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

# THE RICHNESS AND DIVERSITY OF SOIL ARTHROPODS FOR SUCCESFUL RECLAMATION IN GASKELL SAND QUARRY, AUSTRALIA


## Project Coordinator :

Astri Dwi Wulandari

## Others Researchers :

Muhamad Frendy Setyawan

Angry Akbar Apriansyah

Daulah Iftitah

**Departmen of Biology, Faculty of Science and Technology**
**Airlangga University, INDONESIA**


## 1. Contestant profile

| | |
|---|---|
| ▪ Contestant name: | **Astri Dwi Wulandari** |
| ▪ Contestant occupation: | Undergraduate Student |
| ▪ University / Organisation | Airlangga University |
| ▪ Number of people in your team: | **4** |

## 2. Project overview

| | |
|---|---|
| Title: | The Richness and Diversity of Soil Arthropods For Succesful Reclaimation in Gaskell Sand Quarry |
| Contest: (Research/Community) | Research |
| Quarry name: | Gaskell Sands Quarry |

# THE RICHNESS AND DIVERSITY OF SOIL ARTHROPODS FOR SUCCESFUL RECLAMATION IN GASKELL SAND QUARRY, AUSTRALIA

Astri Dwi Wulandari, Muhamad Frendy Setyawan, Angry Akbar Apriansyah, Daulah Iftitah
Airlangga University, Indonesia

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**Abstrack**

Soil arthropods are types of soil insects whose whole or part of their life is in the land. Soil arthropods play an important role in the ecosystem, which is to help the process of weathering organic matter and to supply nutrients for plants. This study aims to determine the diversity, dominance, and evenness of soil arthropods and their role. The study was conducted at site A and site B by means of the active method, on each site there were 15 plots with a total of 30 lots. Sampling was carried out for two days in April 2018. The results of soil arthropod retrieval and identification were found in 12 families, namely Formicidae, Tenebrionidae, Anthicidae, Nosodendridae, Scarabaeidae, Linyphiida, Zodariidae, Acrididae, Gryllidae, Julidae, Oniscidae, and Aphididae. Diversity index at site A is 1, 606 while at site B is 1.464, both sites are included in moderate diversity. Dominance index at site A is 0.2563 while at site B is 0.2753. Evenness index at site A is 0.6264 and at site B is 0.6358, both sites have balanced evenness or the number of individuals of each type in the community spread evenly. From the results of research obtained from arthropod families can be classified as decomposers, Phytophagous, scavenger and Pest. The abiotic factors that measured by the time the samples were taken show mainly soil arthropods like to live in the various type of soils. Three types of soil were iodentified as the top soil which are covered by white silica sand and also yellow silica sand. The various type of soil arthropods shows succesful reclamation proccess in the older years of rehabilitation site, meanwhile the latest of rehabilitation site are shows few type of soil arthropods.

Keywords : Gaskell Sand Quarry, Biodiversity, Soil Arthropods, dominancy.

## INTRODUCTION

Gaskell Sands Quarry has a major role in soil distribution arround the globe especially for its sillica sand. In looking at the specific nutrients and also the sands quality, the important role of soil arthropods becomes even more important. These nutrients are initially not limiting (Fahey, 1983) and also thus it would be leached out if they were not immobilized by the activities of soil arthropods (A. Teuben, 1989). Soil arthropods are co-symbiosis with decomposer fungus and has a major role in nutrient supply (Seastedt, 1984). The most important factors determining arthropods abundance and diversity in the field are the avaibility of food, shelter, and suitable microclimate (air temperature, moisture, pH, and Dissolve Oxygen) (Booij and Noorlander, 1992). These factors are most likely closest related to the survivability, quantity and durability of the crop and plant cover and the otherhand, the crop growing features are a keyfactor to the viability and fertility for the arthropod species too ( E. Hadjicharalampous, 2002). Gaskell Sands Quarry has been doing lots of reclamation site, by planting the Banksia woodland species vegetation, therefore the ability of the plants to grow and maintain its productivity has also depends on the soil Arthropods abundance and richness.

