APPENDIX F

Invertebrate study
(Biodata and Scarab)

June 2011

SPECIALIST INVERTEBRATE STUDY OF THE OMAHOLA PROJECT

Prepared by

BIODATA and SCARAB

For

SOFTCHEM

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ACRONYMS AND ABBREVIATIONS

BSC	Biological soil crust
EIA	Environmental Impact Assessment
EPL	Exclusive Prospecting Licence
MET	Ministry of Environment and Tourism
ML	Mining licence
MME	Ministry of Mines and Energy
RUN	Reptile Uranium Namibia
SEA	Strategic Environmental Assessment
TRS	Tubas Red Sand
WRD	Waste rock dump

EXECUTIVE SUMMARY

A baseline invertebrate study was undertaken of the Omahola Project, comprising of the INCA uranium and iron, Shiyela iron and Tubas Red Sand (TRS) uranium deposits. The terms of reference also required an assessment of the potential impacts of Omahola Project on the invertebrates of the Project Area, but due to the lack of detailed project information the assessment of impacts in this report should be considered at the level of a scoping exercise, and not be mistaken for a formal impact assessment.

The baseline study entailed a desktop literature review as well as an extensive field survey that spanned a period of three months. After the first significant summer rains in the Project Area, preservative pitfall traps were deployed in 12 vegetational habitats. Once-off manual invertebrate collection in each habitat was also undertaken as part of the field survey.

A total of at least 319 distinct invertebrate species were recorded in the Omahola Project Area, and 21021 individual invertebrates were recovered from pitfall traps. Diversity and abundance of recorded invertebrates increased significantly during the fourth trapping period.

The sensitivity of the different habitats was assessed by evaluating it according to the diversity and potential diversity of invertebrate trophic guilds, the habitat restoration potential and the uniqueness of the habitat.

The Salsola river terraces and plains habitat was identified as the most sensitive habitat within the Omahola Project Area, and was categorised as a ‘no-go area’. The Marble ridge habitat, Northern gravel plains, Lower Tumas drainages, Western and Southern gravel plains and Granite hill was categorised as ‘highly sensitive habitats’.

Potential impacts of the Omahola Project on invertebrate ecosystems and the way they function are those that pertain to substrate disruption and impacts on vegetation. This basically comprises any and all aspects of the Project, due to the fragility of the area and the slow nature of natural restoration processes of hyper arid areas. The Omahola project is situated in an extremely fragile environment of global biodiversity significance, and it is advised that the Company proceed with this project with the utmost environmental caution.

Based on the sensitivity of the various invertebrate habitats, potential general impacts of the Omahola project are summarised in the tables below.

Environmental aspect	Invertebrates	Phase	Construction

Description: Disruption and destruction of invertebrate habitats by the footprint of the project-

- including excavation of the mining pit, removal of vegetation, levelling and contouring of slopes, stripping of overburden, dumping of (overburden, waste rock etc.) and general project activities
- Risk of habitat degradation due to increased and unregulated access to the area
- Possibility of poaching, illegal collection of firewood and seeds, indiscriminant driving, pollution
- Introduction of alien invasive species that may outcompete indigenous fauna
- Noise disturbance deterring larger animals from their normal routes as well as nesting birds, with consequent ecological effects.

Avoid: No-go and highly sensitive habitats as far as possible.
Mitigation:

- Design footprints of all facilities to be as small as possible and to restrict unnecessary collateral damage around the periphery
- Where construction are to take place in close proximity to highly sensitive habitats the footprint of such activities should be clearly demarcated to run clear of the sensitive habitats and to avoid collateral damage such habitats
- Plan and operate waste rock and tailings dump sites to minimise terrain changes and fit in with existing topography
- Develop and actively enforce zero-tolerance policies concerning poaching, wood collecting and pollution
- Ensure that guidelines and rules are regularly communicated to workers and visitors, enforce this by adequate signage in appropriate places
- Allow only project personnel and registered visitors on site
- Prohibit off-road driving, plan roads beforehand, reuse existing tracks

Description: Water extraction for construction purposes with consequent impacts on and loss of vegetation forming important invertebrate habitat determinants, consequent impacts on invertebrate populations.
Avoid: Extraction from palaeo water pockets where limited knowledge of their recharge are available.
Mitigation: Limit water extraction; implement water wise processes and water recycling; stringently prevent water wastage; regularly monitor groundwater levels; monitor plants for signs of water stress.

Description: Disrupting surface water flow by blocking or deviation the flow of natural drainages with infrastructure such as roads, dumps of pits –

- Disruption of recharge of alluvium and consequent adverse effects on vegetation and ecosystem
- Interference with re-charge of aquifers
- Disruption of seeds & nutrients transport by surface water flow, threat to survival of vegetation and ecosystem.
- Disruption of nutrient transport
- Interference with water supply of riparian vegetation

Impact on invertebrate, reptile and small mammal populations of the plains habitat that usually find shelter and food within the drainage systems when food and shelter aren't available on the open plains.
Avoid: Building infrastructure across drainage lines as far as possible.
Mitigation: Building infrastructure across drainage lines without making adequate provision for potential flood water to bypass the infrastructure, which will maintain groundwater flow in drainage lines.

Description: Flooding events, seepage or spillage of fuels and other hydrocarbons, hazardous waste materials and domestic waste can cause contamination of groundwater and transport of pollutants downstream with adverse effects on vegetation and ecosystems in general.
Mitigation: Develop a waste policy and hazardous materials handling policy and actively enforce it; provide appropriate waste deposition facilities on site; remove domestic waste often; keep drainage lines clean to ensure that surface water pollutants are not washed downstream in the event of floods; develop and implement appropriate emergency clean-up plans for accidental spills; provide adequate toilet facilities for personnel; vigorously monitor sites for spills, spill hazards or non-compliance.

Description: Habitat fragmentation caused by disturbance or physical barriers - organisms isolated from populations, possible detrimental impacts on the livelihood of range-restricted animals and plants and ecosystems.
Avoid: any sort of development on or across the Marble ridge habitat, Granite hill, Granite ridges.
Mitigation: Avoid or minimise development of infrastructure in or across drainages; design footprints of all facilities to be as small as is practically possible and restrict unnecessary collateral damage around the periphery; research effective biodiversity monitoring procedures and implement during construction, operation and beyond decommissioning.

Description: Increased dust generation in project footprint area and along roads and tracks due to traffic and construction activities.
Mitigation: Adapt policies to limit dust generation (such as avoiding speeding on site and access roads); implement dust suppression measures on site and access roads; monitor dust fallout; monitor vegetation for damage due to dust- adverse effect on invertebrate habitats and vegetation.

Confidence level	Mitigation required	Evaluation of impacts					
		Nature	Extent	Duration	Intensity	Probability	Significance
	yes	-					
Potential for irreplaceable loss of resources		yes	Cumulative impacts			Reversibility	

Environmental aspect	Invertebrates	Phase	Operation

Description: Disruption and destruction of invertebrate habitats by the footprint of the project-

- including excavation of the mining pit, removal of vegetation, levelling and contouring of slopes, stripping of overburden, dumping of (overburden, waste rock etc.) and general project activities
- Risk of habitat degradation due to increased and unregulated access to the area
- Possibility of poaching, illegal collection of firewood and seeds, indiscriminant driving, pollution
- Introduction of alien invasive species that may outcompete indigenous fauna
- Noise disturbance deterring larger animals from their normal routes as well as nesting birds, with consequent ecological effects.

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- Plan and operate waste rock and tailings dump sites to minimise terrain changes and fit in with existing topography
- Develop and actively enforce zero-tolerance policies concerning poaching, wood collecting and pollution
- Ensure that guidelines and rules are regularly communicated to workers and visitors, enforce this by adequate signage in appropriate places
- Allow only project personnel and registered visitors on site
- Prohibit off-road driving, plan roads beforehand, reuse existing tracks

Description: Water extraction for construction purposes with consequent impacts on and loss of vegetation forming important invertebrate habitat determinants, consequent impacts on invertebrate populations.
Avoid: Extraction from palaeo water pockets where limited knowledge of their recharge are available.
Mitigation: Limit water extraction; implement water wise processes and water recycling; stringently prevent water wastage; regularly monitor groundwater levels; monitor plants for signs of water stress.

Description: Disrupting surface water flow by blocking or deviation the flow of natural drainages with infrastructure such as roads, dumps of pits –

- Disruption of recharge of alluvium and consequent adverse effects on vegetation and ecosystem
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Impact on invertebrate, reptile and small mammal populations of the plains habitat that usually find shelter and food within the drainage systems when food and shelter aren't available on the open plains.
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Avoid: any sort of development on or across the Marble ridge habitat, Granite hill, Granite ridges
Mitigation: Avoid or minimise development of infrastructure in or across drainages; design footprints of all facilities to be as small as is practically possible and restrict unnecessary collateral damage around the periphery; research effective biodiversity monitoring procedures and implement during construction, operation and beyond decommissioning.

Description: Increased dust generation in project footprint area and along roads and tracks due to traffic and construction activities - adverse effect on invertebrate habitats and vegetation.
Mitigation: Adapt policies to limit dust generation (such as avoiding speeding on site and access roads); implement dust suppression measures on site and access roads; monitor dust fallout; monitor vegetation for damage due to dust.

Description: Monitoring of environmental aspects within or affected by the project footprint area can generate information about this part of the desert previously not available. Such knowledge can feed into restoration experiments and other databanks which may lead to more effective conservation of desert ecosystems.
Mitigation: Standard monitoring methods should be applied throughout the lifetime of the project, and data should be made available for use in research and inclusion in relevant, accessible databanks.

Confidence level	Mitigation required	Evaluation of impacts					
		Nature	Extent	Duration	Intensity	Probability	Significance

	yes	-					
Potential for irreplaceable loss of resources		yes	**Cumulative impacts**			**Reversibility**	

Environmental aspect	Invertebrates	**Phase**	Decommissioning

Description: Post-closure monitoring of environmental aspects within or affected by the project footprint area can generate information about this part of the desert previously not available. Such knowledge can feed into restoration experiments and other databanks which may lead to more effective conservation of desert ecosystems.
Mitigation: Standard monitoring methods should be applied throughout the lifetime of the project, and data should be made available for use in research and inclusion in relevant, accessible databanks.

Confidence level	**Mitigation required**	**Evaluation of impacts**					
		Nature	**Extent**	**Duration**	**Intensity**	**Probability**	**Significance**
Confidence level	**Mitigation required**	**Evaluation of impacts**					
		Nature	**Extent**	**Duration**	**Intensity**	**Probability**	**Significance**
high	yes	+	4	3	3	4	**25 - 50**

1. INTRODUCTION

Reptile Uranium Namibia (Pty) Ltd (RUN) is a 100% owned subsidiary of the Australian based Deep Yellow Ltd. and has been conducting exploration activities on various Exclusive Prospecting Licences (EPLs) in the Namib Naukluft Park, Namibia, since 2006.

RUN seeks to apply to the Ministry of Mines and Energy (MME) for three mining licences (MLs) on EPL 3496 for the extraction of uranium, iron and associated minerals, a project that is collectively referred to as the Omahola Project (Softchem 2010). Softchem CC was appointed to conduct an Environmental Impact Assessment (EIA) for the Omahola Project, as is the requirement from the Ministry of Environment and Tourism (MET) for all prospective mining projects in Namibia.

2. TERMS OF REFERENCE

Dr John Irish (Biodata CC) and Riana Scholtz (Scarab Enterprises) were appointed to conduct an invertebrate baseline study of the Omahola Project Area and an assessment of the potential impacts that the proposed mining activities could have on the relevant invertebrate communities and their habitats.

The Omahola Project comprises the INCA uranium and iron, Shiyela iron and Tubas Red Sand (TRS) uranium deposits (Figure 1).

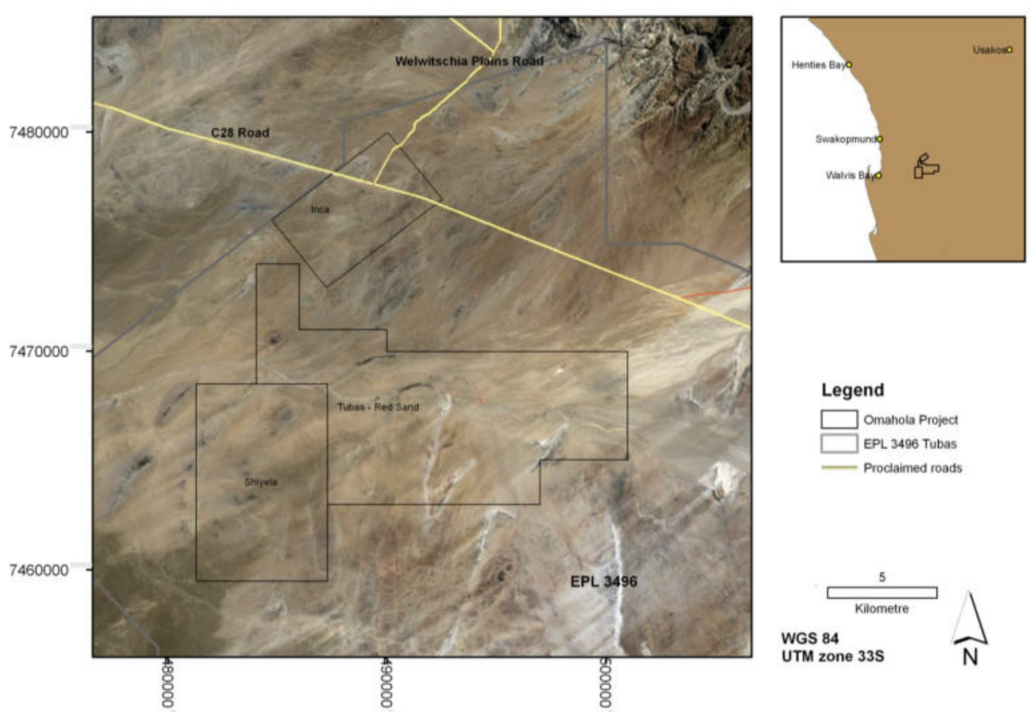

Figure 1. Location of the Omahola Project on EPL 3496 Tubas.

3. INVERTEBRATE BASELINE

3.1. Desktop study

A literature survey of previous studies and available papers was undertaken to get an understanding of the area. The results are presented and discussed in Section 3.3.

3.2. Fieldwork

1.1.1. Materials & methods

The Namib Desert experienced a relatively poor 2009-10 rainy season. For a clear interpretation of the invertebrate assemblages and the potential impact of the proposed Project on these it was proposed that the invertebrate field investigation be conducted during a three month period following a reasonably favourable rainy season or at least after a few good down pours across the area. Resident invertebrate fauna in the Central Namib Desert is comprised firstly of persistent taxa that are always present, and secondly of a more short-lived component that only hatches and breeds following significant rainfall. Since the impact of the proposed mine(s) will persist through future dry and wet periods, it is important to include wet periods in the baseline study, otherwise the results cannot be considered to be representative of invertebrate diversity in the study area.

A number of the other biodiversity baseline studies were conducted earlier during 2010, including the vegetation study. Four major physiographic habitats or vegetation zones were identified in the vegetation study, which were further subdivided into 10 minor habitats (one of which had 2 subdivisions, so 12 in total) based on vegetation type (Table 1). Since vegetation is an important determining factor in invertebrate habitats, the vegetational habitats were used as reference for the invertebrate study.

An intensive 3 month invertebrate field survey of the 12 vegetational habitats commenced within 7 days of the first significant rainfall event in the area to optimise sampling success.

Standard entomological techniques used during the survey comprised preservative pitfall trapping supplemented by manual collecting and field observations. Manual sampling coincided with the installation of the pitfall traps, which took place between 25 and 27 November 2010. The pitfall traps were serviced on 20 December, 10 January 2011 and 1 February and were removed on 28 February after a total of 123 trap days. Initially it was proposed to service the traps only twice, but due to the unexpectedly high rainfall in the region an additional trap service was performed to prevent possible loss of invertebrate material due to traps being filled with rainwater.

Three preservative pitfall traps (Figure 2) were deployed in each of the 12 habitat types

(Table 1, Figure 2). Preservative pitfall traps are 500 cm^3 plastic buckets sunk into the ground with the rim flush to the surface (Figure 2) to allow for passing ground-dwelling invertebrates to fall into them. A small quantity of commercial antifreeze (mono-ethylene-glycol) was placed in each trap to serve the dual purpose of killing trapped invertebrates by drowning and then preserving them from decomposition long enough for survey purposes.

Figure 2. Pitfall trap with invertebrate material and antifreeze as preservative.

Spending 2 man-hours in each of the 12 different vegetational habitats, more cryptic invertebrates that are not normally trapped in pitfalls were manually collected by hand, aspirator or insect net while investigating suitable micro-habitats such as underneath rocks, shrubs or other shelters. Conspicuous flying insects were also collected. Specimens that could be identified on the spot were released after species and locality notes were taken, while other invertebrates were collected and preserved in alcohol.

After trap services, trap contents was separated and sorted in the laboratory. Invertebrate specimens were identified and properly preserved and bottled in labelled glass Polytop™ vials for deposition in a reputable biological collection for future curation.

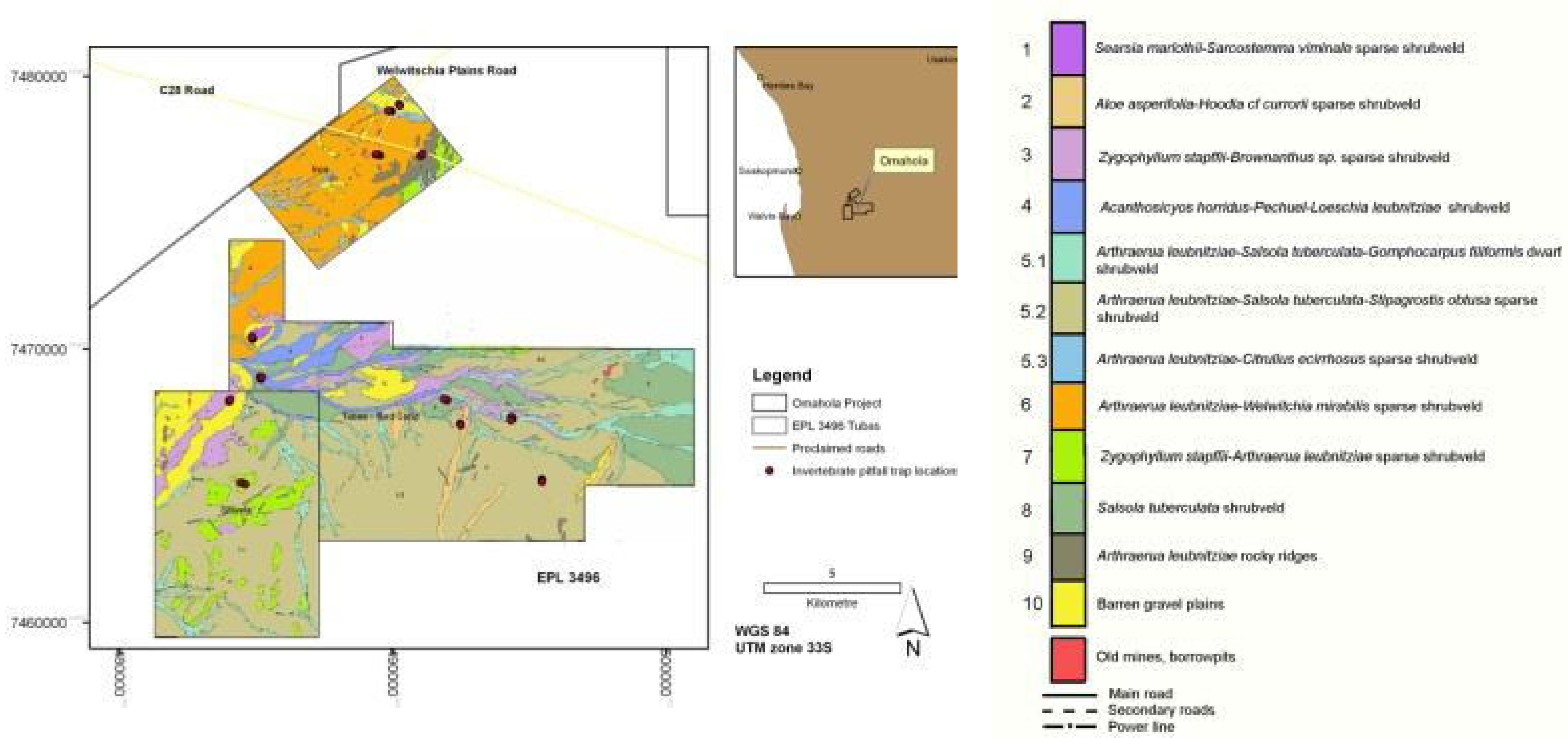

Figure 3. Location of invertebrate pitfall trap and manual collecting localities in relation to the 12 identified habitats (Ecotrust 2010) within the Omahola Project.

Table 1. Omahola invertebrate pitfall trap locality details. Habitat categorisation used in the vegetation report (Figure 3) (Ecotrust 2010) served as reference for the invertebrate survey. Corresponding habitat designations used in this report are listed below column 5.

Trap number	Latitude	Longitude	ML block	Invertebrate Habitat	Vegetation Habitat No.
1	-22.8743	14.8523	TRS	Granite hill	1
2	-22.874	14.85217	TRS	Granite hill	1
3	-22.8736	14.85201	TRS	Granite hill	1
4	-22.9027	14.92656	TRS	Marble ridge	2
5	-22.9024	14.92641	TRS	Marble ridge	2
6	-22.9029	14.92658	TRS	Marble ridge	2
7	-22.8947	14.84398	Shiyela	Granite ridges	3
8	-22.895	14.844	Shiyela	Granite ridges	3
9	-22.8943	14.84441	Shiyela	Granite ridges	3
10	-22.8875	14.85523	TRS	Lower Tumas drainages	4
11	-22.887	14.85491	TRS	Lower Tumas drainages	4
12	-22.8871	14.85554	TRS	Lower Tumas drainages	4
13	-22.9008	14.94497	TRS	Southern drainages & washes	5.1
14	-22.9002	14.94465	TRS	Southern drainages & washes	5.1
15	-22.9012	14.94449	TRS	Southern drainages & washes	5.1
16	-22.9208	14.95551	TRS	Southern gravel plains	5.2
17	-22.9211	14.95554	TRS	Southern gravel plains	5.2
18	-22.9217	14.95547	TRS	Southern gravel plains	5.2
19	-22.7989	14.9019	INCA	Northern drainages & washes	5.3
20	-22.799	14.90132	INCA	Northern drainages & washes	5.3
21	-22.7988	14.90078	INCA	Northern drainages & washes	5.3
22	-22.8135	14.89778	INCA	Northern gravel plains	6
23	-22.8134	14.89712	INCA	Northern gravel plains	6
24	-22.8133	14.89626	INCA	Northern gravel plains	6
25	-22.922	14.84855	Shiyela	Western gravel plains	7
26	-22.9225	14.8497	Shiyela	Western gravel plains	7
27	-22.9219	14.84793	Shiyela	Western gravel plains	7
28	-22.8945	14.92131	TRS	Salsola river terraces & plains	8
29	-22.8946	14.92168	TRS	Salsola river terraces & plains	8
30	-22.8942	14.92056	TRS	Salsola river terraces & plains	8
31	-22.8134	14.91274	INCA	Barren dolerite ridges & dykes	9
32	-22.8138	14.91227	INCA	Barren dolerite ridges & dykes	9
33	-22.8132	14.91295	INCA	Barren dolerite ridges & dykes	9
34	-22.7968	14.90456	INCA	Barren gravel plains	10
35	-22.797	14.90479	INCA	Barren gravel plains	10
36	-22.7971	14.90495	INCA	Barren gravel plains	10

3.3. Results

3.3.1. Literature survey

Prior invertebrate work in the area was investigated through a survey of published literature and online data sources. The area included in the search was the bounding box that includes the three EPLs, rounded outwards to the nearest full 0.01° geographical to give a 1-2 km wide gutter (Table 2, Figure 4). For quarter degree square based datasets, square SE 2214Dd was used.

Table 2. Boundary coordinates of search quadrangle used for literature study.

	Longitude	Latitude
Northwestern corner	14.81° E	-22.78° S
Southeastern corner	15.02° E	-22.98° S

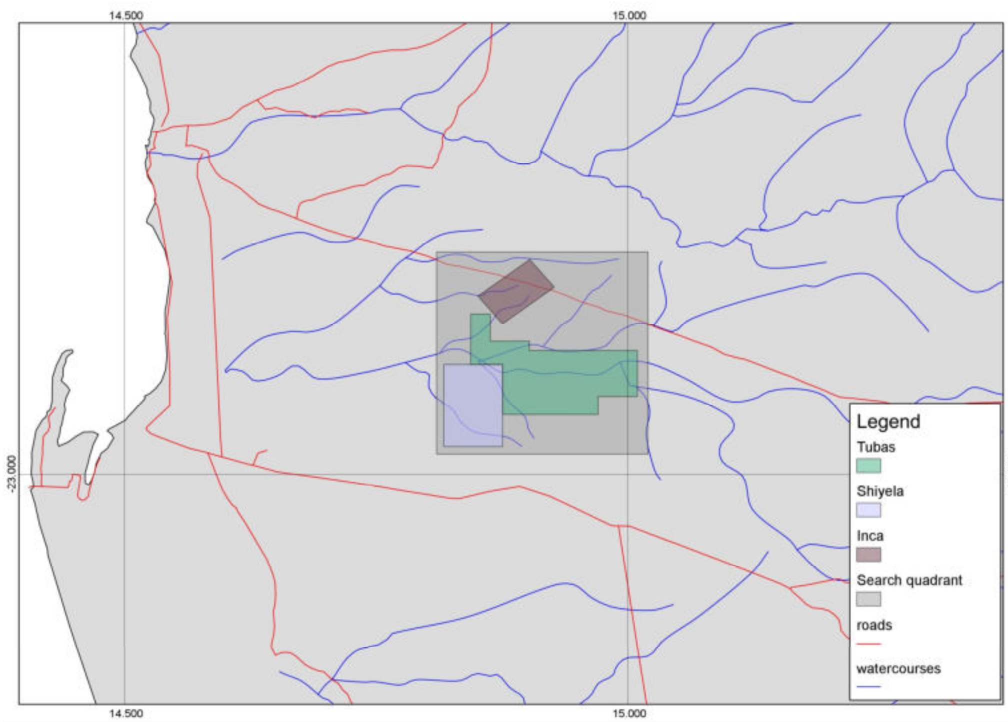

Figure 4. Literature search quadrant in relation to mining areas.

No comprehensive summary of Namibian invertebrate information exists, and data is scattered in fragments throughout literally tens of thousands of taxonomic research papers published all over the world, often in quite obscure journals and languages. No literature search on Namibian invertebrates can therefore ever be complete, and the quality of results depends on the library utilised. In the present case the Biodata private collection was used, that currently comprises 25044 pdf files, or 43.8 Gb, of original paper publications concerned with Namibian biodiversity, spanning the period from 1838 to 2011. Full text searches were run against the library, for Tubas / Tumas, Shiyela, Inca, Swakopmund plus E or SE or District, Namib Park or Namib-Naukluft, 22°, 14° and 2214Dd, as well as logical permutations or translations. All hits were inspected, but only 7 positive records representing 4 species from the study area were found.

In addition, online museum collection data was similarly searched for possible unpublished material. The Global Biodiversity Information Facility (http://www.gbif.org), their Southern African counterpart SABIF (http://www.sabif.ac.za/) and the collections of the African Museum Tervuren (http://www.africamuseum.be) were specifically targeted. Despite collectively representing approximately 350 million specimen records from 400 museums worldwide, they included no records from the study area. National Museum of Namibia collection data is not available online, but an off-line search produced no records either. Our own Namibian Biodiversity Database (http://www.biodiversity.org.na) did include the same 7 records as were found through the literature search.

The study area has not been subjected to any systematic invertebrate study before, and those records that were traced related to incidental sampling along the C28 road only. This confirmed the need for invertebrate sampling in the area.

3.3.2. Invertebrates recorded during field survey

At least 311 distinct invertebrate species were recovered from pittraps in the study area (Tables 3 and 4 and Figures 5 and 6), while an additional 8 species not recorded in pitfall traps were recorded during the manual survey. This is a minimum number representing the invertebrates that occur, since the majority of taxa have been identified to higher groupings or morphospecies only. Species level identifications have been provided where knowledge of the group concerned is sufficient to allow that. Given the scarcity of taxonomic experts worldwide, and the consequent full schedules of taxonomists, it is not viable to have expert species-level identifications done within the project time frame. However, material is being deposited in the National Museum of Namibia from where it should disseminate to experts eventually as per usual museum practice. By the time mine closure becomes an issue, more should be known about the present collections, which will then be the definitive record of pre-mining conditions that can be used to evaluate the effectiveness of post-mining habitat restoration.

Diversity and abundance of recorded invertebrates increased significantly during the fourth trapping period (refer figures and tables below), and many taxa were only recorded then, confirming the need to wait for significant rain before doing invertebrate sampling.

A discussion of individual taxa recorded follows. Details of trap yields can be found in APPENDIX 1, while the basis on which morphospecies were distinguished is listed in APPENDIX 2.

Table 3. Summary of invertebrate taxa recorded from pittraps and observed in study area. Details are in APPENDIX 1.

Higher grouping	Minimum number of Taxa in pitfall traps	Number of Taxa observed	Total
ARACHNIDA	46	1	47
Mites	11		
Spiders	26		
Other arachnids	9	1	
INSECTA	261	7	268
Beetles	66	4	
Flies	54		
Bugs	35		
Bees and ants	67	1	
Other insects	39	2	
OTHER INVERTEBRATES	4		4
Total:	311	8	319

Table 4. Number of individual invertebrates found in the combined traps for each trap line for each sampling period. Column "(4)" represents modified results for sampling period 4, proportionally reduced (÷ 28, x 20) to reflect the longer sampling period and maintain comparability with periods 1 to 3.

Periods / traplines	1	2	3	(4)	4	Total, excl. (4)
1	134	90	549	1224	1714	2487
2	106	484	144	446	624	1358
3	263	327	447	511	716	1753
4	139	251	271	601	842	1503
5	271	282	329	521	729	1611
6	164	233	319	749	1048	1764
7	525	405	373	769	1076	2379
8	428	448	554	794	1111	2541
9	274	354	376	1581	2214	3218
10	287	245	202	325	455	1189
11	244	74	87	286	400	805
12	52	55	91	154	215	413
Total:	2887	3248	3742	7961	11144	21021

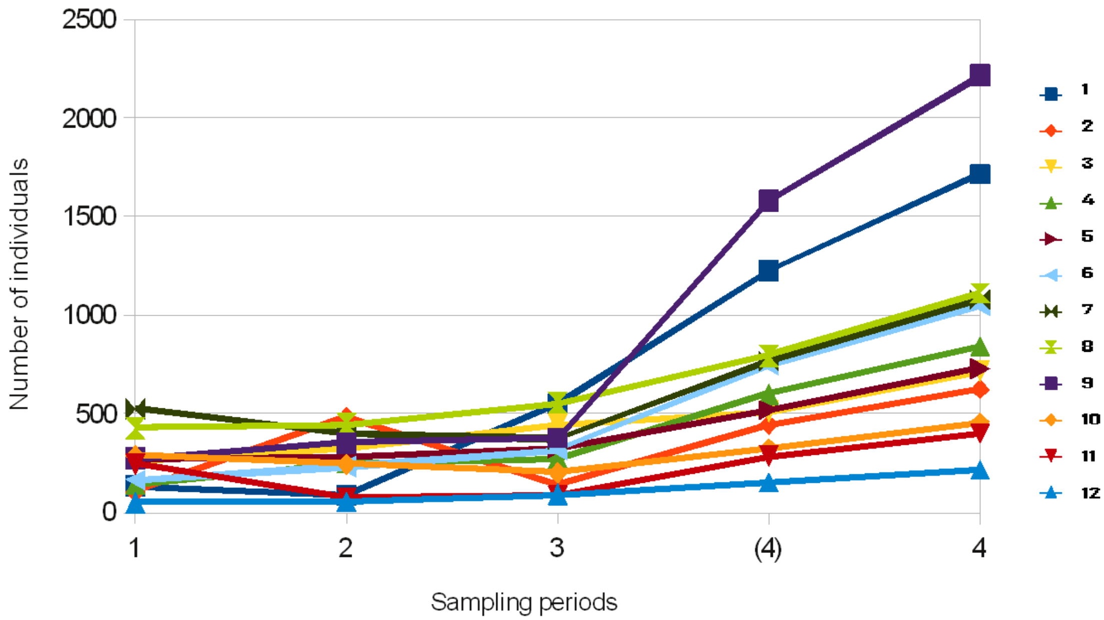

Figure 5. Graph of Table 1, showing increase in overall abundance following rains during period 4.

Table 5. Number of taxa found in the combined traps for each trap line for each sampling period. Due to overlap in diversity between traplines, the figures for individual traps do not add up to the overall total for each period. For the same reason, figures for period 4 were not proportionally reduced as was possible for gross numbers above.

