style="list-style-type: none"> <input checked="" type="checkbox"/> Authorities <input type="checkbox"/> Local community <input checked="" type="checkbox"/> NGOs <input type="checkbox"/> Schools <input checked="" type="checkbox"/> Universities