RÖSSING BIODIVERSITY ASSESSMENT

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1. Introduction

1.1 Background

Rössing Uranium Limited (RUL, hereafter referred to as 'Rössing') has operated a uranium mine in the Erongo Region of Namibia, in the central Namib Desert, since 1976 (Figure 1). The mine comprises an open pit, rock dumps and tailings dam, and mine infrastructure associated with processing plants, manufacturing, maintenance and administrative operations (Figure 2), situated within the Mining Licence Area.

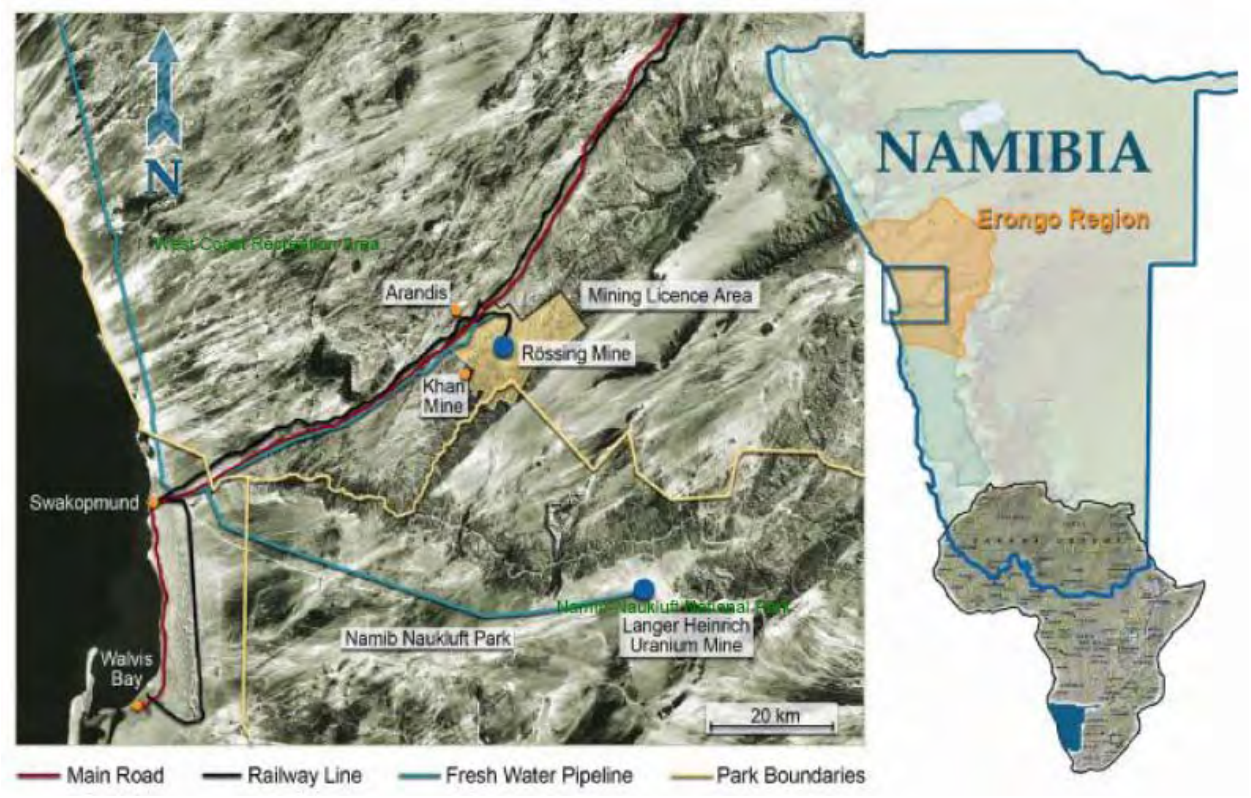

Figure 1: Location of the Rössing Uranium mine in the central Namib Desert, Erongo Region, Namibia. (Rössing Uranium Limited, August 2007).

Rössing is considering expansion of its operations that entail opening new pits with concomitant new disposal areas for waste rock, new or expanded processing plants, additional tailings dam capacity, and an increase in staff numbers and facilities. This will take place in a phased approach. Only three specific components, comprising Phase I, are being considered in the present EIA. These are:

- a sulphuric acid plant and associated storage and transport,
- a radiometric ore sorter plant and disposal of waste rock in the Dome are
- mining of an ore body known as SK4.

The acid plant and ore sorter will be situated on ground that is extensively disturbed by existing mine activities. In this phase, only the expansion into the SK4 area and Dome,

and establishment of infrastructures to them, constitute activities that will newly impact on biodiversity in the Rössing area.

The scope of the current work considers biodiversity in the wider area, namely the Rössing Mining Licence Area and the surroundings (up to about 10 km away). In addition, we make recommendations with regard to the proposed expansion into SK4, where impacts on biodiversity will be felt soonest.

Figure 2: Satellite image of the Rössing Mining License Area and Accessory Works Area, highlighting the proposed new mining areas named SH (yellow) and SK (blue). SK4, the western-most tip of SK, is the area to be directly impacted in Phase 1. (Rössing Uranium Limited, November 2007)

1.2 Terms of Reference

The Terms of Reference for this work comprised description of a procedure, defined by Rössing, that was to be followed to implement the project. This was accepted by EEAN after review and some refinement in joint discussion with Rössing. The procedure was as follows:

Action 1: Inception meeting and site visit. The team considers that it will be valuable to meet the Rössing team that will be directing the project, and to have access to as much information as possible from Rössing at the very start. This information includes aspects such as long-term weather, hydrological and groundwater records, and any previous work

of relevance such as the State Museum and other biodiversity projects. An inception meeting will facilitate exchange of information between the client and consulting teams, and will help to establish a common understanding of how this information will be used by the team.

Additionally, a preliminary visit to the project area and to the surroundings that will be included in the assessment, will be valuable. It will provide team members with a better idea of topography and habitats that will be encountered, and with at least some preliminary knowledge of the changes that would be expected, and where they would occur, from mine expansion.

This preliminary information-gathering exercise will also give a kick-start to the mapping work, as presumably some of the information is available in a GIS format that Rössing would want to build on.

Action 2: Status and distributional and ecological information pertaining to the known and expected animal species occurring in the area will be compiled into a format appropriate to the client's needs. Follow-up of the 1980s work has already been initiated by Dr John Irish and will be brought to a conclusion.

Action 3: Field surveys of the biological soil crusts and lichens, invertebrate pit-trapping and collecting surveys and small vertebrate censuses will be conducted to work over the area for information pertaining to the distribution and occurrence of the species listed in Action 2.

While on site, habitats encountered within the mining lease area and within a radius of about 10 km will be identified, mapped and described.

Action 4:
Species lists will be compiled, including distribution and habitat information for all known and expected species.

Species will be ranked according to the criteria of vulnerability and irreplaceability, to identify those that have high conservation priority.

Action 5: Information from Action 4 will be fed in to the growing database, thereby gradually building up a model of conservation priority of the different habitats, and the spatial occurrence of the various habitats known to host high-priority species. Once the high-priority habitats are recognisable in terms of topography, vegetation and other features, it will be possible to check outlying areas for the occurrence of similar habitats.

Likewise, the botanical survey conducted by Antje Burke will be fed into the database.

Action 6: Compile multi-layered maps and reports that will be easily interpreted by decision-makers involved in planning the mine expansion, and make oral presentations to Rössing management on the conclusions and recommendations of the project.

Information collected in the entire exercise will serve as a useful baseline for future monitoring of occurrence and abundance of high-priority species.

1.3 Previous work

This report draws on biodiversity work done at Rössing over the last 23 years. Most important is the survey undertaken in 1984-1985 by State Museum staff, incorporating plants, terrestrial invertebrates and vertebrates and aquatic organisms, which is described fully in Irish 2007 (Appendix A). Different animal groups were surveyed with varying intensity and at six different sites in and around Rössing. For various reasons described in Appendix A, the work was not properly concluded. As far as is practically possible, this has now been done in the present study, although taxonomic work that progresses slowly but steadily will continue to add information to the current knowledge base in years to come.

A short spell of animal collecting was done for the current project, although it was recognized by both EEAN and Rössing management that the results from working in the hot dry season would not significantly add to the biodiversity information that existed already. A summary of the 2007 biodiveristy sampling is provided in Irish *et al*., 2007 (Appendix B). The main benefit of the work was to familiarize the team with the habitats in the Mining Licence Area and surrounds and to collectively consider the biodiversity impacts of mine expansion, with input from a range of specialists.

Rössing has, through the work of the botanist Dr Antje Burke, undertaken vegetation and biotope mapping in the area prior to this project (Burke, 2005), and as part of the current project (Burke, 2007). The results of this work are included in this report.

1.4 Project area

As described in Section 1.1, the focus of the current fieldwork was to assess biodiversity in the areas likely to be most impacted by the proposed mine expansion. We therefore selected three sampling sites within the Mining Licence Area which were directly in the areas of impact or close to them (in Phases 1 and 2) and had habitat that was typical of the areas to be directly impacted.

More broadly, the Terms of Reference required the assessment of animal biodiversity to cover the area of direct impacts as well as surrounding areas, within a radius of about 10 km. This would reveal whether species that were found in the Rössing area only also occurred in surrounding areas beyond the boundaries of Rössing's Mining Licence and Accessory Works areas. However, because it was impossible to assess distributions of all species, particularly invertebrates and those animals that are naturally rare, species occurrence had to be linked to habitats. The focus of the project therefore concentrated on habitats, largely determined by topography, occurring in and around the Rössing area. Visualisation of the project area is shown in Figure 3.

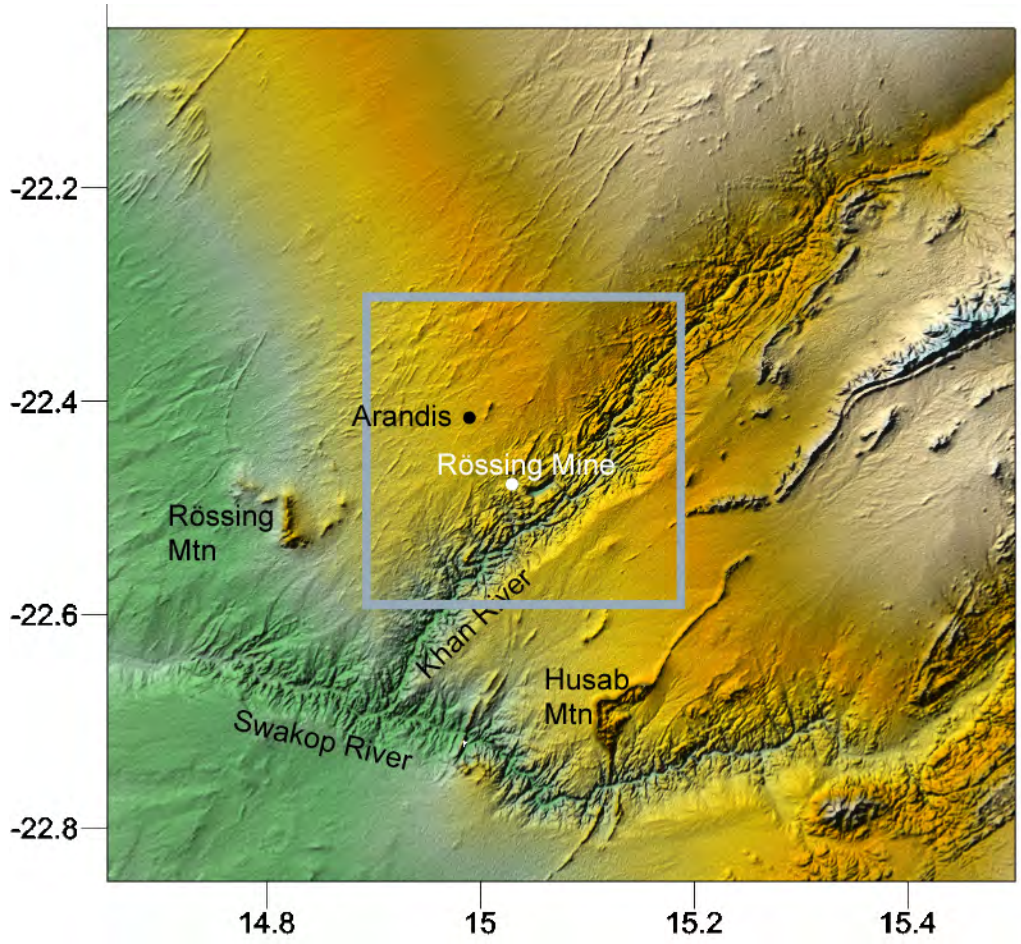

Figure 3: Rössing Uranium Mine in the context of the surrounding physical environment. The square delineates the project area. Shading from green to brown to grey indicates rising altitude.

2. Methods

2.1 Inception visit

The consulting team for the entire Social and Environmental Impact Assessment, led by Brett Lawson from Ninham Shand (Pty) Ltd., was introduced to the overall objectives of the project and the setting in which it would take place, during a two-day inception visit and mini-workshop. This took place on 17-18 September 2007, and involved only John Irish and John Pallett from EEAN. The proposed mine expansion process and desired goals were described by Rössing staff. A site visit was conducted, including a view over the SK4 area itself. All the consultants then described their individual components, information needs and expected deliverables. The schedule to have preliminary results available by early November, and final reports submitted by end November, was agreed.

2.2 Student assistance

It is DRFN and Gobabeb policy to involve students and young interns in practical work wherever possible. The Gobabeb In-Service Training programme was hosting five final-year students at the time of the project, and they were included in the implementation of the fieldwork. This was to bring more eyes and hands to the fieldwork so that it could be done more effectively in the very short time available, and to give them experience in this small component of an EIA. Three were Nature Conservation students and two were studying Land-Use Planning, all at the Polytechnic of Namibia. Mini-projects were designed for each person to undertake in the course of the ten days of fieldwork.

2.3 Area reconnaissance and study areas

Fieldwork took place from Monday 8 to Wednesday 17 October 2007, inclusive. After safety and administrative induction on the first day at Rössing, the 10-member team briefly visited the Dome study site, SK study site, and the following morning, SH study site (Figure 4, precise localities in Appendix B). This provided everyone with direct experience of what habitats they would encounter, and the opportunity to better plan their work and schedules. Three days of field collecting and habitat mapping was done at each of the SK and SH sites, while only two days were spent at Dome.

2.4 Follow-ups of State Museum work

The precise locations of four of the six invertebrate pit-trapping sites were GPS-referenced in the current fieldwork (Appendix A), since the 1980s survey predated the availability of GPSs. Two of the sites could not be confirmed this way: one is now part of the Rock Africa granite quarry adjacent to Rössing, while the other is covered by a Rössing rock dump.

Reports from the State Museum work proved difficult to track down, and not all were complete. Appendix A contains the most up-to-date information from that survey, which can now be considered finished. As taxonomists continue to work on various animal groups, such as solifuges and huntsman spiders, so it can be expected that new species will be named and described. It is impossible to force the pace at which this happens, or to predict the outcome of such ongoing studies.

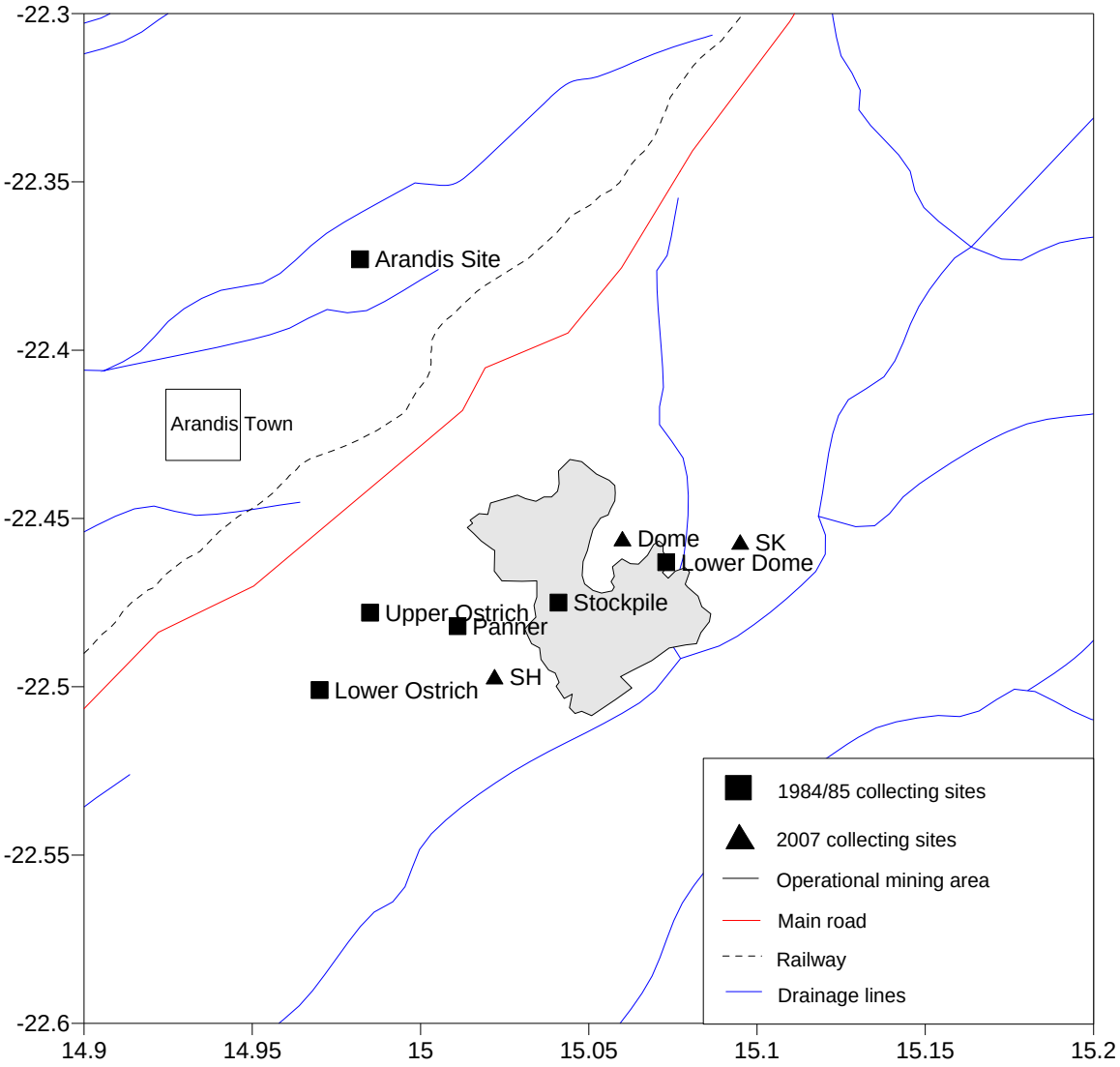

Figure 4: Location of animal biodiversity sampling sites during the 1984-1985 and 2007 fieldwork periods.

2.5 Taxa focused on

2.5.1 Biological soil crusts

Biological soil crusts (BSCs) are crucial features of desert ecosystems. Because their presence, importance and role is generally under-appreciated, or confined to lichens only, BSCs are given a short introduction here.

Biological soil crusts in the Namib comprise primarily lichens, microfungi, green algae and cyanobacteria (blue-green algae) in various proportions (Belnap & Lange 2001). Protozoans (single-celled animals), nematodes (roundworms and threadworms) and mites are often associated with them. BSCs are located on the surface to several millimeters into the ground or under translucent stones.

Figure 5: Close-up picture of a cross-section through brown biological soil crust on an open soil surface as seen on the Namib gravel plains north of Arandis.

In areas of the Namib where more conspicuous lichens do not dominate, a biological soil crust (BSC) can most easily be seen underneath stones and rocks that harbour *fensteralgen* (green diatoms) and blue-green algae (cyanobacteria, appear black in their dry state) (Rumrich *et al*. 1989, 1992; Büdel & Wessels 1991; Belnap & Lange 2001). These organisms find a home under translucent quartz and quartzite stones, and they can also grow as a near-surface ring around opaque or large stones (Warren-Rhodes *et al*. 2007). Stones trap moisture from fog or dew that condenses and runs down the sides to create a moist hypolithic (below-rock) environment, where photosynthesis is possible due to the sunlight that penetrates through them.

BSCs were assessed only in the 2007 fieldwork. We recorded the presence or absence of BSC under stones, and where present, we noted whether the colour was green or black (mixed colour was recorded as green), or whether the BSC comprised a layer of soil (brown BSC), often with fine filaments loosely binding soil and stones, possibly mycelia

of micro-fungi or filamentous cyanobacteria. These three "types" of BSC each comprise micro-communities, and our casual observations indicate that the complexity increases from brown to black to green (Rumrich *et al*. 1989, 1992; Büdel & Wessels 1991; Belnap & Lange 2001).

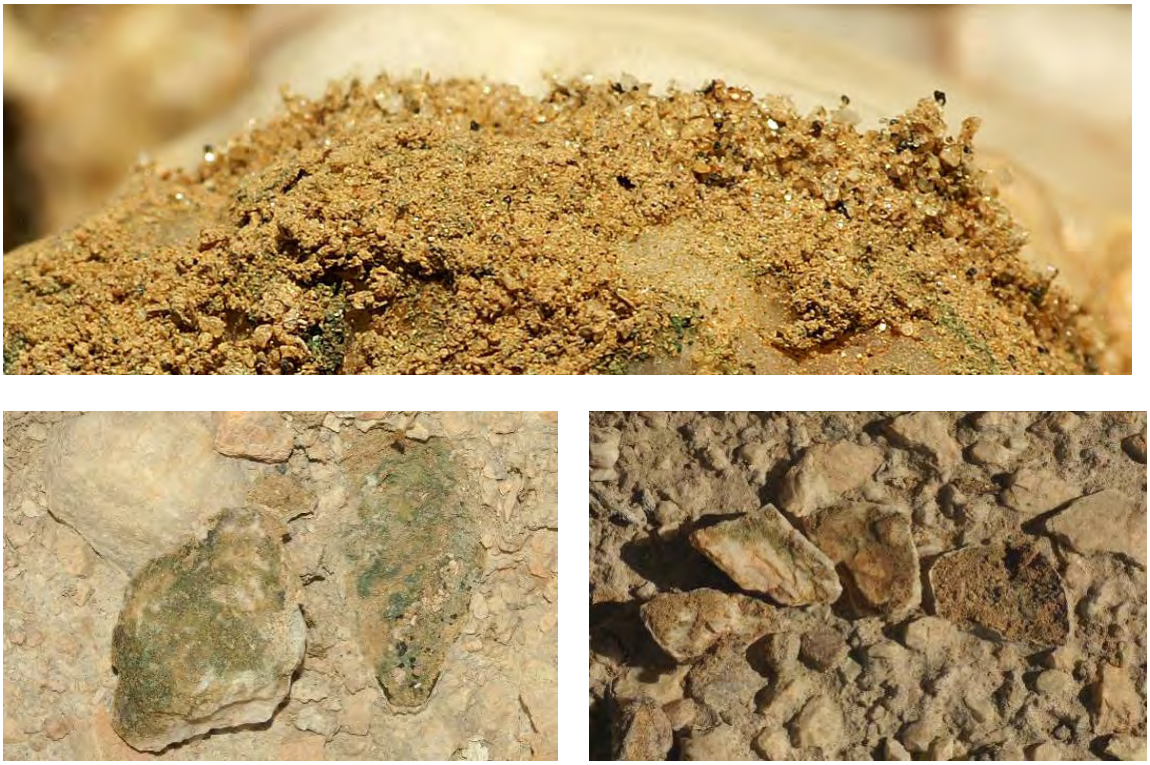

Figure 6: Top = brown BSC (with traces of green components); bottom left = green BSC; bottom right = black BSC.

BSCs are ecologically significant in stabilizing soil surfaces by protecting the soil from erosion, and in promoting water infiltration, seed germination and nitrogen and carbon fixation (Belnap & Lange 2001). They can act as biological indicators of environmental conditions. For example, lichens are sensitive to air pollution and can indicate the extent of terrestrial pollution (Hale, 1969). BSCs tend to be poorly established in areas with higher frequency of disturbance, i.e. an abundance of BSC indicates reduced disturbance (Eldridge & Greene, 1994).

2.5.2 Plants

A plant species inventory was compiled in the 1980s work. Subsequent botanical work by Burke (2005 and 2007) has concentrated on defining and describing biotopes in the Rössing area.

2.5.3 Arachnids and other non-insect invertebrates

Spiders, scorpions and sun-spiders (solifugids) were collected and recorded in both biodiversity surveys. Ticks and mites (Acari) and false scorpions (Pseudoscorpiones) were collected opportunistically, but were not focused on. Surveying the tiny

pseudoscorpions and mites would have required a very careful search of rock samples and could not be combined with the more extensive, rapid survey method applied in 2007, or the pit-trapping surveys in 1984. Furthermore, pseudoscorpions are not expected to be diverse and, because they are comparatively understudied, to identify them beyond order would require drawn-out involvement of international experts of these groups.

Centipedes and millipedes were collected in the various pitfall traps set out for other terrestrial taxa in the 1984-1985 survey. None were recorded in the 2007 fieldwork.

The presence of terrestrial snails was recorded in the 2007 fieldwork, in the process of searching underneath stones while assessing arachnids and soil crusts.

2.5.4 Insects

Insects were collected in a structured pitfall-trap sampling programme in 1984-1985 and again in the brief 2007 sampling period.

2.5.5 Amphibians and reptiles

Frogs were recorded in the Rössing area from observations and calls after rain in the 1984-1985 fieldwork, and from records of a MET biologist (Griffin 2007, pers. comm.). Lizards and snakes were sampled in pitfall traps in the 1984-1985 and 2007 fieldwork periods, and records were supplemented with information from Griffin.

2.5.6 Birds

Bird fauna was assessed by two ornithologists in the 1984-1985 work, confirmed in the 2007 fieldwork, and expanded through consultation of the Southern African Bird Atlas records (Harrison *et al.* 1997). In addition, a Birdlife International ornithologist did brief bird surveys in the Rössing area in 2005, 2006 and 2007 (Stacey 2007), and there has been recent follow-up on one enigmatic species by a Swakopmund-based ornithologist (Boorman pers. comm. 2007).

2.5.7 Mammals

A small mammal trapping survey in 1984-1985 sampled rodents, sengis (elephant-shrews) and shrews. Fieldwork in 2007 and input from the MET biologist (Griffin 2007, pers. comm.) broadened the mammal inventory to include larger terrestrial mammals such as antelope and baboons, as well as bats.

2.5.8 Aquatic organisms

Organisms expected from permanent or ephemeral waterbodies include snails, freshwater crustaceans such as seed shrimps and mussel shrimps, water mites and freshwater insects such as water beetles. Seven water bodies known to exist in the Rössing area were repeatedly sampled, and other *ad hoc* waterpoints as they were encountered, in the 1984-1985 survey. Unfortunately very few specimens from this work were accessible and the written records were largely unintelligible.

3. Results

3.1 Habitat categorisation

3.1.1 Aligning biotopes with broader habitat categories

The Terms of Reference specify that species in the area should be assigned to preferred habitats or biotopes. As a first step, a biotope classification for the Rössing area by Burke (2005 and 2007) was available.

Burke identified and mapped 19 plant-based biotopes:

1. *Aloe asperifolia* plains
2. *Arthraerua luebnitziae* plains
3. Central hills
4. Eastern hills
5. *Euphorbia virosa* belt
6. Gorges
7. Khan River
8. Khan River mountains
9. Marble hill
10. Marble ridge
11. Northern dome
12. Plain drainage lines
13. South-western hills
14. Undulating granite hills
15. Western granite hills
16. *Zygophyllum stapfii* plains
17. Northern tributaries
18. Southern tributaries
19. South-eastern gneiss hills

The main sampling sites from both the 1984-1985 and 2007 biodiversity survey work can be mapped to Burke's biotopes as follows (Table 1).

Table 1: Categorisation of the 1984-1985 and 2007 fieldwork sites according to Burke's biotopes.

Sample group	Sample Site	Burke (2007) biotope
1984/85	Arandis Site	Extralimital
1984/85	Upper Ostrich Site	*Zygophyllum stapfii* plains
1984/85	Panner Site	Gorges
1984/85	Lower Ostrich Site	Extralimital
1984/85	Stockpile Site	Central hills
1984/85	Lower Dome Site	*Euphorbia virosa* belt
2007	SK Sampling Area	Eastern hills
2007	SH Sampling Area	Central hills
2007	Dome Sampling Area	*Euphorbia virosa* belt

However, we encountered difficulties in relating animal biodiversity to these plant-centric biotopes. Despite harbouring recognisably different plant communities, many of Burke's biotopes are virtually indistinguishable when factors of relevance to animal life are considered.

As an alternative, we undertook an independent habitat categorization, employing different methods (Appendix D). We ended up with a coarser categorization, distinguishing just three habitat types in the Rössing area: rocky hillsides, open plains and watercourses (Figure 7). Each of these has its own distinctive food, shelter and refuge characteristics, and each harbors a definably distinct faunal component, therefore we used only these three main habitat types in further analysis.

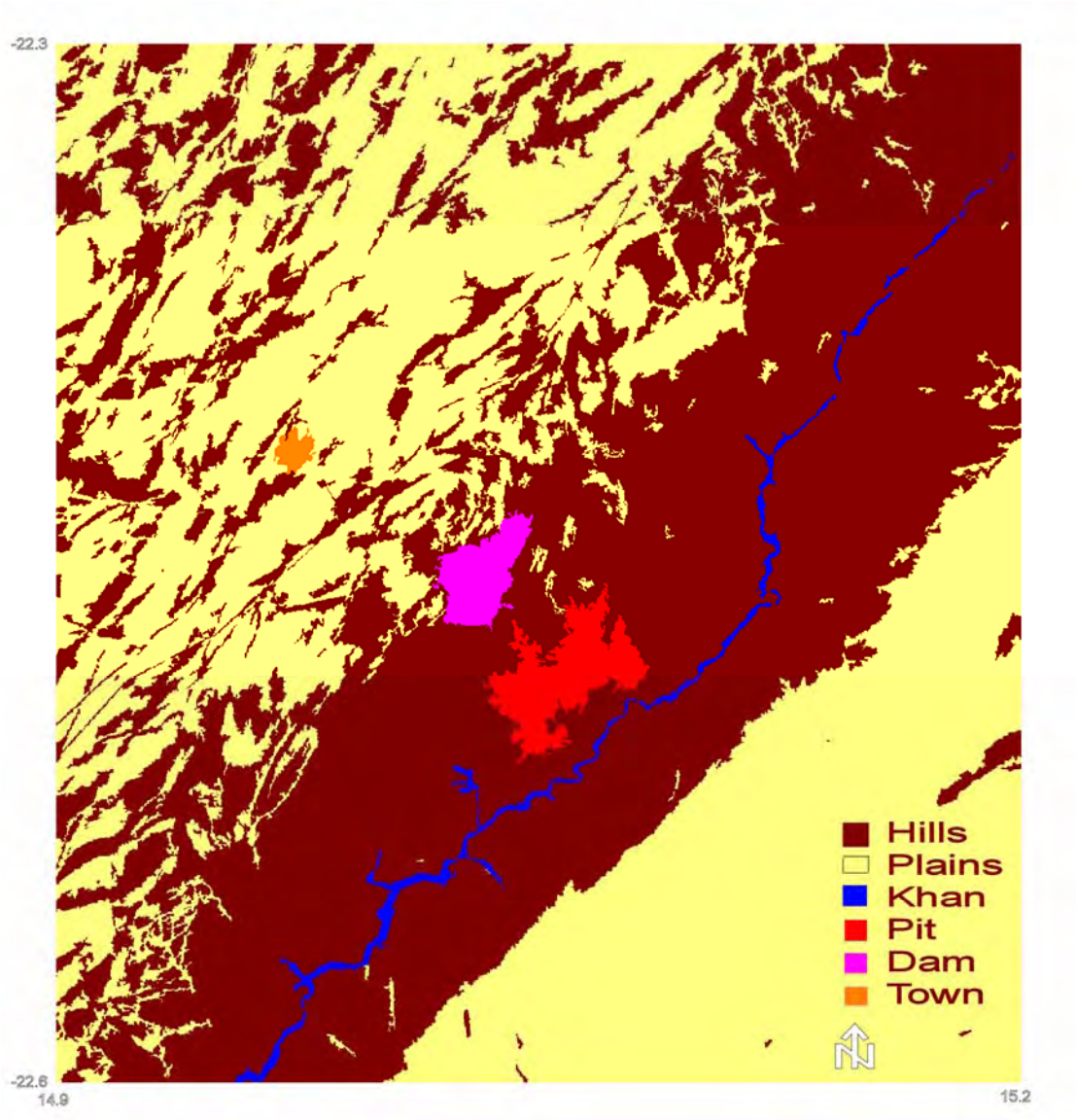

Figure 7. Habitat map of Rössing and surroundings, as used here.

Referring our habitats back to Burke's biotopes, it becomes clear that the two approaches simply categorise the environment at different scales, and the high degree of mutual correspondence increases the confidence in both (Table 2 and Figure 8).

The only significant points of difference between the two schemes are:

- Our habitat classification shows that the plains are not homogenous, but include numerous, low rocky ridges. Experience bears this out.
- Our classification does not distinguish minor watercourses from the habitat they flow through.

These differences do not impact on the conclusions drawn from habitat preferences later.

Table 2. Alignment of Burke's (2007) biotopes with the habitat types used in this assessment.

Burke (2005 and 2007) biotopes	Current habitat types
Aloe asperifolia plains	Plains
Arthraerua luebnitziae plains	
Zygophyllum stapfii plains	
Central hills	Hills and mountains
Eastern hills	
Euphorbia virosa belt	
Khan River mountains	
Marble hill	
Marble ridge	
Northern dome	
South-western hills	
Western granite hills	
South-eastern gneiss hills	
Gorges	Watercourses
Khan River	
Northern tributaries	
Southern tributaries	
Plain drainage lines	Plains + Watercourses
Undulating granite hills	Plains + Hills

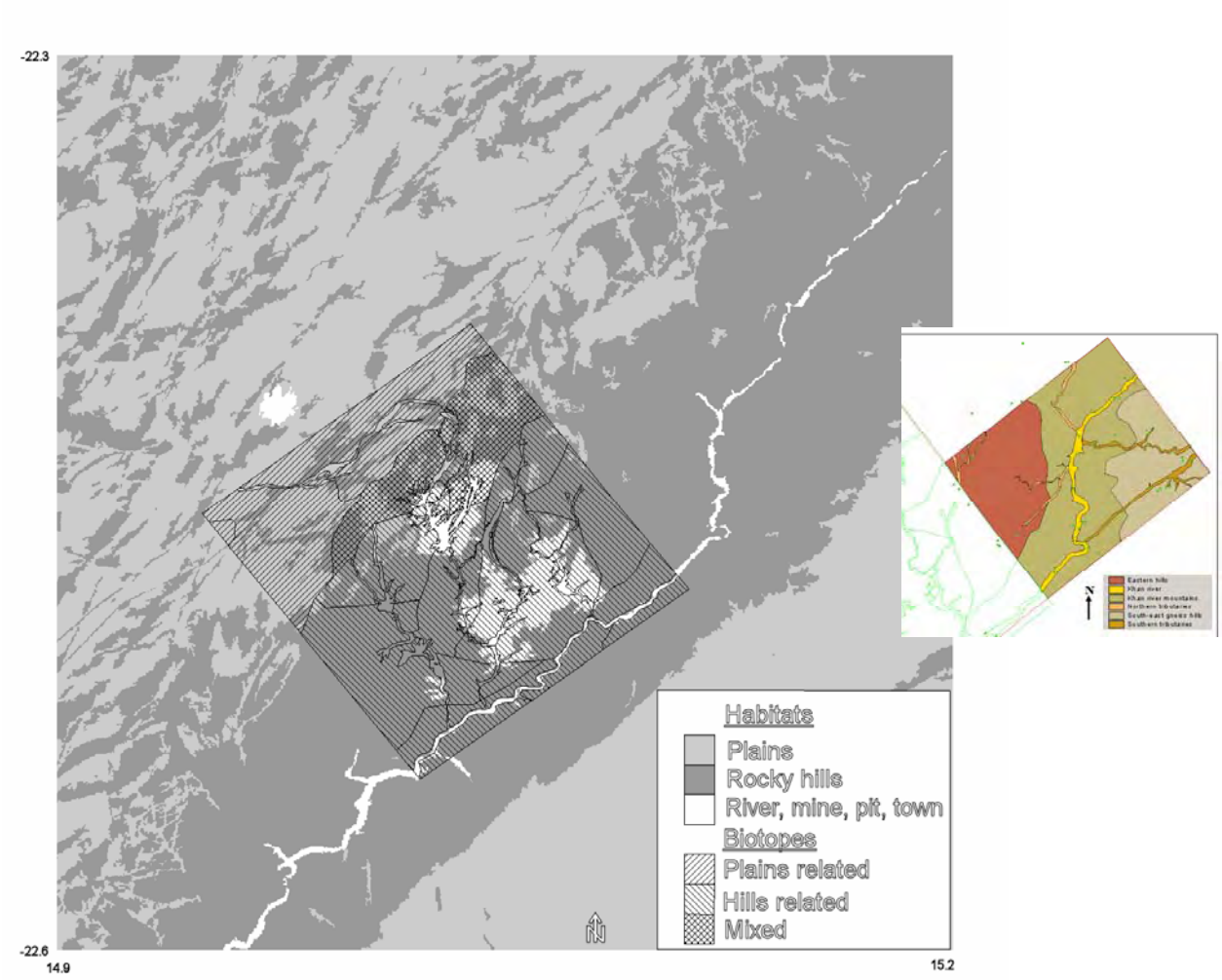

Figure 8. Comparison of habitat types used here with biotopes of Burke (2005, in main map) and Burke (2007, in inset). The inset map lies directly east and adjacent to the shaded biotopes square.

The 1984-1985 and 2007 sampling sites resolve to the following main habitat types (Table 3).

Table 3: Categorisation of the 1984-1985 and 2007 fieldwork sites according to our habitat types.

Group	Sampling site	Habitat type	Notes
1984/85	Arandis Site	Plains	
1984/85	Upper Ostrich Site	Plains	
1984/85	Panner Site	Watercourse	Surrounded by hills
1984/85	Lower Ostrich Site	Watercourse	Surrounded by undulating plains, hills nearby
1984/85	Stockpile Site	Hills	
1984/85	Lower Dome Site	Hills	
2007	SK area	Hills	
2007	SH area	Hills	Adjacent to watercourse
2007	Dome area	Hills	Adjacent to watercourse

3.1.2 Categorising the habitat preference for all species

In order to determine the habitat preference of a species, the locations from where the species was recorded were considered. Each location could be assigned to a habitat, and if a species was only or most commonly found at locations that had the same main habitat, that was considered to be its habitat preference. If known from more than one different habitat type, the proportion of individuals recorded from each habitat was considered, and the significantly higher proportion was selected as the habitat preference. In ambiguous cases, practical knowledge of habitat preference as determined during fieldwork was sometimes used to select one or the other type. Still, some taxa do occur in more than one habitat type, and some are widespread over the entire area, and they were listed as such.

The resultant habitat preferences for all species are listed in the species table in Appendix C.

3.2 Biodiversity inventory

Lists of species identified from the Rössing area, and their habitat affiliations, are provided in Appendix C. Sources of information for these lists are:

- Unpublished information from the 1980's Rössing environmental survey on file at the National Museum of Namibia, on file at Rössing Uranium Limited, or received from individual scientists that were involved at the time.
- At least 45 scientific papers that have since reported on material collected during the survey.
- Relevant excerpts from the National Museum collection catalogues.
- Database query on the National Herbarium holdings.
- Query on the Namibia Biodiversity Database.
- Results of 2007 animal fieldwork and 2004-2007 plant fieldwork
- Consultation with Mike Griffin, MET expert on small mammals and reptiles.

3.2.1 Biological soil crusts

Biological soil crusts (BSCs) observed in the three study areas was exclusively hypolithic (below stones), mostly associated with quartz or quartzite stones. BSC was in general most abundant on the scree and bedrock areas (rocky hillsides) and was reduced in the watercourses. The overall occurrence of BSC was relatively infrequent compared to other undisturbed areas in the mid-zone of the Namib (e.g. north of Arandis and Aussinanis area near Gobabeb). The occurrence of BSC at the current Rössing sites was comparable to the frequency seen on gravel road banks. At Aussinanis (near Gobabeb), BSC increased with distance from a rarely-used gravel road (Aiyambo 2007), possibly correlating with a decrease in dust with distance.

The occurrence of lichen was negligible, and with our method of observation we also did not detect any epilithic BSC (on top of soil and stones) except for occasional perilithic BSC that extended for a short distance laterally from stones. Overall, the environment below stones appeared to be the only viable place for BSC to occur. BSC is therefore considered to be present in a somewhat reduced form compared to its occurrence in other nearby Namib habitats. A reduction in BSC could reduce the productivity of these desert habitats, as BSC is known to be very active in fixing and remobilising carbon and nitrogen in desert soils (Belnap 2001; Evans & Lange 2001).

Fine layers of dust caked many of the rocks and stones and sealed some of their lower extremities at the base. This would probably reduce the natural flow of condensed moisture to the hypolithic environment, resulting in drier microclimates. If this is the case, it could explain a reduction in the occurrence of hypolithic BSC. The extremely fine nature of the caked dust particles could possibly also affect the epilithic condition and explain the absence of epilithic BSC (the only lichen found occurred underneath rock overhangs without dust caking). This suggestion is offered as explanation for the reduced occurrence of BSC based on casual observations.

3.2.2 Plants

214 species of plants are identified from the Rössing area. Most have not been evaluated for IUCN status and are only categorized according to the three main habitat categories described above. Their levels of endemism are tentatively recorded in Appendix C.

3.2.3 Arachnids and other non-insect invertebrates

3.2.3.1 Arachnids

Mites and ticks (Acari)
Tentatively, four species of mites occur at Rössing, but they have been identified only to relatively high levels. Water mites, without further identification, were recorded in

ponds. Ticks, found in pitfall traps after falling from rodents inadvertently collected in the traps, have not been identified.

Spiders (Araneae)
Seventy-nine species of spiders are recorded from Rössing.

The general impression gained from the frequency of encountering spiders and observing their signs during the 2007 survey, compared to our work at other similar sites, is that overall there appear to be fewer individuals and fewer different taxa here than other comparable areas in the central Namib. This may indicate that the sites could already be somewhat depauperate. This impression is, however, qualified due to the very limited scope of the 2007 survey. Nevertheless, the array of different taxa at each location does indicate that SK and SH still have relatively good representation of this group of predators.

By comparison, the Dome area has severely reduced spider diversity and abundance. Near our Dome site, but in a different habitat, is the type locality (and only known occurrence, in 1984) of the trap-door spider *Moggridgea eremicola* (Migidae, Griswold 1987). This species is listed as Critically Endangered, and it is not known whether it still persists in this area. The general reduction of all arachnids at this site raises concern.

There is potential conservation concern of several of the observed spiders (e.g. one of the huntsmen and termite-eating spiders). Given that several other species with even higher conservation status were not recorded during the short 2007 survey, and the apparent suitability of the site for these species, it is highly recommended that further studies be conducted to confirm the status of spiders in the area.

Scorpions (Scorpionida)
Fourteen species of scorpions are recorded from Rössing. Given the limited amount of effort that has been devoted to assessing scorpions, it is not possible to make conclusions on their status.

Sun-spiders or camel-spiders (Solifugae)
Twenty-two species of solifuges are recorded from Rössing.

Solifuges are known to be diverse and fairly common in the central Namib, a world hotspot of solifuge diversity (Lawrence 1963; Wharton 1981; Griffin 1990, 1998). However, the 2007 survey revealed only one individual in the nine days of fieldwork. According to our previous experience in other nearby areas, this absence of solifuges is exceptional. This could be a seasonal effect, but solifuges were not even found below many hundreds of rocks that were examined. Further work will be required to establish the status of these predators at Rössing.

3.2.3.2 Snails (Molluscs)
Aquatic snails are only mentioned in the limnological notes, without any identifications.

During the 2007 work on soil crusts we incidentally found three shells of snails (no live animals) of different species under rocks at SK and Dome. None have been identified. Their presence indicates that these environments supported mollusks and perhaps still do, but this needs to be established with further studies. Snails are known to occur under stones in rocky habitats of the Central Namib in association with biological soil crusts (Seely 1987; Hodgson et al. 1994). The potential significance of these findings is that it indicates that populations of highly moisture-dependent organisms have the ability to survive at Rössing.

3.2.3.3 Centipedes and millipedes (Myriapods)

Three species of centipedes and one millipede represent this group at Rössing.

3.2.3.4 Crustaceans

Seed shrimps and mussel shrimps, without identifications, are recorded from Rössing waterbodies.

3.2.4 Insects

Two hundred and seventy-one species of insects are recorded from Rössing. These cover ground-living species and some winged species that were accidentally collected in pitfall traps. Certain winged groups such as moths and butterflies (Lepidoptera) and lacewings (Neuroptera) remain largely unknown for this area on account of this sampling bias, but handcollecting and the specialized treatment that specimens need, were not possible in either of the surveys.

3.2.5 Amphibians and reptiles

Three species of frogs are known to occur or are expected from the Rössing area.

Reptile diversity is high in the Namib Desert and the central Namib in particular has a surprisingly high diversity of lizards, especially geckos. The State Museum work, together with more recent literature (Griffin 2002 and Griffin 2007, pers. comm.), lists a total of 33 lizard species recorded or having a high probability of occurrence in the Rössing area. This comprises 15 Geckos, 2 Agamas, the Namaqua Chameleon, 7 Skinks, 7 Sand Lizards and one Plated Lizard. Of these 33 species, 8 are endemic to the Namib and one, the Husab Sand Lizard, has a distribution range that is restricted to the mountainous Rössing-Husab area.

During the initial phases of this assessment, concern was expressed about *Pedioplanis husabensis*, the Husab Sand Lizard, a range-restricted endemic from the Rössing area. Further investigation has shown that the species has an extent of occurrence of ca. 7800 km² (Griffin 2007, pers. comm.) and has been recorded from at least 47 locations in this

small area (Berger-Dell'Mour & Mayer, 1989), which by itself should evaluate to a non-Threatened status. However, the official status is 'Data Deficient' (Griffin 2007, pers. comm.). The reason for this is that the potential effect of uranium mining on the species is not yet known. The currently operational Rössing and Langer Heinrich Mines, as well as the proposed Valencia, Husab and Goanikontes Mines, in combination affect the entire distribution range of the species. This is a case that strongly argues for the central Namib uranium mining industry players to confront environmental issues collectively rather than individually: while mining at any particular site (e.g. SK4) may not have a particularly severe effect on overall *Pedioplanis husabensis* populations, the same cannot be said for the combined effect of mining at an increasing number of adjacent sites.

A further species of *Meroles* is newly described from work done outside of this study, and is categorized as Not Evaluated. On the basis of the precautionary principle it is classified as Threatened – Data Deficient.

With the exception of the latter species and the Husab Sand Lizard, all the above lizard species are categorized as Least Concern (Griffin 2007, pers. comm.). Apart from lizards, one other reptile is red-listed, namely Leopard Tortoise (Vulnerable). Occurrence of Leopard Tortoise in the Rössing area is possible but very unlikely, as this species generally prefers moister habitats. It might very rarely be found in the Khan River.

3.2.6 Birds

The Rössing bird list records high diversity for an area this barren, largely due to the influence of the Khan and its tributaries as linear oases (Stacey 2007). There are no birds found in the area which are restricted to the area or threatened by the mine expansion. Two raptor species – Martial Eagle and Lesser Kestrel - carry IUCN Threatened status and another – Verreaux's Eagle – is Near-Threatened, but their populations are scattered over southern Africa, and the mine expansion will not significantly increase the factors causing their decline.