Periods / traplines	1	2	3	4
1	28	29	36	79
2	29	46	38	83
3	39	53	48	69
4	44	57	55	72
5.1	50	58	52	64
5.2	45	52	59	110
5.3	62	55	61	105
6	62	60	70	100
7	47	51	56	116
8	42	52	53	76
9	16	20	23	68
10	18	17	31	55
Total:	164	165	175	239

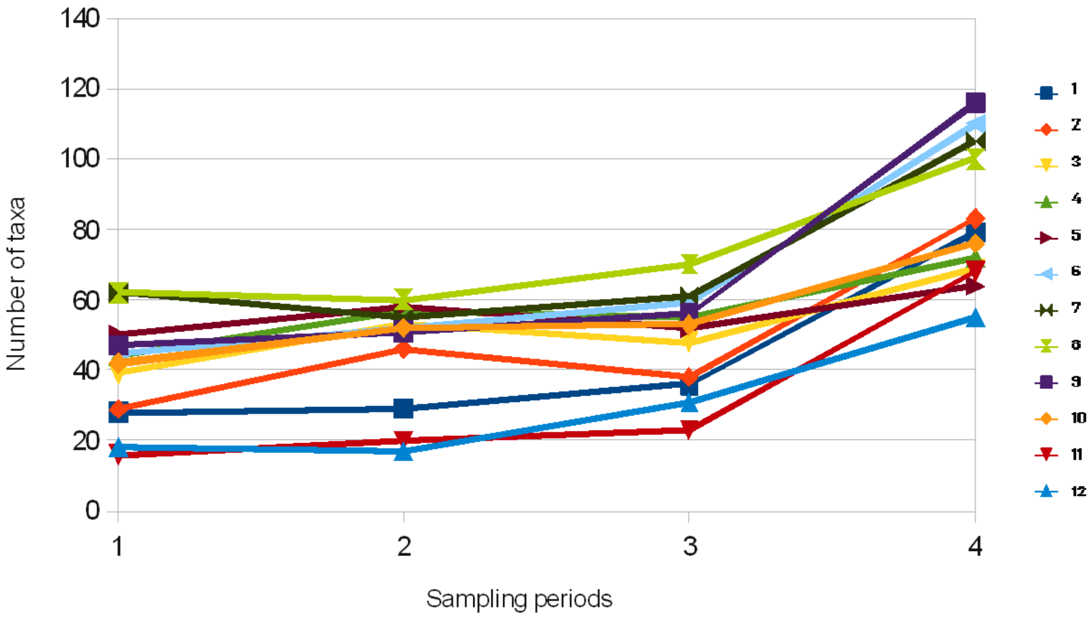

Figure 6. Graph of Table 2, showing increase in diversity following rains in period 4.

3.3.2.1. Phylum Arthropoda, Class Arachnida - arachnids

Order Acari – ticks and mites

No comprehensive source for Acari information in Namibia exists, nor are there any experts working on our fauna. At least 11 morphospecies were recorded, and they include representatives of both the Acariformes and the Parasitiformes. Overall diversity increased in the fourth period, indicating response to rain. Acari tended to be particularly abundant in habitat 7.

Order Araneae - spiders

Some families of Namibian spiders are moderately well known and there are workers active on our fauna. Other families are completely unworked.

- Family Ammoxenidae – burrowing spiders: *Ammoxenus* spp. are all-year residents, and hence show almost no response to rain. They are associated with sandier habitats, particularly habitats 2 and 5. The genus was recently revised (T. Bird, pers. comm.) but results have not yet been published. By contrast, the tiny *Rastellus* spp. did respond to rain, and were found in a wider variety of habitats. The genus was only described in 1990 and remains poorly known (Platnick & Griffin 1990).
- Family Araneidae – orb web spiders: Recorded mainly in habitats 8 and 10, drainage lines with vegetation that allow for the spinning of vertical webs.
- Family Eresidae – velvet spiders: Only two specimens recorded during the first period.
- Family Gnaphosidae – ground spiders: The three recorded morphospecies probably mask a much higher diversity, but the group is poorly known and there are no experts active on our fauna. They are the second most abundant spiders encountered in the study area. Morphospecies 3 was consistently very abundant in habitat 5. They are year-round residents and showed no particular response to rain.
- Family Oonopidae – goblin spiders: The group is essentially unstudied in Namibia, and the single morphospecies recorded might mask higher diversity. They occurred throughout the area, but were consistently absent from habitats 1 and 11, both hill habitats. Oonopidae responded to rain.
- Family Oxyopidae – lynx spiders: Only a single specimen seen.
- Family Palpimanidae – palp-footed spiders: At least two morphospecies were common throughout the area, and represented the third most abundant spiders encountered. They are year-round residents and did not respond to rain. A third morphospecies was recorded in low numbers only.

- Family Philodromidae: A single morphospecies recorded, mostly in habitat 2. No apparent response to rain.
- Family Pholcidae – daddy long legs spiders: At least two morphospecies present in low numbers in most habitats, but consistently absent from habitats 3, 7 and 12. No apparent response to rain.
- Family Prodidomidae – long spinneret ground spiders: A single morphospecies found in too low numbers to draw conclusions.
- Family Salticidae – jumping spiders: The most abundant spiders in the study area, found in all habitats, and showing no apparent response to rain. While they have been recorded as a single morphospecies, the large size variation in the material suggests that multiple species may be involved. Unfortunately the group is essentially unstudied in Namibia and there are no experts active on our fauna.
- Family Sicariidae – six-eyed crab spiders: Two genera encountered, but too seldom to draw conclusions. It may be noted that *Loxosceles* was only encountered in habitats 7 and 9.
- Family Sparassidae – huntsman spiders: At least two morphospecies, too seldom encountered to draw conclusions, but seems to be mostly associated with watercourses.
- Family Zodariidae – ant spiders: Only a single specimen encountered.

Order Pseudoscorpionida – false scorpions

The group is fairly common in the Namib, but has not received any attention since the study by Beier (1973) and there is no expert active on our fauna any more, so the encountered material could not be identified further and was referred to single morphospecies. Numbers were low, but most specimens came from habitats 5 and 6.

Order Scorpiones - scorpions

Namibian scorpions are fairly well known and there is an expert working on our fauna. The collected material will receive expert identification in due course. Two genera were encountered. Numbers collected are too low to draw any conclusions from, and most were juveniles, making species identifications difficult. The *Parabuthus* material included a single adult that could be identified as *Parabuthus granulatus*, a widespread species (Lamoral 1979), but the *Uroplectes* material included no adults. Both genera include several Central Namib species.

Order Solpugida – sun spiders

Namibia has the highest diversity of solifuges in the world, and most species are endemic and range-restricted. The Central Namib Desert is a particular hotspot. Unfortunately they are also very poorly known and cannot be reliably identified beyond family level at this stage. A global solifuge study is under way to rectify this (T. Bird, pers. comm.) and the collected material will receive expert identification in due course. Until then, no conclusions can be drawn from the data.

3.3.2.2. Phylum Arthropoda, Class Crustacea

Order Isopoda – pill bugs

Namibian terrestrial isopods have never been properly studied and there is no expert active on the fauna. Almost all of the material collected came from habitat 2, and there was a clear response to rain.

3.3.2.3. Phylum Arthropoda, Class Insecta – insects

Order Blattodea - cockroaches

No modern treatment of Namibian cockroaches is available, and historical sources are of little use in under-collected places like the study area. No expert is active on our fauna. At least five morphospecies were encountered, but no clear trends emerge from the data.

Order Collembola - springtails

Collembola are essentially unstudied in Namibia and there is no expert active on our fauna. Their sometimes abundant presence in the Central Namib has only recently become known since pittrap sorting has been done by experienced technicians. Previous studies like the 15 month Rössing pittrap survey in 1984/85 did not record a single collembolan (Irish 2007), probably because these tiny animals were missed by the technicians at that time. Two families were encountered, and either may include several species. Both showed a remarkable response to rain.

Order Coleoptera - beetles

- Family Anobiidae – furniture beetles: Badly known in Namibia. No current experts active. One morphospecies was rarely encountered in the study area. They are wood-borers, and their tiny size allows them to utilise the small woody shrubs available in habitats 2 and 5.

- Family Anthicidae – ant beetles: Poorly known. No current experts. A single morphospecies was encountered, with most specimens coming from habitat 5.
- Family Bruchidae – seed beetles: Poorly known. No current experts. A single individual encountered, in trapping period four. This is consistent with their food source, seed, only developing some time after rain, and there may have been higher bruchid abundance in the area beyond the last trapping period.
- Family Carabidae – ground beetles: No current experts active on the Namibian fauna, but moderately well known. At least five morphospecies encountered. The most common was an Anthiinae species that showed a clear response to rain, but the others were too uncommon to show recognisable trends.
- Family Catopidae: Minute beetles (< 1 mm). Essentially unstudied in Namibia. No current experts. Two morphospecies were encountered in low numbers. The first was a typical catopid, but the second had a highly unusual body shape resembling the Clambidae, a family of aquatic beetles that has not been formally recorded from Namibia yet. They were identified as Catopidae on balance of characters, but do not fit comfortably here and might be something new and unknown instead.
- Family Chrysomelidae – leaf beetles: Moderately well known, and receiving some expert attention. Members of three different subfamilies were encountered, in numbers too low to draw conclusions from.
- Family Coccinellidae – ladybird beetles: Moderately well known. No current experts. A single individual was encountered.
- Family Curculionidae – weevils: Some groups moderately well known, but previous Namibian experts no longer active. At least nine species or morphospecies encountered, all in low numbers.
- Family Dascillidae: Poorly known. No current experts. A single specimen encountered in habitat 10.
- Family Dermestidae – museum beetles: Moderately well known in Namibia, no current expert. At least 3 morphospecies encountered in low numbers.
- Family Histeridae – hister beetles: Poorly known, no current expert. Only two individuals of one morphospecies encountered.
- Family Meloidae – blister beetles: Moderately well known, and receiving sporadic expert attention, At least two morphospecies were encountered, and as can be expected from their association with flowers, there was a clear rain response.
- Family Melyridae - flower beetles: Partially known, but previous Namibian expert deceased. Two very distinctive morphospecies were encountered, and both were particularly abundant in habitat 7. Numbers of morphospecies 1 declined sharply in

the fourth trapping period, which is counter-intuitive and would need more observations to explain.

- Family Mordellidae – tumbling flower beetles: Poorly known, no current expert. A single morphospecies encountered. Clearly rain responsive, as only found in trapping period 4.
- Family Nitidulidae - sap beetles: Poorly known, previous expert died before Namibian work was published. A single individual encountered in trapping period 4.
- Family Ptinidae – spider beetles: Some subgroups moderately known, and our fauna is receiving sporadic expert attention. Only one individual each of two different taxa were encountered.
- Family Scarabaeidae – dung beetles, chafers and allies. Some groups well known, others poorly; our fauna is receiving sporadic expert attention. Small numbers of three different plant-feeding subfamilies were encountered, all in the fourth period, showing a clear rain response.
- Family Silvanidae: Poorly known, no current experts. A single individual encountered.
- Family Staphylinidae – rove beetles: Poorly known, no current experts. Only two individuals, belonging to two different morphospecies, encountered both in the fourth trapping period, indicating a rain response.
- Family Tenebrionidae – toktokkies: Most subgroups are relatively well-known in Namibia, although there are no more any experts active on our fauna. Central Namib tenebrionids tend to be range-restricted and endemic. Many are highly substrate-specific. They are present all year round and show only a moderate response to rain. At least 22 species or morphospecies were encountered. Of note are the following:
    - *Cauricara eburnea*. Central Namib Endemic, only recorded in the far west of the study area. Endangered status.*Epiphysa punctatissima*. Central Namib Endemic, widespread throughout the study area. Vulnerable status.
    - *Zophosis devexa*. Central Namib Endemic, apparently associated with hillsides, particularly habitat 2, in the study area. Endangered status.
    - *Zophosis dorsata*. Central Namib Endemic, a single individual found in habitat 8. Vulnerable status.
    - *Metriopus depressus.* Exceedingly common in the Central Namib and regularly encountered throughout the study area. Notable because it is represented by one of the few literature records from the study area, at '26 miles SE Swakopmund' (Penrith 1979), which was assumed to be along the C28, and which would then fall within the Inca EPL.
- Family Thorictidae. Badly known, no current expert. Small number encountered, all in

habitat 5.

- Indeterminate Coleoptera: A small variety of Coleoptera larvae were encountered. They could not be assigned to particular families.

Order Diptera - flies

Historically, Namibian Diptera has not been well known. In the recent past there had been a locally based expert, but he has since left the country and the former *status quo* has returned.

- Division Acalyptratae - This is a taxonomically difficult group composed of a large number of poorly known small families that are difficult to distinguish from each other. At least four indeterminate acalyptrate morphospecies were distinctive enough to be treated separately, but a few others had to be lumped as indeterminate.
- Family Bombyliidae – bee flies: Known to include range-restricted endemics in Namibia and the Central Namib. At least three morphospecies encountered in small numbers. Two of them were only found in the fourth trapping period, indicating a rain response.
- Family Calliphoridae – blow flies: A single morphospecies, encountered only during the fourth trapping period, indicating a rain response.
- Family Camillidae: What appears to be a single morphospecies was completely absent during the first two trapping periods, but relatively abundant after, possibly also indicating a rain response.
- Family Cecidomyiidae – gall midges: The single morphospecies recorded may mask more diversity of these minute flies. They also showed an increase in abundance in the second half of the study period, indicating rain response.
- Family Chironomidae – midges: Two individuals were encountered during the fourth trapping period, in habitats 7 and 11 respectively. Since chironomid larvae can only develop in open water, the presence of adults in the study area at first appeared unusual, but their identity was carefully verified. Further research showed that there exists a genus of Chironomidae, *Knepperia*, which is known from a single species *K. gracilis*, collected at Rooibank on the Kuiseb River in 1908 and not seen since (Freeman 1956). It is not known whether the specimens from the study area represent *K. gracilis*, but since there is no permanent open water at Rooibank either, the implication is that these insects only hatch and breed in temporary pools after rare rain events.
- Family Chloropidae – shoot flies: At least seven morphospecies were encountered,

but some may mask further diversity. These were some of the most abundant flies in the study area, and they showed an increase in abundance in the fourth trapping period in response to rain.

- Family Conopidae – thick-headed flies: Only a single individual encountered.
- Family Culicidae – mosquitoes: Only single individuals encountered, during the second half of the trapping period. Since mosquitoes also need open water to breed, a similar situation as for Chironomidae above is possible, though in this case no Central Namib endemic mosquitoes are known.
- Family Curtonotidae: Small numbers encountered, mostly in habitat 6.
- Family Drosophilidae – vinegar flies: Only two individuals encountered, both in habitat 1 in the fourth trapping period. Since the larvae live in rotting plant material, they are probably rain responsive.
- Family Empididae - dance flies: At least three morphospecies present in small numbers throughout the area. No apparent rain response.
- Family Heleomyzidae: One apparent morphospecies was encountered at a number of sites during the first trapping period only, and not again after that.
- Family Lonchaeidae – lance flies: Two individuals encountered in habitat 1 during the fourth trapping period only.
- Family Muscidae – house flies. At least four morphospecies were encountered. Of these, two showed a dramatic rain response with 1559 individuals encountered during the fourth trapping period, against only three individuals in the previous three trapping periods.
- Family Mycetophilidae – fungus gnats: What appears to be one morphospecies was encountered in moderate numbers throughout the study area, during the fourth trapping period only. This is a clear rain response, related to their larval food source, fungal spores, only appearing after rain.
- Family Mythicomyiidae – microbombyllid flies: A single morphospecies was encountered in small numbers only.
- Family Phoridae - scuttle flies: At least three morphospecies were encountered, all in the fourth trapping period only, indicating a rain response that is probably related to their larval food source, decaying organic matter.
- Family Psychodidae – moth flies: Two individuals in habitat 1 in the fourth trapping period only, probably a rain response.
- Family Sarcophagidae – flesh flies: At least three morphospecies encountered throughout the study area, with at least species 2 showing a rain response in the fourth trapping period.

- Family Sciaridae – darkwinged fungus gnats: One morphospecies encountered in small numbers throughout the study area.
- Family Sepsidae – ensign flies: One morphospecies encountered in small numbers, only in the fourth trapping period, indicating a rain response. Their larval food source is animal excrement. The implication is that rain produced grazing, allowing game to move in, whereafter the sepsids could utilise their dung.
- Family Syrphidae – hover flies: Only two morphospecies encountered in small numbers, only in the fourth trapping period, indicating a rain response related to the adult food source which is flowers and nectar.
- Family Tachinidae: At least four morphospecies encountered throughout the area, with an increase in abundance in the fourth trapping period. Since the larvae are parasites of mostly other invertebrates, this indicates a rain response related to the increased abundance of prey animals.
- Family Tephritidae – fruit flies: At least three morphospecies encountered, with an increase in abundance during the fourth trapping period, indicating a rain response related to the increased availability of the larval food source, fruit.
- Family Therevidae – stiletto flies: One morphospecies encountered in small numbers throughout.
- Indeterminate Diptera: One trap during the fourth trapping period included a number of larvae (maggots) that could not be assigned to a particular family.

Order Hemiptera – bugs

Namibian bugs were last treated comprehensively by Hesse (1925), which is by now very outdated, and fairly useless in areas that were poorly collected at that time, like the Central Namib. There are no experts active on our fauna. Except for a few predators, the majority of bugs feed on plant sap, and can be expected to be more abundant when plants sprout after rain.

- Family Alydidae – broad-headed bugs: A single individual encountered in habitat 4.
- Family Anthocoridae - flower bugs: Two morphospecies encountered in small numbers, in the second half of the study period only.
- Family Aphididae – aphids: Only two individuals encountered.
- Family Berytidae – stilt bugs: One morphospecies encountered in small numbers, in the fourth trapping period only.
- Family Cicadellidae – leaf hoppers: At least seven morphospecies encountered, some showing an increase in abundance during the fourth trapping period.
- Family Cicadidae – cicadas: Only two individuals were encountered, in the fourth

trapping period only. Cicadas seldom fall into pittraps, and this indicates increased activity, probably rain related.

- Superfamily Coccoidea – scale insects: Scale insects have complicated life cycles with various stages, and the current material was too limited to attempt family level identification. At least three morphospecies were encountered, of which two only appeared in the fourth trapping period.
- Family Cydnidae – burrowing bugs: Two morphospecies were encountered throughout, as well as a number of nymphs that could not be unequivocally assigned to either morphospecies.
- Superfamily Fulgorioidea – plant hoppers: At least four morphospecies as well as a number of unidentified nymphs were encountered. The group is poorly known and no family level identifications were attempted.
- Family Lygaeidae – ground bugs: At least two morphospecies were encountered, in the second half of the trapping period only.
- Family Miridae - plant bugs: A single individual encountered during the fourth trapping period only.
- Family Pentatomidae – stink bugs: Small numbers of one morphospecies encountered in the first half of the trapping period only.
- Family Pyrrhocoridae – harlequin bugs: The Welwitschia bug, *Odontopus* sp., was present throughout the trapping period, but mainly confined to those habitats that include *Welwitschia mirabilis* plants: 6, 7 and 8. Despite it being so well-known, the taxonomic identity of the Welwitschia bug has not been established (refer Appendix 3 to: Irish (2010)).
- Family Reduviidae – assassin bugs: Four different morphospecies in three different subfamilies, as well as indeterminate nymphs, were encountered.
- Indeterminate Hemiptera: A small number of nymphs could not be unequivocally assigned to specific families.

Order Hymenoptera – bees, wasps and ants

No comprehensive source exists for Namibian Hymenoptera. While many groups received sporadic attention in the past, there are no current experts active on our fauna. The majority of Hymenoptera are predators or parasites, and their populations are expected to show a response to increased prey availability following rain, although there will be a time lag between the two responses and some might only have responded after our last trapping period was over. Some Hymenoptera are associated with flowers, and they should show clearer rain responses.

- Superfamily Apoidea – honey bees: Two individuals of a distinctive large bee were encountered during the fourth trapping period only, indicating a rain response. It could not be unequivocally assigned to any of the constituent families and has not been identified beyond superfamily.
- Family Bethylidae: A single morphospecies was encountered during the second half of the trapping period only, with a clear rain response in the fourth period.
- Family Braconidae: Small numbers of two different morphospecies were encountered.
- Family Bradynobaenidae: A single individual encountered during the fourth trapping period. Bradynobaenids have not been properly studied in Namibia, but the Central Namib is the only place they are regularly encountered. Range-restricted endemism is expected.
- Superfamily Chalcidoidea – parasitic wasps: The superfamily includes a large number of families that are difficult to distinguish, given their generally minute size (< 1 mm). No attempt was therefore made to identify them beyond superfamily level. Chalcids were relatively abundant, especially during the fourth trapping period, indicating a rain response related to greater prey availability.
- Family Chrysididae – cuckoo wasps: Very few individuals of a single morphospecies were encountered, all except one in the fourth trapping period.
- Family Cynipidae – gall wasps: At least four morphospecies encountered, all in small numbers.
- Family Formicidae – ants: At least 14 ants, identified to generic level and thereafter treated as morphospecies, were encountered. Pittraps are not ideal for monitoring ants, as their yield tends to reflect the proximity of particular ant nests, rather than actual ant abundance. Most ants were active throughout, and while abundance did increase in trapping period four in response to increased food availability following rain, the increase is not as dramatic as in many other groups. Ants of note include the genera *Monomorium* and *Ocymyrmex,* both of which include range-restricted Central Namib endemic species, with Threatened conservation status in some cases. While at least four *Monomorium* morphospecies were encountered, the taxonomy of these ants is too poorly known to attempt to link them to known species. Alate (winged reproductive) ants were mostly encountered in the second half of the trapping period only, corresponding to their well-known habit of dispersing after rain events.
- Family Gasteruptiidae: Small numbers of one morphospecies were encountered throughout; half of the records were from habitat 12.

- Family Halictidae – sweat bees: At least four morphospecies were encountered, mostly during the second half of the trapping period, indicating a rain response probably related to the availability of food in the form of flowers and nectar.
- Family Ichneumonidae: Very few individuals of at least two morphospecies were encountered.
- Family Masaridae: At least six morphospecies were encountered, some present throughout, but others like sp. 4 mainly present in the second half of the trapping period only. Masaridae are common in the Central Namib, and while they have not been comprehensively studied there, extrapolation from better studied arid areas of South Africa indicates that high rates of endemism can be expected from them.
- Family Melittidae: Small numbers of two morphospecies were encountered, all of them in the fourth trapping period, indicating a rain response related to the availability of food in the form of flowers and nectar.
- Family Mutillidae – velvet ants: Only two individuals of a single morphospecies were encountered.
- Family Plumariidae: Few specimens of one morphospecies were encountered. Plumariidae are poorly known. While the present material could not be identified to species, observations over the years suggest that the Central Namib plumariids occur only there and might be range-restricted endemics.
- Family Pompilidae – spider wasps: At least five morphospecies encountered, but only sp. 1 showed a rain response. Since their prey, spiders, are always present, an absence of rain response is not unexpected.
- Family Proctotrupidae: Small numbers of one morphospecies encountered.
- Family Sapygidae: A single specimen encountered during the fourth trapping period, indicating a possible rain response.
- Family Scoliidae: A single individual was encountered.
- Family Sphecidae – digging wasps: At least 12 morphospecies were encountered, many showing increased abundance during the second half of the trapping period, related to increased prey availability following rain. The Namib sphecid wasps are essentially unstudied. The few that have been described are range-restricted endemics, some with Threatened conservation status.
- Family Tiphiidae: Only three individuals, one each of three morphospecies, encountered.
- Indeterminate Hymenoptera: A single individual could not be assigned to any known family using available taxonomic resources.

Order Isoptera - termites

Most Namibian termites have been comprehensively studied historically and the results remain valid. The two termites recorded, *Hodotermes mossambicus* and *Psammotermes allocerus* are both common throughout the Central Namib. As for ants, pittraps yields for termites say more about proximity to foraging holes that happened to be open during the trapping period, than anything about actual diversity. Both had been recorded from the study area before, at different places along the C28 (Coaton & Sheasby 1973, 1975).

Order Lepidoptera – butterflies and moths

No comprehensive source for Namibian Lepidoptera exists, and there are no experts active on our fauna. The Central Namib fauna is practically unknown, despite experience indicating that a variety of moths commonly occur. Since identification is at least partially based on wing patterns, and material from preservative pitfall traps lose that, most collected material could not be identified further than mere sorting into 'larger' and 'smaller' taxa. Both probably mask considerable diversity. What can be seen in the data though, is that abundance increases during the second half of the trapping period, indicating a rain response related to higher availability of food in the form of flowers and nectar.

Order Mantodea – praying mantids

The Namibian fauna has been relatively well studied, and recent publications exist that treat our fauna. Unfortunately, they are not available in Namibian libraries and only the first part (Kaltenbach 1996) has so far become available on the Internet. Lacking a complete basis for identification, current material was sorted into four morphospecies only. They were encountered in small numbers only.

Order Neuroptera – lacewings

Namibian lacewings have been relatively well studied historically, but results are scattered through disparate literature sources and there is no recent comprehensive treatment available.

- Family Chrysopidae – green lacewings: A single specimen was encountered, in the fourth trapping period. Chrysopids are seldom seen in the Namib Desert and their presence might be rain related.
- Family Coniopterygidae – dustywings: Three individuals were encountered, in the first half of the trapping period only. These tiny animals are seldom seen, and are not typical of desert fauna. Records from the Central Namib are all from large, tree-rich

riverbeds like the Kuiseb (Meinander 1998), and their occurrence in the study area is incongruous. Material from the study area might represent and undescribed taxon.

- Family Myrmeleontidae - ant lions: The single individual encountered was a larva.
- Family Nemopteridae – threadwinged antlions: The single individual encountered was a larva.
- Family Psychopsidae – silky lacewings: Only three individuals encountered, in the first half of the trapping period.

Order Orthoptera – grasshoppers and crickets

While a body of historical work exists on Namibian Orthoptera, comprehensive treatments are lacking for key components; some local expertise exists in limited groups.

- Family Acrididae – grasshoppers and locusts: Two recognisable taxa, and a number of unidentifiable nymphs, were encountered. The common genus *Acrotylus* was represented by two individuals and was only present in the fourth trapping period. One morphospecies belonging to the western southern African endemic subfamily Lithidiinae was encountered throughout. It is probably a Central Namib endemic, but the expert that was planning to revise the group has since deceased.
- Family Lathiceridae: The Central Namib species, *Crypsicerus cubicus*, belonging to this endemic Namibian family has been recorded from 'Namib Park at turn-off to big Welwitschia' (Irish 1988), which was assumed at the time to mean the turnoff from the C28 that is now in the Inca EPL. It was not encountered during the present survey, but probably occurs anyway.
- Family Mogoplistidae – pygmy crickets: Small numbers were encountered. Mogoplistidae are often found in the Namib Desert, but seldom in the rest of the country. The material probably represents endemic species, but the group has never been worked on in Namibia.
- Family Schizodactylidae – feathertoed crickets: The widespread *Comicus capensis* was only encountered in the fourth trapping period, indicating rain response.
- Family Thericleidae: One morphospecies was encountered throughout, with increased abundance in the fourth trapping period, indicating rain response. Thericleids are known to include endemics from western southern Africa, but the Namibian taxa have never been properly revised. The material from the study area may represent a Central Namib endemic.

Order Psocoptera - booklice

The order is virtually unstudied in Namibia, with only five species known, all from single locations only. The expert that described them has since retired. In recent, properly sorted, collections from the Central Namib they have proven to be very numerous. Though the encountered material had been treated as one morphospecies only, this evidently masks some diversity. The potential for endemic Central Namib species in the group is huge.

Order Thysanoptera - thrips

No treatment of the Namibian fauna exists, and there are no active experts. At least two morphospecies were encountered, with an increase in abundance in the second half of the trapping period, indicating a rain response related to increased presence of green plant material.

Order Thysanura - fishmoths

The Namibian fauna is moderately well known and local expertise exists. Unfortunately, preservative pittrap material of Thysanura is usually too damaged for species-level identifications. The encountered material was sorted into five generic groups. Most were present throughout and showed only a moderate increase in abundance during the fourth trapping period. This is to be expected from taxa that live from dried plant material and function effectively independently of rain.

Indeterminate Order

Samples from habitat 2 during the third trapping period included eight, probably larval, individuals that could not be assigned to any known order.

3.3.2.4. Phylum Arthropoda, Class Myriapoda

Order Chilopoda - centipedes

A single individual was encountered during the fourth trapping period.

Order Myriapoda - millipedes

A few minute individuals belonging to the Polyxenida group of the Penicillata were encountered. These animals are almost never seen, but there is a species, *Afraustraloxenodes coineaui,* that is only known from between Swartbank and Mirabib, further south in the Central Namib Desert (Nguyen Duy-Jacquemin 2003). It is not known whether these specimens indeed belong to that species or are something new, but they will be range-restricted endemics regardless.

3.3.2.5. Phylum Mollusca

Order Gastropoda

A single small snail was encountered in habitat 2 during the fourth trapping period. Though snails are known from the Central Namib Desert, they are rarely encountered since they are only active after infrequent rain.

3.4. Discussion

3.3.3. <u>Invertebrate Endemicity and Conservation Status</u>

The Central Namib Desert is a hotspot for invertebrate endemicity (Irish, 2009). Most Central Namib endemics have very narrow east-west distribution ranges. This is probably related to the steep east-west environmental gradient across the Namib. It follows that superficially similar habitats also have to be in a narrowly similar longitudinal position (i.e., at a similar distance from the coast) before their invertebrate faunas can be assumed to be possibly comparable. With this considerable variation in habitat parameters over gradients and desert invertebrates being exceptionally well adapted to their distinct habitats, Irish (2009) determined that Central Namib invertebrate endemics have a median distribution range of 25 km^2.

The increased threat to Central Namib invertebrate habitats due to the increase in uranium mining and related activities, coupled with the high level of endemicity and small distribution ranges result in all evaluated endemic Central Namib invertebrates having Threatened status (Irish, 2009).

Endemicity and conservation statuses of relevant taxa recorded on the Omahola Project are presented in Table 6.

Since the report by Irish (2009) that details the application of IUCN evaluation criteria to Central Namib endemic invertebrates has not yet officially been excepted by IUCN, reference to conservation statuses in this report should be read as unofficial but IUCN-equivalent.

Table 6. Endemic and Threatened taxa recorded at the Omahola Project Area. The IUCN group all Vulnerable, Endangered or Critically Endangered species as Threatened. Conservation status: EN=Endangered, VU=Vulnerable, NE=Not evaluated. Endemicity: CN=endemic to the Central Namib. NA=endemic to Namibia.

		Conservation status	**Endemicity**	**Source**
Curculionidae	*Hyomora* sp.	NE	NA	All *Hyomora* spp. that occur in the Central Namib are Namibian endemics, some also Central Namib endemics (Louw 1981). While the recorded material cannot be identified to species level, it is certainly at least a Namibian endemic.
Tenebrionidae	*Cauricara eburnea*	EN	CN	(Irish 2009)
	Epiphysa punctatissima	VU	CN	(Irish 2009)
	Metriopus depressus	NE	NA	(biodiversity.org.na)
	Namibomodes sp.	NE	NA	The genus is endemic to the Namib Desert (Koch 1962). While the recorded material cannot be identified to species level, it is certainly at least a Namibian endemic
	Physadesmia globosa	NE	NA	(biodiversity.org.na)
	Physosterna cribripes	NE	NA	(biodiversity.org.na)
	Zophosis amabilis	NE	NA	(biodiversity.org.na)
	Zophosis devexa	EN	CN	(Irish 2009)
	Zophosis dorsata	VU	CN	(Irish 2009)
Formicidae	*Monomorium* sp.	EN	CN	There are at least 8 *Monomorium* spp that are both endemic to the Central Namib and Threatened (Irish 2009). While the material cannot be identified to species level, it is likely that at least one of the four recorded morphospecies have the same status.
Lepismatidae	*Thermobia nebulosa*	NE	NA	(biodiversity.org.na)

Of a total of 316 invertebrate taxa recorded on the Omahola Project site (APPENDIX 1), 16 taxa were identified up to species level and can be evaluated for endemicity and conservation status. An additional 3 taxa could be evaluated based on the level of knowledge of their constituent groups, so 19 out of a possible 316 species recorded could be evaluated with confidence.

Five of the 19 (26.32%) evaluated invertebrate species were endemic to the Central Namib (Table 6), while seven (36.84%) species were endemic to Namibia. In evaluating endemism we follow the usual convention of considering taxa with more than 75% of their distribution ranges in-country to be endemic. A total of 12 of the possible 19 species (63.16 %) were thus found to be endemic to Namibia.

Of the 19 species evaluated, three species were Endangered (Table 6) and two were

Vulnerable, i.e. five species (26, 32 %) were Threatened species.

Proportionally applying the percentages of Threatened and endemic invertebrates with species-level identifications to the sum of the taxa recorded, we can thus expect a potential total of 83 species (26.32% of 316 species) to be endemic to the Central Namib, with a potential total Namibian endemicity of 199 species. Furthermore, 50 of the 316 taxa are potentially Endangered and 33 potentially Vulnerable, amounting to a total of 83 species of the total 316 potentially being Threatened.

3.4.1. Invertebrate Habitats and communities

Invertebrates are the most important component of any ecosystem, in terms of absolute numbers, biomass, and ecosystem function. This is even more so in arid ecosystems, where plants and large vertebrates are less numerous. Conversely, invertebrates are small and seldom noticed, and therefore often ignored in the average EIA.

In determining the best way to approach the current study, the following important differences between working with invertebrates in Namibia, compared to vertebrates and plants, were considered:

- *The difference in overall numbers*. The most complete available listing of Namibian life forms (Namibian Biodiversity Database 2009) lists 4468 plants and 2037 vertebrates. These lists are 99%+ complete. A total of 10470 invertebrates are also listed. This is considered to represent < 50% of described Namibian invertebrates.
- *The proportion of known species*. Most species of vertebrates and plants are already known, but most species of invertebrates remain unknown. New invertebrate species are continuously being described from Namibia: the 10470 species mentioned above is considered to be < 10% of the actual number occurring. (Example: in 1983/84, a 15 month long invertebrate survey at Rössing Uranium Mine produced > 100 000 invertebrate specimens. New taxa are still being described from that material today, despite the fact that entire insect orders collected at the time have not even been looked at yet (Irish 2007).
- *The reality of limits to expertise*. Even non-experts can know most key vertebrate or plant species, but even invertebrate specialists can know only a small part of this overwhelming diversity.