Insects have been pointed out as a potential bio indicators, among the indicator organisms that provide useful information for monitoring rehabilitation practices due to the very abundant and sensitive to the environmental changes (Mc.Goech, 1998). Many characteristics support soil arthropods for use as a bioindicators of an ecological disturbance such as mining activities (Hafsah, A, Z, 2016). These methods can be use to investigate the sands quality in the quarry rehabilitation site, the more diverse and rich soil arthropods species, the more good the quality of the sands. These methods are suitable to be conducted every each of the time to report the progress of the biodiversity and richness from the soil arthropods so that it can be compare to make a better decision in the future time. In the present paper the specific roles from each of the soil arthropods species are studied against the background of the different soil composition in each years. The study was performed in the open site to allow monitor the abiotic factors such as temperature and humidity and thus obtain more casual information on these soil environment.

This study aimed to fill a gap in the current management plan by undertaking a formal assesment of the soil arthropods species diversity, abundance, and richness values of rehabilitated sites at the Gaskell Sands Quarry. The result of this research will be able to inform management progress and development, and be highly valuable to the restoration efforts of the quarry. The primary objectives of this project were:

1. Assess the soil arthropod biodiversity values of the rehabilitated sites.
2. Conduct comparable surveys in reference vegetation to gain some usefull finding to increase and maintain the diversity richness.
3. Use predictive methods and application to estimate the accurate species richness, domination, and also evennes.
4. Compare species accumulation curves in different aged of rehabilitation years to understand how soil arthropods diversity properties change through time and also investigating the abiotic factors which contribute to the species diversity and richness.
5. Describe whether the active management from each of rehabilitation years has achieved the desired goals of the speciess diversity and richness and make recommendations based on the finding

## METHODS

### Study sites

This research was conducted at rehabilitation sites at the Gaskell Sands Quarry in April 2018 for one week.

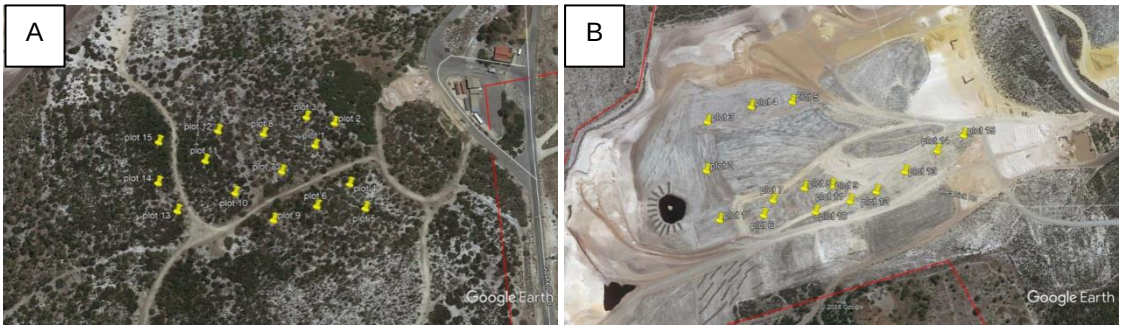


**Figure 1. (A) Plots of the site A In the Gaskell Sand Quarry, (B) Plots of the site B. There are 15 plots for every site and total for the both are 30 plots.**

### Materials

The materials used in this research is soil arthropods and aquades. The tools are DO meters, Thermometer, sling phsycometer, Trowels, ruler, and stationary.

### Sampling Methods

The research procedures is carried out throught a several number of steps, 1)observation of the Gaskell Snd Quarry; 2) Determination of the sampling location; 3) Measuring abiotic environmental factors. Sampling was using the active methods, by finding a predetermined plot as many 15 plots for every sampling site, there are 2 sampling sites. Each plots is made a hole depth 25 cm within width 25 cm x 25 cm. Every soil arthropods caught on the plot will be taken for identification. Measured abiotic data includes air and soil temperature, humidity, DO, soil composition, and vegetation. The data will be presented quantitatively with the richness parameters, index of diversity, Dominance index and index of equatibility or evennes. According to Brower et al. (1998) for species diversity index was calculated using Shannon Wiener Index ;

H '= - Σ [ni / N. ln (ni / N)].....(1)

Where is :

H' : Shanon-Wiener Diversity Index

Ni : Number of individual species was found

N : Total species

The Domination species was analyzed using the Simpsons Diversity Index (Junaidi 2016). It's calculated in the following way :

$C = \sum(\frac{ni}{N})^2$.....(2)

Where is

n : number of individuals in species –i

N : Total number of individuals in the community

Index of equatibility or evennes using the formula from Shannon (Magurran 2004) ;

J '= H' / ln s..... ...(3)

Where is

s : Number of species

H' : Shannon-Wiener Diversity Index

### Collecting and Identifying

Every soil arthropods that founded will be washed and then entered into plastic clip. This steps must be done carefully , because it can cause damage to the body , wings (if any) , and the antenna , this will make identification difficult. Sample will be saved in collection box.