One species, Karoo Eremomela, has some taxonomic uncertainty as the central Namib population may be sufficiently genetically distinct to warrant sub-species or full species status. This is now being investigated with the assistance of local birder Mark Boorman and ornithology experts based in South Africa. Initial indications are that, even if the population is genetically distinct, it is distributed over an area exceeding 20,000 km^2, in which its preferred habitat of thinly vegetated watercourses is abundant.

3.2.7 Mammals

The mammals list shows medium diversity – 43 species – which is typical for the central Namib. While larger mammals such as kudu and baboon are conspicuous and quickly recognized by lay people, the mammal list includes 6 hoofed mammals, 9 carnivores, 11 bat species and 16 small terrestrial mammals including rodents and one each of shrew,

sengi (elephant shrew), hare, dassie and hedgehog. Many of these, particularly the carnivores, are naturally uncommon to rare, while a few others, such as hedgehog and fruitbats, are likely to occur only very rarely as vagrants linked to the Khan River linear oasis.

Eight of the mammal species are classified as Near-Threatened, one as Vulnerable and one as Endangered. The latter, Namibian Mountain Zebra, is confined to the Namib Desert. African Wild Cat, the Vulnerable species, is threatened most by hybridization with domestic cats. The latter are likely to occur in and around the Rössing buildings, but the existence or threat posed by feral cats at Rössing has not been assessed. The threat is probably low.

3.3 Vulnerability and endemicity of taxa

3.3.1 Categorisation of taxa using IUCN guidelines

The Terms of Reference require that all species occurring in the Rössing area be ranked for vulnerability by IUCN category. The IUCN (International Union for the Conservation of Nature) maintains global Red List data. It defines Red List categories, as well as the evaluation criteria to be followed before red listing a species (IUCN 2000, 2005).

Formal IUCN categorisation is not available for most Namibian animals. Only mammals (Griffin & Coetzee 2006) and some endemic plants (not all plants, or even all endemic plants) (Loots 2005) have been formally evaluated using the latest IUCN criteria and published. Reptile categorization has been done but is not published (Griffin 2007, pers. comm.). No evaluations are available for Namibian invertebrates, or, strangely enough, birds (excepting those few species occurring in Namibia that have been evaluated on a global level).

Categorisation of the invertebrates in particular, but of all taxa, is hampered by the low level of collecting and biodiversity sampling that has been done in the study area and surrounds. As a worst-case example, some taxa are known only from one specimen that was trapped during the 1980s work. With such specimens, on the basis of the precautionary principle, their conservation status must be judged as Critically Endangered, and distribution as being limited to the Rössing area only. Taxa known from three or more specimens at least can render a polygon area of occurrence using the sites where they were sampled. These examples provide a hint of the difficulties encountered in the assessment.

Since the bulk of biodiversity at Rössing is concentrated in the invertebrates, IUCN categorisation criteria had to be newly applied to arrive at vulnerability categories for those taxa not yet formally evaluated. A full explanation of the calculation of vulnerability and endemicity using limited data is provided in Appendix E.

Table 4 shows those animal taxa categorized as Threatened (Critically Endangered, Endangered and Vulnerable), derived from the 1980s State Museum survey and the 2007 fieldwork. Information is drawn from data presented in Appendix C. No plants are sufficiently threatened to be included in the table (Loots 2005). Only one plant species – *Adenia pechuelii* – is classified as Near-Threatened, but it has a wide range in the Namib Desert and escarpment (Curtis & Mannheimer 2005).

Table 4: Threatened taxa occurring in the Rössing area.

IUCN statuses: CR = Critically Endangered;
EN = Endangered;
VU = Vulnerable.
EOO = extent of occurrence
NOL = number of locations where collected
Habitats: RH = Rocky hillsides;
OP = open plains;
WC = watercourses
Endemism: RA = Rössing area only;
CN = Central Namib Desert (ca. Kuiseb - Ugab);
CW = Central Western Namibia;
ND = Namib Desert (Orange - Kunene);
NA = Namibia;
empty cell = Widespread (not endemic to Namibia)

Common name	Genus, species	IUCN stat.	EOO (km²)	NOL	Habitat			Ende-mism
Tingle trapdoor spider	*Moggridgea eremicola*	CR	-	1	RH			RA
Velvet spider	*Seothyra anettae*	CR	-	1		OP		RA
Ant spider	*Cyrioctea namibiensis*	CR	-	1		OP		RA
Bee fly	*Pteraulacodes hessei*	CR	-	1		OP		RA
Sun spider	*Daesiella pluridens*	CR	-	1		OP		RA
Ant spider	*Caesetius sp. nov.*	CR	-	1			WC	RA
Flower beetle	*Hedybius irishi*	CR	-	1			WC	RA
Bee fly	*Heterotropus apertus*	CR	-	2		OP		RA
Prodidomid spider	*Namundra griffinae*	EN	-	2	RH			RA
Sun spider	*Blossia sp. Nov. A*	EN	-	2	RH			RA
Sand wasp	*Namiscophus pilosus*	EN	-	2		OP		CN
Sun spider	*Blossia sp. Nov. B*	EN	-	2			WC	RA
Flower beetle	*Metaphilehedonus swakopmundensis*	EN	5	3	RH		WC	RA
Ant spider	*Heradida griffinae*	EN	11	3	RH	OP	WC	RA
Silverfish	*Ctenolepisma sp. nov. nr. Pauliani*	EN	11	3		OP	WC	RA
Sun spider	*Lawrencega sp. nov.*	EN	12	5	RH			RA
Jewel beetle	*Nothomorphoides irishi*	EN	13	3		OP		RA
Jumping plant louse	*Crastina swakopensis*	EN	27	3			WC	CN
Blister beetle	*Iselma deserticola*	EN	41	3	RH	OP		RA
Ant spider	*Diores Namibia*	EN	1084	3			WC	CW
Jumping plant louse	*Colposcenia australis*	EN	1336	4			WC	CN

Common name	Genus, species	IUCN stat.	EOO (km²)	NOL	Habitat			Ende-mism
Jumping plant louse	*Colposcenia namibiensis*	EN	1336	4			WC	CN
Bee fly	*Parisus damarensis*	EN	1366	4		OP		CW
Sun spider	*Blossia planicursor*	EN	1609	5		OP		CN
Sun spider	*Hexisopus moiseli*	EN	1689	3			WC	CW
Centipede	*Cormocephalus pontifex*	EN	2127	3	RH	OP		CN
Toktokkie	*Horatoma deserticola*	EN	2347	3		OP		CN
Toktokkie	*Zophosis (Carpiella) latisterna*	EN	2776	5		OP		CN
Sun spider	*Lawrencega longitarsis*	EN	3895	5		OP		CN
Martial Eagle	*Polemaetus bellicosus*	EN						
Namibian Mountain Zebra	*Equus zebra*	EN			RH	OP		ND
Silverfish	*Ctenolepisma occidentalis*	VU	151	6		OP	WC	RA
Toktokkie	*Zophosis (Gyrosis) ornatipennis*	VU	357	9		OP	WC	CN
Sun spider	*Trichotoma michaelseni*	VU	790	6		OP		ND
Scorpion	*Uroplectes pilosus*	VU	1003	6	RH	OP	WC	CN
Sun spider	*Lawrencega solaris*	VU	2824	6		OP		CN
Sun spider	*Lawrencega minuta*	VU	4754	6		OP		CN
Toktokkie	*Pachynoteles punctipennis*	VU	6228	6		OP	WC	CW
Scorpion	*Parabuthus namibensis*	VU	7653	7		OP	WC	CN
Sun spider	*Blossia rooica*	VU	7998	5	RH	OP	WC	CW
Scorpion	*Opisthophthalmus coetzeei*	VU	8581	9	RH	OP		CW
Jewel beetle	*Acmaeodera liessnerae*	VU	9411	5		OP	WC	CW
Sand wasp	*Miscophus sabulosus*	VU	13281	5				CN
Snout beetle	*Hyomora porcella*	VU	18592	8		OP		CN
Leopard Tortoise	*Geochelone pardalis*	VU					WC	
Lesser Kestrel	*Falco naumanni*	VU						
African Wild Cat	*Felis lybica*	VU					WC	

3.3.2 Priority classification

The two criteria of endemicity (equated to irreplaceability in the Terms of Reference) and conservation status (equated to threat) can be combined to give an overall priority classication, from critical to minor, for all taxa. This is shown in Table 5, for only the taxa listed in Table 4. All other taxa are classified by this process as minor priority.

Table 5. Numbers of threatened taxa and their levels of endemicity. CR = Critically Endangered; EN = Endangered; VU = Vulnerable.

Vulnerability	CR	EN	VU	Total
Endemicity				
Endemic to Rössing area	Critical 8	Critical 9	Critical 1	18
Endemic to Central Namib	Critical 0	Essential 9	Major 7	16
Endemic to Central Western Namibia	Essential 0	Major 3	Medium 4	7
Endemic to Namib Desert within Namibia	Major 0	Medium 1	Significant 1	2
Endemic to geopolitical Namibia	Medium 0	Significant 0	Minor 0	0
Widespread	0	1	3	4
Total	8	23	16	47

Species in the upper left hand side of the matrix – those scoring critical, essential, major and medium priority – consitute our working list of key species of conservation concern. Those taxa in the lower right hand side of the matrix, scoring significant and minor priority – there is only one species, *Trichotoma michaelseni* – are not regarded as taxa of conservation concern.

By this scoring process, the Husab Sand Lizard and the new species of *Meroles* sand lizard do not evaluate to being priority species. However, intuition and the precautionary principle dictate that these should be included. They are listed below as high undefined priority species (Table 6), together with all the taxa of key conservation concern.

Table 6: Names and preferred habitats of high priority taxa. RH = rocky hillsides, OP = open plains, WC = watercourses.

Priority level	**Taxa**	**Habitat**		
Critical priority	*Moggridgea eremicola*	RH		
	Seothyra anettae		OP	
	Cyrioctea namibiensis		OP	
	Pteraulacodes hessei		OP	
	Daesiella pluridens		OP	
	Caesetius sp. nov.			WC
	Hedybius irishi			WC
	Heterotropus apertus		OP	
	Namundra griffinae	RH		
	Blossia sp. nov. A	RH		
	Blossia sp. nov. B			WC
	Metaphilehedonus swakopmundensis	RH		WC
	Heradida griffinae	RH	OP	WC
	Ctenolepisma sp. nov. nr. Pauliani		OP	WC
	Lawrencega sp. nov.	RH		
	Nothomorphoides irishi		OP	
	Iselma deserticola	RH	OP	
	Ctenolepisma occidentalis		OP	WC
Essential priority	*Namiscophus pilosus*		OP	
	Crastina swakopensis			WC
	Colposcenia australis			WC
	Colposcenia namibiensis			WC
	Blossia planicursor		OP	
	Cormocephalus pontifex		OP	
	Horatoma deserticola		OP	
	Zophosis (Carpiella) latisterna		OP	
	Lawrencega longitarsis		OP	
Major priority	*Zophosis (Gyrosis) ornatipennis*		OP	WC
	Uroplectes pilosus	RH	OP	WC
	Lawrencega solaris		OP	
	Lawrencega minuta		OP	
	Parabuthus namibensis		OP	WC
	Miscophus sabulosus		OP	
	Hyomora porcella		OP	
	Diores Namibia			WC
	Parisus damarensis		OP	
	Hexisopus moiseli			WC
Medium priority	*Pachynoteles punctipennis*		OP	WC
	Blossia rooica	RH	OP	WC
	Opisthophthalmus coetzeei	RH	OP	
	Acmaeodera liessnerae		OP	WC
	Equus zebra	RH	OP	
High undetermined priority	*Pedioplanis husabensis*	RH		
	Meroles sp.nov.			

Our assessment of vulnerability and endemicity carries serious implications for the decisions that must be made regarding future mining expansion. The weight of these decisions prompted much discussion and self-evaluation of the methods. A case study of one of the Critical Priority species, the spider *Moggridgea eremicola*, elaborates the logical steps and background information that justify our categorization, and makes suggestions about the next steps that follow. It is presented in full in Appendix E.

3.3.3 Habitat preferences of high priority taxa

Table 7 shows the habitat preferences of the high priority taxa. Note that the totals are more than in Table 5 because some species occur in more than one habitat.

Table 7: Habitat preferences of high priority taxa at Rössing.

Habitat	Rocky hillsides	Open Plains	Water-courses
Priority level			
Critical	7	10	7
Essential	0	6	3
Major	1	8	5
Medium	3	5	3
High (undetermined)	1	0	0
Total:	12	30	18

While this information is based on very low sample numbers and therefore carries a low confidence level, it is all that is available.

The open plains are the habitat that supports half of the high priority taxa at Rössing. This habitat extends much further beyond the Rössing area, and is considered to be less likely to hold very range-restricted taxa. Species found in open plain habitat in the central Namib might be restricted by factors such as amount and frequency of fog and or rain, which would put broad east and west limits on their occurrence. North and south limits would be less restrictive. Burke (2005 and 2007) lists only three biotopes that accord to our plains habitat (Table 2), confirming the relative homogeneity of the plains. Where habitats are homogeneous and cover a large area, the likelihood of a species being confined to a small part of that area is very low.

Watercourses support just over a quarter of the high priority taxa at Rössing. These ephemeral river beds act as linear oases, as they have more and bigger plants than the surrounding plains, and provide more plant food to organisms higher up the food chain. The fact that the watercourses are joined with each other and that vegetation in them is similar upstream and downstream indicates that this habitat is also relatively widespread

and homogeneous. By the same argument used for open plains, we consider the likelihood of a species being confined to a small segment of a watercourse very low.

Rocky hillsides and steep terrain make a habitat that is relatively confined in this part of the central Namib (Figure 9). The outline of this habitat in Figure 9 encloses an area of 850 km². A small terrestrial animal that lives in this area and requires a rocky habitat has only so much area to spread in to.

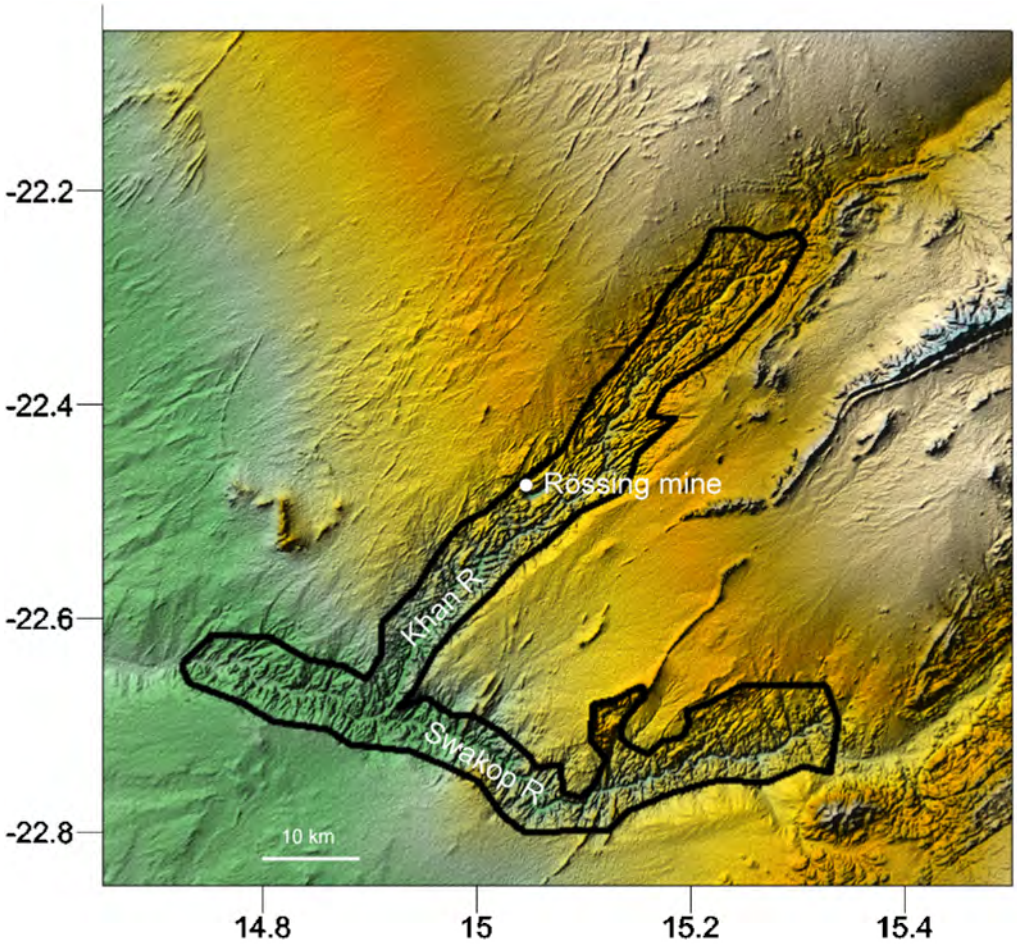

Figure 9: Satellite view of the Rössing mine area showing extent of the rocky hillside habitat associated with the dissected terrain of the Khan and Swakop Rivers.

Rocky habitats have much greater diversity of microhabitats than the plains, provided by slopes of different angles and attitudes, varying amounts of runoff from fog and rain, varying penetration of moisture, exposure to winds of different intensity and frequency, and more varied plant life. The greater number of biotopes listed by Burke (2005 and 2007) that occur on rocky and steep terrain (Table 2) reflects the diversity of habitats. Therefore distribution ranges of taxa preferring rocky habitat are more likely to be smaller and more restricted than distribution ranges of plains and watercourse species.

It must be remembered that ascribing a habitat preference to an animal on the basis of one or just a few specimens carries a very low confidence level. Recognising this, both the higher variety of microhabitats within rocky terrain and the restricted area in which these microhabitats are found, imply that the high priority taxa occurring in rocky terrain at Rössing are more likely to be range restricted. Therefore, to minimize serious negative impacts on biodiversity in the Rössing area, rocky hillsides are the habitat that should be the least disturbed.

3.3.4 Ranking of Burke's biotopes

Burke (2005 and 2007) follows a different method to arrive at a ranking of the identified biotopes that goes from critical to rare and then general. The ranking is based on the presence of selected indicator species that are red-listed (according to IUCN criteria, as shown in Appendix C) and that have designated levels of endemism. Based on the scores from the indicator plants, five biotopes emerge as critical (Table 8), four as rare and ten as general.

Table 8: Ranking of Burke's biotopes (2007) according to the scores of selected indicator plant species.

Biotope	**Assignation according to Burke**
Central hills	Critical
Eastern hills	Critical
Euphorbia virosa belt	Critical
Undulating granite hills	Critical
Western granite hills	Critical
Gorges	Rare
Khan River mountains	Rare
South-eastern gneiss hills	Rare
South-western hills	Rare
Khan River	General
Marble hill	General
Marble ridge	General
Northern dome	General
Plain drainage lines	General
Aloe asperifolia plains	General
Arthraerua luebnitziae plains	General
Zygophyllum stapfii plains	General
Northern tributaries	General
Southern tributaries	General

Significantly, all five of the critical biotopes are found in rocky habitat. This confirms our finding that rocky hillsides deserve the greatest protection from disturbance.

4. Summary and conclusions

4.1 Summary of habitat and biodiversity information

Biodiversity assessments made in 1984-1985 and in 2007, as well as other projects focusing on particular taxa, have produced a wealth of information on the plant and animal biodiversity occurring in the Rössing area. Rössing Uranium Limited deserves credit for initiating and supporting this important baseline environmental research.

This work stands out as a small focus of a lot of information in the wider area of the central Namib that is generally very poorly known in terms of biodiversity. Thus there are many species and unnamed or undescribed taxa that have been found in the Rössing surveys, and that are known only from those one or few localities. This apparent high level of endemism might be real or it might be from the sampling bias.

4.1.1 Habitats and biotopes

The habitats in the area are divided into
(i) rocky hillsides with loose surface rocks and no soil or soil that is very shallow soil, and relatively the least vegetation.
(ii) open plains with deeper soil and scattered bushes and shrubs. The plains are interrupted with rocky outcrops of varying sizes.
(iii) watercourses that are normally dry but that carry water for very short periods during the rainy season. The watercourses are marked by having more bushes and scattered trees along their length, and the substrate is usually sandy and uncompacted.

The biotopes identified and mapped by Burke (2007) form subsets of these broad habitat types. The animal biodiversity data does not carry detailed habitat descriptions for each of the specimens, thus our understanding of each species' preferred habitat is at the level of broad habitat types, not biotopes.

4.1.2 Biodiversity

The biodiversity inventory can be summarized as follows:

Biological soil crusts, comprising lichens, micro-fungi, algae and blue-green algae (cyanobacteria) are present in a somewhat reduced form compared to their occurrence in other nearby Namib habitats. Lichens are largely absent, while hypolithic organisms (the green or black coating found underneath translucent quartz stones) are more abundant but relatively reduced. This is tentatively explained as a result of fine layers of dust coating rocks and stones and reducing the natural flow of condensed moisture to the hypolithic environment, resulting in drier microclimates.

Two plant species growing in the Rössing area are of concern. The charismatic 'elephant's foot' *Adenia pechuelli*, occurs in relatively high concentrations on rocky hillsides here, whereas it is found more widely scattered and as isolated individuals elsewhere. It is classified as Near-Threatened and has a wide distribution in the Namib and escarpment. *Lithops ruschiorum* is listed as 'Least Concern' but it has a very restricted range and is sought after by collectors. Rössing possibly has the largest population of this plant ever recorded.

Spiders, scorpions and solifuges constitute a group of predators of smaller invertebrates that can give an indication of the state of populations of their prey. Recognising the shortcomings of the 2007 biodiversity fieldwork, preliminary indications are that the abundance and diversity of spiders is relatively lower than expected, and of solifuges is exceptionally low. The latter is particularly surprising given that the central Namib is known as a world hotspot of solifuge diversity. Seven taxa of the spiders, and 11 taxa of the solifuges, are classified as Threatened. It is not possible to draw conclusions on the status of scorpions, besides the fact that 14 species are known from the area, of which three are Threatened. Further work is required to establish whether arachnid populations are indeed diminished in and near the Rössing operations, and whether mining activities are responsible.

271 species of ground-living insects are recorded from Rössing, and this excludes flying groups such moths and lacewings. 20 species are Threatened.

Three species of frogs are known to occur or are expected from the Rössing area. None are Threatened.

Reptile diversity is high in the Namib Desert and the central Namib in particular has a surprisingly high diversity of lizards, especially geckos. 33 reptile species are known or expected to occur in the Rössing area. Of these, one (a tortoise) is classified as Threatened but it prefers moister habitat and its occurrence in the area is very marginal. The Husab Sand Lizard is classified as Data Deficient as its population in the relatively small area of occurrence – rocky terrain in the area of the lower Khan and Swakop Rivers – is not well known, yet faces fragmentation and disturbance from proposed mining operations. Another recently discovered species of Sand Lizard, also known only from the area immediately inland of Swakopmund, has not yet been evaluated for its conservation status, so by the precautionary principle is also classified as Threatened.

Birdlife in the Rössing area reaches relatively high diversity for an area this barren, largely due to the influence of the Khan and other smaller linear oases. While two species are classified as Threatened, there are no birds found in the area which are restricted to the area or threatened by the mine expansion.

Mammal diversity at Rössing is not very high, as is typical in the central Namib. The list includes two Threatened species. Mine expansion will probably incrementally increase the threats that face them, namely increased habitat fragmentation and expanded area of human influence and disturbance.

4.1.3 Taxa of high priority

Combining the criteria of IUCN status and the degree of endemism of taxa provides a way to score the priority that Rössing should accord to individual taxa. By this process, 44 taxa are scored as high priority – critical, essential, major, medium and undetermined. A breakdown of these taxa using common names of animal groups is shown in Table 9. No plants are sufficiently threatened or range-restricted to warrant inclusion in this list.

Table 9: Breakdown of the taxa of high priority in the Rössing area.

Priority level	**Number of taxa**	**Taxa**
Critical	18	Spiders – 6 Solifuges – 4 Beetles – 4 Silverfish – 2 Flies – 2
Essential	9	Solifuge – 2 Centipede – 1 Beetles – 2 Plant louses – 3 Wasp – 1
Major	10	Spider – 1 Solifuges – 3 Scorpions – 2 Beetles – 2 Wasp – 1 Fly – 1
Medium	5	Solifuge – 1 Scorpion – 1 Beetles – 2 Hoofed mammal – 1
Undetermined but high	2	Lizards – 2
Significant	1	Solifuge – 1
Minor	All other taxa	

4.1.4 Habitat preferences of taxa of high priority

Five of the 19 biotopes identified in the Rössing area are ranked as critical. All five are found in rocky habitats.

The open plains are the habitat that supports half of the high priority taxa at Rössing. Watercourses support just over a quarter of the high priority taxa, and rocky hillsides just less than a quarter.

Compared to rocky hillsides, open plains and watercourse habitats are more widespread and more homogeneous. This is not the case with rocky terrain, which occupies a relatively small area - 850 km² of continuous habitat in the lower Khan and Swakop River gorges and linked with Husab Mountain. From the perspective of biodiversity, rocky hillsides are the habitat that should be the least disturbed. Avoidable disturbance in any of the three habitats should be minimized, since they all support taxa of high priority.

4.2 Conclusions regarding Rössing mine expansion

4.2.1 Impacts of mine expansion

The only component of Phase 1 expansion that has biodiversity impacts is the creation of a new open pit at SK4 and rock dumps in the Dome area. The new acid plant and ore sorter will be situated on ground that is already intensely disturbed, so no further biodiversity impacts are expected there.

SK4, an area of 0.2 km², makes up a small proportion – 6.7% – of the whole SK. Since the habitat of SK4 is similar to the whole SK, direct biodiversity impacts in SK4 will be proportionally reduced in extent. The direct impact of eradication of animals is dealt with under Impact 1 below.

An indirect impact on biodiversity, namely the effect of dust on invertebrates and on productivity of plants, is dealt with under Impact 2.

4.2.1.1 Eradication and/or extinction of highly endemic animals

Impact 1 Eradication and/or extinction of animals occurring in SK and proposed rock dump sites in Dome area.
Significance This impact is highly significant as it carries the possibility of the project being fatally flawed by the fact that some species may become extinct from mine expansion.
Nature of the impact

Opening a new mining pit in SK, and covering a new area in Dome with rock debri, will decrease the known area of occurrence, the quality of rocky hillside habitat and the population size of many animal species. 44 known taxa are assigned as High Priority on the basis of their conservation status and area of occurrence. Very little is known about these taxa, but 18 of them are known from the Rössing area only. Of these, seven taxa are understood to live in rocky habitat.

Extent of the impact

Direct disturbance to the animals will occur in the mined area, the rock dumps and in the road and power servitude leading from existing facilities. In these areas, habitat will be completely destroyed. We believe that effects of blasting and noise decrease very rapidly away from the sites of direct disturbance. Dispersal of dust will be more widespread, but probably confined within a radius of 5 km from the mining activity.

This EIA is concerned only with the Rössing expansion, but cumulative impacts from similar developments must also be considered. Phase 1, involving SK4 only, directly affects an area of 0.2 km². Further expansion of Rössing in subsequent phases will directly impact an additional 6 km². Establishment of mines similar to Rössing at Valencia and Goanikontes within the next 5 – 10 years, will destroy greater areas and further fragment the rocky hillside habitat.

Duration of the impact

Permanent.

Intensity of the impact

The severity of the impact is difficult to assess. Seven species are listed in Table 4 as Threatened and occurring on rocky habitat in the Rössing area only. They are:

Tingle trapdoor spider *Moggridgea eremicola*
Prodidomid spider *Namundra griffinae*
Sun spider 1 *Blossia sp*
Sun spider 2 *Lawrencega sp*
Blister beetle *Iselma deserticola*
Ant spider *Heredida griffinae* (also on plains and watercourses)
Flower beetle *Metaphilehedonus swakopmundensis* (also in watercourses)

So little is known about these animals that their role in the ecosystem is not known. The case study of the spider *Moggridgea* (Appendix E) indicates that, because of its rarity, it is not likely to be a 'keystone' species i.e. not one on which many others depend or which fills a critical niche in the ecosystem. (Animals which are vital to pollination of certain plants [e.g. wasps, bees], or which play a big role in cycling nutrients back into the soil [e.g. termites], are considered as keystone species.) While we cannot be certain, it is likely that the other six taxa, also known to be very rare, are not key components in the ecosystem. Caution in this prediction is deserved as examples are known of species whose importance has been realized after their extinction (e.g. the case of the seeds of a certain tree eaten by dodos, and no longer establishing young plants as the seeds no

longer pass through dodo guts (Gould 1980).

As an educated guess, eradication of a few species which are naturally rare in an arid ecosystem that naturally has very low productivity, will have a low to medium impact i.e. the environment will be altered but the ecosystem will continue to function, possibly in a modified manner.

While our prediction is a low to medium impact, the combination of Rössing expansion with other mines in the area will exacerbate the impact. It is impossible to predict how much it will be exacerbated.

Probability of the impact
SK and Dome constitute rocky hillside habitat. By our assessment, the total extent of this habitat in and around Rössing is 850 km². The total area of direct disturbance to this habitat is 6 km². As a direct proportion, the disturbed area is therefore less than 1% of this habitat.

Open plains and watercourse habitats cover a larger area in and around Rössing, so if there is any direct disturbance in them, it will be a smaller proportion than that of rocky hillsides.

The likelihood of causing any extinction from mining in SK and expanding rock dumps in Dome, is therefore very low.

Degree of confidence in predictions
The severe shortage of information leaves us with very little confidence in our predictions. This translates to the need for greater caution in our recommendations, as our judgements become based on worst case scenarios.

Possibilities for mitigation
Nothing can be done to reduce the severity of destroying an area by open pit mining or permanently covering it in rock debri. Infrastructures associated with the mining should be sited on lower-priority habitat, namely plains.

4.2.1.2 Dust accumulation

Indications from the 2007 fieldwork were that biological soil crust activity was reduced, and spider and solifuge populations were less than expected. While still inconclusive, these results might be early indications of habitat deterioration caused by Rössing mining activities, outside of the area of direct disturbance.

Impact 2
Increased area of accumulation of dust around the mining operations, which may reduce the productivity of plants, and reduce the abundance and diversity of soil crust organisms

and small invertebrates.
Significance Medium to low significance. This impact has the potential to lower productivity of the ecosystem by reducing plant growth, reducing the cycling of nutrients through soil crust organisms, and reducing the ability of animals such as spiders and solifuges to survive in the area.
Nature of the impact It is suggested that dust, originating from blasting and earth-moving operations, is blanketing rocks on the soil surface, then during fog events being washed down the sides of stones and sealing the cracks and crevices around the base of stones. The mechanism by which this affects soil crust organisms is not known. For invertebrates such as spiders and solifuges, it possibly reduces their shelter and refuge places.
Extent of the impact Dispersal of dust was not assessed in this study. Sites within 2 km from the present open pit and rock dumps showed this feature. It is estimated that the impact could extend about 5 km away from dust-creating operations.
Duration of the impact During mining operations and for a few years, possibly decades, after the end of dust-creating operations.
Intensity of the impact This impact is indirect and probably low to medium severity. Further work is required to understand whether this is responsible for the low arachnid abundance recorded in 2007.
Probability of the impact Possible. At the present state of understanding, it is impossible to predict whether this impact is likely or unlikely.
Degree of confidence in predictions Dust accumulation is certain, yet its role in influencing invertebrate abundance and diversity is very uncertain. Our confidence in stating this impact is very low, hence the need for further work to assess its validity and importance.
Possibilities for mitigation Greater emphasis on dust suppression, and reduction of dust generation at source.

4.2.2 Confidence of our predictions

4.2.2.1 Quantifying risks with statistically perilous data

Critical parts of this biodiversity assessment are bedeviled by inadequate information. Particularly, the very small sample sizes for some taxa, due to their inherent rarity, make our understanding of their extent of occurrence and habitat preference extremely limited.

The very significant consequence of this shortcoming is that our recommendations must err on the side of caution. As explained in Appendix E, the worst case scenario for the spider *Moggridgea* and the 17 other taxa known only from Rössing, is that the small area centred on the Rössing mine is their only area of occurrence, and their populations are severely threatened by mining operations. The best case scenario is that they occupy similar habitats within a radius of 20 – 40 km and, though they are rare, Rössing's impact on their populations is low. The truth probably lies somewhere between the two.

We have tried to quantify the risks to biodiversity according to areas of occurrence and preferred habitats, both of which are based on sample sizes that are statistically worthless. Practicality demands that our biodiversity and ecological expertise should inform our recommendations in the interest of doing least harm to the natural environment. Using this as a basis, the emphasis changes from concentrating on individual taxa, to the functioning of the ecosystem as a whole.

The information from the 1984-1985 and 2007 studies does show which taxa are common and which are rare. In terms of ecosystem functioning, the ones that are very rare are less likely to be 'keystone species'. Thus we can be reasonably confident that ecosystem functioning will be maintained even if slightly altered or deteriorated by the proposed Rössing expansions.

4.2.2.2 Strengths and weaknesses of preliminary field observations

The tight schedule for this biodiversity assessment did not allow the second round of animal collecting in 2007 to be done in an appropriate season or over a more productive length of time. Yet observations were made and possible causes of worrying signs have been suggested. How worthy are they?

Preliminary indications of the impacts of dust from the 2007 fieldwork are exactly that – only preliminary, not well verified, and only indications, not proof. Yet the observations were made conscientiously and with scientific rigour, so deserve proper consideration. The suggestions for further biodiversity and ecological work at Rössing will help to assess whether the indications are borne out, and whether possibly unexpected impacts will be identified. If they are, they can contribute to improved environmental management of the mining activities.

4.2.3 Options for mitigation

Options for mitigation of the proposed mine expansion activities are severely limited.

4.2.3.1 Minimise the new footprint

As a critical biotope will be directly affected by the planned mine extension, reducing the footprint of the expansion to a minimum is mandatory. This will require clearly demarcated access routes and stringently enforced track discipline. All work areas need to be clearly demarcated and sign-posted. Any movements outside these marked areas will require special permission involving Rössing's environmental staff. Further, waste and pollution management, water and energy usage will need to follow established procedures.

4.2.3.2 Translocation of plants

The area ear-marked for mining harbours several large *Adenia pechuelii* plants, some of which may be directly affected by the future mine extension. As these are charismatic species of high conservation importance, transplanting trials would be a very valuable exercise enabling Rössing to demonstrate its commitment to biodiversity conservation. Once the site lay-outs for the extension area are available, affected specimens should be marked and a suitable site selected for a transplant trial. Involvement of the National Botanical Research Institute would be essential to obtain permits and relevant expertise.

While translocation or rescue operations can be worthwhile for plants and some large animals, this option is not practical for small animals such as scorpions or solifuges, especially rare ones. Firstly, capturing small fast moving or very cryptic or very scattered animals is impractical. Once caught, they have to be moved to another area of suitable habitat. Such habitat will already be occupied by other individuals of those species, and the new arrivals will face problems such as territoriality from the residents, inability to find or make adequate shelter, and consequent predation or death from being exposed. A high proportion of the newcomers are likely to die. Even if they do survive immediately, the final population size is closely related to the area of appropriate habitat, and the fact will remain that some of the appropriate habitat has been destroyed, so total population size will decrease proportionally. These are just a few of the obstacles that make translocation of very small animals an impossible or ineffective solution.

4.3 Recommendations for further work

4.3.1 Improve biodiversity data collection

Although more intensive plant collecting over the past growing seasons have greatly improved overall plant data coverage, most parts of the Rössing extension area have only been surveyed once. Repeated sampling will be necessary, particularly in those mapping units that were only accessed along their margins, such as the Khan River mountains and south-east gneiss hills.

Long-term collecting of animals, especially invertebrates, in particular biotopes will shed more light on the habitat requirements of those species that exist in the Rössing area. As mentioned in Section 3.2.3.1 (arachnid results), questions have been raised about the status of arachnids, particularly solifuges, in the Rössing area. Fieldwork on an ongoing basis, to include rainy seasons and the periods of activity that follow rains, will be beneficial here. This will enable Rössing to better understand and possibly mitigate its negative impacts on arachnids as well as other animals.

The approach to biotope monitoring by Burke (2005 and 2007) is to monitor selected indicator plants. This approach could usefully by applied to animals too. Appropriate animal indicator species, such as solifuges which are readily trappable and hold relatively high positions in the food chain, should be identified and monitored.

At the same time, it must be recognized that more collecting is very likely going to reveal more new species, so the process is likely to answer some questions and open up some more. This is not a reason to avoid doing such work, as all of the information contributes to improved understanding of the central Namib ecosystem, for the benefit of sustainable management.

4.3.2 Evaluate restoration and rehabilitation methods

Special measures to facilitate the recovery of critical biotopes are required. Rehabilitation practices such as preserving and re-spreading topsoil, seeding and replanting with indigenous species will need to be tested and site-specific protocols developed for particular habitats. Presently very little is known about appropriate practices in this arid environment and setting up trials will be an essential part of Rössing's biodiversity strategy.

With regard to biological soil crusts, it will be useful to retain surface soil layers in areas to be newly disturbed. Experiments could reveal whether this assists restoration rehabilitation of disturbed areas, and could provide practical guidelines on how to most effectively maintain biological soil crusts. As a first lesson, always return BSC-bearing stones to their original place and orientation, so that the organisms are not killed by being dried out.

4.3.3 Specifically evaluate impacts of dust on micro-habitats

We suggest that dust could have a more profound effect on ecological processes than has been previously recognized. In this regard, it would be useful to monitor physical quantities of dust and its deposition in areas surrounding the mining areas, and associated features such as biological soil crusts, moisture below stones and rocks, and processes associated with them.

4.4 Conclusions regarding Phase I expansion

Opening up and mining of the SK4 area, expanding rock dumps in Dome and establishment of road and power infrastructure to the new pit, are the components of expansion in Phase I involving extension onto undisturbed land. It is possible, but unlikely, that any of the species recorded at Rössing will be eradicated by these expansions. Since the individuals of the taxa categorized as High Priority are naturally rare, it is unlikely that any of them can be considered 'keystone species', therefore functioning of the ecosystem will continue with little change.

Phase 2 expansion into the remainder of SK and into SH will slightly increase the likelihood of causing any extinctions, and will add to the cumulative impacts of habitat fragmentation and disturbance caused by other quarries and uranium mines in the surroundings. For this reason, further biodiversity sampling work and ecological investigations are urgently needed to improve our understanding of the species that are highlighted as High Priority, and of their ecological roles. Additionally, work on biological soil crusts and apparent scarcity of arachnids will reveal whether there are other features of mining activities at Rössing that require management.

5. Glossary

biological soil crust (BSC)	association in different proportions between soil particles and cyanobacteria, actinomycetes, microalgae, microfungi, lichens, mosses and liverworts in the top millimeters of soil surfaces or under translucent stones
black BSC	biological soil crust without active diatoms and green algae, this assumed to be dominated by cyanobacteria
brown BSC	soil-coloured crust adhering to stones/rocks and sometimes lightly bound with filaments that could be microfungal mycelia or filamentous cyanobacteria
green BSC	biological soil crust assumed to be dominated by diatoms / microalgae
cyanobacteria	blue-green algae that grow in crusts, filamentous aggregations or mats
epilithic	on top of stones/rocks
fensteralgen	hypolithic green algae and diatoms found under translucent stones
hypolithic	under stones/rocks
morphospecies	organisms that look alike and are probably the same species
perilithic	near-surface soil area around the base of stones/rocks
voucher specimen	a specimen collected for identification, and representing many other individuals of the same species that are not collected.

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ANNEXURE K2 – Appendices to Rössing Biodiversity Assessment, produced by EEAN for RUL, via Ninham Shand (Pty) Ltd

Appendix A. SUMMARY OF THE 1984/85 BASELINE BIODIVERSITY SURVEY OF THE RöSSING AREA, CENTRAL NAMIB DESERT

J. Irish
4 December 2007

1. INTRODUCTION

Rössing Uranium Ltd. (RUL) sponsored an environmental survey of the Rössing Mine area under the auspices of the State Museum in Windhoek (now the National Museum of Namibia), in 1984/85. An impressive amount of information was collected, but due to factors prevalent at the time, no concerted effort to collate or summarise it was ever made. In the context of the current work, the need for baseline environmental data both for the areas to be mined and those surrounding them, prompted this effort to bring together the 1980's information in one place.

Negotiations and planning for the survey commenced in mid-1983, and a visit to the area took place on 20 September 1983. The museum files include a draft project proposal dated 24 November 1983. The survey formally started on 12 March 1984. From then, site visits were made and traps serviced at four-week intervals throughout 1984. The initial plan was for the project to run for 18 months. Within the first 3 months, however, staff changes at both the Museum and RUL had delegated bilateral project responsibility to uninvolved individuals. Project participants were left without oversight, guidance, or recourse. Most continued regardless, out of scientific curiosity, but by the end of 1984 the project had mostly petered out. The invertebrate traps were active till 7 May 1985, when problems with RUL security blocking access to the two secondary sampling sites prompted termination. The reptile trap survey was stopped soon after on 13 June 1985. There was no formal overall project termination date. Most participants did submit reports to RUL, and these are still on file there, but they were disjunct, individual efforts.

Sources of information for the current summary included:

- unpublished data on file at the Museum
- reports submitted to RUL on file at RUL
- unpublished data in the possession of individual scientists
- information on specimen labels in the museum collections
- incidentally published information

Disciplines involved in the survey were:

- Arachnology (eight-legged invertebrates)
- Botany (plants)
- Entomology (six-legged invertebrates)
- Herpetology (reptiles and amphibians)
- Limnology (water biology)
- Mammalogy (mammals)
- Ornithology (birds)

More information on each follows later.

2. SAMPLING SITES

There were six fixed sampling sites where traps were deployed on a regular or continuous basis, depending on the discipline. Selection of the sites was based on an experimental design intended to test the effects of the two main environmental impacts of concern at the time, namely windblown dust and raised groundwater levels originating from mining activities. Because of the long time span since, data gaps, and data inconsistencies between different disciplines, it would be very difficult indeed to today test these hypotheses using 1980's data, and it will not be attempted here. The current report takes the conservative approach of attributing observed differences in biodiversity between sites primarily to habitat differences between sites. The data remains eminently useful as a biodiversity baseline without attributing causality to such differences.

The locations of sites are mapped in Figure 1. Since the project predates the availability of GPS's, the opportunity was used in 2007 to relocate and GPS-reference the fixed sites (Table 1).

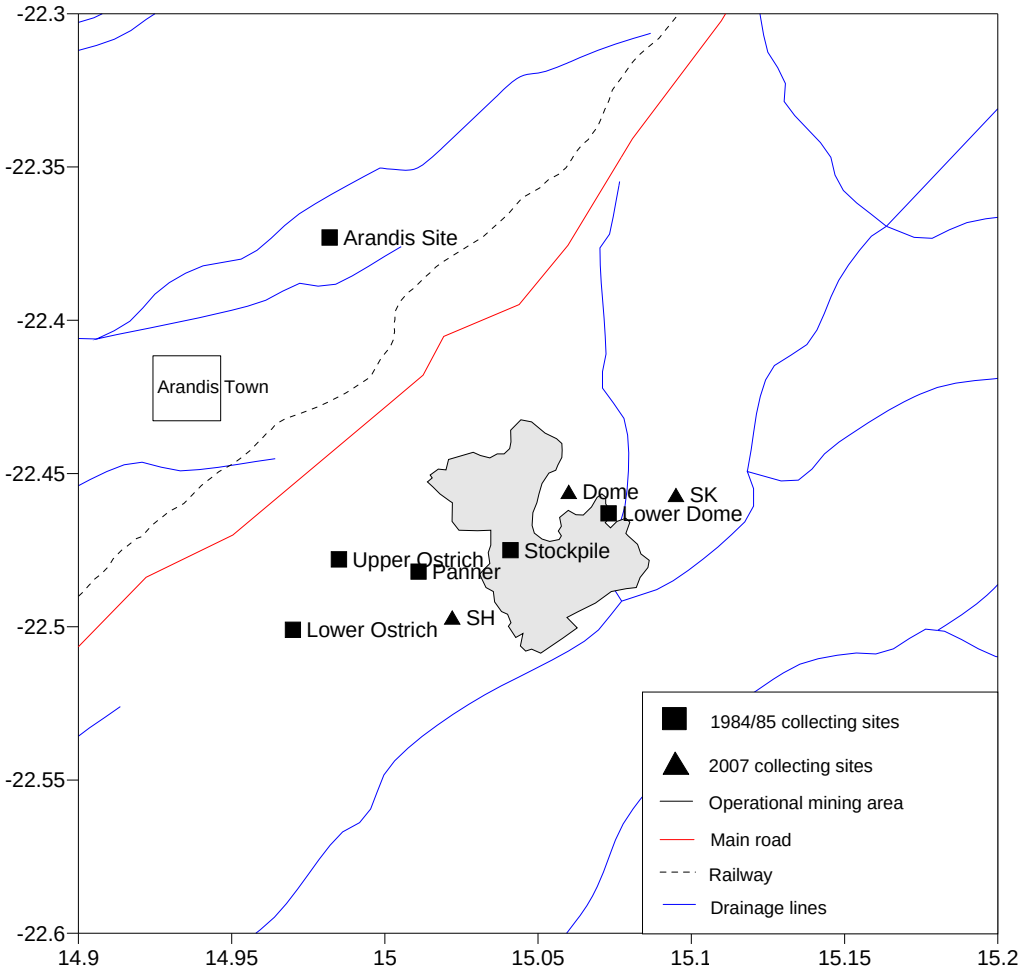

Figure 1. Location of the 1984/85 fixed collecting sites in the Rössing area, with 2007 sites for comparison.

Table 1. Coordinates of central points in each fixed trapline.

Site	Longitude °E	Latitude °S	Notes
Upper Ostrich Site	14.985	-22.478	GPS
Arandis Site	14.982	-22.373	GPS
Panner Site	15.011	-22.482	GPS
Lower Ostrich Site	14.970	-22.501	Site destroyed, GPS adjacent
Stockpile Site	15.041	-22.475	GPS
Lower Dome Site	15.073	-22.463	Site destroyed, map estimate

At each of the four primary trap sites (Upper Ostrich Site, Lower Ostrich Site, Panner Site and Arandis Site), five parallel trap lines were deployed (Figure 2). Trap lines were surveyed with the aid of a steel tape measure and dumpy level, and each trap node was marked with an iron peg. Many of these pegs remain *in situ* today. Three of the five lines were for mammal traps, one for invertebrate traps, and one for reptile traps. Mammal and reptile traps were deployed only during site visits, serviced daily, and retrieved at the end of the visit. Invertebrate traps contained preservative, so they were continuously active, and site visits served to retrieve the previous sampling period's catch and replace the preservative with clean liquid. At each of the two secondary sites (Stockpile Site and Lower Dome Site), only invertebrate traps were deployed.

More information on each of the individual sites follow.

Upper Ostrich Site

Situated southeast of Arandis Airport, in the upper reaches of the Ostrich drainage basin. The site was intended to sample plains biota at a location relatively close to the mine and potentially affected by it. Traps were placed 25 m apart, and almost all pegs remain in place today. The site is often referred to as 'Upper Ostrich Gorge', but is on flat ground, not in a gorge.

Arandis Site

Situated about 6 km NE of Arandis town, and often referred to as '6 km NE Arandis', the site was intended to sample plains biota at a location far from the mine and possibly unaffected by it. Traps were placed 25 m apart, and at least some pegs remain in place. Also referred to as 'Arandis Control Site'.

Panner Site

Situated just north of the point where the NamPower line crosses the Panner drainage line. The site was intended to sample drainage line biota at a location that was visibly affected by mining activities. Groundwater levels in the area were raised, but there was no actual open water on site. Traps were placed 15 m apart. A shorter interval between traps was necessary to fit the entire trap line into the available space in the river bed. Despite floods since, a

few pegs remain in place. The site is also referred to as ‘Upper Panner Gorge’, or simply ‘Panner Gorge’.