For these reasons, Namibian invertebrate workers cannot produce species lists on the same level as is possible for plants or vertebrates. Instead, species lists are used as an entry point to an assessment based on invertebrate community responses to differences in habitats and ecosystem processes.

Trophic guilds

Trophic guilds are aggregates of species that share similar trophic resources, i.e. depend on the same food sources within a particular habitat. This is an appropriate level to work at for invertebrates, because:

- Food availability is a key determinant of diversity in most communities, therefore trophic guilds will reflect fundamental information about that community.
- Food preference of invertebrates is generally known at the family level. The family is also a standard identification level in invertebrates. Therefore, even though a particular species may be unidentifiable (see above), its family and therefore trophic guild will generally be known, allowing us to proceed with the job instead of getting bogged down by a lengthy identification process.

The following invertebrate trophic guilds were identified in the Project Area:

- Herbivores – eating live plant matter
- Leaf-eaters (folivores)
- Flower feeders – includes nectarivores (nectar feeders) and palynivores (pollen feeders)
- Fruit feeders – includes frugivores (strict fruit feeders) and granivores (seed eaters)
- Sap feeders (mucivores)
- Wood eaters (xylophages)
- Grass eaters (graminivores)
- Fungus feeders (fungivores)
- Recyclers – eating dead plant or animal remains or products
- Detritus feeders (detritivores) – eating dead, dry plant remains
- Dung feeders (coprophages) – eating vertebrate faeces
- Scavengers (necrophages) – eating dead animal remains
- Predators – killing and eating other animals
- Parasites – living in or on other animals, feeding on them without killing them outright

The presence of a food source in a particular habitat can be used to infer the presence of the relevant trophic guild in that habitat, and vice versa. A full list of invertebrates observed and/or collected, with their trophic guild associations, appears in APPENDIX 3.

Habitats

The Omahola Project area is located in the hyper arid Central Namib Desert, with average daily summer air temperatures of 32 °C during February, which is hottest month. August is the coldest month with average winter temperatures are around 11 °C (Mendelsohn *et al*. 2009).

The potential evaporation for this section of the Desert, 40 – 90 km inland from the coast, is 128 times higher than the rainfall and 113 times the fog precipitation, making this the most extreme arid zone of the Namib. The area experiences an annual average of 10 to 25 days of fog and 0 to 50 mm of rain (Mendelsohn *et al.* 2009). Rainfall in the Namib is highly variable, unpredictable and patchy. The 2010 –'11 rainy season was an exceptionally good one, and numbers from the weather station at INCA showed 8.8 mm of rain for February 2011 and 20 mm for March (RUN, pers. comm.). No rain was recorded by this weather station during November, December and January, although it did rain in large parts of the immediate area, including the Omahola Project area. During the regular invertebrate pittrap services, the gradual emergence of vegetation across the Project Area was clearly visible, and invertebrate abundance recorded also increased accordingly (Section 3.3.2).

Based on physiography and general vegetation, Ecotrust (2010) identified four major habitats to occur within the Omahola Project Area, namely:

- Northern gravel plains and sheetwashes of INCA and the north-western portion of Tubas, with *Arthraerua leubnitziae*, *Zygophyllum stapffii* and *Welwitschia mirabilis*. No *Salsola tuberculata* occurs in this zone.
- Northern and eastern plains of Tubas and Shiyela, with *Salsola tuberculata*, *Arthraerua leubnitziae* and *Zygophyllum stapffii*. *Welwitschia mirabilis* are mostly absent from this zone.
- Rocky inselbergs, ridges and other outcrops which cover small parts of INCA, TRS and Shiyela. Diagnostic species of these rocky outcrops include *Aloe asperifolia*, *Hoodia cf currorii* and *Commiphora saxicola*.
- Ephemeral rivers, washes and sheetwashes where *Salsola tuberculata*, *Arthraerua leubnitziae*, *Pechuel-Loeschia leubnitziae* and *Citrullus ecirrhosus* are the dominating plant species.

The habitat classification by Ecotrust (2010), based on vegetation (Figure 3) were used as reference for sample localities during the invertebrate survey.

Notes on the habitat descriptions:

- Sensitivity rankings for each habitat have been listed in the initial discussion for the sake of convenience, even though the full calculation and explanation of their derivation only follows in the subsequent Section 3.4.2.

- In each paragraph titled 'Occurrence elsewhere in the Central Namib', the term 'Central Namib' is used to denote the area between the Kuiseb and the Ugab Rivers, extending inland between 120 km (in the north) and 150 km (in the south) (Irish 2009).

3.4.1.1. Granite hill (Vegetation habitat 1)

• **Diversity**: 1 out of 12	
• **Biodiversity potential:** 6 out of 12	
• **Restoration potential:** zero	**Restoration sensitivity ranking:** 9 out of 12
• **Uniqueness:** limited occurrence elsewhere	**Uniqueness sensitivity ranking:** 11 out of 12
• **Overall sensitivity ranking:** 6 out of 12	**Habitat sensitivity:** highly sensitive

Occurrence in Omahola Project Area (Figure 3): This granite inselberg only occurs in one isolated location within the Omahola Project area, specifically in the far western parts of TRS block.

Description (Figure 7 and 8): This habitat falls under the ‘rocky inselbergs, ridges and other outcrops’ major physiographic/vegetation zone categorization. The granite inselberg habitat is comprised of a relatively low, isolated granite outcropping consisting of one large “boulder”, deeply dissected to the west by a sandy gully that serves as a natural water course originating in this high laying area. The boulders themselves have mostly smooth, barren surfaces and life associated with this habitat is largely concentrated around the footslopes and associated with the watercourse.

Vegetation of this habitat is spares but diverse. Besides the dominating plant species vegetation included *A. asperifolia* (‘kraalaalwyn’), *Commiphora* spp. (‘kanniedood’), other shrubs and trees of medium height and an emergent grass cover. Plenty of antelope spoor and droppings were noted in and around the watercourse.

Occurrence elsewhere in the Central Namib: There is much granite in the Central Namib, but most of it takes the form of low ridges and flat sheetrock, as in habitat 3 below. Dome-shaped bare granite hills are less common, and most of them are located in the Outer Namib (e.g. Bloedkoppie -22.841°S 15.382°E, or Tumasberg -23.175°S 15.496°E). In the comparable climatic zone of the Inner Namib, only three other such habitats exist: Rooikop (-22.980°E 14.660°E), Vogelfederberg (-23.056°S 14.985°E) and an unnamed hill to the south of the TRS area (-22.970°S 14.953°E).

Figure 7. Granite inselberg of habitat nr. 1.

Figure 8. Water course originating from granite inselberg with associated vegetation.

Trophic guilds:

- Leaf-eaters (10 invertebrate species): Resource permanently available through the presence of evergreen plant species such as *Searsia marlothii* ('bitter karee') and *Zygophyllum stapffii* (dollar bush).
- Flower, nectar and pollen feeders (6 invertebrate species): Resource dependable but only seasonally available.
- Fruit and seed feeders (6 invertebrate species): Resource seasonally available.
- Sap feeders (6 invertebrate species): Resource permanently available due to presence of evergreen vegetation.
- Wood eaters (0 invertebrate species): Resource available but sparsely due to the limited occurrence of woody species such as *Searsia marlothii* ('bitter karee').
- Grass eaters (0 invertebrate species): This guild may occur in the habitat due to the presence of the resource through sparse perennial grass species.
- Fungus and lichen feeders (2 invertebrate species): Potential seasonal occurrence of resource.
- Detritus feeders (30 invertebrate species): The ruggedness of the habitat allows for the efficient trapping of detritus. The resource is relatively abundant and permanently available.
- Dung feeders (2 invertebrate species): Due to the availability of shelter and permanently available vegetation, small mammals should permanently inhabit this habitat while larger game species may frequent the habitat.
- Scavengers (13 invertebrate species): This resource should be available with the presence of vertebrates in the habitat.
- Predators (23 invertebrate species): Resource should be permanently available through the presence of other guilds in the habitat.
- Parasites (7 invertebrate species): As with dung feeders, this resource is expected to occur in the area.

Invertebrate habitat determinants: The habitat structure is determined by the substrate. The inselberg mostly consists of smooth granite rock surfaces, while surrounding and associated substrates include coarse gravels, loose sands, silts and clays and weakly consolidated soil crusts. A large variety of microhabitats exists around the weathered footslopes and associated with the watercourse and its banks (Figure 9). The cracks and fissures not only serve as refugia for specifically adapted invertebrates, but it also traps detritus, the main food source and driver of desert invertebrate communities and food chains (Ayal 2006).

Figure 9. High available microhabitats of granite inselberg habitat amongst granite flakes and porous drainage banks.

Runoff from main outcrop has a channelling effect down the smooth rock surfaces into gullies and supports vegetation, sustains vertebrates and large mammals, opportunity for ectoparasites, dung feeders and scavengers.

Key ecological drivers: Rainfall is the most important ecological driver. The smooth rock surfaces of the outcrop and resulting channelling effect concentrates water runoff in certain areas to support the comparatively higher diversity of life most often associated with inselbergs in the Namib. Detritus production is mostly autochthonous and the complexity of the habitat ensures that detritus and the habitat's seed bank are retained.

Vulnerabilities and threats: Namib Desert inselbergs are isolated by definition, and are island habitats which often support a higher diversity of species, many of which could be endemics, than the surrounding plains. Due to the physical complexity of the habitat, restoration of the habitat, once it was impacted on, is nearly impossible (Burke 2007). The lower the restoration potential and the higher the species diversity and endemicity, the more vulnerable the habitat is. Inselbergs often also supports important ecosystem processes and functions, in that it serves as a nutrient and water trap for the area and provides shelter and food at critical periods.

3.4.1.2. Marble ridge (Vegetation habitat 2)

• **Diversity**: 4 out of 12	
• **Biodiversity potential:** 9.5 out of 12	
• **Restoration potential:** zero	**Restoration sensitivity ranking:** 9 out of 12
• **Uniqueness:** limited individual extent	**Uniqueness sensitivity ranking:** 9 out of 12
• **Overall sensitivity ranking:** 11 out of 12	**Habitat sensitivity:** highly sensitive

Occurrence in Omahola Project Area (Figure 3): This habitat has a limited distribution within the Omahola project and only occurs in the central to southern parts of the TRS block.

Description (Figure 10): This habitat falls under the 'rocky inselbergs, ridges and other outcrops' major physiographic/vegetation zone categorization. Within the Omahola project the habitat comprises linear marble ridges of varying lengths and heights, all more or less orientated in a north-easterly/south-westerly direction. The ridges are fairly weathered and loose blocks, boulders and rock chips are scattered across the ridge's surface.

Figure 10. Isolated marble ridge with sparse vegetation of habitat nr. 2.

The sparse vegetation of the habitat were not distinctly associated with drainage lines and included *A. asperifolia*, *A. leubnitziae* and *Z. stapffii* shrubs and sparse grasses.

Occurrence elsewhere in the Central Namib: Southwest to northeast trending marble ridges are common at scattered localities throughout the Central Namib, albeit generally narrow and of limited areal extent.

Trophic guilds:

- Leaf-eaters (10 invertebrate species): The resource is sparse but permanently available through the presence of evergreen shrubs such as *Arthraerua leubnitziae* (pencil bush) and *Zygophyllum stapffii* (dollar bush).
- Flower, nectar and pollen feeders (9 invertebrate species): The resource sparse and seasonally available only.
- Fruit and seed feeders (3 invertebrate species): The resource sparse and seasonally available only.
- Sap feeders (2 invertebrate species): The resource permanently available but sparse.
- Wood eaters (2 invertebrate species): The resource permanently available but sparse.
- Grass eaters (1 invertebrate species): The resource very sparsely available, only seasonally and mostly associated with windblown sand deposits.
- Fungus and lichen feeders (2 invertebrate species): Resource permanently available but sparse. Fog precipitation by the elevated ridge sustains some lichen growth.
- Detritus feeders (38 invertebrate species): The complexity of the habitat allows for the efficient trapping of detritus. The resource is not as abundant as in the granite hill habitat, but it is permanently available.
- Dung feeders (2 invertebrate species): The permanent but sparse vegetation may attract some game but very seldom and in small numbers only. The resource is unpredictable and in essence unimportant in this habitat.
- Scavengers (13 invertebrate species): Due to the same reasons as for the dung feeder guild, this resource is unpredictable and in essence unimportant in this habitat.
- Predators (23 invertebrate species): The resource should be permanently available through the presence of other guilds in the habitat.
- Parasites (11 invertebrate species): Parasite of invertebrates are expected to occur with the presence of other invertebrate guilds.

Invertebrate habitat determinants: The substrate of this habitat determines the habitat structure. Substrates associated with the marble ridge included a fair amount of windblown sand on its western flanks, courser gravels and rugged marble boulders, blocks and flakes of various sizes. Although the habitat is comparatively equally or more physically complex compared to the granite inselberg habitat, the small amount of trapped detritus noted here can be attributed to the sparse vegetation of this marble ridge. The presence of fractured rock surfaces and loose blocks creates abundant shelter for invertebrates.

Key ecological drivers: Rainfall is the most important ecological driver for this and other rocky outcrop habitats. The rock surfaces of the outcrop have a channelling effect that concentrates water runoff in certain areas. The result is that similar amounts of precipitation on one of these rocky outcrop surfaces can have a more profound effect on the vegetation associated with that habitat compared to surrounding flatter areas. Fog precipitation is important as a sustaining water source.

Vulnerabilities and threats: Similar to other rocky outcrops and inselbergs, the marble ridges of the Omahola Project Area are very sensitive to impacts due to its physical complexity and resultant low restoration potential. Contributing to the sensitivity is also the relatively high diversity and uniqueness of the vegetation associated with these marble outcrops and the fact that it serves as a water and nutrient sink in an area otherwise supporting a comparatively low biomass and biodiversity. These marble inselbergs were also identified during the Strategic Environmental Assessment (SEA) as areas with high biodiversity value due to the high plant diversity it support (SAIEA 2010).

3.4.1.3. Granite ridges (Vegetation habitat 3)

• **Diversity**: 3 out of 12	
• **Biodiversity potential:** 3 out of 12	
• **Restoration potential:** zero	**Restoration sensitivity ranking:** 9 out of 12
• **Uniqueness:** common, widespread	**Uniqueness sensitivity ranking:** 4.5 out of 12
• **Overall sensitivity ranking:** 2 out of 12	**Habitat sensitivity:** sensitive

Occurrence in Omahola Project Area (Figure 3): This habitat is fairly widely distributed across the centre of the Omahola Project, and occurs along the central to northwestern parts of the TRS block as well as the northwestern parts of the Shiyela block.

Description (Figure 11): This habitat falls under the 'rocky inselbergs, ridges and other outcrops' major physiographic/vegetation zone categorisation. The rocky ridges are rounded, low to medium height hills comprised of weathered granites. The substrates of these ridges are generally rocky with sandy patches and washes.

Figure 11. Granite ridges habitat with vegetation concentrated in sandy drainage lines.

Compared to the surrounding plains, these rocky outcrops support a much higher diversity of vegetation and larger biomass. Besides *Zygophyllum stapffii* (dollar bush) and *Arthraerua leubnitziae* (pencil bush), sparse grasses and several species of lichens (Figure 12) were also noted during the field survey.

Occurrence elsewhere in the Central Namib: Relatively flat granite sheetrock and low ridges are common throughout the Central Namib.

Trophic guilds:

- Leaf-eaters (11 invertebrate species): The resource is sparse but permanently available through the presence of evergreen shrubs such as *Zygophyllum stapffii* (dollar bush) and *Brownanthus* sp.
- Flower, nectar and pollen feeders (11 invertebrate species): The resource sparse and seasonally available only when perennial shrubs flower.

Figure 12. Several lichen species associated with the rocky outcrops and ridges.

- Fruit and seed feeders (2 invertebrate species): The resource sparse and seasonally available only.
- Sap feeders (5 invertebrate species): The resource permanently available but sparse.
- Wood eaters (0 invertebrate species): The resource is virtually absent as most shrubs are softwood species.
- Grass eaters (0 invertebrate species): The resource permanently available, although very sparsely, through presence of *Stipagrostis ciliata* (tall bushman grass) in sandy gullies only. The resource may be absent during droughts.
- Fungus and lichen feeders (2 invertebrate species): The resource permanently available although scarce.
- Detritus feeders (24 invertebrate species): The complexity of the habitat, as well as the presence of shrubs allows for detritus to be trapped within the habitat. The resource should is permanently available.
- Dung feeders (1 invertebrate species): The permanent but sparse vegetation may attract some game but very seldom and in small numbers only. The resource is unpredictable and in essence unimportant in this habitat.
- Scavengers (11 invertebrate species): Due to the same reasons as for the dung feeder guild, this resource is unpredictable and unimportant in this habitat.

- Predators (30 invertebrate species): Resource should be permanently available through the presence of other guilds in the habitat.
- Parasites (8 invertebrate species): Parasites of other invertebrates are expected to occur with the presence of other invertebrate guilds.

Invertebrate habitat determinants: The habitat structure is determined by the substrate. Similar to the other inselberg- and rocky outcrop habitats, this habitat is very complex and offers a wide variety of shelter and microhabitats for invertebrates. Detritus, mainly originating from within the habitat, this is trapped in the various cracks and crevices and can sustain associated feeding guilds long periods. Substrates include solid, rounded rocky outcrops, weathered loose rock boulders and blocks, rock chips and flakes, course to finer gravels and loose sands associated with various washes on and around the outcropping. Runoff from the rocky outcrops has a channelling effect down the rock surfaces into gullies water is trapped in weathered rocky substrates and sandy washes. Similar to the granite and marble inselbergs, these rocky ridges act as water and nutrient traps and also as important seed banks.

Key ecological drivers: Similar to previously discussed rocky outcrops, rainfall is the most important ecological driver for this habitat. Rock surfaces of the outcrop channels precipitation down gulleys where it is retained in the sandy washes and supports ephemeral grasses. Water, and to some extent wind, also plays a role in weathering and erosion of the rocky surfaces which helps develop the habitat determinants.

Vulnerabilities and threats: The complexity of the habitat renders it impossible to restore once impacted on. Any impact to the physical structure of the habitat will have an impact on the substrate, the most important habitat determinant. This will render the habitat unsuitable to support its highly adapted invertebrates.

3.4.1.4. Lower Tumas drainages (Vegetation habitat 4)

• **Diversity**: 5 out of 12	
• **Biodiversity potential:** 11 out of 12	
• **Restoration potential:** low	**Restoration sensitivity ranking:** 3 out of 12
• **Uniqueness:** limited occurrence elsewhere	**Uniqueness sensitivity ranking:** 11 out of 12
• **Overall sensitivity ranking:** 9 out of 12	**Habitat sensitivity:** highly sensitive

Occurrence in Omahola Project Area (Figure 3): Within the Omahola Project area this habitat occurs only in the northwestern portion of the TRS block and the far northeastern corner of the Shiyela block.

Description (Figure 13): the wide, flat-bottomed riverbed of the lower reaches of the Tumas River makes up this habitat. Although the general habitat supports quite a diversity of vegetation (Ecotrust 2010), only a limited number of plant species were noted in the site surveyed for the invertebrate study. No trees were observed and vegetation mainly included large *Acanthosicyos horridus* (!narra) shrubs, dense *Salsola* sp. ('gannabos') hummocks, *Arthraerua leubnitziae* (pencil bush) and *Zygophyllum stapffii* (dollar bush). The vegetation of the habitat act as detritus traps and detritus created within the habitat mostly stay within the habitat. Substrates of this habitat include coarser gravels and sand, silt and clay. Over the course of the trapping period the river experienced some flooding, but no observable new grass or sprouts were noted even at the end of the survey period. In February many shrubs were in flower. Plenty of small antelope spoor and droppings were observed around the prominent shrubs, as well as a number of small burrows and even small predator spoor, probably jackal, were noted.

Figure 13. Wide, flat-bottomed riverbed of the lower reaches of the Tumas River, habitat 4.

Occurrence elsewhere in the Central Namib: While minor watercourses (e.g. habitats 5, 7) are common throughout the Central Namib, relatively few attain the size of the Tumas, or have catchments of comparable size.

Trophic guilds:

- Leaf-eaters (9 invertebrate species): The resource permanently available through presence of evergreen shrubs such as *Arthraerua leubnitziae* (pencil bush) and *Zygophyllum stapffii* (dollar bush).
- Flower, nectar and pollen feeders (10 invertebrate species): The resource is only seasonally available.
- Fruit and seed feeders (5 invertebrate species): The resource is only seasonally available.
- Sap feeders (7 invertebrate species): The resource is permanently available through presence of evergreen shrubs such as *Arthraerua leubnitziae* (pencil bush) and *Zygophyllum stapffii* (dollar bush).
- Wood eaters (1 invertebrate species): The resource is permanently available through the presence of the woody *Salsola* sp. ('gannabos') shrubs, although in limited quantities.
- Grass eaters (1 invertebrate species): The resource should be permanently available except during periods of drought.
- Fungus and lichen feeders (1 invertebrate species): Not important in this habitat.
- Detritus feeders (28 invertebrate species): The vegetation, especially the large Salsola and *Acanthosicyos horridus* (!narra) hummocks are good detritus traps, and autochthonous detritus stays within the habitat. The resource is very important in this habitat.
- Dung feeders (2 invertebrate species): Due to the reliable vegetation, watercourses act as concentrators for game movement. Dung is a reliable resource in this habitat.
- Scavengers (11 invertebrate species): Where there is game there should be carcasses every once in a while. The resource should be available frequently.
- Predators (38 invertebrate species): The resource should be permanently available through the presence of other guilds in the habitat.
- Parasites (9 invertebrate species): Where there is game ectoparasites such as ticks and biting flies will occur. This resource should be available frequently for the same reason as for the scavenger guild. Parasites of other invertebrates are also expected.

Invertebrate habitat determinants: The key habitat determinant is the vegetation, which is sustained by groundwater. Vegetation associated with this habitat is present throughout the year where resources in other habitats may only be available temporarily after rain. Since the vegetation is sustained by groundwater and not rain, food-sources such leaves, flowers, nectar, pollen, fruits and seeds are more reliably available for the dependent feeding guilds than in other habitats. Riverbeds with perennial vegetation also serve as linear oasis for vertebrates due to the availability of food and shelter. The presence of vertebrates also enables the presence of invertebrate food guilds such as parasites, scavengers and dung feeders.

Key ecological drivers: Groundwater supports and drives the ecological systems of this habitat. The various riverbed substrates facilitate groundwater flow but also trap moisture sufficiently to maintain the vegetation beyond rainy seasons. Groundwater amounts and flow is dependent on rain in the upstream catchment.

Vulnerabilities and threats: The biggest threats to this habitat is the loss of vegetation and along with it the seed bank and source of detritus. Impacts on vegetation can include physical impacts such as the removal of vegetation, or any impacts on the groundwater availability or quality that supports the vegetation of this habitat.

3.4.1.5. Southern drainages & washes (Vegetation habitat 5.1)

• **Diversity**: 7 out of 12	
• **Biodiversity potential:** 9.5 out of 12	
• **Restoration potential:** low	**Restoration sensitivity ranking:** 3 out of 12
• **Uniqueness:** common, widespread	**Uniqueness sensitivity ranking:** 4.5 out of 12
• **Overall sensitivity ranking:** 5 out of 12	**Habitat sensitivity:** sensitive

Occurrence in Omahola Project Area (Figure 3): In the Omahola Project Area this habitat type is fairly widely distributed across the TRS and Shiyla blocks.

Description (Figure 14): This sub-division of habitat 5 constitutes most of the washes of the TRS and Shiyela blocks and is distinguished from 5.2 and 5.3 not on geomorphological basis but by the presence and absence of certain plant species. Similar to habitat 4, these washes are also wide with sandy/gravelly flat-bottoms that serve as important water carriers through the area after rain episodes upstream in the catchment. Substrates of the lower lying sections of the wash that most frequently channels rainwater comprise compactly consolidated fines, while medium to large shrubs vegetate sandy to gravelly islands within the main wash. No trees were observed in the study area and dominant plant species included *Salsola* sp. and *Arthraerua leubnitziae*. Several shrubs were in flower during the final trap period of February. The river flooded during the survey period and one pitfall trap, which was amongst dense shrubbery on a sandy island, was completely filled with mud.

Figure 14. Wide riverbed with high banks that represents habitat 5.1.

Occurrence elsewhere in the Central Namib: Widespread.

Trophic guilds:

- Leaf-eaters (11 invertebrate species): The resource is permanently available through presence of evergreen shrubs such as *Arthraerua leubnitziae* (pencil bush) and *Zygophyllum stapffii* (dollar bush).
- Flower, nectar and pollen feeders (8 invertebrate species): The resource is only seasonally available.
- Fruit and seed feeders (2 invertebrate species): The resource is only seasonally available.
- Sap feeders (3 invertebrate species): The resource is permanently available due to the same reasons as for the leaf-eater guild.
- Wood eaters (1 invertebrate species): The resource is permanently available through the presence of the woody *Salsola* sp. ('gannabos') shrubs, although in limited quantities.

- Grass eaters (1 invertebrate species): The resource should be permanently available except during periods of drought.
- Fungus and lichen feeders (1 invertebrate species): The resource in unimportant in this habitat.
- Detritus feeders (32 invertebrate species): The vegetation of the habitat forms good detritus traps, and autochthonous detritus stays within the habitat. The resource is permanently available and important in this habitat.
- Dung feeders (2 invertebrate species): Due to the reliable vegetation, watercourses act as concentrators for game movement. Dung is a reliable resource in this habitat.
- Scavengers (10 invertebrate species): Where there is game there should be carcasses, and springbok remains were observed. The resource should be available frequently.
- Predators (35 invertebrate species): Resource should be permanently available through the presence of other guilds in the habitat.
- Parasites (9 invertebrate species): Where there are larger shrubs or trees where game can rest, ectoparasites of game may occur. Parasites of other invertebrates are expected to occur with the presence of other guilds in the habitat.

Invertebrate habitat determinants: Similar to habitat 4 the vegetation, which is sustained by groundwater, is the key habitat determinant.

Key ecological drivers: As with habitat 4, groundwater supports and drives the ecological systems of this habitat and groundwater flow is dependent on rain in the upstream catchment. The nature of the substrate facilitates groundwater flow and traps moisture to maintain the vegetation.

Vulnerabilities and threats: Similar to the other drainage habitats of the Omahola Project Area, major threats to this habitat include those concerning the loss of vegetation. Impacts on vegetation can include physical impacts such as the removal of vegetation, or any impacts on the groundwater availability or quality that supports the vegetation of this habitat.

3.4.1.6. Southern gravel plains (Vegetation habitat 5.2)

• **Diversity**: 10 out of 12	
• **Biodiversity potential:** 6 out of 12	
• **Restoration potential:** zero	**Restoration sensitivity ranking:** 9 out of 12
• **Uniqueness:** common, widespread	**Uniqueness sensitivity ranking:** 4.5 out of 12
• **Overall sensitivity ranking:** 8 out of 12	**Habitat sensitivity:** highly sensitive

Occurrence in Omahola Project Area (Figure 3): Within the Omahola Project Area, this habitat occurs as a few patches in the INCA block but is widely distributed throughout TRS and Shiyela blocks.

Description (Figure 15): This habitat comprise of sparsely vegetated gravel plains with intermittent shallow, sandy washes. A well-developed desert pavement, consisting of gypsum-rich, consolidated medium-coarse gravels covers the largest parts of this habitat. Vegetation is mostly associated with the sandy washes and generally occurs sparsely on the plains. Dominant plant species includes *Arthraerua leubnitziae* (pencil bush) and *Salsola* sp. Towards the end of the survey period sparse annual grass started to appear in places and pencil bushes were in flower.

Figure 15. Sparsely vegetated gravel plains of habitat 6.

Occurrence elsewhere in the Central Namib: Widespread.

Trophic guilds:

- Leaf-eaters (14 invertebrate species): The resource is permanently available through the presence of evergreen shrubs.
- Flower, nectar and pollen feeders (9 invertebrate species): The resource is only seasonally available when shrubs flower.
- Fruit and seed feeders (4 invertebrate species): The resource is seasonally available as for flower, nectar and pollen.
- Sap feeders (7 invertebrate species): As for leaf-eaters, resource permanently available.
- Wood eaters (1 invertebrate species): The resource is permanently available through the presence of the woody *Salsola* sp. ('gannabos') shrubs, although in limited quantities.
- Grass eaters (1 invertebrate species): The resource should be sparsely available through the presence of *Stipagrostis ciliata* (tall bushman grass) and *S. obutusa* (small bushman grass), which are annual or perennial grasses. The resource is expected to be absent in periods of drought.
- Fungus and lichen feeders (2 invertebrate species): Lichens are an important resource on the gravel plains of the Central Namib, while BSC are present in the area.
- Detritus feeders (33 invertebrate species): habitat. The resource is permanently available and important in this habitat. The vegetation of the habitat forms good detritus traps, and autochthonous detritus stays within the habitat.
- Dung feeders (1 invertebrate species): Game may be attracted to the permanent vegetation, especially to the denser concentrations in the washes. The resource is thus expected to occur in the habitat but more unpredictably than in the larger drainages so rather scarcely.
- Scavengers (14 invertebrate species): Where there is game there should be carcasses every once in a while. The resource should be available intermittently.
- Predators (42 invertebrate species): Resource should be permanently available through the presence of other guilds in the habitat.
- Parasites (12 invertebrate species): Without larger vegetation such as trees or big shrubs which are typical resting places for game, ectoparasites are not expected to occur in this habitat. Parasites of other invertebrates are expected since, with the presence of other invertebrate guilds, this resource is permanently available.

Invertebrate habitat determinants: The substrate determines the nature of this habitat. The desert pavement is formed through various processes, the nature and timeline of which is not clear. Surface fines are blown away through natural erosion processes and fog or rainfall stabilises surface materials by binding surface layers into a thin crust. A further important agent in stabilising soil crusts are biological soil crusts (BSCs). BSCs in the Namib comprise various proportions of lichens, micro-fungi, green algae and cyanobacteria (blue-green algae) (Belnap & Lange 2001) located on the soil surface to several millimeters into the ground or under translucent stones such as quartz pebbles. These biological accumulations are most easily observed underneath stones that accommodate fenster algae or blue green algae, which appears black when dry, beneath them (Figure 16). Stones trap moisture from fog or dew that condenses and runs down the sides to create a moist environment below the rock where photosynthesis is possible due to penetrating sunlight.

Figure 16. Populations of fenster algae and bluegreen algae beneath a quartz pebble.

BSCs contribute a large portion of the desert biological biomass and is located within the top 3 mm of the soils (Belnap & Gilette 1998). BSCs create and maintaining fertility in otherwise infertile desert soils by fixing carbon and nitrogen and capturing nutrient-rich dust, all of which can stimulate plant growth (Belnap 2003).

The desert pavement surfaces are generally quite hard. Invertebrates can't dig to escape the high surface temperatures and the only shelter available on the plains is the sparse vegetation. Many gravel plains invertebrates spent the majority of their lives in inactive stages such as eggs and only hatch at the sprouting of annual grass after good rain. Though present only fleetingly, the annual grass offers sufficient food and shelter newly invertebrates to continue or complete their life cycles. The perennial vegetation on the gravel plains can survive in this extremely low rainfall area by making use of fog water, but require rainfall to flower, produce fruit and germinate (Walter 1976). Feeding guilds that live off fruits and flowers are only present fleetingly after such events.

Key ecological drivers: The surface crust formation processes maintains the habitat. Rainfall is the most important ecological driver as it triggers the sprouting of annual grass, which in turn allows for the hatching of dormant invertebrates. Rain also allows for the flowering of perennial plants and the formation of fruit, while fog is important in sustaining this vegetation between rain events. Due to the simplicity of the plains surfaces detritus can only be captured by the sparse vegetation, with the result that most detritus is exported out of the system. The maintenance of seed banks is important for this habitat.

Vulnerabilities and threats: The biggest threat to the gravel plains of the Central Namib is the substrate disruption. Biological soil crusts are fragile and easily disturbed. The loss of BSCs can result in reduced site productivity, as well as exposure of unprotected subsurface sediments to wind and water erosion. Recovery times are generally measured in decades or centuries (Belnap 2003).

3.4.1.7. Northern drainages & washes (Vegetation habitat 5.3)

• **Diversity**: 8 out of 12	
• **Biodiversity potential:** 6 out of 12	
• **Restoration potential:** low	**Restoration sensitivity ranking:** 3 out of 12
• **Uniqueness:** common, widespread	**Uniqueness sensitivity ranking:** 4.5 out of 12
• **Overall sensitivity ranking:** 4 out of 12	**Habitat sensitivity:** sensitive

Occurrence in Omahola Project Area (Figure 3): Within the Omahola Project the drainages and washes of this habitat type occurs commonly on the plains of the INCA block as well as in the northwestern-most portion of Shiyela.

Description (Figure 17): Unlike the southern drainages and washes of habitat 5, this habitat mostly comprises less pronounced ephemeral washes with shallow sands. Substrates of this washes includes course to finer gravels and sands. Sparse perennial vegetation in the form of *Citrullus ecirrhosus* (tsamma) and small *Arthraerua leubnitziae* (pencil bush), occurs along the drainages and were in flower during the last month of the survey. No grass was observed along the drainages or on the plains during the survey but *Stipagrostis ciliata* (tall bushman grass) and *S. obtusa* (short bushman grass) should occur after sufficient rains (Ecotrust 2010). Plenty of small mammal burrows and antelope droppings were also noted along the sandy washes, usually in close association with vegetation.