Visualization or documentation is carried on for every specis of soil arthropods obtained using digital camera. Identification of soil arthropods to species level using identification book

**RESULT**

From this research , various species of soil arthropods were obtained as the richness parameters of soil arthropods in the rehabilitation sites at Gaskell Sands Quarry.

**Table 2. The richness parameters of soil arthropods**

| No | Order | Famili | Species | Found on | | Total |
|---|---|---|---|---|---|---|
| | | | | Site A | Site B | |
| 1 | Hymenoptera | Formicidae | *Rhytidoponera metallica* | 18 | 50 | 68 |
| 2 | | | *Rhytidoponera violacea* | 10 | - | 10 |
| 3 | | | *Iridomyrmex purpureus* | 23 | 59 | 82 |
| 4 | | | *Camponotus fragilis* | 17 | 21 | 38 |
| 5 | Coleoptera | Tenebrionidae | *Tenebrionidae sp.* | - | 1 | 1 |
| 6 | | Anthicidae | *Ischyropalpus nitidulus* | - | 3 | 3 |
| 7 | | Nosodendridae | *Nosodendron unicolor* | 7 | - | 7 |
| 8 | | Scarabaeidae | *phyllophaga crinita* | 3 | 16 | 19 |
| 9 | Araneae | Linyphiidae | *Microlinyphia pusilla* | 2 | - | 2 |
| 10 | | Zodariidae | *Habronestes sp.* | 1 | - | 1 |
| 11 | Orthoptera | Acrididae | *Trimerotropis pallidipennis* | 4 | 1 | 5 |
| 12 | | Gryllidae | *Gryllus veletis* | 2 | - | 2 |
| 13 | Julida | Julidae | *Ommatoiulus sp.* | 80 | 4 | 84 |
| 14 | Isopoda | Oniscidae | *Armadillidium vulgare* | 7 | - | 7 |
| 15 | Hemiptera | Aphididae | *Periphyllus sp.* | - | 1 | 1 |
| | | Total ∑ | | 174 | 156 | 330 |

