

1. Contestant profile

▪ Contestant name:	Alessandro Mazzoleni
▪ Contestant occupation:	Biologist
▪ University / Organisation	Freelancer in the environmental field
▪ Number of people in your team:	4

2. Project overview

Title:	Biodiversity quarry: 501 species for Colle Pedrino!
Contest: (Research/Community)	Research
Quarry name:	Colle Pedrino

Abstract

The aim of this project is to describe the biodiversity of the Colle Pedrino quarry (Bergamo Province, Lombardy, Italy), through a broad-spectrum analysis of the different forms of life, with the achievement of the symbolic purpose of identifying 501 species. The research area extends for 1.15 square km in the pre-Alps region, in the heart of the Insubric district. In order to record the largest number of species, the use of mainly opportunistic methods was necessary; targets taxa, like birds, medium-large size mammals and soil fauna invertebrates were investigated with specific data collecting methodologies. More than 1500 field data belonging to 678 species were recorded, 15 species are included in the Annexes of "Birds Directive" (Council Directive 2009/147/EC) and "Habitats Directive" (Council Directive 92/43/EEC), such as *Circaetus gallicus*, *Bombina variegata* and *Proserpinus proserpina*, while many others are rare or endemic. The results show that the quarry hosts an unexpected biodiversity due to the marked environmental heterogeneity that the type of activity has generated over the decades.

Introduction

Colle Pedrino is a southern exposure limestone quarry located at an altitude between 850 m and 1380 m above sea level, nearby the Linzone Mountain (Municipality of Palazzago and Caprino Bergamasco, Province of Bergamo, Lombardy, Italy). The site is part of the pre-Alpine region, located between the great lakes of Lombardy and facing the Po Valley, defined as "Insubric district".

Colle Pedrino is characterized by a temperate and moderately oceanic climate, where precipitation values are higher than 1500 mm/year (strongly oceanic pre-alpine regime). The area of interest for our survey involves all the quarry sectors of the Colle Pedrino site, including currently cultivated sectors, sectors not yet exhausted, region of future processing and areas of the former quarry. The cultivation started more than 50 years ago and involves a half-coast excavation with descending steps; the amount of material extracted annually is about 400,000 cubic meters. When the cultivation of a quarry sector is finished and the final morphology of the slopes is created, environmental recovery operations are carried out, simultaneously with the cultivation work of other non-exhausted quarry sectors, through the re-profiling of the slope, with the creation of a natural inclination (30 ° -35 °). It follows the carryover of vegetal soil coming from the uncovered quarry on the final slope and hydro-seeding or spread-seeding, followed by the planting of native shrubs or trees. Finally, the species list template was filled out with data referred to organisms determined at genus or species level.

Methods

The research carried out in Colle Pedrino quarry involved four peoples (freelance naturalists and biologists). The area of study covers the entire extractive site owned by Italcementi S.p.A. and a buffer of 50 meters outside the borders of the quarry, for a total extension of approximately 1.15 sq. km (fig.1). A 100-meter grid consisting of 224 Square Units (S.U.) was used to facilitate data registering. In the period between February and August 2018, 35 field surveys have been conducted.