Figure 17. Sparse vegetation in a sandy wash on INCA, northern washes & drainages habitat.

Occurrence elsewhere in the Central Namib: Widespread in Central Namib.

Trophic guilds:

- Leaf-eaters (12 invertebrate species): The resource is permanently available, although sparsely, through presence of evergreen shrubs.

- Flower, nectar and pollen feeders (11 invertebrate species): The resource is only available seasonally, and then only sparsely.
- Fruit and seed feeders (5 invertebrate species): The resource is only available seasonally, and then only sparsely.
- Sap feeders (9 invertebrate species): As with for leaf-eaters, resource permanently available, although sparsely, through presence of evergreen shrubs.
- Wood eaters (1 invertebrate species): Although no trees occur in the habitat some sparsely scattered *Salsola* (‘gannabos) shrubs in the habitat accounts for the presence of the resource, although only in small measure.
- Grass eaters (1 invertebrate species): The resource may be sparsely available through the presence of *Stipagrostis ciliata* and *S. obtusa*, but is expected to be absent in periods of drought.
- Fungus and lichen feeders (2 invertebrate species): The resource is expected to be absent from the sandy washes of this habitat but occurs abundantly on adjacent plains, which may account for the occurrence of the guild in this habitat.
- Detritus feeders (29 invertebrate species): The resource is permanently available and important in this habitat. The vegetation of the habitat forms good detritus traps.
- Dung feeders (1 invertebrate species): Game may be attracted to the permanent vegetation but unpredictably, so the resource is scarce in the habitat.
- Scavengers (11 invertebrate species): The resource should be available intermittently.
- Predators (41 invertebrate species): The resource should be permanently available through the presence of other guilds in the habitat
- Parasites (9 invertebrate species): Ectoparasites are not expected to occur in the habitat with the absence of game concentrators such as larger vegetation where they can rest. The presence of other guilds facilitates the presence of other parasites.

Invertebrate habitat determinants: The vegetation determines the nature of the habitat. The surrounding gravel plains are almost barren and the vegetation of these washes serves as the only dependable source of food and shelter for invertebrates in the area. It follows that the gravel plains and the plains drainage channels form a single functional habitat for invertebrates. Vegetation associated with the washes, although sparsely scattered, serves as reliable food source for various small mammals, herds of springbuck and other vertebrates, which supports invertebrate groups such as dung feeders, vertebrate ectoparasites and scavengers that would otherwise not be present.

Key ecological drivers: Surface water runoff and groundwater, to some extent, drives the ecological systems of this habitat. Small concentrations of vegetation occur in lower lying areas with a small slope where surface water run-off collects and thus improve survival of vegetation (Ecotrust 2010). The sandy substrates facilitate groundwater flow and traps moisture to maintain the vegetation.

Vulnerabilities and threats: Similar to the other drainage habitats of the Omahola Project Area, major threats to this habitat include those concerning the loss of vegetation. Impacts on vegetation can include physical impacts such as the removal of vegetation, or any impacts on the groundwater availability or quality that supports the vegetation of this habitat.

3.4.1.8. Northern gravel plains (Vegetation habitat 6)

• **Diversity**: 11 out of 12	
• **Biodiversity potential:** 6 out of 12	
• **Restoration potential:** zero	**Restoration sensitivity ranking:** 9 out of 12
• **Uniqueness:** common, widespread	**Uniqueness sensitivity ranking:** 4.5 out of 12
• **Overall sensitivity ranking:** 10 out of 12	**Habitat sensitivity:** highly sensitive

Occurrence in Omahola Project Area (Figure 3): The northern gravel plains habitat covers the largest part of the INCA block as well as the northwestern-most part of the Shiyela block.

Description (Figure 18): The habitat is comprised of relatively flat gravel plains frequently intersected by the shallow northern drainages and washes (habitat 7). Substrates are rich in gypsum and mostly consist of coarse sands and gravels. Biological soil crusts are well developed away from the drainages. A variety of lichen species occur. Prominent plant species includes *Zygophyllum stapffii* (dollar bush), *Arthraerua leubnitziae* (pencil bush) and *Welwitschia mirabilis*. This habitat mainly differs from the southern gravel plains of habitat 6 (Vegetation habitat 5.2) by the presence of *Welwitschia mirabilis* and absence of *Salsola sp*. in this habitat. During the last month of the invertebrate survey shrubs like *A. leubnitziae* were in flower after the good rains, but no grass were noted on the plains.

Occurrence elsewhere in the Central Namib: Widespread in Central Namib.

Trophic guilds:

- Leaf-eaters (12 invertebrate species): Resource permanently available, although sparsely, through presence of evergreen shrubs.

Figure 18. Sparse vegetation of the northern gravel plains habitat.

- Flower, nectar and pollen feeders (16 invertebrate species): Resource only available seasonally, and then only sparsely. Nectar-feeders also visit the cones of *Welwitschias*.
- Fruit and seed feeders (4 invertebrate species): Resource only available seasonally, and then only sparsely.
- Sap feeders (2 invertebrate species): As with for leaf-eaters, resource permanently available, although sparsely, through presence of evergreen shrubs.
- Wood eaters (1 invertebrate species): Resource not important in this habitat due to absence of trees or woody shrubs.
- Grass eaters (1 invertebrate species): The resource may be seasonally available, but then only sparsely.
- Fungus and lichen feeders (2 invertebrate species): Lichens are an important resource on the gravel plains of the Central Namib. The fungus on *Welwitschia* plants are also a resource for fungus feeders.
- Detritus feeders (33 invertebrate species): The resource is permanently available and

important in this habitat. The vegetation, although sparse, forms good detritus traps, and autochthonous detritus stays within the habitat.

- Dung feeders (1 invertebrate species): The resource may be present in the habitat but scarce.
- Scavengers (12 invertebrate species): The resource may be present in the habitat but scarce and only seasonal.
- Predators (43 invertebrate species): The resource should be permanently available through the presence of other guilds in the habitat.
- Parasites (11 invertebrate species): Parasites of other invertebrates are expected since, with the presence of other invertebrate guilds, this resource is permanently available.

Invertebrate habitat determinants: Comparable to the southern plains habitat (habitat 5), the substrate determines the nature of this habitat. Rain and fog stabilises surface crusts and biological soil crusts constitute the largest part of the biomass in this habitat. As on the southern plains, the majority of invertebrates on the northern plains survives in inactive forms due to the harshness of the plains and only emerges once sufficient rains triggered the emergence of a sparse cover of annual grass. The northern washes and drainages habitat (habitat 7) in reality forms one ecological unit with the northern plains as the perennial vegetation concentrations of these washes are an important source of food and shelter for many plains invertebrates. Feeding groups such as dung-feeders, ectoparasites and scavengers are also able to survive due to the vertebrates that utilize this reliable food source. In an effort to avoid high daily temperatures many plains invertebrates are nocturnal. Specialised lichen-feeders are sustained by the continual presence of this food source. The perennial vegetation on the gravel plains can survive in this extremely low rainfall area by making use of fog water, but require rainfall to flower, produce fruit and germinate (Walter 1976). Feeding guilds that live off fruits and flowers are only present fleetingly after such events.

Key ecological drivers: The surface crust formation processes maintains the habitat, while rainfall is the most important ecological driver. Rain triggers the sprouting of annual grass, which in turn allows for the hatching of dormant invertebrates. Rain also allows for the flowering of perennial plants and the formation of fruit, while fog is important in sustaining this vegetation between rain events. Due to the simplicity of the plains surfaces detritus can only be captured by the sparse vegetation, with the result that most detritus is exported out of the system. The maintenance of seed banks is important for this habitat.

Vulnerabilities and threats: As with the other gravel plains habitats of the Central Namib, the biggest threat to the habitat is the substrate disruption. Biological soil crusts are fragile and easily disturbed. The loss of BSCs can result in reduced site productivity, as well as exposure of unprotected subsurface sediments to wind and water erosion. Recovery times are generally measured in decades or centuries (Belnap 2003).

3.4.1.9. Western gravel plains (Vegetation habitat 7)

• **Diversity**: 9 out of 12	
• **Biodiversity potential:** 6 out of 12	
• **Restoration potential:** zero	**Restoration sensitivity ranking:** 9 out of 12
• **Uniqueness:** common, widespread	**Uniqueness sensitivity ranking:** 4.5 out of 12
• **Overall sensitivity ranking:** 7 out of 12	**Habitat sensitivity:** highly sensitive

Occurrence in Omahola Project Area (Figure 3): This habitat occurs in the far southeastern corner of the INCA block, in one north-central patch on the TRS block and widely scattered across the Shiyela block.

Description (Figure 19): This habitat is mainly differentiated from the northern and southern gravel plains habitats based on the vegetational composition. It comprises of undulating consolidated gravel plains to frequently incised, low rocky outcrops. Substrates are gypsum rich and vary between course sands and gravels. Vegetation is mostly concentrated along drainage lines and includes *Zygophyllum stapffii* (dollars bush) and *Arthraerua leubnitziae* (pencil bush). Biological soil crusts are well developed and lichens of various species are abundant. During February 2011 a number of annual herbs were flowering and sparse grass was emerging along drainage lines and in lower areas where run-off rainwater concentrated.

Occurrence elsewhere in the Central Namib: This habitat can be clustered with the southern and northern gravel plains, which is widespread in the Central Namib.

Trophic guilds:

- Leaf-eaters (13 invertebrate species): Resource permanently available through the presence of evergreen shrubs such as *Zygophyllum stapffii* (dollar bush) and *Arthraerua leubnitziae* (pencil bush).
- Flower, nectar and pollen feeders (14 invertebrate species): Resource only seasonally available when shrubs flower.
- Fruit and seed feeders (5 invertebrate species): Resource only seasonally available.

Figure 19. Sparsely vegetated rocky-gravel plains habitat.

- Sap feeders (5 invertebrate species): As for leaf-eaters, the resource is permanently available.
- Wood eaters (1 invertebrate species): The resource is unimportant in the habitat due to the absence of trees or woody shrubs.
- Grass eaters (1 invertebrate species): The resource in the form of *Stipagrostis ciliata* (tall bushman grass) is rain-dependent and only available seasonally.
- Fungus and lichen feeders (2 invertebrate species): Lichens are an important resource on the gravel plains of the Central Namib.
- Detritus feeders (37 invertebrate species): The resource is permanently available and important in this habitat. The vegetation of the habitat forms good detritus traps, and autochthonous detritus stays within the habitat.
- Dung feeders (3 invertebrate species): The sparsity of evergreen vegetation is expected to attract little game. The resource may be present in the habitat but scarce.
- Scavengers (14 invertebrate species): If game visits the habitat the occasional carcass should occur. The resource is unpredictably available, thus scarce.
- Predators (41 invertebrate species): The resource is permanently available through

the presence of other guilds in the habitat.

- Parasites (11 invertebrate species): Parasites of other invertebrates are expected since, with the presence of other invertebrate guilds, this resource is permanently available. Ectoparasites of game may be present at times but the resource is unpredictable.

Invertebrate habitat determinants: Comparable to the northern and southern gravel plains.

Key ecological drivers: Comparable to the northern and southern gravel plains.

Vulnerabilities and threats: As with the other gravel plains habitats of the Central Namib, the biggest threat to the habitat is the substrate disruption. Biological soil crusts are fragile and easily disturbed. The loss of BSCs can result in reduced site productivity, as well as exposure of unprotected subsurface sediments to wind and water erosion. Recovery times are generally measured in decades or centuries (Belnap 2003).

3.4.1.10. Salsola river terraces & plains (Vegetation habitat 8)

• **Diversity**: 12 out of 12	
• **Biodiversity potential:** 12 out of 12	
• **Restoration potential:** low	**Restoration sensitivity ranking:** 3 out of 12
• **Uniqueness:** limited occurrence elsewhere	**Uniqueness sensitivity ranking:** 11 out of 12
• **Overall sensitivity ranking:** 12 out of 12	**Habitat sensitivity:** no-go area

Occurrence in Omahola Project Area (Figure 3): This habitat is associated with the larger drainages that pass through the Omahola Project area and is concentrated in the eastern and western portions of the TRS block and occurs locally in the northeastern parts of the Shiyela block.

Description (Figure 20): This habitat is mainly characterised by the dense stands of *Salsola tuberculata* ('gannabos') and other halophytic species on firm, brackish and gypsum-rich soils (Ecotrust 2010). Where surface substrates are looser, biological soil crusts are well developed, while various lichen species also occur on harder substrates. After the good rains of the survey period the habitat was covered with an emergent stand of annual grass species and various shrubs were in flower.

Occurrence elsewhere in the Central Namib: Localised occurrences in western Central Namib.

Figure 20. Permanent vegetation of Salsola river terraces and plains habitat.

Trophic guilds:

- Leaf-eaters (12 invertebrate species): Resource permanently available due to the presence of *Salsola* sp. ('gannabos') and *Arthraerua leubnitziae* (pencil bush) shrubs.
- Flower, nectar and pollen feeders (8 invertebrate species): Resource only seasonally available, and then only sparsely, when the shrubs flowers.
- Fruit and seed feeders (2 invertebrate species): Resource only seasonally available, and then only sparsely.
- Sap feeders (8 invertebrate species): As with leaf-eaters, resource permanently available.
- Wood eaters (1 invertebrate species): The resource is permanently available through the presence of the *Salsola* sp. ('gannabos') shrubs.
- Grass eaters (1 invertebrate species): The resource is seasonally available.
- Fungus and lichen feeders (1 invertebrate species): The resource is unimportant in this habitat.
- Detritus feeders (31 invertebrate species): The *Salsola* ('gannabos') forms sandy hummocks that are efficient detritus traps. The detritus resource is important in this habitat and permanently available as detritus, mostly originating from outside the habitat, is trapped within the habitat.

- Dung feeders (3 invertebrate species): The *Salsola* hummocks present ample shelter for small mammals, while the permanent availability of forage attracts game mammals. The resource should thus be permanently available.
- Scavengers (10 invertebrate species): No carcasses were observed during the survey but with the presence of larger vertebrates the resource should be available intermittently.
- Predators (34 invertebrate species): The resource is permanently available through the presence of other guilds in the habitat.
- Parasites (11 invertebrate species): Parasites of other invertebrates are expected since, with the presence of other invertebrate guilds, this resource is permanently available. Ectoparasites of game may be present at times but the resource is unpredictable.

Invertebrate habitat determinants: The most important habitat determinant is the vegetation. The dense, perennial vegetation creates sandy hummocks by trapping windblown sand. The sandy hummocks act as biological 'islands' and provides food and shelter to various fossorial invertebrates and burrowing small mammals. The vegetation also serves as excellent detritus traps which sustain detritus feeders. The food source is omnipresent for vertebrates and their reliant invertebrate feeding guilds, but fruit- and seed feeder invertebrate guilds are only present after sufficient rains allow for germination of the flowering of the vegetation and the emergence of annual grass. Specialised lichen-feeders are supported by the presence of lichens throughout the year. Parts of the habitat occur on calcrete, with abundant loose surface scatter that afford additional shelter to invertebrates.

Key ecological drivers: The vegetation is sustained by groundwater from the adjacent watercourses, which are recharged by rain upstream in the catchment. Local rain events trigger the emergence of grass and flowering and seed production of vegetation, which allows for the presence of fruit and seed feeders, but also for the maintenance of the seed bank. The dense vegetation acts as effective detritus traps and the maintenance of this food source.

Vulnerabilities and threats: The maintenance of the vegetation in this habitat is very important, as is the availability and quality of groundwater that sustains it. Impacts on these important habitat determinants and drivers may cause long-term or even permanent destruction of the habitat due to the extremely slow growth tempo of the vegetation.

3.4.1.11. Barren dolerite ridges & dykes (Vegetation habitat 9)

• **Diversity**: 2 out of 12	
• **Biodiversity potential:** 2 out of 12	
• **Restoration potential:** low	**Restoration sensitivity ranking:** 3 out of 12
• **Uniqueness:** common, widespread	**Uniqueness sensitivity ranking:** 4.5 out of 12
• **Overall sensitivity ranking:** 1 out of 12	**Habitat sensitivity:** least sensitive

Occurrence in Omahola Project Area (Figure 3): This habitat occurs localised in the Shiyela, TRS and INCA blocks.

Description (Figure 21): The habitat comprises dykes and low ridges of exposed, weathered dolerite. During the survey no vegetation was noted within the habitat itself, and the only vegetation in the area was sparse Zygophyllum stapffii (dollar bush) and Arthraerua leubnitziae (pencil bush) shrubs on the surrounding gravel plains. Due nature of the dolerite rock and the way in which it weathers, loose rocks and boulders are mostly flat with sharp edges, laying mostly level with substrate surfaces and afford very little natural shelter for invertebrates. Due to the same reasons, very little detritus is also stored within the habitat, generally rendering it unfavourable for invertebrate habitation.

Figure 21. Barren dolerite ridges & dykes habitat at INCA.

Occurrence elsewhere in the Central Namib: Northeast to southwest trending dolerite dikes are commonly found throughout the Central Namib Desert, albeit varying in the extent of summit boulder exposure. Examples in the study area have poorly developed boulder habitats.

Trophic guilds:

- Leaf-eaters (11 invertebrate species): No vegetation directly associated with the dolerite ridges were observed during the survey, but sparse *Arthraerua leubnitziae* (pencil bush) and *Zygophyllum stapffii* (dollar bush) occurred on the surrounding plains. Leaf-eating invertebrates collected on the dolerite ridges were rather associated with the vegetation of adjacent habitats.
- Flower, nectar and pollen feeders (10 invertebrate species): As with leaf-eaters, the resource is not available in the habitat but do occur on the surrounding plains but only seasonally and sparsely.
- Fruit and seed feeders (1 invertebrate species): The resource is not available in the habitat but do occur on the surrounding plains but only seasonally and sparsely.
- Sap feeders (5 invertebrate species): As for leaf-eaters, the resource only occurs on the surrounding plains in the form of the sparsely occurring, evergreen *Arthraerua leubnitziae* (pencil bush) and *Zygophyllum stapffii* (dollar bush).
- Wood eaters (1 invertebrate species): The resource does not occur in the habitat, but sparse *Salsola* shrubs on the surrounding plains may provide this resource to invertebrates of the dolerite ridges habitat but in modest amounts.
- Grass eaters (1 invertebrate species): The resource does not occur in the habitat but may occur on the surrounding plains.
- Fungus and lichen feeders (1 invertebrate species): Sparse lichens do occur on the dolerite rocks and may be the only resource produced within the habitat. Lichens occur abundantly on the surrounding plains.
- Detritus feeders (18 invertebrate species): The rocks and boulders of this habitat are mostly flat-bottomed and weathered smooth, so no real crevices and small spaces are created to trap windblown detritus from the surrounding plains. During the survey no grass was present on the plains and almost no trapped detritus was to be found on the dolerite ridges. Due to the vegetation that act as detritus traps this resource is available on the surrounding plains. Invertebrates form this guild collected during the survey may be supported by the detritus on the plains but was seeking shelter in the shade of the dolerite rocks.
- Dung feeders (1 invertebrate species): The resource is unimportant in this habitat, ,

although the presence of a well-worn track along the ridge indicates that game may move through seasonally. Invertebrates of this guild collected in the dolerite ridges habitat during the survey may have been associated with the resource on the surrounding plains.

- Scavengers (4 invertebrate species): The resource is unimportant in this habitat. As with the dung feeders, invertebrates of this guild collected in the dolerite ridges habitat during the survey may have been associated with the resource on the surrounding plains.
- Predators (20 invertebrate species): The resource is permanently available through the presence of other guilds, albeit scarce in this habitat.
- Parasites (8 invertebrate species): Parasites of other invertebrates are expected since, with the presence of other invertebrate guilds, this resource is available.

Invertebrate habitat determinants: The sparsity of vegetation and limited detritus and shelter due to poorly developed boulder outcropping renders the habitat less suitable for invertebrates.

Key ecological drivers: The structure of the habitat is the most important ecological driver. It is expected that invertebrate guilds encountered in this habitat may include to odd opportunistic predator as well those guilds that occur in surrounding habitats.

Vulnerabilities and threats: Due to the complexity of the habitat it can't be restored once impacted on. Impacts may include levelling of the habitat, dumping on the habitat or building any infrastructure on or across the habitat.

3.4.1.12. Barren gravel plains (Vegetation habitat 10)

• **Diversity**: 6 out of 12	
• **Biodiversity potential:** 1 out of 12	
• **Restoration potential:** zero	**Restoration sensitivity ranking:** 9 out of 12
• **Uniqueness:** common, widespread	**Uniqueness sensitivity ranking:** 4.5 out of 12
• **Overall sensitivity ranking:** 3 out of 12	**Habitat sensitivity:** sensitive

Occurrence in Omahola Project Area (Figure 3): patches of this habitat occur on the INCA, TRS and Shiyela blocks.

Description (Figure 22): Barren gravel plains where substrates are gypsum-rich and comprise course gravels to sand. Biological soil crusts are well-developed in many places and lichens occur on harder patches. Small mammal burrows occur in places, and serve as shelter for a number of vertebrates and also as traps for windblown detritus from surrounding habitats. The barren plains habitat are actually just patches of vegetationless plains that occur within the normal, sparsely vegetated western, northern and southern gravel plains habitats.

Figure 22. Barren gravel plains habitat of the Omahola Project area.

Occurrence elsewhere in the Central Namib: Associated with general gravel plains, widespread throughout the Central Namib.

Trophic guilds:

- Leaf-eaters (10 invertebrate species): The resource is absent in this habitat but members of this guild collected on the barren gravel plains were most likely associated with the vegetation of adjacent vegetated gravel plains.
- Flower, nectar and pollen feeders (5 invertebrate species): As with leaf-eaters, the

resource is not available in the habitat but do occur on the surrounding plains but only seasonally.

- Fruit and seed feeders (1 invertebrate species): The resource is not available in the habitat but do occur on the surrounding plains but only seasonally.
- Sap feeders (5 invertebrate species): As for leaf-eaters, the resource only occurs on the surrounding vegetated plains in the form of the sparsely occurring, evergreen *Arthraerua leubnitziae* (pencil bush) and *Zygophyllum stapffii* (dollar bush).
- Wood eaters (1 invertebrate species): The resource does not occur in the habitat, but sparse *Salsola* shrubs on the surrounding plains may provide this resource to invertebrates of the barren gravel plains habitat but in modest amounts.
- Grass eaters (0 invertebrate species): The resource does not occur in the habitat but may occur on the surrounding plains.
- Fungus and lichen feeders (1 invertebrate species): As with other gravel plains, this resource is important in this habitat, and the only autochthonous trophic resource.
- Detritus feeders (18 invertebrate species): A number of small mammal burrows occur on the barren gravel plains, which act as traps for small amounts of detritus.
- Dung feeders (1 invertebrate species): The resource is unimportant in this habitat. Invertebrates of this guild collected on the barren plains during the survey may have been associated with the resource on the surrounding vegetated gravel plains.
- Scavengers (4 invertebrate species): The resource is unimportant in this habitat. As with the dung feeders, invertebrates of this guild collected on the gravel plains during the survey may have been associated with the resource on the surrounding plains.
- Predators (16 invertebrate species): The resource is permanently available through the presence of other guilds, albeit scarce in this habitat.
- Parasites (6 invertebrate species): Parasites of other invertebrates are expected since, with the presence of other invertebrate guilds, this resource is available.

Invertebrate habitat determinants: The substrate determines the nature of the habitat. The habitat, like the other gravel plains habitat, supports biological soil crusts which are stabilised by rain and fog driving the crust formation processes. Besides the BSCs, the main drivers of the barren gravel plains are the vegetation that occurs on the surrounding gravel plains and washes, and the proximity of any point on the barren plains to nearest vegetation. Invertebrate guilds encountered on the barren plains that are not directly dependent on the biological soil crusts for subsistence dependent on the perennial vegetation of the surrounding plains and washes, either directly or indirectly.

Key ecological drivers: The surface crust formation processes maintains the habitat, while rainfall is the most important ecological driver. Other drivers important in this habitat include those that sustain the vegetation and detritus production of the surrounding gravel plains and drainages, such as the availability of groundwater.

Vulnerabilities and threats: As with the other gravel plains habitats of the Central Namib, the biggest threat to the habitat is the substrate disruption, while impacts to the surrounding plains substrates and vegetation will also directly or indirectly affect the barren plains habitat.

3.4.2. ***Habitat sensitivity assessment***

In order to assess the relative environmental sensitivity of each of the 12 habitats they were each considered for three factors:

- General invertebrate diversity
- Restoration potential
- Uniqueness

In order to make scores for the different criteria comparable, they were reduced to a priority ranking of habitats for each score. The average of all rankings then became the composite sensitivity ranking for the habitat. This was done by arranging the habitats in sequence from highest to lowest rating, and ranking them sequentially, with 12 (the total number of habitats) being the highest sensitivity ranking and 1 the lowest. Where more than one habitat had the same sensitivity rating, they were given the same rank, represented by the average of their individual ranks (e.g., if the three lowest ranks 1, 2 and 3 had identical ratings, each would end up with a ranking of 2, because 1+2+3 / 3 = 2).

The various ratings were also noted in boxes at the top of each habitat discussion (Section 3.4.1) for easy reference.

3.4.2.1. General invertebrate diversity of each habitat

Two factors were considered in determining the general invertebrate diversity for each habitat. Firstly the Shannon diversity index was used as biodiversity measure by combining the diversity and abundance of species recorded at each of the habitats. Results are presented in Table 7.

Table 7. Diversity rank of each habitat based on Shannon diversity index. Diversity: Taxa trapped & observed during survey; Abundance: recording each observed taxon as 1 occurrence only; Shannon index: only applied to trapped taxa, not observed taxa.

Habitat	Diversity	Abundance	Shannon diversity Index	Rank
Salsola river terraces & plains	129	1611	3.723612	12
Northern gravel plains	145	1753	3.6731	11
Southern gravel plains	149	1358	3.644367	10
Western gravel plains	155	2487	3.580745	9
Northern drainages & washes	140	1503	3.575048	8
Southern drainages & washes	119	2541	3.491798	7
Barren gravel plains	71	413	3.470412	6
Lower Tumas drainages	128	1764	3.414441	5
Marble ridge	124	2379	3.357307	4
Granite ridges	115	3218	3.23164	3
Barren dolerite ridges & dykes	87	805	3.067066	2
Granite hill	110	1189	1.98725	1

A second measure of invertebrate diversity measure applied is the number of invertebrate trophic guilds represented in each habitat. To simply consider the presence or absence of a trophic guild from a particular habitat would not be very informative. The persistence of the trophic resource was also taken into account, e.g., a guild that was present in a habitat where the particular trophic resource was permanently available was scored higher than one that was present in a habitat where the resource was seasonal only. The reasoning behind this was that a perennial food source probably supports a higher diversity of invertebrates than the same non-perennial food source. On this basis, trophic guilds in a particular habitat were scored for the persistence of their trophic resource in that habitat, as follows:

- 0: Resource not present, or present but unimportant.
- 1: Resource present, but scarce, rain-dependent or short-lived.
- 2. Resource present and long lasting or annually predictable.
- 3. Resource permanently available.

Results are listed in Table 8.

Habitats that support high levels of diversity are considered to be more sensitive to habitat destruction, compared to habitats that support lower levels of diversity. The reasoning behind this was simply that the loss of a large variety of biodiversity would be more serious than the loss of a smaller variety, therefore more diverse habitats should receive a higher sensitivity rating.

Table 8. Biodiversity potential of habitats based on trophic resource availability. Key: 0: resource not present; 1: resource presence sparse and/or unpredictable; 2: resource available, and more predictable (seasonal, or along game movement corridors); 3: resource permanently available.

	Trophic guilds													
	Leaves	**Flowers, nectar, pollen**	**Fruit, seed**	**Sap**	**Wood**	**Grass**	**Fungi, lichens**	**Detritus**	**Dung**	**Scavengers**	**Predators**	**Parasites**	**Total trophic resource availability score**	**Rank**
Habitat														
Salsola river terraces & plains	3	2	2	3	3	2	1	3	2	2	3	2	28	12
Lower Tumas drainages	3	2	2	3	3	2	0	3	2	2	3	2	27	11
Marble ridge	3	2	2	3	1	2	3	3	1	1	3	1	25	9.5
Southern drainages & washes	3	2	2	3	1	2	0	3	2	2	3	2	25	9.5
Granite hill	3	2	2	3	1	1	1	3	2	1	3	2	24	6
Southern gravel plains	3	2	2	3	1	1	3	3	1	1	3	1	24	6
Northern drainages & washes	3	2	2	3	1	1	0	3	2	2	3	2	24	6
Northern gravel plains	3	2	2	3	1	1	3	3	1	1	3	1	24	6
Western gravel plains	3	2	2	3	0	2	3	3	1	1	3	1	24	6
Granite ridges	3	2	2	3	0	1	1	3	1	1	3	1	21	3
Barren dolerite ridges & dykes	1	1	1	1	0	0	3	1	1	1	2	1	13	2
Barren gravel plains	0	0	0	0	0	0	3	1	0	0	2	1	7	1

3.4.2.2. Restoration potential of each habitat

The restoration potential of each habitat is dependent upon our ability to recreate the invertebrate habitat determinants of the original habitats in the newly restored habitats. From an invertebrate viewpoint, the key ecological driver for the majority of habitats above is rainfall, over which we have little control, but if restoration can at least get the basic habitat determinants back into place, rainfall will have the desired effect eventually.

Based on the perceived ease or difficulty of restoring invertebrate habitat determinants, each habitat was rated as having a restoration potential that was either High, Medium, Low, or Zero.

Table 9. Restoration potential of each habitat. Potential rated as zero, low, medium or high. The rationale behind the rating of the restoration potential is based on the habitat determinants as discussed in Section 3.4.1.

Habitat	Restoration potential	Rationale	Rank
Granite hill	Zero	Complexity of habitat can't be restored	9
Marble ridge	Zero	Complexity of habitat can't be restored	9
Granite ridges	Zero	Complexity of habitat can't be restored	9
Lower Tumas drainages	Low	Slow growing vegetation	3
Southern drainages & washes	Low	Slow growing vegetation	3
Southern gravel plains	Zero	Sensitive gypsum soils, slow growing lichen fields and biological soil crusts	9
Northern drainages & washes	Low	Slow growing vegetation	3
Northern gravel plains	Zero	Sensitive gypsum soils, slow growing lichen fields and biological soil crusts	9
Western gravel plains	Zero	Sensitive gypsum soils, slow growing lichen fields and biological soil crusts	9
Salsola river terraces & plains	Low	Slow growing vegetation	3
Barren dolerite ridges & dykes	Low	Complexity of habitat can't be restored	3
Barren gravel plains	Zero	Sensitive gypsum soils, slow growing lichen fields and biological soil crusts	9

3.4.2.3. Uniqueness

The uniqueness or rarity of a habitat is also a contributing factor to its sensitivity. Habitats that are widespread elsewhere in the Central Namib would be less sensitive to destruction than those that are not found significantly elsewhere.

Habitats of the Omahola Project were ranked based on their occurrence in the Central Namib (detailed in Section 3.4.1) as follows:

1: common and widespread over large areas within a similar bioclimatic envelope elsewhere in the Central Namib;

2: less common, less widespread and/or less extensive elsewhere in the Central Namib;

3: occurrence elsewhere in the Central Namib limited in number and/or size.

Results are listed in Table 10.

Table 10. Spatial extent of habitats outside the study area. (Note: evaluation of extralimital extent of gravel plains and associated washes is based on the aggregate general occurrence of these habitats in the Central Namib. No data exists on the distribution of individual vegetation types outside the study area, and all may not necessarily be widespread.)

Habitat	Spatial distinctness	Rationale	Rank
Granite hill	3	Limited occurrence elsewhere	11
Marble ridge	2	Common and widespread but limited individual extent	9
Granite ridges	1	Common and widespread	4.5
Lower Tumas drainages	3	Limited occurrence elsewhere	11
Southern drainages & washes	1	Common and widespread	4.5
Southern gravel plains	1	Common and widespread	4.5
Northern drainages & washes	1	Common and widespread	4.5
Northern gravel plains	1	Common and widespread	4.5
Western gravel plains	1	Common and widespread	4.5
Salsola river terraces & plains	3	Limited occurrence elsewhere	11
Barren dolerite ridges & dykes	1	Common and widespread	4.5
Barren gravel plains	1	Common and widespread	4.5

3.4.2.4. Overall habitat sensitivity

The sensitivity rankings calculated in Sections 3.4.2.1 to 3.4.1.3 above were combined in order to obtain a composite overall sensitivity ranking for all habitats. The four rankings were summed, and expressed as a percentage of the maximum possible sensitivity score, which is 48 (4 rankings x 12, the maximum rank). The sensitivity index gives an indication of how close the sensitivity a particular habitat is to this hypothetical maximum sensitivity index of 1.

Results are listed in Table 11.

Table 11. Sensitivity indices of each of the 12 invertebrate habitats evaluated. Sensitivity indices approaching 1 are more sensitive, while lower indices are less sensitive. Scores of 0.75-1=No-go areas; 0.5-0.75=Highly sensitive; 0.25-0.50=sensitive; <0.25=least sensitive.