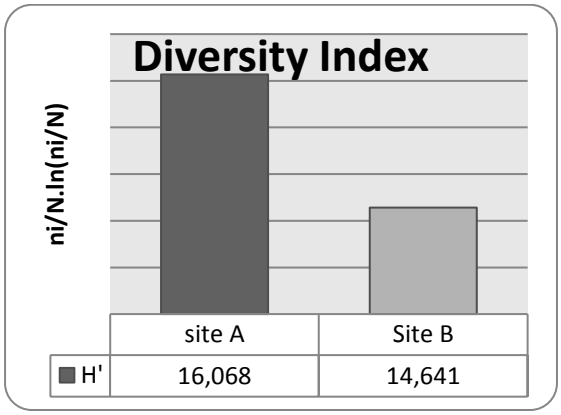


**Figure 2. Diversity Index of site A and site B.**

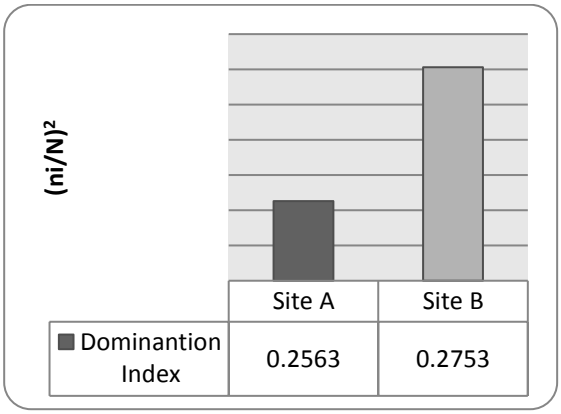


**Figure 3. Domination Index of site A and site B.**

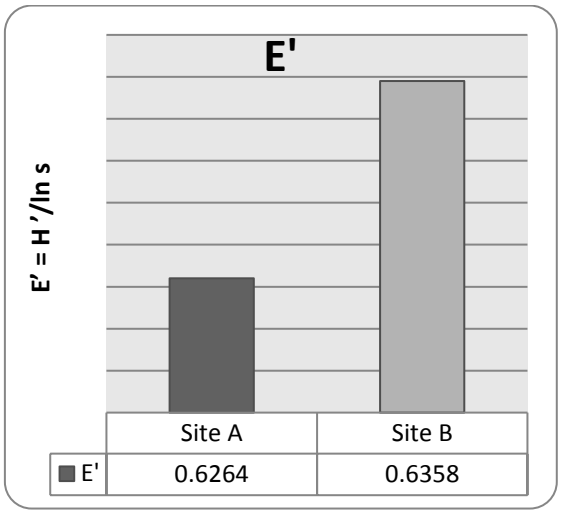


**Figure 4. Index of evenness**

**Table 2. Species Role In the Quarry**

| Species | Species Role |
|---|---|
| *Rhytidoponera metallica* | Ant |
| *Rhytidoponera violacea* | |
| *Iridomyrmex purpureus* | |
| *Camponotus fragilis* | |
| *Tenebrionidae sp.* | Decomposer |
| *Ischyropalpus nitidulus* | |
| *Nosodendron unicolor* | |
| *Ommatoiulus sp.* | |
| *phyllophaga crinita* | Phytophagous |
| *Microlinyphia pusilla* | Scavenger |
| *Habronestes sp.* | |
| *Trimerotropis pallidipennis* | |
| *Gryllus veletis* | |
| *Periphyllus sp.* | |
| *Armadillidium vulgare* | Pest |

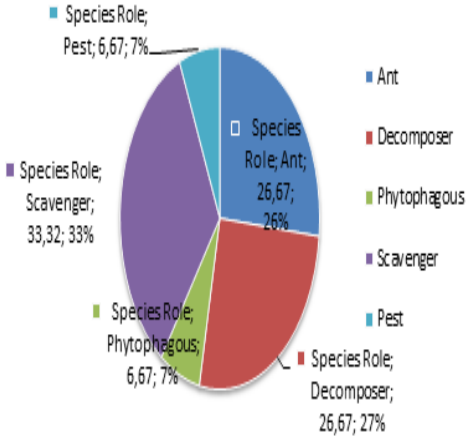


**Figure 5. Arthropods Role In the Quarry**

**Table 3. Abiotics Factors and Plant Vegetation in the Sampling Point**

| No. | Site | Sampling Point | Soil Temperature ('C) | | Air Temperature ('C) | Humidity (%) | DO (%) | Soil Composition | VEGETATION |
|---|---|---|---|---|---|---|---|---|---|
| | | | Wet | Dry | | | | | |
| 1 | SITE A | 1993 | 16 | 15,3 | 24,8 | 76,6 | 7,4 | Silica Soil | Crassulaceae<br>Euphorbiacae<br>Proteaceae |
| | | | | | | | | Top Soil | |
| | | | | | | | | Yellow Sand | |
| 2 | | 1994 | 18,2 | 16,2 | 30,8 | 77,6 | 6,06 | Yellow Sand | |
| | | | | | | | | Silica Soil | |
| | | | | | | | | Top Soil | |
| 3 | | 1996 | 17 | 13 | 32,2 | 59 | 4 | Silica Soil | |
| 4 | | 1999 | 20 | 19 | 32,8 | 74,3 | 4,8 | Yellow Sand | |
| 5 | SITE B | 2011 | 17 | 15,5 | 28 | 69 | 0,2 | Silica Soil | |
| 6 | | 2012 | 16 | 15 | 29,15 | 70 | 1,35 | | |
| 7 | | 2014 | 17 | 15,6 | 29,13 | 66,7 | 1,3 | | |
| 8 | | 2016 | 17,7 | 16 | 25,5 | 63,25 | 0,425 | | |