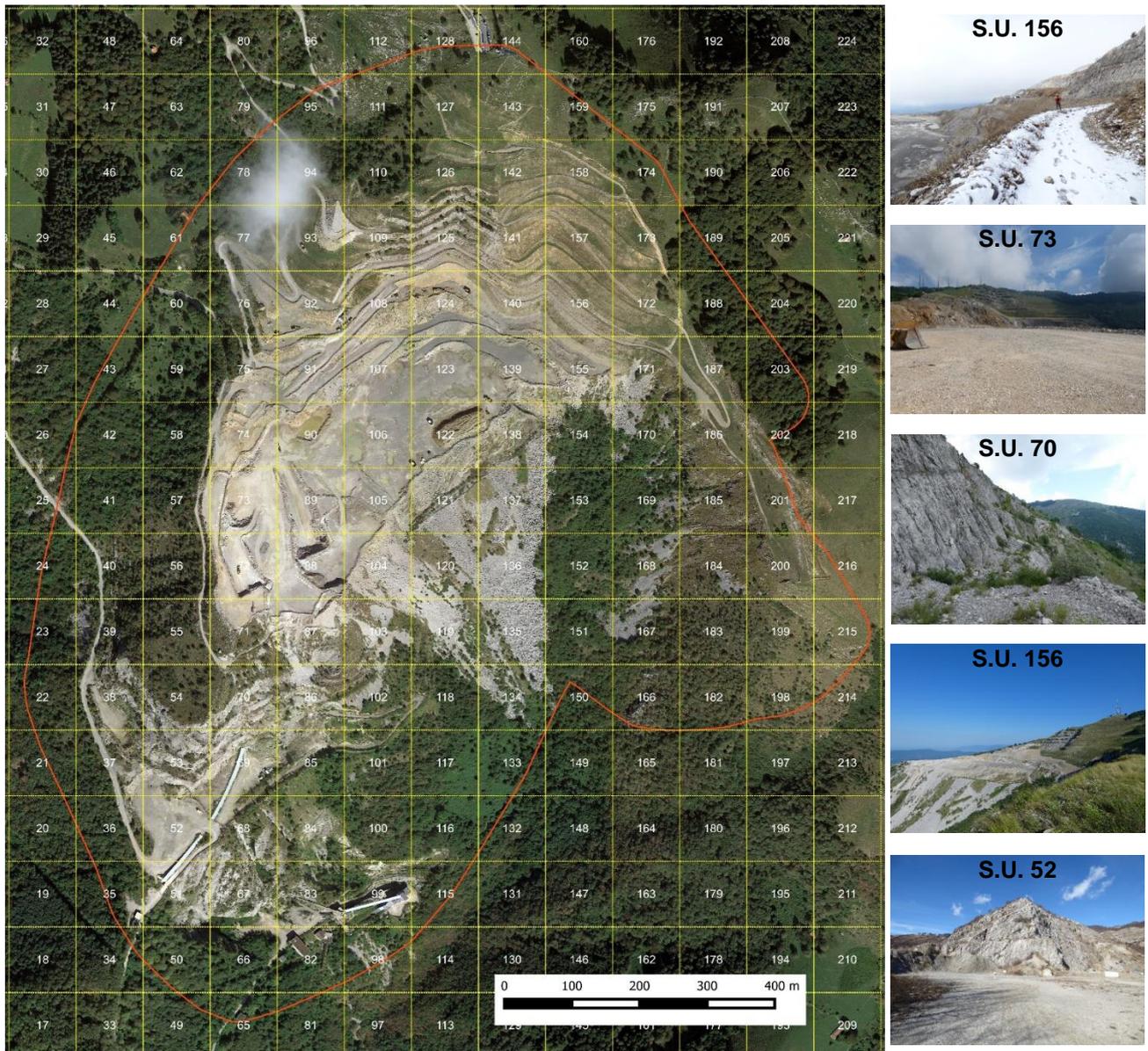


Fig.1: Colle Pedrino quarry: map of the area of research with data localization grid (*Square Unit* S.U.).

The site shows different habitats: rocky slopes (S.U. 125, 53), rocky debris on mountain slopes (S.U. 104), quarry areas (S.U. 89, 105, 106, 123, 52, 139), grazing (S.U. 44, 45, 60, 61, 174), deciduous forests (S.U. 58, 188, 203), shrub-lands (S.U. 183, 184, 185) and uncultivated areas (S.U. 74, 75, roads).

In order to register the largest amount of species belonging to different systematic groups, the use of mainly opportunistic methods was necessary. Targets taxa were investigated with specific data collecting methodologies, such as camera traps (used for medium-large size mammals), point counts and linear transects surveys (used for birds) and pitfall traps (used for sampling soil fauna invertebrates, such as coleopterans).

Moreover, all the areas suitable for the existence of other insects (dragonflies, crickets, grasshoppers, butterflies, flies and bees) were investigated through the use of visual encounter survey and direct collecting methods. All specimens of insects were photographed and, when necessary, captured with handle net and collected in order to be determined; the researches were carried out during day time and in the most suitable

weather conditions; light traps for monitoring nocturnal lepidopterans were also used. Due to the impossibility of accessing the quarry at night, no detections of bats and nocturnal birds of prey have been made. A floristic investigation was carried out (Spermatophytes, Pteridophytes, Briophytes) in all the habitats of Colle Pedrino. Each observation was reported and georeferenced on a special sheet.