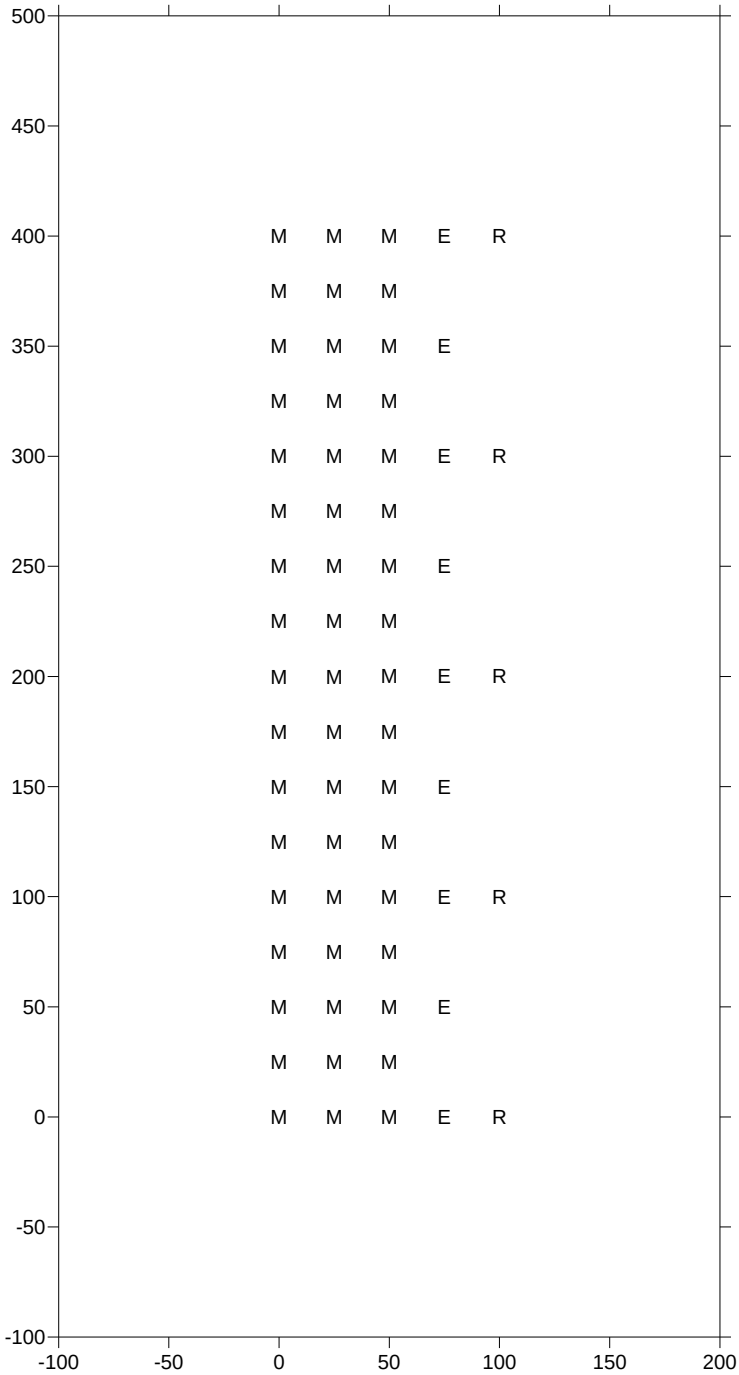

Figure 2. Generalised layout of typical fixed trapline site. M = live mammal traps, E = invertebrate preservative pitfall traps, R = live reptile traps. Scale in meters. Directionality differs between sites.

Lower Ostrich Site

Situated just north of the point where the NamPower line crosses the Ostrich drainage line. The site was intended to sample drainage line biota in a location unaffected by raised groundwater levels. Traps were placed 25 m apart, but no pegs could be relocated since it has been levelled and is being

used to stockpile granite blocks originating from a nearby quarry operated by Rock Africa. The site is also referred to as ‘Lower Ostrich Gorge’.

Stockpile Site

Situated immediately west of the Coarse Ore Strockpile. The site was intended to sample the fauna of a rocky ridge that was visibly impacted by windblown dust originating from the stockpile. Only invertebrate traps were deployed here. For consistency with the previous sites, nine traps were placed 25 m apart, in a relatively but not absolutely straight line following the contour of the ridge. Some pegs remain in place. The site is also referred to as ‘Stockpile Ridge’, ‘Primary Crusher Dust area’, or simply ‘Rössing Mine’.

Lower Dome Site

Situated adjacent to Lower Dome Gorge. The site was intended to sample the fauna of a rocky ridge that was less visibly impacted by windblown dust. During the course of the project it became clear that the site did receive its share of dust fallout from blasting in the adjacent open pit, but dust deposition was not at the same intensity as at the Stockpile Site. Because of the exceedingly rocky substrate, regularly spaced traps as at the other sites proved impractical here. Only six traps were deployed. One trap was placed on the summit and one at mid-height on each flank of each of two parallel ridges. The placement of individual traps was determined by substrate conditions, i.e., traps were placed wherever it was possible to dig a large enough hole, as close as possible to a straight line perpendicularly across the ridges. The particular area was selected because we were told during the planning phase that two adjacent ridges there had different levels of natural background radiation, and we saw this as an opportunity to also test whether that affected the fauna. At project start, it proved impossible to find anybody able to point out which particular ridges had been meant. Because of this, traps were only deployed at Lower Dome during the third trapping period, and even then we had no way of knowing whether the traps were placed on ridges with different radiation levels, or not. Because of the project management vacuum that had developed by this time, no further information on location or radiation levels could be gained. With hindsight, the initial indication probably referred to parallel ridges of alaskite and country rock. Today the site has been at least partially covered by waste rock dumps. Only invertebrate traps were deployed at Lower Dome. The site is also referred to as ‘Lower Dome Gorge’, or simply ‘Dome Gorge’.

Limnological sampling sites

The limnological equivalent of the fixed survey sites above was a program of repeat sampling at the following seven water bodies.

- Arandis pools. Bulldozed holes in watercourse south of Arandis town.
- Boulder Gorge. South of Tailings Dam.
- E camp. Location unknown, suspected west of Tailings Dam.
- Fish Pond / Pinnacle Gorge. South of Tailings Dam.

- Panner seepage. Upper Panner Gorge, originating from Tailings Dam, exact location unknown.
- Piet se gat (a.k.a. Rock Fountain). Adjacent to Panner Gorge, at 15.0198°E, 22.492°S.
- Pinnacle Pond. South of Tailings Dam. 15.035°E, 22.4777°S.

Ad hoc sampling

In addition to fixed sampling, all participants did *ad hoc* sampling and made observations throughout the area, but only Entomology followed a structured sampling programme. They selected an area around the mine and divided it into 16 squares, each square measuring 5 x 5 geographical minutes (Figure 3). Each square was visited and sampled at least once during the project period.

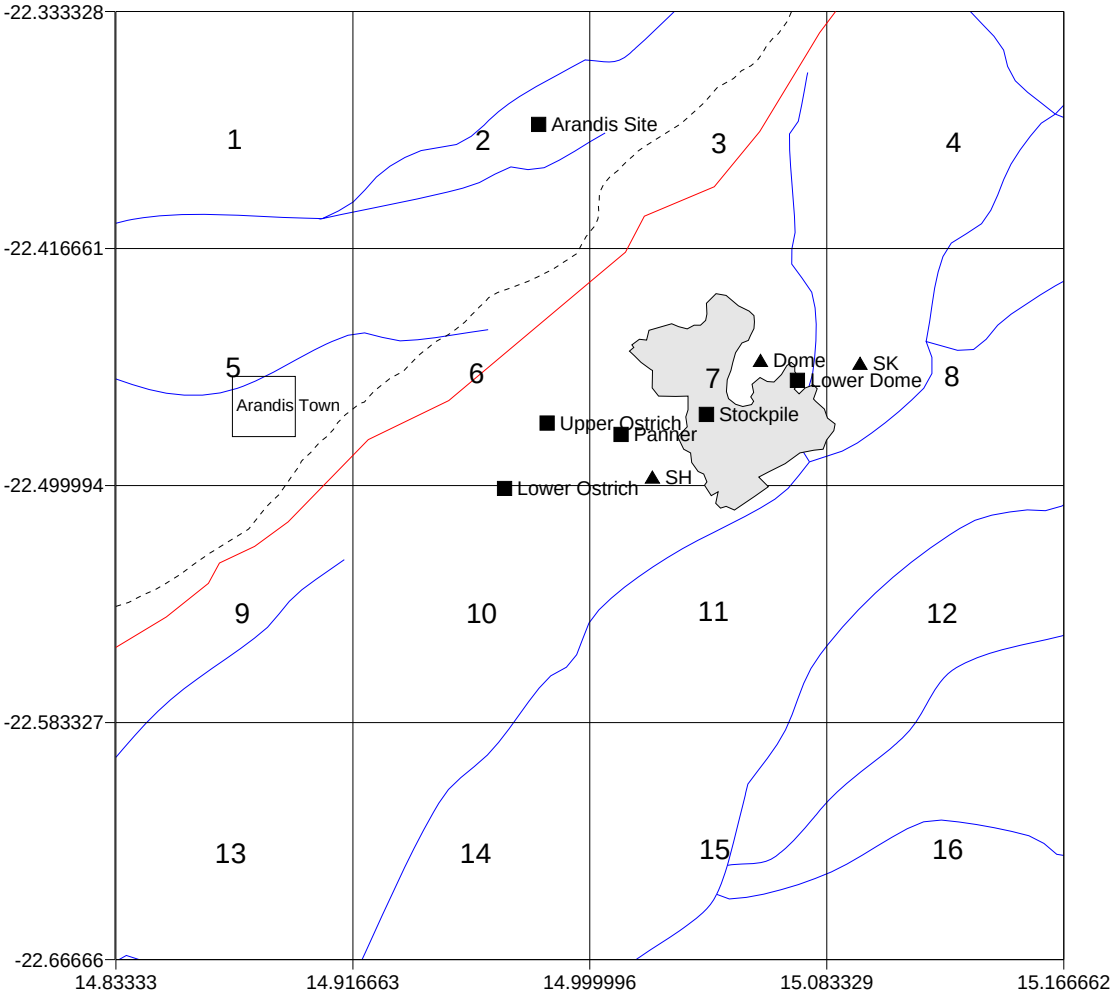

Figure 3. Collecting blocks for wider entomological survey.

3. INDIVIDUAL DISCIPLINES

Arachnology

Terrestrial non-insect invertebrates (spiders, solifuges, scorpions, mites, myriapods, etc.) were treated by the Museum's Curator of Arachnology, Eryn

Griffin. A major source of arachnid material was the preservative pitfall traps run by Entomology, and this was supplemented by *ad* hoc handsampling throughout the area. Mrs. Griffin is currently based in the United States and is no longer active in arachnology. She declined involvement with the current work, but allowed us to use whatever of her work we could find. Original handwritten identification sheets of pitfall trap material was available on file at the National Museum, and this was crosschecked for consistency against the collection database.

Eryn gave a talk on her work at an arachnological meeting (Griffin 1986), wrote two popular accounts based in part on this project (Griffin 1987, 1989), and published two scientific papers based on the material (Griffin 1990; Platnick & Griffin 1990). Collected material was also studied by other scientists: Griswold (1987), Dippenaar-Schoeman (1990), Jocqué (1990a), Starega (1992), Szütz & Jocqué (2001), Prendini (2003, 2004, 2005), Van Niekerk & Dippenaar-Schoeman (1994), Foord (2005) and Platnick & Bird (2007). The latter, published in January this year, is indicative of the fact that a full study of the material collected by the Rössing project is nowhere near complete.

Botany

Since the Museum had no in-house botanical expertise, survey work was contracted out to a consultant from Omaruru, Patricia Craven. Mrs. Craven declined involvement with the current work. At the time she accompanied other participants during sampling, collected plants and made notes. The RUL files include a document on plants (Anon, no date, a), that probably represents the results of this work. An additional source of information for the current report was a database query of specimen holdings in the National Herbarium in Windhoek. It includes a total of 1602 records from the area, of which 346 were collected by Craven.

Entomology

Terrestrial insects were treated by the Museum's Curator of Entomology, John Irish, and Assistant Curator Hella Rust (néé Liessner). The main source of information was a preservative pitfall trap survey that ran for 60 weeks. Though all trapped insects are preserved in the Museum, only apterous (flightless) insects from the pitfall traps were treated in detail, since pitfall traps only trap flightless insects in statistically comparable way. Alate (flying) insects were to have been sampled by a mechanical rotary trap built by RUL, but that only functioned for a few hours before breaking down. It was never fixed or used again, explaining the lack of detail available for alate insects. Extensive handsampling was also done throughout the area to supplement trap results.

The main source of information for the current report is Dr. Irish's handwritten notes from the time, which relate almost exclusively to flightless pitfall trap material. Since the Museum insect collection is not computerised, there is no simple way to extract information on either the flighted insects captured in pitfall traps, or the handsampled material from the 16 blocks (fig. 3). At the

time, collected specimens were sorted into morphospecies (i.e, things that look alike and are probably the same species), and numbered from 1 onwards. As the project progressed, the help of expert taxonomists were solicited to put proper species names to these morphospecies. In some cases original taxonomic research was done to identify particular groups. Where there are gaps in the numbering today, these reflect cases where subsequent identification by experts, or our own experience as the survey progressed, indicated that what we had been distinguishing were in fact one species. A voucher collection of these morphospecies was maintained at the time, and should still be in the Museum. Neither the main collection nor the vouchers were accessible to us during the current work. Many insect species remain unidentified.

Small numbers of insect specimens that fell into reptile traps, that were encountered during arachnological handsampling, and that colleagues came across in the course of their work, were also incorporated into the collection. Wherever notes of these survived, they were incorporated into lists below.

Preliminary results were compiled into an unpublished report to RUL by Irish (1987b). Popular accounts of the work were published by Irish (1984) and Irish & Liessner (1985). Material from the Rössing Project was published on by numerous experts, including Holm (1985, 1986a, 1986b), Irish (1986, 1987a, 1988a, 1988b, 1988c, 1992), Scholtz & Howden (1987), Wittmer (1988, 1989), Eardley (1989, 1991a, b), Marais & Holm (1989), Penrith & Endrödy-Younga (1994), Gussmann (1995), Greathead (2000), Bologna *et al*. (2001), Hancock *et al.* (2001), Irish & Roberts (2006) and Kurahashi & Kirk-Spriggs (2006).

Herpetology

Reptiles were treated by the Museum's Curator of Herpetology, Hartwig Dell'Mour. Dr. Dell'Mour is currently based in Austria and no longer professionally active in herpetology, but he kindly provided information and allowed its use here. The main source of material at the time was a series of pitfall traps at the four main sampling sites. Reptile traps were only deployed during site visits, and captured specimens were released after identification, so that material today in the Museum collections are mostly from handsampling in the area. A small number of reptiles drowned in invertebrate traps, and were also incorporated into the collections.

The main sources of information for the current report were copies of field notes and reports provided by Hartwig, updated information on distribution and conservation status provided by Mr. Mike Griffin (Ministry of Environment and Tourism), and a few queries on particular species from the museum's herpetological database.

The discovery of the Husab sand lizard (*Pedioplanis husabensis*) is closely linked to the Rössing project (Berger-Dell'Mour & Mayer 1989).

Limnology

Aquatic invertebrates were treated by the Museum's Curator of Aquatic Biology, Charmaine Meyer. Charmaine is known to still be in Namibia, but is no longer professionally active, and could not be traced with regard to the present study. For any biota that she could not identify herself, Charmaine solicited the help of a more experienced limnologist, Prof. Jenny Day from the University of Cape Town. Jenny informed us that the bulk of the Rössing survey material is still at UCT, and has still not been identified.

Most limnological material came from handsampling by Charmaine, from the seven repeat sites mentioned above, as well as at *ad hoc* waterpoints elsewhere. Information for the current report came mainly from unpublished notes and correspondence on file in the (vacant) Aquatic biology section at the Museum, and material on file at RUL. Despite reference in the files and notes to much collected material, the Museum's Aquatic Biology database includes only 7 specimens from Rössing, the rest is assumed to be in Cape Town. A problem with all of the above is that species and localities are often indicated by codes, the meaning of which is unknown (B1, B3, L5 etc).

Not much has been published on the aquatic Rössing material. The summary paper by Day (1990) maps waterpoints at Rössing, and is probably partly based on Rössing material, but includes no actual site records. Other sources used here include Archibald (1987) and Grichanov (2000).

Mammalogy

Small mammals were treated by the Museum's Technical Assistant for Mammalogy, Brian Colahan. Brian is currently based in South Africa, and kindly supplied information for use here. Most material came from live rodent traps deployed at the four main trap sites during site visits only. Captured specimens were weighed and sexed, and marked before being released again. No specimens were supposed to be killed, except those from the final month. This final killing was never done, though (B. Colahan, pers. comm.), so the museum collection today reflects mainly the few specimens that suffered incidental drowning in invertebrate traps.

Information for the current report comes mainly from Brian's field notes. No published information on the survey could be traced. A listing of additional species either observed in the area, or not seen but expected to occur, was prepared by John Pallett and is included here.

Ornithology

Birds were the responsibility of the Museum's Curator of Ornithology, Joris Komen. Joris is still in Windhoek, but no longer active in ornithology. He declined involvement with the current work, but allowed us to use whatever of his work we could find. Brian Colahan also did an independent bird survey as an aside to his mammal work.

RUL files include a checklist for the area prepared by Joris. Brian's work was published as Colahan (1987). A listing of additional species either observed in the area, or not seen but expected to occur, was prepared by John Pallett and is included here.

General assessment

Consideration of the published literature based on the Rössing material as enumerated above indicates a slow but steady stream of new invertebrate species described over the years, up to and including 2007. This happened despite the fact that there was no active effort by the museum to get Rössing material described – everything happened as a result of individual interest or passive dissemination of material. There are still major invertebrate groups for which the Rössing material is completely unidentified. No doubt many more new species still await description and publication. If the results to date are anything to go by, a significant number of the described species will be Central Namib endemics that are range restricted to the Rössing area.

4. TAXONOMIC LISTING

4.1. Mollusca (snails)

Unidentified molluscs are mentioned in the limnological notes. Snails in the Rössing area are expected only near water.

4.2. Crustacea (crustaceans)

Copepoda (seed shrimps) and Ostracoda (mussel shrimps) are mentioned in limnological notes and correspondence. These are all aquatic animals. No further identifications are available.

4.3. Myriapoda (centipedes and millipedes)

4.3.1 Chilopoda (centipedes)

- *Diphteropgaster flavus* is widespread in western Namibia and adjacent countries, and had been recorded from Swakopmund previously (Lawrence 1975). Since this is the only known *Diphtherogaster* species in Namibia, it is assumed that the Rössing material, though identified to genus only, belongs to it.
- *Lamyctes* includes a single Namibian species, but since this has only been recorded from the interior, the Rössing material, which was identified to genus only, may represent either another species or a range extention.
- *Cormocephalus* includes at least 9 Namibian species, of which one, *C. pontifex*, is a central Namib endemic known from Arandis (Lawrence 1975). The Rössing material was identified to genus only, but does not necessarily represent *C. pontifex*, since both *C. multispinosus* and *C. oligoporus* could potentially occur in the area as well.

4.3.2 Diplopoda (millipedes)

Millipedes prefer moister habitats, and none were found in the pitfall traps. However, one *Chilexenus* species was handsampled at the Arandis Site. The current generic assignment of Namibian species previously referred to *Chilexenus* is probably to *Afraustraloxenodes*, of which one species, *A. coineaui* is found in the Central Namib (Duy-Jacquenin 2003), but it is not known whether the Rössing material refers to this.

4.4. Arachnida (eight-legged invertebrates)

4.4.1 Acari (mites and ticks)

The Rössing mites are identified to higher levels only. No detailed information is available,but at least four species seem to be present. The few ticks (Ixodida) found in pitfall traps probably fell from the few rodents that drowned in invertebrate traps. The limnological survey collected water mites from various water bodies.

4.4.2 Araneae (spiders)

4.4.2.1 Agelenidae (funnel-web spiders)

Most Rössing material was identified to generic level as *Agelena* species, but some specimens were identified to family level as Agelenidae only. Since some with only family level identifications in the data sheets are in the museum database with generic identities, it is assumed that all the Rössing Agelenidae material belongs to *Agelena*. Material was also hand-collected from funnel webs in shrubs and among stones around waterpoints. Only one *Agelena* species (*A. suboculata*) is known from Namibia, but it is not known whether the Rössing material belongs to it or not.

4.4.2.2 Ammoxenidae (termite-eating spiders)

All Rössing Ammoxenidae were collected from pitfall traps

- *Ammoxenus coccineus* is a common and widespread species (T. Bird, pers. comm.)

The genus *Rastellus* was first described based in part on Rössing material, by Platnick & Griffin (1990).

- *R. narubis* is known from a restricted area of central western Namibia only, and was recorded from Lower Dome Site.
- *R. struthio* is more widespread, and was recorded from both Upper and Lower Ostrich Sites (the species name, *struthio*, is Latin for Ostrich, and refers to Ostrich Gorge).

4.4.2.3 Araneidae (orb-web spiders)

There are at least 25 species from this family found in Namibia but the Rössing material is unidentified beyond family. Very few came from pitfall traps. Most were caught in webs in vegetation throughout the area.

4.4.2.4 Caponiidae (spiders, no common name)

All Rössing material is from pitfall traps, and was identified as *Diploglena* species The only species in the genus known from Namibia is *D. capensis*, It has been recorded from the central Namib (Gobabeb) before by Henschel *et al.* (2003), and all Rössing material is provisionally referred to it here.

4.4.2.5 Clubionidae (sac spiders)

Rössing material was identified to family only, but since only the genus *Clubiona* has been recorded from Namibia, it is assumed they belong to this. Two *Clubiona* species are known from Namibia. Besides pitfall trap material, specimens were handsampled in a variety of habitats.

4.4.2.6 Dictynidae (mesh-web spiders)

At least 3 genera, and an unknown number of species occur in Namibia, but the Rössing material was not identified beyond family. Besides some pitfall trap material, specimens were also caught in webs in vegetation.

4.4.2.7 Eresidae (velvet spiders)

Genus *Eresus*.

- One specimen from a reptile trap at the Lower Ostrich Site was identified as *Eresus* species There is only one *Eresus* species recorded from Namibia, but it is not known if this is it or not.

Genus *Seothyra*. Rössing material was published on by Dippenaar-Schoeman (1990).

- *S. fasciata* was recorded from the Arandis Site, and is widespread in western southern Africa.
- *S. longipedata* is known from 2 localities only, of which the Lower Ostrich Site is one.
- *S. anettae* is known only from a single specimen collected from a pitfall at the Arandis Site.
- More, unidentified, *Seothyra* material was collected, mainly from trapdoor tunnels, at Arandis Site and the Lower Ostrich Site, but nowhere else in the area. Pitfall trap material from both these sites additionally includes juvenile material identified only as ‘Eresidae’, probably also *Seothyra*, but not possible to refer to species.
- The species *Seothyra griffinae*, listed as a Rössing endemic in Anon (no date, b), does not occur anywhere near Rössing, according to the authority cited there: Dippenaar-Schoeman (1990).

4.4.2.8 Filistatidae (crevice-weaver spiders)

Rössing material was not identified beyond family, but possibly more than one species is present. Filistatidae have been recorded from Namibia before, but there are no published species level records from the country, and it is therefore not possible to evaluate the Rössing specimens further. Besides

pitfall trap material, specimens were handsampled under stones and other shelter in the area.

4.4.2.9 Gnaphosidae (ground spiders)

One of the commoner spider families encountered at Rössing, but unfortunately none have been identified to species level.

- *Asemesthes* species. One of the commonest spiders at Rössing. At least 15 species have been recorded from Namibia, but their taxonomy is in disarray, and it is not known which are represented at Rössing. Eryn Griffin sorted pitfall trap material into 4 morphospecies.
- *Diaphractus* species. Only one species is known from Namibia, but it is not known whether the three Rössing specimens belong to it or not. All were from pitfall traps.
- *Megamyrmaekion* species. Only one species has been recorded from Namibia, but it is not known whether Rössing pitfall trap material represents it or not.
- *Micaria* species. One specimen was collected under stones at 'E camp pond'. There are 2 species recorded from Namibia, but it is not known which it them this is.
- *Setaphis* species. There are 9 species in Namibia, but it is not known which is represented by the Rössing specimens. Most were from pitfall traps, a few from under stones.
- *Zelotes* species. There are 12 species in Namibia, but it is not known which are represented by Rössing specimens. Most were from pitfall traps, some from under stones.
- A few pitfall trap specimens were identified to subfamily only: Drassodinae, Echeminae and Hemichloeinae, and many juveniles were not identified further than Gnaphosidae only.

4.4.2.10 Hahniidae (spiders, no common name)

A single specimen was found in a pitfall trap at the Upper Panner Site. The family is badly known in Namibia: at least two species may be present in the country, but it is not known which occurs at Rössing.

4.4.2.11 Hersiliidae (long-spinneret spiders)

- *Hersilia arborea*. A single pitfall trap specimen from the Lower Ostrich Site. This is a widespread species (Foord 2005).
- *Tyrotama fragilis*. Pitfall traps and under stones (Foord 2005).

4.4.2.12 Idiopidae (spurred trapdoor spiders)

Idiops species There are 6 species in Namibia, but it is not known which are these. Only a few specimens were recorded, all from pitfall traps, all at the Lower Dome Site.

4.4.2.13 Linyphiidae (sheet-web spiders)

The family includes about 15 Namibian species, but it is not known which are represented by the two Rössing specimens, from the Panner and Lower Ostrich Sites respectively.

4.4.2.14 Lycosidae (wolf spiders)

A large family with 93 species in Namibia, but the Rössing specimens were not identified beyond family. Only one was found in a pitfall trap, but many were hand-collected around water points.

4.4.2.15 Migidae (tingle trapdoor spiders)

A single specimen of *Moggridgea eremicola* came from a pitfall trap at the Lower Dome Site. It remains the only known record for this species in the world (Griswold 1987).

4.4.2.16 Oecobiidae (flatmesh-weaver spiders, star-legged spiders)

Rössing material has been identified as *Paroecobius* species. Only one *Paroecobius* species is known from Namibia, but pitfall trap material has been sorted into two unnamed morphospecies in the museum collection. Specimens were also collected under rocks.

4.4.2.17 Oonopidae (dwarf six-eyed spiders)

Rössing material has not been identified beyond family. All were from pitfall traps. There are at least 5 species of Oonopidae known from Namibia, but it is not known which are represented by the Rössing material.

4.4.2.18 Oxyopidae (lynx spiders)

Rössing pitfall trap material was not identified below family, though one sample in the collection is labelled *Oxyopes* species There are two *Oxyopes* species known from Namibia.
There are also some hand-collected *Peucetia* specimens in the collection, mostly vegetation associated, identified as *Peucetia crucifer* (Lower Dome Site) and *P. viridis* (Panner Site) respectively. The former was published on by Van Niekerk & Dippenaar-Schoeman (1994).

4.4.2.19 Palpimanidae (palp-footed spiders)

- With one exception, pitfall trap material was identified as *Diaphorocellus* species, as were incidental hand-collected material, mostly from under stones. There are 3 *Diaphorocellus* species known from Namibia. One hand-sampled specimen in the museum collection has been identified as *D. biplagiata*. While there are literature records of *D. biplagiata* from Namibia (e.g. Henschel *et al.* 2003), the World Spider Catalogue lists it as occurring in South Africa only, implying that the Namibian specimens might be misidentified. For this reason, Rössing specimens are here listed as *Diaphorocellus* species only.

- *Palpimanus* species. A single specimen from the Stockpile Site. There are at least 5 *Palpimanus* species known from Namibia, but it is not known which this one is.

4.4.2.20 Philodromidae (running crab spiders)

- Most pitfall trap material is identified as *Hurriusa* species Two *Hirriusa* species are known from Namibia, but in the museum collection the Rössing material is sorted into three morphospecies. No clear distributional difference between the 3 morphospecies is apparent – all 3 seem to occur everywhere in the Rössing area.
- *Philodromus* species. Hand-collected material associated with vegetation. There are four species known from Namibia.
- *Suemus* species. One specimen from the Panner Site. The World Spider Catalogue lists the genus as occurring only in South Africa, and no Namibian records could be found. Either this is a new record, or it is misidentified.
- *Thanatus* species. From pitfall traps, but also hand-collected associated with vegetation. Four species are known from Namibia.

4.4.2.21 Pholcidae (daddy long-legs spiders)

- *Pholcus* species. Only found in pitfall traps at the Stockpile Site. Two species are known from Namibia.
- *Smeringopus hypocrita*. Found in pitfall traps at all fixed trap sites.

4.4.2.22 Prodidomidae (spiders, no common name)

Most Rössing material is from pitfall traps, but a few were hand-collected under stones. The bulk have not been identified beyond family.

- A small number of specimens have been specified as either *Prodidomus* species or *Theuma* species in the museum collection. There are 3 *Prodidomus* and 16 *Theuma* species known from Namibia.
- *Namundra griffinae*. Only known from the Lower Dome and Stockpile Sites, and only described earlier this year (Platnick & Bird, 2007).

4.4.2.23 Salticidae (jumping spiders)

Among the most common spiders in the pitfall traps, and also hand-collected extensively throughout the area. There are at least 62 species in Namibia. Mos were not identified beyond family, but some have been specified in the museum collection as: *Bianor* species, *Langona* species, *Mogrus* species and *Neaetha* species.

4.4.2.24 Scytodidae (spitting spiders)

All Rössing material has been identified as *Scytodes* species, but in the museum collection they have been sorted into two morphospecies. They were not found on the plains sites. There are 8 *Scytodes* species in Namibia.

4.4.2.25 Segestriidae (tube-web spiders)

Most Rössing material came from pitfall traps, though one was handsampled in a tube web. Material in the museum collection has been sorted into two morphospecies, but both seem to occur over the entire area. The family in Namibia includes only one genus, *Ariadna*, with 7 species. Rössing material is assumed to belong to *Ariadna* as well.

4.4.2.26 Selenopidae (wall spiders, flatties)

- One *Anyphops* species was collected in a pitfall trap at the Lower Ostrich Site. There are 3 species known from Namibia.
- One *Selenops* species was collected in the guest house at Arandis. There are 5 species known from Namibia.

4.4.2.27 Sicariidae (violin spiders)

- *Loxosceles pilosa.* Mostly from pitfall traps, one hand-sampled under a stone.
- *Sicarius* species, probably *allospinosis* (Lotz, pers. comm.). Besides pitfall traps, also hand-sampled under stones throughout area.

4.4.2.28 Sparassidae (huntsmen spiders)

The family Sparassidae has a high rate of endemism in the Namib Desert. It includes such iconic species as the Dancing White Lady Spider, and the Wheel Spider. The Rössing material holds high potential interest, and may include species of concern, but the material is inadequately identified, and many of the identities listed below are suspect. The group is receiving attention from a German expert, Dr. Dirk Kunz, and it will hopefully be possible to treat it in more detail in future.

- *Arandisa* species. One specimen from the Lower Dome Site was identified as a potential *Arandisa* species. Since the specimen is a juvenile, this identification may not be accurate. The only Namibian species in the genus is *Arandisa deserticola*, a Namibian endemic, that could potentially occur at Rössing.
- *Carparachne* species. A series of specimens from the Arandis Site were identified as *Carparachne* species. Both Namibian species are dune specialists, so it is highly unlikely that the Rössing material indeed belongs to this genus.
- *Leucorchestris* species. The genus includes 7 Namibian species, of which 5 are endemic, and most are range restricted. The very few Rössing specimens have not been further identified, but hold high interest.
- *Microrchestris melanogaster*. Only one Rössing specimen has been identified to species level in the collection, but it is assumed the other *Microchestris* specimens are the same. It is a Namibian endemic, but the identification might not be accurate.
- *Olios* species. There are 4 species known from Namibia.

- *Orchestrella* species. There are 3 species known from Namibia. The Rössing material is sorted into two morphospecies in the museum collection.
- *Palystella* species. There are 3 species known from Namibia. The Rössing material is sorted into two morphospecies in the museum collection.

4.4.2.29 Tetragnathidae (long-jawed spiders)

Tetragnatha species. The genus has 6 known Namibian species. It was not found in pitfall traps, but all material was hand-collected, mainly on reeds around waterpoints.

4.4.2.30 Theridiidae (comb-footed spiders)

The Rössing material has not been identified beyond family. There are 13 species known from Namibia. Besides pitfall traps, mostly found under stones.

4.4.2.31 Thomisidae (crab spiders)

Only one specimen came from a pitfall trap, the rest were hand-collected from vegetation.

- *Diaea* species. Pitfall trap. Three species known from Namibia.
- *Heriaeus* species. Only one species known from Namibia, but it is unknown whether the Rössing material belongs to it.
- *Misumenops* species. Only one species known from Namibia, but it is unknown whether the Rössing material belongs to it.
- *Thomisus machadoi* and *T. schultzei*. Both widespread species.

4.4.2.32 Trochanteriidae (spiders, no common name)

Six specimens, of which 4 are from the Lower Dome Site, were identified as possibly *Platyoides* species There are 3 species known from Namibia, but it is not known what these are.

4.4.2.33 Uloboridae (hackled orb spiders)

One specimen was hand-sampled in the Ostrich Gorge area. There are at least 2 species known from Namibia, but it is not known which one this is.

4.4.2.34 Zodariidae (ant spiders)

- The genus *Ceasetius* includes 7 species from southern Africa. In the revision by Jocque (1990a) a single Namibian specimen, handsampled at the Panner Site, was listed as belonging to an undescribed species, but description was postponed till more material is available.
- *Capheris* species. The genus has 9 Namibian species. Found in pitfall traps.
- *Cydrela* species. One specimen hand-sampled under stones at the Upper Ostrich Site. Three species known from Namibia.

- *Cyrioctea namibiensis*. This species was described from Rössing material by Platnick & Griffin (1988) and is only known from there.
- *Diores namibia*. This species was described from Rössing material by Jocqué (1990b). Most were from pitfall traps, and it was especially numerous at the Panner Site.
- *Heradida griffinae*. Described and still only known from the Rössing material studied by Jocqué (1987). Found in pitfall traps at the Lower Dome, Upper and Lower Ostrich Sites.
- *Mallinus* species. Handsampled under stones only. The genus has been recorded from Namibia before, but specimens have not been assigned to any particular species yet.
- *Palfuria panner*. Described from Rössing material (the name refers to Panner Gorge). It was only found once in a pitfall trap, and is a Namibian endemic, but is widespread outside the Rössing area (Szütz & Jocqué 2001).
- *Psammoduon deserticola*. Sandloving species, not found during Rössing survey. However, Jocque (1990a) lists a specimen from 'Khan', suggesting that it may occur in windblown sand in the area.
- There are also some specimens in the museum collection labelled as Zodariidae gen. nov. Their status is indeterminate.

4.4.3 Opiliones (harvestmen)

Harvestmen are typically forest dwellers in moister climates, and the endemic Namibian species are anomalies. The Rössing specimens of *Namutonia scabra* were published on by Starega (1992).

4.4.4 Pseudoscorpiones (false scorpions)

Ectactolpium and *Pseudohorus* species. The Rössing material was identified to genus only. Eight *Ectactolpium* and 6 *Pseudohorus* species are known from Namibia, and more than one of each may potentially occur at Rössing. One specimen from the Arandis Site is identified in the museum collection as *P. vermiformis*, but no further information is currently available about this species.

4.4.5 Scorpionida (scorpions)

Additional distributional information for scorpions was derived from Lamoral (1979).

4.4.5.1 Bothriuridae

Lisposoma elegans. Found throughout the area. A Namibian endemic, but widespread beyond Rössing. Rössing material was listed by Prendini (2005).

4.4.5.2 Buthidae

- *Parabuthus brevimanus*. Recorded mainly from the Stockpile and Panner Sites.

- *Parabuthus gracilis*. Found at the Arandis, Upper Ostrich, Lower Ostrich and Panner Sites. Lamoral (1979) did not record the species further south than Cape Cross.
- *Parabuthus granulatus*. Not recorded during the survey, but a widespread species that is expected to occur in the Rössing area as well.
- *Parabuthus namibensis*. A Central Namib endemic that was found at the Arandis, Upper Ostrich, Lower Ostrich and Panner Sites. Rössing material has been published on by Prendini (2003, 2004).
- *Parabuthus villosus*. One specimen each found at the Arandis, Upper Ostrich and Panner Sites.
- *Uroplectes pilosus*. Found at most of the fixed sites. The only other known locality for the species prior to the Rössing survey was Cape Cross (Lamoral 1979).
- *Uroplectes planimanus*. One specimen from Stockpile Site. Widespread elsewhere.
- *Uroplectes* species. Two specimens from the Panner and Lower Dome Sites respectively are labelled in the museum collection as an undescribed species. In addition, the occurrence of e.g. *U. otjimbinguensis* and *U. gracilior* at Rössing is also plausible (the former is known from Swakopmund, Hentiesbaai and the interior, the latter is known i.a. from Trekkopje), even though theyhave not been recorded yet.

4.4.5.3 Ischnuridae

Hadogenes tityrus. One specimen from a pitfall trap at the Stockpile Site. Near-endemic to Namibia, but widespread elsewhere in the country.

4.4.5.4 Scorpionidae

- *Opisthophthalmus carinatus*. One specimen from a pifall trap at the Stockpile Site, another collected at the Mine Office Complex. A widespread species.
- *Opisthophthalmus coetzeei*. Found in pitfall traps at Arandis and Lower Dome Sites.
- *Opsthophthalmus wahlbergi*. One specimen in a pitfall trap at the Arandis Site.

4.4.6 Solifugae (solifuges, sun spiders)

4.4.6.1 Daesiidae

- *Biton* species. The genus has 16 known species in Namibia. Griffin (1990) considered the species in the Rössing material to be undescribed. It has not been described since. It was found in pittraps at mainly the Arandis and Upper Ostrich Sites.
- *Blossia falcifera.* Found at most fixed sites, but commonest at Lower Dome and Stockpile Sites. Widespread in southern Africa.

- *Blossia planicursor*. Found in pitfall traps, mainly at Arandis and Upper Ostrich Sites. Central Namib endemic.
- *Blossia* new species A of Griffin (1990). Found in pittraps at the Stockpile and Lower Dome Sites only.
- *Blossia* new species B of Griffin (1990). A total of only 3 speciemns found in pitfall traps at the Panner and Lower Ostrich Sites only.
- *Blossia rooica*. Three single specimens from pitfall traps at the Stockpile, Upper Ostrich and Lower Ostrich Sites respectively. This species was not included in the summary by Griffin (1990), but the specimens in the museum collection carry this identification, and they were listed as such in the original identification sheets. Its occurrence at Rössing is not impossible.
- *Hemiblossia etosha*. Found at all fixed pitfall trap sites.
- *Namibesia pallida*. Found at several of the fixed pitfall trap sites, but only in numbers at the Stockpile Site.

4.4.6.2 Gylippidae

Trichotoma michaelseni. Numerous in pitfall traps at the Arandis Site. Occasionally found at most of the other fixed trap sites, but absent from the rocky hillsides (Lower Dome and Stockpile Sites).

4.4.6.3 Hexisopodidae

Hexisopus moiseli. Two *Hexisopus* specimens were found in pitfall traps, at the Lower Ostrich and Panner Sites respectively, but both were juveniles and could not be identified to species. On distributional grounds, the species most likely to occur in the area is *H. moiseli*, since it has been recorded from i.a. ’32 km E of Swakopmund’, which was here assumed to be along the Swakopmund-Usakos road.

4.4.6.4 Melanoblossidae

- *Daesiella pluridens*. This species was not recorded during the survey. It is known only from ‘Arandis’ (Wharton 1981).
- *Lawrencega longitarsis*. Only found at the Upper Ostrich and Arandis Sites.
- *Lawrencega minuta*. Found at the Upper Ostrich, Arandis and Lower Ostrich Sites.
- *Lawrencega solaris*. Only found at the Upper Ostrich and Arandis Sites.
- *Lawrencega* new species. Found in numbers at the two rocky hillside fixed sites (Stockpile and Lower Dome Sites), but only occasionally at a few other sites. Listed as new in Griffin (1990), but not yet described. Known only from the Rössing area.

4.4.6.5 Solpugidae

- *Solpugassa furcifera.* A single specimen was found in a pitfall trap at the Lower Ostrich Site. It was not identified beyond genus. There are

two *Solpugassa* species in Namibia, and on distributional grounds the likely one to occur at Rössing is *S. furcifera*. This species was not included in the summary by Griffin (1990).

- *Solpugema* species. Found mostly in pitfall traps at the Arandis Site, but also hand-sampled at the Lower Ostrich Site. There are 5 species known from Namibia. Based on Wharton (1981), *S. genucornis* is the one most likely to occur at Rössing. This species was not included in the summary by Griffin (1990).
- *Solpugiba lineata*. Very common at the plains and riverbed fixed sites, but completely absent from the rocky hillside sites.
- *Solpugista bicolor*. Common at the plains fixed sites, occasionally found at the riverbed sites, absent from the rocky hillside sites.
- *Zeria lawrencei* . Found at several of the fixed pitfall trap sites, but absent from the rocky hillside sites.

4.5. Insecta (six-legged invertebrates, insects)

4.5.1 Blattodea (cockroaches)

Besides at least one species of alate cockroach (Blattodea species 1), eight morphospecies of apterous cockroaches were recorded in the pitfall trap survey. They were numbered as species 2, 5, 6, 7, 8, 9, 10 and 11 respectively. They were not identified further at the time. Blattodea species 2 was the most commonly encountered species and occurred at all pitfall trap sites as well as in handsampling blocks 3, 4 and 9. At the other end of the spectrum Blattodea species 11 was represented by a single specimen only. Most Blattodea occurred at the riverbed sites and the least on rocky hillsides.

4.5.2 Coleoptera (beetles)

4.5.2.1 Anthicidae (ant beetles)

Anthicidae were found in the pitfall traps but, being alate, they were not treated further.

4.5.2.2 Bruchidae (seed weevils)

Bruchidae may have been found in the pitfall traps, but being alate, they would not have been specifically noted. One species is known from the area: *Bruchidius cretaceus.* Recorded from Arandis (Anton & Delobel 2003).

4.5.2.3 Buprestidae (jewel beetles)

Being alate, Buprestidae were not specifically noted in the pitfall trap survey, but some material from the traps had been worked on since.

- *Acmaeodera decemguttata*. Recorded from the Stockpile Site (Holm 1986a). Widespread in southern Africa.

- *Acmaeodera liessnerae*. First described from material collected during the Rössing project (Holm 1986a), but also found elsewhere. Named after project participant Hella Liessner. Namibian endemic.
- *Acmaeodera penrithae*. First described in part from material collected during the Rössing project (Holm 1985). Namibian endemic.
- *Acmaeodera swammerdami*. Recorded from the Upper Ostrich Site by Holm (1986a). Widespread elsewhere.
- A few other *Acmaeodera* species have been recorded from localities surrounding the Rössing area and may potentially occur there as well.
- *Julodis egho*. Not recorded during the survey but probably does occur in the Rössing area, since it is widespread in the Namib Desert and is known i.a. from Palmenhorst near the Khan-Swakop confluence (Gussmann 2000).
- *Julodis namibiensis*. Rössing material was published on by Gussmann (1995).
- *Nothomorphoides irishi*. Described from pitfall trap material from the Arandis, Upper Ostrich and Lower Ostrich Sites (Holm 1986b), and still known only from there.

4.5.2.4 Carabidae (ground beetles)

- *Anthia* species. Common at the riverbed sites, also found on plains sites, absent from rocky hillsides. There are at least 4 species known from Namibia.
- *Graphipterus* species. At least 53 species are known from Namibia, many endemic and range-restricted. The Rössing material therefore holds high interest, but has not been identified further. A few specimens from pitfall traps at the Arandis, Upper Ostrich and Lower Ostrich Sites.
- *Microlestia* species. Only found at the Upper Panner Site, but relatively common there. At least 3 species are known from Namibia.
- Besides two alate morphospecies (Carabidae species 1 and 5), four presumably apterous morphospecies (Carabidae species 2, 3, 4 and 6 respectively) were found in the pitfall traps. Sp 2 was only found at the Panner Site, species 3 and 4 only at the Arandis Site, and species 5 and 6 only at the Stockpile Site.

The following two species are alate, but were treated throughout the survey as if they were apterous. The reason for this is no longer apparent.

- *Calosoma* species. At least 4 species are known from Namibia. Only once recorded, at the Stockpile Site.
- *Passalidius fortipes*. Found at the Arandis, Panner and Lower Ostrich Sites. Widespread elsewhere.

4.5.2.5 Chrysomelidae (leaf beetles)

Found in pitfall traps, but being alate, specific records were not kept.

4.5.2.6 Coccinellidae (ladybird beetles)

At least one species was found, but being alate, it was not treated further.

4.5.2.7 Curculionidae (snout beetles, weevils)

- *Brachycerus rotundatus*. Found in pitfall traps at the Arandis Site.
- *Brachycerus* cf. *granifer*. Found in pitfall traps at the plains sites, also handcolelcted at the plains blocks 2, 3 and 5.
- *Brachycerus* cf. *perfossus*. Once found in a pitfall trap at the Upper Ostrich Site.
- *Episus contractus*. A widespread species. At Rössing it was only found at plains pitfall sites, and also at plains handsampling blocks 2, 3 and 6. Louw (1986) had previously recorded the species from the area based on collections predating the Rössing survey.
- *Gronops brincki*. Not found in pitfall traps, but hand-collected in the area.
- *Hyomora manca*. Found in riverbed and plains pitfall traps. Louw (1981) had listed pre-survey material from the area.
- *Hypocolobus* species. In pitfall traps found only at the Panner Site, but also handsampled in blocks 1 and 5.
- *Hyomora porcella*. Found in pitfall traps, mainly at the plains sites.
- *Leptostethus spicatirostris*. Not recorded during the survey. Known from several collections near Rössing Mts, and one at Ganab, so probably occurs in the area (Thompson 1988).
- *Ocladius* species. Found mostly in plains pitfall traps, but also handsampled at plains blocks 4, 6 and13. There are seven species known from Namibia.
- *Spartecerus* cf. *mendax*. Mostly found in plains or watercourse pitfall traps, but also handsampled in blocks 4 and 8.
- *Spartecerus nasalis*. Mostly found in rocky hillside pitfall traps, but also handsampled in block 8.
- Brachyderinae species. Mostly from pitfall traps at the Arandis Site, with one record each from the Stockpile Site and handsampling block 1

All the previous Curculionidae are apterous. The following are alate:

- *Macrolarinus angustulus*. An alate species, but for some reason it was included in pitfall trap records till the end. Found at almost all sites.
- Ceutorhynchinae species Another alate, but included in data sheets. Also found at almost all fixed sites.
- *Lixus* species. Found once at the Panner Site.
- *Siderodactylus* species. Found at the Arandis Site only.
- Barinae species. Mostly found at the Panner Site.
- Zygopinae species. Only found at rocky hillside sites.

4.5.2.8 Dermestidae (museum beetles)

Commonly found in the pitfall traps, but alate and not treated further. Anon (no date, b) mentions an undescribed *Attagenus* species from Rössing under study by Dr. Kalik. No reference to such a species could be traced; the Museum library has no publications by Kalik.

4.5.2.9 Dytiscidae (water beetles)

Yolina brincki. A Namibian endemic. Mentioned in the limnological survey notes.

4.5.2.10 Glaresidae (tiny beetles, no common name)

Glaresis koenigsbaueri. Not found during survey, but probably occurs in area, as it is known both from the Rössing Mts and further inland (Scholtz 1983). A Namibian endemic.

4.5.2.11 Histeridae (hister beetles)

Found in pitfall traps, but alate, hence not treated further.

4.5.2.12 Hydraenidae (moss beetles)

Ochthebius species. Mentioned in the limnological survey notes. Six species are known from Namibia, two of them being endemic.

4.5.2.13 Hydrophilidae (water scavenger beetles)

Mentioned in limnological survey notes.