**Discussion**

A total of 330 soil arthropod individuals have been found in 2 different locations, namely 174 at site A and 156 at site B which are divided into 7 orders and 12 families. The three largest Arthropoda families were Fomicidae (60.4%), Julidae (25.6%), and Scarabaeidae (5.8%). The diversity of soil arthropods obtained based on the Shannon-Wiener index (Figure 2.) on site A is higher (H '= 1.606) than site B (H' = 1.464), but both sites are in moderate diversity due to 1.0 <H '< 3.0 which means sufficient productivity, the condition of the ecosystem is quite balanced and the ecological pressure is moderate. The abundance of soil asthropods is also affected by the above vegetation. Vegetation produces litter that is a food source for soil arthropods. Availability of food in the form of plants as well as being used as a shelter. Vegetation from site A and site B is in the form of plants from the tribes of Crasullaceae, Euphorbiaceae, and Proteaceae. Vegetation will affect the life of soil arthropods, especially vegetation of vegetation covering shrubs and shrubs will affect the abundance and diversity of soil arthropods (Surya, 2011). The level of diversity is influenced by several factors, namely biotic factors and abiotic factors. The abiotic factors measured during the study were soil temperature, air temperature, humidity, oxygen density (DO), and soil composition. The factors of soil temperature, air temperature and humidity at site A and site B are in the same range. The correlation between several factors and species abundance is relatively small, but when viewed from the factors of soil composition and Oxygen Density (DO) there is a broad influence on species abundance. Site A has a DO value that is much higher when compared to site B, so that the abundance of more species is found at site A. In addition, the composition of the soil also has a role in habitat formation and residence for soil insects. site A has a soil composition in the form of 3 soil layers, namely the top layer in the form of white silica sand, yellow silica sand, and dark soil top soil. While at site B only has a soil composition in the form of silica white sand. In the research data it was found that site A with varying soil composition had higher species abundance than site B with 1 type of soil. Observation of soil type is done by digging the soil plot as deep as 5 cm, and the data is obtained based on the separation of the soil type components at each site sampling.

Dominance Soil arthropods in a habitat are influenced by a suitable environment to support their lives (Suin, 1997). Based on the

analysis of the dominance index calculation, it is known that the dominance index value (Figure 3.) at site A is 0.2563 while at site B is 0.2753. based on these results, the simpson dominance index value is close to 0, so there are species that dominate. Odum (1971) states that the least number of species contained in an example will affect the dominance index, although this value depends on the number of individuals of each species.

Evenness index results **(Figure 4.)** from site A (E '= 0.6264) and site B (E' = 0.6358), According to Winarni (2005) The higher the evenness value of species indicates that the number of individuals of each species is increasingly uniform. Odum in Ramdiah (2005) states that if the evenness value of a community is in the range 0.6-0.8, then the community is said to have balanced equity or in other words the number of individuals of each type in the community spread evenly.

Based on **Figure 5.** Soil arthropods have their respective ecological roles. The results obtained from the family of soil Arthropods were classified as decomposers, phytophagous, scavenger, and pest. Basically the role of each insect is as a natural decomposer, but there are some soil insectspecies that also have other roles as phytophagous, scavenger, pest, etc. In soil insects identified from the Sand Quarry Gaskell shows more soil insects that act as scavenger or predator of other species, this indicates that the food chain in the ecosystem is in a stable state. Species that act as decomposers and ants are abundant in the ecosystem, indicating that the biodegradation process is going well as a result of the nutritional supply being met. While there are several species that act as parasites or harmful to humans, but in a small percentage. The results of the comparative studies show that soil types and composition affect the diversity and abundance of soil insect species. Silica soil is a non-biodegradable and nutrient-poor soil type, so the discovery of a number of ant species in this type of soil raises a discussion for further research on life-defense mechanisms and nutritional sources for the development of species diversity in this soil type.

Compared to the previous research conducted by Hafzah (2016), regarding the diversity of arhropods in the Indonesian Hambalang Quarry mine, it is known to have a significant difference in soil composition, where in Indonesia is dominated by volcanic soils rich in nutrients while at Gaskell Sand Quarry in Australia has silica sand or soil which has little nutrients and non biodegradable. The difference between the two soils causes differences in the diversity of soil organisms that are able to live in them, it also affects the above plants vegetation, which is more diverse in volcanic soils while in the Gaskell Sand Quarry mine is dominated by Banksia or succulent plants. Climate differences also affect organisms that live inside and on the surface of the soil. The climate in Indonesia is tropical with air conditions that tend to be warm throughout the year compared to Australia's subtropical regions which tend to be drier and dominated by deserts.

**Expected value added for biodiversity, communities and companies**

Soil arthropod biodiversity studies are a form of research activity that can help communities and companies on concepts in ecology and entomology, especially regarding soil arthropods. This research is expected to provide new insights to analyze problems in the environment and instill values directly to the community and related companies to make decisions in the effort to save the environment. to be improved again through mine restoration efforts. The results of this study provide information about the diversity of soil arthropods in the form of species found, sampling techniques, identification and reference for research activities on subsequent soil arthropods.