All data collected, punctually located by GPS coordinates (flora) or within units on the monitoring grid (fauna), have been archived in a database attached to this report, with date-indication of the of collection and possible ecology notes. Subsequently, the notifications were inserted, mostly with photos, on the iNaturalist platform, a Citizen Science community (<https://www.inaturalist.org/projects/biodiversity-quarry-501-species-for-colle-Pedrino>). The use of the platform had the dual purpose of creating a dataset that could be easily consulted for the research purposes and to be able to benefit from the immediate collaboration of international experts and nature-enthusiasts.

Finally, the species list template was filled out with data referred to organisms determined at genus or species level.

Results

In the Colle Pedrino quarry, more than 1550 field data have been recorded, belonging in total to 678 organisms determined at genus (n. 57) or species (n.621) level (Fig. 2) and 610 of them are documented with pictures. 122 S.U. covers the research area (Fig. 1), have been recorded data, at least 1 species, in 105 S.U..

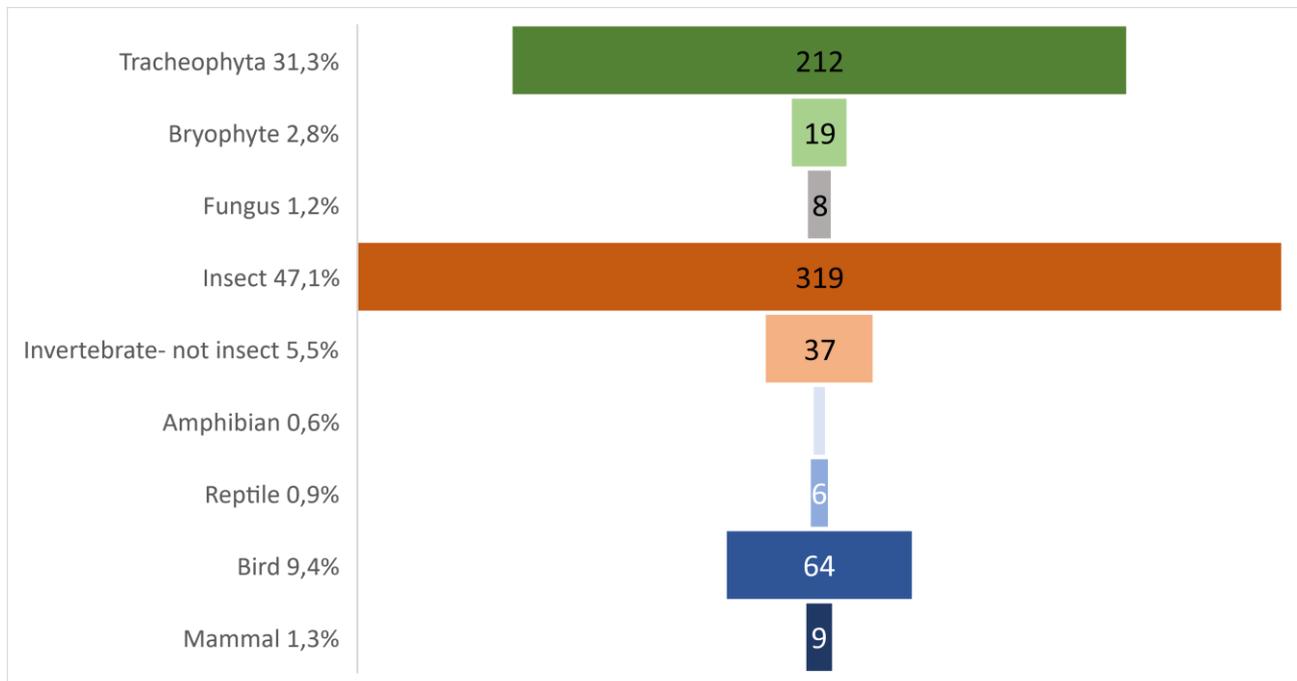


Fig.2: Class subdivision of the 678 identified species at the Colle Pedrino quarry.

