

Optimising the balance between quarrying and nature conservation

Establishing sustainable development indicators for integrated raw material and nature conservation management in quarrying sites

BY DR MICHAEL RADEMACHER AND DR ULRICH TRÄNKLE

IN AUGUST 2005, the HeidelbergCement Technology Centre started a pilot project in co-operation with the German Association of the Cement Industry (BDZ) and other institutions to develop and test sustainable development indicators under the umbrella of the 'Initiative for Sustainability' in the German cement industry.

The project aims to optimise the balance between the quarrying of raw materials and nature conservation. Indicators for measuring biodiversity qualitatively and quantitatively are being developed and tested in order to make the conservation value of quarrying sites and the effects of nature conservation measures both measurable and predictable before, during and after quarrying. The indicators are tailored to the specific circumstances and potential of quarrying sites in order to fulfil the demands of business practices and nature conservation in equal measure, and form part of a monitoring programme that can be carried out during quarrying.

Up until now there were no appropriate and, above all, generally accepted instruments for an understandable measurement of the value of quarries regarding nature conservation. Now this has begun and we can see the first practical experience in the form of contractual conservation and ecological accounts, the so-called Sustainable Development Indicators (SDIs) are being developed on the European level. However, the indicators discussed there will meet the specific requirements in quarries of the cement industry only in a limited way – they even might lead to steps back concerning the nature conservation concepts already developed for quarrying.

The trial project is to be carried out in the quarry of the Schelklingen cement plant of HeidelbergCement AG; findings are already available for this quarrying site and can be used as reference values to test the indicators. The knowledge acquired from developing and testing the indicators will also be assessed for transferability to other locations in the cement industry and other stone and earth industries. This will then also be used as a basis, as far as possible, to derive information regarding the further development of eco-accounts for the extraction of raw materials.

The great importance of quarries from a conservation viewpoint is also proved by several other studies in Germany. The most extensive study on biodiversity in quarries was conducted in Bavaria by Gilcher & Tränkle (2005). One of the aims of a study by the Bayerischer Industrieverband Steine und Erden (Federation of the Bavarian Building Materials Industry) was to determine the conservation value of quarries and pits for flora and fauna. Out of 1,008 quarries with a combined area of 5,757 ha, 52 quarries with a total area of 408 ha were chosen for this study. The study focused on carbonate, gypsum, basalt, diabase and granite rocks. The study includes 41 abandoned and 11 operational quarries. The area studied represents approximately 7% of the quarrying area of the entire data pool, i.e. 0.006% of the total area of Bavaria. Biotopes, plants, vegetation, birds, butterflies, burnet moths and grasshoppers were studied.

Right: In the Vohenbronnen quarry the working level is being prepared for agricultural use even while the quarry is still operational. Young saplings are already growing on the sides of the slopes

BIOTOPES AND FLORA – NUMBERS OF SPECIES

Over 1,000 plant species were found. This corresponds to 41% of all known species in Bavaria. As the 52 quarries studied only cover 0.006% of the area of Bavaria, this value should be regarded as very high. An average of 203 species were identified per quarry. The highest number of species in a quarry was 344, the lowest 61. The inventory of species depends primarily on the type of rock and the characteristics of the surrounding area. Other factors, such as the size of the area, age, disturbances and number of subhabitats, also affect the number of plant species and vegetation units.

All quarries studied contained an above-average percentage of the species found in the surrounding area in relation to their size (the surrounding area is deemed to be an area of 33 km² around each quarry). The average percentage of the total number of plant species found in the surrounding area was 32%, even though the quarry corresponds to just 0.24% of that area. The percentages recorded for the individual quarries ranged between 14% and 59% (see Figure 1 below).

The rocks vary greatly in terms of the average number of species found, with very large numbers of species found in basalt and diabase quarries (243 and 234 respectively).