**Conclusion**

Total soil arthropods were found as many as 7 orders, 12 families, and 330 individuals. The most commonly found family of species is Formicidae followed by Julidae then Scarabaeidae. Index of diversity of soil arthropods at site A (H '= 1.606) and on site B (H' = 1,464) classified as medium. Species abundance and diversity index of the highest

soil arthropod species were found in Site A. Dominance index at site A was 0.2563 while at site was 0.2753, with the simpson dominance index value approaching 0, then there was no species or species dominating. The accumulation of soil insect species at various ages of rehabilitation shows the success of reclamation on site A, with an increasing abundance of soil insect species, when compared to the newly reclaimed site B land. The various abiotic factors measured show no significant difference, but the diverse soil composition shows more diversity of soil insect species, when compared to the soil with the composition of silica soil alone.

**Acknowledgement**

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**ATTACHMENT**


**Figure 6. Condition land of the sampling area, the vegetation dominated by banksia (Gaskell sand quarry, West Australia)**

**Table 4. Longitude and Latitude in the Site A and the Site B looked from Google Earth**

| Plot | Site A | | Site B | |
|---|---|---|---|---|
| | Longitude | Latitude | Longitude | Latitude |
| 1 | 31°47'5.92"S | 115°56'38.58"T | 31°45'4.30"S | 115°56'11.80"E |
| 2 | 31°47'5.19"S | 115°56'39.36"T | 31°45'0.43"S | 115°56'11.78"E |
| 3 | 31°47'4.97"S | 115°56'38.27"T | 31°44'56.85"S | 115°56'12.96"E |
| 4 | 31°47'7.22"S | 115°56'39.87"T | 31°44'56.59"S | 115°56'17.09"E |
| 5 | 31°47'8.02"S | 115°56'40.42"T | 31°44'57.01"S | 115°56'20.74"E |
| 6 | 31°47'7.91"S | 115°56'38.58"T | 31°45'4.82"S | 115°56'15.66"E |
| 7 | 31°47'6.76"S | 115°56'37.27"T | 31°45'3.90"S | 115°56'16.83"E |
| 8 | 31°47'5.50"S | 115°56'36.59"T | 31°45'3.64"S | 115°56'19.81"E |
| 9 | 31°47'8.33"S | 115°56'36.92"T | 31°45'3.99"S | 115°56'22.23"E |
| 10 | 31°47'7.44"S | 115°56'35.47"T | 31°45'5.60"S | 115°56'20.20"E |
| 11 | 31°47'6.36"S | 115°56'34.33"T | 31°45'5.51"S | 115°56'23.44"E |
| 12 | 31°47'5.37"S | 115°56'34.83"T | 31°45'5.33"S | 115°56'25.94"E |
| 13 | 31°47'7.98"S | 115°56'33.27"T | 31°45'4.41"S | 115°56'28.88"E |
| 14 | 31°47'7.05"S | 115°56'32.53"T | 31°45'3.52"S | 115°56'32.14"E |
| 15 | 31°47'5.70"S | 115°56'32.53"T | 31°45'2.89"S | 115°56'34.81"E |

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

**Project tags (select all appropriate):**

This will be use to classify your project in the project archive (that is also available online)

Project focus:

- ☐Beyond quarry borders
- ☐Biodiversity management
- ☐Cooperation programmes
- ☐Connecting with local communities
- ☐Education and Raising awareness
- ☐Invasive species
- ☐Landscape management
- ☐Pollination
- ☐Rehabilitation & habitat research
- ☐Scientific research
- ☒Soil management
- ☒Species research
- ☐Student class project
- ☐Urban ecology
- ☐Water management

Flora:

- ☐Trees & shrubs
- ☐Ferns
- ☐Flowering plants
- ☐Fungi
- ☐Mosses and liverworts

Fauna:

- ☐Amphibians
- ☐Birds
- ☐Insects
- ☐Fish
- ☐Mammals
- ☐Reptiles
- ☐Other invertebrates
- ☒Other insects
- ☐Other species

Habitat:

- ☐Artificial / cultivated land
- ☐Cave
- ☐Coastal
- ☐Grassland
- ☐Human settlement
- ☐Open areas of rocky grounds
- ☐Recreational areas
- ☐Sandy and rocky habitat
- ☐Screes
- ☐Shrub & groves
- ☒Soil
- ☐Wander biotopes
- ☐Water bodies (flowing, standing)
- ☐Wetland
- ☐Woodland

Stakeholders:

- ☒Authorities
- ☐Local community
- ☐NGOs
- ☐Schools
- ☒Universities