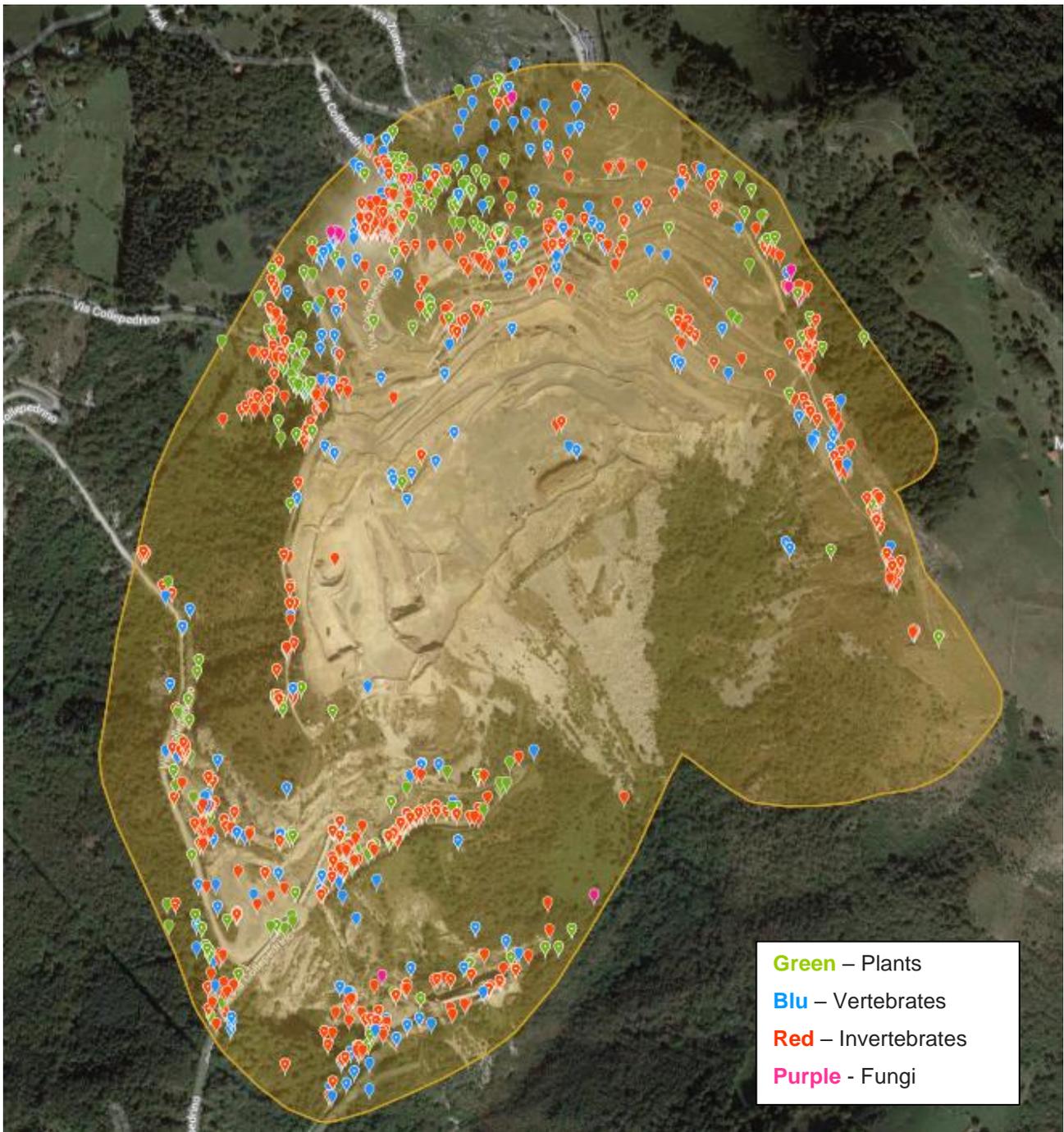


Fig. 3: Map showing the distribution of data collected in 2018 in the Colle Pedrino quarry. Different colours represent different taxonomic groups. All the habitats in the site have been explored to find the largest number of species with opportunistic methods.

Fifteen species are recorded in the Annexes of “Birds Directive” (Council Directive 2009/147/EC) and “Habitats Directive” (Council Directive 92/43/EEC (Tab.1).