Habitat	Diversity rank	Biodiversity potential rank	Restoration potential rank	Spatial extent rank	Total of rankings	Sensitivity index	Sensitivity
Salsola river terraces & plains	12	12	3	11	38	0.79	No-go area
Marble ridge	4	9.5	9	9	31.5	0.66	Highly sensitive
Northern gravel plains	11	6	9	4.5	30.5	0.64	Highly sensitive
Lower Tumas drainages	5	11	3	11	30	0.63	Highly sensitive
Southern gravel plains	10	6	9	4.5	29.5	0.61	Highly sensitive
Western gravel plains	9	6	9	4.5	28.5	0.59	Highly sensitive
Granite hill	1	6	9	11	27	0.56	Highly sensitive
Southern drainages & washes	7	9.5	3	4.5	24	0.50	Sensitive
Northern drainages & washes	8	6	3	4.5	21.5	0.45	Sensitive
Barren gravel plains	6	1	9	4.5	20.5	0.43	Sensitive
Granite ridges	3	3	9	4.5	19.5	0.41	Sensitive
Barren dolerite ridges & dykes	2	2	3	4.5	11.5	0.24	Least sensitive

4. INVERTEBRATE IMPACT ASSESSMENT

4.1. Introduction

Reptile Uranium Namibia proposes to apply for three mining licenses for the extraction of uranium ore, iron ore and associated minerals. This project, referred to as the Omahola Project, includes the INCA uranium and magnetite, Tubas Red Sands (TRS) uranium and Shiyela magnetite deposits. The location of these project areas are outlined in Figure 1.

4.2. Approach and limitations

No project description was provided in the terms of reference for the invertebrate impact assessment. Details of the project was extracted from the Scoping report for the Omahola Project (Softchem 2010), dated 11 October 2010, that was published online on Deep Yellow Limited and Softchem's websites. Due to the lack of detailed project information the following should be considered at the level of a scoping exercise, and not be mistaken for a formal impact assessment.

The approach for this impact assessment section of the report is based on sensitivity assessment of the various habitats in the Omahola Project Area (Section 3.4.2). Due to the lack of a detailed project description, broad aspects of the Omahola project, rather than specific process- and activity detail is considered. The impact assessment focuses on the sensitive habitats and possible risks that the Project poses to each, instead of the various Project aspects and their possible effect on the habitats as the case would normally be where a detailed project description was available.

4.3. Omahola Project description

Details for this section were obtained from the Scoping Report for the Omahola Project by Softchem (2010).

Activities of the Omahola Project will broadly encompass:

- Extraction of uranium and magnetite from the INCA ore body;
- Processing of the INCA uranium and magnetite ore on site;
- Extraction of secondary uranium ore from the TRS ore body;
- Scrubbing and sizing of TRS ore on site; and,
- Transferring TRS ore to and processing ore at INCA plant.

Although not explicitly stipulated in the Scoping report, it is assumed that:

- Magnetite ore will be extraction at Shiyela; and,
- That the Shiyela ore will be transported to and processed at the INCA plant.

The Scoping Report stipulates that the main process plant and utilities will be located at the INCA site (Figure 1), while a satellite plant will be operated at the TRS plant.

Activities and facilities at the INCA site will comprise:

- An open pit;
- Covered stockpiles;
- Crushers and mills;
- A (tank) leach plant, an iron plant, a lime plant;
- Solvent extraction facilities;
- Workshops and stores;
- Admin buildings;
- Three waste rock dumps (WRDs);
- A brine evaporation pond; and
- A tailings facility
- Water extraction from the pit or local boreholes for desalination, to be used for all water requirements at INCA.

Activities and facilities at the TRS site will comprise:

- An access road of 14 km between INCA and TRS;
- An open pit;
- Scrubbing and sizing facilities;
- Transportation of ore to INCA plant;
- Water extraction from local wells for onsite processing activities; and,
- Dewatering and backfilling of barren, oversized materials into pit.

Assumed activities and facilities at the TRS site will comprise:

- An open pit, and,
- Transportation of ore to INCA plant.

No external water will be required for the Omahola Project since it is proposed that all water for processing and domestic purposes will be sources on site. The existing servitudes for the

Langer Heinrich power line and communications lines may possibly be used for the supply to the Omahola Project, but no linear infrastructure was assessed in this report. No employees will be housed on site during construction or operation.

4.4. Impact assessment methodology

The impact assessment methodology is not presented here as it is set out in the main Environmental Impact Assessment report by Softchem.

4.5. Impact assessment

The primary determinants of invertebrate habitats in the Central Namib are the habitat structure, substrate and vegetation. The vast majority of direct impacts on invertebrate habitats by mining and related activities in the Desert relates to any kind of activity which entail the potential destruction of the physical structure of a habitat, the substrate that makes up the habitat or impacts on the vegetation of a habitat. Other important invertebrate habitat determinants and drivers are the availability of uncontaminated groundwater to sustain vegetation, production and availability of detritus and the presence of game and other vertebrates.

The potential impacts of the Omahola Project on invertebrate habitats and/or the key habitat determinants include:

4.5.1. Impact 1. Impacts on invertebrate habitats by footprint of the Project Area.

The footprint of the project includes all construction, mining and related activities and infrastructure, both within the project area but also along access routes to the Project area during all phases of the project.

Large scale terrain changes (open pits, waste rock dumps, tailings dumps) affect the microclimate of the area, and replace the natural substrate with one that is unusable for indigenous invertebrates and other biota. Dumps will not weather back into natural hillsides within time scales compatible with invertebrate life cycles, and backfilling of open pits likewise will not constitute restoration of habitats to previously existing conditions. The only effective mitigation measures that will ensure the preservation of invertebrate habitats and ecosystems is to avoid impacts as far as possible, or minimise them from the start of the project and beyond decommissioning through careful planning, monitoring and feedback systems.

All invertebrate habitats are threatened by this these potential impacts.

Environmental aspect	Invertebrates	Phase	Construction

Description: Disruption and destruction of invertebrate habitats by the footprint of the project-

- including excavation of the mining pit, removal of vegetation, levelling and contouring of slopes, stripping of overburden, dumping of (overburden, waste rock etc.) and general project activities
- Risk of habitat degradation due to increased and unregulated access to the area
- Possibility of poaching, illegal collection of firewood and seeds, indiscriminant driving, pollution
- Introduction of alien invasive species that may outcompete indigenous fauna
- Noise disturbance deterring larger animals from their normal routes as well as nesting birds, with consequent ecological effects

Avoid: No-go and highly sensitive habitats as far as possible.
Mitigation:

- Design footprints of all facilities to be as small as possible and to restrict unnecessary collateral damage around the periphery
- Where construction are to take place in close proximity to highly sensitive habitats the footprint of such activities should be clearly demarcated to run clear of the sensitive habitats and to avoid collateral damage such habitats
- Plan and operate waste rock and tailings dump sites to minimise terrain changes and fit in with existing topography
- Develop and actively enforce zero-tolerance policies concerning poaching, wood collecting and pollution
- Ensure that guidelines and rules are regularly communicated to workers and visitors, enforce this by adequate signage in appropriate places
- Allow only project personnel and registered visitors on site
- Prohibit off-road driving, plan roads beforehand, reuse existing tracks

<table>
<tr><th rowspan="2">Confidence level</th><th rowspan="2">Mitigation required</th><th colspan="6">Evaluation of impacts</th></tr>
<tr><th>Nature</th><th>Extent</th><th>Duration</th><th>Intensity</th><th>Probability</th><th>Significance</th></tr>
<tr><td>high</td><td>yes</td><td>-</td><td>3</td><td>4</td><td>3</td><td>6</td><td>>50</td></tr>
<tr><td colspan="2">Potential for irreplaceable loss of resources</td><td>yes</td><td colspan="2">Cumulative impacts</td><td>Int syn</td><td>Reversibility</td><td>probably</td></tr>
</table>

Environmental aspect	Invertebrates	Phase	Operation

Description: Disruption and destruction of invertebrate habitats by the footprint of the project-

- including excavation of the mining pit, removal of vegetation, levelling and contouring of slopes, stripping of overburden, dumping of (overburden, waste rock etc.) and general project activities
- Risk of habitat degradation due to increased and unregulated access to the area
- Possibility of poaching, illegal collection of firewood and seeds, indiscriminant driving, pollution
- Introduction of alien invasive species that may outcompete indigenous fauna
- Noise disturbance deterring larger animals from their normal routes as well as nesting birds, with consequent ecological effects

Avoid: No-go and highly sensitive habitats as far as possible.
Mitigation:

- Design footprints of all facilities to be as small as possible and to restrict unnecessary collateral damage around the periphery
- Where construction are to take place in close proximity to highly sensitive habitats the footprint of such activities should be clearly demarcated to run clear of the sensitive habitats and to avoid collateral damage such habitats
- Plan and operate waste rock and tailings dump sites to minimise terrain changes and fit in with existing topography
- Develop and actively enforce zero-tolerance policies concerning poaching, wood collecting and pollution
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<tr><td colspan="2">Potential for irreplaceable loss of resources</td><td>yes</td><td colspan="2">Cumulative impacts</td><td>Int syn</td><td>Reversibility</td><td>no</td></tr>
</table>

4.5.2. *Impact 2. Impacts on invertebrate habitats due to water extraction.*

The extraction of water for construction and operation purposes may have diminishing effects on the availability of groundwater to sustain vegetation, one of the key invertebrate habitat determinants.

All invertebrate habitats of the Omahola project are potentially threatened, either directly or indirectly, by impacts associated with over-extraction of groundwater.

Environmental aspect	Invertebrates					**Phase**	Construction
Description: Water extraction for construction purposes with consequent impacts on and loss of vegetation forming important invertebrate habitat determinants, consequent impacts on invertebrate populations.							
Avoid: Extraction from palaeo water pockets where limited knowledge of their recharge are available. **Mitigation:** Limit water extraction; implement water wise processes and water recycling; stringently prevent water wastage; regularly monitor groundwater levels; monitor plants for signs of water stress.							
Confidence level	**Mitigation required**	**Evaluation of impacts**					
		Nature	**Extent**	**Duration**	**Intensity**	**Probability**	**Significance**
medium	yes	-	3	4	3	6	**>50**
Potential for irreplaceable loss of resources		yes	**Cumulative impacts**		Int syn	**Reversibility**	probably

Environmental aspect	Invertebrates					**Phase**	Operation
Description: Water extraction for construction purposes with consequent impacts on and loss of vegetation forming important invertebrate habitat determinants, consequent impacts on invertebrate populations.							
Avoid: Extraction from palaeo water pockets where limited knowledge of their recharge are available. **Mitigation:** Limit water extraction; implement water wise processes and water recycling; stringently prevent water wastage; regularly monitor groundwater levels; monitor plants for signs of water stress.							
Confidence level	**Mitigation required**	**Evaluation of impacts**					
		Nature	**Extent**	**Duration**	**Intensity**	**Probability**	**Significance**
medium	yes	-	3	4	3	6	**>50**
Potential for irreplaceable loss of resources		yes	**Cumulative impacts**		Int syn	**Reversibility**	probably

4.5.3. *Impact 3. Impacts on invertebrate habitats due to disruption of surface water flow.*

Drainage lines are important lifelines to invertebrate populations as it sustains vegetation, one of the key habitat determinants desert ecosystems. The availability of groundwater and the maintenance of geohydrological processes of drainage lines are vital for the longevity invertebrate populations.

All invertebrate habitats of the Omahola project are potentially threatened, either directly or indirectly, by impacts associated with disruption of surface water flow.

Environmental aspect	Invertebrates	Phase	Construction

Description: Disrupting surface water flow by blocking or deviation the flow of natural drainages with infrastructure such as roads, dumps of pits –

- Disruption of recharge of alluvium and consequent adverse effects on vegetation and ecosystem
- Interference with re-charge of aquifers
- Disruption of seeds & nutrients transport by surface water flow, threat to survival of vegetation and ecosystem.
- Disruption of nutrient transport
- Interference with water supply of riparian vegetation
- Impact on invertebrate, reptile and small mammal populations of the plains habitat that usually find shelter and food within the drainage systems when food and shelter aren't available on the open plains

Avoid: Building infrastructure across drainage lines as far as possible.
Mitigation: Building infrastructure across drainage lines without making adequate provision for potential flood water to bypass the infrastructure, which will maintain groundwater flow in drainage lines.

Confidence level	Mitigation required	Evaluation of impacts					
		Nature	Extent	Duration	Intensity	Probability	Significance
low	yes	-	2	1	2	4	**< 25**
Potential for irreplaceable loss of resources		probably	**Cumulative impacts**		Int syn	**Reversibility**	probably

Environmental aspect	Invertebrates	Phase	Operation

Description: Disrupting surface water flow by blocking or deviation the flow of natural drainages with infrastructure such as roads, dumps of pits –

- Disruption of recharge of alluvium and consequent adverse effects on vegetation and ecosystem
- Interference with re-charge of aquifers
- Disruption of seeds & nutrients transport by surface water flow, threat to survival of vegetation and ecosystem.
- Disruption of nutrient transport
- Interference with water supply of riparian vegetation
- Impact on invertebrate, reptile and small mammal populations of the plains habitat that usually find shelter and food within the drainage systems when food and shelter aren't available on the open plains

Avoid: Building infrastructure across drainage lines as far as possible.
Mitigation: Building infrastructure across drainage lines without making adequate provision for potential flood water to bypass the infrastructure, which will maintain groundwater flow in drainage lines.

medium	yes	-	3	3	3	6	**>50**
Potential for irreplaceable loss of resources		yes	**Cumulative impacts**		Int syn	**Reversibility**	probably

4.5.4. ***Impact 4. Impacts on invertebrate habitats due to discharge to groundwater.***

As with the potential impacts associated with the extraction of groundwater or the disruption of surface water flow, any impacts on the quality the groundwater available in the ecosystem may have detrimental effects on the invertebrate populations and the ecosystem in general.

All invertebrate habitats of the Omahola project are potentially threatened, either directly or indirectly.

Environmental aspect	Invertebrates					**Phase**	Construction
Description: Flooding events, seepage or spillage of fuels and other hydrocarbons, hazardous waste materials and domestic waste can cause contamination of groundwater and transport of pollutants downstream with adverse effects on vegetation and ecosystems in general.							
Mitigation: Develop a waste policy and hazardous materials handling policy and actively enforce it; provide appropriate waste deposition facilities on site; remove domestic waste often; keep drainage lines clean to ensure that surface water pollutants are not washed downstream in the event of floods; develop and implement appropriate emergency clean-up plans for accidental spills; provide adequate toilet facilities for personnel; vigorously monitor sites for spills, spill hazards or non-compliance.							
Confidence level	**Mitigation required**	**Evaluation of impacts**					
		Nature	**Extent**	**Duration**	**Intensity**	**Probability**	**Significance**
medium	yes	-	3	2	2	4	**25-50**
Potential for irreplaceable loss of resources		probably	**Cumulative impacts**		yes	**Reversibility**	probably

Environmental aspect	Invertebrates					**Phase**	Operation
Description: Flooding events, seepage or spillage of fuels and other hydrocarbons, hazardous waste materials and domestic waste can cause contamination of groundwater and transport of pollutants downstream with adverse effects on vegetation and ecosystems in general.							
Mitigation: Develop a waste policy and hazardous materials handling policy and actively enforce it; provide appropriate waste deposition facilities on site; remove domestic waste often; keep drainage lines clean to ensure that surface water pollutants are not washed downstream in the event of floods; develop and implement appropriate emergency clean-up plans for accidental spills; provide adequate toilet facilities for personnel; vigorously monitor sites for spills, spill hazards or non-compliance.							
Confidence level	**Mitigation required**	**Evaluation of impacts**					
		Nature	**Extent**	**Duration**	**Intensity**	**Probability**	**Significance**
high	yes	-	3	3	3	6	**> 50**
Potential for irreplaceable loss of resources		yes	**Cumulative impacts**		Int syn	**Reversibility**	probably

4.5.5. Impact 5. Impacts on invertebrate populations due to habitat fragmentation.

Increased construction and mining activities, as well as development of physical barriers can cause fragmentation of habitats and restrict movement of animals. Fragmentation isolates organisms from populations, with possible detrimental effects on populations and consequently to whole ecosystems.

Increased activity or barriers can deter and prevent access to game, physical barriers isolate small populations of range-restricted invertebrates or plants in patchy habitats and blocking or interference with surface water flow in drainages can prevent downstream transport of seeds and threaten the survival of vegetation.

Omahola habitats most threatened by these impacts include the Marble ridge habitat, Granite hill, Granite ridges and all the drainages and washes.

Environmental aspect	Invertebrates				Phase	Construction
Description: Habitat fragmentation caused by disturbance or physical barriers - organisms isolated from populations, possible detrimental impacts on the livelihood of range-restricted animals and plants and ecosystems.						
Avoid: any sort of development on or across the Marble ridge habitat, Granite hill, Granite ridges. **Mitigation:** Avoid or minimise development of infrastructure in or across drainages; design footprints of all facilities to be as small as is practically possible and restrict unnecessary collateral damage around the periphery; research effective biodiversity monitoring procedures and implement during construction, operation and beyond decommissioning.						

Confidence level	Mitigation required	Evaluation of impacts					
		Nature	Extent	Duration	Intensity	Probability	Significance
medium	yes	-	3	1	2	6	**25 – 50**
Potential for irreplaceable loss of resources		probably	**Cumulative impacts**		yes	**Reversibility**	probably

Environmental aspect	Invertebrates				Phase	Operation
Description: Habitat fragmentation caused by disturbance or physical barriers - organisms isolated from populations, possible detrimental impacts on the livelihood of range-restricted animals and plants and ecosystems.						
Avoid: any sort of development on or across the Marble ridge habitat, Granite hill, Granite ridges. **Mitigation:** Avoid or minimise development of infrastructure in or across drainages; design footprints of all facilities to be as small as is practically possible and restrict unnecessary collateral damage around the periphery; research effective biodiversity monitoring procedures and implement during construction, operation and beyond decommissioning.						

Confidence level	Mitigation required	Evaluation of impacts					
		Nature	Extent	Duration	Intensity	Probability	Significance
medium	yes	-	4	4	3	6	**> 50**
Potential for irreplaceable loss of resources		yes	**Cumulative impacts**		yes	**Reversibility**	probably

4.5.6. Impact 6. Impacts on invertebrate habitats due to dust.

Excessive deposition of unnatural dust can alter invertebrate habitats to the extent that it becomes uninhabitable. In the presence of coastal fog, fine dust can form a physical soil crust that cements rocks and stones to the substrate, preventing invertebrates from using these as natural shelter. Central Namib invertebrates tend to be substrate specific, so drastic substrate alteration will lead to local loss of species. Elevated dust levels can also affect the photosynthetic and respiratory abilities of vegetation.

All invertebrate habitats are threatened by these potential impacts.

Environmental aspect	Invertebrates				Phase	Construction	
Description: Increased dust generation in project footprint area and along roads and tracks due to traffic and construction activities - adverse effect on invertebrate habitats and vegetation.							
Mitigation: Adapt policies to limit dust generation (such as avoiding speeding on site and access roads); implement dust suppression measures on site and access roads; monitor dust fallout; monitor vegetation for damage due to dust.							
Confidence level	**Mitigation required**	**Evaluation of impacts**					
		Nature	**Extent**	**Duration**	**Intensity**	**Probability**	**Significance**
medium	yes	-	3	1	2	6	**25 – 50**
Potential for irreplaceable loss of resources		probably	**Cumulative impacts**		yes	**Reversibility**	probably

Environmental aspect	Invertebrates				Phase	Operation	
Description: Increased dust generation in project footprint area and along roads and tracks due to traffic and construction activities - adverse effect on invertebrate habitats and vegetation.							
Mitigation: Adapt policies to limit dust generation (such as avoiding speeding on site and access roads); implement dust suppression measures on site and access roads; monitor dust fallout; monitor vegetation for damage due to dust.							
Confidence level	**Mitigation required**	**Evaluation of impacts**					
		Nature	**Extent**	**Duration**	**Intensity**	**Probability**	**Significance**
high	yes	-	3	3	3	6	**> 50**
Potential for irreplaceable loss of resources		yes	**Cumulative impacts**		yes	**Reversibility**	probably

4.5.7. Impact 7. Impacts on invertebrates and their habitats due to environmental monitoring.

The environmental management plan of the Omahola project will stipulate various environmental monitoring requirements, as is prescribed by the Namibian environmental legislation, worldwide best practice as well as the Strategic Environmental Assessment (SAIEA 2010). If done properly and continuously, the application of this monitoring data may have vast positive outcomes for future restoration and conservation endeavours in the Namib.

<table>
<tr><td colspan="2">Environmental aspect</td><td colspan="4">Invertebrates</td><td>Phase</td><td>Operation</td></tr>
<tr><td colspan="8">Description: Monitoring of environmental aspects within or affected by the project footprint area can generate information about this part of the desert previously not available. Such knowledge can feed into restoration experiments and other databanks which may lead to more effective conservation of desert ecosystems.</td></tr>
<tr><td colspan="8">Mitigation: Standard monitoring methods should be applied throughout the lifetime of the project, and data should be made available for use in research and inclusion in relevant, accessible databanks.</td></tr>
<tr><td rowspan="2">Confidence level</td><td rowspan="2">Mitigation required</td><td colspan="6">Evaluation of impacts</td></tr>
<tr><td>Nature</td><td>Extent</td><td>Duration</td><td>Intensity</td><td>Probability</td><td>Significance</td></tr>
<tr><td>high</td><td>yes</td><td>+</td><td>4</td><td>3</td><td>3</td><td>4</td><td>25 - 50</td></tr>
<tr><td colspan="2">Potential for irreplaceable loss of resources</td><td></td><td colspan="2">Cumulative impacts</td><td>yes</td><td>Reversibility</td><td></td></tr>
</table>

<table>
<tr><td colspan="2">Environmental aspect</td><td colspan="4">Invertebrates</td><td>Phase</td><td>Decommissioning</td></tr>
<tr><td colspan="8">Description: Post-closure monitoring of environmental aspects within or affected by the project footprint area can generate information about this part of the desert previously not available. Such knowledge can feed into restoration experiments and other databanks which may lead to more effective conservation of desert ecosystems.</td></tr>
<tr><td colspan="8">Mitigation: Standard monitoring methods should be applied throughout the lifetime of the project, and data should be made available for use in research and inclusion in relevant, accessible databanks.</td></tr>
<tr><td rowspan="2">Confidence level</td><td rowspan="2">Mitigation required</td><td colspan="6">Evaluation of impacts</td></tr>
<tr><td>Nature</td><td>Extent</td><td>Duration</td><td>Intensity</td><td>Probability</td><td>Significance</td></tr>
<tr><td rowspan="2">Confidence level</td><td rowspan="2">Mitigation required</td><td colspan="6">Evaluation of impacts</td></tr>
<tr><td>Nature</td><td>Extent</td><td>Duration</td><td>Intensity</td><td>Probability</td><td>Significance</td></tr>
<tr><td>high</td><td>yes</td><td>+</td><td>4</td><td>3</td><td>3</td><td>4</td><td>25 - 50</td></tr>
</table>

5. CONCLUSIONS AND RECOMMENDATIONS

The Omahola project is situated in an extremely fragile environment of global biodiversity significance, significant enough to have been proclaimed a National Park by the Namibian government. Mining is an unsustainable economic activity with a history of causing environmental degradation. The Namibian people expect the post-mining environment of their National Park to have suffered no degradation compared to pre-mining conditions (as exemplified i.a. by the current baseline study). This places an enormous responsibility on RUN to proceed with their enterprise with the utmost environmental caution. In cases where the maintenance of the post-mining ecological viability of the Omahola mining area conflicts with the cost of doing business, established mining methodology, logistical expedience, practicality, or whatever, the latter should be carefully reconsidered to find win-win solutions.

Potential impacts of the Omahola Project on invertebrate ecosystems and the way they function are those that pertain to substrate disruption and impacts on vegetation. This basically comprises any and all aspects of the Project, due to the fragility of the area and the slow nature of natural restoration processes of hyper arid areas. In many cases the self-healing ability of the ecosystem may even cease after impact. In light of this, the footprint of the Project should be kept to a minimum and be clearly demarcated to prevent damage to adjacent habitats. It is recommended that no-go habitats and other highly sensitive habitats be avoided completely, and that effective operational controls and feedback mechanisms be implemented to guarantee the preservation of these habitats.

Regular monitoring of ecosystem vitality parameters is essential throughout the lifetime of the Project and beyond. This can only be effective if the information gaps identified during baseline and subsequent studies are addressed from the onset and if management systems are designed as such to allow for the incorporation of the resulting feedback.

Studies like the current one can survey the invertebrate fauna and point out the taxa of interest and gaps in knowledge (Section 3 above), but the necessary follow-up work to fully identify the collected material and describe the undoubtedly many new species that are involved, is not included in the Terms of Reference. The Government, in the form of the National Museum of Namibia, currently and into the foreseeable future lacks the capacity to fulfil its obligation in this regard. As each subsequent Central Namib study adds more general information, the proportion of available specific, species-level information gets progressively less (refer already low number of species level identifications compared to overall taxa encountered). Companies wishing to enhance their ability to implement environmental management to include invertebrates as well, may wish to include in their commitment to environmental and social responsibility the occasional commissioning of short-term taxonomic revisions that are targeted to clarify the status of particular invertebrates of concern in their operational area. This could become a significant positive offset to counter environmental damage to a National Park and enhance post-mining rehabilitation potential. In the case of RUN, any of the taxa mentioned as potentially undescribed, endemic or particularly diverse but unknown in Section 3 above would be appropriate first targets.

6. REFERENCES

African Museum Tervuren, 2011. Website accessed May 2011. http://www.africamuseum.be

AYAL, Y. 2006. Trophic structure and the role of predation in shaping hot desert communities. *Journal of Arid Environments*. **68(**2): 171-187

BEIER, M. 1973. Weiteres zur Kenntnis der Pseudoscorpioniden Südwestafrikas. *Cimbebasia*, (A)**2**(7): 97-101.

BELNAP J. & LANGE O.L., 2001. Biological soil crusts: structure, function and management. *Springer Ecological Studies Vol. 150.* 503 pp.

BELNAP, J. & GILETTE, D.A., 1998. Vulnerability of desert biological soil crusts to wind erosion: the influences of crust development, soil texture, and disturbance. *Journal of Arid Environments*. **39**(2): 133-142.

BELNAP, J., 2003. The World At Your Feet: Desert Biological Soil Crusts. *Frontiers in Ecology and the Environment*. **1**(4): 181-189.

BURKE A., 2007. *Eleven Steps to rehabilitation in the Succulent Karoo and Namib Desert*. EnviroScience and Namibia Nature Foundation. Oranjemund & Windhoek. 24 pp.

COATON, W.G.H. & Sheasby, J.L. 1973. National survey of the Isoptera of southern Africa. 3. The genus *Psammotermes* Desneux (Rhinotermitidae). *Cimbebasia*, (A)**3**: 19-28.

COATON, W.G.H. & Sheasby, J.L. 1975. National Survey of the Isoptera of Southern Africa. 8. The genus *Hodotermes* Hagen (Hodotermitidae). *Cimbebasia*, (A) **3**(10): 105-138.

ECOTRUST, 2010. Vegetation of the Inca, Tubas and Shiyela Sites of Reptile Uranium Namibia (RUN).Unpublished report prepared for Softchem CC.

FREEMAN, P. 1956. A study of African Chironomidae, Part II. *Bulletin of the British Museum of Natural History (Entomology)*, **4**(7):285-366.

GLOBAL BIODIVERSITY INFORMATION FACILITY (GBIF), 2011. Website accessed May 2011. http://www.gbif.org

HESSE, A.J. 1925. Contributions to a knowledge of the fauna of South West Africa. IV. A list of the heteropterous and homopterous Hemiptera of South West Africa. *Annals of the South African Museum*, **23**(1): 1-190.

IRISH, J. 1988. A review of the family Lathiceridae Dirsh (Orthoptera: Acridoidea). *Revue de Zoologie africaine / Journal of African Zoology*, **102**: 463-472.

IRISH, J. 2007. Summary of the 1984/85 baseline biodiversity survey of the Rössing area, Central Namib Desert. 59 pp. (Unpublished report to RUL).

IRISH, J. 2009. *Conservation status of endemic Central Namib invertebrates.* Unpublished report for Uranium Province SEA, via SAIEA.

IRISH, J. 2010. Specialist study on the invertebrates of the proposed Rössing South Project site and surrounding areas. Unpublished report for Extract, via AWR and Metago.

KALTENBACH, A.P. 1996. Unterlagen für eine Monographie der Mantodea des südlichen Afrika: 1. Artenbestand, geographische Verbreitung und Ausbreitungsgrenzen (Insecta: Mantodea). *Annalen des Naturhistorischen Museums in Wien*, **98**B: 193-346.

KOCH, C. 1962. The Tenebrionidae of Southern Africa. XXXII. New psammophilous species from the Namib Desert. *Annals of the Transvaal Museum*, 24: 107-159.

LAMORAL, B.H. 1979. The scorpions of Namibia (Arachnida: Scorpionida). *Annals of the Natal Museum*, **23**(3):497-784.

LOUW, S. 1981. Revision of the genus *Hyomora* Pascoe, 1865 (Coleoptera: Curculionidae: Rhytirrhininae). *Cimbebasia*, (A) **5**: 229-250.

MEINANDER, M. 1998. Coniopterygidae (Neuroptera) from southern and eastern Africa. *African Entomology*, **6**(1): 117-146.

MENDELSOHN, J., JARVIS, A., ROBERTS, C., & ROBERTSON, T., 2009. *Atlas of Namibia: A Portrait of the Land and its People.* Cape Town: Sunbird Publishers. 200 pp.

NAMIBIAN BIODIVERSITY DATABASE (NaBiD)-. Website accessed May 2011: http://oldsite.biodiversity.org.na

NGUYEN DUY-JACQUEMIN, M. 2003. A new genus of Penicillata from Southern Africa with pseudoarticulated sensilla on the palpi of the gnathochilarium (Diplopoda: Polyxenida: Polyxenidae). *African Invertebrates*, **44**(1): 71-87.

PENRITH, M.-L. 1979. Revision of the western Southern African Adesmiini (Coleoptera: Tenebrionidae). *Cimbebasia*, (A)**5**(1): 1-94.

PLATNICK, N.I. & GRIFFIN, E. 1990. On *Rastellus*, a new genus of the spider family Ammoxenidae (Araneae: Gnaphosoidea). *American Museum Novitates*, **2995**: 1-11.

SAIEA, 2010. Strategic Environmental Assessment for the Central Namib Uranium Rush. Ministry of Mines and Energy, Windhoek, Republic of Namibia.

SEELY, M.K. & PALLET, J., 2008. *Namib. Secrets of a desert uncovered*. Venture Publications, Windhoek, Namibia. 202 pp.

SOFTCHEM CC, 2010. *Scoping Report for the Omahola Project*. Unpublished Public Access Report compiled for Reptile Uranium Namibia.

SOUTH AFRICAN BIODIVERSITY INFORMATION FACILITY, 2011. Website accessed May 2011. http://www.sabif.ac.za

TURGIS CONSULTING, 2008. Report of the Environmental and Social Impact Assessment Trekkopje Uranium Project, Erongo Region, Namibia. Final Draft. Prepared for Uramin Namibia.

WALTER, H. 1976. Gibt es in der Namib Nebelpflanzen? *Namib und Meer* 7: 5-13.

Appendix 1

Numbers of invertebrates encountered during a survey of the Omahola Project.

a) Numbers of individuals encountered per taxon per trapline per trapping period, first two periods

b) Numbers of individuals encountered per taxon per trapline per trapping period, last two periods

c) Taxa recorded during manual survey

a) Numbers of individuals encountered per taxon per trapline per trapping period, first two periods.