4.5.2.14 Meloidae (blister beetles

Several different species were found in pitfall traps, but since they are alate they were not treated further. One species has been described from the material:
Iselma deserticola. Known only from the Arandis, Upper Ostrich and Lower Dome Sites (Bologna *et al.* 2001).

4.5.2.15 Melyridae (flower beetles)

Specimens found in pitfall traps were not treated further at the time since they are alate, however, some have been independently identified:

- *Hedybius irishi*. Only known from 3 specimens found in pitfall traps at the Lower Ostrich Site only (Wittmer 1988).
- *Metaphilhedonus swakopmundensis*. Only known from pitfall traps at the Lower Dome, Stockpile and Lower Ostrich Sites (Wittmer 1989).

4.5.2.16 Monommidae (beetles, no common name)

Two morphospecies were found in pitfall traps, mostly those at rocky hillside sites. The family includes nine species in Namibia.

4.5.2.17 Ptinidae (spider beetles)

- Pitfall trap material was sorted into 5 morphospecies, but they were never identified further. In total, very few specimens were found, and most were from rocky hillside sites.
- *Damarus singularis.* A predominantly coastal species that has been recorded as far inland as Rössing Mtn (Irish 1996), but is unlikely to occur nearer to the mine. The origin of a purported undescribed *Damarus* species in the Rössing area, attributed to Irish in Anon (no date, b), is therefore unclear.

4.5.2.18 Scarabaeidae (dung beetles, fruit chafers)

Since they are alate, those found in pitfall traps were not treated further, however, some have been independently identified.

- *Anoplocheilus namibicus*. Survey material labelled 'Rössing Mine' (implying the Stockpile Site) was published on by Marais & Holm (1989).
- *Pycnopanelus krikkeni*. Found in pittraps at the Arandis Site, Upper and Lower Ostrich Sites (Scholtz & Howden 1987).

4.5.2.19 Silvanidae (flat grain beetles)

Specimens were found in plains and watercourse pitfall traps, and also handsampled in block 9, but since they are alate they were not treated further. There are 8 species known from Namibia.

4.5.2.20 Tenebrionidae (toktokkies, darkling beetles)

- *Aphrotus tricorniger*. Found in small numbers in pitfall traps at the Upper Ostrich, Arandis and Panner Sites.
- *Caenocrypticus damara*. Endemic to Central Western Namibia, this species was not recorded during the Rössing survey. However, since it is known from i.a. Rössing Mountain and the Khan River SE of Trekkopje (Endrödy-Younga 1996), it probably occurs near Rössing Mine which is between the previous two, as well.
- *Cauricara velox.* Found only in plains pitfall traps, and also handsampled in plains blocks 1 and 9.
- *Ennychiatus fitzsimonsi*. Found in pitfall traps at plains sites only.
- *Epiphysa arenicola*. Found in pitfall traps at all plains and watercourse sites, also handsampled in blocks 3 and10.
- *Eurychora* species. Found mainly in pitfall traps at plains sites, also handsampled in block 6.
- *Geophanus* species. Collected material was sorted into 3 morphospecies, species 1, 2 and 4 respectively. *Geophanus* species 1 was abundant at the Stockpile, Lower Dome and Lower Ostrich Sites. *Geophanus* species 2 was abundant at the Arandis and Upper Ostich Sites. *Geophanus* species 4 was present in low numbers at all sites. Species 2 and 4 were also handsampled in block 4.
- *Gonopus* species. These were especially numerous in pitfall traps at the Panner Site. The genus had been revised after the Rössing Survey,

but for some reason no material from there was included in the (posthumously produced) publication (Endrödy-Younga 2000). More than one species may occur in the area.

- *Herpiscius* species. Found mostly in pitfall traps on rocky hillsides. There are 3 species known from Namibia.
- *Horatoma deserticola.* A single specimen was found in a pitfall trap at the Arandis Site. The original description of the species was based in part on this specimen (Penrith & Endrödy-Younga 1994).
- *Horatoma spinipes*. Found in pitfall traps at rocky hillside sites only. Rössing material was described by Penrith & Endrödy-Younga (1994).
- *Metriopus depressus.* Found in pitfall traps at the plains and rocky hillside sites, but absent from the riverbed sites. Also handsampled in blocks 2, 3, 4, 5 and13.
- *Pachynoteles machadoi*. Only three specimens found in pitfall traps at the the Stockpile and Lower Ostrich sites. Material published on by Penrith & Endrödy-Younga (1994).
- *Pachynoteles punctipennis*. Found in pitfall traps at most of the fixed sites, particularly common at Lower Ostrich. The species was described mainly from Rössing material by Penrith & Endrödy-Younga (1994).
- *Palpomodes physoptera*. Found in pitfall traps at the plains sites of Arandis and Upper Ostrich only.
- *Parastizopus armaticeps*. Common in pitfall traps at plains and watercourse sites, also handcollected in block 4.
- *Phanerotomea damarense*. Common in plains and watercourse pitfall traps, also handcollected at block 1.
- *Physadesmia globosa*. Common in plains and watercourse pitfall traps, also handcollected at blocks 5, 6, 10 and 13.
- *Physosterna cribripes*. Common in plains and watercourse pitfall traps, also handcollected in block 4.
- *Planostibes* species. Found in pitfall traps at most fixed sites. There are 2 species known from Namibia.
- *Rhammatodes aequalipennis*. Very common in pitfall traps throughout the area, also handsampled in blocks 1, 3, 4, 5, 6, 8, 9 and 10.
- *Rhammatodes longicornis*. Common in pitfall traps, mainly at rocky hillside sites.
- *Rhammatodes tagenesthoides*. Found in pitfall traps at rocky hillside and watercourse sites, but much less common than either of the preceding two other *Rhammatodes* species.
- *Somaticus bohemani*. Found in pitfall traps mainly at the rocky hillside sites.
- *Somaticus stali*. Only two specimens from pitfall traps at the Arandis Site. Published information (Koch 1955) suggests that the species may be a range-restricted Central Namib endemic.
- *Stenocara aenescens.* A widespread species, that had previously been recorded i.a. from Rössing Mts and from Khan River SE of Trekkopje, so it can be expected to also occur at Rössing Mine which is between these two, but not recorded during the survey.

- *Stenocara dilaticornis*. Exceedingly common in pitfall traps at all fixed sites, also handsampled at block 1.
- *Stenocara gracilipes.* Common in pitfall traps at rocky hillside and watercourse sites.
- *Stips dohrni*. Found in pitfall traps at plains and riverbed sites, also handsampled in block 10.
- *Synhimba melancholica*. Found only in pittraps at the Lower Dome Site, but quite common there (obviously not any more). Also occurs outside the area.
- *Trachynotidus rufozonatus*. Found in pitfall traps throughout the area.
- *Zophosis (Calosis) amabilis*. A plains species found in pitfall traps at plains sites, also handcollected at blocks 1 and 9.
- *Zophosis (Carpiella) latisterna*. A plains species found in pitfall traps mostly at the Upper Ostrich Site.
- *Zophosis (Gyrosis) ornatipennis.* Found in pitfall traps mainly at watercourse and plains sites, also handcollected at blocks 4, 5 and 9.
- *Zophosis (Occidentophosis) damarina*. Found mainly in plains pitfall trap sites, also handcollected at blocks 1, 3, 5 and 6.
- *Zophosis (Protocalosis) balti*. A Central Western Namibian endemic that was not recorded during the survey, but had previously been recorded from Rössing Mountain, Arandis, and Trekkopje (the original farm 120, not the current mine), so it does occur in area (Penrith 1977).
- *Zophosis (Scopulophosis) fulgens*. A Central Western Namibian endemic, ranging from inland areas as far west as Rössing Mountain (Penrith 1977), so should occur near Rössing Mine, even though it was not recorded by the survey.
- *Zophosis(Z.) dorsata.* Found in pitfall traps at plains sites only.
- *Zophosis (Z.) kochi*. Found in pitfall traps, only at the Arandis Site, but quite common there. Also handsampled in the adjacent blocks 2, 3 and 5.
- *Zophosis (Z.) lamentabilis*. Only found in pitfall traps at the Arandis Site.
- *Zophosis (Z.) mniszechi*. A Central Western Namibian endemic known from many surrounding areas, i.a. recorded from Rössing Mountain (Penrith 1977). Was not recorded during the survey but probably occurs in the area.

A few Tenebrionidae could not be identified to species level at the time and were sorted into morphospecies.

- Tenebrionidae species 9. Found in pitfall traps throughout the area, quite common in places, also handsampled in block 10.
- Tenebrionidae species 10. Found at the Arandis, Upper and Lower Ostrich Sites.
- Tenebrionidae species 13. Found mainly at plains sites.
- Tenebrionidae species 16. Found at the Upper Ostrich Site only.
- Tenebrionidae species 17. Found at the Upper Ostrich and Panner Sites only.
- Tenebrionidae species 18. Found at plains sites only.
- Tenebrionidae species 27. A single specimen from handsampling in block 1.

The following alate Tenebrionidae were also recorded (the previous are all apterous).

- *Cheirodes* species.
- *Cyphostethe tau*. Found in plains and watercourse pitfall traps, also handsampled in block 9.
- *Neocaedius* species Extremely abundant in pitfall traps, but only at the Panner Site. Also handsampled at the nearby Piet-se-gat, and in the adjacent block 6.
- *Tribolium* species.
- Alleculinae. Pitfall material has been sorted into at least 2 morphospecies.
- Drosochrini. Found both in pitfall traps, and handsampled in blocks 2, 3 and 9.

4.5.2.21 Thorictidae (beetles, no common name)

A single specimen was found in a pitfall trap at the Stockpile Site. This is a badly known group. There is only one species known from Namibia, and that is known only from the original material collected at Gobabeb. It is not known whether the Rössing material belongs to it or not.

4.5.2.22 Coleoptera family indeterminate

Coleoptera species 1. This could not be assigned to any beetle family at the time. It was found in pitfall traps at the Stockpile and Panner Sites only.

4.5.3 Dermaptera (earwigs)

Earwigs prefer moister climates and are not very common in Namibia. Only 4 species have been recorded from the country. Therefore it is unexpected to find three morphospecies in the arid Rössing area.

- Dermaptera species 1. Found in pitfall traps at the Arandis and Panner Sites, and once found inside the guest house in Arandis.
- Dermaptera species 2. Common in pitfall traps at the Panner Site, only single specimens recored elsewhere.
- Dermaptera species 3. Found in small numbers in pitfall traps throughout most of the area.

4.5.4 Diptera (flies and allies)

Flies, being alate, were not specifically sampled for during the pitfall trap survey, but a large number got into the traps anyway. All this material was preserved, and some of it had found its way into print by now. What follows below does no credit to the diverse dipteran fauna of the Rössing area, though.

4.5.4.1 Asilidae (robber flies)

Notes mention Asilidae, without further details.

4.5.4.2 Bombyliidae (bee flies)

- *Apolysis thornei.* Recorded from the Upper Ostrich and Panner Sites (Greathead 2000).
- *Australoechus molitor*. Recorded from the Upper Ostrich and Stockpile Sites (Greathead 2000).
- *Australoechus naibensis*. Recorded from all sites except the Stockpile (Greathead 2000).
- *Crocidium immaculatum*. Recorded from the Panner Site only. Widespread elsewhere (Greathead 2000).
- *Crocidium phaenochilum*. Recorded from the Lower Dome Site only. Widespread elsewhere (Greathead 2000).
- *Heterotropus apertus*. Only known from 3 specimens collected during the Rössing survey. One is from the Upper Ostirch Site, the other two from the Stockpile Site (Greathead 2000).
- *Hyperusia soror*. Recorded from the Arandis and Upper Ostrich Sites. Namibian endemic, widespread elsewhere in the country (Greathead 2000).
- *Parisus aurantiacus*. Recorded from the Arandis Site (Greathead 2000).
- *Parisus damarensis*. Known only from the town of Okahandja, and 3 sites in the Rössing area (Greathead 2000).
- *Pteraulacodes hessei*. This species is known only from the imprecise locality ‘Welwitschia Flats’, which is in the Husab area across the Khan River from Rössing Mine (Lindner 1972). It could potentially occur in the mining area as well.

4.5.4.3 Calliphoridae (flesh flies)

- *Bengalia peuhi*. Found at the Panner Site (Kurahashi & Kirk-Spriggs 2006).
- *Chrysomya albiceps*. Found at the Arandis Site (Kurahashi & Kirk-Spriggs 2006).
- *Chrysomya chloropyga*. Found at the Upper Ostrich Site (Kurahashi & Kirk-Spriggs 2006).
- *Rhyncomya hessei*. Found at the Lower Ostrich Site (Kurahashi & Kirk-Spriggs 2006).
- *Rhyncomya messoria.* Found at the Upper Ostrich Site (Kurahashi & Kirk-Spriggs 2006).
- *Rhyncomya minutalis.* Found at the Arandis Site (Kurahashi & Kirk-Spriggs 2006).
- *Stomorhina guttata*. Found at the Panner Site (Kurahashi & Kirk-Spriggs 2006).
- *Zumba antennalis*. Found at the Panner and Lower Ostrich Sites (Kurahashi & Kirk-Spriggs 2006).

4.5.4.4 Ceratopogonidae (biting midges)

Aquatic larvae recorded by the limnological survey.

4.5.4.5 Chironomidae (midges)

Aquatic larvae recorded by the limnological survey.

4.5.4.6 Culicidae (mosquitoes)

Aquatic larvae recorded by the limnological survey. The following species identifications exist, but no further details are known.

- *Anopheles listeri*
- *Culex theileri*
- *Culiseta longiareolata*

4.5.4.7 Dolichopodidae (long-legged flies)

Aquatic larvae recorded by the limnological survey.

- *Hydrophorus praecox*. A widespread species, recorded (presumably as aquatic larvae) from 'Boulder Pool 3' and 'Panner HC7' by Grichanov (2000).

4.5.4.8 Ephydridae (shore flies)

Ephydra stuckenbergi. Found around water. Adults were recorded by the limnological survey, but no further details are known.

4.5.4.9 Hippoboscidae (horse flies)

Large horseflies were occasionally encountered during fieldwork. No further information is available.

4.5.4.10 Sarcophagidae (carrion flies)

Very numerous in pitfall trap material. No further information available.

4.5.4.11 Tephritidae (fruit flies)

- *Brachydesis rivularis.* Recorded from the Lower Dome Site (Hancock *et al.* 2001).
- *Deroparia reticulata*. Namibian endemic, recorded from the Lower Dome Site. (Hancock *et al.* 2001).
- *Desmella myiopitoides.* Recorded from the Lower Dome Site (Hancock *et al.* 2001).
- *Euryphalara barnardi*. Namibian endemic, recorded from the Lower Dome Site (Hancock *et al.* 2001).
- *Euryphalara mecistocephala*. Namibian endemic, recorded from most fixed pitfall trap sites (Hancock *et al.* 2001).
- *Hyaloctoides semiater*. Recorded from the Panner, Lower Dome and Lower Ostrich Sites (Hancock *et al.* 2001).

- *Hyaloctoides superhyalinus*. Near-endemic to Namibia. Recorded from the Lower Dome and Lower Ostrich Sites, also known from Husab Mountain (Hancock *et al.* 2001).
- *Hyalotephritis australis.* Recorded from the Lower Dome Site (Hancock *et al.* 2001).
- *Insizwa oblita*. Namibian near-endemic, recorded from the Panner Site (Hancock *et al.* 2001).
- *Leucothrix barbata.* Recorded from the Upper Ostrich and Lower Dome Sites, also known from Husab Mountain (Hancock *et al.* 2001).
- *Leucothrix oryx.* Recorded from the Stockpile Site, also known from Husab Mountain (Hancock *et al.* 2001).
- *Metasphenisca interrupta*. Recorded from most fixed pitfall trap sites (Hancock *et al.* 2001).
- *Metasphenisca longulior*. Recorded from the Panner Site (Hancock *et al.* 2001).
- *Platomma luniferum.* Namibian near-endemic, known i.a. from Husab Mountain (Hancock *et al.* 2001), probably occurs at Rössing as well.
- *Xenodorella mira*. Namibian endemic, recorded from the Arandis Site (Hancock *et al.* 2001).

4.5.5 Ephemeroptera (mayflies)

Mayflies of the family Baetidae were recorded, probably as aquatic nymphs, b the limnological survey.

4.5.6 Hemiptera (bugs)

Since most bugs are alate, those that were found in pitfall traps were preserved, but no specific records were kept.

4.5.6.1 Aphididae (aphids, plant lice)

Aphids were recorded as an aside by the limnological survey.

4.5.6.2 Cicadellidae (leafhoppers)

Found in pitfall traps, but alate and not treated further.

4.5.6.3 Cicadidae (cicadas)

Occasionally found in pitfall traps, but alate and not treated further.

4.5.6.4 Fulgorioidea (planthoppers)

At least five morphospecies were recorded in the first month, before alate taxa were discarded. These initial records indicate the following site preferences.

- Fulgorioidea species 1. Only at the Lower Dome Site.
- Fulgorioidea species 2. Only at the Arandis Site.
- Fulgorioidea species 3. Only at the Panner Site.

- Fulgorioidea species 4. Only at the Lower Dome and Stockpile Sites (rocky hillsides).
- Fulgorioidea species 5. Only at the Arandis Site.

4.5.6.5 Lygaeidae (seed bugs, ground bugs)

Certainly occur, but alate and records not kept.

4.5.6.6 Naucoridae (saucer bugs)

Aquatic species recorded b the limnological survey.

4.5.6.7 Pentatomidae (stink bugs)

Certainly occur, but alate and records not kept.

4.5.6.8 Pleidae (pygmy backswimmers)

Aquatic species recorded bu the limnological survey.

4.5.6.9 Psyllidae (jumping plant lice)

Three species of endemic psyllids have been recorded from *Tamarix* trees in the Lower Swakop River between the mouth and Goanikontes (Hollis 1974). They potentially occur in the Khan River adjacent to Rössing Mine as well. They were not recorded during the survey. They are *Colposcenia australis, Colposcenia namibiensis* and *Crastina swakopensis*. The former two are also known from the Lower Kuiseb River, but the latter is endemic to the Lower Swakop River according to current knowledge.

4.5.6.10 Reduviidae (assassin bugs)

Besides at least one alate species that was not treated further, five apterous morphospecies were found in pitfall traps. Some of these might be juveniles of alate species.

- Reduviidae species 2. Found mostly at the Panner Site, also handsampled in block 3.
- Reduviidae species 3. Found at most sites, also handsampled in block 2.
- Reduviidae species 4. Found ,mostly at the Upper Ostrich Site, also handsampled in block 2 (which includes the Upper Ostrich Site).
- Reduviidae species 5. One specimen found at the Panner Site only.
- Reduviidae species 6. One specimen found at the Upper Ostrich Site only.

4.5.6.11 Tingidae (lace bugs)

Found in pitfall traps, but alate and not treated further.

4.5.7 Hymenoptera (bees, wasps, ants)

Just as for flies, bees were commonly found in pitfall traps and all were preserved, but since most hymenopterans are alate, they were not considered further. What follows below does no credit to the diverse hymenopteran fauna in the Rössing area.

4.5.7.1 Andrenidae (bees, no common name)

Meliturgula haematospila. Recorded from the Lower Dome Site, also handsampled but block not recorded (Eardley 1991b).

4.5.7.2 Anthophoridae (carpenter bees)

- *Tetraloniella abrochia.* Described in part based on Rössing material, from the Stockpile Site (Earley 1989), but widespread, albeit rare, elsewhere.
- *Thyreus delumbatus.* Recorded from the Arandis and Upper Ostrich Sites, also handsampled but block not recorded (Eardley 1991a).

4.5.7.3 Apidae (honey bees)

The ubiquitous honey bee, *Apis mellifera*, also occurs in the Rössing area.

4.5.7.4 Bethyloidea (cuckoo wasps and allies)

Besides normally alate species, the group includes species where one or both sexes are apterous. Apterous specimens referable to Bethyloidea were found in pitfall traps. Only one species seemed to be involved, but it was not identified further. Most came from the Lower Ostrich Site.

4.5.7.5 Formicidae (ants)

Worker ants, being apterous, were recorded in the pitfall traps. Alate, reproductive ants were seldom found – those that were are presumed to belong to the same species as the workers. Unfortunately most ants were only recorded as morphospecies and not identified further.

- *Camponotus fulvopilosus.* This common ant was encountered at most fixed sites, but was more common in watercourses. Also handsampld in blocks 5 and 9.
- Formicidae species 1. Very common at rocky hillside and watercourse sites, but almost absent from plains sites (although handsampled in block 9).
- Formicidae species 2. One specimen from the Lower Ostrich Site only.
- Formicidae species 3. Very common at all fixed sites.
- Formicidae species 4. Very common at all fixed sites, also handsampled in block 6.
- Formicidae species 5. Found at all fixed sites, also handsampled in block 9.
- Formicidae species 6. Found in small numbers at most fixed sites.

- Formicidae species 7. Found at rocky hillside and watercourse sites only.
- Formicidae species 8. Very common at all fixed sites, also handsampled in block 4.
- Formicidae species 9. Very few specimens found, almost all of them at the Arandis Site.

4.5.7.6 Mutillidae (velvet ants)

Male velvet ants are apterous and were recorded, while the alate females were preserved but not treated further.

- Mutillidae species 1. Found at all fixed sites, also handsampled in block 1.
- Mutillidae species 2. Found at most fixed sites.
- Mutillidae species 3. Found at the Arandis, Lower and Upper Ostrich Sites only.
- Mutillidae species 4. Found in small numbers at most fixed sites, commoner at the Stockpile and Upper Ostrich Sites.
- Mutillidae species 5. Mostly found at plains and watercourse sites, also handsampled in block 3.
- Mutillidae species 6. Only two specimens found, one at each of the Upper and Lower Ostrich Sites.
- Mutillidae species 7. Small numbers were found at various fixed sites, with no obvious distribution pattern emerging.
- Mutillidae species 8. Found in larger numbers at the Stockpile and Panner SItes, but almost absent everywhere else.

4.5.7.7 Parasitica (parasitic wasps)

A large variety of tiny parasitic wasps were found in pitfall traps. Being alate, they were preserved but not treated further.

4.5.7.8 Pompilidae (spider-hunting wasps)

Being alate, these were preserved but not treated further. Given the high diversity of spiders in the area, a corresponding diversity of specialist spider predators is expected.

4.5.7.9 Sphecidae (sand wasps)

Specimens were found in pitfall traps, but being alate, were not treated further. The following three species are known in the literature (Lomholdt 1985) from ’40 km NE Swakopmund’ and may be expected to occur in the mining area as well.

- *Miscophus kriechbaumeri*. Widespread elsewhere.
- *Miscophus sabulosus*. Central Namib endemic.
- *Namiscophus pilosus*. Central Namib endemic.

4.5.8 Isoptera (termites)

Worker termites are apterous, and were recorded in the pitfall traps. Alate reproductive termites were encountered only twice, in response to rainfall events.

- Hodotermitidae, *Hodotermes mossambicus*. The ubiquitous harvester termite was abundant at all fixed trap sites, also handsampled in blocks 9 and 13. It had previously been reported from three places in the Rössing area, all along the Usakos-Swakopmund main road (Coaton & Sheasby 1975).
- Kalotermitidae, *Epicalotermes* species. Found in small numbers at most fixed sites. Coaton & Sheasby (1972) had already recorded the genus (no species specified) along the main road through the area.
- Termitidae, Nasutitermitinae species. Small numbers were found at the Lower Ostrich Site, and a few at the Arandis Site. They have not been identified further, but the only genus that is expected to occur in the Rössing area is *Trinervitermes*, of which 4 species are known from Namibia (Coaton & Sheasby 1972).
- Rhinotermitidae, *Psammotermes allocerus*. Not recorded during the survey, probably because their habits are not conducive to sampling by pitfall trap methods. They have been recorded from several places along the main road through the area by Coaton & Sheasby (1973).

4.5.9 Lepidoptera (butterflies and moths)

Numerous butterflies and moths were found in the pitfall traps, but the loss of scales and setae following immersion in liquid generally renders them unidentifiable to the point where it was believed it would serve no purpose to even preserve them. They were commonly seen during the survey, but not collected. The handcollecting methods employed were aimed at recording the widest variety of insects in the limited time available, and the specialised and time-consuming treatment needed by Lepidoptera was not compatable with this. The rotary trap, which was meant to fill the gap and capture flying insects like these, did not function. As a result, no Lepidoptera were recorded, and the true diversity and abundance of the group remains essentially unknown for the area.

4.5.10 Mantodea (mantids)

Two apterous mantid specimens each were collected at the Stockpile and Upper Ostrich Sites respectively. They were not identified further.

4.5.11 Neuroptera (lacewings and antlions)

Lacewings were found in preservative traps, but are alate and were not treated further.

4.5.12 Odonata (dragonflies and damselflies)

Rössing material was collected mainly by the limnological survey as aquatic nymphs, but adults were also handsampled by the entomological survey, e.g. at the Arandis Sewerage works. Since Odonata are alate the material was not treated further at the time, but it is known to have since been identified and incorporated into Suhling & Martens (2007). The latter, however, does not list localities, and while dots in the Rössing area are apparent on the distribution maps for some species, the tiny size of the maps does not allow any details to be deduced. The following list is therefore certainly incomplete.

- Aeshnidae, *Anax* species. Limnological survey.
- Coenagrionidae species. Limnological survey.
- Gomphidae, *Paragomphus* species. Limnological survey
- Libellulidae, unspecified species. Limnological survey.
- *Palpopleura jucunda*. Martens *et al.* (2003) recorded this widespread species from near the main road in the Rössing area east of Arandis.

4.5.13 Orthoptera (grasshoppers, locusts and crickets)

4.5.13.1 Acrididae (short-horned grasshoppers)

A variety of grasshoppers occur, but being alate, only the following one apterous species was recorded.

- Lithidiinae species. Tiny apterous grasshoppers that were found in pitfall traps at plains and watercourse sites, but not on rocky hillsides. Also handsampled in block 4. Some 7 species in 2 genera are known from Namibia, and many are endemic, but these were not identified further.

4.5.13.2 Bradyporidae (koringkrieks, armoured ground crickets)

- *Acanthoplus longipes.* Namibian near-endemic, only found on rocky hillside fixed trap sites at Rössing (Irish 1992). Also handsampled in block 4, which is consistent with rocky hillsides.
- *Acanthoproctus cervinus*. Found throughout area, but more commonly recorded at the plains fixed trap sites (Irish 1992).

4.5.13.3 Gryllidae (crickets)

Most crickets are alate and were not recorded, but five apterous morphospecies were recorded from pitfall traps. At least one belonged to the Mogoplistinae, a subfamily of tiny apterous crickets.

- Gryllidae species 1. Found at all fixed trap sites, but commoner at the plains and watercourse sites.
- Gryllidae species 2. Found mainly at plains and watercourse sites.
- Gryllidae species 3. Found only at plains and watercourse sites.
- Gryllidae species 4. Found in small numbers at most fixed trap sites.
- Gryllidae species 5. Two specimens from the Lower Ostrich Site only.

4.5.13.4 Lathiceridae (grasshoppers, no common name)

The family is near-endemic to Namibia

- *Crypsicerus cubicus*. Namibian endemic. Commonest at the plains sites, but a few recorded at the Panner Site as well (Irish 1988a).

4.5.13.5 Pamphagidae (grasshoppers, no common name)

Trachypetrella anderssonii. The widespread Toad Grasshopper was only found at the plains trap sites at Rössing (Irish & Roberts 2006). Also handsampled in block 1, which is consistent with plains.

4.5.13.6 Schizodactylidae (feather-toed crickets)

Comicus campestris. Namibian near-endemic. Found at all fixed trap sites, but most common at plains and watercourse sites (Irish 1986).

4.5.13.7 Tettigoniidae (long-horned grasshoppers)

Most tettigoniids are alate. The following three apterous morphospecies were encounterd in very low numbers only. They may turn out to be nymphs of alate species.

- Tettigoniidae species 1. Found at rocky hillside and watercourse sites only, not on the plains.
- Tettigoniidae species 2. Only two specimens, from the Lower Dome site.
- Tettigoniidae species 3. Only one specimen, from the Lower Dome site.

4.5.13.8 Thericleidae (grasshoppers, no common name)

Thericles species. An apterous grasshopper, found in low numbers throughout area. The genus includes 4 species in Namibia.

4.5.14 Phasmatodea (stick insects)

A total of only 3 specimens were found, only at the two watercourse sites. The material was sorted into two morphospecies, but not identified further.

- Phasmatodea species 1.
- Phasmatodea species 2.

4.5.15 Psocoptera (book lice)

Includes both alate and apterous species. Not noted during survey, but known to have been handcollected in the area.

4.5.16 Siphonaptera (fleas)

A single flea was found in a pitfall trap at the Arandis Site. Since fleas are ectoparasites of vertebrates, it is presumed to have come from one of the rodents that occasionally fell into the preservative traps. They are probably found wherever their hosts occur.

4.5.17 Thysanoptera (thrips)

Found in pitfall traps, but alate and not treated further.

4.5.18 Thysanura (silverfish, fishmoths)

All the following belong to the family Lepismatidae.

- *Afrolepisma* species. Two specimens from pitfall traps at the Panner Site. At least 4 species are known from Namibia, but since they have not been revised yet, it is not possible to assign the specimens to a species. The genus is normally found in inland area, and is unexpected in the desert.
- *Ctenolepisma detritus*. A Central Namib endemic, described i.a. from Rössing material (Irish 1987a). Found at plains and watercourse sites, not on rocky hillsides. Also handsampled in blocks 1, 5 and 9, which is consistent with plains.
- *Ctenolepisma grandipalpis*. One specimen from a pitfall trap at the Lower Ostrich Site, also handsampled in block 4.
- *Ctenolepisma namibensis*. A Central Namib endemic, described in part on Rössing material (Irish 1987a). Found in pitfall traps at the Arandis and Lower Ostrich Sites only. Also handsampled in blocks 2, 5 and 9, which suggest a plains association. Its listing as a species of concern in Anon (no date, b) cannot be justified under the criteria followed here.
- *Ctenolepisma occidentalis*. Known only from the Rössing area, from material collected during the survey (Irish 1987a). Found mostly in pitfall traps at plains and watercourse sites. Also one specimen handsampled in block 13.
- *Ctenolepisma plusiochaeta*. Namibian endemic. Not recorded in pitfall traps. Handsampled once in block 3 (Irish 1987a).
- *Ctenolepisma* new species near *pauliani*. This species is only known from pitfall trap material collected during the Rössing survey (small numbers at the Arandis, Upper and Lower Ostrich Sites), but has never been described. Preservative pitfall trap material is sufficient to identify lepismatids, but generally too damaged to allow descriptions of new species. The species it most resembles, *C. pauliani*, is an endemic Namib dune specialist.
- *Ctenolepisma penrithae*. A Central Namib endemic. Found in small numbers at most sites, but commoner on rocky hillsides.
- *Monachina stilifera*. Recorded from the Arandis and Lower Ostrich Sites, and also handsampled in block 13 (Irish 1988b).
- *Thermobia aegyptiaca*. Common in pitfall traps only at rocky hillside sites (Irish 1988c). Also handsampled in block 4, which is consistent with this.
- *Thermobia nebulosa*. Namib endemic, described in part on Rössing material (Irish 1988c). Recorded from the Arandis, Upper and Lower Ostrich Sites. Since it is widespread throughout the Namib, its listing as a species of concern in Anon (no date, b) cannot be justified.
- *Thermobia vallaris*. Not found in pitfall traps, but described in part on material that was handsampled in block 4 (Irish 1988c).

4.6. Amphibia (frogs)

Berger-Dell'Mour (1985) listed the following from the Rössing area, no specific localities given, not recorded in pitfall traps. Both are widespread elsewhere.

- *Poyntonophrynus hoeschi*. Toad.
- *Xenopus laevis*. Platanna.

Griffin (pers. comm.) adds the following.

- *Phrynomantis annectens*. Rubber Frog. Expected.

4.7. Reptilia (reptiles)

4.7.1 Agamidae (agamas)

Berger-Dell'Mour (1985) listed the following from the Rössing area, no specific localities given, not recorded in pitfall traps. Both are widespread elsewhere.

- *Agama anchietae*. Western Rock Agama.
- *Agama planiceps*. Namibian Rock Agama.

4.7.2 Chamealeonidae (chamaeleons)

Chamaeleo namaquensis. Namaqua Chameleon. Recorded from the Upper Ostrich Site.

4.7.3 Colubridae (snakes)

- *Dipsina multimaculata*. Dwarf Beaked Snake. Recorded from the Arandis Site.
- *Lamprophis fuliginosus*. Brown House Snake. Recorded from the Upper Ostrich Site.
- *Psammophis namibiensis*. Namib Sand Snake. Recorded by Berger-Dell'Mour (1985), no site specified.
- *Psammophis trigrammus*. Western Whip Snake. Recorded by Berger-Dell'Mour (1985), no site specified.

4.7.4 Gekkonidae (geckos)

- *Chondrodactylus angulifer*. Giant Ground Gecko. Recorded from the Arandis Site.
- *Narudasia festiva*. Festive Gecko. Recorded from the Stockpile and Panner Sites.
- *Chondrodactylus turneri*. Button-scale Gecko. Recorded from the Upper Ostrich Site.
- *Pachydactylus bicolor*. Velvety Gecko. Recorded from the Arandis Site.
- *Pachydactylus kochii*. Namib Ghost Gecko. Recorded from the Panner Site.
- *Pachydactylus punctatus*. Speckled Gecko. Recorded from the Upper and Lower Ostrich, Panner and Arandis Sites. Griffin (pers. comm.) is

of the opinion that these are more likely referable to *Pachydactylus scherzi*, the Namib Variable Gecko.
- *Pachydactylus weberi werneri*. Weber's Gecko. Recorded from the Stockpile Site.
- *Ptenopus garrulus.* Common Barking Gecko. Recorded from the Upper and Lower Ostrich, Arandis and Panner Sites. Especially numerous at the watercourse sites.
- *Rhoptropus afer.* Namib Day Gecko. Recorded mostly from the Upper Ostrich Site, occasionally at the Arandis and Lower Ostrich Sites.
- *Rhoptropus barnardi*. Barnard's Namib Day Gecko. Listed by Berger-Dell'Mour (1985), but no sites specified.
- *Rhoptropus bradfieldi*. Bradfield's Namib Day Gecko. Recorded from the Lower Dome, Stockpile, Panner and Lower Ostrich Sites.

4.7.5 Gerrhosauridae (plated lizards)

Cordylosaurus subtessellatus. Dwarf Plated Lizard. Recorded from the Lower Ostrich Site.

4.7.6 Lacertidae (lizards)

- *Meroles suborbitalis*. Spotted Sand Lizard. Recorded from the Upper Ostrich, Arandis and Lower Ostrich Sites.
- *Pedioplanis breviceps*. Short-headed Sand Lizard. Recorded from the Upper Ostrich, Arandis and Lower Ostrich Sites.
- *Pedioplanis husabensis*. Husab Sand Lizard. Recorded from Lower Dome, Stockpile, Panner and Lower Ostrich Sites, but commonest at the former two (rocky hillsides). This species was first discovered during the Rössing project (Berger-Dell'Mour & Mayer, 1989). It is a Central Namib endemic only found in a restricted area around the Lower Swakop and Khan Rivers.
- *Pedioplanis namaquensis*. Namaqua Sand Lizard. Listed by Berger-Dell'Mour (1985), but no sited specified.
- *Pedioplanis undata*. Western Sand Lizard. Recorded from the Upper Ostrich, Arandis and Lower Ostrich Sites.

4.7.7 Leptotyphlopidae (worm snakes)

- *Leptotyphlops occidentalis*. Namibian Worm Snake. Recorded from the Upper Ostrich, Arandis and Panner Sites, especially common at the latter.

4.7.8 Scincidae (skinks)

- *Trachylepis acutilabris*. Wedge-snouted Skink. Listed by Berger-Dell'Mour (1985), but no sites given.
- *Trachylepis hoeschi*. Western Rock Skink. Recorded from the Stockpile, Panner and Lower Ostrich Sites.

- *Trachylepis occidentalis*. Western Three-lined Skink. Recorded from the Upper Ostrich, Arandis, Panner and Lower Ostrich Sites.
- *Trachylepis spilogaster*. Namibian Tree Skink. Listed by Berger-Dell'Mour (1985), but no sites given – probably Khan River.
- *Trachylepis sulcata*. Koppie Skink. Listed by Berger-Dell'Mour (1985), but no sites given.
- *Trachylepis variegata*. Western Variegated Skink. Recorded from the Arandis and Panner Sites.
- *Scelotes capensis*. Namibian Dwarf Burrowing Skink. Record based on a photograph taken by J. Irish between Arandis Town and Arandis Site, identified by M. Griffin.

4.7.9 Typhlopidae (blind snakes)

Rhinotyphlops lalandei. Delalande's Blind Snake. Recorded from the Upper Ostrich Site.

4.7.10 Viperidae (adders)

- *Bitis caudalis*. Horned Adder. Recorded from the Arandis Site.

4.8. Aves (birds)

The following birds were recorded by either Colahan (1987) or Komen (undated checklist on file at RUL), or both.

- *Agapornis roseicollis*. Rosy-faced Lovebird.
- *Amadina erthrocephala.* Red-headed Finch.
- *Ammomanopsis grayi*. Gray's Lark.
- *Anthus cinnamomeus*. African Pipit.
- *Anthus similis*. Long-billed Pipit.
- *Apus affinis*. Little Swift.
- *Apus apus*. Common Swift.
- *Apus bradfieldi*. Bradfield's Swift.
- *Aquila verreauxii*. Verreaux's Eagle.
- *Batis pririt*. Pririt Batis.
- *Bradornis infuscatus*. Chat Flycatcher.
- *Bradornis mariquensis*. Marico Flycatcher.
- *Bubo africanus*. Spotted Eagle Owl.
- *Burhinus capensis*. Spotted Thick-knee.
- *Calendulauda africanoides*. Fawn-coloured Lark.
- *Calendulauda sabota.* Sabota Lark.
- *Cercomela familiaris*. Familiar Chat.
- *Cercomela schlegelii*. Karoo Chat.
- *Cercomela tractrac.* Tractrac Chat.
- *Cercotrichas paena.* Kalahari Scrub Robin.
- *Certhilauda subcoronata*. Karoo Long-billed Lark.
- *Chersomanes albofasciata*. Spike-heeled Lark.

- *Cinnyris fuscus*. Dusky Sunbird.
- *Circaetus pectoralis*. Black-chested Snake-Eagle.
- *Cisticola subruficapilla*. Grey-backed Cisticola.
- *Colius colius*. White-backed Mousebird.
- *Columba livia*. Rock Dove (Feral Pigeon).
- *Columba guinea*. Speckled Pigeon.
- *Corvus albus*. Pied Crow.
- *Corvus capensis*. Cape Crow.
- *Crithagra albogularis*. White-throated Canary.
- *Crithagra atrogularis*. Black-throated Canary.
- *Cursorius rufus*. Burchell's Courser.
- *Dicrurus adsimilis.* Fork-tailed Drongo.
- *Emberiza capensis*. Cape Bunting.
- *Emberiza impetuani*. Lark-like Bunting.
- *Emberiza tahapisi*. Cinnamon-breasted Bunting.
- *Eremomela gregalis*. Karoo Eremomela.
- *Eremomela icteropygialis*. Yellow-bellied Eremomela.
- *Eremopterix verticalis*. Grey-backed Sparrowlark.
- *Estrilda astrild*. Common Waxbill.
- *Eupodotis ruepellii*. Ruppell's Korhaan.
- *Falco biarmicus*. Lanner Falcon.
- *Falco rupicoloides*. Greater Kestrel.
- *Falco tinnunculus*. Rock Kestrel.
- *Granatina granatina*. Violet-eared Waxbill.
- *Hirundo fuligula*. Rock Martin.
- *Hirundo rustica*. Barn Swallow.
- *Lamprotornis nitens*. Cape Glossy Starling.
- *Lanius collaris*. Common Fiscal.
- *Malcorus pectoralis*. Rufous-eared Warbler.
- *Melierax canorus.* Southern Pale Chanting Goshawk.
- *Merops hirundineus*. Swallow-tailed Bee-eater.
- *Monticola brevipes*. Short-toed Rock Thrush.
- *Nilaus afer*. Brubru.
- *Numida meleagris*. Helmeted Guineafowl.
- *Oena capensis*. Namaqua Dove.
- *Oenanthe monticola*. Mountain Wheatear.
- *Oenanthe pileata*. Capped Wheatear.
- *Onychognathus nabouroup*. Pale-winged Starling.
- *Parisoma layardi.* Layard's Tit-babbler.
- *Parisoma subcaeruleum.* Chestnut-vented Titbabbler.
- *Parus carpi*. Carp's Tit.
- *Parus cinerascens*. Ashy Tit.
- *Passer diffusus*. Southern Grey-headed Sparrow.
- *Passer domesticus*. House Sparrow.
- *Passer melanurus*. Cape Sparrow.
- *Plocepasser mahali*. White-browed Sparrow-Weaver.
- *Ploceus velatus*. Southern Masked Weaver.

- *Prinia flavicans*. Black-chested Prinia.
- *Pterocles bicinctus*. Double-banded Sandgrouse.
- *Pterocles namaqua*. Namaqua Sandgrouse.
- *Pycnonotus nigricans*. African Red-eyed Bulbul.
- *Riparia paludicola*. Brown-throated Martin.
- *Rhinoptilus africanus*. Double-banded Courser.
- *Spizocorys starki*. Stark's Lark.
- *Sporopipes squamifrons*. Scaly-feathered Finch.
- *Streptopelia capicola*. Cape Turtle Dove.
- *Streptopelia senegalensis*. Laughing Dove.
- *Struthio camelus*. Common Ostrich.
- *Sylvietta rufescens*. Long-billed Crombec.
- *Tachymarptis melba*. Alpine Swift.
- *Telophorus zeylonus*. Bokmakierie.
- *Tricholaema leucomelas*. Acacia Pied Barbet.
- *Tyto alba*. Barn Owl.
- *Vanellus coronatus*. Crowned Lapwing.
- *Zosterops pallidus*. Orange River White-eye.

From the same sources, the following wetland birds were associated with open water either on the mine or at the Arandis sewerage works.

- *Actitis hypoleucos*. Common Sandpiper.
- *Acrocephalus baeticatus*. African Reed-Warbler.
- *Alopochen aegyptiaca.* Egyptian Goose.
- *Amaurornis flavirostris*. Black Crake.
- *Anas capensis*. Cape Teal.
- *Anas erythrorhyncha*. Red-billed Teal.
- *Anas hottentota*. Hottentot Teal.
- *Anas smithii*. Cape Shoveller.
- *Ardea cinerea*. Grey Heron.
- *Ardea melanocephala*. Black-headed Heron.
- *Calidris minuta*. Little Stint.
- *Charadrius hiaticula*. Common Ringed Plover.
- *Charadrius marginatus*. White-fronted Plover.
- *Charadrius pecuarius*. Kitlitz's Plover.
- *Charadrius tricollaris*. Three-banded Plover.
- *Fulica cristata*. Red-knobbed Coot.
- *Gallinula chloropus*. Common Moorhen.
- *Himantopus himantopus*. Black-winged Stilt.
- *Motacilla capensis*. Cape Wagtail.
- *Netto erythrophthalma*. Southern Pochard.
- *Oxyura maccoa*. Maccoa Duck.
- *Pelecanus onocrotalus*. Great White Pelican.
- *Phalacrocorax africanus*. Reed Cormorant.
- *Philomachus pugnax*. Ruff.
- *Phoenicopterus ruber*. Greater Flamingo.
- *Phoenicopterus minor*. Lesser Flamingo.

- *Podiceps nigricollis*. Black-necked Grebe.
- *Recurvirostra avosetta*. Pied Avocet.
- *Tachybaptus ruficollis*. Little Grebe.
- *Tadorna cana*. South African Shelduck.
- *Tringa glareola*. Wood Sandpiper.
- *Tringa nebularia*. Common Greenshank.
- *Tringa stagnatilis*. Marsh Sandpiper.
- *Vanellus armatus*. Blacksmith Lapwing.
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4.9. Mammalia (mammals)

The following were recorded during the small mammal trap survey.

- *Aethomys namaquensis*. Namaqua Rock Rat. Found at the Panner and Lower Ostrich Sites only.
- *Crocidura cyanea.* Reddish-grey Musk Shrew. One specimen from an invertebrate trap at the Stockpile Site only.
- *Desmodillus auricularis.* Short-tailed Gerbil. Found at the Panner, Upper and Lower Ostrich Sites only.
- *Gerbillurus paeba.* Pygmy Gerbil. Common at the Arandis Site, occasionally at the Panner and Upper Ostrich Sites.
- *Gerbillurus setzeri.* Namib Brush-tailed Gerbil. Common at the Arandis, Panner, Upper and Lower Ostrich Sites.
- *Macroscelides proboscideus*. Round-eared Elephant Shrew. Found at the Arandis, Upper Ostrich and Lower Dome sites only.
- *Petromyscus collinus*. Namibian Pygmy Rock Mouse. Recorded by the mammal survey at the Panner Site only, but also found in invertebrate traps at the Arandis, Stockpile, Lower Dome and Lower Ostrich Sites.
- *Rhabdomys pumilio*. Three-striped Mouse. One specimen from an invertebrate trap at the Panner Site only.
- *Thallomys paedulcus*. Tree Rat. Found at the Lower Ostrich Site only.

4.10. Micro-plants

Archibald (1987) reported 36 diatom taxa from Rössing water samples, emanating from the limnological survey, but they were listed by sample numbers only, lacking localities. Some taxa were stated to be endemic to Namibia, but none were specific to the Rössing area.

Algae are mentioned in the limnological survey notes.

4.11. Lichens

Anon (no date, a) mentions 2 unidentified lichens.

4.12. Plants

Occurrence at survey and other sites of interest (as per specimens in Herbarium database) were specifically mentioned below.

4.12.1 Acanthaceae

- *Blepharis bossii*. Listed in Anon (no date, a), no localities.
- *Blepharis grossa*. Arandis, Lower Dome and Stockpile Sites. Also Khan Mine.
- *Blepharis obmitrata*. Lower Dome Site.
- *Doellia caffra*.
- *Monechma cleomoides*. Lower Dome, Lower Ostrich, Stockpile and Upper Ostrich Sites. Also 'Northeast of mine'.
- *Monechma debile*. Arandis
- *Monechma desertorum*. Upper Ostrich Site.
- *Monechma genistifolium*. Arandis Site.
- *Petalidium canescens*. Panner and Stockpile Sites. Also 'Mining area'.
- *Petalidium lanatum*. Arandis.
- *Petalidium variabile*. Lower Ostrich, Panner and Stockpile Sites.
- *Ruellia diversifolia*. Khan Mine and Mining Area.

4.12.2 Aizoaceae

- *Aizoanthemum dinteri*. Lower Dome Site.
- *Aizoanthemum membrumconnectens*. Listed in Anon (no date, a), no localities.
- *Galenia africana*. Arandis and along main road.
- *Galenia meziana*. Listed in Anon (no date, a), no localities.
- *Sesuvium sesuvioides*. Arandis area, Khan Mine, Mining area, Panner and Upper Ostrich Sites.
- *Tetragonia reduplicata.* Panner Site, also near mine gate.
- *Trianthema parvifolia*. Stockpile Site, also Mining Area.

4.12.3 Amaranthaceae

- *Arthraerua leubnitziae*. Arandis, Panner and Upper Ostrich Sites.
- *Calicorema capitata*. Arandis.
- *Hermbstaedtia argenteiformis*. Khan River.
- *Hermbstaedtia spathulifolia*. Lower Dome and Panner Sites.
- *Sericocoma heterochiton*. Mine area.
- *Sericorema sericea*. Panner Site.

4.12.4 Anacardiaceae

- *Rhus marlothii*. Arandis area, Khan River valley.