Class	Species	Annex Dir. 2009/147/EC	Annexes Dir. 92/43/EEC
Aves	<i>Pernis apivorus</i>		
Aves	<i>Milvus migrans</i>		
Aves	<i>Circaetus gallicus</i>		
Aves	<i>Circus aeruginosus</i>		

Aves	<i>Aquila chrysaetos</i>	I	
Aves	<i>Falco peregrinus</i>	I	
Aves	<i>Caprimulgus europaeus</i>	I	
Aves	<i>Lullula arborea</i>	I	
Insecta	<i>Euplagia quadripunctaria</i>		IV
Insecta	<i>Proserpinus proserpina</i>		IV
Amphibia	<i>Bombina variegata</i>		II & IV
Amphibia	<i>Rana dalmatina</i>		IV
Reptilia	<i>Podarcis muralis</i>		IV
Reptilia	<i>Lacerta bilineata</i>		IV
Reptilia	<i>Zamenis longissimus</i>		IV

Tab.1: Species included in the Annex I of the Dir. 2009/147/EC or in the Annex II and IV of the Dir. 92/43/EEC.

Invertebrates

In the Colle Pedrino quarry a total of 356 species of Invertebrates were assessed. The following species have been identified as belonging to "invertebrate - not insects": Gastropoda (10 species), one scorpions, one Pseudoscorpionida, some species of spiders – Aranea (19 species), one mite, two opilions, three isopods and a diplopode (Tab .2).

Insects represent the largest number of species recorded (309). The most investigated taxa were Coleoptera (91 species) and the Lepidoptera (132 species); of the latter, 55 were "diurnal butterflies" (Papilionoidea and Hesperioidea), and 77 "moths" (a heterogeneous and numerous group of butterflies divided into over 25 families, to which belong species with prevalently, but not exclusively, crepuscular habits). Targeted outputs were also made for the research of Orthoptera (17 species), Diptera Syrphidae (16 species) and Hymenoptera Apoidea (12 species). The results grouped by Order are summarized in Table 2.

Class	Order	N° Species
Gastropoda	Stylommatophora	10
Arachnida	Scorpiones	1
	Aranea	19
	Trombidiformes	1
	Opiliones	2
Malacostraca	Isopoda	3
Diplopoda	Glomerida	1
Insect	Odonata	7
	Blattaria	1
	Mantodea	1
	Orthoptera	17
	Heteroptera	25
	Coleoptera	91
	Neuropterida	1
	Mecoptera	1
	Diptera	21
	Lepidoptera	132
	Hymenoptera	22

Tab.2: Number of species of invertebrates, summarized by Order.

Three species are considered of conservation interest: two species are included in Annexes of the Fauna-Flora-Habitats Directive of the European Union 92/43/EEC (the Lepidoptera *Proserpinus proserpina* and *Euplagia quadripunctaria*), while the third, the Cerambycidae *Lamia textor*, is considered "near threatened" according to the Red List of Italian Saproxyllic Coleoptera. The Apidae *Anthophora quadrimaculata* has not sufficiently been investigated to define its conservation status (Data Deficient) at a European level.

Amphibians

Four species of amphibians were registered, all belonging to the order of the Anuri. *Bufo bufo* and *Rana temporaria* were observed several times in the site; they tend to reproduce the temporary and semi-temporary waterbody in the flat sectors of the quarry. Although these are adventitious and simplified habitats, in the 2018 season the completion of larval development in these biotypes has been documented. Adult specimens of *Bufo bufo* and *Rana temporaria* use quarry tunnels as shelter sites during the daytime hours. In one of the major pond described (SU 37), facing a wide wooded slope, a clump attributable to *Rana dalmatina* was documented in April. *Rana dalmatina* altitude limit distribution on the Pre Alps coincides with the site-altitude (1020m asl). Particularly significant is the discovery of a meta-population of *Bombina variegata*, a species of conservation interest (Annexes II & IV Dir. 92/43/EEC) and in strong decline in Italy and in particular in Lombardy. The individuals, observed from April until late summer, were located in small water collections, even in a few square meters, in correspondence of the 3 largest quarries, placed respectively at an altitude of 1170, 1000 and 880m asl. The reproduction in the site has been documented. Also for this species, in particular in presence of a small wetland (probably perennial) that developed in correspondence of a depression that collects the waste water coming from the current mining area (S.U. 68 and S.U. 69). No newts or salamanders (Urodela) have been recorded in Colle Pedrino, probably due to the lack of suitable waterbodies, such as permanent ponds or streams with an all-year-long presence of water.

Reptiles

At Colle Pedrino a total of six species of reptiles were assessed.