		25 November 2010 – 20 December 2010													20 December 2010 – 10 January 2011												
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
ARACHNIDA																											
ACARI	sp. 1					2			1	2				**5**	1	1	1	2		6		7					**18**
	sp. 2										1			**1**					5					2			**7**
	sp. 3																						57				**57**
	sp. 4								1					**1**			1										**1**
	sp. 5									1				**1**			1	1						1			**3**
	sp. 6													**0**						2			2				**4**
	sp. 7													**0**			2			1							**3**
	sp. 8													**0**								1					**1**
	sp. 9													**0**													**0**
	sp. 10													**0**													**0**
	sp. 11													**0**													**0**
ARANEAE																											
Ammoxenidae	*Ammoxenus* sp.		3			2								**5**					4				2	1			**7**
	Rastellus sp.				1		1		1		1			**4**	1	1	3	1	4	7		3		7			**27**
Araneidae	sp.													**0**								1		1			**2**
Eresidae	sp.		1	1										**2**													**0**
Gnaphosidae	sp. 1	3				3	1							**7**										1			**1**
	sp. 2							1						**1**					1				2				**3**
	sp. 3					36		2	2		6		3	**49**	2	1	1		56	1	3			2		1	**67**
Oonopidae	sp.		1					5	6	1	3			**16**		2	2	10	3	3	2	5	5	2			**34**
Oxyopidae	sp.													**0**													**0**
Palpimanidae	sp. 1	2		1	2	2	3	1	4		2			**17**	3	1	1		6	2	3	1		1			**18**
	sp. 2			1	2		7	10	2	3	4			**29**			1	5	10	12	12	3	7	2			**52**
	sp. 3													**0**										1	1		**2**
Philodromidae	sp.		1	3					2					**6**		2						1					**3**
Pholcidae	sp. 1	2				1			1					**4**									2				**2**
	sp. 2								2	1	1			**4**					1			2	4		1		**8**
Prodidomidae	sp.								1					**1**			1			1							**2**

		25 November 2010 – 20 December 2010													20 December 2010 – 10 January 2011												
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
Salticidae	sp.	3	1	23	4	6	16	13	16	24	10	3	12	**131**	1		21	7	9	18	14	11	25	6	3	10	**125**
Sicariidae	*Loxosceles* sp.													**0**									1				**1**
	Sicarius sp.													**0**					1								**1**
Sparassidae	sp. 1				1									**1**				1				3	1				**5**
	sp. 2									1				**1**													**0**
Zodariidae	sp.									1				**1**													**0**
indet.	sp. 1			1							1			**2**			1	1									**2**
	sp. 2				1									**1**													**0**
	sp. 3								1	2				**3**													**0**
	sp. 4													**0**													**0**
	indet.													**0**									1				**1**
PSEUDO-SCORPIONIDA	sp.						4							**4**					9	2				1			**12**
SCORPIONIDA																											
Buthidae	*Parabuthus granulatus*	1		1					1	1				**4**						1		1	1				**3**
	Uroplectes sp.					1		1	2					**4**						1	1						**2**
	indet.													**0**													**0**
SOLPUGIDA																											
Ceromidae	spp.						1		2					**3**					2								**2**
Hexisopodidae	sp.						1							**1**											1		**1**
Melanoblossidae	spp.							3	3	7	4	3	2	**22**	2	1	3	3	5	8	6	2	5	3	2	3	**43**
Solpugidae	spp.		1	1	2	4	4	12	1	3	7			**35**				3	4	1	11	1	4	9	1		**34**
indet.			1	1	6	3	4							**15**						2	1				1		**4**
CRUSTACEA																											
Isopoda	sp.													**0**		5											**5**
INSECTA																											
BLATTODEA																											
Blattellidae	sp. 1	3	1		1									**5**							1			1			**2**
	sp. 2	7	4			4	1		1		1			**18**	2			1	1			1		2			**7**
	sp. 3	10	6		2	1			1					**20**		3		1	2	1							**7**
	sp. 4				1									**1**		4						1	1				**6**

		25 November 2010 – 20 December 2010													20 December 2010 – 10 January 2011												
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
	sp. 5					1								**1**	1												**1**
COLLEMBOLA																											
Entomobryidae	spp.					1	1		1		1			**4**	1	13		1	2	1		1	2	1			**22**
Poduridae	sp.													**0**													**0**
COLEOPTERA																											
Anobiidae	sp.													**0**		4											**4**
Anthicidae	sp.													**0**	1				1			1					**3**
Bruchidae	sp.													**0**													**0**
Carabidae	Anthiinae sp.						4	1		2				**7**						3	1		1				**5**
	Caminara sp.													**0**													**0**
	sp. 1							1		1				**2**							1						**1**
	sp. 2													**0**	1												**1**
	sp. 3													**0**	1												**1**
Catopidae	sp. 1							2		1				**3**			1				4						**5**
	sp. 2													**0**			8				5						**13**
Chrysomelidae	Cassidinae sp.													**0**					1								**1**
	Clytrinae sp.			4		1								**5**													**0**
	Eumolpinae sp.													**0**											1	1	**2**
Coccinellidae	sp.													**0**													**0**
Curculionidae	Brachycerinae sp.													**0**													**0**
	Hyomora sp.			1		1								**2**													**0**
	Neocleonus sp.			1										**1**													**0**
	Ocladius sp.													**0**													**0**
	sp. 1						1					1	1	**3**													**0**
	sp. 2							2						**2**													**0**
	sp. 3													**0**										1			**1**
	sp. 4													**0**													**0**
	sp. 5											2		**2**							1		1				**2**
Dascillidae	sp.										1			**1**													**0**
Dermestidae	sp. 1	1		2		1								**4**				1				2					**3**

		25 November 2010 – 20 December 2010													20 December 2010 – 10 January 2011												
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
	sp. 2		1											**1**													**0**
	sp. 3										1			**1**													**0**
Histeridae	sp.													**0**													**0**
Meloidae	sp. 1											1		**1**													**0**
	sp. 2													**0**													**0**
Melyridae	sp. 1			15	2	1		71	77	5	59			**230**			6	1		2	43	45	5	20	1		**123**
	sp. 2						1	5						**6**				1		1	3			1			**6**
Mordellidae	sp.													**0**													**0**
Nitidulidae	sp.													**0**													**0**
Ptinidae	Ptininae sp.													**0**		1											**1**
	Stethomezium sp.													**0**													**0**
Scarabaeidae	Aphodiinae sp.													**0**													**0**
	Melolonthinae sp.													**0**													**0**
	Rutelinae													**0**													**0**
Silvanidae	sp. 1	1												**1**													**0**
Staphylinidae	sp. 1													**0**													**0**
	sp. 2													**0**													**0**
Tenebrionidae	*Cauricara eburnea*													**0**													**0**
	Drosochrini sp.													**0**										1			**1**
	Epiphysa punctatissima	2		1	2	3	2	7	1	2	10			**30**							2	1		2		1	**6**
	Eurychora sp.													**0**													**0**
	Geophanus sp.				1		1		2					**4**							1	1	1				**3**
	Gonopus sp.	12				1		1	1					**15**	1												**1**
	Metriopus depressus		1									2	1	**4**		3									1		**4**
	Namibomodes sp.										1			**1**													**0**
	Parastizopus sp.	7	7	1	1	3		1	1		2			**23**	3	6	3	1	1	2			3	1			**20**
	Physadesmia globosa		1	1			1							**3**				1	2				1				**4**
	Physosterna cribripes	8	10	16	2	10								**46**	1		4				1						**6**
	Rhammatodes sp.	11	2		7	39	22	45	51	49	19	15	5	**265**	4	3	2	19	14	22	55	45	4	20		5	**193**
	Somaticus sp.													**0**													**0**

		25 November 2010 – 20 December 2010													20 December 2010 – 10 January 2011												
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
	Stips dohrni	3			1	1		1						**6**	1						1						**2**
	Stizopina sp.					14					1			**15**					3			1					**4**
	Tenebrioninae sp.													**0**											2	1	**3**
	Tentyriini sp.													**0**				1									**1**
	Zophosis amabilis				2						1	31		**34**											2	2	**4**
	Zophosis devexa	1	5											**6**		3											**3**
	Zophosis dorsata								1					**1**													**0**
	Zophosis sp.								6	1				**7**			1					2	1				**4**
	Zophosis cf. *Gyrosis* sp.													**0**													**0**
Thorictidae	sp.					2								**2**					1								**1**
indet.														**0**			2		1				3		1		**7**
DIPTERA																											
Acalyptratae	sp. 1													**0**		2	1	1	1								**5**
	sp. 2													**0**		1	1				1						**3**
	sp. 3													**0**													**0**
	sp. 3													**0**													**0**
	indet.							2		3				**5**		1	1		1								**3**
Bombyliidae	sp. 1													**0**								1					**1**
	sp. 2													**0**													**0**
	sp. 3													**0**													**0**
Calliphoridae	sp.													**0**													**0**
Camillidae	sp.													**0**													**0**
Cecidomyiidae	sp.											1		**1**									1				**1**
Chironomidae	sp.													**0**													**0**
Chloropidae	sp. 1		1		7	3	2							**13**						1				1			**2**
	sp. 2		1			1	1	1						**4**		11	2	2	5	1		1	6	3	1		**32**
	sp. 3					1				4				**5**		2	3	1	2	2	3	3	8			2	**26**
	sp. 4			1		7		2						**10**				2	3								**5**
	sp. 5							3			7			**10**	2	2	2		2	4	10	3	1	7	1		**34**
	sp. 6							1						**1**			4	1	1	1	3						**10**

		25 November 2010 – 20 December 2010													20 December 2010 – 10 January 2011												
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
	sp. 7													**0**		1	10	5	1	3		2		4			**26**
Conopidae	sp.													**0**													**0**
Culicidae	sp.													**0**													**0**
Curtonotidae	sp.													**0**									1				**1**
Drosophilidae	sp.													**0**													**0**
Empididae	sp. 1							1						**1**								2					**2**
	sp. 2													**0**													**0**
	sp. 3													**0**													**0**
Heleomyzidae	sp.	1	6	3		3	2			1				**16**													**0**
Lonchaeidae	sp.													**0**													**0**
Muscidae	sp. 1	1						1		2				**4**													**0**
	sp. 2													**0**													**0**
	sp. 3								1					**1**													**0**
	sp. 4													**0**													**0**
Mycetophilidae	sp.													**0**													**0**
Mythicomyiidae	sp.										1			**1**	1									1			**2**
Phoridae	sp. 1													**0**													**0**
	sp. 2													**0**													**0**
	sp. 3													**0**													**0**
Psychopsidae	sp.													**0**													**0**
Sarcophagidae	sp. 1					3		1						**4**				1	3			2	1	1			**8**
	sp. 2					3								**3**			1	1	2					1			**5**
	sp. 3													**0**						1							**1**
Sciaridae	sp.							2						**2**			1		1								**2**
Sepsidae	sp.													**0**													**0**
Syrphidae	sp. 1													**0**													**0**
	sp. 2													**0**													**0**
Tachinidae	sp. 1			1										**1**													**0**
	sp. 2							1						**1**					1								**1**
	sp. 3					1								**1**													**0**

		25 November 2010 – 20 December 2010													20 December 2010 – 10 January 2011												
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
	sp. 4													**0**				1									**1**
Tephritidae	sp. 1													**0**					1								**1**
	sp. 2													**0**													**0**
	sp. 3													**0**													**0**
Therevidae								1	1					**2**		2											**2**
indet.														**0**													**0**
HEMIPTERA																											
Alydidae	sp.													**0**				1									**1**
Anthocoridae	sp. 1													**0**													**0**
	sp. 2													**0**													**0**
Aphididae	sp.													**0**				1					1				**2**
Berytidae	sp.													**0**													**0**
Cicadellidae	sp. 1	1			1									**2**													**0**
	sp. 2					1								**1**				2	5								**7**
	sp. 3													**0**													**0**
	sp. 4													**0**													**0**
	sp. 5													**0**													**0**
	sp. 6													**0**													**0**
	sp. 7													**0**										1			**1**
Cicadidae	sp.													**0**													**0**
Coccoidea	sp. 1							1						**1**				1						1			**2**
	sp. 2													**0**													**0**
	sp. 3													**0**													**0**
Cydnidae	sp. 1													**0**	1												**1**
	sp. 2													**0**													**0**
	indet.													**0**							8						**8**
Fulgorioidea	sp. 1						1							**1**			1										**1**
	sp. 2						2							**2**			1			2							**3**
	sp. 3										2			**2**				1		2				7			**10**
	sp. 4													**0**													**0**

		25 November 2010 – 20 December 2010													20 December 2010 – 10 January 2011												
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
	indet.													**0**										1			**1**
Lygaeidae	sp. 1													**0**													**0**
	sp. 2													**0**													**0**
Miridae	sp.													**0**													**0**
Pentatomidae	sp.						2	6						**8**						1							**1**
Pyrrhocoridae	*Odontopus* sp.							65	16			1	2	**84**							28	5					**33**
Reduviidae	Emesinae sp.				1									**1**													**0**
	Holoptilinae sp.								1					**1**													**0**
	Piratinae sp. 1													**0**													**0**
	Piratinae sp. 2		1						1					**2**													**0**
	indet.													**0**						2		1					**3**
indet.														**0**		1		1						1			**3**
HYMENOPTERA																											
Apoidea	sp.													**0**													**0**
Bethylidae	sp.													**0**													**0**
Braconidae	sp. 1													**0**		2								1			**3**
	sp. 2													**0**													**0**
Bradynobaenidae	sp.													**0**													**0**
Chalcidoidea	spp.			1	1	2	3	1	1	1				**10**		6	5		7	4	4	2	12	3			**43**
Chrysididae	sp.									1				**1**													**0**
Cynipidae	sp. 1													**0**				1									**1**
	sp. 2													**0**													**0**
	sp. 3													**0**													**0**
	sp. 4													**0**													**0**
Formicidae	*Anoplolepis* sp.			23	2									**25**	27		89	4									**120**
	Camponotus sp.	2	1	1				10	2		14			**30**				1		1	5	5	8	5			**25**
	Camponotus maculatus				2	3		17	5	9				**36**	1	1					12	6	3				**23**
	Crematogaster sp.													**0**													**0**
	Lepisiota sp.	3	26	58			3	46	63	34	45			**278**	1	18	1				29	36	15	32			**132**
	Messor sp.		1	1			6	1	1	3				**13**		9	4			7	1	17					**38**

		25 November 2010 – 20 December 2010													20 December 2010 – 10 January 2011												
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
	Monomorium sp. 1	42	15	51	39	65	24	65	46	39	4		4	**394**		21		23	7	51	60	34	23	2			**221**
	Monomorium sp. 2					2	5	37	9	14	8		6	**81**	3	1	1	19	8	2	6	7	6	2		4	**59**
	Monomorium sp. 3							2	2					**4**		2		29	16	2	2						**51**
	Monomorium sp. 4							2	29	18	18	13	2	**82**	19	11	39	29	18	4	9	57	40	26	25	10	**287**
	Ocymyrmex sp.	1			3	17			11		1	41	3	**77**	2			13	14	1		16		5	18	5	**74**
	Pheidole sp.	1		2						1				**4**		2		1				3					**6**
	Tetramorium sp. 1				18		1				16			**35**			5					1	12	15			**33**
	Tetramorium sp. 2													**0**													**0**
	indet.								1					**1**				2			2						**4**
Gasteruptiidae	sp.								1		1		2	**4**		1										3	**4**
Halictidae	sp. 1			3		1	1		1	1				**7**			1		2	1		1	3				**8**
	sp. 2							1						**1**				2	1		1	4				1	**9**
	sp. 3								1					**1**													**0**
	sp. 4													**0**													**0**
Ichneumonidae	sp. 1				1	2								**3**													**0**
	sp. 2													**0**													**0**
Masaridae	sp. 1				1			10	1					**12**				21			3	1					**25**
	sp. 2							1						**1**			1	3	2					1			**7**
	sp. 3								1					**1**													**0**
	sp. 4												1	**1**				2									**2**
	sp. 5													**0**													**0**
	sp. 6													**0**													**0**
Melittidae	sp. 1													**0**													**0**
	sp. 2													**0**													**0**
Mutillidae	sp.										1			**1**													**0**
Plumariidae	sp.										1			**1**										2	1	1	**4**
Pompilidae	sp. 1		1	1	2		3	5		6	1			**19**				1		1	5	1					**8**
	sp. 2				1									**1**													**0**
	sp. 3					1		2						**3**					1		3	1	2	1			**8**
	sp. 4				1									**1**													**0**

		25 November 2010 – 20 December 2010													20 December 2010 – 10 January 2011												
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
	sp. 5						2		1					**3**						3	1						**4**
Proctotrupidae	sp.								2					**2**	1												**1**
Sapygidae	sp.													**0**													**0**
Scoliidae	sp.													**0**													**0**
Sphecidae	sp. 1			3			4			5		1		**13**			1	1	2	1	2	2	4				**13**
	sp. 2			1	1			2		3				**7**				3	5	1	2		5				**16**
	sp. 3					1	1	1						**3**													**0**
	sp. 4			1				1						**2**			2										**2**
	sp. 5							1			1			**2**		1					1						**2**
	sp. 6									1				**1**													**0**
	sp. 7				1									**1**													**0**
	sp. 8					1		2		1				**4**													**0**
	sp. 9					1				1				**2**													**0**
	sp. 10													**0**													**0**
	sp. 11													**0**													**0**
	sp. 12													**0**													**0**
Tiphiidae	sp. 1												1	**1**													**0**
	sp. 2													**0**													**0**
	sp. 3													**0**													**0**
indet.	sp.						1							**1**													**0**
ISOPTERA	*Hodotermes mossambicus*		2					3		1				**6**		313						24					**337**
	Psammotermes allocerus						1							**1**							1						**1**
LEPIDOPTERA																											
Lycaenidae	?*Lepidochrysops* sp.													**0**													**0**
indet.	spp.			3			1	1	2	9		3	1	**20**	3		2	3	6		1		1		2		**18**
	spp.			1	1			1	2	1				**6**								1					**1**
	indet.			8	1		12	23	9	2				**55**			1			2	13	2	1				**19**
	indet.					2								**2**													**0**
MANTODEA	sp. 1				1									**1**													**0**

		25 November 2010 – 20 December 2010													20 December 2010 – 10 January 2011												
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
	sp. 2													**0**													**0**
	sp. 3													**0**													**0**
	sp. 4				1		1							**2**													**0**
NEUROPTERA																											
Chrysopidae	sp.													**0**													**0**
Coniopterygidae	sp.									1	1			**2**			1										**1**
Myrmeleontidae	sp.							1						**1**													**0**
Nemopteridae	sp.													**0**							1						**1**
Psychopsidae	sp.							1						**1**					1			1					**2**
ORTHOPTERA																											
Acrididae	*Acrotylus* sp.													**0**													**0**
	Lithidiinae sp.			1	3		4	1	2		1			**12**		1	1										**2**
	indet.								5					**5**							9						**9**
Mogoplistinae	sp.													**0**		1											**1**
Schizodactylidae	*Comicus capensis*													**0**													**0**
Thericleidae	sp.				1	3		2						**6**					2		1	10					**13**
PSOCOPTERA	spp.			6	4	2	1	12	8	2	1	124	1	**161**	2	2	32	6	6	17	1	25	23	10	8	1	**133**
THYSANOPTERA	sp. 1								1					**1**			1	1									**2**
	sp. 2													**0**			29					5	9				**43**
THYSANURA																											
Lepismatidae	*Afrolepisma* sp.													**0**													**0**
	Ctenolepisma sp. 1	3	2		2		1		7	1	9		1	**26**		4	10	1	3	8	4	10	24	8			**72**
	Ctenolepisma sp. 2	1	2	18	2	1	3		1	1	17	2	4	**52**		7	7	1	3	6	1	13	2	13		4	**57**
	Monachina sp.													**0**		1											**1**
	Thermobia sp.	1							1					**2**													**0**
ORDER	indet.													**0**													**0**
MOLLUSCA																											
Gastropoda	sp.													**0**													**0**
MYRIAPODA																											
Chilopoda	sp.													**0**													**0**

		25 November 2010 – 20 December 2010													20 December 2010 – 10 January 2011												
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
Polyxenida	sp.													**0**		3				1							**4**
	Total	**134**	**106**	**263**	**139**	**271**	**164**	**525**	**428**	**274**	**287**	**244**	**52**	**2887**	**90**	**484**	**327**	**251**	**282**	**233**	**405**	**448**	**354**	**245**	**74**	**55**	**3248**

b) Numbers of individuals encountered per taxon per trapline per trapping period, last two periods.

		10 January 2011 – 1 February 2011													**1-28 February 2011**														
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**	**Grand Total**
ARACHNIDA																												
ACARI	sp. 1	7		19	13	14	10	6	20	67	12	1	2	**171**	6		2	1	4	8	4	7	3			1	**36**	**230**
	sp. 2					10	1				6			**17**					5	1			1	8			**15**	**40**
	sp. 3								1					**1**													**0**	**58**
	sp. 4													**0**										2			**2**	**4**
	sp. 5													**0**		2	1		1				13	1			**18**	**22**
	sp. 6									1				**1**						1							**1**	**6**
	sp. 7													**0**		1		2			3	3	4	1		1	**15**	**18**
	sp. 8													**0**								7	6	2			**15**	**16**
	sp. 9													**0**		2							15				**17**	**17**
	sp. 10													**0**		1											**1**	**1**
	sp. 11													**0**									2				**2**	**2**
ARANEAE																												
Ammoxenidae	*Ammoxenus* sp.		1			4			1					**6**		2			1			1	1				**5**	**23**
	Rastellus sp.						4	2		1	5		2	**14**				1		3	2	4	2	2	1		**15**	**60**
Araneidae	sp.								1		4			**5**									1				**1**	**8**
Eresidae	sp.													**0**													**0**	**2**
Gnaphosidae	sp. 1		1		1									**2**				1				1					**2**	**12**
	sp. 2					1	2				1			**4**										4			**4**	**12**
	sp. 3				2	37	1	4	1			1	1	**47**		1		5	46	1	2		1	1		2	**59**	**222**
Oonopidae	sp.				7	1	6	4	6	4	1			**29**		5	3	4	1	7	12	18	5	3		1	**59**	**138**
Oxyopidae	sp.								1					**1**													**0**	**1**
Palpimanidae	sp. 1	2	1			7	4	3	1	1	1			**20**	5	2		1	5	2	3						**18**	**73**
	sp. 2	1		4	2	2	1	8	14	5	2			**39**		1		1	7	6	15	8	7	3			**48**	**168**
	sp. 3		1							2				**3**				2									**2**	**7**
Philodromidae	sp.		1											**1**		4											**4**	**14**
Pholcidae	sp. 1									1		1		**2**		1		2	1	1			1	1			**7**	**15**
	sp. 2					2								**2**									1				**1**	**15**

		10 January 2011 – 1 February 2011													1-28 February 2011													
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**	**Grand Total**
Prodidomidae	sp.			1										**1**													**0**	**4**
Salticidae	sp.	1	1	11	6	8	29	11	8	35	8		8	**126**	2	5	7	10	4	29	9	18	34	9	1	12	**140**	**522**
Sicariidae	*Loxosceles* sp.							1						**1**							1		1				**2**	**4**
	Sicarius sp.	3									1			**4**			1										**1**	**6**
Sparassidae	sp. 1								1					**1**				1		1			2	1			**5**	**12**
	sp. 2													**0**													**0**	**1**
Zodariidae	sp.													**0**													**0**	**1**
indet.	sp. 1			2	1	2					4			**9**			2							5			**7**	**20**
	sp. 2													**0**													**0**	**1**
	sp. 3									1				**1**													**0**	**4**
	sp. 4	1												**1**													**0**	**1**
	indet.													**0**					3	1	5	2		1			**12**	**13**
PSEUDO-SCORPIONIDA	sp.					1	5					1		**7**					4	8			2				**14**	**37**
SCORPIONIDA																												
Buthidae	*Parabuthus granulatus*					1				1			3	**5**						1				2	1	1	**5**	**17**
	Uroplectes sp.						1	1	1					**3**		1	1										**2**	**11**
	indet.													**0**						2	2						**4**	**4**
SOLPUGIDA																												
Ceromidae	spp.													**0**													**0**	**5**
Hexisopodidae	sp.													**0**									1				**1**	**3**
Melanoblossidae	spp.		1	2			5	5	3	1	6		4	**27**	1		2		1	11	3	10	3	5	6	6	**48**	**140**
Solpugidae	spp.				2	7	1	2	2	3	3			**20**			1	9	9	21	5	3	6	8	2		**64**	**153**
indet.							1		1		2			**4**		1				2	1				1		**5**	**28**
CRUSTACEA																												
Isopoda	sp.		2											**2**		21			1								**22**	**29**
INSECTA																												
BLATTODEA																												
Blattellidae	sp. 1	1												**1**		1		2		2	1			2			**8**	**16**

		10 January 2011 – 1 February 2011													1-28 February 2011													
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**	**Grand Total**
	sp. 2					3	1				1			**5**	2			3	7	8	4	5		7			**36**	**66**
	sp. 3								1					**1**					2		1		1				**4**	**32**
	sp. 4				1	1	1	2			1		1	**7**	2	3		3	6	3	1			9			**27**	**41**
	sp. 5													**0**		1			1								**2**	**4**
COLLEMBOLA																												
Entomobryidae	spp.	4	30		2				4	10	1	4	1	**56**	140	97	2	4		2	5	135	140	17	36	1	**579**	**661**
Poduridae	sp.	1								1		1		**3**	6	2				1		2	1				**12**	**15**
COLEOPTERA																												
Anobiidae	sp.					1								**1**													**0**	**5**
Anthicidae	sp.					4								**4**	1				3	1		1	1		1		**8**	**15**
Bruchidae	sp.																							1			**1**	**1**
Carabidae	Anthiinae sp.						5	2	3	3			1	**14**						1			21	2			**24**	**50**
	Caminara sp.													**0**	1										1		**2**	**2**
	sp. 1			1						1				**2**				1									**1**	**6**
	sp. 2					1						1		**2**	3					1			1				**5**	**8**
	sp. 3													**0**													**0**	**1**
Catopidae	sp. 1							1	1					**2**			1				1		1				**3**	**13**
	sp. 2			1	1			1						**3**							8	1					**9**	**25**
Chrysomelidae	Cassidinae sp.													**0**													**0**	**1**
	Clytrinae sp.													**0**			2										**2**	**7**
	Eumolpinae sp.													**0**									1				**1**	**3**
Coccinellidae	sp.							1						**1**													**0**	**1**
Curculionidae	Brachycerinae sp.													**0**	1	1											**2**	**2**
	Hyomora sp.												1	**1**													**0**	**3**
	Neocleonus sp.			1										**1**													**0**	**2**
	Ocladius sp.													**0**						1							**1**	**1**
	sp. 1													**0**								1					**1**	**4**
	sp. 2									1				**1**				1		1			1			1	**4**	**7**
	sp. 3													**0**													**0**	**1**
	sp. 4													**0**							2						**2**	**2**

		10 January 2011 – 1 February 2011													1-28 February 2011													
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**	**Grand Total**
	sp. 5						3	2		3				**8**						2		1			1		**4**	**16**
Dascillidae	sp.													**0**													**0**	**1**
Dermestidae	sp. 1							1						**1**		1		1		1		1					**4**	**12**
	sp. 2													**0**													**0**	**1**
	sp. 3		1											**1**													**0**	**2**
Histeridae	sp.										1			**1**	1												**1**	**2**
Meloidae	sp. 1													**0**		2		1				1			1		**5**	**6**
	sp. 2													**0**			1					1					**2**	**2**
Melyridae	sp. 1			1			1	25	11	2	2			**42**						1	19	1	1				**22**	**417**
	sp. 2				1		1	3						**5**						1	11						**12**	**29**
Mordellidae	sp.													**0**			3						9				**12**	**12**
Nitidulidae	sp.													**0**						1							**1**	**1**
Ptinidae	Ptininae sp.													**0**													**0**	**1**
	Stethomezium sp.				1									**1**													**0**	**1**
Scarabaeidae	Aphodiinae sp.													**0**				1	1				1				**3**	**3**
	Melolonthinae sp.													**0**										1			**1**	**1**
	Rutelinae													**0**	4												**4**	**4**
Silvanidae	sp. 1													**0**													**0**	**1**
Staphylinidae	sp. 1													**0**	1												**1**	**1**
	sp. 2													**0**					1								**1**	**1**
Tenebrionidae	*Cauricara eburnea*			2										**2**		1											**1**	**3**
	Drosochrini sp.	1									2			**3**													**0**	**4**
	Epiphysa punctatissima	1		1	2	1	1	4	2	1	2			**15**	2		1				8	1	1	1		1	**15**	**66**
	Eurychora sp.							1					2	**3**													**0**	**3**
	Geophanus sp.								4	1				**5**	1					1	2	9	5	1			**19**	**31**
	Gonopus sp.	33	1	3	11		1	2	1	7	1			**60**	17	1	13	9		4	1		6	2			**53**	**129**
	Metriopus depressus		6									1		**7**		18	1								3	1	**23**	**38**
	Namibomodes sp.													**0**										6			**6**	**7**

		10 January 2011 – 1 February 2011													1-28 February 2011													
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**	**Grand Total**
	Parastizopus sp.	1	11	1	1		1		1	3	7			**26**	4	11				3	4	11		6			**39**	**108**
	Physadesmia globosa		1	1										**2**		7	12										**19**	**28**
	Physosterna cribripes			2		4	1	1			1			**9**	2	3	8		4	3	4		1	2			**27**	**88**
	Rhammatodes sp.	4	1	1	10	9	22	35	19	17	13		6	**137**	5	13	1	14	2	40	99	47	84	33	4	6	**348**	**943**
	Somaticus sp.	1	1					1	1		1		1	**6**	1	2			2	1		1			1	2	**10**	**16**
	Stips dohrni	7	2	5			1	3	2	1	1			**22**	11	1	6	1	1		4	1	16				**41**	**71**
	Stizopina sp.			1	1	5								**7**			2			1	1	2		5			**11**	**37**
	Tenebrioninae sp.												1	**1**													**0**	**4**
	Tentyriini sp.	1												**1**													**0**	**2**
	Zophosis amabilis												1	**1**								1			2	3	**6**	**45**
	Zophosis devexa		2	4										**6**		18	1										**19**	**34**
	Zophosis dorsata													**0**													**0**	**1**
	Zophosis sp.								3	1				**4**		1						2	1				**4**	**19**
	Zophosis cf. *Gyrosis* sp.											1		**1**													**0**	**1**
Thorictidae	sp.													**0**													**0**	**3**
indet.				1	2			2		2		2		**9**		1	1			2			2	1	1		**8**	**24**
DIPTERA																												
Acalyptratae	sp. 1	1				1								**2**						6	5	5	19	1	1		**37**	**44**
	sp. 2													**0**													**0**	**3**
	sp. 3							1						**1**													**0**	**1**
	sp. 3													**0**	1	1							1				**3**	**3**
	indet.			1			1							**2**	3	7	3		1	4	1	1	3		3		**26**	**36**
Bombyliidae	sp. 1					1								**1**													**0**	**2**
	sp. 2													**0**						2						1	**3**	**3**
	sp. 3													**0**						1							**1**	**1**
Calliphoridae	sp.													**0**	7				1				1				**9**	**9**
Camillidae	sp.	1		7	21				4	1	1		2	**37**	2	4	5	3	2	2	4	2	4		5	1	**34**	**71**
Cecidomyiidae	sp.	1	21	1	2	1								**26**	4	1	1		1		2	1	6	2			**18**	**46**

		10 January 2011 – 1 February 2011													1-28 February 2011													
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**	**Grand Total**
Chironomidae	sp.													**0**							1				1		**2**	**2**
Chloropidae	sp. 1													**0**	2					9							**11**	**26**
	sp. 2		9	3	3	4		1	1	3	1	1	1	**27**	2	29	26	3	3	4	11	13	30	5	5	3	**134**	**197**
	sp. 3	6	1			7	3	6	1		1	1		**26**	4	6	46	16	15	40	25	25	69	4	17	11	**278**	**335**
	sp. 4					14	1	2						**17**	10	19	48	366	102	51	48	27	19	6		2	**698**	**730**
	sp. 5		1							1			1	**3**	20	4	6		14	9		2	1		2	2	**60**	**107**
	sp. 6		1	1	4	1	3		1	1	4	1		**17**			1	1	2	2	5	3	11		3		**28**	**56**
	sp. 7				3				1					**4**						4	3	9	9		2		**27**	**57**
Conopidae	sp.								1					**1**													**0**	**1**
Culicidae	sp.				1									**1**	1										1		**2**	**3**
Curtonotidae	sp.						2							**2**						1					1		**2**	**5**
Drosophilidae	sp.													**0**	2												**2**	**2**
Empididae	sp. 1													**0**									1				**1**	**4**
	sp. 2		1											**1**		1											**1**	**2**
	sp. 3													**0**								1					**1**	**1**
Heleomyzidae	sp.													**0**													**0**	**16**
Lonchaeidae	sp.													**0**	2												**2**	**2**
Muscidae	sp. 1	2												**2**							1						**1**	**7**
	sp. 2							1		1		1		**3**	28	68	24	10	54	74	13	9	78	27	28	19	**432**	**435**
	sp. 3													**0**													**0**	**1**
	sp. 4													**0**	89	52	29	32	218	226	102	26	263	62	21	7	**1127**	**1127**
Mycetophilidae	sp.													**0**	4	1	8			2	8	2	6				**31**	**31**
Mythicomyiidae	sp.													**0**	1							1	2				**4**	**7**
Phoridae	sp. 1													**0**	3	3			6	14	3	3	22	1	4	1	**60**	**60**
	sp. 2													**0**	5	6	2	2	11	13	9	3	28		4		**83**	**83**
	sp. 3													**0**					6	3	1		4				**14**	**14**
Psychopsidae	sp.													**0**	2												**2**	**2**
Sarcophagidae	sp. 1			1	3	1	1	1		2				**9**		4				1	2					1	**8**	**29**
	sp. 2								1	1				**2**		5	3	4		2	1	3	5				**23**	**33**
	sp. 3													**0**													**0**	**1**

		10 January 2011 – 1 February 2011													1-28 February 2011													
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**	**Grand Total**
Sciaridae	sp.									1				**1**		2		1	1					1			**5**	**10**
Sepsidae	sp.													**0**		1							1	1			**3**	**3**
Syrphidae	sp. 1													**0**	1												**1**	**1**
	sp. 2													**0**									3				**3**	**3**
Tachinidae	sp. 1													**0**						2	1		2				**5**	**6**
	sp. 2		1						1					**2**	3	4	2		1	1			4				**15**	**19**
	sp. 3													**0**	2	3				2			1	1	1	1	**11**	**12**
	sp. 4						1							**1**				2	2	4		1			3	1	**13**	**15**
Tephritidae	sp. 1													**0**	5			2	1	1	1		1				**11**	**12**
	sp. 2	2					1							**3**	1								1				**2**	**5**
	sp. 3													**0**	8	1		3			1	1	1		4	2	**21**	**21**
Therevidae						1								**1**							1						**1**	**6**
indet.														**0**											17		**17**	**17**
HEMIPTERA																												
Alydidae	sp.													**0**													**0**	**1**
Anthocoridae	sp. 1					1								**1**													**0**	**1**
	sp. 2												1	**1**						1					1		**2**	**3**
Aphididae	sp.													**0**													**0**	**2**
Berytidae	sp.													**0**	3								3		2	1	**9**	**9**
Cicadellidae	sp. 1				2									**2**													**0**	**4**
	sp. 2				2	7								**9**													**0**	**17**
	sp. 3										1			**1**				1		1	1				1		**4**	**5**
	sp. 4													**0**					1		2				2	1	**6**	**6**
	sp. 5						1					1		**2**	1	2	3	5	3	1	1	2	1	1	3	1	**24**	**26**
	sp. 6													**0**												1	**1**	**1**
	sp. 7													**0**													**0**	**1**
Cicadidae	sp.													**0**										1		1	**2**	**2**
Coccoidea	sp. 1													**0**													**0**	**3**
	sp. 2													**0**	1	3	1						1				**6**	**6**
	sp. 3													**0**									1				**1**	**1**