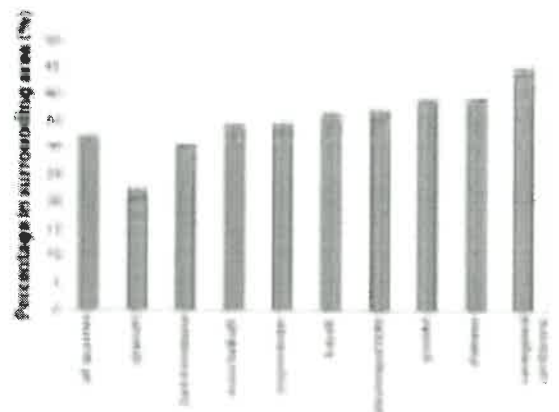


Figure 1: Average number of plant species found in the quarry as a percentage of the inventory of species found in the relevant quadrants of the Topographical Map 1:25,000, by rock type.



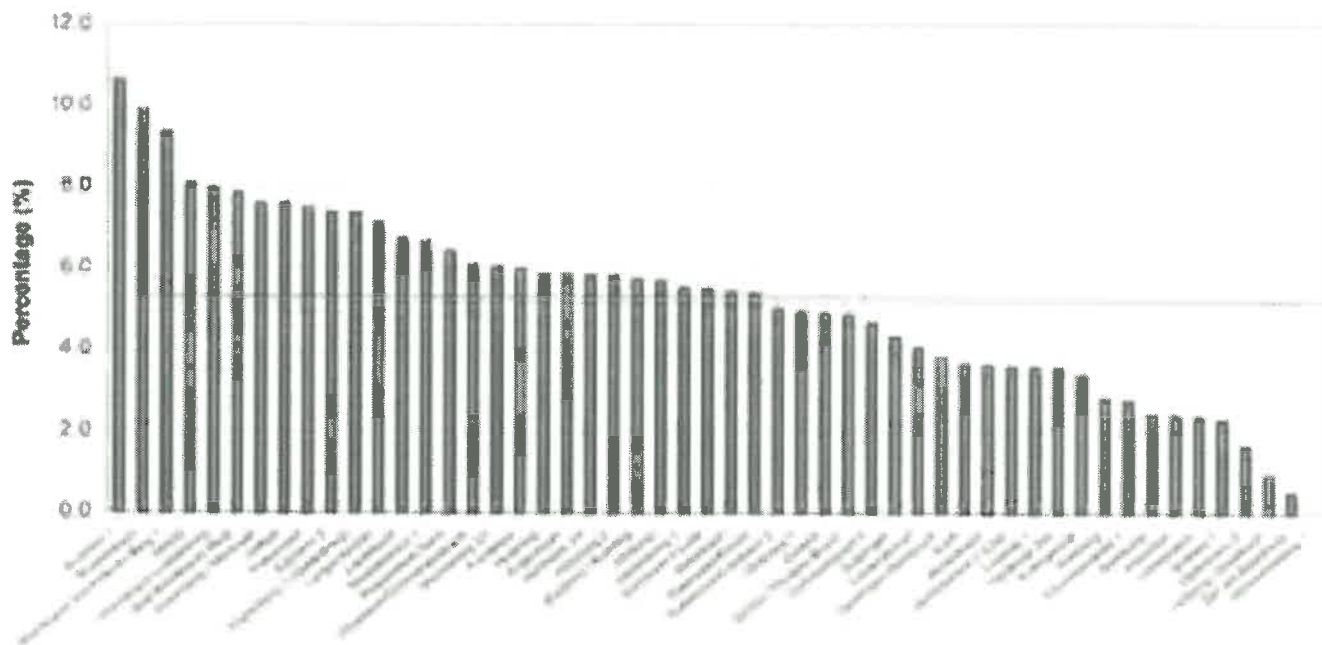


Figure 2: Number of plant species endangered in Germany, Bavaria and the natural landscape as a percentage of the total number of species found in each quarry studied. The red line represents the average of all quarries.

The granite (157 species) and gypsum quarries (166 species) contain rather small numbers of species, while average figures were recorded for the limestone quarries (muschelkalk quarries 209 species; Jura limestone quarries 228 species). The number of species increases with the area of the quarry and decreases with age.