Podarcis muralis is widespread and has been observed in the mining area and in the recently restored areas. *Lacerta bilineata* and *Anguis veronensis* were rarely observed, they seem located at the quarry margins, in ecotone habitats.

Observations on three species of snake have been collected: *Zamenis longissimus*, *Natrix natrix* and *Vipera aspis*. After the assessment of the ecological needs of the detected species and the study area habitats, we presume that all the reptiles observed could reproduce within the Colle Pedrino quarry.

Birds

A total of 64 bird species have been assessed, in particular 46 passerines and 18 non-passerines. Eight species are listed in Annex I of the "Birds directive" (Annex I Dir. 2009/147/EC). In late winter we reported the frequent observation of a wintering contingent of *Prunella collaris* (n > 20), an alpine species which is not common at these altitudes, located on the slopes of the most recent quarry, feeding on the scarce vegetation

present (S.U. 140 and S.U. 156). The Colle Pedrino area in spring is interested by a significant migration of short-range migratory species (on some days hundreds of passerines in active migration have been observed on the quarry area, including *Turdus iliacus*, *Fringilla coelebs*, *Fringilla montifringilla* and *Spinus spinus*), transaharian, such as *Hirundo rustica*, *Oenanthe oenanthe*, *Phylloscopus trochilus* and raptors such as *Circus aeruginosus*. The community of nesting birds has been investigated in detail in the area: we have found 42 species, between certain and possible nesting birds. Many birds are typical of broad-leaved forest formations of the Orobic-hillside, such as *Cuculus canorus*, *Troglodytes troglodytes*, *Erithacus rubecula*, *Poecile palustris*, *Sitta europaea* and *Garrulus glandarius*, that live in the wood nearby the quarry. The species observed in the quarry area are very peculiar, in particular in correspondence with the old decommissioned rock steps, which have been exposed for a long time (eg: S.U. 109, 125, 141, 53, 70); in this context we recorded the nidification of *Lullula arborea* (1 pair), *Monticola saxatilis* (1-3 pairs), *Phylloscopus bonelli* (2-4 pairs), extremely rare and localized species in the pre-Alpine area. Particularly interesting is also the presence of nine species of diurnal birds of prey, such as *Falco tinnunculus*, that nests in the quarry, or *Pernis apivorus*, *Milvus migrans*, *Circaetus gallicus*, *Accipiter gentilis*, *Buteo buteo* and *Falco peregrinus*, that live nearby the site. Two species (*Circus aeruginosus* and *Aquila chrysaetos*) only occasionally pass in the area. Lastly, the presence of some species introduced for hunting purposes in the neighbouring hunting areas, such as *Alectoris rufa*, *Perdix perdix* and *Coturnix coturnix*, have been recorded.

Mammals

Nine species of mammals, (*Talpa* sp. and *Apodemus* sp.), have been recorded in the Colle Pedrino quarry. Between the nine species, only two are at the genus level. The presence of three species of carnivores, *Vulpes vulpes*, *Martes foina* and *Meles meles*, was widely assessed in the vast area of the project by several camera traps pictures. *Sciurus vulgaris* has been surveyed in the woody areas facing the quarry. The regular presence of *Lepus europaeus* is instead attributable to the release of this specie for hunting purposes in the nearby hunting sectors.

Capreolus capreolus and *Rupicapra rupicapra* are the two ungulates species recorded, the latter with a single observation of an adult specimen during summer, unusual at low altitude, located in correspondence of a rock cliff created by the quarry activity (S.U. 38).

The survey methods employed are not suitable for gathering information on particularly elusive groups (micro-mammals and bats), as a result the list is to be considered only partial.

Plants

The floristic analysis of the quarry area, carried out in all the different habitats, led to the census of 231 species, including 208 spermatophytes, 4 pteridophytes and 19 bryophytes (Tab .3). The rich floristic cortege observed is distinguished by a strong presence of thermophilous elements typical of the pre-alpine limestone district, followed by a contingent of more ubiquitous species and features of disturbed habitats and high environmental dynamics.

Among the species detected, we noticed here the presence of the following group of varieties worthy of conservation and protected under the Regional Law 10/2008:

Dianthus sylvestris, *Dianthus seguieri*, *Gentiana clusii*, *Gentiana cruciata*, *Daphne mezereum*, *Anemone nemorosa*, *Cephalanthera longifolia*, *Dactylorhiza sambucina*, *Dactylorhiza fuchsii*, *Epipactis atrorubens*, *Galanthus nivalis*, *Gymnademina conopsea*, *Orchis mascula*, *Paeonia officinalis*, *Primula vulgaris*.