		10 January 2011 – 1 February 2011													1-28 February 2011														
		1	2	3	4	5	6	7	8	9	10	11	12	Total	1	2	3	4	5	6	7	8	9	10	11	12	Total	Grand Total
Cydnidae	sp. 1							3						**3**							1						**1**	**5**
	sp. 2													**0**	3												**3**	**3**
	indet.													**0**													**0**	**8**
Fulgorioidea	sp. 1													**0**													**0**	**2**
	sp. 2													**0**			2			3							**5**	**10**
	sp. 3				2		1				1			**4**										3			**3**	**19**
	sp. 4													**0**	1												**1**	**1**
	indet.													**0**			1						4		1		**6**	**7**
Lygaeidae	sp. 1								1					**1**							1						**1**	**2**
	sp. 2													**0**							1						**1**	**1**
Miridae	sp.													**0**										1			**1**	**1**
Pentatomidae	sp.													**0**													**0**	**9**
Pyrrhocoridae	*Odontopus* sp.							37	10					**47**							77	18				2	**97**	**261**
Reduviidae	Emesinae sp.													**0**						1		1					**2**	**3**
	Holoptilinae sp.				1			1						**2**				2				2					**4**	**7**
	Piratinae sp. 1													**0**						1							**1**	**1**
	Piratinae sp. 2													**0**													**0**	**2**
	indet.								2					**2**								1			1		**2**	**7**
indet.								1						**1**				1		2	5		1	4			**13**	**17**
HYMENOPTERA																												
Apoidea	sp.													**0**									1		1		**2**	**2**
Bethylidae	sp.			1						2				**3**		2	2			1	1		3	1	1		**11**	**14**
Braconidae	sp. 1			1										**1**						1							**1**	**5**
	sp. 2				1									**1**		1		1									**2**	**3**
Bradynobaenidae	sp.													**0**							1						**1**	**1**
Chalcidoidea	spp.		2	1	3	7	3		1	18	10			**45**		2	5	2		16	6	18	48	3	1	1	**102**	**200**
Chrysididae	sp.													**0**				2		1		1					**4**	**5**
Cynipidae	sp. 1				1						1			**2**													**0**	**3**
	sp. 2		1		1									**2**													**0**	**2**
	sp. 3													**0**							1			1			**2**	**2**

		10 January 2011 – 1 February 2011													1-28 February 2011													
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**	**Grand Total**
	sp. 4								1		1			**2**													**0**	**2**
Formicidae	*Anoplolepis* sp.	401		167	27									**595**	1143		154	68		5		1	2				**1373**	**2113**
	Camponotus sp.	4						7	4		4			**19**	1			1		3	8	5	4				**22**	**96**
	Camponotus maculatus					1	1	4	7	4				**17**	10			1			7	35	15	4			**72**	**148**
	Crematogaster sp.								6	1				**7**								23					**23**	**30**
	Lepisiota sp.	17	8	80	14		3	33	73	32	24			**284**	7	58	75	5		2	64	32	107	32	2		**384**	**1078**
	Messor sp.		2	22	1		18		29					**72**	2	1	12			9	1	29	8				**62**	**185**
	Monomorium sp. 1	4			32	14	110	73	147	47	1		9	**437**	5	26		29		91	157	45	275	14		20	**662**	**1714**
	Monomorium sp. 2	1			9	2	7	9	26	9	8			**71**	1			15	4	22	20	54	10	7		4	**137**	**348**
	Monomorium sp. 3	9	2	2	1	16	1							**31**	14	1		2	8	9	2	31			1		**68**	**154**
	Monomorium sp. 4	20	10	30	20	61	1		37	8	8	15	6	**216**	9	14	48	63	90	91	6	133	62	14	64	8	**602**	**1187**
	Ocymyrmex sp.	2			8	18		1	18		1	24	4	**76**	5			20	19	4		10		1	32	7	**98**	**325**
	Pheidole sp.						11		12	2				**25**			1	1	1	2		14	2				**21**	**56**
	Tetramorium sp. 1	1		5						15	14		2	**37**	2		3				1		28	44	2	2	**82**	**187**
	Tetramorium sp. 2				15		2	1	1		1			**20**	4	4	2	36		9	5	1					**61**	**81**
	indet.		1	2	1	1	3	9	6	4	3	5		**35**	3		2	2	1	6	2	4	1	1	4	2	**28**	**68**
Gasteruptiidae	sp.												2	**2**									4			1	**5**	**15**
Halictidae	sp. 1			3		1	4		1	4	1			**14**	1	2	1	5			1		10	1	3		**24**	**53**
	sp. 2				1			1	7			1		**10**			1	4		4	7	15	3	1	7	13	**55**	**75**
	sp. 3							1	3				1	**5**			2	2		4	4	3		1			**16**	**22**
	sp. 4													**0**	1				1								**2**	**2**
Ichneumonidae	sp. 1													**0**								1					**1**	**4**
	sp. 2													**0**	1												**1**	**1**
Masaridae	sp. 1			1					6					**7**		2					6	3	1				**12**	**56**
	sp. 2			6	1	8		4						**19**			1	1	3	1	1	2			1		**10**	**37**
	sp. 3													**0**													**0**	**1**
	sp. 4				3							1	3	**7**		3		8	1	1	2	5	7	2	15	5	**49**	**59**
	sp. 5													**0**				1									**1**	**1**
	sp. 6													**0**								1	1				**2**	**2**

		10 January 2011 – 1 February 2011													1-28 February 2011														
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**	**Grand Total**
Melittidae	sp. 1													**0**	1	1	2				2		1				**7**	**7**
	sp. 2													**0**		1						1	1				**3**	**3**
Mutillidae	sp.													**0**		1											**1**	**2**
Plumariidae	sp.													**0**			1						1		1	1	**4**	**9**
Pompilidae	sp. 1				1									**1**						3	3		23	1			**30**	**58**
	sp. 2													**0**													**0**	**1**
	sp. 3			1			2	1	1					**5**	1							2	3				**6**	**22**
	sp. 4													**0**						1							**1**	**2**
	sp. 5	1			1		1	1	1					**5**			1		1		2	1				1	**6**	**18**
Proctotrupidae	sp.			1										**1**													**0**	**4**
Sapygidae	sp.													**0**						1							**1**	**1**
Scoliidae	sp.					1								**1**													**0**	**1**
Sphecidae	sp. 1			2			4		1	1				**8**				4		4	10	7	19		3	1	**48**	**82**
	sp. 2					6			1					**7**					4				1				**5**	**35**
	sp. 3				1			2	1					**4**	2	6	2	4	5	8	1		1				**29**	**36**
	sp. 4													**0**							2					1	**3**	**7**
	sp. 5	1												**1**													**0**	**5**
	sp. 6													**0**													**0**	**1**
	sp. 7													**0**						1							**1**	**2**
	sp. 8						1							**1**				1			1			1			**3**	**8**
	sp. 9													**0**													**0**	**2**
	sp. 10							2						**2**													**0**	**2**
	sp. 11													**0**						1							**1**	**1**
	sp. 12													**0**							3						**3**	**3**
Tiphiidae	sp. 1													**0**													**0**	**1**
	sp. 2													**0**	1												**1**	**1**
	sp. 3													**0**						1							**1**	**1**
indet.	sp.													**0**													**0**	**1**
ISOPTERA	*Hodotermes mossambicus*		1			1	2	22	1		3			**30**		1			1		66	1	358				**427**	**800**

		10 January 2011 – 1 February 2011													1-28 February 2011													
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**	**Grand Total**
	Psammotermes allocerus									1				**1**		8		1		7	1	5		1	2	4	**29**	**32**
LEPIDOPTERA																												
Lycaenidae	?*Lepidochrysops* sp.										1			**1**													**0**	**1**
indet.	spp.	4	2		2	3	3		3	4		4		**25**	31	13	15	11	14	36	29	47	107	7	45	40	**395**	**458**
	spp.			1				3						**4**	20	3		3	2	1	3	3	6	3	5	1	**50**	**61**
	indet.							2	1					**3**							2	1					**3**	**80**
	indet.													**0**													**0**	**2**
MANTODEA	sp. 1							2						**2**													**0**	**3**
	sp. 2				1									**1**													**0**	**1**
	sp. 3										1			**1**													**0**	**1**
	sp. 4													**0**							3						**3**	**5**
NEUROPTERA																												
Chrysopidae	sp.													**0**												1	**1**	**1**
Coniopterygidae	sp.													**0**													**0**	**3**
Myrmeleontidae	sp.													**0**													**0**	**1**
Nemopteridae	sp.													**0**													**0**	**1**
Psychopsidae	sp.													**0**													**0**	**3**
ORTHOPTERA																												
Acrididae	*Acrotylus* sp.													**0**								1			1		**2**	**2**
	Lithidiinae sp.						1			1			1	**3**			1			2			1				**4**	**21**
	indet.													**0**	1					1		2	1		1		**6**	**20**
Mogoplistinae	sp.				1									**1**			1					1					**2**	**4**
Schizodactylidae	*Comicus capensis*													**0**							1	1	1		1	1	**5**	**5**
Thericleidae	sp.					1	1	3	5		2			**12**			1	2	1		9	12		1			**26**	**57**
PSOCOPTERA	spp.			21	11	15	10	2	8	9	4	15	16	**111**	2	2	56	10	3	10	25	13	26	12	4		**163**	**568**
THYSANOPTERA	sp. 1													**0**			1					1	4	1	1		**8**	**11**
	sp. 2		1	7			2		2	12				**24**			20				5	51	27		2	1	**106**	**173**
THYSANURA																												

		10 January 2011 – 1 February 2011													1-28 February 2011													
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**	**Grand Total**
Lepismatidae	*Afrolepisma* sp.													**0**		1											**1**	**1**
	Ctenolepisma sp. 1		5	7		5	3	1	3	9	6		1	**40**		2	12	2		8	5	9	20	11	1		**70**	**208**
	Ctenolepisma sp. 2		1	7	3	3		1	2	5	9	3	4	**38**	6	6	8		2	3	9	16	7	12	2	1	**72**	**219**
	Monachina sp.													**0**							10						**10**	**11**
	Thermobia sp.	1												**1**								1		2			**3**	**6**
ORDER	indet.		8											**8**													**0**	**8**
MOLLUSCA																												
Gastropoda	sp.													**0**		1											**1**	**1**
MYRIAPODA																												
Chilopoda	sp.													**0**												1	**1**	**1**
Polyxenida	sp.												2	**2**													**0**	**6**
	Total	**549**	**144**	**447**	**271**	**329**	**319**	**373**	**554**	**376**	**202**	**87**	**91**	**3742**	**1714**	**624**	**716**	**842**	**729**	**1048**	**1076**	**1111**	**2214**	**455**	**400**	**215**	**11144**	**21021**

c) Invertebrate taxa encountered during manual survey.

Site	**Date**	**Order**	**Family**	**Morphospecies**	**Record**
1	25-Nov-10	Blattodea	Blattellidae	sp. 3	Hand collected
	25-Nov-10	Coleoptera	Curculionidae	*Ocladius* sp.	Hand collected

Site	Date	Order	Family	Morphospecies	Record
	25-Nov-10		Tenebrionidae	*Physosterna cribripes*	Field notes
	25-Nov-10		Tenebrionidae	*Zophosis* sp.	Hand collected
2	26-Nov-10		Tenebrionidae	*Cauricara eburnea*	Field notes
	26-Nov-10		Tenebrionidae	*Geophanus* sp.	Hand collected
	26-Nov-10		Tenebrionidae	*Metriopus depressus*	Hand collected
	26-Nov-10		Tenebrionidae	*Metriopus* sp.	Field notes
	26-Nov-10		Tenebrionidae	*Physosterna cribripes*	Hand collected
	26-Nov-10		Tenebrionidae	*Zophosis amabilis*	Field notes
	26-Nov-10		Tenebrionidae	*Zophosis devexa*	Hand collected
	26-Nov-10	Neuroptera	Myrmeleontidae	sp.	Field notes
3	25-Nov-10	Coleoptera	Tenebrionidae	Adesmiini sp.	Hand collected
	25-Nov-10		Tenebrionidae	*Cauricara eburnea*	Field notes
	25-Nov-10		Tenebrionidae	Drosochrini sp. 1	Hand collected
	25-Nov-10		Tenebrionidae	*Gonopus* sp.	Hand collected
	25-Nov-10		Tenebrionidae	*Metriopus* sp.	Field notes
	25-Nov-10		Tenebrionidae	*Physosterna cribripes*	Field notes
	25-Nov-10		Tenebrionidae	*Rhammatodes* sp.	Hand collected
	25-Nov-10		Tenebrionidae	*Zophosis amabilis*	Field notes
	25-Nov-10		Tenebrionidae	*Zophosis devexa*	Hand collected
	25-Nov-10	Mantodea		sp.	Field notes
4	25-Nov-10	Araneae	Sicariidae	*Sicarius* sp.	Field notes
	25-Nov-10	Coleoptera	Coccinellidae	sp.	Hand collected
	25-Nov-10		Tenebrionidae	*Cauricara eburnea*	Field notes
	25-Nov-10		Tenebrionidae	*Physosterna cribripes* (smooth)	Field notes
	25-Nov-10		Tenebrionidae	*Rhammatodes* sp.	Hand collected
	25-Nov-10		Tenebrionidae	*Zophosis amabilis*	Hand collected
	25-Nov-10	Hemiptera	Aphididae	sp.	Hand collected
	25-Nov-10	Isoptera	Hodotermitidae	*Hodotermes mossambicus*	Field notes

Site	Date	Order	Family	Morphospecies	Record
5	26-Nov-10	Araneae	Sicariidae	*Sicarius* sp.	Field notes
	26-Nov-10	Coleoptera	Tenebrionidae	*Metriopus* sp.	Field notes
	26-Nov-10		Tenebrionidae	*Physosterna cribripes*	Field notes
	26-Nov-10		Tenebrionidae	*Zophosis amabilis*	Field notes
	26-Nov-10		Tenebrionidae	*Zophosis devexa*	Hand collected
	26-Nov-10	Diptera	Bombyliidae	sp. 1	Field notes
	26-Nov-10		Bombyliidae	sp. 1	Field notes
	26-Nov-10	Hymenoptera	Pompilidae	sp.	Field notes
	26-Nov-10	Isoptera	Hodotermitidae	*Hodotermes mossambicus*	Field notes
	26-Nov-10	Orthoptera	cf. Lentulidae	sp.	Field notes
6	26-Nov-10	Coleoptera	Curculionidae	sp. 5?	Hand collected
	26-Nov-10		Tenebrionidae	Drosochrini sp. 1	Hand collected
	26-Nov-10		Tenebrionidae	*Metriopus* sp.	Field notes
	26-Nov-10		Tenebrionidae	*Molurini* sp.	Hand collected
	26-Nov-10		Tenebrionidae	Tentyriinae sp.	Hand collected
	26-Nov-10		Tenebrionidae	*Zophosis amabilis*	Field notes
	26-Nov-10		Tenebrionidae	*Zophosis* sp.	Hand collected
	26-Nov-10	Hemiptera	Pyrrhocoridae	*Odontopus* sp.	Field notes
	26-Nov-10	Hymenoptera	Formicidae	*Messor denticornis*	Field notes
	26-Nov-10	Pseudoscorpionida		sp. 1	Field notes
7	27-Nov-10	Coleoptera	Curculionidae	*Episus* sp.	Field notes
	27-Nov-10		Tenebrionidae	*Metriopus* sp.	Field notes
	27-Nov-10		Tenebrionidae	*Rhammatodes* sp.	Hand collected
	27-Nov-10		Tenebrionidae	*Zophosis amabilis*	Field notes
	27-Nov-10	Diptera	Sarcophagidae	sp.	Field notes
	27-Nov-10	Hemiptera	Cicadidae	sp.	Field notes
	27-Nov-10		Pyrrhocoridae	*Odontopus* sp.	Field notes
	27-Nov-10	Isoptera	Hodotermitidae	*Hodotermes mossambicus*	Field notes

Site	Date	Order	Family	Morphospecies	Record
8	26-Nov-10	Coleoptera	Tenebrionidae	*Metriopus* sp.	Field notes
	26-Nov-10		Tenebrionidae	*Metriopus* sp.	Field notes
	26-Nov-10	Hemiptera	Pyrrhocoridae	*Odontopus* sp.	Hand collected
	26-Nov-10	Hymenoptera	Formicidae	*Messor denticornis*	Field notes
	26-Nov-10	Thysanura	Lepismatidae	*Thermobia nebulosa*	Field notes
9	25-Nov-10	Araneae	Sicariidae	*Sicarius* sp.	Field notes
	25-Nov-10	Coleoptera	Curculionidae	*Ocladius* sp.	Hand collected
	25-Nov-10		Tenebrionidae	*Cauricara eburnea*	Field notes
	25-Nov-10		Tenebrionidae	*Drosochrini* sp.1	Hand collected
	25-Nov-10		Tenebrionidae	*Metriopus* sp.	Field notes
	25-Nov-10		Tenebrionidae	sp.	Hand collected
	25-Nov-10		Tenebrionidae	*Zophosis amabilis*	Field notes
	25-Nov-10	Hymenoptera	Formicidae	*Messor denticornis*	Field notes
	25-Nov-10	Mantodea	Mantodea	sp.	Field notes
	25-Nov-10	Solifugae		sp.	Field notes
	25-Nov-10	Thysanura	Lepismatidae	*Thermobia nebulosa*	Field notes
10	26-Nov-10	Coleoptera	Scarabaeidae	Aphodiinae sp.	Hand collected
	26-Nov-10		Tenebrionidae	Drosochrini sp. 1	Hand collected
	26-Nov-10		Tenebrionidae	Drosochrini sp. 2	Hand collected
	26-Nov-10		Tenebrionidae	*Metriopus* sp.	Field notes
	26-Nov-10		Tenebrionidae	*Physosterna cribripes*	Hand collected
	26-Nov-10		Tenebrionidae	*Rhammatodes* sp.	Hand collected
	26-Nov-10		Tenebrionidae	sp.	Hand collected
	26-Nov-10		Tenebrionidae	*Zophosis amabilis*	Field notes
	26-Nov-10		Tenebrionidae	*Zophosis* sp.	Hand collected
	26-Nov-10	Diptera	Bombyliidae	sp.	Field notes
	26-Nov-10	Hymenoptera	Formicidae	*Messor denticornis*	Field notes
11	27-Nov-10	Coleoptera	Tenebrionidae	Drosochrini sp. 1	Hand collected

Site	Date	Order	Family	Morphospecies	Record
	27-Nov-10		Tenebrionidae	*Metriopus* sp.	Field notes
	27-Nov-10		Tenebrionidae	*Metriopus* sp.	Field notes
	27-Nov-10		Tenebrionidae	*Zophosis amabilis*	Field notes
	27-Nov-10	Hymenoptera	Formicidae	*Messor denticornis*	Field notes
	27-Nov-10	Isoptera	Hodotermitidae	*Hodotermes mossambicus*	Field notes
12	27-Nov-10	Coleoptera	Tenebrionidae	*Metriopus* sp.	Field notes
	27-Nov-10	Hemiptera	Pyrrhocoridae	*Odontopus* sp.	Field notes
	27-Nov-10	Hymenoptera	Formicidae	*Messor denticornis*	Field notes

Appendix 2

Basis on which invertebrate morphospecies were distinguished.

Basis for distinguishing morphospecies in trap content. Diagnostics valid for current study only. Colours refer to wet preserved material under artificial light (e.g. many pinks probably yellow or white in life). 'Unmistakeable' or lack of diagnostics refers to well-known or otherwise distinctive taxa.

Higher taxon	Morphospecies	Diagnostic basis
ARACHNIDA		
ACARI	sp. 1	Crablike, black, stout spinose legs, dorsum with lines of clavate setae
	sp. 2	Body shape as sp. 1, but lighter in colour and dorsum bare
	sp. 3	Body shape as sp. 1, dark brown, relatively large, dorsum rugose
	sp. 4	Small, smooth domed carapace (Caeculidae?)
	sp. 5	Elongate, yellowish-red, rugose integument, long pedipalpi, smaller
	sp. 6	Elongate, light to dark brown, smooth, long pedipalpi, larger
	sp. 7	Grey, legs hairy and apically curling
	sp. 8	Tiny, flat oval black, short legs
	sp. 9	Pale, flat, exceptionally long legs
	sp. 10	Tiny red velvet mite
	sp. 11	Very large, black, oval
ARANEAE		
Ammoxenidae	*Ammoxenus* sp.	Fossorial spines on chelicerae, curled tarsi
	Rastellus sp.	Spadelike sclerotisation on anterior chelicerae; typical eye pattern
Araneidae	sp.	Tiny, reddish cephalothorax, huge bulbous grey abdomen with lighter dorsal line
Eresidae	sp.	Dark, stout legs, anterior cephalothorax angular
Gnaphosidae	sp. 1	Flimsy, yellowish-brown, laterally compressed femorae
	sp. 2	Larger, light-coloured, pectinate claws and scopulae; sparassid-like, but eyes centrally clumped, not 2 rows
	sp. 3	Normal stoutness, darker brownish, shieldlike cephalothorax, pectinate claws, single long dorsal femoral spines, very complicated male palpi
Oonopidae	sp.	Tiny, rounded abdomen on petiole, raised anterior cephalothorax
Oxyopidae	sp.	Small brown, cephalothorax 8-shaped in dorsal view, with median dorsal hump; 8 eyes, circular arrangement, clypeus wide
Palpimanidae	sp. 1	Large, unicolourous brown
	sp. 2	Small, four light spots on abdomen
	sp. 3	Large, robust, completely light; only 2 eyes medially
Philodromidae	sp.	Entelegyne, 2 clawed (pectinate tufted), 8 eyes, typical colour pattern
Pholcidae	sp. 1	Typical eye pattern, male palpi huge; typical legs

Higher taxon	Morphospecies	Diagnostic basis
	sp. 2	Long-legged but more robust; 6 eyes (2+2+2); light coloured
Prodidomidae	sp.	Small, lightcoloured; long fangs, eyes triangular arrangement
Salticidae	sp.	Brown; distinctive dorsal femoral spines; pectinate tarsal claws with black scopulae
Sicariidae	*Loxosceles* sp.	Pale yellowish with slightly darker abdomen
	Sicarius sp.	Unmistakeable
Sparassidae	sp. 1	Light coloured; black scopulae and apical abdomen
	sp. 2	Small, lightcoloured, setal brush anterodorsally on abdomen
Zodariidae	sp.	Cephalothorax narrowed anteriorly, abdomen with lateral light lines, rest dark, legs heavily setose
indet.	sp. 1	Entelegyne, 2 clawed, 8 eyed; tarsi threadlike, dark, abdomen globose
	sp. 2	Entelegyne, 2 clawed, 4+2 eyes; dark, stout legs, flat cephalothorax; fangs hidden under mentum-like ventral plate
	sp. 3	Haplogyne; large, light-coloured, robust; black scopulae, 3 clawed (pectinate); 8 eyes (3+2+3)
	sp. 4	Entelegyne, claws obscured by scopulae, 2+2+4 eyes, light coloured, slightly overhanging abdomen, robust legs, slightly protruding chelicerae
	indet.	Unidentifiable juveniles or broken specimens
PSEUDO-SCORPIONIDA	sp.	Unmistakeable
SCORPIONIDA		
Buthidae	*Parabuthus granulatus*	Ventral cheliceral teeth
	Uroplectes sp.	No ventral cheliceral teeth
	indet.	Unidentifiable juveniles
SOLPUGIDA		
Ceromidae	spp.	Tarsus IV with 2 segments, tarsus I with 2 claws
Hexisopodidae	sp.	Unmistakeable
Melanoblossidae	spp.	Tarsus IV with 2 segments, tarsus I clawless
Solpugidae	spp.	Tarsus IV with 4-5 segments
indet.		Juveniles or broken specimens missing key pieces
CRUSTACEA		
Isopoda	sp.	Unmistakeable
INSECTA		
BLATTODEA		
Blattellidae	sp. 1	Alate, 2 longitudinal lines
	sp. 2	Black, transverse transparency
	sp. 3	Yellowish, usually with black mottling; cerci annulate, apically acute

Higher taxon	Morphospecies	Diagnostic basis
	sp. 4	Reddish, with or without black mottling; cerci entire, apically blunt
	sp. 5	Globose, fossorial spines, reddish
COLLEMBOLA		
Entomobryidae	spp.	Unmistakeable
Poduridae	sp.	Unmistakeable
COLEOPTERA		
Anobiidae	sp.	Tiny brown, deflexed head, serrate antenna
Anthicidae	sp.	Elongate, unmistakeable body shape
Bruchidae	sp.	Tiny, black, globose, shortened elytra, larger hind legs
Carabidae	Anthiinae sp.	Anthiinae, small, all black, striate elytrae, inverted cordate pronotum
	Caminara sp.	Unmistakeable
	sp. 1	Tiny, reddish, truncate elytra with flat striate-reticulate sculpture
	sp. 2	Small, reddish black with light pronotal margins, lined elytra
	sp. 3	Medium-sized, black with two faint reddish posterior elytral spots, reddish femorae and antennal bases
Catopidae	sp. 1	Minute, brownish, two reddish posterior elytral dots, head not bent
	sp. 2	Minute, black, globose, head bent, clambid-like
Chrysomelidae	Cassidinae sp.	Unmistakeable
	Clytrinae sp.	Small, black with yellowish legs and antennae; short grey elytral setae
	Eumolpinae sp.	Greenish body, light yellowish antennae and long legs; anobiid-like
Coccinellidae	sp.	Black with red lateral pronotal patches
Curculionidae	Brachycerinae sp.	Medium-sized, brownish, elytra with tuberculate carinae, pronotum rounded and knobbly, nose short and very wide
	Hyomora sp.	Unmistakeable
	Neocleonus sp.	Unmistakeable
	Ocladius sp.	Unmistakeable
	sp. 1	Tiny, brown, elytrae punctate, nose long but wide, thorax much narrower than elytra
	sp. 2	Tiny, brownish, nose long and slender, femorae swollen
	sp. 3	Tiny, brownish, cylindrical, nose very long and curved, femorae normal
	sp. 4	Small, brown, nose short wide, thorax narrower than abdomen, anterior elytral angles acute, elytral ridges produce 3 square posterior processes
	sp. 5	Medium-sized, very light brown, elytra striate carinate; nose short and wide; thickset and knobbly
Dascillidae	sp.	Large, yellowish-brown with blackish head
Dermestidae	sp. 1	Small, globose, reddish, abdomen banded, antennae clubbed

Higher taxon	**Morphospecies**	**Diagnostic basis**
	sp. 2	Small, reddish, abdomen plain, antennae flabellate
	sp. 3	Medium-sized, all brown, antennae clubbed
Histeridae	sp.	Small, dark brown/black, elongate oval
Meloidae	sp. 1	Three zig-zag crossbars on elytra
	sp. 2	One narrow median crossbar, single small dots fore and aft only
Melyridae	sp. 1	Small, dark, serrate antennae 5 clubbed, faintly banded abdomen
	sp. 2	Short elytrae, black with transparent crossband
Mordellidae	sp.	Black
Nitidulidae	sp.	Small, brown, stizopina-like, but shortened elytra and circular antennal club
Ptinidae	Ptininae sp.	Unmistakeable
	Stethomezium sp.	Unmistakeable
Scarabaeidae	Aphodiinae sp.	Tiny, smooth, brown, yellow 3-lamellate antennae
	Melolonthinae sp.	Small, smooth, brown, two-ridged frons, 5-lamellate antenna, exposed pygidium
	Rutelinae	*Peritrichia* sp.
Silvanidae	sp. 1	Pronotal edge serrate
Staphylinidae	sp. 1	Stout bristles along abdominal edges
	sp. 2	Black head, elytra and apical abdomen, red thorax and basal abdomen
Tenebrionidae	*Cauricara eburnea*	
	Drosochrini sp.	
	Epiphysa punctatissima	
	Eurychora sp.	Small, roundish sp.
	Geophanus sp.	
	Gonopus sp.	
	Metriopus depressus	
	Namibomodes sp.	
	Parastizopus sp.	Prominent metafemoral setal brush
	Physadesmia globosa	
	Physosterna cribripes	
	Rhammatodes sp.	Roundbacked, black, acarinate species
	Somaticus sp.	Large, elytra shagreened, dorsally flattened, legs tuberculate
	Stips dohrni	

Higher taxon	Morphospecies	Diagnostic basis
	Stizopina sp.	Small, pronotum wider than elytra, elytral humeral angles pointed
	Tenebrioninae sp.	Tiny, brown, elongate, wide flat blunt head
	Tentyriini sp.	Elongate, smooth, brownish; larger than Rhammatodes
	Zophosis amabilis	
	Zophosis devexa	Small, faintly ridged elytrae
	Zophosis dorsata	Large, elytral carinae
	Zophosis sp.	Large, smooth, acarinate, ovate, apical elytra minutely caudate
	Zophosis cf. *Gyrosis* sp.	Round, globose, elytra with scattered small bumps, acarinate
Thorictidae	sp.	
indet.		Various unidentifiable coleopterous larvae
DIPTERA		
Acalyptratae	sp. 1	Tiny, flimsy yellowish, spear-shaped antenna, veins faint, mildly humpbacked
	sp. 2	Tiny, dark, strongly humpbacked, dark veins, much reduced, psocid-like
	sp. 3	Tiny, dark, wings veins reduced to two prominent ones of which one has a terminal button, bulbous pedicel, long arista, grotesque head
	sp. 3	Yellowish, elongate, pedicel with large ventral lobes, two dark dorsal lines on thorax, vaguely wasplike
	indet.	Undifferentiated acalyptrates, damaged and unidentifiable
Bombyliidae	sp. 1	Tiny, large head and eyes (syrphid-like) but venation typical bombyllid; anterobasal wings mottled
	sp. 2	Large, pale reddish with yellow-tinged wings
	sp. 3	Large, fluffy white on a black base, yellow-tinged wings
Calliphoridae	sp.	Large, pale, plumose arista
Camillidae	sp.	Small, black, lighter abdomen, plumose antennae, no sternopleural setae
Cecidomyiidae	sp.	Tiny, humpback, discshaped head, beaded antenna, long legs, wings 2 anterior veins prominent, rest absent or unclear
Chironomidae	sp.	Medium-sized, characteristic long front legs, flat head, short bushy antennae, strong anterior wing veins
Chloropidae	sp. 1	Dark, smooth, rounded, costa black, rest of wing and veins colourless
	sp. 2	Flat prognathous head, distinctive pink and black pattern
	sp. 3	Wings veins reduced, anterior only; head square, no large setae; thorax arcuate, pedicel discshaped
	sp. 4	Yellowish, 3 dorsal thoracic lines, 1 abdominal, prominent black lateral thoracic spot; 2 costal breaks, arista present, vibrissae absent
	sp. 5	Two very long posteriorly-directed setae on scutellum, veins faint yellowish, legs reddish, abdomen bloated, laterally transparent, disc-shaped pedicel
	sp. 6	Yellowish-brown, very long arista, blackened tarsi, dorsum black, dorsal abdomen furry, thorax with large ventrolateral spot; peristomal setae as robust as vibrissae
	sp. 7	Abdomen almost completely white

Higher taxon	Morphospecies	Diagnostic basis
Conopidae	sp.	Roundheaded, long flat abdomen, generally pinkish with black thoracic dorsum and yellowish tinge on dorsal abdomen; cell r5 closed.
Culicidae	sp.	Dark, long legs, scales on wing veins prominent, wing fringed with long setae
Curtonotidae	sp.	Medium, yellowish; four silvery longitudinal lines on thorax; plumose arista
Drosophilidae	sp.	Reddish, black marks on abdomen, plumose antennae with forked tips
Empididae	sp. 1	Characteristic apically rounded anal cell; flagellum globular with tridentate apex; abdomen pink with dark crossbar on second tergite
	sp. 2	Apically narrowing cell, flagellum simple pointed
	sp. 3	Small, wing apex with 2 terminal cells
Heleomyzidae	sp.	Small, dark, suffuse wings, hairy tarsi; strong costal bristles, complete subcosta, discal crossvein broken
Lonchaeidae	sp.	Black, yellow legs, round shiny eyes, very long prominent pedicel
Muscidae	sp. 1	Small, black, scutellum setae and morphology tachinid-like, but no hypopleural setae; profemoral plus tibial setae comblike; all hind marginal setae on head finely comblike
	sp. 2	Abdomen yellowish with 4 characteristic black spots; head very square in front, long droopy pedicellum, smooth arista
	sp. 3	Light brownish, two long stout setae on scutellum, tarsi black, huge pulvilli, geniculate proboscis
	sp. 4	Greenish black, slender, yellowish tibiae, plumose arista, conspicuous very robust setae on top of head, conspicuous palpi
Mycetophilidae	sp.	Pale reddish, humpbacked, long legs with tibial spurs, apical abdominal setae and distinct 'eyebrows'
Mythicomyiidae	sp.	Small, dark, humpbacked, round head, long proboscis
Phoridae	sp. 1	Robust, black
	sp. 2	Smaller, completely pale
	sp. 3	Pale, with 2 black dorsal basal abdominal spots
Psychopsidae	sp.	Small, humpbacked, pointed wings with parallel veins, beaded antennae
Sarcophagidae	sp. 1	Lateral abdominal setae inserted in pigmented spots; abdominal colour tends to testaceous ground
	sp. 2	No lateral abdominal spots; abdominal pattern varies, tends to whitish ground
	sp. 3	Large, black, reddish-banded abdomen and legs, disproportionately large head and eyes, few blunt stout posterior abdominal setae
Sciaridae	sp.	Tiny; eyes connected above antennae, anterior wing-veins stronger, with characteristic faint free-floating apical V-vein (sometimes faint)
Sepsidae	sp.	Black with yellow legs, round head, abdomen slender and shiny, preapical wingspots
Syrphidae	sp. 1	Banded abdomen, yellowish legs, rest black
	sp. 2	Black thorax, lighter head, abdomen reddish base with black central dorsal line and black tip; head disproportionately large
Tachinidae	sp. 1	Large, typical posterior abdominal spines, convex black postscutellum under pale scutellum; basal abdomen bilaterally red
	sp. 2	Smaller, all spines typical, all black, veins dark
	sp. 3	Smaller, all dark, strong postscutellar spines, weak abdominal; discal veins yellowish
	sp. 4	Large, black with reddish basal abdomen; only few major spines present, all conspicuously short and blunt; large eyes
Tephritidae	sp. 1	Black, wing predominantly black, markings vary, often five-fingered