BIOTOPES AND FLORA – RED-LISTED PLANT SPECIES

A total of 75 plant species endangered in Germany and 155 endangered in Bavaria were identified. This corresponds to 12.4% of all species classified as endangered in Bavaria, in just 0.006% of the total area of Bavaria. The average figures were 7.2% and 15% respectively of the total number of species found in each quarry. In the individual quarries, the numbers of endangered species ranged from 0 to 24. The endangered plant species also include several species threatened with extinction across Germany and Bavaria (eg *Ophrys apifera*, *Veronica austriaca*). Of particular interest is the incidence of five plant species classified as extinct in the relevant natural landscape (eg *Cyperus fuscus* and *Medicago minima*).

More than 140 vegetation units were identified in the quarries studied. These include 75 endangered and 6 rare plant communities. In the quarries studied, 25 of the 49 biotope types are classified as particularly worthy of protection. The percentage of the total area covered by the protected biotopes in the individual quarries ranges from 0 to 96%.

Number of bird species on Bavaria's and Germany's Red Lists, broken down into territorial birds and others

Both the large total numbers of species and the very high percentages of the total number of plant species found in the surrounding areas, as well as the number of rare vegetation units and protected biotopes, indicate the value of quarries as refuges for flora and their great importance for biodiversity. A large number of quarrying sites fulfil this function while still in operation, and it is maintained for decades.

BIRDS – NUMBERS OF SPECIES

In the 52 quarries, 123 bird species were identified. Of these species, 99 are classified as territorial birds, corresponding to approximately 49% of the species of regular breeding birds in Bavaria. This means that just under half of all breeding bird species in Bavaria are found in only around 0.006% of the total area. A further 24 species are classified as feeding visitors.

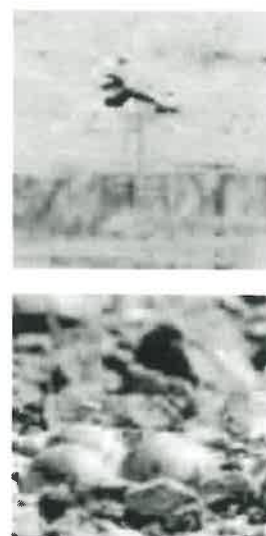
In the individual quarries, between 14 and 66 species were encountered. This high percentage of the total spectrum of species in just a small percentage of the total area of Bavaria suggests that quarries are a highly attractive habitat for avifauna. Bird species with very different habitat requirements are found within a small area.

Over 50 of these bird species are found in Bavaria's Red List and 27 in Germany's. And 38 of these species are territorial birds, including the highly endangered (categories 1 and 2) species wood lark, eagle owl and peregrine falcon (see Table 1 below).

THE MAJOR HABITATS OF BIRD SPECIES

The area inhabited by various bird species is determined to a large extent by the presence of quarries. If rocky areas and virgin soil sites are not found in the natural landscape, species like the eagle owl, peregrine falcon, little ringed plover and wheatear nearly always find their breeding sites in quarries alone. Of the first three species mentioned, a significant

Continued on page 18



The Vohenbronnen quarry is characterised by a tremendous biological richness. The wide variety of biotopes makes the quarry an exceptionally valuable habitat. One example is the ringed plover, a bird adapted to living on gravel islands and shallow banks. Nowadays virtually its only breeding grounds in Germany are in sand pits (gravel pits) and quarries

TABLE 1

	Bavaria					Germany					
	0	1	2	3	V	0	1	2	3	V	R
Territorial birds	-	2	3	13	17	-	-	3	7	9	1
All species	-	5	6	17	23	1	-	5	10	10	1

V = caution list (the species is recently not endangered but the population decrease continuously in Bavaria)
R = geographical restriction (species endangered in some parts of Germany/ Bavaria)