In the habitats surrounding the active extraction area, seven species of spontaneous orchids have been surveyed, located in stable stations with a good number of individuals.

As far as the non-vascular flora is concerned, we the new station of *Schistidium elegantulum* ssp. *elegantulum*, a rare Grimmiacea characteristic of basic rocks, distributed from the flat to the alpine land.

The coexistence of very differentiated habitats made it possible to define a list of species that is well nourished and worthy of future studies, which includes species with very different ecological needs. Overall, the area examined confirms the high level of plant biodiversity characteristic of thermophilous mountain environments, thus constituting an interesting floristic laboratory for future interventions of restoration and renaturation.

Class	Order	N° Species
Bryopsida	Dicranales	1
	Fissidentales	1
	Funariales	1
	Orthotrichales	1
	Bryales	2
	Grimmiales	3
	Hypnales	6
	Pottiales	6
Jungermanniopsida	Jungermanniales	1
	Porellales	1
Liliopsida	Liliales	4
	Asparagales	13
	Poales	28
Magnoliopsida	Boraginales	1
	Myrtales	1
	Oxalidales	1
	Sapindales	1
	Solanales	2
	Ericales	3
	Malvales	3
	Saxifragales	3
	Fagales	4
	Geraniales	4
	Apiales	5
	Dipsacales	6
	Brassicales	7
	Gentianales	8
	Malpighiales	8
	Ranunculales	8
	Caryophyllales	9
	Rosales	10
	Fabales	18
	Lamiales	24
Asterales	29	
Pinopsida	Pinales	3
Polypodiopsida	Polypodiales	5

Tab.3: Number of species of Plant, summarized by Order.

Discussion

The declared symbolic goal of the scientific research, namely to record at least 501 species, has been achieved. The study has allowed to obtain many interesting data and to check unexpected species within the area of cava of Colle Pedrino, due to the marked environmental heterogeneity that the type of activity generated over the decades.

Fifteen species included in the annexes of the EU Habitats and Birds Directives have been checked, and dozens of rare species (such as the birds *Lullula arborea* and *Monticola saxatilis*), and endemic species (ex. the Coleoptera Carabidae *Laemostenus macropus*, *Pterostichus dissimilis* and *Abax fiorii*, which are diffused exclusively on the Alps and Lombardy Prealps) have been recorded. *Proserpinus proserpina*, a sporadic and rare Sphingidae which live in warm rocky slopes, grassy cliffs and dry scrubland, has been observed for the first time in Lombardy in the last thirty years. Moreover, within the quarry, vital populations of priority species have been recorded in marked decline, in the last decades, in the pre-Alpine area, even within protected areas belonging to the Natura2000 Community conservation system. The amphibian *Bombina variegata* has been recorded in three distinct areas in the quarry (12-20 individuals). A part of the species detected is attributable to the cenosis of dry grasslands and xerothermic environments and linked to dry or rocky substrates. Characteristic Insects of this habitat are: *Mantis religiosa*, *Oedipoda caerulescens*, *Aiolopus strepens*, *Sphingonotus caeruleans*, *Cicindela campestris*, *Carabus cancellatus*, *Hemaris tityus*, *Hyles vespertilio*, *Scolitantides orion* and *Melanargia galathea*. In the summit meadows and open areas live *Anthus trivialis*, *Turdus viscivorus*, *Phylloscopus collybita*, *Emberiza citronella*, while in rupicolous areas with scarce vegetation live *Ptyonoprogne rupestris* (2-4 couples), *Phoenicurus ochruros* (4-10 pairs), which also settles near the active quarry areas, *Linaria cannabina* (1-2 pairs), *Corvus corax* (1 pair) and *Emberiza cia* (4-6 couples). Lastly, among the non-passeriforms, we notice the presence in the reproductive period of *Caprimulgus europaeus*.

Butterflies are good bio-indicators; fiftyfive species have been identified in the Colle Pedrino quarry; meadows, open woodland edges, shrubs and rocky slopes constitute the habitats that hosts many species. *Erebia styx* is a local and uncommon butterfly with a sparse distribution in Lombardy, an alpine species that inhabits warm rocky slopes, cliffs with sparse vegetation and dry grassy limestone slopes.