4.12.5 Apocynaceae

- *Cryptolepis decidua.* Arandis and Stockpile Sites.
- *Gomphocarpus filiformis*. Arandis Mountain, along Main road, Upper Ostrich Site.
- *Hoodia currorii*. Arandis.
- *Hoodia gordonii*. Listed in Anon (no date, a), no localities.
- *Larryleachia marlothii*. Arandis.

- *Orthanthera albida*. Arandis, Stockpile Site.
- *Pergularia daemia*. Lower Dome Site, mining area.
- *Sarcostemma viminale*. Arandis area.

4.12.6 Asparagaceae

- *Asparagus pearsonii*. Arandis, Stockpile Site, Upper Ostrich Site.

4.12.7 Asphodelaceae

- *Aloe asperifolia*. Many records from the Arandis area.
- *Aloe dichotoma*. SK area.
- *Aloe namibiensis*. Arandis.
- *Trachyandra laxa.* Arandis.

4.12.8 Asteraceae

- *Berkeya spinosissima*. Khan River.
- *Calostephane marlothiana*. Mining area.
- *Dauresia alliariifolia.* Lower Dome Site, Stockpile Site, Mining area.
- *Doellia caffra*. Northeast of mine.
- *Emilia marlothiana*. Fish Factory, Stockpile Site.
- *Felicia anthemidodes*. Khan Mine, Panner Site.
- *Flaveria bidentis*. Alien. Main road near mine.
- *Foveolina dichotoma*. Northwest of mine.
- *Gazania jurineifolia*. Arandis.
- *Geigeria ornativa*. Arandis, Lower Dome SIte, Khan mine, mining area.
- *Helichrysum roseo-niveum*. Lower Ostrich Site, Upper Ostrich Site
- *Kleinia longiflora*. Upper Ostrich Site.
- *Launaea intybacea*. Northeast of mine.
- *Myxopappus acutilobus*. Khan Mine.
- *Myxopappus hereroensis*. Mining area.
- *Nolletia arenosa*. Khan Mine.
- *Nolletia gariepina*. Listed by Anon (no date, a), no localities.
- *Othonna lasiocarpa*. Arandis.
- *Pechuel-Loeschea leubnitziae*. Khan River.
- *Tripteris microcarpa*. Arandis, Mining area.

4.12.9 Boraginaceae

- *Cordia sinensis*. Arandis, and Main road northeast of mine.
- *Heliotropium albiflorum*. Upper Ostrich Site.
- *Heliotropium ovalifolium*. East of mine.
- *Heliotropium tubulosum*. Arandis, along main road, northeast of mine, Panner Site, Upper Ostrich Site.
- *Trichodesma africanum*. Lower Ostrich Site, Khan River.

4.12.10 Burseraceae

- *Commiphora glaucescens*. Arandis area.
- *Commiphora oblanceolata*. Khan River. This is a tiny isolated population, widely separated from the main distribution area in Kaokoland (Curtis & Mannheimer 2005).

- *Commiphora saxicola*. Arandis, Khan Mine, Lower Ostrich Site, Stockpile Site.
- *Commiphora tenuipetiolata*. Arandis Area, Lower Dome Site.
- *Commiphora virgata*. Arandis area.

4.12.11 Capparaceae

- *Boscia albitrunca*. Listed by Anon (no date, a), no localities.
- *Boscia foetida*. Records from Arandis and Khan Mine, but found throughout.
- *Cleome foliosa*. Arandis, Arandis Airport, Lower Dome Site, Khan Mine.
- *Cleome suffruticosa*. Arandis Airport, Khan River.
- *Maerua schinzii*. Khan River valley.

4.12.12 Caryophyllaceae

- *Spergularia media*. Arandis. Alien.

4.12.13 Celastraceae

- *Gymnosporia buxifolia*. Listed in Anon (no date, a), no localities.
- *Gymnosporia senegalensis*. Arandis.

4.12.14 Chenopodiaceae

- *Chenopodium amboanum*. Mining area.
- *Chenopodium ambrosioides*. Alien. Listed in Anon (no date, a), no localities.
- *Chenopodium murale*. Stockpile Site.
- *Lophiocarpus polystachyus*. Mining area.
- *Salsola kali*. Alien. Mining area.
- *Salsola tuberculatiformis*. Arandis. (Indigenous *Salsola* does occur in the Rössing area, but the taxonomy of the genus in Namibia is in disarray. Therefore this identification should be treated with caution – other *Salsola* species may occur in the area as well).
- *Suaeda plumosa.* Arandis.

4.12.15 Convolvulaceae

- *Ipomoea adenioides*. Listed in Anon (no date, a), no localities.

4.12.16 Crassulaceae

- *Cotyledon orbiculata*. Listed in Anon (no date, a), no localities.

4.12.17 Cucurbitaceae

- *Citrullus ecirrhosus*. Khan Mine, Mining area.
- *Corallocarpus dissectus*. Listed in Anon (no data), no localities.
- *Corallocarpus schinzii*. Arandis area.
- *Cucumella aspera*. Lower Dome Site, but probably in riverbed next to site, not on hills.
- *Cucumis africanus*. Mining area.
- *Cucumis meeusei*. Lower Dome Site, but probably in riverbed next to site, not on hills.

4.12.18 Cyperaceae

- *Cyperus laevigatus*. Panner SIte. Associated with open water.
- *Cyperus marginatus*. Arandis sewerage works. Associated with open water.

4.12.19 Ebenaceae

- *Euclea pseudebenus*. Khan River.

4.12.20 Eriospermaceae

- *Eriospermum bakerianum*. Listed in Anon (no date, a), no localities.
- *Eriospermum rautanenii*. Arandis.

4.12.21 Euphorbiaceae

- *Euphorbia damarana*. Main road E of Arandis, also NW of tailings dam.
- *Euphorbia gariepina*. Khan Mine.
- *Euphorbia giessii*. Near security gate.
- *Euphorbia glanduligera*. Arandis, Lower Dome Site, mining area.
- *Euphorbia phylloclada.* Arandis, Lower Dome SIte, mining area.
- *Euphorbia virosa*. Listed in Anon (no date, a), no localities.
- *Ricinus communis*. Listed by Anon (no date, a), no localities. Alien.

4.12.22 Fabaceae

- *Acacia albida*. Khan River.
- *Acacia erioloba*. Lower Ostrich Site, Panner Site.
- *Acacia reficiens*. Upper Ostrich Site, Panner Site.
- *Acacia tortilis*. Khan River.
- *Adenolobus garipensis*. Khan River.
- *Adenolobus pechuelii*. Arandis Site, Lower Dome Site, Khan Mine, Lower Ostrich Site, Panner Site, Stockpile Site, Upper Ostrich Site.
- *Indigastrum argyroides*. Khan Mine.
- *Indigofera adenocarpa*. Northeast of mine.
- *Indigofera auricoma*. Arandis, Khan Mine, Stockpile Site.
- *Lotononis platycarpa*. Arandis.
- *Microcharis disjuncta*. Arandis.
- *Parkinsonia africana*. Lower Ostrich Site, Panner Site.
- *Sesbania pachycarpa*. Arandis, Mining area.
- *Tephrosia dregeana*. Arandis, Mining area, Northeast of mine, Panner Site, Stockpile Site.

4.12.23 Gerianaceae

- *Monsonia luedritziana*. Mining area.
- *Monsonia umbellata*. Arandis.
- *Pelargonium otaviense*. West of Arandis.
- *Sarcocaulon marlothii*. Arandis Site, Panner Site, Stockpile Site.
- *Sarcocaulon salmoniflorum*. Listed in Anon (no date, a), no localities.

4.12.24 Gisekiaceae

- *Gisekia africana*. Arandis, Khan Mine.

4.12.25 Hyacinthaceae

- *Dipcadi bakerianum*. Arandis.
- *DIpcadi platyphyllum*. Arandis.
- *Ornithogalum stapfii*. Arandis.

4.12.26 Hydnoraceae

- *Hydnora africana*. Listed in Anon (no date, a), no localities.

4.12.27 Hydrophyllaceae

- *Codon royenii*. Arandis.
- *Codon schenckii*. Lower Ostrich Site, Panner Site.

4.12.28 Lemnaceae

- *Lemna aequinoctialis*. Aquatic plant. Seepage in mining area.

4.12.29 Loasaceae

- *Kissenia capensis*. Panner Site.

4.12.30 Lobeliaceae

- *Lobelia erinus*. Khan River.

4.12.31 Loranthaceae

- *Tapinanthus oleifolius*. Arandis area.

4.12.32 Lythraceae

- *Ammannia wormskioldii*. Listed in Anon (no date, a), no localities.
- *Nesaea sarcophylla*. Khan River.

4.12.33 Malvaceae

- *Abutilon pycnodon*. Lower Dome Site.

4.12.34 Mesembryanthemaceae

- *Brownanthus kuntzei*. Panner Site, Stockpile Site.
- *Lithops ruschiorum*. Mining area. Species currently the subject of intensive study (Loots, pers. comm.).
- *Mesembryanthemum guerichianum*. Lower Dome Site, Khan Mine, Mining area.
- *Psilocaulon salicornioides*. Arandis area, Panner SIte, Stockpile Site.

4.12.35 Molluginaceae

- *Limeum argute-carinatum*. Arandis.
- *Mollugo cerviana*. Lower Dome Site.

4.12.36 Moringaceae

- *Moringa ovalifolia*. Khan River valley.

4.12.37 Nyctaginaceae

- *Boerhavia hereroensis*. Listed by Anon (no date, a), no localities.

- *Commicarpus squarrosus*. Khan Mine, Panner Site.

4.12.38 Ophioglossaceae (fern)
- *Ophioglossum polyphyllum*. Arandis.

4.12.39 Papaveraceae
- *Argemone ochroleuca*. Alien. Arandis, Khan River.

4.12.40 Passifloraceae
- *Adenia pechuelii*. Stockpile Site. Currently under study (Loots, pers. comm.).

4.12.41 Pedaliaceae
- *Sesamum capense*. Arandis, Stockpile Site.
- *Sesamum marlothii*. Near gate, Khan Mine, Panner Site.
- *Sesamum schinzianum*. Stockpile Site.

4.12.42 Plumbaginaceae
- *Dyerophytum africanum*. Arandis.

4.12.43 Poaceae
- *Aristida parvula*. Arandis, Stockpile Site.
- *Brachiaria glomerata*. Khan Mine, Lower Ostrich Site, Stockpile Site.
- *Cynodon dactylon*. Alien. Around seepage ponds.
- *Enneapogon desvauxii*. Arandis, Lower Ostrich Site, Stockpile Site.
- *Enneapogon scaber*. Stockpile Site.
- *Eragrostis macrochlamys*. Khan Mine.
- *Eragrostis nindensis*. Arandis.
- *Phragmites australis*. Mining area, Panner Site. Water-associated. Also mentioned in limnology reports.
- *Paspalum vaginatum*. Listed by Anon (no date, a), no locations. Alien.
- *Setaria verticillata*. Lower Dome Site
- *Sporobolus consimilis*. Khan River.
- *Sporobolus nebulosus*. Arandis, Khan Mine, Mining area.
- *Stipagrostis ciliata*. Mining area, Stockpile Site, Upper Ostrich Site.
- *Stipagrostis damarensis*. Mining area, Upper Ostrich Site.
- *Stipagrostis dinteri*. Khan Mine, Mining area, Stockpile Site.
- *Stipagrostis hermannii*. Arandis.
- *Stipagrostis hirtigluma*. Arandis, Khan Mine.
- *Stipagrostis hochstetteriana*. Arandis.
- *Stipagrostis namaquensis*. Listed in Anon (no date, a), no localities. Occurrence plausible.
- *Stipagrostis obtusa*. Arandis.
- *Stipagrostis schaeferi*. Khan Mine, Mining area, Panner Site.
- *Stipagrostis subacualis*. Arandis.
- *Stipagrostis uniplumis*. Arandis.

4.12.44 Polygalaceae

- *Polygala guerichiana*. Khan Mine, Mining area, Upper Ostrich Site.
- *Polygala pallida*. Mining area.

4.12.45 Polygonaceae
- *Polygonum plebeium*. Northeast of mine.

4.12.46 Portulacaceae
- *Anacampseros albissima*. Listed in Anon (no date, a), no localities.

4.12.47 Rubiaceae
- *Kohautia cynanchica*. Arandis.

4.12.48 Ruppiaceae
- *Ruppia maritima*. Panner Site. Water associated. Also mentioned in limnology reports.

4.12.49 Salvadoraceae
- *Salvadora persica*. Arandis area, Khan Mine, Lower Ostrich Site.

4.12.50 Scrophulariaceae
- *Anticharis ebracteata*. Arandis.
- *Anticharis imbricata*. Khan Mine.
- *Anticharis inflata*. Arandis area.
- *Aptosimum lineare*. Arandis Site.
- *Diclis petiolaris*. Khan River.
- *Jamesbrittenia canescens*. Listed in Anon (no date, a), no localities.
- *Jamesbrittenia hereroensis*. Lower Dome Site, mining area.
- *Jamesbrittenia maxii*. Arandis, Lower Dome Site, along main road.
- *Manulea dubia*. Arandis.

4.12.51 Solanaceae
- *Datura innoxia*. Alien. Khan River.
- *Nicotiana glauca*. Alien. Khan River
- *Solanum rigescentroides*. Arandis, Lower Dome Site.

4.12.52 Sterculiaceae
- *Hermannia affinis*. Arandis, Stockpile Site, Upper Ostrich Site.
- *Hermannia amabilis*. Lower Dome Site, Khan Mine.
- *Hermannia complicata*. Arandis.
- *Hermannia glandulosissima*. Arandis.
- *Hermannia helianthemum*. Along main road, mining area.
- *Hermannia modesta*. Arandis.
- *Hermannia solaniflora*. Arandis.
- *Sterculia africana*. Khan River valley.

4.12.53 Tamaricaceae
- *Tamarix usneoides*. Khan River, Panner Site.

4.12.54 Tiliaceae

- *Grewia tenax*. Northeast of mine.

4.12.55 Typhaceae

- *Typha capensis*. Water associated. Also mentioned in limnology reports.

4.12.56 Urticaceae

- *Forrskaolea candida*. Stockpile Site.
- *Forrskaolea hereroensis*. Mining area.

4.12.57 Vahliaceae

- *Vahlia capensis*. Listed in Anon (no date, a), no localities.

4.12.58 Verbenaceae

- *Chascanum garipense*. Lower Dome Site, Fish Factory, Khan Mine.

4.12.59 Viscaceae

- *Viscum rotundifolium*. Listed in Anon (no date, a), no localities.

4.12.60 Zygophyllaceae

- *Fagonia isotricha*. Khan Mine.
- *Fagonia sinaica*. Khan Mine.
- *Tribulus zeyheri*. Khan River.
- *Zygophyllum cylindrifolium*. Arandis Site.
- *Zygophyllum simplex*. Arandis, Mining area.
- *Zygophyllum stapfii*. Arandis Site, Lower Ostrich Site, Stockpile Site, Upper Ostrich Site.

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Appendix B. SUMMARY OF THE 2007 BIODIVERSITY SAMPLING WORK IN THE RöSSING AREA, CENTRAL NAMIB DESERT

J. Irish, D.Aiyambo, K. Eelu, J.Guittar, J. Henschel, R. Kavari, V. Nghiitombo, J. Pallett, J. Shikangala and V. Siteteka.

4 December 2007

1. INTRODUCTION

The three sites of immediate concern to RUL (SK4 area as the next to be mined, SH area to be mined in future, and Dome area as a potential dump site) were not included in the 1984/85 baseline biodiversity survey. In order to place them into that context, and to have firsthand experience of both biodiversity and general environmental conditions at these three sites, biodiversity sampling fieldwork was conducted there during October 2007.

2. SAMPLING SITES

The locations of sites are mapped in Figure 1, and GPS-references are listed in Table 1.

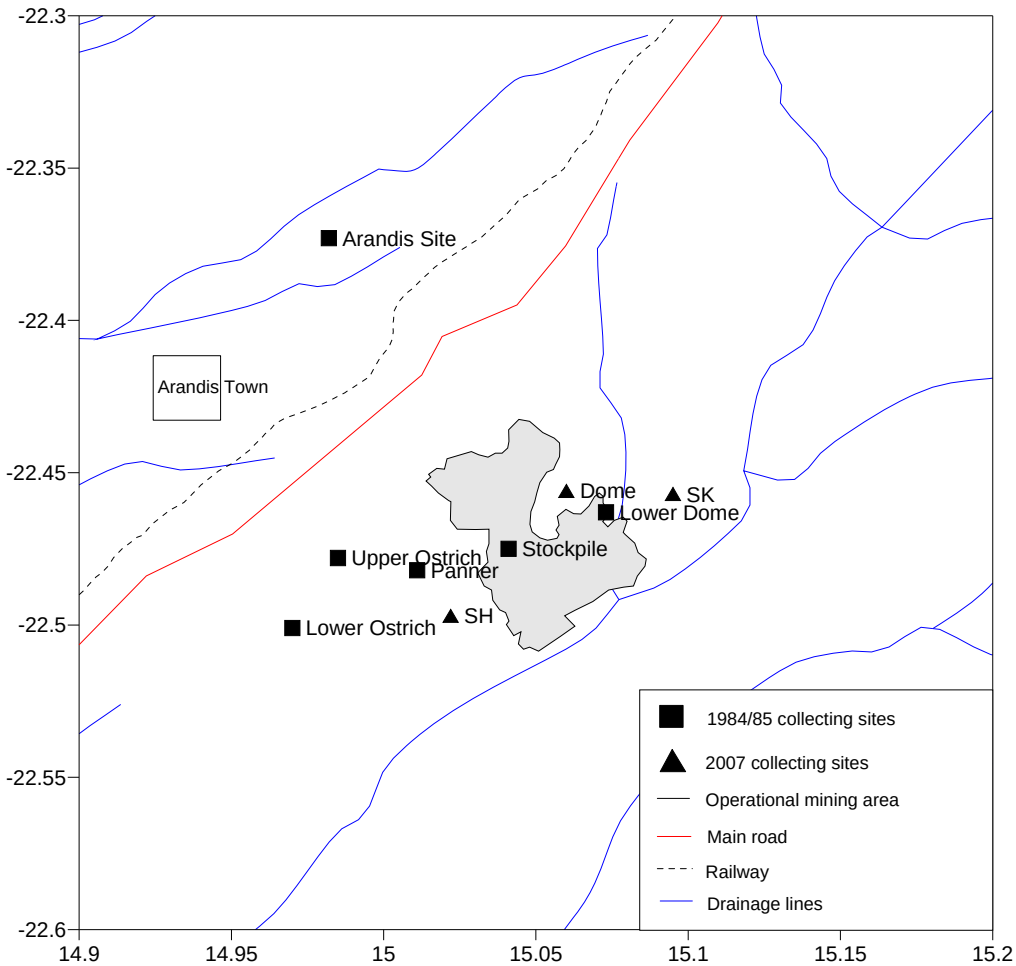

Figure 1. Location of the 2007 sampling sites in the Rössing area, with 1984/85 sites for comparison.

Table 1. Coordinates of central points in each sampling area.

Site	Longitude °E	Latitude °S	Notes
SK sampling site	15.095	22.457	GPS
SH sampling site	15.022	22.497	GPS
Dome area sampling site	15.056	22.450	GPS

SK sampling site

Ongoing drilling operations in SK4 rendered sampling on the actual spot to be mined impractical, and the selected site was located 1.6 km northeastwards. The working area was roughly square with 600m sides (Fig 1).

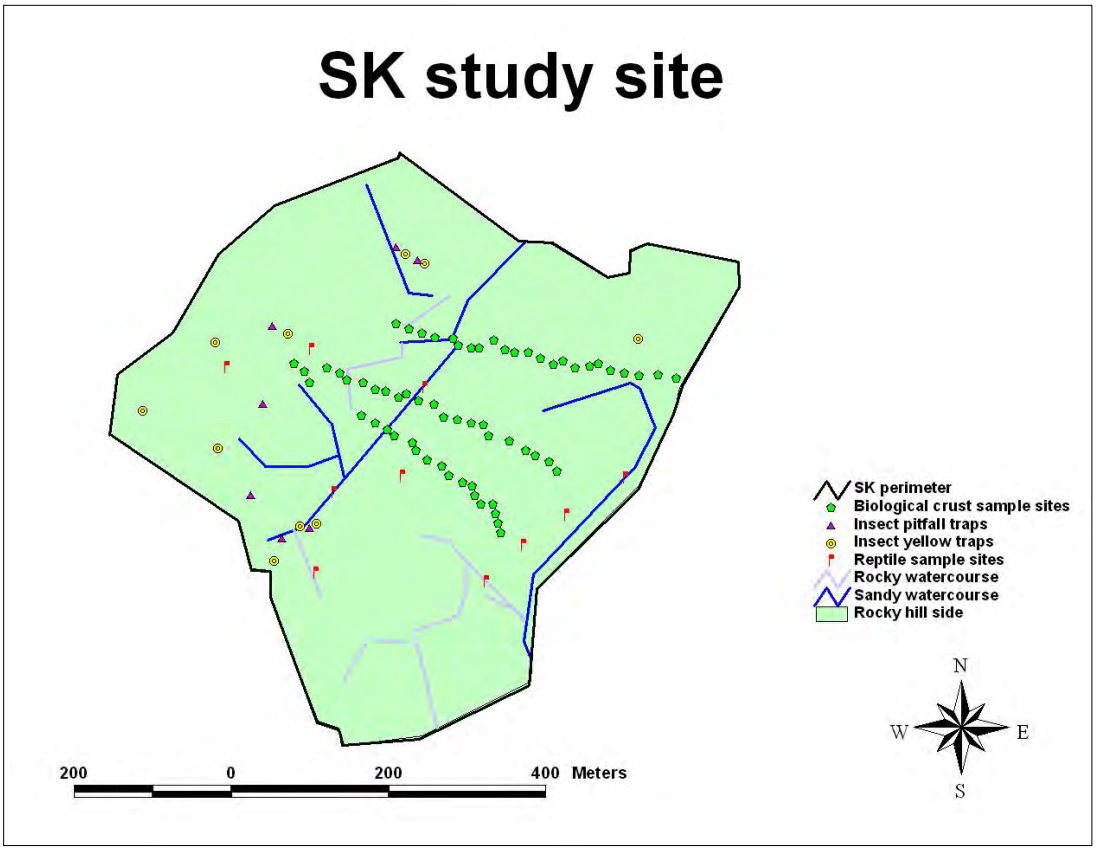

Figure 1: Habitat types, layout of trapping sites and dimensions of the SK study site.

The topography at the sampling site was similar to that found at SK4, namely extremely rugged slopes and dissected landscape, with the rocky outcrops and scree slopes being separated by deeply incised and very thin rocky washes or slightly more conspicuous washes with sandy alluvium. Very little of either site is flat or even.

The geology at the sampling site is also similar to that at SK4, since it is located along the strike of the rock, in the same geological formations that are present at SK4. The rocky slopes comprised loose rubble and rocks, gravel

and fine-grained material, without clear boundaries between areas of actual rock outcrop and the debris-strewn slopes below. There was much mixing of rock types on the scree depending on the geology of the outcrops above. Consequently it was not possible to accurately classify the rocks and debris that comprised the rocky slopes for the purpose of habitat categorisation of the biota encountered there. The habitat was simply named rocky hillsides. These slopes and the outcrops contained many cracks, crevices and overhangs, all of which provided refuge and sheltering places for small animals. Lizards and insects were frequently seen occupying such crevices and shelters.

Figure 2: Landscape photos of the SK study area, to show very rugged terrain and general sparseness of vegetation, except in the sandy watercourse, top right.

There was a sparse scatter of plants on the slopes. These comprised many small *Zygophyllum simplex* plants, rather few grass tufts, dormant *Geigeria* stems, *Psilocaulon* sp and dead *Blepharis* remnants. The only plants that appeared to be providing food on the slopes were *Adenolobus pechuellii*, which in most cases were browsed to just a few bare stems. Less common were occasional *Hermannia amabilis* herbs (in flower), and rare *Orthanthera*. Scattered *Adenia pechuellii* plants were found and all were photographed and GPSed. In one area of about 50m diameter were five *Aloe dichotoma* trees.

In certain areas many *Sarcocaulon marlothii* (Bushman's candle) were observed, particularly on S-facing slopes. In the sandy washes were a few *Parkinsonia africana* trees and very rare *Commiphora glaucescens* trees.

SH sampling site

As for SK, a roughly square study area with 600m sides was selected. Geology and topography in the SH area was generally similar to SK, but the river washes were wider and more pronounced, giving more space between the rocky outcrops and slopes. Outcrops comprised granite, schist and marble, and rocky slopes had mixtures of these rock types. Plant life on the rocky slopes was similar to that at SK.

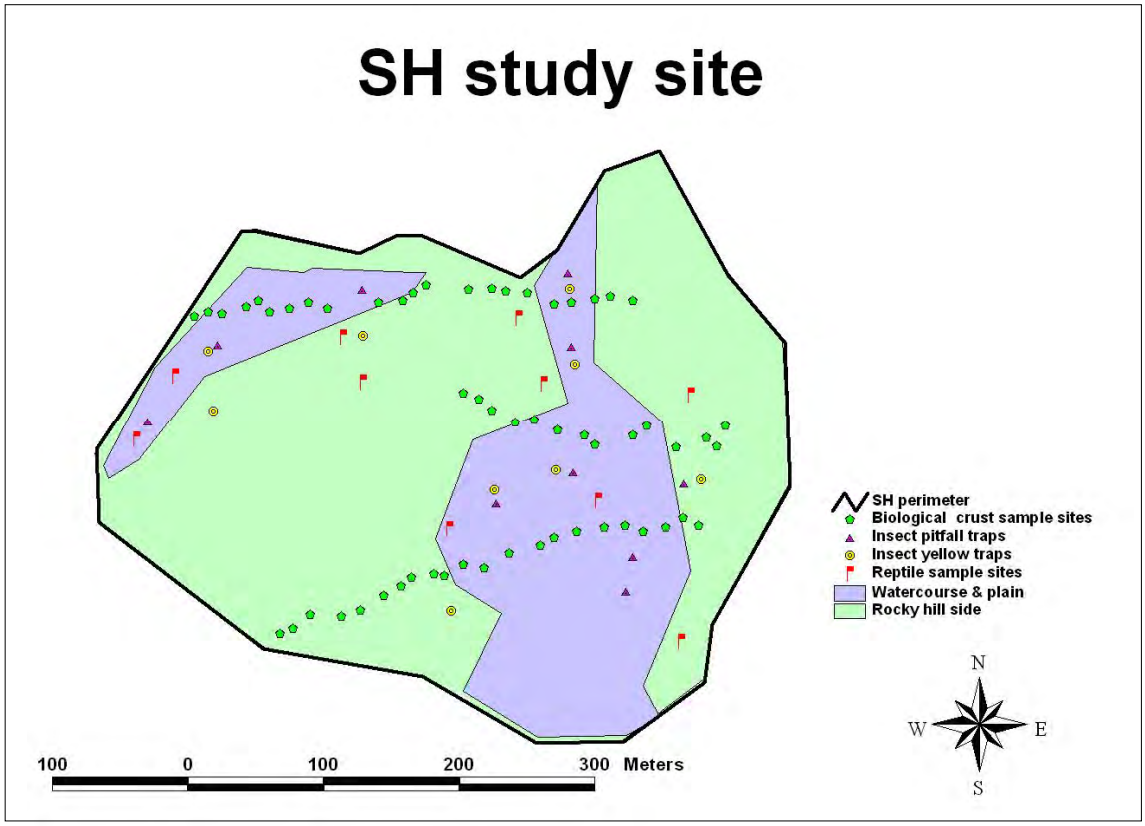

Figure 3: Habitat types, layout of trapping sites and dimensions of the SH study site.

Plant life in the wide washes and the areas of plain that separated washes from rocky slopes, was more prolific than in SK. There were scattered trees, mainly *Acacia erioloba*, and a few dense clumps of *Salvadora* bush. The gentle slopes and river washes also hosted many small *Blepharis* plants. Bird life in the SH area was more common than in SK, and the presence of springbok, kudu and ostrich also indicated greater availability of food to support these large animals. A saline spring immediately north of the study area, known as 'Piet se gat', acted as an attraction to birds and mammals in the area.

Figure 4: Landscape photos of the SH study area, showing rugged terrain similar to SK but with more plain and watercourse habitat, and vegetation associated with it.

Dome sampling site

The camp site was located in Dome Gorge, an alluvial river bed located about 2 km from the entrance to Rossing Mine. The study area described a rough square with 600m sides that included this and the neighbouring alluvial wash, and the mountainous area in between. Dome topography was more gentle than at SK or SH, with less steep slopes and less rock-strewn scree slopes, comprising mainly granite rocks and debris. This habitat was classified as 'rocky hillsides'.

Plant life at Dome was more prolific than at the other two sites. Hillsides and slopes hosted individuals of the following species: *Euphorbia virosa , Euphorbia damarana, Commiphora saxicola, Commiphora virgata, Zygophyllum stapfii, Calicorema capitata* and *Adenolobus pechuellii*, with some rare *Boscia foetida* low bushy trees. *Salvadora* bushes, *Tamarix usneoides* and *Euclea pseudebenus* trees occurred in the river bed, as well as numerous *Zygophyllum stapfii* and 10c bushes. *Adenia pechuellii* plants were relatively common compared to SK and SH, living on rocky outcrops and slopes. All Adenias were GPSed and photographed. Some of them appeared to be dying, with many dried out, grey-black stems and very few greenish ones. Two dead *Adenias* were found in the study area.

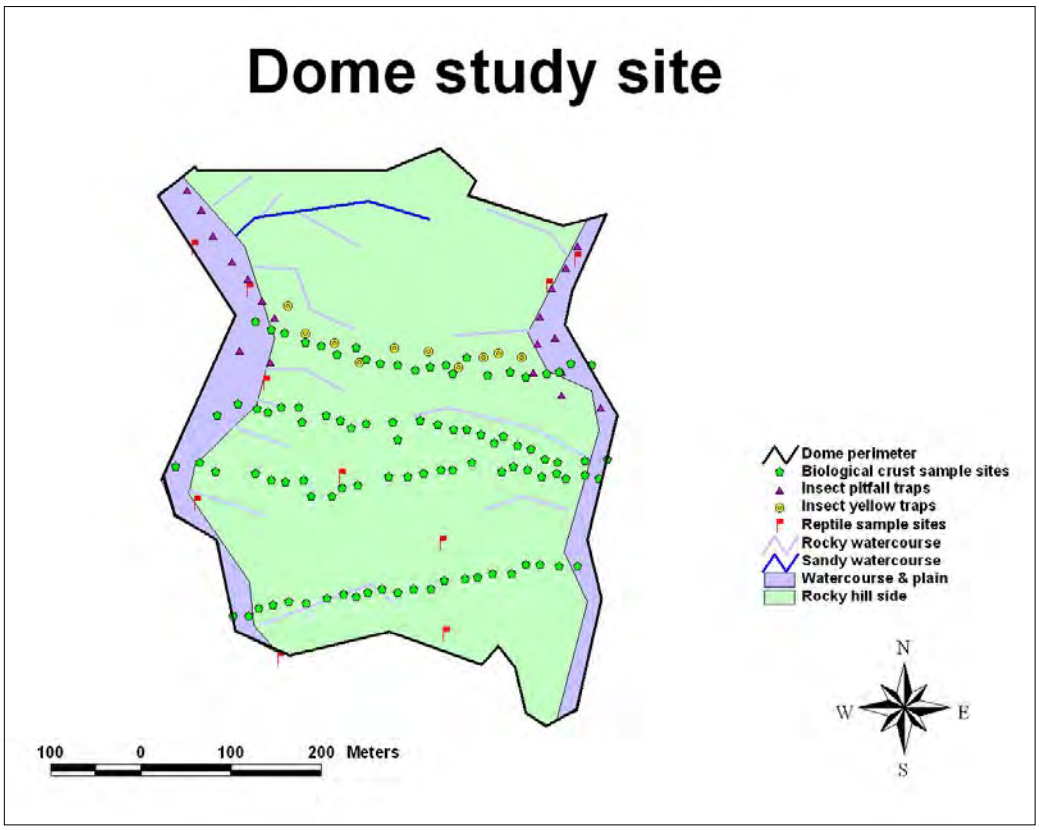

Figure 5: Habitat types, layout of trapping sites and dimensions of the Dome study site.

Figure 6: Landscape photos of the Dome study area, showing rocky terrain similar to the other two sites but more gently undulating. Top left photo shows an *Adenia pechuelli* in typical habitat.

3. METHODS AND FOCAL TAXA

Different participants had ultimate responsibility for different components of the sampling, but the overall survey was a collaborative effort, and all participants contributed observations and specimens to all components.

Biological crusts

Responsible participant: D. Aiymabo. Refer Aiyambo (2007).

Biological crusts and 'fensteralgen' were sampled on the transects that were made for arachnids (see below). At 15m intervals, a 0.25m2 quadrant was placed on the substrate and all rocks within it were rolled over to check for the presence of fensteralgen. Presence or absence of a biological soil crust was noted.

Arachnids

Responsible participants: J. Henschel & D. Aiyambo. Refer Henschel & Aiyambo (2007).

Depending on the nature and size of each study area, either three or four line transects were established across each area to sample arachnids. The line transects were approximately 100 m long and they were placed approximately 50 m apart. Every 15 m along each transect we searched for arachnids within a diameter of 10 m. We searched by looking on the ground, under shrubs, under overhangs and turning over stones. Approximately 12 hours were spent actively searching each of the three sites in this fashion. Each site was classified into one of three microhabitats, namely i) wash (drainage line), ii) bedrock and rocky hillside, or iii) gravel plains. The substrate, slope and vegetation composition of these microhabitats is described elsewhere.

Arachnids were collected at first sighting. Signs of spiders (e.g. silk or egg cocoon) where the animal was not present were noted. Webs and burrows of common spiders (e.g. Agelenidae, Pholicidae, Sparassidae, Segestriidae) or sightings of common surface-active species (e.g. the gnaphosid spider *Asemesthes* sp., or scorpion *Parabuthus brevimanus*) were noted but only a few voucher specimens of each were collected. Specimens obtained from systematic searches along transects were supplemented by specimens collected in pitfall traps or casual traversing of the area by colleagues.

Scorpions were searched using a black-light at night along linear transects across low-lying areas of the study sites. For reasons of personal safety, hillsides (scree and bedrock) were not intensively searched, and for scorpions it is not possible from our study to make deductions of relative distribution across different microhabitats.

The current survey did not focus on the Acari (mites and ticks) and no attempt is made to assess their status. Similarly, although signs of pseudoscorpions

were observed during the current survey, the focus was not directed towards this group.

Collected specimens were identified to family level, and sometimes tentatively to species level (Lamoral 1979; Dippenaar-Schoeman & Jocqué 1997). The possible identity was sometimes inferred from previous records of arachnids from the Rössing area or surrounding areas. Although all species were only tentatively identified, we refer to some of the animals in this report by these tentative names.

Insects

Responsible participants: John Irish and Kaarina Eelu. Refer Eelu (2007).

Insects were sampled by sinking pitfall traps along river washes, and by placing yellow trays filled with anti-freeze on rocky slopes and alongside pitfall traps in the washes. All insects collected by any members of the team were brought in for identification in the field.

Reptiles

Responsible participant: R. Kavari. Refer Kavari (2007).

Reptiles were collected with ten 20cm-deep buckets sunk in the various habitats at each site. Sightings were recorded by all members of the team, and photographs were taken to help identification.

Birds
Responsible participant: J. Pallett. Were identified from calls and sightings.

Mammals

Responsible participant: J. Pallett. Small terrestrial mammals were not collected due to the low diversity that was found in the 1980s work. All signs and tracks of mammals, as well as a few skulls, were identified as far as possible. Mist-netting was done for bats but single bats were seen on only a few nights, showing that bat activity was in any case very low.

4. TAXONOMIC LISTING

To allow comparison, numbering follows that in the 1984/85 report. Given that 2007 fieldwork was limited in time and place, and happened at a non-ideal time of year, many of the 1984/5 taxa were not encountered.

4.4. Arachnida (eight-legged invertebrates)

4.4.1. Acari (mites and ticks)

Unidentified Acari (tiny mites) were found at the SK site, and also at Piet-se-gat.

4.4.2. Araneae (spiders)

4.4.2.1. Agelenidae (funnel-web spiders)

Agelena species were recorded from the SH and SK areas.

4.4.2.2. Ammoxenidae (termite-eating spiders)

Only recorded at the SH area.

4.4.2.9. Gnaphosidae (ground spiders)

Asemesthes species recorded from SH and SK areas.

4.4.2.16. Oecobiidae (flatmesh-weaver spiders, star-legged spiders)

Paroecobius species recorded from SH and SK areas.

4.4.2.21. Pholcidae (daddy long-legs spiders)

Smeringopus species recorded from SH and SK areas.

4.4.2.23. Salticidae (jumping spiders)

Unidentified Salticidae were recorded from SK and Dome areas.

4.4.2.25. Segestriidae (tube-web spiders)

Ariadna species were recorded from the SH, SK and Dome areas.

4.4.2.27. Sicariidae (violin spiders)

Sicarius species recorded from SH and SK areas.

4.4.2.28. Sparassidae (huntsmen spiders)

Sparassidae were recorded from SH , SK and Dome areas. Attempts to identify specimens to genus proved problematical, and highlighted the unsatisfactory state of taxonomic knowledge of this important group in Namibia.

4.4.2.30. Theridiidae (comb-footed spiders)

The conspicuous absence of the normally abundant webs of these spiders at the three sample sites was specifically noted by Henschel & Aiymabo (2007).

4.4.2.34. Zodariidae (ant spiders)

Recorded only from the SH area.

4.4.4. Pseudoscorpiones (false scorpions)

Unidentified species found at SK.

4.4.5. Scorpionida (scorpions)

4.4.5.2. Buthidae

Hottentota conspersus was recorded from the SK area. This small scorpion was not recorded during the 1980's survey, possibly because of sampling method bias.
Parabuthus brevimanus was recorded from the SH and Dome areas.
Parabuthus namibensis was recorded from the SK area.

4.4.6. Solifugae (solifuges, sun spiders)

Unidentified species were found in the SK and Dome areas. Henschel & Aiyambo (2007) remarked on what they considered unusually low solifugid abundance.

4.5. Insecta (six-legged invertebrates, insects)

4.5.1. Blattodea (cockroaches)

Unidentified species were found in the SK and SH areas.

4.5.2. Coleoptera (beetles)

4.5.2.1. Anthicidae (ant beetles)

A *Notoxus* species was found in the Dome area.

4.5.2.2. Bruchidae (seed weevils)

Bruchidae were recorded in the SH area.

4.5.2.4. Carabidae (ground beetles)

Recorded in the SK, SH and Dome areas.

4.5.2.5a. Cleridae (chequered beetles)

Cleridae were not specifically recorded during the 1980's survey, and this may be because they are alate, or because clerids are relatively uncommon in Namibia anyway. In 2007, Cleridae were recorded in the SH area.

4.5.2.7. Curculionidae (snout beetles, weevils)

Unidentified species recorded in the SK and Dome areas.

A *Hyomora* species recorded in the Dome area.

4.5.2.12. Hydraenidae (moss beetles)

Recorded from the Dome area.

4.5.2.15. Melyridae (flower beetles)

Recorded in the SH area.

4.5.2.16. Monommidae (beetles, no common name)

Recorded in the SK area.

4.5.2.20. Tenebrionidae (toktokkies, darkling beetles)

Epiphysa species recorded in the SK and Dome areas.
Geophanus species recorded in the SK, SH and Dome areas.
Metriopus species recorded in the SK, SH and, Dome areas.
Physosterna species recorded in the SH area.
Rhammatodes species recorded in the SK, SH and Dome areas, and at Piet-se-gat.
Asphaltheshes species recorded in the SK and Dome areas. (*Asphaltheshes* was not recorded by the 1980's survey.)
Stenocara species recorded in the SK, SH and Dome areas.
Tarsocnodes species recorded in the SK area.
Zophosis species recorded in the SK and Dome areas.
Indeterminate Tenebrionidae species recorded in the SH area.

4.5.2.22. Coleoptera family indeterminate

Two indeterminate beetles recorded, one each from the SK and SH areas.

4.5.4. Diptera (flies and allies)

4.5.4.1. Asilidae (robber flies)

Recorded from the SH area.

4.5.4.2. Bombyliidae (bee flies)

Recorded from the SK, SH and Dome areas, also at Piet-se-gat.

4.5.4.6. Culicidae (mosquitoes)

Recorded from the SK area.

4.5.4.9. Hippoboscidae (horse flies)

Recorded from the SK area, and at Piet-se-gat.

4.5.4.9a. Muscidae (typical flies)

Recorded from the SK area. Though muscids are common flies, they were not specifically recorded by the 1980's survey, probably because they are alate.

4.5.4.10. Sarcophagidae (carrion flies)

Recorded from the SK and SH areas.

4.5.4.11. Tephritidae (fruit flies)

Recorded from the SH area.

4.5.6. Hemiptera (bugs)

4.5.6.1. Aphididae (aphids, plant lice)

Recorded from the SK and SH area, also at Piet-se-gat.

4.5.6.2. Cicadellidae (leafhoppers)

Recorded at the Dome area.

4.5.6.3a. Coccoidea (scale insects)

Recorded from the SH area, and Piet-se-gat. Not specifically recorded during the 1980's survey, probably because of sampling bias: coccids are stuck to plants, and as such do not get into pitfall traps.

4.5.6.4. Fulgorioidea (planthoppers)

Recorded from the SK and SH areas, also at Piet-se-gat.

4.5.6.5. Lygaeidae (seed bugs, ground bugs)

Recorded from the SK and Dome areas, also at Piet-se-gat.

4.5.18.1 Reduviidae (assassin bugs)

Recorded from the SK and SH areas.

4.5.7. Hymenoptera (bees, wasps, ants)

4.5.7.3. Apidae (honey bees)

Apis mellifera recorded from Piet-se-gat.

4.5.7.5. Formicidae (ants)

Camponotus maculatus recorded from the SK, SH and Dome areas, also at Piet-se-gat.
Crematogaster species recorded from the Dome area, also at Piet-se-gat.
Ocymyrmex species recorded from the SK, SH and Dome areas.
Unidentified small ant species were recorded from all sites.
None of the genera and species specified above is unexpected in the area, and they are probably identical to taxa recorded only as morphospecies during the 1980's survey.

4.5.7.5a. Masaridae (small wasps, no common name)

Recorded from the SK, SH and Dome areas. Masarids were not specifically recorded during the 1980's survey, probably because they are alate. Their presence in the area is not unexpected.

4.5.7.6. Mutillidae (velvet ants)

Recorded from the SH area, also at Piet-se-gat.

4.5.7.7. Parasitica (parasitic wasps)

Recorded from the SK, SH and Dome areas, also at Piet-se-gat.

4.5.7.8. Pompilidae (spider-hunting wasps)

Recorded from the SH area.

4.5.7.9. Sphecidae (sand wasps)

Recorded from the SK and SH areas.

4.5.7.9a. Vespidae (true wasps)

Recorded from Piet-se-gat. Vespidae were not specifically recorded during the 1980's survey, possibly because they are alate. Their presence in the area is not unexpected.

4.5.8. Isoptera (termites)

Hodotermes mossambicus was recorded from the Dome area.

4.5.9. Lepidoptera (butterflies and moths)

Unidentified Lepidoptera were observed in the SK and SH areas.

4.5.10. Mantodea (mantids)

Recorded from the SK and SH areas.

4.5.11. Neuroptera (lacewings and antlions)

Myrmeleontidae (ant lions) were recorded in the SK and SH areas.

4.5.13. Orthoptera (grasshoppers, locusts and crickets)

4.5.13.3. Gryllidae (crickets)

Mogoplistinae species were recorded from the SK area.

4.5.13.6. Schizodactylidae (feather-toed crickets)

Comicus species was recorded from the Dome area.

4.5.15. Psocoptera (book lice)

Psocoptera were recorded from Piet-se-gat.

4.5.17. Thysanoptera (thrips)

Recorded from all sampling sites.

4.5.18. Thysanura (silverfish, fishmoths)

Ctenolepisma species were recorded from the SK, SH and Dome areas.
Thermobia species recorded from the SK area.

4.6. Amphibia (frogs)

Griffin (pers. comm.) adds the following species to the two recorded by the 1980's survey.

- *Phrynomantis annectens*. Rubber Frog. Expected.

4.7. Reptilia (reptiles)

4.7.2. Chamealeonidae (chamaeleons)

Chamaeleo namaquensis was recorded from the SH area.

4.7.3. Colubridae (snakes)

Psammophis notostictus. Karoo Whip Snake. Recorded from the Dome area.

Griffin (pers. comm.) added the following to the colubrids recorded during the 1980's survey.

- *Dasypeltis scabra*. Rhombic Egg-eater. Expected.
- *Psammophis leopardinus*. Leopard Whip Snake. Expected.
- *Pseudaspis cana*. Mole Snake. Expected.
- *Pythonodipsas carinata*. Western Keeled Snake. Expected.
- *Telescopus beetzii*. Namaqua Tiger Snake. Known to occur.

- *Telescopus semiannulatus*. Southern Tiger Snake. Expected.
- *Telescopus* new species. Damara Tiger Snake. Not yet described. Known to occur.

4.7.3a. Elapidae (cobras and allies)

Not recorded during the 1980's survey, but Griffin (pers. comm.) records the following from the area.

- *Naja nigricincta*. Zebra Snake.

4.7.4. Gekkonidae (geckos)

Ptenopus species recorded from the SH area.
Rhoptropus afer recorded from the SK, SH nad Dome areas.
Griffin (pers. comm..) adds the following to the species recorded during the 1980's survey.

- *Pachydactylus rugosus*. Namibian Rough-scaled Gecko. Expected.
- *Ptenopus carpi*. Banded Barking Gecko. Expected.

4.7.6. Lacertidae (lizards)

Pedioplanis husabensis recorded from the SK, SH and Dome areas.
Griffin (pers. comm.) adds the following to the species recorded during the 1980's survey.

- *Meroles* new species. Recently identified east of Swakopmund and may eventually prove to occur in the Rössing area as well.
- *Pedioplanis inornata*. Namibian Sand Lizard. Occurs.

4.7.7. Leptotyphlopidae (worm snakes)

Griffin (pers. comm.) added the following to the species recorded during the 1980's survey.

- *Leptotyphlops labialis*. Damara Worm Snake. Expected.

4.7.8. Scincidae (skinks)

Trachylepis hoeschi recorded from the SK area.
Trachylepis variegata recorded from the SK, SH and Dome areas.

4.7.10. Viperidae (adders)

Griffin (pers. comm.) adds the following to the species recorded during the 1980's survey.

- *Bitis arietans*. Puff Adder. Expected.

4.8. Aves (birds)

Besides the species recorded during the 1980's survey, the following additional birds have been observed or may potentially occur in the area.