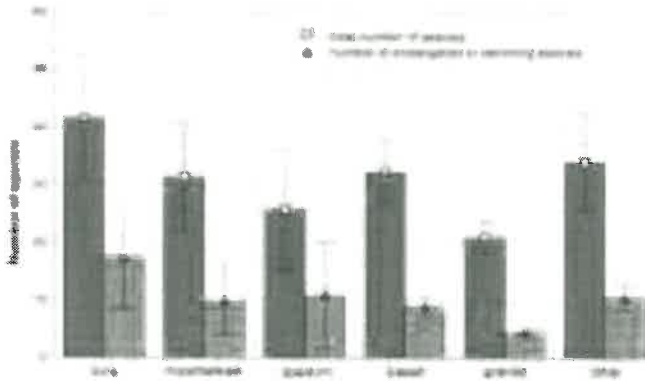


Figure 3 : Average number of species and number of endangered species of butterfly and burnet moth, by quarrying stone (indicator: standard deviation)

Continued from page 17

proportion of the population in several administrative districts or regions of Bavaria is now almost entirely dependent on quarries. This is particularly marked in the case of the eagle owl, with approximately 50% of its Bavarian breeding grounds located in quarries.

From the point of view of bird protection, the most important structures of quarries are escarpments and areas with sparse vegetation or virgin soil. Escarpments significantly increase the number of secure breeding sites, particularly for the eagle owl, peregrine falcon and jackdaw, and allow a greater number of birds as well as more widespread colonisation. Areas with sparse vegetation are home to the wood lark, yellow wagtail or corn bunting – or, in wet areas, the little ringed plover.

BUTTERFLIES AND BURNET MOTHS

In 26 of the 52 quarries, butterflies and burnet moths were also studied. Nearly 100 butterfly species and 11 burnet moth species were found. This corresponds to 65% of the butterflies regularly seen in Bavaria. Between 19 and 56 species were identified in each quarry. Given that just 0.006% of the total area of Bavaria was studied, we can only deduce that quarrying sites are very important for fauna throughout the state. The quarries studied are obviously particularly attractive.

Of these 109 species, 79 are endangered in Bavaria or Germany, or are classified as being in decline. This corresponds to 72%, with all quarries containing species that are endangered or declining state-wide or nationwide. Between three and 31 of these species were found in each quarry. The number of endangered species as a percentage of the total number of species ranges from 8% to 79% in the Solnhofener Berg quarry. Only three of the ten species currently threatened with extinction in

Bavaria were found during the year of the study (eg *Chazara briseis*, *Pyrgus armoricanus*); the same applies to eight of the 35 heavily-endangered species in the state.

Rock-specific differences were detected, particularly in terms of the diversity of species. Particularly large numbers of species exist in the Jura limestone quarries. Accordingly, the number of endangered species is also highest in those quarries. The lowest values were recorded for granite stones (see Figure 3 above).

The quarries are particularly important for xerothermic species of neglected grassland and ruderalised borders.

This is due to the very extreme abiotic living conditions often found in some parts of quarries and specific combinations of habitats. Quarrying sites act as a refuge for a large number of species. From there, species can recolonise abandoned areas in the open agricultural landscape.

GRASSHOPPERS AND CRICKETS

The results described also apply to grasshoppers and crickets. In the 22 quarries considered, 36 species of grasshopper and burnet moth were recorded. This corresponds to approximately 53% of all known species in non-Alpine areas of Bavaria. The number of species ranges from four to 21 per quarry. Of the 36 species of grasshopper and cricket recorded in 2002, the year of the study, 19 species are found in Bavaria's Red List and 10 in Germany's. *Oedipoda germanica* und *Psophus stridulus*, for example, are particularly valuable species.

For grasshoppers, quarries act – at least regionally – as important replacement habitats for occupants of dynamic habitats who have lost large parts of their natural habitats in the cultural landscape.

EVALUATION

Bringing all the data on species diversity together and evaluating the quarries using the evaluation rules set by the State of Bavaria, 13% of the quarries studied should be classified as having state-wide importance, 70% as having supra-regional importance and 17% as having regional importance.

Dr Michael Rademacher is senior ecologist on the Quarry Restoration and Nature Protection project. He works for HeidelbergCement Technology Centre. Dr Ulrich Tränkle is executive director and senior ecologist on the Quarry Restoration and Nature Protection project. He works for AG LN (Landscape planning and nature conservation management)

Open virgin soils with high biodiversity in gravel pits (Upper Rhine Valley)