From the point of view of the vegetation, the surveyed area looks like a very heterogeneous mosaic, characterized by the contact between habitable flaps of habitat for ecology and floristic wealth. *Sesleria* prairie strips and mixed broad-leaved thermophilous formations are in close contact with coarse debris and rocky slopes originated from mining activities. These stony and rupicolous environments show a good spontaneous re-colonization by the plant species that normally inhabit similar habitats of natural origin, particularly in the less recent cultivation areas. On the contrary, in the areas subject to recovery, we observe a flora linked to more eutrophic soils, characterized by a flora that is less coherent with the surrounding semi-natural vegetation. In the future, it will be possible to evaluate the possibility of greening the steps during recovery with mixtures of seeds closer to the floristic composition of the surrounding semi-natural vegetation, taking as a possible reference the summit prairies of the Linzone massif, for example referring to *Festuca* species.

Despite the interference caused by the extraction activities and the presence of numerous areas of uncovered soil, the number of alien species surveyed is rather limited. However, there is a widespread

presence of *Buddleja davidii* and *Senecio inaequidens*, species now widespread in the Italian territory, in areas of gravel, in mining sites and on detritus, detect up from lowlands to the mountain areas included.

The most important biocenoses are associated with older restored areas characterized by rocky slopes and cliff with sparse vegetation. Recent restored slopes have apparently an inferior richness of biodiversity. The presence of invasive flora in all sites of the quarry, including the more recent revegetated ones, suggests continuous monitoring and the application of specific actions of restoration with vegetation, closer to the floristic composition of the surrounding semi-natural dry grasslands (for example referring to essences of the genus *Festuca*).

During the study, some species of conservation interest were observed in habitats due to the quarry activities, such as temporary ponds; in the future, it could be necessary to preserve these important environments.

Hunting and related dog-training carried out in the authorized surrounding areas, but also in restored slopes, have had a negative impact on birds and mammals reproductive populations, and they will be prohibited in the quarry.

This project can be considered the first step for the development of further specific studies and ecological analyses, focused mainly on the species of major conservation interest present in the Colle Pedrino area.

The collected data represent a strong and strategic knowledge base, which could be used by Heidelberg for the definition of consistent actions aimed to protect biodiversity and habitats, both in relation to restored areas and to the sites currently under cultivation.

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)	
<p>Project focus:</p> <ul style="list-style-type: none"><input 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 type="checkbox"/> Pollination<input checked="" type="checkbox"/> Rehabilitation & habitat research<input 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>Habitat:</p> <ul style="list-style-type: none"><input checked="" type="checkbox"/> Artificial / cultivated land<input checked="" type="checkbox"/> Cave<input type="checkbox"/> Coastal<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 checked="" type="checkbox"/> Sandy and rocky habitat<input type="checkbox"/> Screens<input type="checkbox"/> Shrub & groves<input type="checkbox"/> Soil<input type="checkbox"/> Wander biotopes<input checked="" type="checkbox"/> Water bodies (flowing, standing)<input type="checkbox"/> Wetland<input checked="" type="checkbox"/> Woodland
<p>Flora:</p> <ul style="list-style-type: none"><input checked="" type="checkbox"/> Trees & shrubs<input checked="" type="checkbox"/> Ferns<input checked="" type="checkbox"/> Flowering plants<input checked="" type="checkbox"/> Fungi<input checked="" type="checkbox"/> Mosses and liverworts	<p>Stakeholders:</p> <ul style="list-style-type: none"><input checked="" type="checkbox"/> Authorities<input type="checkbox"/> Local community<input type="checkbox"/> NGOs<input type="checkbox"/> Schools<input checked="" type="checkbox"/> Universities
<p>Fauna:</p> <ul style="list-style-type: none"><input checked="" type="checkbox"/> Amphibians<input checked="" type="checkbox"/> Birds<input checked="" type="checkbox"/> Insects<input type="checkbox"/> Fish<input checked="" type="checkbox"/> Mammals<input checked="" type="checkbox"/> Reptiles<input checked="" type="checkbox"/> Other invertebrates<input checked="" type="checkbox"/> Other insects<input checked="" type="checkbox"/> Other species	