Higher taxon	Morphospecies	Diagnostic basis
	sp. 2	Reddish, wing with narrow median crossbar, and large apical markings: from a single spot to a band with holes
	sp. 3	Reddish, wing with spot and dash only
Therevidae		Large, black, wings suffused; pedicel length = flagellum length; pedicel with prominent macrosetae
indet.		Unidentifiable small maggots
HEMIPTERA		
Alydidae	sp.	Large, brown, rugose frons
Anthocoridae	sp. 1	Dark; hemelytron transparent, apically suffused
	sp. 2	Pale yellowish, almost transparent,except eyes and paired dark spines on metatibiae; mirid-like but hemelytron typical
Aphididae	sp.	Unmistakeable
Berytidae	sp.	Unmistakeable
Cicadellidae	sp. 1	Hairy, spotted, brachypterous
	sp. 2	Tiny, bare, two frontal spots
	sp. 3	Similar to sp. 2, sparse mottling, no similar frontal spots
	sp. 4	Narrow short median frontal line only
	sp. 5	Small, dark, body with overall mottled pattern
	sp. 6	Conical head, pink, transparent wings
	sp. 7	Looks like a fulgorid, but all characters = Cicadellidae; small, head half as large as body, leathery apically rounded wings, long legs
Cicadidae	sp.	Small pale yellowish species with unmarked wings
Coccoidea	sp. 1	Apterous scales
	sp. 2	Alate, pale, flat triangular thorax, smooth
	sp. 3	As above, but hairy and swollen antennae
Cydnidae	sp. 1	Brown speckled, banded edge of abdomen
	sp. 2	Completely black, except for red tarsi
	indet.	Unidentifiable cydnid nymphs
Fulgorioidea	sp. 1	Boxed head with frontal valley, leathery leaflike wings (Meenoplidae?)
	sp. 2	Large hemispherical eyes, long transparent apically rounded wings flat on back
	sp. 3	Apterous, thickset, parallel dorsal median carinae on prothorax
	sp. 4	Tiny, black, frons extremely elongate: half of total body length
	indet.	Unidentifiable fulgorid nymphs
Lygaeidae	sp. 1	Greenish grey, speckled; medium sized; transparent wings; dorsal abdomen black with clear edges and median spots
	sp. 2	Large, all black except lighter legs and antennae

Higher taxon	Morphospecies	Diagnostic basis
Miridae	sp.	Pale yellowish
Pentatomidae	sp.	Punctate spotted pronotum and hemelytra
Pyrrhocoridae	*Odontopus* sp.	Unmistakeable
Reduviidae	Emesinae sp.	Unmistakeable
	Holoptilinae sp.	Apterous; feathered antennae and legs
	Piratinae sp. 1	Apterous, black with red abdominal edges
	Piratinae sp. 2	Squat, reddish, alate
	indet.	Unidentifiable reduvid nymphs
indet.		Unidentifiable hemipteran nymphs
HYMENOPTERA		
Apoidea	sp.	Large, dark with a reddish tinge on abdomen and legs; hind femurs swollen, hind tibiae sickle shaped; long antennae
Bethylidae	sp.	Dark brown, smooth, prognathe head,large mandibles; doubled/interrupted pterostigma
Braconidae	sp. 1	Small, large rounded brown pterostigma, all dark, or with lighter abdomen
	sp. 2	Small, reddish, roundheaded, wing veins partly obliterated
Bradynobaenidae	sp.	Unmistakeable
Chalcidoidea	spp.	Undifferentiated minute parasitic wasps
Chrysididae	sp.	Small, metallic golden green
Cynipidae	sp. 1	Apterous, shiny black, antlike, characteristic abdomen
	sp. 2	Alate, black with yellow legs, head anterior angles with bifurcate prongs, characteristic abdomen
	sp. 3	Similar to above, but head smooth and rounded, clear wings
	sp. 4	Alate, all black, wing with two dark crossbars
Formicidae	*Anoplolepis* sp.	Unmistakeable
	Camponotus sp.	Large, pale yellowish-white, abdomen smooth
	Camponotus maculatus	Pale reddish, at least some black on abdomen
	Crematogaster sp.	Unmistakeable
	Lepisiota sp.	Unmistakeable
	Messor sp.	Unmistakeable
	Monomorium sp. 1	Roundheaded, never uniformly dark
	Monomorium sp. 2	Flatheaded, uniform dark
	Monomorium sp. 3	Tiny, pale yellowish
	Monomorium sp. 4	Dark head and abdomen, reddish legs and thorax

Higher taxon	Morphospecies	Diagnostic basis
	Ocymyrmex sp.	Unmistakeable
	Pheidole sp.	Unmistakeable
	Tetramorium sp. 1	Large, dark reddish brown
	Tetramorium sp. 2	Tiny, reddish
	indet.	Unidentified alate reproductives
Gasteruptiidae	sp.	Tiny, brown, boxy thorax, flat abdomen, shorter than thorax, well-developed 'neck', large round pterostigma
Halictidae	sp. 1	Black, sometimes with light intersegmental membranes showing; larger
	sp. 2	Pronotum with wide curved pale anterior crossmarking; abdomen banded, flattened; antennae long; smaller
	sp. 3	Thorax and head metallic green; legs and veins yellowish
	sp. 4	Black, with reddish basal abdomen and apical legs
Ichneumonidae	sp. 1	Black and pink body, yellowish legs, black hind tarsi
	sp. 2	Black head, thorax and long petiole; lighter abdomen, yellowish legs
Masaridae	sp. 1	Black; pink labrum, lower frons, eyespot and earline, 2 lateral thoracic spots, dorsal rim and 3 posterior spots; pterostigma prominent, ringshaped
	sp. 2	Pink banded abdomen; black thoracic dorsum, thoracic sides pink, face mostly pink, highlighting kidney-shaped eyes
	sp. 3	Large, dark, abdomen lighter, apical legs yellowish; sphecid-like
	sp. 4	Almost entirely pink; 'M' shaped black mark on dorsal thorax
	sp. 5	Tiny, head and thorax dark, antennae long, white with black tips
	sp. 6	Large, red, black face, dorsal thorax and abdominal bands
Melittidae	sp. 1	Large, predominantly dark, with pink clypeus and median lower frontal line
	sp. 2	Large, predominantly dark, frons and clypeus hairy, wings apically corrugated and suffused, all claws bifid
Mutillidae	sp.	Female, abdomen basal spot and apical crossband
Plumariidae	sp.	Apterous, typical abdominal pattern; spatulate setae on protarsi
Pompilidae	sp. 1	Tiny, clear or mostly clear wings, red spot basal abdomen
	sp. 2	Medium-sized, black, dark wings, red hind femurs
	sp. 3	Medium-sized, all black, faintly suffused wings with dark tips
	sp. 4	Large, black, red wings with dark tips
	sp. 5	Large, completely black, wings dark suffused throughout
Proctotrupidae	sp.	Tiny, dark, lightly suffused wings with yellowish main veins, legs faint reddish, antennae yellowish
Sapygidae	sp.	Black with reddish abdomen, flat head and short antennae, prominent 'eyebrow' setae; nodular rounded pterostigma
Scoliidae	sp.	Dark, mutillid-like, but wing apically rugose and suffused, and mid-tibia with a single, very large, apical spur
Sphecidae	sp. 1	Tiny, body and legs all black, wings apical half suffused

Higher taxon	Morphospecies	Diagnostic basis
	sp. 2	Medium-sized, body and head black, abdomen and legs reddish, wings apical half suffused
	sp. 3	Medium-sized, body and head black, abdomen and distal legs reddish, wings clear
	sp. 4	medium, abdomen, legs and prothorax red; wings apical half suffused
	sp. 5	Medium-sized, body and head black, abdomen and distal legs reddish, wings suffused throughout
	sp. 6	Small, prothorax, abdomen and legs reddish; head and rest of thorax black; wings clear
	sp. 7	Tiny, head and thorax dark, front legs light, hind legs and abdomen banded, wings clear
	sp. 8	All black except yellowish apical legs, wings clear with yellowish veins, long antennae
	sp. 9	Tiny, all black, except yellowish legs, wings apically dark
	sp. 10	Light frons and clypeus between large eyes; head and thorax black, apical legs, abdomen and antennae reddish; wings suffused throughout, darker at tips; abdomen hard and ribbed.
	sp. 11	Medium-sized, all black, wings lightly suffused throughout, large wrinkled pulvilli
	sp. 12	Small, all black, head unusually large and pronotal collar unusually high
Tiphiidae	sp. 1	Small, slender, black, large pterostigma, lighter broken crossbands on abdomen, 'spectacle+moustache' marks on round head; apical metasomal upturned hook
	sp. 2	Medium-sized, black with reddish abdomen, suffuse wings, flat head with large mandibles and no marks, normal downturned sting
	sp. 3	Small, thorax and head predominantly pink and black mottled, long antennae; upturned hook
indet.	sp.	Small, black, widely attached abdomen, but not Symphyta (no cenchri), prominent ovipositor, blades apically rounded; posterior tarsi clavate and mildly serrate; prominent pterostigma but little other venation; antenna 16 segments
ISOPTERA	*Hodotermes mossambicus*	Unmistakeable
	Psammotermes allocerus	Unmistakeable
LEPIDOPTERA		
Lycaenidae	?*Lepidochrysops* sp.	Tiny butterfly
indet.	spp.	Undifferentiated tiny, generally slender moths
	spp.	Undifferentiated larger, generally robust moths
	indet.	Smooth lepidopterous larvae
	indet.	Hairy lepidopterous larvae
MANTODEA	sp. 1	Apterous, mottled grey, conspicuous black marks on inner protibiae
	sp. 2	Apterous, small, all dark
	sp. 3	Alate, inner protibiae clear, each tarsal segment with dark apical ring
	sp. 4	Flimsy juveniles
NEUROPTERA		
Chrysopidae	sp.	Unmistakeable

Higher taxon	**Morphospecies**	**Diagnostic basis**
Coniopterygidae	sp.	Not Symphyta: antennae 23 segments; not Psocoptera: no re-entrant vein or globose frons
Myrmeleontidae	sp.	Larvae
Nemopteridae	sp.	Larvae
Psychopsidae	sp.	Unmistakeable
ORTHOPTERA		
Acrididae	*Acrotylus* sp.	Unmistakeable
	Lithidiinae sp.	Unmistakeable
	indet.	Unidentifiable acridid nymphs
Mogoplistinae	sp.	Unmistakeable
Schizodactylidae	*Comicus capensis*	Unmistakeable
Thericleidae	sp.	Unmistakeable
PSOCOPTERA	spp.	Undifferentiated
THYSANOPTERA	sp. 1	Larger, pale yellowish with dark head and apical abdomen
	sp. 2	Tiny, black
THYSANURA		
Lepismatidae	*Afrolepisma* sp.	Unmistakeable
	Ctenolepisma sp. 1	Squat body shapes (C. namibensis-like)
	Ctenolepisma sp. 2	Elongate body shapes
	Monachina sp.	Unmistakeable
	Thermobia sp.	Unmistakeable
ORDER	indet.	Order indeterminate. Coccid-like body. Robust fossorial front legs, others slender cursorial, Short antennae. No further distinguishing characters. Maybe larvae?
MOLLUSCA		
Gastropoda	sp.	Unmistakeable
MYRIAPODA		
Polyxenida	sp.	Tiny, setal tufts on head

Appendix 3

Trophic guild associations of invertebrate taxa recorded.

Invertebrata taxa recorded in the 12 Omahola Project habitats with their various trophic guild associations.

		Trophic guild													Habitat											
		Leaves	Flowers, nectar, pollen	Fruit, seed	Sap	Wood	Grass	Fungi, lichens	Detritus	Dung	Scavengers	Predators	Parasites	Unknown	1	2	3	4	5	6	7	8	9	10	11	12
ARACHNIDA																										
ACARI	sp. 1								x						x	x	x	x	x	x	x	x	x	x	x	x
	sp. 2								x										x	x			x	x		
	sp. 3								x													x	x			
	sp. 4								x								x					x		x		
	sp. 5								x							x	x	x	x				x	x		
	sp. 6								x											x			x			
	sp. 7								x							x	x	x		x	x	x	x	x		x
	sp. 8								x													x	x	x		
	sp. 9								x							x							x			
	sp. 10								x							x										
	sp. 11								x														x			
ARANEAE																										
Ammoxenidae	*Ammoxenus* sp.											x				x			x			x	x	x		
	Rastellus sp.											x			x	x	x	x	x	x	x	x	x	x	x	x
Araneidae	sp.											x										x	x	x		
Eresidae	sp.											x				x	x									
Gnaphosidae	sp. 1											x			x	x		x	x	x		x		x		
	sp. 2											x							x	x	x		x	x		
	sp. 3											x			x	x	x	x	x	x	x	x	x	x	x	x
Oonopidae	sp.											x				x	x	x	x	x	x	x	x	x		x
Oxyopidae	sp.											x										x				
Palpimanidae	sp. 1											x			x	x	x	x	x	x	x	x	x	x		
	sp. 2											x			x	x	x	x	x	x	x	x	x	x		
	sp. 3											x				x		x					x	x	x	

		Trophic guild													Habitat											
		Leaves	Flowers, nectar, pollen	Fruit, seed	Sap	Wood	Grass	Fungi, lichens	Detritus	Dung	Scavengers	Predators	Parasites	Unknown	1	2	3	4	5	6	7	8	9	10	11	12
Philodromidae	sp.											x				x	x					x				
Pholcidae	sp. 1											x			x	x		x	x	x		x	x	x	x	
	sp. 2											x							x			x	x	x	x	
Prodidomidae	sp.											x					x			x		x				
Salticidae	sp.											x			x	x	x	x	x	x	x	x	x	x	x	x
Sicariidae	*Loxosceles* sp.											x									x		x			
	Sicarius sp.											x			x		x	x	x				x	x		
Sparassidae	sp. 1											x						x		x		x	x	x		
	sp. 2											x											x			
Zodariidae	sp.											x											x			
indet.	sp. 1											x					x	x	x					x		
	sp. 2											x						x								
	sp. 3											x										x	x			
	sp. 4											x			x											
	indet.											x							x	x	x	x	x	x		
PSEUDO-SCORPIONIDA	sp.											x							x	x			x	x	x	
SCORPIONIDA																										
Buthidae	*Parabuthus granulatus*											x			x		x		x	x		x	x	x	x	x
	Uroplectes sp.											x				x	x		x	x	x	x				
	indet.											x								x	x					
SOLPUGIDA																										
Ceromidae	spp.											x							x	x		x				
Hexisopodidae	sp.											x								x			x		x	
Melanoblossidae	spp.											x			x	x	x	x	x	x	x	x	x	x	x	x
Solpugidae	spp.											x				x	x	x	x	x	x	x	x	x	x	

		Trophic guild													Habitat											
		Leaves	Flowers, nectar, pollen	Fruit, seed	Sap	Wood	Grass	Fungi, lichens	Detritus	Dung	Scavengers	Predators	Parasites	Unknown	1	2	3	4	5	6	7	8	9	10	11	12
indet.	sp. 1											x				x	x	x	x	x	x	x		x	x	
indet.	sp. 2																						x			
CRUSTACEA																										
Isopoda	sp.								x							x			x							
INSECTA																										
BLATTODEA																										
Blattellidae	sp. 1								x						x	x		x		x	x			x		
	sp. 2								x						x	x		x	x	x	x	x		x		
	sp. 3								x						x	x		x	x	x	x	x	x			
	sp. 4								x						x	x		x	x	x	x	x	x	x		x
	sp. 5								x						x	x			x							
COLLEMBOLA																										
Entomobryidae	spp.								x						x	x	x	x	x	x	x	x	x	x	x	x
Poduridae	sp.								x						x	x				x		x	x		x	
COLEOPTERA																										
Anobiidae	sp.					x										x			x							
Anthicidae	sp.								x						x				x	x		x	x		x	
Bruchidae	sp.			x																				x		
Carabidae	Anthiinae sp.											x								x	x	x	x	x		x
	Caminara sp.											x			x										x	
	sp. 1											x					x	x			x		x			
	sp. 2											x			x				x	x			x		x	
	sp. 3											x			x											
Catopidae	sp. 1								x								x				x	x	x			
	sp. 2																x	x			x	x				
Chrysomelidae	Cassidinae sp.	x																	x							
	Clytrinae sp.	x															x		x							

		Trophic guild													Habitat											
		Leaves	Flowers, nectar, pollen	Fruit, seed	Sap	Wood	Grass	Fungi, lichens	Detritus	Dung	Scavengers	Predators	Parasites	Unknown	1	2	3	4	5	6	7	8	9	10	11	12
	Eumolpinae sp.	x																					x		x	x
Coccinellidae	sp.											x						x			x					
Curculionidae	Brachycerinae sp.	x													x	x										
	Hyomora sp.	x															x		x							x
	Neocleonus sp.	x															x									
	Ocladius sp.	x													x					x			x			
	Episus sp.																				x					
	sp. 1	x																		x		x			x	x
	sp. 2	x																x		x	x		x			x
	sp. 3	x																						x		
	sp. 4	x																			x					
	sp. 5	x																		x	x	x	x		x	
Dascillidae	sp.	x																						x		
Dermestidae	sp. 1										x				x	x	x	x	x	x	x	x				
	sp. 2										x					x										
	sp. 3										x					x								x		
Histeridae	sp.										x				x									x		
Meloidae	sp. 1		x													x		x				x			x	
	sp. 2		x														x					x				
Melyridae	sp. 1											x					x	x	x	x	x	x	x	x	x	
	sp. 2											x						x		x	x			x		
Mordellidae	sp.		x														x						x			
Nitidulidae	sp.													x						x						
Ptinidae	Ptininae sp.								x							x										
	Stethomezium sp.								x									x								
Scarabaeidae	Aphodiinae sp.									x								x	x				x	x		

		Trophic guild													Habitat											
		Leaves	Flowers, nectar, pollen	Fruit, seed	Sap	Wood	Grass	Fungi, lichens	Detritus	Dung	Scavengers	Predators	Parasites	Unknown	1	2	3	4	5	6	7	8	9	10	11	12
	Melolonthinae sp.	x																						x		
	Rutelinae	x													x											
Silvanidae	sp. 1								x						x											
Staphylinidae	sp. 1											x			x											
	sp. 2											x							x							
Tenebrionidae	Adesmiini sp														x											
	Cauricara eburnea								x							x	x	x					x			
	Drosochrini sp. 1								x						x		x			x			x	x	x	
	Drosochrini sp. 2																							x		
	Epiphysa punctatissima								x						x		x	x	x	x	x	x	x	x		x
	Eurychora sp.								x												x					x
	Geophanus sp.								x						x	x		x		x	x	x	x	x		
	Gonopus sp.								x						x	x	x	x	x	x	x	x	x	x		
	Metriopus depressus								x							x	x		x	x	x	x	x	x	x	x
	Molurini sp.																			x						
	Namibomodes sp.								x															x		
	Parastizopus sp.								x						x	x	x	x	x	x	x	x	x	x		
	Physadesmia globosa								x							x	x	x	x	x			x			
	Physosterna cribripes								x						x	x	x	x	x	x	x		x	x		
	Rhammatodes sp.								x						x	x	x	x	x	x	x	x	x	x	x	x
	Somaticus sp.								x						x	x			x	x	x	x		x	x	x
	Stips dohrni								x						x	x	x	x	x	x	x	x	x	x		
	Stizopina sp.								x								x	x	x	x	x	x		x		
	Tenebrioninae sp.								x																x	x

		Trophic guild													Habitat											
		Leaves	Flowers, nectar, pollen	Fruit, seed	Sap	Wood	Grass	Fungi, lichens	Detritus	Dung	Scavengers	Predators	Parasites	Unknown	1	2	3	4	5	6	7	8	9	10	11	12
	Tentyriini sp.								x						x			x								
	Zophosis amabilis								x							x	x	x	x			x	x	x	x	x
	Zophosis devexa								x						x	x	x		x							
	Zophosis dorsata								x													x				
	Zophosis sp.								x						x	x	x			x		x	x	x		
	Zophosis cf. *Gyrosis* sp.								x																x	
Thorictidae	sp.								x										x							
indet.																x	x	x	x	x	x		x	x	x	
DIPTERA																										
Acalyptratae	sp. 1													x	x	x	x	x	x	x	x	x	x	x	x	
	sp. 2													x		x	x				x					
	sp. 3													x							x					
	sp. 4													x	x	x							x			
	indet.													x	x	x	x		x	x	x	x	x		x	
Bombyliidae	sp. 1		x																x			x				
	sp. 2		x																	x						x
	sp. 3		x																	x						
Calliphoridae	sp.										x				x				x				x			
Camillidae	sp.									x					x	x	x	x	x	x	x	x	x	x	x	x
Cecidomyiidae	sp.													x	x	x	x	x	x		x	x	x	x	x	
Chironomidae	sp.		x																		x				x	
Chloropidae	sp. 1	x													x	x		x	x	x				x		
	sp. 2	x													x	x	x	x	x	x	x	x	x	x	x	x
	sp. 3	x													x	x	x	x	x	x	x	x	x	x	x	x
	sp. 4	x													x	x	x	x	x	x	x	x	x	x		x
	sp. 5	x													x	x	x		x	x	x	x	x	x	x	x

		Trophic guild													Habitat											
		Leaves	Flowers, nectar, pollen	Fruit, seed	Sap	Wood	Grass	Fungi, lichens	Detritus	Dung	Scavengers	Predators	Parasites	Unknown	1	2	3	4	5	6	7	8	9	10	11	12
	sp. 6	x														x	x	x	x	x	x	x	x	x	x	
	sp. 7	x														x	x	x	x	x	x	x	x	x	x	
Conopidae	sp.												x									x				
Culicidae	sp.												x		x			x							x	
Curtonotidae	sp.										x									x			x		x	
Drosophilidae	sp.			x											x											
Empididae	sp. 1											x									x	x	x			
	sp. 2											x				x										
	sp. 3											x										x				
Heleomyzidae	sp.										x				x	x	x		x	x			x			
Lonchaeidae	sp.													x	x											
Muscidae	sp. 1										x				x						x		x			
	sp. 2								x						x	x	x	x	x	x	x	x	x	x	x	x
	sp. 3								x													x				
	sp. 4								x						x	x	x	x	x	x	x	x	x	x	x	x
Mycetophilidae	sp.							x							x	x	x			x	x	x	x			
Mythicomyiidae	sp.		x												x							x	x	x		
Phoridae	sp. 1								x				x		x	x			x	x	x	x	x	x	x	x
	sp. 2								x				x		x	x	x	x	x	x	x	x	x		x	
	sp. 3								x				x						x	x	x		x			
Psychodidae	sp.									x					x											
Sarcophagidae	sp. 1										x					x	x	x	x	x	x	x	x	x		x
	sp. 2										x					x	x	x	x	x	x	x	x	x		
	sp. 3										x									x						
Sciaridae	sp.								x							x	x	x	x		x		x	x		
Sepsidae	sp.									x						x							x	x		
Syrphidae	sp. 1		x												x											

		Trophic guild													Habitat											
		Leaves	Flowers, nectar, pollen	Fruit, seed	Sap	Wood	Grass	Fungi, lichens	Detritus	Dung	Scavengers	Predators	Parasites	Unknown	1	2	3	4	5	6	7	8	9	10	11	12
	sp. 2		x																				x			
Tachinidae	sp. 1												x				x			x	x		x			
	sp. 2												x		x	x	x		x	x	x	x	x			
	sp. 3												x		x	x			x	x			x	x	x	x
	sp. 4												x					x	x	x		x			x	x
Tephritidae	sp. 1			x											x			x	x	x	x		x			
	sp. 2			x											x					x			x			
	sp. 3			x											x	x		x			x	x	x		x	x
Therevidae			x													x			x		x	x				
indet.																									x	
HEMIPTERA																										
Alydidae	sp.			x														x								
Anthocoridae	sp. 1											x							x							
	sp. 2																			x					x	x
Aphididae	sp.				x													x					x			
Berytidae	sp.	x													x								x		x	x
Cicadellidae	sp. 1				x										x			x								
	sp. 2				x													x	x							
	sp. 3				x													x		x	x			x	x	
	sp. 4				x														x		x				x	x
	sp. 5				x										x	x	x	x	x	x	x	x	x	x	x	x
	sp. 6				x																					x
	sp. 7				x																			x		
Cicadidae	sp.				x																x			x		x
Coccoidea	sp. 1				x													x			x			x		
	sp. 2				x										x	x	x						x			
	sp. 3				x																		x			

		Trophic guild													Habitat											
		Leaves	Flowers, nectar, pollen	Fruit, seed	Sap	Wood	Grass	Fungi, lichens	Detritus	Dung	Scavengers	Predators	Parasites	Unknown	1	2	3	4	5	6	7	8	9	10	11	12
Cydnidae	sp. 1				x										x						x					
	sp. 2				x										x											
	indet.				x																x					
Fulgorioidea	sp. 1				x												x			x						
	sp. 2				x												x			x						
	sp. 3				x													x		x				x		
	sp. 4				x										x											
	indet.				x												x						x	x	x	
Lygaeidae	sp. 1			x																	x	x				
	sp. 2			x																	x					
Miridae	sp.				x																			x		
Pentatomidae	sp.				x															x	x					
Pyrrhocoridae	*Odontopus* sp.				x															x	x	x			x	x
Reduviidae	Emesinae sp.											x						x		x		x				
	Holoptilinae sp.											x						x			x	x				
	Piratinae sp. 1											x								x						
	Piratinae sp. 2											x				x						x				
	indet.											x								x		x			x	
indet.																x		x		x	x		x	x		
HYMENOPTERA																										
Apoidea	sp.		x																				x		x	
Bethylidae	sp.												x			x	x			x	x		x	x	x	
Braconidae	sp. 1												x			x	x			x				x		
	sp. 2												x			x		x								
Bradynobaenidae	sp.												x								x					
Chalcidoidea	spp.												x			x	x	x	x	x	x	x	x	x	x	x
Chrysididae	sp.												x					x		x		x	x			

		Trophic guild													Habitat											
		Leaves	Flowers, nectar, pollen	Fruit, seed	Sap	Wood	Grass	Fungi, lichens	Detritus	Dung	Scavengers	Predators	Parasites	Unknown	1	2	3	4	5	6	7	8	9	10	11	12
Cynipidae	sp. 1												x					x						x		
	sp. 2												x			x		x								
	sp. 3												x								x			x		
	sp. 4												x									x		x		
Formicidae	*Anoplolepis* sp.										x				x		x	x		x		x	x			
	Camponotus sp.										x				x	x	x	x		x	x	x	x	x		
	Camponotus maculatus										x				x	x		x	x	x	x	x	x	x		
	Crematogaster sp.										x											x	x			
	Lepisiota sp.										x				x	x	x	x		x	x	x	x	x	x	
	Messor denticornis																			x		x	x	x	x	x
	Messor sp.			x											x	x	x	x		x	x	x	x			
	Monomorium sp. 1										x				x	x	x	x	x	x	x	x	x	x		x
	Monomorium sp. 2										x				x	x	x	x	x	x	x	x	x	x		x
	Monomorium sp. 3										x				x	x	x	x	x	x	x	x			x	
	Monomorium sp. 4										x				x	x	x	x	x	x	x	x	x	x	x	x
	Ocymyrmex sp.											x			x			x	x	x	x	x		x	x	x
	Pheidole sp.			x											x	x	x	x	x	x		x	x			
	Tetramorium sp. 1											x			x		x	x		x	x	x	x	x	x	x
	Tetramorium sp. 2											x			x	x	x	x		x	x	x		x		
	indet.														x	x	x	x	x	x	x	x	x	x	x	x
Gasteruptiidae	sp.												x			x						x	x	x		x
Halictidae	sp. 1		x												x	x	x	x	x	x	x	x	x	x	x	
	sp. 2																x	x	x	x	x	x	x	x	x	x
	sp. 3																x	x		x	x	x		x		x
	sp. 4														x				x							

		Trophic guild													Habitat											
		Leaves	Flowers, nectar, pollen	Fruit, seed	Sap	Wood	Grass	Fungi, lichens	Detritus	Dung	Scavengers	Predators	Parasites	Unknown	1	2	3	4	5	6	7	8	9	10	11	12
Ichneumonidae	sp. 1												x					x	x			x				
	sp. 2												x		x											
Masaridae	sp. 1		x													x	x	x			x	x	x			
	sp. 2		x														x	x	x	x	x	x		x	x	
	sp. 3		x																			x				
	sp. 4		x													x		x	x	x	x	x	x	x	x	x
	sp. 5		x															x								
	sp. 6		x																			x	x			
Melittidae	sp. 1		x												x	x	x				x		x			
	sp. 2															x						x	x			
Mutillidae	sp.												x			x								x		
Plumariidae	sp.												x				x						x	x	x	x
Pompilidae	sp. 1											x				x	x	x	x	x	x	x	x	x		
	sp. 2											x						x								
	sp. 3											x			x		x		x	x	x	x	x	x		
	sp. 4											x						x		x						
	sp. 5											x			x		x	x	x	x	x	x				x
Proctotrupidae	sp.												x		x		x					x				
Sapygidae	sp.												x							x						
Scoliidae	sp.												x						x							
Sphecidae	sp. 1											x					x	x	x	x	x	x	x		x	x
	sp. 2											x					x	x	x	x	x	x	x			
	sp. 3											x			x	x	x	x	x	x	x	x	x			
	sp. 4											x					x				x					x
	sp. 5											x			x	x					x			x		
	sp. 6											x											x			

		Trophic guild													Habitat											
		Leaves	Flowers, nectar, pollen	Fruit, seed	Sap	Wood	Grass	Fungi, lichens	Detritus	Dung	Scavengers	Predators	Parasites	Unknown	1	2	3	4	5	6	7	8	9	10	11	12
	sp. 7											x						x		x						
	sp. 8											x						x	x	x	x		x	x		
	sp. 9											x							x				x			
	sp. 10											x									x					
	sp. 11											x								x						
	sp. 12											x									x					
Tiphiidae	sp. 1											x														x
	sp. 2											x			x											
	sp. 3											x								x						
indet.	sp.																			x						
ISOPTERA	*Hodotermes mossambicus*						x									x		x	x	x	x	x	x	x	x	
	Psammotermes allocerus					x										x		x		x	x	x	x	x	x	x
LEPIDOPTERA																										
Lycaenidae	?*Lepidochrysops* sp.		x																					x		
indet.	spp.		x												x	x	x	x	x	x	x	x	x	x	x	x
	spp.		x												x	x	x	x	x	x	x	x	x	x	x	x
	indet.		x														x	x		x	x	x	x			
	indet.		x																x							
MANTODEA	sp. 1											x					x	x			x		x			
	sp. 2											x						x								
	sp. 3											x												x		
	sp. 4											x						x		x	x					
NEUROPTERA																										
Chrysopidae	sp.											x														x
Coniopterygidae	sp.											x					x						x	x		

		Trophic guild													Habitat											
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Myrmeleontidae	sp.											x				x					x					
Nemopteridae	sp.											x									x					
Psychopsidae	sp.											x							x		x	x				
ORTHOPTERA																										
Acrididae	*Acrotylus* sp.	x																				x			x	
	Lithidiinae sp.	x														x	x	x		x	x	x	x	x		x
	indet.	x													x					x	x	x	x		x	
cf. Lentulidae																			x							
Mogoplistidae	sp.											x				x	x	x				x				
Schizodactylidae	*Comicus capensis*											x									x	x	x		x	x
Thericleidae	sp.	x															x	x	x	x	x	x		x		
PSOCOPTERA	spp.							x	x						x	x	x	x	x	x	x	x	x	x	x	x
THYSANOPTERA	sp. 1		x														x	x				x	x	x	x	
	sp. 2		x													x	x			x	x	x	x		x	x
THYSANURA																										
Lepismatidae	*Afrolepisma* sp.								x							x										
	Ctenolepisma sp. 1								x						x	x	x	x	x	x	x	x	x	x	x	x
	Ctenolepisma sp. 2								x						x	x	x	x	x	x	x	x	x	x	x	x
	Monachina sp.								x							x					x					
	Thermobia nebulosa																					x	x			
	Thermobia sp.								x						x							x		x		
ORDER	indet.															x										
MOLLUSCA																										
Gastropoda	sp.	x														x										
MYRIAPODA																										
Chilopoda	sp.											x														x
Polyxenida	sp.								x							x				x						x