- *Aegypius tracheliotos*. Lappet-faced Vulture.
- *Afrotis afraoides*. Northern Black Korhaan.
- *Apus caffer*. White-rumped Swift.
- *Aquila pennatus*. Booted Eagle.
- *Ardeotis kori*. Kori Bustard.
- *Bubo capensis*. Cape Eagle Owl.
- *Buteo augur*. Augur Buzzard.
- *Buteo rufofuscus*. Jackal Buzzard.
- *Caprimulgus tristigma*. Freckled Nightjar.
- *Chalcomitra senegalensis*. Scarlet-chested Sunbird.
- *Chrysococcyx caprius*. Diderick Cuckoo.
- *Cinniricinclus leucogaster*. Violet-backed Starling.
- *Corythaixoides concolor.* Grey Go-away-bird.
- *Creatophora cinerea.* Wattled Starling.
- *Crithagra flaviventris*. Yellow Canary.
- *Cypsiurus parvus*. African Palm Swift.
- *Dendropicos fuscescens*. Cardinal Woodpecker.
- *Dendropicos namaquus*. Bearded Woodpecker.
- *Elanus caeruleus*. Black-shouldered Kite.
- *Estrilda erythronotos*. Black-faced Waxbill.
- *Falco chicquera*. Red-necked Falcon.
- *Falco naumanni*. Lesser Kestrel.
- *Falco peregrinus*. Peregrine Falcon.
- *Falco subbuteo*. Eurasian Hobby.
- *Glaucidium perlatum*. Pearl-spotted Owlet.
- *Hirundo cucullata*. Greater Striped Swallow.
- *Lanius minor*. Lesser Grey Shrike.
- *Merops apiaster*. European Bee-eater.
- *Muscicapa striata*. Spotted Flycatcher.
- *Myrmecocichla formicivora*. Anteating Chat.
- *Namibornis herero*. Herero Chat.
- *Neotis ludwigii*. Ludwig's Bustard.
- *Otus leucotis*. Southern White-faced Scops-Owl.
- *Passer motitensis.* Great Sparrow.
- *Philetairus socius.* Sociable Weaver.
- *Phylloscopus trochilus*. Willow Warbler.
- *Poicephalus rueppellii*. Rüppell's Parrot.
- *Polemaetus bellicosus*. Martial Eagle.
- *Pternistis adspersus*. Red-billed Spurfowl.
- *Quelea quelea*. Red-billed Quelea.
- *Rhinopomastus cyanomelas*. Common Scimitarbill.
- *Terpsiphone viridis*. African Paradise Flycatcher.
- *Tockus leucomelas*. Southern Yellow-billed Hornbill.
- *Tockus nasutus.* African Grey Hornbill.
- *Upupa africana.* African Hoopoe.
- *Urocolius indicus*. Red-faced Mousebird.

Additional water birds which may also potentially occur include:

- *Alcedo cristata*. Malachite Kingfisher.
- *Bubulcus ibis*. Cattle Egret.
- *Egretta garzetta*. Little Egret.
- *Egretta intermedia.* Yellow-billed Egret.
- *Phalacrocorax lucidus*. White-breasted Cormorant.
- *Pluvialis squatarola*. Grey Plover.
- *Scopus umbretta*. Hamerkop.

4.9. Mammalia (mammals)

Besides the rodents recorded during the 1980's survey, the following mammals were observed, or are expected to occur in the area.

- *Antidorcas marsupialis*. Springbok.
- *Canis mesomelas*. Black-backed Jackal.
- *Cistugo seabrai.* Namibian Wing-gland Bat.
- *Crocuta crocuta*. Spotted Hyaena.
- *Eidolon helvum*. Straw-coloured Fruit Bat.
- *Eptesicus hottentotus*. Long-tailed Serotine.
- *Equus zebra*. Namibian Mountain Zebra.
- *Felis lybica*. African Wild Cat.
- *Genetta felina*. Southern Small-spotted Genet.
- *Graphiurus rupicola*. Western Rock Dormouse.
- *Hipposideros caffer*. Sundevall's Leaf-nosed Bat.
- *Hystrix afrcaeaustralis*. Porcupine.
- *Ictonyx striatus*. Striped Polecat.
- *Laephotis namibiensis*. Namib Long-eared Bat.
- *Lepus capensis*. Cape Hare.
- *Malacothrix typica*. Large-eared Mouse.
- *Miniopterus natalensis.* Southern Long-fingered Bat.
- *Nycteris thebaica*. Egyptian Slit-faced Bat.
- *Oreotragus oreotragus*. Klipspringer.
- *Oryx gazella*. Gemsbok.
- *Otocyon megalotis*. Bat-eared Fox.
- *Papio ursinus*. Chacma Baboon.
- *Petromus typicus*. Dassie Rat.
- *Procavia capensis*. Rock Dassie.
- *Proteles cristatus*. Aardwolf.
- *Raphicerus campestris*. Steenbok.
- *Rhinolophus darlingi*. Darling's Horseshoe Bat.
- *Rhinolophus denti*. Dent's Horseshoe Bat.
- *Sauromys petrophilus*. Flat-headed Free-tailed Bat.
- *Scotophilus dinganii*. Yellow House Bat.
- *Suricata suricatta*. Suricate.
- *Tragelaphus strepsiceros*. Greater Kudu.
- *Vulpes chama*. Cape Fox.

4.10. Micro-plants

Biological soil crusts were recorded in the SK, SH and Dome areas.

4.12. Plants

The 1980's botanical work has since been superceded by the work of Burke (2005) and Loots *et al.* (in progress).

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Appendix C. INVENTORY OF ALL ASSESSED TAXA

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4 December 2007

Key:

IUCN statusses: CR = Critically Endangered,
EN = Endangered,
VU = Vulnerable,
NT = Near-threatened,
LC = Least Concern,
NE = Not Evaluated,
DD = Data Deficient,
\- = Alien, evaluation irrelevant.

Determinination of IUCN status:
EOO = Extent of Occurrence (km^2),
NOL = Number of Locations where recorded.

Habitat preference: RH = Rocky hillsides,
OP = Open plains,
WC = Watercourses
WC = Aquatic.

Endemicity: RA = Endemic to Rössing area,
CN = Endemic to Central Namib Desert (ca. Kuiseb - Ugab),
CW = Endemic to Central Western Namibia,
ND = Endemic to wider Namib Desert (Orange - Kunene),
NA = Endemic to geopolitical Namibia,
? = endemism indeterminate (higher categories, not identified to species),
Cell empty = Widespread (not endemic to Namibia)

Taxa are listed in the following order:

Taxa are listed by common name, Family or higher taxonomic grouping, and Genus and species.

PLANTS

Common name	Family	Genus, species	IUCN stat.	Habitat			Ende-mism
	Acanthaceae	*Blepharis bossii*	NE				NA
	Acanthaceae	*Blepharis grossa*	NE	RH	OP	WC	
	Acanthaceae	*Blepharis obmitrata*	NE	RH			
Bitterbos	Acanthaceae	*Monechma cleomoides*	NE	RH	OP	WC	
	Acanthaceae	*Monechma debile*	NE		OP		
	Acanthaceae	*Monechma desertorum*	NE		OP		NA
	Acanthaceae	*Monechma genistifolium*	NE		OP		
	Acanthaceae	*Monsonia umbellata*	NE		OP		
	Acanthaceae	*Petalidium canescens*	NE			WC	NA
	Acanthaceae	*Petalidium lanatum*	NE		OP		
	Acanthaceae	*Petalidium variabile*	NE	RH		WC	
	Acanthaceae	*Ruellia diversifolia*	NE	RH			
	Aizoaceae	*Aizoanthemum dinteri*	NE	RH			NA
	Aizoaceae	*Aizoanthemum membrumconnectens*	NE				NA
Kraalbos	Aizoaceae	*Galenia africana*	NE		OP		
	Aizoaceae	*Galenia meziana*	NE				
	Aizoaceae	*Sesuvium sesuvioides*	NE	RH	OP	WC	
	Aizoaceae	*Tetragonia reduplicata*	NE	RH			
	Aizoaceae	*Trianthema parvifolia*	NE	RH			
Pencil bush	Amaranthaceae	*Arthraerua leubnitziae*	NE		OP	WC	CN
Kleinswartstorm	Amaranthaceae	*Calicorema capitata*	NE		OP		
	Amaranthaceae	*Hermbstaedtia argenteiformis*	NE	RH			
	Amaranthaceae	*Hermbstaedtia spathulifolia*	NE	RH		WC	
	Amaranthaceae	*Sericocoma heterochiton*	NE				
	Amaranthaceae	*Sericorema sericea*	NE			WC	
Bitter karee	Anacardiaceae	*Rhus marlothii*	NE	RH			
Bokhoring	Apocynaceae	*Cryptolepis decidua*	NE	RH	OP		
	Apocynaceae	*Gomphocarpus filiformis*	NE	RH	OP		
Ghaap	Apocynaceae	*Hoodia currorii*	NE	RH	OP		
Ghaap	Apocynaceae	*Hoodia gordonii*	NE				
	Apocynaceae	*Larryleachia marlothii*	NE		OP		
	Apocynaceae	*Orthanthera albida*	NE	RH	OP		
	Apocynaceae	*Pergularia daemia*	NE	RH			
Caustic bush, melktou	Apocynaceae	*Sarcostemma viminale*	NE		OP		
	Asparagaceae	*Asparagus pearsonii*	NE	RH	OP		
Roughleaved aloe	Asphodelaceae	*Aloe asperifolia*	NE		OP		CN
Kokerboom	Asphodelaceae	*Aloe dichotoma*	NE	RH			
	Asphodelaceae	*Aloe namibensis*	LC	RH			CN
	Asphodelaceae	*Trachyandra laxa*	NE		OP		
	Asteraceae	*Berkheya spinosissima*	NE			WC	
	Asteraceae	*Calostephane marlothiana*	NE	RH			NA
	Asteraceae	*Dauresia alliariifolia*	NE	RH			NA

Common name	Family	Genus, species	IUCN stat.	Habitat			Ende-mism
	Asteraceae	*Doellia cafra*	NE		OP		
	Asteraceae	*Emilia marlothiana*	NE	RH	OP		
	Asteraceae	*Felicia anthemidodes*	NE	RH		WC	
Smelter's bush	Asteraceae	*Flaveria bidentis*	NE		OP		
	Asteraceae	*Foveolina dichotoma*	NE	RH			
	Asteraceae	*Gazania jurineifolia*	NE		OP		
Vermeerbos	Asteraceae	*Geigeria ornativa*	NE	RH	OP		
Edelweiss	Asteraceae	*Helichrysum roseo-niveum*	NE		OP	WC	
Sambokbos	Asteraceae	*Kleinia longiflora*	NE		OP		
	Asteraceae	*Launaea intybacea*	NE	RH	OP		
	Asteraceae	*Myxopappus acutilobus*	NE	RH			
	Asteraceae	*Myxopappus hereroensis*	NE	RH			
	Asteraceae	*Nolletia arenosa*	NE	RH			
	Asteraceae	*Nolletia gariepina*	NE				
	Asteraceae	*Othonna lasiocarpa*	NE		OP		
Bitterbos	Asteraceae	*Pechuel-Loeschea leubnitziae*	NE	RH		WC	
	Asteraceae	*Tripteris microcarpa*	NE	RH	OP		
Grey-leaved saucer berry	Boraginaceae	*Cordia sinensis*	NE	RH			
	Boraginaceae	*Heliotropium albiflorum*	NE		OP		NA
	Boraginaceae	*Heliotropium ovalifolium*	NE		OP		
	Boraginaceae	*Heliotropium tubulosum*	NE		OP	WC	
	Boraginaceae	*Trichodesma africanum*	NE	RH		WC	
Blue-leaved Corkwood	Burseraceae	*Commiphora glaucescens*	NE	RH		WC	
Swakopmund Corkwood	Burseraceae	*Commiphora oblanceolata*	NE	RH			NA
Rock Corkwood	Burseraceae	*Commiphora saxicola*	NE	RH	OP	WC	ND
Satin-bark Corkwood	Burseraceae	*Commiphora tenuipetiolata*	NE	RH			
Slender Corkwood	Burseraceae	*Commiphora virgata*	NE	RH			ND
Witgat	Capparaceae	*Boscia albitrunca*	NE				
Noeniebos	Capparaceae	*Boscia foetida*	NE			WC	
	Capparaceae	*Cleome foliosa*	NE	RH	OP	WC	
	Capparaceae	*Cleome suffruticosa*	NE		OP	WC	
Lammerdrol	Capparaceae	*Maerua schinzii*	NE	RH			
	Caryophyllaceae	*Spergularia media*	-		OP		
Common Spikethorn	Celastraceae	*Gymnosporia buxifolia*	NE	RH			
Confetti Spikethorn	Celastraceae	*Gymnosporia senegalensis*	NE		OP		
	Chenopodiaceae	*Chenopodium amboanum*	DD	RH			NA
Wormseed	Chenopodiaceae	*Chenopodium ambrosioides*	-				
Nettle-leaved goosefoot	Chenopodiaceae	*Chenopodium murale*	-	RH			
	Chenopodiaceae	*Lophiocarpus polystachyus*	NE	RH			
Tumbleweed	Chenopodiaceae	*Salsola kali*	-			WC	
	Chenopodiaceae	*Salsola tuberculatiformis*	DD		OP		

Common name	Family	Genus, species	IUCN stat.	Habitat			Ende-mism
Inkbos	Chenopodiaceae	*Suaeda plumosa*	NE		OP		
Trompetblom	Convolvulaceae	*Ipomoea adenioides*	NE				
Pig's Ear	Crassulaceae	*Cotyledon orbiculata*	NE				
Tsamma	Cucurbitaceae	*Citrullus ecirrhosus*	NE		OP	WC	
	Cucurbitaceae	*Corallocarpus dissectus*	NE				
	Cucurbitaceae	*Corallocarpus schinzii*	NE		OP		NA
	Cucurbitaceae	*Cucumella aspera*	NE			WC	
Wild Cucumber	Cucurbitaceae	*Cucumis africanus*	NE		OP		
	Cucurbitaceae	*Cucumis meeusei*	NE		OP		
Sedge	Cyperaceae	*Cyperus laevigatus*	NE			WC	
Sedge	Cyperaceae	*Cyperus marginatus*	NE			WC	
Wild Ebony	Ebenaceae	*Euclea pseudebenus*	NE			WC	
	Eriospermaceae	*Eriospermum bakerianum*	NE				
	Eriospermaceae	*Eriospermum rautanenii*	NE		OP		
Milkbush	Euphorbiaceae	*Euphorbia damarana*	NE		OP		NA
	Euphorbiaceae	*Euphorbia gariepina*	NE	RH			
	Euphorbiaceae	*Euphorbia giessii*	NE	RH			NA
	Euphorbiaceae	*Euphorbia glanduligera*	NE	RH	OP		
	Euphorbiaceae	*Euphorbia phylloclada*	NE	RH	OP		
	Euphorbiaceae	*Euphorbia virosa*	NE	RH			
Castor oil plant	Euphorbiaceae	*Ricinus communis*	NE			WC	
Ana tree	Fabaceae	*Faidherbia albida*	NE			WC	
Camel thorn	Fabaceae	*Acacia erioloba*	NE			WC	
Red thorn	Fabaceae	*Acacia reficiens*	NE			WC	
Umbrella thorn	Fabaceae	*Acacia tortilis*	NE			WC	
Bloubeesklou	Fabaceae	*Adenolobus garipensis*	NE			WC	
	Fabaceae	*Adenolobus pechuelii*	NE	RH	OP	WC	
	Fabaceae	*Indigastrum argyroides*	NE			WC	
	Fabaceae	*Indigofera adenocarpa*	NE		OP		
	Fabaceae	*Indigofera auricoma*	NE	RH	OP		
	Fabaceae	*Lotononis platycarpa*	NE		OP		
	Fabaceae	*Microcharis disjuncta*	NE		OP		
Green-hair tree	Fabaceae	*Parkinsonia africana*	NE	RH		WC	
	Fabaceae	*Sesbania pachycarpa*	NE	RH	OP		NA
	Fabaceae	*Tephrosia dregeana*	NE	RH	OP	WC	
	Geraniaceae	*Pelargonium otaviense*	NE		OP		NA
Bushman's candle	Geraniaceae	*Sarcocaulon marlothii*	NE	RH			NA
	Gisekiaceae	*Gisekia africana*	NE		OP	WC	
	Hyacinthaceae	*Dipcadi bakerianum*	NE		OP		
	Hyacinthaceae	*Dipcadi platyphyllum*	NE		OP		
	Hyacinthaceae	*Ornithogalum stapffii*	NE		OP		NA
	Hydnoraceae	*Hydnora africana*	NE				
	Hydrophyllaceae	*Codon royenii*	NE		OP	WC	
	Hydrophyllaceae	*Codon schenckii*	NE			WC	
Duckweed	Lemnaceae	*Lemna aequinoctialis*	NE			WC	
	Loasaceae	*Kissenia capensis*	NE			WC	
	Lobeliaceae	*Lobelia erinus*	NE			WC	
Bird lime	Loranthaceae	*Tapinanthus oleifolius*	NE		OP		
	Lythraceae	*Ammannia wormskioldii*	NE				

Common name	Family	Genus, species	IUCN stat.	Habitat			Ende-mism
	Lythraceae	*Nesaea sarcophylla*	NE			WC	
	Malvaceae	*Abutilon pycnodon*	NE	RH			
	Mesembryanthem-aceae	*Brownanthus kuntzei*	NE	RH		WC	
	Mesembryanthem-aceae	*Lithops ruschiorum*	LC	RH			ND
	Mesembryanthem-aceae	*Mesembryanthemum guerichianum*	NE			WC	
	Mesembryanthem-aceae	*Psilocaulon salicornioides*	NE	RH	OP		NA
	Molluginaceae	*Limeum argute-carinatum*	NE		OP		
	Molluginaceae	*Mollugo cerviana*	NE	RH			
Moringa	Moringaceae	*Moringa ovalifolia*	NE	RH			
	Nyctiginaceae	*Boerhavia hereroensis*	NE				
	Nyctiginaceae	*Commicarpus squarrosus*	NE			WC	
Adder's tongue fern	Ophioglossaceae	*Ophioglossum polyphyllum*	NE		OP		
Mexican poppy	Papaveraceae	*Argemone ochroleuca*	-			WC	
	Passifloraceae	*Adenia pechuelii*	NT	RH			NA
	Pedaliaceae	*Sesamum capense*	NE	RH	OP		
	Pedaliaceae	*Sesamum marlothii*	NE	RH		WC	
	Pedaliaceae	*Sesamum schinzianum*	NE	RH			
	Plumbaginaceae	*Dyerophytum africanum*	NE		OP		
	Poaceae	*Aristida parvula*	NE	RH	OP		NA
Annual sweet-grass	Poaceae	*Brachiaria glomerata*	NE	RH		WC	
Quick grass	Poaceae	*Cynodon dactylon*	-			WC	
Eight-day grass	Poaceae	*Enneapogon desvauxii*	NE	RH	OP	WC	
Nine-awn grass	Poaceae	*Enneapogon scaber*	NE	RH	OP		
	Poaceae	*Eragrostis macrochlamys*	NE	RH		WC	
Perennial love-grass	Poaceae	*Eragrostis nindensis*	NE		OP		
	Poaceae	*Paspalum vaginatum*	-				
Reed	Poaceae	*Phragmites australis*	NE			WC	
Bur bristle-grass	Poaceae	*Setaria verticillata*	NE	RH			
	Poaceae	*Sporobolus consimilis*	NE	RH		WC	
	Poaceae	*Sporobolus nebulosus*	NE	RH	OP		
Tall bushman-grass	Poaceae	*Stipagrostis ciliata*	NE	RH	OP		
	Poaceae	*Stipagrostis damarensis*	NE		OP	WC	NA
	Poaceae	*Stipagrostis dinteri*	NE	RH		WC	NA
	Poaceae	*Stipagrostis hermannii*	NE		OP		ND
Blue bushman-grass	Poaceae	*Stipagrostis hirtigluma*	NE		OP	WC	
Gemsbok tail grass	Poaceae	*Stipagrostis hochstetteriana*	NE		OP		
River bushman-grass	Poaceae	*Stipagrostis namaquensis*	NE				
Small bushman-grass	Poaceae	*Stipagrostis obtusa*	NE		OP		
	Poaceae	*Stipagrostis schaeferi*	NE	RH	OP	WC	
	Poaceae	*Stipagrostis subacaulis*	NE		OP		

Common name	Family	Genus, species	IUCN stat.	Habitat			Ende-mism
Silky bushman-grass	Poaceae	*Stipagrostis uniplumis*	NE		OP		
	Polygalaceae	*Polygala guerichiana*	NE	RH	OP	WC	NA
	Polygalaceae	*Polygala pallida*	NE	RH			
	Polygonaceae	*Polygonum plebeium*	NE			WC	
	Portulaceae	*Anacampseros albissima*	NE				
	Rubiaceae	*Kohautia cynanchica*	NE		OP		
	Ruppiaceae	*Ruppia maritima*	NE			WC	
Mustard tree	Salvadoraceae	*Salvadora persica*	NE			WC	
	Scrophulariaceae	*Anticharis ebracteata*	NE		OP		ND
	Scrophulariaceae	*Anticharis imbricata*	NE			WC	NA
	Scrophulariaceae	*Anticharis inflata*	NE		OP		NA
	Scrophulariaceae	*Aptosimum lineare*	NE		OP		
	Scrophulariaceae	*Diclis petiolaris*	NE			WC	
	Scrophulariaceae	*Jamesbrittenia canescens*	NE				
	Scrophulariaceae	*Jamesbrittenia hereroensis*	NE	RH			NA
	Scrophulariaceae	*Jamesbrittenia maxii*	NE	RH	OP		
	Scrophulariaceae	*Manulea dubia*	NE		OP		NA
Thorn apple	Solanaceae	*Datura innoxia*	-			WC	
Wild tobacco	Solanaceae	*Nicotiana glauca*	-			WC	
	Solanaceae	*Solanum rigescentoides*	NE			WC	NA
	Sterculiaceae	*Hermannia affinis*	NE	RH	OP	WC	
	Sterculiaceae	*Hermannia amabilis*	NE	RH			NA
	Sterculiaceae	*Hermannia complicata*	NE		OP		NA
	Sterculiaceae	*Hermannia glandulosissima*	NE		OP		NA
	Sterculiaceae	*Hermannia helianthemum*	NE		OP		
	Sterculiaceae	*Hermannia modesta*	NE		OP		
	Sterculiaceae	*Hermannia solaniflora*	NE		OP		NA
Sterculia	Sterculiaceae	*Sterculia africana*	NE	RH			
Wild tamarisk	Tamaricaceae	*Tamarix usneoides*	NE			WC	
Small-leaved cross-berry	Tiliaceae	*Grewia tenax*	NE		OP		
Bullrush	Typhaceae	*Typha capensis*	NE			WC	
	Urticacea	*Forsskaolea candida*	NE	RH			
	Urticacea	*Forsskaolea hereroensis*	NE	RH			
	Vahliaceae	*Vahlia capensis*	NE				
	Verbenaceae	*Chascanum garipense*	NE	RH			
	Viscaceae	*Viscum rotundifolium*	NE				
	Zygophyllaceae	*Fagonia isotricha*	NE	RH		WC	
	Zygophyllaceae	*Fagonia sinaica*	NE			WC	
Duwweltjie	Zygophyllaceae	*Tribulus zeyheri*	NE			WC	
	Zygophyllaceae	*Zygophyllum cylindrifolium*	NE		OP		NA
	Zygophyllaceae	*Zygophyllum simplex*	NE	RH	OP		
Dollar bush	Zygophyllaceae	*Zygophyllum stapffii*	NE	RH	OP	WC	ND

ARACHNIDS AND OTHER NON-INSECT INVERTEBRATES

Common name	Family, higher grouping	Genus, species	IUCN Stat.	EOO (km²)	NOL	Habitat			Ende-mism	Actual Locations (only if <=10)
ARACHNIDA										
Mites and ticks	**ACARI**									
Mites	Trombidiidae	*sp.*	NE			RH	OP	WC	?	
Water mites	Hydracarina	*sp.*	NE					WC	?	
Ticks	Ixodida	*sp.*	NE			RH	OP	WC	?	
Mites	Mesostigmata	*sp.*	NE			RH	OP	WC	?	
Spiders	**ARANEAE**									
Funnel-web spiders	Agelenidae	*Agelena sp.*	NE			RH	OP	WC	?	
Termite-eating spiders	Ammoxenidae	*Ammoxenus coccineus*	NE					WC		
	Ammoxenidae	*Rastellus narubis*	EN	3838	3	RH			CW	Lower Dome Gorge, Narubis, Otjongoro
	Ammoxenidae	*Rastellus struthio*	LC	>20000	5		OP			1712, Omega, Lower Ostrich Gorge, Smiti, Upper Ostrich Gorge
Orb-web spiders	Araneidae	*sp.*	NE					WC	?	
	Caponiidae	*Diploglena capensis*	NE				OP	WC	?	
Sac spiders	Clubionidae	*Clubiona sp.*	NE					WC	?	
Mesh-web spiders	Dictynidae	*sp.*	NE				OP		?	
Velvet spiders	Eresidae	*Eresus sp.*	NE				OP		?	
	Eresidae	*Seothyra anettae*	CR	-	1		OP		RA	Arandis Site
	Eresidae	*Seothyra fasciata*	LC				OP			
	Eresidae	*Seothyra longipedata*	EN	-	2			WC		Claim Peak, Lower Ostrich Gorge
Crevice-weaver spiders	Filistatidae	*sp.*	NE				OP	WC	?	
Ground spiders	Gnaphosidae	*Asemesthes sp.*	NE				OP	WC	?	
	Gnaphosidae	*Diaphractus sp.*	NE				OP	WC	?	

Common name	Family, higher grouping	Genus, species	IUCN Stat.	EOO (km²)	NOL	Habitat			Ende-mism	Actual Locations (only if <=10)
	Gnaphosidae	*Megamyrmaekion sp.*	NE			RH	OP	WC	?	
	Gnaphosidae	*Setaphis sp.*	NE				OP	WC	?	
	Gnaphosidae	*Zelotes sp.*	NE			RH				
	Gnaphosidae - Drassodinae	*sp.*	NE				OP		?	
	Gnaphosidae - Echeminae	*sp.*	NE					WC	?	
	Gnaphosidae - Hemichloeinae	*sp.*	NE				OP		?	
	Hahniidae	*sp.*	NE					WC		
Long-spinneret spiders	Hersiliidae	*Hersilia arborea*	LC	>20000	6			WC		Annabis, Kaoko-Otavi, Lower Ostrich, Outjo, Vic Falls, Warmbad
	Hersiliidae	*Tyrotama fragilis*	LC	>20000	8	RH	OP			Arandis, Brandberg, Espinheira, Kaross, Outjo, Sesfontein, Stockpile Ridge, Upper Ostrich
Spurred trapdoor spiders	Idiopidae	*Idiops sp.*	NE			RH			?	
Sheet-web spiders	Linyphiidae	*sp.*	NE					WC	?	
Wolf spiders	Lycosidae	*sp.*	NE				OP		?	
Tingle trapdoor spiders	Migidae	*Moggridgea eremicola*	CR	-	1	RH			RA	Lower Dome Gorge
Flatmesh-weaver spiders	Oecobiidae	*Paroecobius sp.*	NE			RH	OP		?	
Dwarf six-eyed spiders	Oonopidae	*sp.*	NE				OP	WC	?	
Lynx spiders	Oxyopidae	*Oxyopes sp.*	NE				OP	WC	?	
	Oxyopidae	*Peucetia crucifera*	LC			RH			NA	
	Oxyopidae	*Peucetia viridis*	LC					WC		

Common name	Family, higher grouping	Genus, species	IUCN Stat.	EOO (km²)	NOL	Habitat			Ende-mism	Actual Locations (only if <=10)
Palp-footed spiders	Palpimanidae	*Diaphorocellus sp.*	NE			RH	OP	WC	?	
	Palpimanidae	*Palpimanus sp.*	NE			RH			?	
Running crab spiders	Philodromidae	*Hirriusa sp.*	NE					WC	?	
	Philodromidae	*Philodromus sp.*	NE				OP	WC	?	
	Philodromidae	*Suemus sp.*	NE					WC	?	
	Philodromidae	*Thanatus sp.*	NE				OP	WC	?	
Daddy long legs	Pholcidae	*Pholcus sp.*	NE			RH			?	
	Pholcidae	*Smeringopus hypocrita*	LC			RH	OP	WC		
	Prodidomidae	*Namundra griffinae*	EN	-	2	RH			RA	Lower Dome Gorge, Stockpile Ridge
	Prodidomidae	*Prodidomus sp.*	NE				OP	WC	?	
	Prodidomidae	*Theuma sp.*	NE			RH		WC	?	
Jumping spiders	Salticidae	*Bianor sp.*	NE			RH	OP	WC	?	
	Salticidae	*Langona sp.*	NE			RH	OP	WC	?	
	Salticidae	*Mogrus sp.*	NE			RH	OP	WC	?	
	Salticidae	*Neaetha sp.*	NE			RH	OP	WC	?	
Spitting spiders	Scytodidae	*Scytodes sp.*	NE			RH		WC	?	
Tube-web spiders	Segestriidae	*Ariadna sp.*	NE				OP	WC	?	
Wall spiders	Selenopidae	*Anyphops sp.*	NE					WC	?	
	Selenopidae	*Selenops sp.*	NE				OP		?	
Violin spiders	Sicariidae	*Loxosceles pilosa*	LC				OP	WC		
	Sicariidae	*Sicarius allospinosis*	LC				OP	WC	NA	
Huntsmen spiders	Sparassidae	*Arandisa sp.*	NE			RH			NA	
	Sparassidae	*Carparachne sp.*	NE				OP		?	
	Sparassidae	*Leucorchestris sp.*	NE			RH	OP		NA	
	Sparassidae	*Microrchestris melanogaster*	NE				OP	WC	NA	
	Sparassidae	*Olios sp.*	NE			RH		WC	?	

Common name	Family, higher grouping	Genus, species	IUCN Stat.	EOO (km²)	NOL	Habitat			Ende-mism	Actual Locations (only if <=10)
	Sparassidae	*Orchestrella sp.*	NE				OP	WC	?	
	Sparassidae	*Palystella sp.*	NE				OP	WC	?	
Long-jawed spiders	Tetragnathidae	*Tetragnatha sp.*	NE					WC	?	
Comb-footed spiders	Theridiidae	*sp.*	NE				OP	WC	?	
Crab spiders	Thomisidae	*Diaea sp.*	NE					WC	?	
	Thomisidae	*Heriaeus sp.*	NE					WC	?	
	Thomisidae	*Misumenops sp.*	NE			RH		WC	?	
	Thomisidae	*Thomisus machadoi*	LC				OP	WC		
	Thomisidae	*Thomisus schultzei*	LC				OP			
	Trochanteriidae	*cf. Platyoides sp.*	NE			RH			?	
Hackled orb spiders	Uloboridae	*sp.*	NE				OP		?	
Ant spiders	Zodariidae	*Caesetius sp. nov.*	CR	-	1			WC	RA	Upper Panner Gorge
	Zodariidae	*Capheris sp.*	NE				OP		?	
	Zodariidae	*Cydrela sp.*	NE				OP		?	
	Zodariidae	*Cyrioctea namibiensis*	CR	-	1		OP		RA	
	Zodariidae	*Diores namibia*	EN	1084	3			WC	CW	Hohenheim, Panner, Portsmut
	Zodariidae	*Heradida griffinae*	EN	11	3	RH	OP	WC	RA	Dome, Lower Ostrich, Upper Ostrich
	Zodariidae	*Mallinus sp.*	NE				OP		?	
	Zodariidae	*Palfuria panner*	LC	>20000	7			WC	NA	2816, Jakkalsputz, Fransfontein, Panner Gorge, Richthofen, Waterberg, Windhoek
	Zodariidae	*Psammoduon deserticola*	LC					WC	NA	
Harvestmen	**OPILIONES**									
	Assamiidae	*Namutonia scabra*	LC				OP		NA	

Common name	Family, higher grouping	Genus, species	IUCN Stat.	EOO (km²)	NOL	Habitat			Ende-mism	Actual Locations (only if <=10)
False scorpions	**PSEUDOSCORPIONES**									
	Hesperolpiidae	*Ectactolpium sp.*	NE			RH	OP		?	
	Olpiidae	*Pseudohorus sp.*	NE				OP		?	
Scorpions	**SCORPIONES**									
	Bothriuridae	*Lisposoma elegans*	LC			RH	OP	WC	NA	
	Buthidae	*Hottentota conspersus*	LC			RH				
	Buthidae	*Parabuthus brevimanus*	LC			RH		WC		
	Buthidae	*Parabuthus gracilis*	LC				OP	WC	ND	
	Buthidae	*Parabuthus granulatus*	LC							
	Buthidae	*Parabuthus namibensis*	VU	7653	7		OP	WC	CN	Arandis Site, Cape Cross 5 km N, Gobabeb, Gobabeb 32 km NE, Lower Ostrich, Panner, Upper Ostrich
	Buthidae	*Parabuthus villosus*	LC				OP	WC		
	Buthidae	*Uroplectes pilosus*	VU	1003	6	RH	OP	WC	CN	Arandis Site, Cape Cross, Lower Dome Gorge, Lower Ostrich, Panner, Upper Ostrich
	Buthidae	*Uroplectes planimanus*	LC			RH				
	Buthidae	*Uroplectes sp. nov.*	NE			RH		WC	?	
	Ischnuridae	*Hadogenes tityrus*	NE			RH			NA	
	Scorpionidae	*Opisthophthalmus carinatus*	LC			RH				
	Scorpionidae	*Opisthophthalmus coetzeei*	VU	8581	9	RH	OP		CW	Arandis Site, Bloedkoppie, Ganab, Gobabeb, Gorob, Lower Dome, Valencia

Common name	Family, higher grouping	Genus, species	IUCN Stat.	EOO (km²)	NOL	Habitat			Ende-mism	Actual Locations (only if <=10)
										(farm 42); Ambiguous localities excluded from EOO calculation since there is more than one similarly named place: Klein Aub, Narib.
	Scorpionidae	*Opisthophthalmus wahlbergi*	LC				OP			
Sun spiders	**SOLIFUGAE**									
	Daesiidae	*Biton sp. nov.*	NE				OP		?	
	Daesiidae	*Blossia falcifera*	LC			RH				
	Daesiidae	*Blossia planicursor*	EN	1609	5		OP		CN	Arandis Site, Gobabeb, Hope Min, Panner, Upper Ostrich
	Daesiidae	*Blossia rooica*	VU	7998	5	RH	OP	WC	CW	Gobabeb, Lower Ostrich, Naukluft, Stockpile Ridge, Upper Ostrich
	Daesiidae	*Blossia sp. nov. A*	EN	-	2	RH			RA	Lower Dome, Stockpile Ridge
	Daesiidae	*Blossia sp. nov. B*	EN	-	2			WC	RA	Lower Ostrich, Panner
	Daesiidae	*Hemiblossia etosha*	LC			RH	OP	WC	NA	
	Daesiidae	*Namibesia pallida*	LC			RH			NA	
	Gylippidae	*Trichotoma michaelseni*	VU	790	6		OP		ND	Arandis Site, Gobabeb, Lower Ostrich, Lüderitz, Panner, Upper Ostrich
	Hexisopodidae	*Hexisopus moiseli*	EN	1689	3			WC	CW	Emeritus, Ganab, Swakopmund 32 km E
	Melanoblossidae	*Daesiella pluridens*	CR	-	1		OP		RA	Arandis
	Melanoblossidae	*Lawrencega longitarsis*	EN	3895	5		OP		CN	Arandis Site, Gobabeb, Hentiesbaai 60 km NE, Swartbank, Upper

Common name	Family, higher grouping	Genus, species	IUCN Stat.	EOO (km²)	NOL	Habitat			Ende-mism	Actual Locations (only if <=10)
										Ostrich
	Melanoblossidae	*Lawrencega minuta*	VU	4754	6		OP		CN	Arandis Site, Gobabeb, Lower Ostrich, Narabeb, Tsondabvlei, Upper Ostrich
	Melanoblossidae	*Lawrencega solaris*	VU	2824	6		OP		CN	Arandis Site, Gobabeb, Gobabeb E 60 km, Gobabeb ENE 86 km, Hope Mine, Upper Ostrich
	Melanoblossidae	*Lawrencega sp. nov.*	EN	12	5	RH			RA	Dome, Lower Ostrich, Panner, Stockpile Ridge, Upper Ostrich
	Solpugidae	*Solpugassa furcifera*	LC					WC		
	Solpugidae	*Solpugema sp.*	NE				OP		?	
	Solpugidae	*Solpugiba lineata*	LC				OP	WC		
	Solpugidae	*Solpugista bicolor*	LC				OP		ND	
	Solpugidae	*Zeria lawrencei*	LC				OP	WC	ND	
Centipedes	**CHILOPODA**									
	Henicopidae	*Lamyctes sp.*	NE						?	
	Oryidae	*Diptherogaster flavus*	NE				OP			
	Scolopendridae	*Cormocephalus pontifex*	EN	2127	3	RH	OP		CN	Arandis, Brandberg, Karub
Millipedes	**DIPLOPODA**									
	Polyxenidae	*Chilexenus sp.*	NE				OP		?	
Crustaceans	**CRUSTACEA**									
Seed shrimps	Copepoda	*sp.*	NE					WC		
Mussel shrimps	Ostracoda	*sp.*	NE					WC		
Molluscs	**MOLLUSCA**									

Common name	Family, higher grouping	Genus, species	IUCN Stat.	EOO (km²)	NOL	Habitat			Ende-mism	Actual Locations (only if <=10)
Snails	Mollusca	*sp.*	NE					WC		

INSECTS

Common name	Family	Genus, species	IUCN Stat.	EOO (km^2)	NOL	Habitat			Ende-mism	Actual Locations (only if <=10)
Cockroaches	**BLATTODEA**									
	Blattodea	*sp. 1*	NE						?	
	Blattodea	*sp. 2*	NE			RH	OP	WC	?	
	Blattodea	*sp. 5*	NE				OP	WC	?	
	Blattodea	*sp. 6*	NE				OP	WC	?	
	Blattodea	*sp. 7*	NE					WC	?	
	Blattodea	*sp. 8*	NE					WC	?	
	Blattodea	*sp. 9*	NE					WC	?	
	Blattodea	*sp. 10*	NE				OP	WC	?	
	Blattodea	*sp. 11*	NE					WC	?	
Beetles	**COLEOPTERA**									
Ant beetles	Anthicidae	*sp.*	NE					WC	?	
Seed weevils	Bruchidae	*Bruchidius cretaceus*	LC				OP			
Jewel beetles	Buprestidae	*Acmaeodera decemguttata*	NE			RH				
	Buprestidae	*Acmaeodera liessnerae*	VU	9411	5		OP	WC	CW	Arandis Site, Gobabeb, Lower Ostrich, Panner, Wasservallei
	Buprestidae	*Acmaeodera penrithae*	LC	>20000	7		OP	WC	NA	Ameib, Arandis Site, Excelsior 286, Lower Ostrich, Ondorusu Falls, Richthofen, Upper Ostrich.
	Buprestidae	*Acmaeodera swammerdami*	NE				OP			
	Buprestidae	*Julodis egho*	LC				OP			
	Buprestidae	*Julodis namibiensis*	NE				OP		CN	
	Buprestidae	*Nothomorphoides irishi*	EN	13	3		OP		RA	Arandis Site, Lower Ostrich, Upper Ostrich
Ground	Carabidae	*Anthia sp.*	NE				OP	WC	?	

Common name	Family	Genus, species	IUCN Stat.	EOO (km^2)	NOL	Habitat			Ende-mism	Actual Locations (only if <=10)
beetles										
	Carabidae	*Calosoma sp.*	NE			RH			?	
	Carabidae	*Graphipterus sp.*	NE				OP	WC	?	
	Carabidae	*Microlestia sp.*	NE					WC	?	
	Carabidae	*Passalidius fortipes*	LC				OP	WC		
	Carabidae	*sp. 1*	NE			RH			?	
	Carabidae	*sp. 2*	NE					WC	?	
	Carabidae	*sp. 3*	NE				OP		?	
	Carabidae	*sp. 4*	NE				OP		?	
	Carabidae	*sp. 5*	NE			RH			?	
	Carabidae	*sp. 6*	NE			RH			?	
Leaf beetles	Chrysomelidae	*sp.*	NE						?	
Chequered beetles	Cleridae	*sp.*	NE						?	
Ladybird beetles	Coccinellidae	*sp.*	NE						?	
Weevils, snout beetles	Curculionidae	*Barinae sp.*	NE					WC	?	
	Curculionidae	*Brachycerus cf. granifer*	NE				OP		?	
	Curculionidae	*Brachycerus cf. perfossus*	NE				OP		?	
	Curculionidae	*Brachycerus rotundatus*	NE				OP		?	
	Curculionidae	*Brachyderinae sp.*	NE				OP		?	
	Curculionidae	*Ceutorhynchinae sp.*	NE			RH	OP	WC	?	
	Curculionidae	*Episus contractus*	LC				OP			
	Curculionidae	*Gronops brincki*	NE						?	
	Curculionidae	*Hyomora manca*	LC				OP	WC	NA	

Common name	Family	Genus, species	IUCN Stat.	EOO (km^2)	NOL	Habitat			Ende-mism	Actual Locations (only if <=10)
	Curculionidae	*Hyomora porcella*	VU	18592	8		OP		CN	Arandis Site, Bethanis, Hentiesbaai 17 km E, Homeb, Kharu-gaiseb 11 km S, Khorixas W 50 miles, Lower Ostrich, Panner
	Curculionidae	*Hypocolobus sp.*	NE				OP	WC	?	
	Curculionidae	*Leptostethus spicatirostris*	EN	-	2		OP		CN	
	Curculionidae	*Lixus sp.*	NE					WC	?	
	Curculionidae	*Microlarinus angustulus*	NE			RH		WC	?	
	Curculionidae	*Ocladius sp.*	NE				OP		?	
	Curculionidae	*Siderodactylus sp.*	NE				OP		?	
	Curculionidae	*Spartecerus cf. mendax*	NE				OP	WC	?	
	Curculionidae	*Spartecerus nasalis*	NE			RH				
	Curculionidae	*Zygopinae sp.*	NE			RH			?	
Museum beetles	Dermestidae	*sp.*	NE						?	
Water beetles	Dytiscidae	*Yolina brincki*	NE					WC	ND	
Unidentified beetles	fam. indet.	*sp.*	NE			RH		WC	?	
	Glaresidae	*Glaresis koenigsbaueri*	LC	>2000 0	9				NA	
Hister beetles	Histeridae	*sp.*	NE						?	
Moss beetles	Hydraenidae	*Ochthebius sp.*	NE					WC		
Water scavenger beetles	Hydrophilidae	*sp.*	NE					WC		
Blister beetles	Meloidae	*Iselma deserticola*	EN	41	3	RH	OP		RA	Arandis Site, Lower Dome, Upper Ostrich

Common name	Family	Genus, species	IUCN Stat.	EOO (km^2)	NOL	Habitat			Ende-mism	Actual Locations (only if <=10)
Flower beetles	Melyridae	*Hedybius irishi*	CR	-	1			WC	RA	Lower Ostrich
	Melyridae	*Metaphilehedonus swakopmundensis*	EN	5	3	RH		WC	RA	Dome, Lower Ostrich, Stockpile
	Monommidae	*sp. 1*	NE			RH			?	
	Monommidae	*sp. 2*	NE			RH			?	
Spider beetles	Ptinidae	*sp. 1*	NE					WC	?	
	Ptinidae	*sp. 2*	NE			RH			?	
	Ptinidae	*sp. 3*	NE			RH			?	
	Ptinidae	*sp. 4*	NE			RH			?	
	Ptinidae	*sp. 5*	NE			RH	OP		?	
Dung beetles	Scarabaeidae	*Anoplocheilus namibicus*	LC	>2000 0	8	RH			ND	Bethanis, Brandberg, Hohenheim, Koichabpan, Hartmannberge, Rossing Mine, Rostock, Zebrapan
	Scarabaeidae	*Pycnopanelus krikkeni*	LC	>2000 0	7		OP		NA	Arandis Site, Bethanis, Ehomba, Lower Ostrich, Opuwo NW 44 km, Sesfontein S 113 km, Upper Ostrich
Flat grain beetles	Silvanidae	*sp.*	NE				OP	WC		
Toktokkies	Tenebrionidae	*Alleculinae sp. 1*	NE						?	
	Tenebrionidae	*Alleculinae sp. 2*	NE						?	
	Tenebrionidae	*Aphrotus tricorniger*	NE				OP	WC	?	
	Tenebrionidae	*Caenocrypticus damara*	LC						CW	
	Tenebrionidae	*Cauricara velox*	LC				OP		ND	
	Tenebrionidae	*Cheirodes sp.*	NE					WC	?	
	Tenebrionidae	*Cyphostethe tau*	NE				OP	WC	?	
	Tenebrionidae	*Drosochrini sp.*	NE			RH		WC	?	
	Tenebrionidae	*Ennychiatus fitzsimonsi*	LC				OP		NA	

Common name	Family	Genus, species	IUCN Stat.	EOO (km^2)	NOL	Habitat			Ende-mism	Actual Locations (only if <=10)
	Tenebrionidae	*Epiphysa arenicola*	LC				OP	WC	CW	
	Tenebrionidae	*Eurychora sp.*	NE				OP		?	
	Tenebrionidae	*Geophanus sp. 1*	NE			RH		WC	?	
	Tenebrionidae	*Geophanus sp. 2*	NE				OP		?	
	Tenebrionidae	*Geophanus sp. 4*	NE			RH	OP	WC	?	
	Tenebrionidae	*Gonopus sp.*	NE				OP	WC	?	
	Tenebrionidae	*Herpiscius sp.*	NE			RH			?	
	Tenebrionidae	*Horatoma deserticola*	EN	2347	3		OP		CN	Arandis Site, Gobabeb, Gorob Mine
	Tenebrionidae	*Horatoma spinipes*	LC			RH			NA	
	Tenebrionidae	*Metriopus depressus*	LC			RH	OP		NA	
	Tenebrionidae	*Neocaedius sp.*	NE					WC	?	
	Tenebrionidae	*Pachynoteles machadoi*	LC			RH		WC		
	Tenebrionidae	*Pachynoteles punctipennis*	VU	6228	6		OP	WC	CW	Arandis Site, Bloemhof 109, Lower Ostrich, Upper Ostrich, Usakos 46 km W, Aruab
	Tenebrionidae	*Palpomodes physoptera*	NE				OP			
	Tenebrionidae	*Parastizopus armaticeps*	LC				OP	WC		
	Tenebrionidae	*Phanerotomea damarense*	NE				OP	WC	?	
	Tenebrionidae	*Physadesmia globosa*	LC				OP	WC	CW	
	Tenebrionidae	*Physosterna cribripes*	LC				OP	WC	NA	
	Tenebrionidae	*Planostibes sp.*	NE			RH	OP	WC	?	
	Tenebrionidae	*Rhammatodes aequalipennis*	NE			RH	OP	WC	?	
	Tenebrionidae	*Rhammatodes longicornis*	NE			RH			?	
	Tenebrionidae	*Rhammatodes*	NE			RH		WC	?	

Common name	Family	Genus, species	IUCN Stat.	EOO (km^2)	NOL	Habitat			Ende-mism	Actual Locations (only if <=10)
		tagenesthoides								
	Tenebrionidae	*Somaticus bohemani*	NE			RH			NA	
	Tenebrionidae	*Somaticus stali*	EN	-	3		OP		CN	Arandis Site. Inexact: Damaraland, Svakop.
	Tenebrionidae	*Stenocara aenescens*	LC							
	Tenebrionidae	*Stenocara dilaticornis*	LC			RH	OP	WC	ND	
	Tenebrionidae	*Stenocara gracilipes*	LC			RH		WC		
	Tenebrionidae	*Stips dohrni*	LC				OP	WC		
	Tenebrionidae	*Synhimba melancholica*	NE			RH			?	
	Tenebrionidae	*Trachynotidus rufozonatus*	NE			RH	OP	WC	?	
	Tenebrionidae	*Tribolium sp.*	NE						?	
	Tenebrionidae	*Zophosis (Calosis) amabilis*	LC				OP		ND	
	Tenebrionidae	*Zophosis (Carpiella) latisterna*	EN	2776	5		OP		CN	Arandis Site, Gobabeb, Messum Mts, Rössing Mts, Upper Ostrich
	Tenebrionidae	*Zophosis (Gyrosis) ornatipennis*	VU	357	9		OP	WC	CN	Arandis, Arandis Site, Khan Mine, Lower Ostrich, Panner, Rössing Mts, Swakopmund, Swakopmund E 50 km, Upper Ostrich
	Tenebrionidae	*Zophosis (Occidentophosis) damarina*	LC				OP		CN	
	Tenebrionidae	*Zophosis (Protocalosis) balti*	LC						CW	
	Tenebrionidae	*Zophosis (Scopulophosis) fulgens*	LC						CW	
	Tenebrionidae	*Zophosis (Z.) dorsata*	LC				OP		CN	
	Tenebrionidae	*Zophosis (Z.) kochi*	LC				OP		CN	

Common name	Family	Genus, species	IUCN Stat.	EOO (km^2)	NOL	Habitat			Ende-mism	Actual Locations (only if <=10)
	Tenebrionidae	*Zophosis (Z.) lamentabilis*	LC				OP		CN	
	Tenebrionidae	*Zophosis (Z.) mniszechi*	LC						CW	
	Tenebrionidae	*sp. 9*	NE			RH	OP	WC	?	
	Tenebrionidae	*sp. 10*	NE				OP	WC	?	
	Tenebrionidae	*sp. 13*	NE			RH	OP		?	
	Tenebrionidae	*sp. 16*	NE				OP		?	
	Tenebrionidae	*sp. 17*	NE				OP	WC	?	
	Tenebrionidae	*sp. 18*	NE				OP		?	
	Thorictidae	*sp.*	NE			RH			?	
Earwigs	**DERMAPTERA**									
	Dermaptera	*sp. 1*	NE				OP	WC	?	
	Dermaptera	*sp. 2*	NE					WC	?	
	Dermaptera	*sp. 3*	NE			RH	OP	WC	?	
Flies	**DIPTERA**									
Assassin flies	Asilidae	*sp.*	NE						?	
Bee flies	Bombyliidae	*Apolysis thornei*	LC				OP	WC		
	Bombyliidae	*Australoechus molitor*	LC							
	Bombyliidae	*Crocidium immaculatum*	LC					WC		
	Bombyliidae	*Crocidium phaenochilum*	LC			RH				
	Bombyliidae	*Heterotropus apertus*	CR	-	2		OP		RA	Stockpile, Upper Ostrich
	Bombyliidae	*Hyperusia soror*	LC	>20000	8		OP		NA	Arandis Site, Haris-Claratal, Okahandja, Otjituo, Tsumkwe, Upper Ostrich, Wasserfallflaeche. Ambiguous: Warmbad
	Bombyliidae	*Parisus aurantiacus*	LC				OP			

Common name	Family	Genus, species	IUCN Stat.	EOO (km^2)	NOL	Habitat			Ende-mism	Actual Locations (only if <=10)
	Bombyliidae	*Parisus damarensis*	EN	1366	4		OP		CW	Arandis Site, Okahandja, Panner, Upper Ostich
	Bombyliidae	*Pteraulacodes hessei*	CR	-	1		OP		RA	Welwitschia Flats
Flesh flies	Calliphoridae	*Bengalia peuhi*	LC					WC		
	Calliphoridae	*Chrysomya albiceps*	LC				OP			
	Calliphoridae	*Chrysomya chloropyga*	LC				OP			
	Calliphoridae	*Rhyncomya hessei*	LC					WC		
	Calliphoridae	*Rhyncomya messoria*	LC				OP			
	Calliphoridae	*Rhyncomya minutalis*	LC				OP			
	Calliphoridae	*Stomorhina guttata*	LC					WC		
	Calliphoridae	*Zumba antennalis*	LC					WC		
Biting midges	Ceratopogonidae	*sp.*	NE					WC		
Midges	Chironomidae	*sp.*	NE					WC		
Mosquitoes	Culicidae	*Anopheles listeri*	NE					WC		
	Culicidae	*Culex theileri*	NE					WC		
	Culicidae	*Culiseta longiareolata*	NE					WC		
Long-legged flies	Dolichopodidae	*Hydrophorus praecox*	LC					WC		
Shore flies	Ephydridae	*Ephydra stuckenbergi*	NE					WC		
Horse flies	Hippoboscidae	*sp.*	NE						?	
House flies	Muscidae	*sp.*	NE						?	
Carrion flies	Sarcophagidae	*sp.*	NE						?	
Fruit flies	Tephritidae	*Brachydesis rivularis*	LC			RH				
	Tephritidae	*Deroparia reticulata*	LC	>2000 0	7	RH			NA	Epembe, Hartmann valley, Lower Dome, Omungwindi, Orupembe, Sesfontein, Uniab Mouth
	Tephritidae	*Desmella myiopitoides*	LC			RH				

Common name	Family	Genus, species	IUCN Stat.	EOO (km^2)	NOL	Habitat			Ende-mism	Actual Locations (only if <=10)
	Tephritidae	*Euryphalara barnardi*	LC			RH			NA	
	Tephritidae	*Euryphalara mecistocephala*	LC			RH	OP	WC	CW	
	Tephritidae	*Hyaloctoides semiater*	LC			RH		WC		
	Tephritidae	*Hyaloctoides superhyalinus*	LC			RH		WC		
	Tephritidae	*Hyalotephritis australis*	LC			RH				
	Tephritidae	*Insizwa oblita*	LC					WC		
	Tephritidae	*Leucothrix barbata*	LC			RH	OP		NA	
	Tephritidae	*Metasphenisca interrupta*	LC			RH	OP	WC		
	Tephritidae	*Metasphenisca longulior*	LC					WC		
	Tephritidae	*Platomma luniferum*	LC			RH			NA	
	Tephritidae	*Xenodorella mira*	LC				OP		NA	
Mayflies	**EPHEMEROPTERA**									
	Baetidae	*sp.*	NE					WC		
Bugs	**HEMIPTERA**									
Plant lice	Aphididae	*sp.*	NE					WC		
Leafhoppers	Cicadellidae	*sp.*	NE						?	
Cicadas	Cicadidae	*sp.*	NE						?	
Planthoppers	Fulgorioidea	*sp. 1*	NE			RH			?	
	Fulgorioidea	*sp. 2*	NE				OP		?	
	Fulgorioidea	*sp. 3*	NE					WC	?	
	Fulgorioidea	*sp. 4*	NE			RH			?	
	Fulgorioidea	*sp. 5*	NE				OP		?	
Seed bugs	Lygaeidae	*sp.*	NE						?	
Saucer bugs	Naucoridae	*sp.*	NE					WC		

Common name	Family	Genus, species	IUCN Stat.	EOO (km^2)	NOL	Habitat			Ende-mism	Actual Locations (only if <=10)
Stink bugs	Pentatomidae	*sp.*	NE						?	
Pygmy backswimmers	Pleidae	*sp.*	NE					WC		
Jumping plant lice	Psyllidae	*Colposcenia australis*	EN	1336	4			WC	CN	Homeb, Goanikontes, Swakopmund, Swakopmund E 8 miles
	Psyllidae	*Colposcenia namibiensis*	EN	1336	4			WC	CN	Homeb, Goanikontes, Swakopmund, Swakopmund E 8 miles
	Psyllidae	*Crastina swakopensis*	EN	27	3			WC	CN	Goanikontes, Swakopmund, Swakopmund E 8 miles
Asassin bugs	Reduviidae	*sp. 1*	NE						?	
	Reduviidae	*sp. 2*	NE					WC	?	
	Reduviidae	*sp. 3*	NE			RH	OP	WC	?	
	Reduviidae	*sp. 4*	NE				OP		?	
	Reduviidae	*sp. 5*	NE					WC	?	
	Reduviidae	*sp. 6*	NE				OP		?	
Lace bugs	Tingidae	*sp.*	NE						?	
Bees, wasps, ants	**HYMENOPTERA**									
	Andrenidae	*Meliturgula haematospila*	LC			RH				
Carpenter bees	Anthophoridae	*Tetraloniella abrochia*	LC			RH				
	Anthophoridae	*Thyreus delumbatus*	LC				OP			
Honey bees	Apidae	*Apis mellifera*	LC			RH	OP	WC		
Cuckoo wasps	Bethyloidea	*sp.*	NE					WC	?	
Ants	Formicidae	*Camponotus fulvopilosus*	LC			RH	OP	WC		
	Formicidae	*Camponotus*	NE							

Common name	Family	Genus, species	IUCN Stat.	EOO (km^2)	NOL	Habitat			Ende-mism	Actual Locations (only if <=10)
		maculatus								
	Formicidae	*Crematogaster sp.*	NE						?	
	Formicidae	*Ocymyrmex sp.*	NE						?	
	Formicidae	*sp. 1*	NE			RH		WC	?	
	Formicidae	*sp. 2*	NE					WC	?	
	Formicidae	*sp. 3*	NE			RH	OP	WC	?	
	Formicidae	*sp. 4*	NE			RH	OP	WC	?	
	Formicidae	*sp. 5*	NE			RH	OP	WC	?	
	Formicidae	*sp. 6*	NE			RH	OP	WC	?	
	Formicidae	*sp. 7*	NE			RH		WC	?	
	Formicidae	*sp. 8*	NE			RH	OP	WC	?	
	Formicidae	*sp. 9*	NE				OP		?	
	Masaridae	*sp.*	NE						?	
Velvet ants	Mutillidae	*sp. 1*	NE			RH	OP	WC	?	
	Mutillidae	*sp. 2*	NE			RH	OP	WC	?	
	Mutillidae	*sp. 3*	NE				OP	WC	?	
	Mutillidae	*sp. 4*	NE			RH		WC	?	
	Mutillidae	*sp. 5*	NE				OP	WC	?	
	Mutillidae	*sp. 6*	NE				OP	WC	?	
	Mutillidae	*sp. 7*	NE			RH	OP	WC	?	
	Mutillidae	*sp. 8*	NE			RH		WC	?	
Parasitic wasps	Parasitica	*sp.*	NE						?	
Spider-hunting wasps	Pompilidae	*sp.*	NE						?	
Sand wasps	Sphecidae	*Miscophus kriechbaumeri*	LC							
	Sphecidae	*Miscophus sabulosus*	VU	13281	5		OP		CN	Agate Beach, Gobabeb, Swakopmund, Swakopmund 40 km E, Ugab River

Common name	Family	Genus, species	IUCN Stat.	EOO (km^2)	NOL	Habitat			Ende-mism	Actual Locations (only if <=10)
										Mouth
	Sphecidae	*Namiscophus pilosus*	EN	-	2		OP		CN	Swakopmund 40 km NE, Ugab River Mouth
True wasps	Vespidae	*sp.*	NE						?	
Termites	**ISOPTERA**									
Harvester termites	Hodotermitidae	*Hodotermes mossambicus*	LC			RH	OP	WC		
	Kalotermitidae	*Epicalotermes sp.*	NE			RH	OP	WC	?	
	Rhinotermitidae	*Psammotermes allocerus*	LC				OP			
	Termitidae	*Trinervitermes sp.*	NE				OP	WC	?	
Butterflies, moths	**LEPIDOPTERA**									
	Lepidoptera	*spp.*	NE			RH	OP	WC		
(Praying) mantids	**MANTODEA**									
	Mantodea	*sp.*	NE			RH	OP		?	
Lacewings, antlions	**NEUROPTERA**									
	Neuroptera	*spp.*	NE							
Dragonflies	**ODONATA**									
	Aeshnidae	*Anax sp.*	NE					WC		
	Coenagrionidae	*sp.*	NE					WC		
	Gomphidae	*Paragomphus sp.*	NE					WC		
	Libellulidae	*Palpopleura jucunda*	LC					WC		
Grasshoppers, crickets	**ORTHOPTERA**									
Short-horned grasshoppers	Acrididae - Lithidiinae	*sp.*	NE				OP	WC	?	
Koringkrieks	Bradyporidae	*Acanthoplus longipes*	LC			RH			NA	

Common name	Family	Genus, species	IUCN Stat.	EOO (km^2)	NOL	Habitat			Ende-mism	Actual Locations (only if <=10)
	Bradyporidae	*Acanthoproctus cervinus*	LC				OP			
Crickets	Gryllidae	*sp. 1*	NE			RH	OP	WC	?	
	Gryllidae	*sp. 2*	NE				OP	WC	?	
	Gryllidae	*sp. 3*	NE				OP	WC	?	
	Gryllidae	*sp. 4*	NE			RH	OP	WC	?	
	Gryllidae	*sp. 5*	NE					WC	?	
	Lathiceridae	*Crypsicerus cubicus*	LC				OP		ND	
	Pamphagidae	*Trachypetrella anderssonii*	LC				OP			
Feather-toed crickets	Schizodactylidae	*Comicus campestris*	LC				OP	WC	NA	
Long-horned grasshoppers	Tettigoniidae	*sp. 1*	NE			RH		WC	?	
	Tettigoniidae	*sp. 2*	NE			RH			?	
	Tettigoniidae	*sp. 3*	NE			RH			?	
	Thericleidae	*sp.*	NE			RH	OP	WC	?	
Stick insects	**PHASMATODEA**									
	Phasmatodea	*sp. 1*	NE					WC	?	
	Phasmatodea	*sp. 2*	NE					WC	?	
Booklice	**PSOCOPTERA**									
	Psocoptera	*sp.*	NE					WC	?	
Fleas	**SIPHONAPTERA**									
	Siphonaptera	*sp.*	NE						?	
Thrips	**THYSANOPTERA**									
	Thysanoptera	*sp.*	NE						?	
Silverfish	**THYSANURA**									
	Lepismatidae	*Afrolepisma sp.*	NE					WC	?	

Common name	Family	Genus, species	IUCN Stat.	EOO (km^2)	NOL	Habitat			Ende-mism	Actual Locations (only if <=10)
	Lepismatidae	*Ctenolepisma sp. nov. nr. pauliani*	EN	11	3		OP	WC	RA	Arandis Site, Lower Ostrich, Upper Ostrich
	Lepismatidae	*Ctenolepisma detritus*	LC				OP	WC	CN	Range-restricted, but 11 localitions.
	Lepismatidae	*Ctenolepisma grandipalpis*	LC				OP	WC		
	Lepismatidae	*Ctenolepisma namibensis*	LC				OP		CN	
	Lepismatidae	*Ctenolepisma occidentalis*	VU	151	6		OP	WC	RA	Arandis Site, Block 13, Dome, Lower Ostrich, Panner, Upper Ostrich
	Lepismatidae	*Ctenolepisma penrithae*	LC			RH	OP	WC	CN	
	Lepismatidae	*Ctenolepisma plusiochaeta*	LC				OP		NA	
	Lepismatidae	*Monachina stilifera*	LC				OP	WC		
	Lepismatidae	*Thermobia aegyptiaca*	LC			RH				
	Lepismatidae	*Thermobia nebulosa*	LC				OP		ND	
	Lepismatidae	*Thermobia vallaris*	LC				OP			

REPTILES AND AMPHIBIANS

Common name	Family	Genus, species	IUCN Stat.	Habitat			Ende-mism
TORTOISES AND TERRAPINS							
Leopard Tortoise	Testudinidae	*Geochelone pardalis*	VU			WC	
Helmeted Terrapin	Pelomedusidae	*Pelomedusa subrufa*	LC			WC	
SCALED REPTILES							
Geckos							
Southwest African Flat Gecko	Gekkonidae	*Afroedura africana*	NT	RH			NA
Coastal Namib Day Gecko	Gekkonidae	*Rhoptropus afer*	LC	RH	OP		ND
Bradfield's Namib Day Gecko	Gekkonidae	*Rhoptropus bradfieldi*	LC	RH	OP		CN
Barnard's Namib Day Gecko	Gekkonidae	*Rhoptropus barnardi*	LC	RH	OP		NA
Giant Ground Gecko	Gekkonidae	*Chondrodactylus angulifer namibensis*	LC		OP		ND
Palmato Gecko	Gekkonidae	*Palmatogecko rangei*	LC			WC	ND
Button-scale Gecko	Gekkonidae	*Chondrodactylus turneri*	LC	RH	OP	WC	
Velvety Gecko	Gekkonidae	*Pachydactylus bicolor*	LC	RH	OP		NA
Weber's Gecko	Gekkonidae	*Pachydactylus weberi werneri*	LC	RH	OP		NA
Namib Ghost Gecko	Gekkonidae	*Pachydactylus kochii*	LC		OP		CN
Namib Variable Gecko	Gekkonidae	*Pachydactylus punctatus/scherzi*	LC		OP	WC	
Namibian Rough Scaled Gecko	Gekkonidae	*Pachydactylus rugosus*	LC		OP		NA
Banded Barking Gecko	Gekkonidae	*Ptenopus carpi*	LC		OP		CN
Barking Gecko	Gekkonidae	*Ptenopus garrulus*	LC		OP	WC	
Festive Gecko	Gekkonidae	*Narudasia festiva*	LC	RH			NA
Agamas							
Namibian Rock Agama	Agamidae	*Agama planiceps*	LC	RH			
Western Rock Agama	Agamidae	*Agama anchietae*	LC	RH			
Chameleons							
Namaqua Chameleon	Chameleonidae	*Chameleo namaquensis*	LC	RH	OP	WC	
Skinks							
Wedge-snouted Skink	Scincidae	*Trachylepis acutilabris*	LC		OP	WC	
Western Rock Skink	Scincidae	*Trachylepis hoeschi*	LC	RH			
Western Three-lined Skink	Scincidae	*Trachylepis occidentalis*	LC	RH		WC	
Namibian Tree Skink	Scincidae	*Trachylepis spilogaster*	LC			WC	
Western Variegated Skink	Scincidae	*Trachylepis variegata*	LC	RH	OP		
Koppie Skink	Scincidae	*Trachylepis sulcata*	LC	RH	OP		

Common name	Family	Genus, species	IUCN Stat.	Habitat			Ende-mism
Namibian Dwarf Burrowing Skink	Scincidae	*Scelotes capensis*	LC	RH	OP		NA
Typical lizards							
Spotted Sand Lizard	Lacertidae	*Meroles suborbitalis*	LC		OP		
New species 1	Lacertidae	*Meroles sp. nov.*	NE				CN
Short-headed Sand Lizard	Lacertidae	*Pedioplanis breviceps*	LC		OP		ND
Husab Sand Lizard	Lacertidae	*Pedioplanis husabensis*	DD	RH			CN
Namibian Sand Lizard	Lacertidae	*Pedioplanis inornata*	LC	RH	OP		NA
Namaqua Sand Lizard	Lacertidae	*Pedioplanis namaquensis*	LC		OP	WC	
Western Sand Lizard	Lacertidae	*Pedioplanis undata*	LC		OP	WC	
Plated lizards							
Dwarf Plated Lizard	Gerrhosauridae	*Cordylosaurus subtesselatus*	LC	RH	OP		
SNAKES							
Worm snakes							
Damara Worm Snake	Leptotyphlopidae	*Leptotyphlops labialis*	LC				NA
Namibian Worm Snake	Leptotyphlopidae	*Leptotyphlops occidentalis*	LC		OP	WC	NA
Blind snakes							
Delalande's Blind Snake	Typhlopidae	*Rhinotyphlops lalandei*	LC		OP	WC	
Typical snakes							
Brown House Snake	Colubridae	*Lamprophis fuliginosus*	LC		OP	WC	
Namibian Wolf Snake	Colubridae	*Lycophidion namibianum*	LC	RH	OP		NA
Namib Sand Snake	Colubridae	*Psammophis namibensis*	LC		OP	WC	
Western Whip Snake	Colubridae	*Psammophis trigrammus*	LC		OP	WC	NA
Karoo Whip Snake	Colubridae	*Psammophis notostictus*	LC		OP	WC	
Leopard Whip Snake	Colubridae	*Psammophis leopardinus*	LC		OP	WC	NA
Rhombic Egg-eater	Colubridae	*Dasypeltis scabra*	LC			WC	
Namaqua Tiger Snake	Colubridae	*Telescopus beetzii*	LC	RH	OP	WC	
Southern Tiger Snake	Colubridae	*Telescopus semiannulatus*	LC	RH	OP	WC	
Damara Tiger Snake	Colubridae	*Telescopus sp. nov.*	LC	RH			CW
Western Keeled Snake	Colubridae	*Pythonodipsas carinatus*	LC	RH			NA
Mole Snake	Colubridae	*Pseudaspis cana*	LC		OP	WC	
Dwarf Beaked Snake	Colubridae	*Dipsina multimaculata*	LC		OP	WC	
Adders							
Horned Adder	Viperidae	*Bitis caudalis*	LC		OP	WC	
Puff Adder	Viperidae	*Bitis arietans*	LC		OP	WC	

Common name	Family	Genus, species	IUCN Stat.	Habitat			Ende-mism
Cobras							
Zebra Snake	Elapidae	*Naja nigricincta*	LC	RH	OP	WC	NA
Frogs							
Hoesch's Toad	Bufonidae	*Poyntonophrynus hoeschi*	LC			WC	
Platanna	Pipidae	*Xenopus laevis*	LC			WC	
Rubber frog	Microhylidae	*Phrynomantis annectens*	LC			WC	

Appendix C. Inventory of assessed taxa

BIRDS

Common name	Family	Genus, species	IUCN stat.	Habitat			Ende-mism	Notes
Common Ostrich	Struthionidae	*Struthio camelus*	NE		OP	WC		
Red-billed Spurfowl	Phasianidae	*Pternistis adspersus*	NE			WC		
Helmeted Guineafowl	Numididae	*Numida meleagris*	NE			WC		
Cardinal Woodpecker	Picidae	*Dendropicos fuscescens*	NE			WC		
Bearded Woodpecker	Picidae	*Dendropicos namaquus*	NE			WC		
Acacia Pied Barbet	Capitonidae	*Tricholaema leucomelas*	NE			WC		
Southern Yellow-billed Hornbill	Bucerotidae	*Tockus leucomelas*	NE			WC		
African Grey Hornbill	Bucerotidae	*Tockus nasutus*	NE			WC		
African Hoopoe	Upupidae	*Upupa africana*	NE			WC		
Common Scimitarbill	Phoeniculidae	*Rhinopomastus cyanomelas*	NE			WC		
European Bee-eater	Meropidae	*Merops apiaster*	NE	0	0	0		
Swallow-tailed Bee-eater	Meropidae	*Merops hirundineus*	NE			WC		
White-backed Mousebird	Coliidae	*Colius colius*	NE			WC		
Red-faced Mousebird	Coliidae	*Urocolius indicus*	NE			WC		
Diderick Cuckoo	Cuculidae	*Chrysococcyx caprius*	NE			WC		
Rosy-faced Lovebird	Psittacidae	*Agapornis roseicollis*	NE			WC		
Rüppell's Parrot	Psittacidae	*Poicephalus rueppellii*	NE			WC	80% of total popltn in Namibia	
Little Swift	Apodidae	*Apus affinis*	NE	0	0	0		
Common Swift	Apodidae	*Apus apus*	NE	0	0	0		
Bradfield's Swift	Apodidae	*Apus bradfieldi*	NE	0	0	0		
White-rumped Swift	Apodidae	*Apus caffer*	NE	0	0	0		
African Palm Swift	Apodidae	*Cypsiurus parvus*	NE	0	0	0		
Alpine Swift	Apodidae	*Tachymarptis melba*	NE	0	0	0		
Grey Go-away-bird	Musophagidae	*Corythaixoides concolor*	NE			WC		
Spotted Eagle Owl	Strigidae	*Bubo africanus*	NE			WC		
Cape Eagle Owl	Strigidae	*Bubo capensis*	NE			WC		
Pearl-spotted Owlet	Strigidae	*Glaucidium perlatum*	NE			WC		
Southern White-faced Scops-Owl	Strigidae	*Otus leucotis*	NE			WC		
Barn Owl	Tytonidae	*Tyto alba*	NE	RH	OP	WC		

Common name	Family	Genus, species	IUCN stat.	Habitat			Ende-mism	Notes
Freckled Nightjar	Caprimulgidae	*Caprimulgus tristigma*	NE	RH	OP	WC		
Speckled Pigeon	Columbidae	*Columba guinea*	NE			WC		
Rock Dove	Columbidae	*Columba livia*	-	0	0	0		
Namaqua Dove	Columbidae	*Oena capensis*	NE		OP	WC		
Cape Turtle Dove	Columbidae	*Streptopelia capicola*	NE			WC		
Laughing Dove	Columbidae	*Streptopelia senegalensis*	NE			WC		
Ludwig's Bustard	Otididae	*Neotis ludwigii*	NE		OP	WC		
Kori Bustard	Otididae	*Ardeotis kori*	NE		OP	WC		
Ruppell's Korhaan	Otididae	*Eupodotis ruepellii*	NE		OP	WC	ND	
Northern Black Korhaan	Otididae	*Afrotis afraoides*	NE		OP	WC		
Double-banded Sandgrouse	Pteroclididae	*Pterocles bicinctus*	NE	RH	OP	WC		
Namaqua Sandgrouse	Pteroclididae	*Pterocles namaqua*	NE	RH	OP	WC		
Spotted Thick-knee	Burhinidae	*Burhinus capensis*	NE		OP	WC		
Crowned Lapwing	Charadriidae	*Vanellus coronatus*	NE			WC		
Double-banded Courser	Glareolidae	*Rhinoptilus africanus*	NE		OP	WC		
Lappet-faced Vulture	Accipitridae	*Aegypius tracheliotos*	NE	0	0	0		
Verreaux's Eagle	Accipitridae	*Aquila verreauxii*	NT	RH				
Augur Buzzard	Accipitridae	*Buteo augur*	NE	RH				
Jackal Buzzard	Accipitridae	*Buteo rufofuscus*	NE	RH		WC		
Black-chested Snake-Eagle	Accipitridae	*Circaetus pectoralis*	NE	0	0	0		
Black-shouldered Kite	Accipitridae	*Elanus caeruleus*	NE	0	0	0		
Southern Pale Chanting Goshawk	Accipitridae	*Melierax canorus*	NE		OP	WC		
Martial Eagle	Accipitridae	*Polemaetus bellicosus*	EN	0	0	0		
Booted Eagle	Accipitridae	*Aquila pennatus*	NE	RH				
Lanner Falcon	Falconidae	*Falco biarmicus*	NE	RH	OP	WC		
Peregrine Falcon	Falconidae	*Falco peregrinus*	NE	RH	OP	WC		
Red-necked Falcon	Falconidae	*Falco chicquera*	NE			WC		
Lesser Kestrel	Falconidae	*Falco naumanni*	VU		OP	WC		
Greater Kestrel	Falconidae	*Falco rupicoloides*	NE	RH	OP			
Eurasian Hobby	Falconidae	*Falco subbuteo*	NE			WC		
Rock Kestrel	Falconidae	*Falco tinnunculus*	NE	RH	OP	WC		
Black-headed Heron	Ardeidae	*Ardea melanocephala*	NE		OP	WC		
Fork-tailed Drongo	Dicruridae	*Dicrurus adsimilis*	NE			WC		

Common name	Family	Genus, species	IUCN stat.	Habitat			Ende-mism	Notes
African Paradise Flycatcher	Muscicapidae	*Terpsiphone viridis*	NE			WC		
Common Fiscal	Laniidae	*Lanius collaris*	NE			WC		
Lesser Grey Shrike	Laniidae	*Lanius minor*	NE			WC		
Brubru	Malaconotidae	*Nilaus afer*	NE			WC		
Bokmakierie	Malaconotidae	*Telophorus zeylonus*	NE		OP	WC		
Pririt Batis	Muscicapidae	*Batis pririt*	NE			WC		
Pied Crow	Corvidae	*Corvus albus*	NE	RH	OP	WC		
Cape Crow	Corvidae	*Corvus capensis*	NE	RH	OP	WC		
Carp's Tit	Paridae	*Parus carpi*	NE				Near-endemic to Namibia	
Ashy Tit	Paridae	*Parus cinerascens*	NE					
Greater Striped Swallow	Hirundinidae	*Hirundo cucullata*	NE			WC		
Rock Martin	Hirundinidae	*Hirundo fuligula*	NE	RH				
Barn Swallow	Hirundinidae	*Hirundo rustica*	NE		OP	WC		
Brown-throated Martin	Hirundinidae	*Riparia paludicola*	NE		OP	WC		
African Red-eyed Bulbul	Pycnonotidae	*Pycnonotus nigricans*	NE			WC		
Long-billed Crombec	Sylviidae	*Sylvietta rufescens*	NE			WC		
Karoo Eremomela	Sylviidae	*Eremomela gregalis*	NE			WC	Namib popltn a separate taxon?	
Yellow-bellied Eremomela	Sylviidae	*Eremomela icteropygialis*	NE			WC		
Willow Warbler	Sylviidae	*Phylloscopus trochilus*	NE			WC		
Layard's Tit-babbler	Sylviidae	*Parisoma layardi*	NE			WC		
Chestnut-vented Titbabbler	Sylviidae	*Parisoma subcaeruleum*	NE			WC		
Orange River White-eye	Zosteropidae	*Zosterops pallidus*	NE			WC		
Grey-backed Cisticola	Sylviidae	*Cisticola subruficapilla*	NE			WC		
Black-chested Prinia	Sylviidae	*Prinia flavicans*	NE		OP	WC		
Rufous-eared Warbler	Sylviidae	*Malcorus pectoralis*	NE			WC		
Gray's Lark	Alaudidae	*Ammomanopsis grayi*	NE		OP		ND	
Fawn-coloured Lark	Alaudidae	*Calendulauda africanoides*	NE		OP			
Sabota Lark	Alaudidae	*Calendulauda sabota*	NE		OP	WC		
Karoo Long-billed Lark	Alaudidae	*Certhilauda subcoronata*	NE		OP	WC		
Spike-heeled Lark	Alaudidae	*Chersomanes albofasciata*	NE		OP			
Grey-backed Sparrowlark	Alaudidae	*Eremopterix verticalis*	NE	RH	OP	WC		
Stark's Lark	Alaudidae	*Spizocorys starki*	NE		OP			

Common name	Family	Genus, species	IUCN stat.	Habitat			Ende-mism	Notes
Short-toed Rock Thrush	Turdidae	*Monticola brevipes*	NE	RH	OP			
Chat Flycatcher	Muscicapidae	*Bradornis infuscatus*	NE		OP	WC		
Marico Flycatcher	Muscicapidae	*Bradornis mariquensis*	NE		OP	WC		
Spotted Flycatcher	Muscicapidae	*Muscicapa striata*	NE			WC		
Kalahari Scrub Robin	Turdidae	*Cercotrichas paena*	NE			WC		
Anteating Chat	Turdidae	*Myrmecocichla formicivora*	NE		OP	WC		
Herero Chat	Turdidae	*Namibornis herero*	NE			WC	CW	
Mountain Wheatear	Turdidae	*Oenanthe monticola*	NE	RH	OP			
Capped Wheatear	Turdidae	*Oenanthe pileata*	NE		OP			
Familiar Chat	Turdidae	*Cercomela familiaris*	NE		OP	WC		
Karoo Chat	Turdidae	*Cercomela schlegelii*	NE		OP			
Tractrac Chat	Turdidae	*Cercomela tractrac*	NE		OP			
Violet-backed Starling	Sturnidae	*Cinnyricinclus leucogaster*	NE			WC		
Wattled Starling	Sturnidae	*Creatophora cinerea*	NE			WC		
Cape Glossy Starling	Sturnidae	*Lamprotornis nitens*	NE			WC		
Pale-winged Starling	Sturnidae	*Onychognathus nabouroup*	NE	RH		WC		
Scarlet-chested Sunbird	Nectariniidae	*Chalcomitra senegalensis*	NE			WC		
Dusky Sunbird	Nectariniidae	*Cinnyris fuscus*	NE		OP	WC		
Scaly-feathered Finch	Ploceidae	*Sporopipes squamifrons*	NE		OP	WC		
White-browed Sparrow-Weaver	Ploceidae	*Plocepasser mahali*	NE			WC		
Southern Masked Weaver	Ploceidae	*Ploceus velatus*	NE			WC		
Red-billed Quelea	Ploceidae	*Quelea quelea*	NE			WC		
Sociable Weaver	Ploceidae	*Philetairus socius*	NE			WC		
Red-headed Finch	Estrildidae	*Amadina erthrocephala*	NE			WC		
Common Waxbill	Estrildidae	*Estrilda astrild*	NE			WC		
Black-faced Waxbill	Estrildidae	*Estrilda erythronotos*	NE			WC		
Violet-eared Waxbill	Estrildidae	*Granatina granatina*	NE			WC		
Southern Grey-headed Sparrow	Ploceidae	*Passer diffusus*	NE			WC		
House Sparrow	Ploceidae	*Passer domesticus*	-			WC		
Cape Sparrow	Ploceidae	*Passer melanurus*	NE			WC		
Great Sparrow	Ploceidae	*Passer motitensis*	NE			WC		
African Pipit	Motacillidae	*Anthus cinnamomeus*	NE		OP			

Common name	Family	Genus, species	IUCN stat.	Habitat			Ende-mism	Notes
Long-billed Pipit	Motacillidae	*Anthus similis*	NE		OP			
White-throated Canary	Fringillidae	*Crithagra albogularis*	NE		OP	WC		
Black-throated Canary	Fringillidae	*Crithagra atrogularis*	NE		OP	WC		
Yellow Canary	Fringillidae	*Crithagra flaviventris*	NE		OP	WC		
Cape Bunting	Fringillidae	*Emberiza capensis*	NE	RH	OP	WC		
Lark-like Bunting	Fringillidae	*Emberiza impetuani*	NE	RH	OP	WC		
Cinnamon-breasted Bunting	Fringillidae	*Emberiza tahapisi*	NE	RH				

MAMMALS

Common name	Family	Genus, species	IUCN stat.	Habitat			Ende-mism
Hedgehogs	**ERINACEOMORPHA**						
Southern African Hedgehog	Erinaceidae	*Atelerix frontalis*	NT			WC	
Shrews	**SORICOMORPHA**						
Reddish-grey Musk Shrew	Soricidae	*Crocidura cyanea*	LC			WC	
Bats	**CHIROPTERA**						
Straw-coloured Fruit Bat	Pteropodidae	*Eidolon helvum*	LC			WC	
Egyptian Slit-faced Bat	Nycteridae	*Nycteris thebaica*	LC			WC	
Darling's Horseshoe Bat	Rhinolophidae	*Rhinolophus darlingi*	LC	RH	OP		
Dent's Horseshoe Bat	Rhinolophidae	*Rhinolophus denti*	LC	RH	OP		
Sundevall's Leaf-nosed Bat	Hipposideridae	*Hipposideros caffer*	LC	RH	OP		
Flat-headed Free-tailed Bat	Molossidae	*Sauromys petrophilus*	LC	RH	OP		
Namibian Wing-gland Bat	Vespertilionidae	*Cistugo seabrai*	NT	RH	OP		NA
Long-tailed Serotine	Vespertilionidae	*Eptesicus hottentotus*	LC	RH	OP		
Namib Long-eared Bat	Vespertilionidae	*Laephotis namibensis*	LC	RH	OP		CN
Yellow House Bat	Vespertilionidae	*Scotophilus dinganii*	LC	RH	OP	WC	
Southern Long-fingered Bat	Vespertilionidae	*Miniopterus natalensis*	LC	RH	OP		
Primates	**PRIMATES**						
Chacma Baboon	Cercopithecidae	*Papio ursinus*	LC	RH	OP	WC	
Hares, rabbits	**LAGOMORPHA**						
Cape Hare	Leporidae	*Lepus capensis*	LC		OP	WC	
Rodents	**RODENTIA**						
Namibian Pygmy Rock Mouse	Muridae	*Petromyscus collinus*	LC	RH	OP		NA
Pygmy Gerbil	Muridae	*Gerbillurus paeba*	LC		OP	WC	
Namib Brush-tailed Gerbil	Muridae	*Gerbillurus setzeri*	LC		OP		ND
Short-tailed Gerbil	Muridae	*Desmodillus auricularis*	LC		OP		
Large-eared Mouse	Muridae	*Malacothrix typica*	LC			WC	

Common name	Family	Genus, species	IUCN stat.	Habitat			Ende-mism
Three-striped Mouse	Muridae	*Rhabdomys pumilio*	LC			WC	
Tree Rat	Muridae	*Thallomys paedulcus*	LC			WC	
Namaqua Rock Rat	Muridae	*Aethomys namaquensis*	LC	RH	OP		
Western Rock Dormouse	Myoxidae	*Graphiurus rupicola*	LC	RH	OP		
Porcupine	Hystricidae	*Hystrix afrcaeaustralis*	LC		OP	WC	
Dassie rat	Petromuridae	*Petromus typicus*	LC	RH	OP		
Carnivores	**CARNIVORA**						
African Wild Cat	Felidae	*Felis lybica*	VU			WC	
Southern Small-spotted Genet	Viverridae	*Genetta felina*	LC			WC	
Suricat	Herpestidae	*Suricata suricatta*	LC		OP		
Spotted Hyaena	Hyaenidae	*Crocuta crocuta*	NT	RH	OP	WC	
Aardwolf	Hyaenidae	*Proteles cristatus*	NT		OP		
Cape Fox	Canidae	*Vulpes chama*	LC	RH	OP	WC	
Bat-eared Fox	Canidae	*Otocyon megalotis*	LC		OP		
Black-backed Jackal	Canidae	*Canis mesomelas*	LC	RH	OP	WC	
Striped Polecat	Mustelidae	*Ictonyx striatus*	NT		OP		
Hoofed mammals	**ARTIODACTYLA + PERISSODACTYLA**						
Springbok	Bovidae	*Antidorcas marsupialis*	LC		OP	WC	
Steenbok	Bovidae	*Raphicerus campestris*	LC			WC	
Gemsbok	Bovidae	*Oryx gazella*	LC		OP	WC	
Klipspringer	Bovidae	*Oreotragus oreotragus*	NT	RH	OP		
Greater Kudu	Bovidae	*Tragelaphus strepsiceros*	NT		OP	WC	
Namibian Mountain Zebra	Equidae	*Equus zebra*	EN	RH	OP		ND
Dassies	**HYRACOIDEA**						
Rock Dassie	Procaviidae	*Procavia capensis*	NT	RH	OP		
Elephant Shrews	**MACROSCELIDEA**						
Round-eared Sengi	Macroscelididae	*Macroscelides proboscideus*	LC	RH	OP	WC	

Appendix D. METHODOLOGY USED TO DERIVE A HABITAT CATEGORISATION FOR THE RöSSING AREA

J. Irish, J. Pallett
4 December 2007

To analyse habitats for the Rössing Mining Licence Area and its surroundings (up to at least 10 km from the pit), we used a remote-sensing approach.

Habitat types as used here were derived from Landsat photography of the area at 30 m resolution. The orthophoto supplied by Rössing has a much finer resolution, but lacked essential components needed for habitat classification, notably an infrared band, therefore it could not be used. An area from 14.9 – 15.2°E and 22.3 - 22.6°S was looked at. The Landsat photo was analysed with Definiens eCognition software at level 20 discrimination by a vegetation ecologist, Mr. B. Strohbach, using settings that have proven useful for the delimitation of habitat types elsewhere in Namibia. The resultant 5073 polygons are shown in Figure 1.

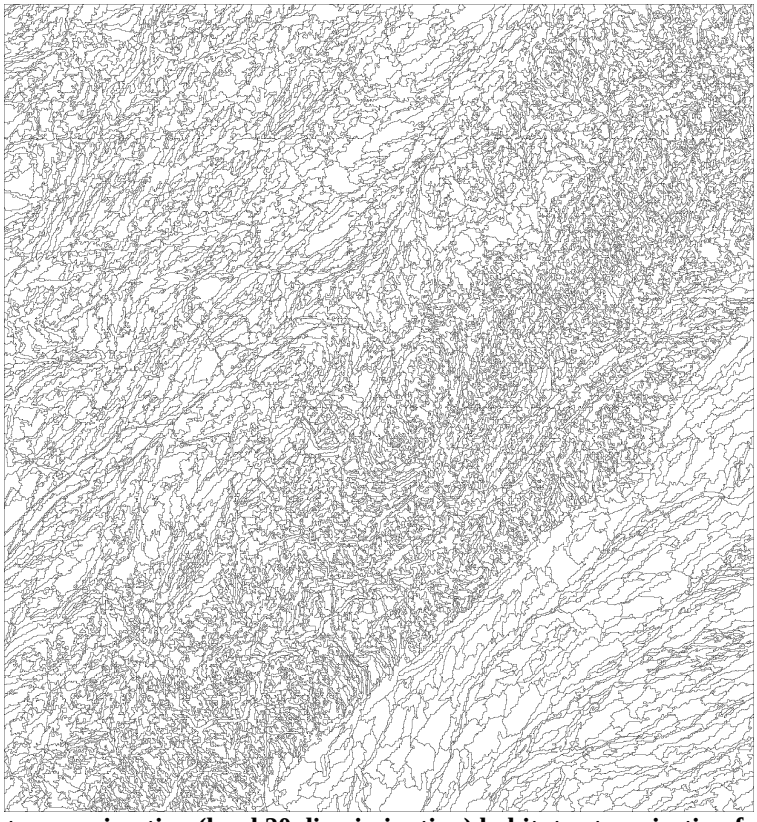

Figure 1. First approximation (level 20 discrimination) habitat categorisation for the Rössing area.

Even though the principal components of the final map are already apparent in Figure 1, clearly this categorisation is too detailed to be of much practical use. Discrimination was therefore progressively relaxed to form larger categories, testing these against known conditions on the ground throughout, until an acceptable balance was found. Along the way, artefacts such as hill shadows that had initially been categorised as separate habitats, were fixed.

The only subjectivity in the categorisation is the decision as to which level of consolidation to accept, and in this Mr. Strohbach was guided by his and project members' experience of the area. The final categorisation and resulting map is shown in Figure 2 below and is included in the main report (Annexure K1) as Figure 7.

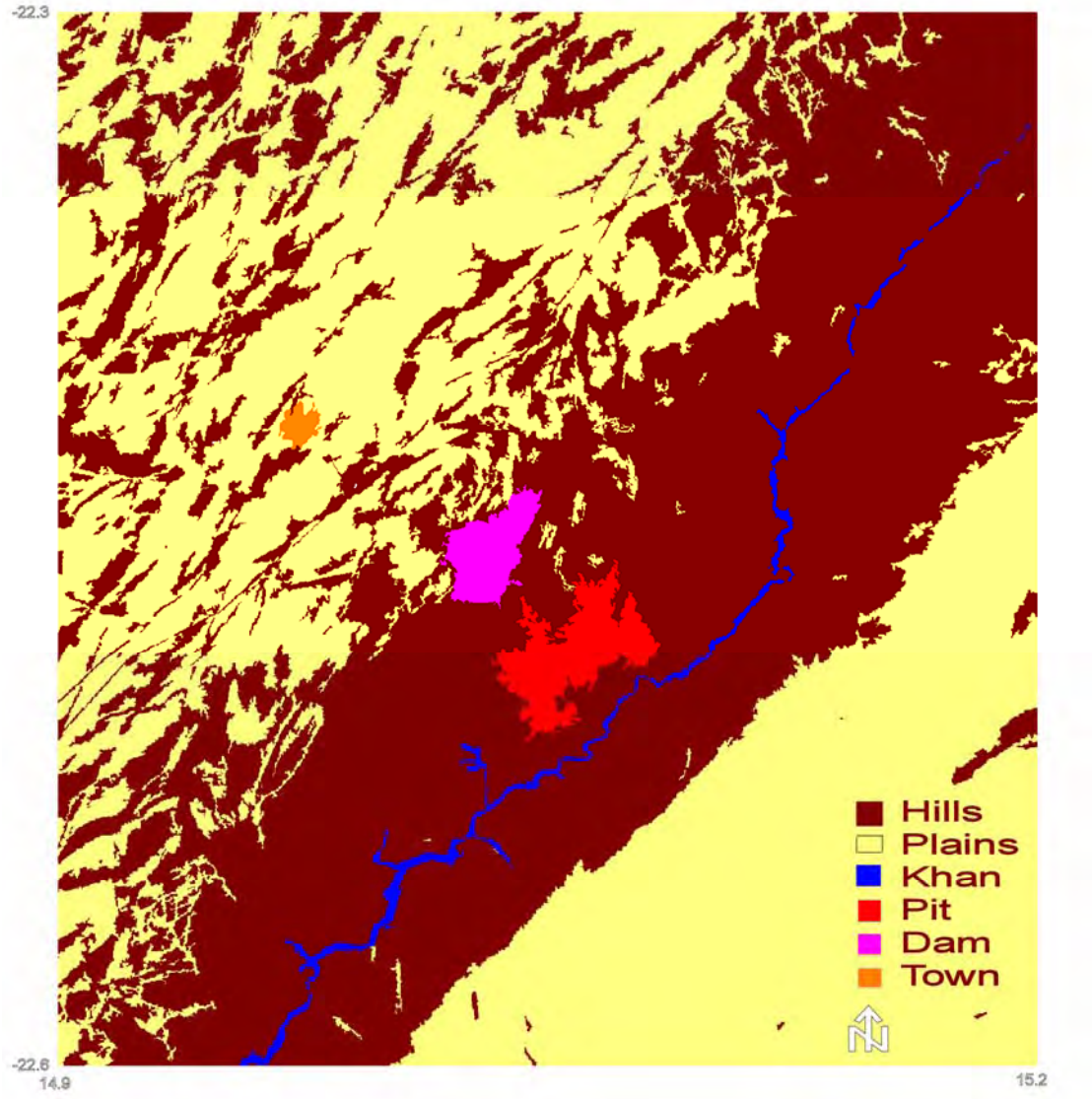

Figure 2. Final categorisation of habitats after relaxation of the discrimination.

A categorisation corresponding exactly to Burke's (2005) biotopes could not be found, but there is general agreement between the two results, as explained in the main report, Section 3.1.

Appendix E. APPLICATION OF IUCN EVALUATION CRITERIA TO RöSSING SPECIES.

J. Irish
4 December 2007

The World Conservation Union (IUCN) maintains global Red List data. It defines Red List categories, as well as the evaluation criteria to be followed before red listing a species (IUCN 2000, 2005). The terms of reference for the current study expect that species occurring in the Rössing area be ranked by IUCN category.

Formal IUCN categorisation is not available for the bulk of Namibian biota. Only mammals (Griffin & Coetzee 2006) and some endemic plants (not all plants, or even all endemic plants) (Loots 2005) have been evaluated using the latest IUCN criteria. Unpublished reptile evaluations using the newest criteria were kindly made available by Mr. Mike Griffin. No evaluations are available for Namibian invertebrates, or, strangely enough, birds (excepting species occurring in Namibia that have been evaluated on a global level). The bulk of biodiversity at Rössing is concentrated in the invertebrates, and IUCN categorisation criteria were newly applied to them here.

Since different suites of information are available for different taxa, IUCN (2005) offers five different entry points into the categorisation process. Categorisation is ultimately a reflection of species demographics, therefore four of the five criteria (numbers A, C, D and E) are exclusively concerned with population sizes and trends. This information is simply not available for Namibian invertebrates. The fifth criterion (number B, specifically B1) incorporates different information, and was used here.

To use criterion B1, information on the following 3 factors is needed:

1. Extent of occurrence of species in km ²
2. Number of locations from which the species has been recorded
3. Directional trends in any of:
    a. Extent of occurrence
    b. Area of occupancy
    c. Area, extent or quality of habitat
    d. Number of locations or subpopulations
    e. Number of mature individuals

Full instructions for using criterion B1, and definitions of terminology, are available in IUCN (2005), but in short it means that:

- if a species has an extent of occurrence of less than 20000 km²
- and is known from 10 or less locations,
- and there is evidence of continued decline or extreme fluctuations in any one of factors 3 a-e in the previous paragraph,

it will evaluate to a Threatened status.

For present purposes, if a species had a limited extent of occurrence that includes the Rössing area (factor 1), and a limited number of known localities

(factor 2), it was taken as a given that the requirements of factor 3 had also been complied with. Past mining activities had undoubtedly led to declines in some or all of factors 3 a-e. This can best be illustrated for taxa that are known only from the Lower Dome sampling site, which is now covered by waste rock. Those species have undoubtedly suffered a decline in the area, extent and quality of their habitat, in the species population size, in its extent of occurrence and/or occupancy, and in the number of known locations (which is now minus one). The same would be true in future for any taxa that currently inhabit areas that will be impacted by habitat destruction in the form of open pits, waste rock dumps, roads, tailings facilities, leeching operations, associated mining infrastructure, and distance effects (dust, noise, vibrations, seepage etc.). For taxa that did not comply with factors 1 and 2, factor 3 was not considered, and they received a non-Threatened status, specifically 'Least Concern'. Current data resolution does not allow distinction between 'Least Concern', 'Near Threatened' and 'Data Deficient'.

The particular kind of Threatened status is determined by the actual values for extent of occurrence and number of locations as follows:

- extent of occurrence < 100 km², or known from a single locality only = Critically Endangered B1a(ii)b(a-e)
- extent of occurrence < 5000 km², and/or known from 5 or less locations only = Endangered B1a(ii)b(a-e)
- extent of occurrence < 20000 km², and/or known from 10 or less locations only = Vulnerable B1a(ii)b(a-e)

The designation 'B1a(ii)v(a-e)' specifies the criteria used, is the correct and complete way to cite an IUCN Threatened status, and should be read as implicit in any Threatened status designations elsewhere in this document.

Practical application of the above principles took place as follows: Known locations were gathered from the cited literature, supplemented by unpublished museum records and fieldwork results from the current study. Species known from more than 10 locations, and/or with an area of occupancy clearly larger than 20000 km² (about 140 x 140 km) were considered to have evaluated to Least Concern. For the rest, area of occurrence was calculated by first plotting known locations on a base map of Namibia, using Golden Software's Didger ® v. 3.04. To allow for accurate subsequent area measurements a Lambert Azimuthal Equal Area Projection with standard parallel of -22 and central meridian of 17 was used.

IUCN recommends the calculation of a convex hull for the locations through the use of Delauney triangulation, followed by discarding of lines longer than twice (2x) the average line length in order to address potential population isolates. These methods are clearly intended for taxa that are more data rich than the Rössing invertebrates. At their most rudimentary, a minimum of three locations (one triangle) are required for triangulation, and a minimum of six points (two triangles) are needed to identify a single isolate. Many taxa evaluated here did not even reach these minima. Under the circumstances, the shortest line connecting and/or including all points was used to construct a polygon representing the area of occurrence. In the light of limited information, no testing for population isolates was done (even if any had been identified, it

would not have changed the number of species of concern that needed to be flagged here - it would only have increased the threat level of that particular taxon). The area of the occurrence polygon, in km², was read from the screen. This, plus number of localities were used to arrive at an IUCN category. Species known from only two locations were a particular problem, since an area of occurrence cannot be calculated for them – they were conservatively evaluated as Endangered on the basis of number of locations, even though an evaluation of Critically Endangered might have been more appropriate in those cases where the locations are proximate enough to imply an area of occurrence < 100 km².

Locations and polygons for all such evaluated species were saved as Didger® project files, and the resultant IUCN categorisations are listed in Appendix C.

Since a number of Threatened categorisations have been based on single specimen occurrences, it is justified to ask how significant such categorisations are. The following case study is presented in an effort to clarify the issues involved.

<u>Case study</u>: *Moggridgea eremicola*, a spider known from a single specimen found in a pittrap at the no longer extant Lower Dome Gorge survey site, and categorised as Criticaly Endangered here.

<u>Question 1</u>: What is the probability that *M. eremicola* is widespread in the Rössing area, but rare, hence only recorded once?

M. eremicola was found in a pit trap. During the 1983/84 Rössing survey, a total of 51 preservative pittraps were deployed at six sites for 420 continuous days = 21420 trap days. A total of 62691 specimens of 269 apterous invertebrate species were collected. (This is not the total number of invertebrates collected in the traps: the rest were alate, and were not counted; estimated to be at least as many again). One specimen out of 62691 is rare, yes. What about being widespread?

Specimens (apterous invertebrates only) were not equally distributed among the sites, as the following table shows:

	Dome	Stockpile	UpOstr	Arandis	LowOstr	Panner
Specimens	3738	10653	4156	6599	7520	29925

The Lower Dome trap site recorded the lowest number of invertebrates, possibly because it consisted of 6 traps only, while all the other sites had 9 traps each. If *M. eremicola* were widespread throughout the sampled area, albeit rare, one would rather expect it at one of the sites where more traps were deployed, and where more specimens were collected, not at the site with the least number of traps and least number of specimens. It follows that the occurrence of *M. eremicola* at Lower Dome probably represents a preference

by this species for the biotope present at Lower Dome, rather than that at any of the other sites. It is probably not widespread in the Rössing area.

Question 2: what is the probability that *M. eremicola* is widespread elsewhere in Namibia, and was only recorded once at Rössing because it is at the extreme edge of its distribution range there?

Many similar preservative pittrap surveys have been done at various other places in Namibia over the years. Most of the material collected ended up in the National Museum of Namibia, yet no other specimens of *M. eremicola* have been recorded before or since the Rössing project. Large and long-term preservative pittrapping surveys are known from a transect between Gobabeb and Windhoek (Endrödy, 1970's), Richthofen and Excelsior in the Windhoek area (Penrith and Louw, late 1970's), Kanaan in the southern Namib and Wildheim in the southern Kalahari (Louw, Ph.D. study, late 1970's), Gocheganas near Windhoek and Chulon near Kalkrand (Penrith, early 1980's), six sites in Etosha (Darwin project, early 1990's) and a transect up the Brandberg (late 1990's). Besides these, numerous 72-hour pittrap surveys have been done all over the country by the National Museum over the years, while a pittrapping survey has been running at Gobabeb continuously for 20 + years. In the same time span, several foreign museums have launched major collecting expeditions in Namibia, of which the largest were the British Museum (1970's), South African National Collection of Insects (1980's, Central Namib), and the Berlin Museum (1990's). Major earlier collections include the Transvaal Museum's Carp expeditions (1950's), Swedish Museum, Lund (1950's), Smithsonian Institution (1930's), South African Museum (1920's) and Michaelsen and Schulze's expeditions (early 1900's). Among the hundreds of thousands of invertebrates collected by them, not a single specimen of *M. eremicola* was found. It follows that it is unlikely that *M. eremicola* is widespread in Namibia, and it is probably restricted to the area where it was found.

Question 3: What is the possibility that there are *M. eremicola* specimens in the previously mentioned material from elsewhere, but they have been misidentified, or just not recognised?

Moggridgea belongs to the primitive (mygalomorph) spiders, which includes better known groups like tarantulas and baboon spiders. Mygalomorphs, even the smaller bodied ones like *Moggridgea*, are distinctive and easily recognisable with the naked eye. The first step when identifying a random batch of spiders, is to split any mygalomorphs from the bulk of non-mygalomorph spiders. Mygalomorphs are seen seldom enough that any will be noticed. They are unlikely to have been mistaken for anything else.

Question 4: Assuming *M. eremicola* is restricted to the biotope that was found at the former Lower Dome sampling site, how far beyond this area could it conceivably occur?

Since no information is available on the habitat requirements of *M. eremicola*, the answer to this question must be based on conjecture.

Worst case scenario: *M. eremicola* was originally restricted to the SJ area only and the open pit has destroyed all available habitat. Lower Dome was a marginal habitat, and the species was already on the verge of extinction when the 1980's specimen was collected there. It has since died out. If not, it is truly Critically Endangered as the categorisation process has suggested.

Best case scenario: *M. eremicola* occurs in habitats similar to that at Lower Dome, elsewhere in the Rössing area. Rocky hills of the kind that occurred at Lower Dome are found on both sides of the Khan River valley, but the surrounding plains are unsuitable habitat, putting northern and southern limits on the potential distribution area. In the Namib, there is a steep east-west gradient in most climatic parameters, putting eastern and western limits on the distributions of most biota. There is a definitive faunal turnover between 30 and 40 km from the coast, at the point where average average annual fog precipitation approximately equals average annual rainfall. Some conspicuous Central Namib invertebrates, e.g. the 'white' tenebrionid beetle, *Cauricara eburnea*, are common west of this line, but absent to the east – no *C. eburnea* were seen during the Rössing survey. Towards the east, there is another faunal turnover between 70 and 80 km from the coast (in this part of the Namib – different distances elsewhere), where the Desert Biome is replaced by the adjacent Nama-Karoo Biome. It follows that the maximum plausible range for a Lower Dome biotope specific taxon might be a 10 km wide strip centered on the Khan River, from the Swakop confluence upstream as far as the Valencia area.

Average case scenario: The truth is probably somewhere between the above two extremes. The best case scenario gives an area of occurrence of ca 500 km² (10km x 50 km), which, given sufficient localities, would evaluate to Endangered, rather than Critically Endangered. However, given that the area range for the Endangered category is 100 to 5000 km², it is clear that a species with an area of occurrence of only 500 km² is close to the lower limits of the category. Bear in mind that Rössing's current operations and the existing extensive stone quarrying in parts of the area have already reduced suitable habitat within this (best case scenario) 500 km² area, and that Rössing's planned extentions as well as the planned Valencia Mine will reduce this even further. It follows that, even if the species were found to be more widespread, and if it were to evaluate to Endangered rather than Critically Endangered, the difference would be mere semantics from the species' viewpoint.

Question 5: Since more information in the form of more records of a species from more localities (and from a larger area of occurrence) can cause a species to be re-evaluated to a lower threat status, what is the possibility of doing more sampling for *M. eremicola* and thereby proving that it is not as threatened as current information seems to suggest?

This is possible, but not simple. At least one specimen would need to be recorded from each of 11 additional localities within the suggested 500 km² range before *M. eremicola* can be evaluated to a non-Threatened category.

Taking what we know as a guide, an average of 2520 trap days (6 traps x 420 days, the operational span of the Lower Dome site) would be needed at each locality. Assuming each selected locality is successful (which is not a given), this equates to 27720 trap days, which is more effort than was required by the original Rössing survey.

It is worth noting that such an exercise would carry a considerable logistical burden. Besides physical trapping, trap contents would need to be sorted, identified, preserved and curated into the future. Current Namibian capacity to do this has declined since the 1980's, and is limited.

Question 6: Assuming that additional sampling can cause *M. eremicola* to evaluate to a lower threat status, can this not also result in additional, previously unknown and highly Threatened species being found, thereby defeating the object of the exercise?

Yes. This is almost guaranteed. Biodiversity follows a logarithmic distribution. In any ecosystem the bulk of species will be of average abundance, but then there will be a very few that are extremely common, and a great many that will be extremely rare. Continued sampling will expend ever greater amounts of effort to record ever more, ever rarer species. While more sampling may cause the current Threatened status of some species to be re-evaluated, it will almost certainly also replace them with other, newly discovered, Threatened species.

This does not mean that additional sampling cannot be useful, just that one should determine beforehand what the desired result is and whether more sampling will achieve that result.

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APPENDIX F

Biotope Mapping for the Rössing Uranium Mine Expansion Project in the Eastern Accessory Works Area

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December 2007

Rössing's Biodiversity Strategy

Biotope mapping for the Rössing Uranium Mine expansion project in the eastern accessory works area

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Summary

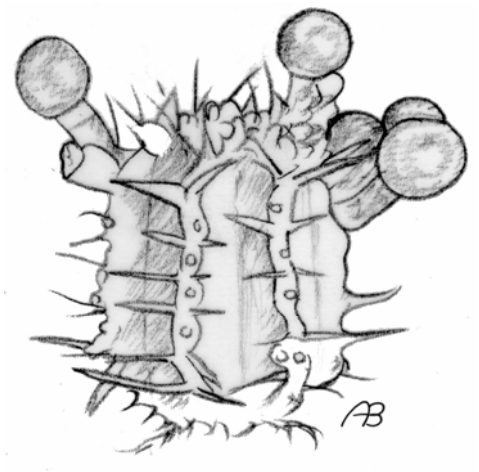
Within the context of Rössing's biodiversity strategy, biotope mapping – as a tool to delineate features of biodiversity importance – had been undertaken in the main part of the mine's licence area in 2005-2006. An extension of the mine's activities is proposed towards the eastern portion of the accessory works area. This report outlines the results of the biotope mapping in Rössing's eastern accessory works area.

Six biotopes were mapped. Three of these were biotopes that extended from the licence area into the accessory works area, the remaining three were new biotopes. In line with the previous biotope mapping, red-list status and level of endemism amongst plants were used to select indicators for biodiversity value. Since the previous biotope assessment in 2005 intensive plant collecting had taken place throughout the licence area. This resulted in a 35 % increase in indicator plants from 24 to 37 species and thus higher scores for almost all biotopes. This required a new definition of the range of values used to assign biotopes. Based on the re-adjusted score ranges, one biotope – eastern hills – emerged as a "critical" biotope of high biodiversity value in the eastern accessory works area, two, Khan river mountains and south-east gneiss hills as "rare", and the remaining three biotopes as "general".

Taking the collecting of the period since 2005 into account, data quality can now be called good in the majority of the Rössing licence area. Only the fringe areas and those difficult to access show poor or medium data quality.

Recommended mitigating measures are (1) measures to minimise the footprint, (2) preserving critical species and (3) testing rehabilitation measures. These need to form an integral part of Rössing's biodiversity strategy.

Contents



Acknowledgements. This report is dedicated to my late husband John whose last activity was assisting with the field work for this assignment. Yvonne Mupupa, Sandra Müller and Rainer Schneeweiss are gratefully acknowledged for improving data coverage, assisting with logistics and input to this report.

Background

Rössing Uranium undertook a biotope assessment as a building block for the mine's biodiversity strategy during the period of 2004 to 2007.

Mapping of biotopes forms the basis of this assessment and, at the time, the mapping boundaries were defined as the Rossing licence area where most mining activities are currently taking place and impacts on biodiversity could thus be expected. In the meantime exploration activities have taken place in the wider mining license area and the mine's activities (for example waste disposal) could extend towards the eastern part of the accessory works area where biotope mapping was not carried out previously. This area was not covered in the earlier biotope assessment. The objective of this study is hence to map and assess biotopes in the Rössing accessory works area to ensure that the entire area in which Rössing operates has been mapped. The same systematic approach as in the previous mapping exercise was used (see Burke & Kyläkorpi 2004, Burke 2005 and 2007 and Burke et al. in review, for detail).

Field survey

A once-off field survey took place during the period 27-31 November 2007. Although rains had been poor during the 2007 rainy season, the effects of an exceptional season in 2006 were still evident. The survey had to focus mainly on perennial plants. Nevertheless a variety of ephemeral plants were still in a condition to be identified.

Data collection in the field focussed on the main landforms: plains, ephemeral river, drainage lines, mountains and hills. Data collection consisted of recording locality, habitat type/landform and compiling a plant species list at each sampling point. A total of 58 sampling points was established in the study area (Figure 1). Plant identifications were done directly in the field.

The Biotope Method

The main purpose of the Biotope Method is to quantify ecological changes (biotope or habitat changes) that take place when a land area is put to a new use. This method consists of a number of steps. (1) System boundaries are defined and then subdivided into discrete biotopes or habitats of site-specific ecological characteristics. (2) Biodiversity indicators suitable in the local context are selected to assign the relative importance of the biotopes. (3) Biotopes are grouped into four standard categories, (a) critical, (b) rare, (c) general biotopes, and (d) areas which no longer support biodiversity, termed technotopes (Kyläkorpi *et al.* 2005). (4) Once exploration and/or mining activities commence, comparing the assigned biotope categories "before" and "after" the impact (in hectares or as a percentage) provides a measure of the impact on the ecological mapping units which are rated according to biodiversity importance.

1. System boundaries and biotope mapping

This report covers the biotope baseline ("before" the impact) in the study area. In line with the previous survey, landforms and vegetation were used to delineate ecological mapping units. High resolution aerial photography of the study area served as a mapping backdrop. Most mapping took place at approximately 1: 10000. The mapping resulted in six biotopes in the study area (Figure 1).

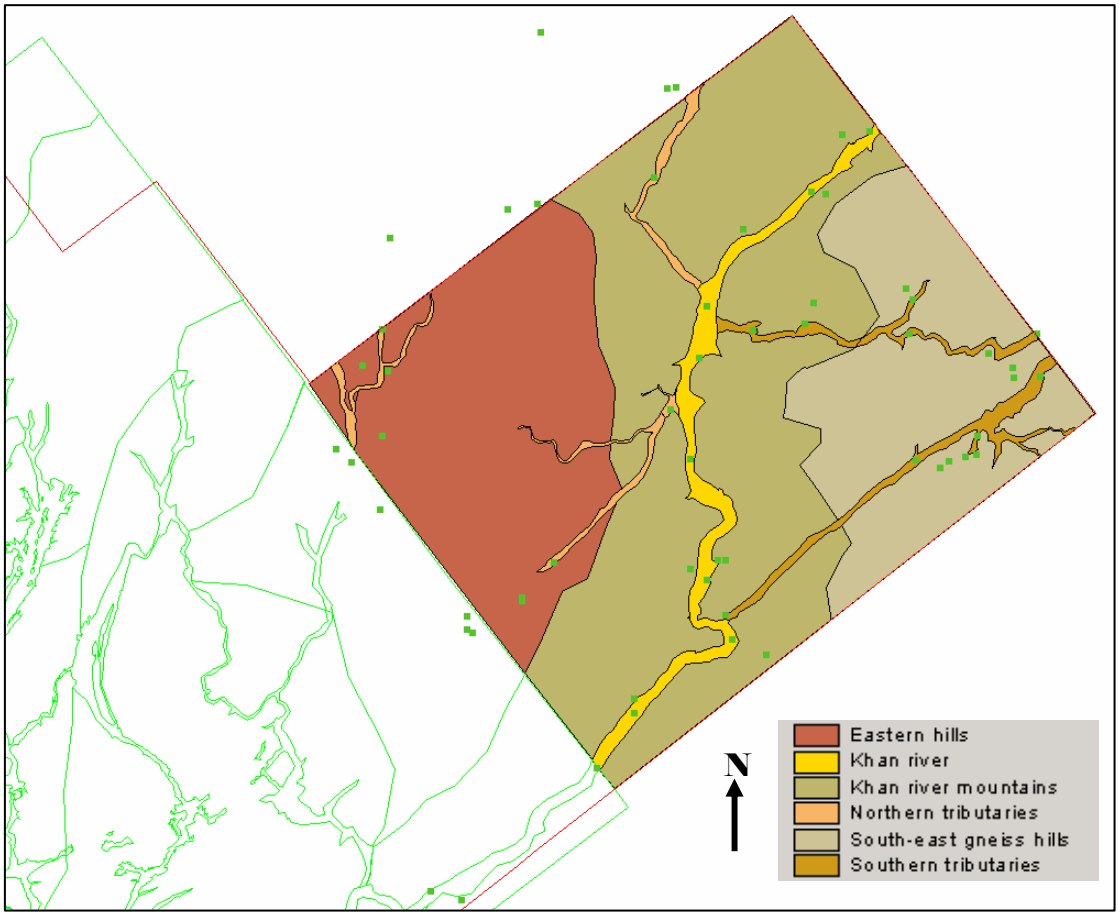


Figure 1. Biotopes in the Rössing accessory works area (green dots represent field sampling points, red line = accessory works boundary).

2. Biodiversity indicators

Plant endemism had been identified as an important feature in the study area (Burke 2005). The presence of endemic and red-list plants in a mapping unit were thus used as indicators for biodiversity value. Red list status referred to the IUCN threat status "vulnerable", "near threatened" or higher. Of the 129 plant species recorded during the October 2007 survey, 19 indicator species occurred that were identified during the previous biotope mapping. In addition, three new plant species were recorded which served as biodiversity indicators. None of the new indicator species were listed in the "vulnerable" or "threatened" IUCN categories (Loots 2005), but all three were endemic.

Endemics were classified according to range, with those with the most restricted range receiving the highest rating on a three-point scale. The rating for level of endemism was assigned as follows (Table 1).

Table 1. Rating of endemism (3 = highest, 1= lowest).

Range	Rating
Central Namib	3
Central Namib and one more region	2
Central Namib and several other regions in Namibia	1

The ratings from the red-listing and endemism ranking were added up per species (Table 2). These 27 species were then used to rate the biotopes in the extension area by recording their

presence and adding up their scores per biotope. The field surveys undertaken by Rössing staff during 2005 and 2006 added 12 new species to the list of indicators. *Blepharis gigantea* and *Ornithogalum bakerianum* were omitted as these proved doubtful, and two species, *Hermannia amabilis* and *Solanum rigescentoides*, were also added during the survey in the extension area. Species for which identifications were still outstanding were not included. Overall the species ranked as biodiversity indicators on the basis of their red-list or endemism status now totals 37.

A global species list for the entire Rössing Mine area, which included the previous field surveys, as well as collections undertaken by Rössing staff during 2005 and 2006 and the surveys from the expansion area now totals about 200 plant species (precise number to be confirmed once outstanding identifications have been clarified).

Table 2. Rating of indicator plant species recorded in the Rössing study area during the period 2003-2007. Species rating based on red-listing and level of endemism (* new indicators species recorded in the accessory works area during 2007, # indicator species recorded by Rössing staff during 2005 and 2006).

Plant species	Endemism	Red list	Rating
Aizoanthemum galenioides	3		3
Lithops ruschiorum	3		3
Cleome carnosa #	3		3
Adenia pechuelii	1	1	2
Aizoanthemum membrumconnectens	2		2
Arthraerua leubnitziae	2		2
Calostephane marlothiana	2		2
Euphorbia giessii	2		2
Hermbstaedtia spathulifolia	2		2
*Marcelliopsis splendens**	2		2
Sarcocaulon marlothii	2		2
Zygophyllum stapffii	2		2
Aloe asperifolia	1		1
Anticharis imbricate	1		1
Anticharis inflata #	1		1
Commiphora saxicola	1		1
Commiphora virgata	1		1
Engleria africana #	1		1
Euphorbia damarana	1		1
Hermannia amabilis * #	1		1
Jamesbrittenia barbata #	1		1
Jamesbrittenia hereroensis #	1		1
Monechma desertorum	1		1
Nolletia ericoides #	1		1
Ornithogalum stapffii #	1		1
Petalidium canescens	1		1
Polygala guerichiana	1		1
Psilocaulon salicornioides	1		1
Senecio alliariifolius	1		1
Sesamum marlothii #	1		1
Sesbania pachycarpa subsp. *dinterana*	1		1
Solanum rigescentoides * #	1		1
Stipagrostis damarensis	1		1
Stipagrostis giessii #	1		1
Stipagrostis hochstetteriana var. *hochstetteriana*	1		1
Tephrosia monophylla #	1		1
Zygophyllum cylindrifolium	1		1

3. Biotope assignation

Species lists were then compiled for the mapped biotopes in the Rössing accessory works area by summarising the detailed field data for each mapping unit. Well over 400 records were so generated and these were then cross-tabulated to present the occurrence of plants in different mapping units in the extension area (Appendix 1).

During the additional field surveys since 2005, the list of indicator species was increased by 35% which affected the biotope assignation, resulting in the majority of the biotopes in the entire licence area being rated of "high" biodiversity value and thus as "critical" biotopes, if the 2005 assignation of scores was used. As this is an unrealistic reflection, a re-adjustment of the ranges of scores to reflect biodiversity value and thus biotope assignation was necessary. In 2005 scores ranged from 4 to 19, in 2007 from 4 to 21. Although the range of scores did not change significantly, many more biotopes scored in the higher class ranges in 2007, once the additional indicator species were accounted for. The new assignment of scores takes the mean of all scores (12.5) as the cut-off point for assigning the category "low" (general) and divided the remaining scores equally between "medium" (rare) and "high" (critical).

Scores correspond to the biotope assignation in the following manner:

Table 3. Comparison of assignation of scores in 2005 (24 indicator species) and 2007 (37 indicator species).

Score 2005	Score 2007	Biodiversity value	Biotope
0			Technotope
1-9	1-13	low	General
10-14	14-17	medium	Rare
15-20	18-21	high	Critical

Despite the re-adjusted score ranges, most biotopes retained their ranking. Only two biotopes, marble hills and marble ridges, were downgraded. As expected, due to more intensive coverage in the field, the "eastern hills" and "Khan river mountain" biotopes received a higher ranking.

Table 4. Biotope assignation in 2005 and 2007 (changes are highlighted).

Biotope	Biotope assignation 2005	Biotope assignation 2007
Aloe asperifolia plains	General	General
Arthraerua leubnitziae plains	General	General
Central hills	Critical	Critical
Eastern hills	Rare	Critical
Euphorbia virosa belt	Critical	Critical
Gorges	Rare	Rare
Khan river mountains	General	Rare
Khan river	General	General
Marble hills	Rare	General
Marble ridge	Rare	General
Northern dome	General	General
Northern tributaries	-	General
Plain drainage lines	General	General
South-eastern gneiss hills	-	Rare
South-western hills	Rare	Rare
Southern tributaries	-	General
Undulating granite hills	Critical	Critical
Western granite hills	Critical	Critical
Zygophyllum stapffii plains	General	General

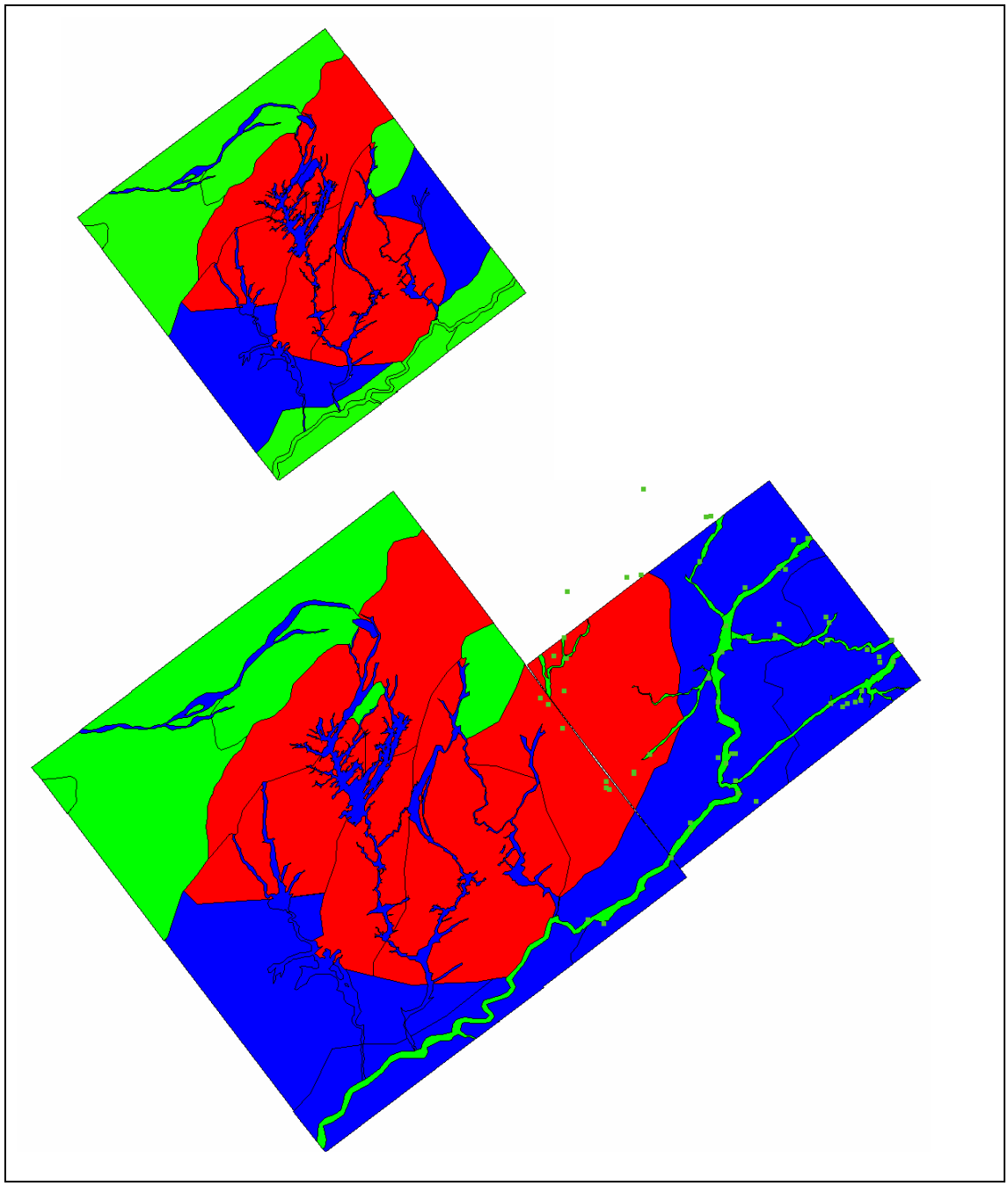


Figure 2. Biotope assignation in 2005 (top: small map) and 2007 (bottom: large map) (red = critical, blue = rare, green = general).

The data quality of the assessment was rated “poor”, “medium” or “good” per biotope, taking into account data coverage in relation to the size of the mapping unit and accessibility. Due to the additional surveys data quality was adjusted for all biotopes in 2007. As expected, data quality clearly improved over the 3-year period.

Table 5. Data quality assessment per biotope in 2005 and 2007 (changes are highlighted).

Biotope	**Data quality 2005**	**Data quality 2007**
Aloe asperifolia plains	poor	medium
Arthraerua leubnitziae plains	poor	poor
Central hills	medium	good
Eastern hills	poor	good
Euphorbia virosa belt	medium	good
Gorges	good	good
Khan river mountains	poor	medium
Khan river	good	good
Marble hills	poor	medium
Marble ridge	poor	medium
Northern dome	poor	medium
Northern tributaries	-	medium
Plain drainage lines	medium	good
South-eastern gneiss hills	-	poor
South-western hills	poor	medium
Southern tributaries	-	good
Undulating granite hills	good	good
Western granite hills	medium	good
Zygophyllum stapffii plains	poor	medium

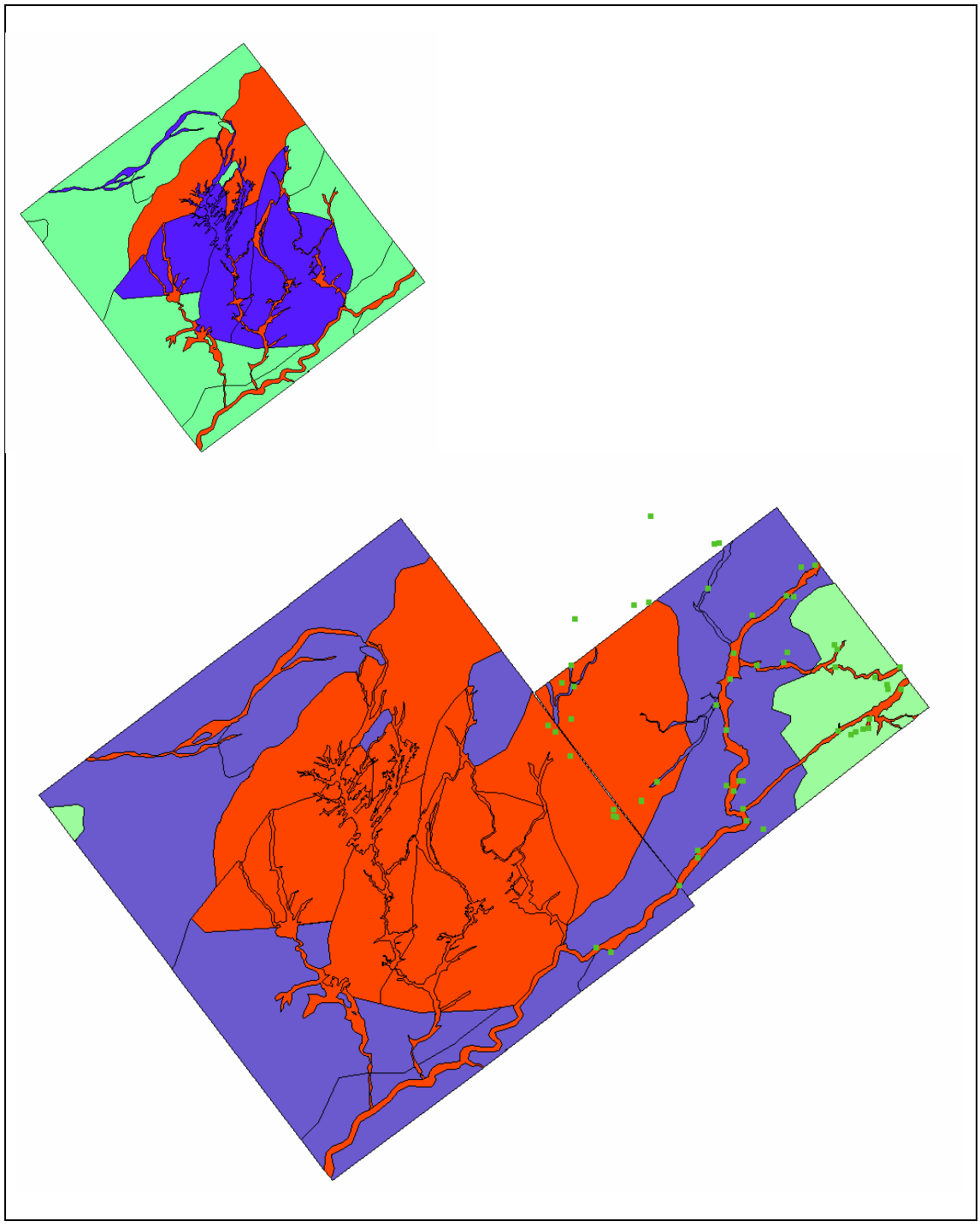


Figure 3. Data quality in 2005 (top: small map) and 2007 (bottom: large map) (red = good, blue = medium, green = poor; green dots = sampling points in 2007 survey).

Status of biotope mapping in the Rössing licence area

Repeated field surveys over the past three years have significantly improved the biotope mapping based on plant indicators in the Rössing licence area (Figure 3), especially as collecting included one exceptional growing season. Interestingly, although the Rössing eastern accessory works area had to be surveyed in the dry season after one poor growing season, the effects of the exceptional rainy season in 2006 were still evident. This means that many short-lived herbs persisted for more than one year and could be recorded during the field survey. However, this is not true for grasses, geophytes and hemicrytophytes which were not present or not in a status to be identified during the survey in October 2007. Plant collecting during a good growing season will thus be important in the eastern Rössing accessory works area.

Nevertheless biotopes which only marginally extend into the Rössing licence area, such as the *Arthraerua leubnitziae* plains and south-eastern gneiss hills, will require further collecting to obtain a realistic assessment (Figure 3). Those and areas of medium coverage should receive more attention in future.

One of three plant species of high conservation importance (range-restricted and rare herbaceous plants), *Cleome carnosa*, was recorded during the excellent rainy season in 2006. However, the other two central Namib endemics, *Cleome foliosa* var. *namibensis* which had been recorded in the Rössing's licence area before, and *Helichrysum marlothianum* were not found even during the good season of 2006. Looking out for these during future surveys is hence a priority.

When data from different survey periods were combined, it was evident that re-assessing the thresholds for assigning biotopes of low (general), medium (rare) or high (critical) biodiversity value is essential to obtain a realistic assessment, and not to overrate biotopes based on class ranges which were set when fewer indicators were recorded (Table 3). As work progresses the biotope ranking may require further adjustment based on the number of indicators included in the assessment.

Work to include other biodiversity components such as invertebrates, birds and reptiles is in progress (Stacey 2005; Schneeweiss pers. comm.). However, ways have to be found to link these assessments to the derived biotopes, and the selection of ecologically sound, mappable indicators amongst these groups requires a thorough review and some testing.

In the interim basing the assessment on the primary producers and their associated habitats provides an ecologically justified approximation.

Description of biotopes in the eastern accessory works area

This section describes the new biotopes that were mapped in the eastern Rössing accessory works area and provides an update of those biotopes that were mapped before, but extend into the 2007 study area.

The concentration of certain species have been used to delineate the biotopes, but many plant species are fairly widespread in this area and boundaries between mapping units are not clear-cut, as indicated in earlier reports (e.g. Burke 2005). Overall, due to dry season survey, plant cover was fairly low ranging from 0.1 to 1 %. Localised patches of higher plant cover were found in some mapping units and drainage lines and rivers could reach up to 5 % plant cover. Correlations with underlying rock types were not evident at the scale of the current mapping, and a combination of substrate conditions and microclimatic factors, for example determined by

slope aspect and angle, as well as access to water and soil moisture, are considered the main factors responsible for the current distribution of plant populations.

Eastern hills. These undulating hills in the central-eastern section of the Rössing licence area are species-rich. Some 66 species were recorded during all surveys in this mapping unit. *Commiphora virgata* (twiggy commiphora) and *Commiphora saxicola* (rock commiphora), *Petalidium variabile* (variable petalidium) and *Calicorema capitata* (grey desert broom) are locally dominant and thus the characteristic species.

Species of conservation importance include, amongst others, *Adenia pechuelii* (elephant's foot), *Aizoanthemum galenioides* and *Petalidium canescens*, and biodiversity value was rated high, thus assigning this a critical biotope. The charismatic *Aloe dichotoma* (quiver tree) and *Euphorbia virosa* (milk bush) also occur in this mapping unit.

Some plants not recorded in other mapping units included *Commiphora tenuipetiolota* (white-stem corkwood), *Cucumella cinerea*, *Eragrostis nindensis* (whether love grass), *Stipagrostis uniplumis* (silky bushman-grass) and *Trianthema triquetra*.

Khan river. The Khan River runs almost parallel along the southern boundary of the licence area. The banks of the riverbed which is dry most of the year, are lined with patches of woodland largely comprised of the tall trees *Acacia erioloba* (camel thorn), *Faidherbia albida* (ana tree) and *Tamarix usneoides* (tamarisk). Dense thickets of *Salvadora persica* are locally dominant. The invasive alien *Prosopis glandulosa* (mesquite), *Nicotiana glauca* (wild tobacco) and *Ricinus communis* (castor oil) are also present.

A diverse assortment of herb, shrubs and grasses form the undergrowth of these riparian woodlands. Although relatively species-rich – 48 species were recorded so far – biodiversity value was rated as low and thus the mapping unit is assigned as a general biotope, largely because very few species of conservation concern were recorded. These include *Aizoanthemum galenioides*, *Sesbania pachycarpa*, *Stipagrostis damarensis* (Damara bushman-grass) and *Zygophyllum stapffii* (dollar bush). Data quality is good.

Khan river mountains. Steep mountains line the northern and southern banks of the Khan River. Although survey work focussed on accessible localities along drainage lines and gentler slopes and has largely been undertaken after poor rainy seasons, the mountain slopes harbour by far the most plant species in this area. Some 71 species have so far been recorded. Characteristic plants are *Calicorema capitata, Commiphora virgata, Commiphora glaucescens* (blue-leaved commiphora), *Psilocaulon salicornioides* and *Ruellia diversifolia.* Species of conservation importance include *Aizoanthemum galenioides, Commiphora saxicola, Marcelliopsis splendens* and *Petalidium canescens. Aloe dichotoma, Euphorbia virosa* and *Hoodia currorii* (Namib hoodia) also occur. This unit is classified of medium biodiversity value making this a rare biotope. Data quality is medium, largely because higher ridges could hitherto not be surveyed.

Northern tributaries. A number of drainage lines join the Khan River from the north. Many are dominated by *Stipagrostis damarensis*. Some 43 species have been recorded, but only some are of conservation importance and thus serve as indicators for biodiversity value. These include *Hermannia amabilis* (white hermannia) and *Zygophyllum stapffii*. Biodiversity value was classified as low and thus assigning a general biotope. Data quality is medium.

Southern tributaries. Tributaries joining the Khan River from the south-east in the accessory works area have been mapped as one unit. They are dominated largely by *Stipagrostis hochstetteriana* (gemsbok-tail grass). *Blepharis pruinosa* (desert thistle) is locally dominant. Although only 37 species were recorded during the survey, data quality is good, since the area was accessible and well surveyed.

Few species of conservation importance were recorded. These include, amongst other, *Anticharis imbricata, Stipagrostis damarensis, Stipagrostis hochstetteriana* and *Zygophyllum stapffii*. The unit is ranked of low biodiversity value and thus as a general biotope.

South-east gneiss hills. As the general elevation rises towards south-east of the Rössing accessory works area, the Khan river mountains gradually lose height and become less steep transforming into undulating hills. Although gneissic rocks are considered characteristic of these hills, many other rock types also occur and plants are not strictly associated with gneiss. Characteristic shrubs are *Petalidium canescens* and *Petalidium variabile*, and a healthy population of *Aloe dichotoma* (quiver tree) is noticeable in the eastern corner of this mapping unit. With some 51 species recorded during 2007, this area is fairly species rich. Data quality is, however, considered poor as only certain parts of this mapping unit were accessed. Biodiversity value is medium, assigning this area as a rare biotope. Species of conservation importance include *Adenia pechuelii, Calostephane marlothiana* and *Sarcocaulon marlothii*.

Recommendations

Minimising the new footprint

As a critical biotope will likely be affected by the planned mine expansion, reducing the footprint of the new mine to a minimum is mandatory. This will require clearly demarcated access routes and stringently enforced track discipline. Also work areas need to be clearly demarcated and sign-posted. Any movements outside these marked areas will require special permission involving Rössing's environmental staff. Further, waste and pollution management, water and energy usage will need to follow established procedures.

Preserving *Adenia pechuelii*

Should there be a mine expansion into the SK area, several large *Adenia pechuelii* plants may directly be affected. As these are charismatic species of high conservation importance testing transplanting these would be a very valuable exercise enabling Rössing to demonstrate its commitment to biodiversity conservation. Once the site lay-outs for the expansion area are available, affected specimens should be marked and a suitable site selected for a transplant trial. Involvement of the National Botanical Research Institute would be essential to obtain permits and relevant expertise.

Testing rehabilitation measures in impacted areas

Apart from minimising environmental impacts, special measures to facilitate the recovery of critical biotopes are required. Rehabilitation practices such as preserving and re-spreading topsoil, seeding and replanting with indigenous species will need to be tested and site-specific protocols developed for particular habitats. Presently very little is known about appropriate practices in this arid environment and setting up trials will be an essential part of Rössing's biodiversity strategy.

Improving biodiversity data collection

Although more intensive collecting over the past growing seasons have greatly improved overall plant data coverage, most parts of the eastern accessory works area have only been surveyed once. Repeated sampling will be necessary, particularly in those mapping units that were only accessed along their margins, such as the Khan River mountains and south-east gneiss hills.

Integration of other biodiversity indicators

Work to include other biodiversity components such as invertebrates, birds and reptiles is in progress (Stacey 2006; Schneeweiss, Pallet pers. comm.). A systematic approach to selecting appropriate indicators and to link these assessments to the derived biotopes is required. This includes:

1. a transparent process of selecting indicators which are feasible to map,
2. ranking these according to relevant ecological criteria,
3. determining appropriate thresholds for biotope assignation and
4. developing a process of integrating these assessments with the existing habitat- and plant-based biotope assessment.

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Appendix 1. Cross-tabulated species list for mapped biotopes in the eastern accessory works area.

Species[1]	Eastern hills	Khan river mountains	Khan River	Northern tributaries	Southern tributaries	South-east gneiss hills
Abutilon pycnodon	x	x				
Acacia erioloba	x		x	x	x	
Acacia tortilis			x			
Adenia pechuelii	x					x
Adenolobus garipense			x			
Adenolobus pechuelii	x			x	x	x
Aizoanthemum galenioides	x	x	x	x		x
Aloe dichotoma	x	x				x
Anticharis imbricata	x			x	x	x
Asparagus denudatus	x	x		x		x
Berkheya spinossisima		x				
Blepharis grossa	x	x		x	x	x
Blepharis obmitrata		x				
Blepharis pruinosa		x	x	x	x	
Boscia foetida		x		x	x	x
Calicorema capitata	x	x		x	x	x
Calostephane marlothiana	x					x
Chascanum garipense		x			x	x
Cleome suffruticosa			x	x	x	
Cleome species	x	x		x		x
Codon royenii	x	x	x	x		
Codon schenckii			x			
Combretum imberbe			x			
Commiphora glaucescens	x	x				x
Commiphora saxicola	x	x				x
Commicarpus squarrosus		x				
Commiphora tenuipetiolata	x					
Commiphora virgata	x	x				x
Corbichonia decumbens						x
Cryptolepis decidua	x	x				x
Cucumella cinerea	x					
Cyperus marginatus			x			
Datura innoxia			x			
Dyerophytum africanum	x	x		x	x	
Enneapogon scaber	x	x				x
Eragrostis nindensis	x					
Euclea pseudebenus				x		
Euclea undulata		x				
Euphorbia glandulosa	x					
Euphorbia virosa	x	x				x

[1] Combined species of 2005 and 2007 field survey.

Fagonia sinuata var *isotricha*	x	x		x	x	x
Faidherbia albida			x	x	x	
Ficus cordata			x			
Forsskaolea candida	x	x	x			x
Geigeria alata		x				x
Geigeria ornativa	x	x			x	x
Gisekia africana	x	x	x			x
Gossypium anomalum		x				
Gymnosporia szyszylowiczii		x				
Herb - unknown 06	x		x			
Helichrysum candolleanum				x		
Helichrysum roseo-niveum	x	x	x			x
Heliotropium tubulosum	x	x				
Heliotropium species					x	x
Hermannia affinis	x				x	
Hermannia amabilis		x		x		x
Hermannia glandulosa						
Hermannia modesta						x
Hermbstaedtia spathulifolia		x	x	x		
Hoodia currorii		x				
Jamesbrittenia maxii					x	
Jamesbrittenia species		x				x
Kissenia capensis	x		x	x	x	
Kohautia caespitosa	x	x	x	x		x
Kohautia cynanchica		x				x
Limeum aethiopicum		x				
Limeum argute-carinatum			x			
Lophiocarpus polystachyus						x
Lotononis species	x	x				
Maerua schinzii		x	x	x	x	x
Marcelliopsis splendens		x				
Mesembryanthemum guerichianum		x	x			x
Mollugo cerviana	x		x			
Monechma cleomoides	x	x	x	x	x	x
Moringa ovalifolia		x		x		
Nicotiana glauca			x			
Orthanthera albida	x	x		x	x	
Ozoroa crassinervia		x				
Parkinsonia africana	x			x	x	
Pechuel-Loeschea leubnitziae	x	x	x		x	
Peliostomum leucorrhizum	x	x				x
Peliostomum viscosum			x			
Pentzia monocephala						x
Pergularia daemia				x		
Petalidium canescens	x	x			x	x
Petalidium variabile	x	x		x	x	x
Phyllanthus pentrandus			x			
Polygala guerichiana				x		
Prosopis glandulosa			x			
Psilocaulon salicornioides	x	x				x
Rhus marlothii	x	x			x	
Rogeria longiflora			x	x	x	x

Ruellia diversifolia	x	x	x	x	x	x
Salsola species		x				
Salvadora persica	x	x	x	x	x	
Sarcocaulon marlothii	x					x
Scirpoides dioeicus			x			
Senecio alliarifolia	x	x				
Sesamum capense		x		x		
Sesamum species						x
Sesbania pachycarpa			x		x	
Sesuvium sesuvioides	x	x	x	x	x	x
Shrub - unknown 07		x				
Solanum rigescentoides	x	x				
Sterculia africana	x	x				x
Stipagrostis ciliata	x	x	x	x		x
Stipagrostis damarana	x		x	x	x	
Stipagrostis hirtigluma	x		x			
Stipagrostis hochstetterana				x	x	
Stipagrostis schaeferi	x	x		x	x	
Stipagrostis species	x	x	x		x	x
Stipagrostis uniplumis	x					
Suaeda species			x			
Tamarix usneoides		x	x	x		
Tapinanthus oleifolius			x			
Tephrosia dregeana	x					
Tetragonia reduplicata	x					x
Thamnosma africana		x				
Trianthema triquetra	x					
Tribulus excrucians			x		x	
Tribulus zeyheri	x	x				
Trichodesma africana	x	x	x	x	x	x
Tripteris microcarpa			x	x		
Vernonia species		x				
Zygophyllum cylindrifolium	x	x				x
Zygophyllum simplex	x		x	x		
Zygophyllum stapffii	x	x	x	x	x	