

Small mammal survey: Palabora Mining Company and Kruger National Park (2012)

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1. Introduction and Project brief

1.1 Introduction

The South African Environmental Observation Network (SAEON) is a research platform funded by the Department of Science and Technology (DST) and managed by the National Research Foundation (NRF). It is mandated to develop and sustain a dynamic South African *in situ* environmental observation and research network aimed at collecting, processing, interpreting and archiving long term data; as well as making such data accessible to end users: decision makers, researchers and industry. It has a decentralised structure with the National Office in Pretoria providing corporate and shared services, and six (6) nodes distributed in different geographical regions providing the actual platforms for research and education.

The SAEON Ndlovu Node is based in Phalaborwa, within the Kruger National Park, and maintains a number of long-term ecological research sites in the Limpopo and Mpumalanga Provinces. Regular collection of ecological data is required from these sites, for the purposes of detecting, understanding and predicting changes occurring to major ecosystems in the region. From time to time, specialist contractors are needed to assist with the collection and capture of such data.

1.2 Terms of reference

“The Consultant shall be required to conduct the following activities on Palabora Mining Company landholdings, including Cleveland Game Reserve and Pompey farm, and within an area of the Kruger National Park directly adjacent to the Cleveland Game Reserve:

- Survey small mammal species presence and abundance using both live-trapping and active searches.
- Survey small mammal diversity and abundance during daylight and night time hours, as appropriate.
- Record, using a handheld GPS, the position of live-traps.
- Record, using a handheld GPS, the areas of active searches.
- Conduct the small mammal survey in each of the following land types. Number of sites and intensity of sampling to be decided, in consultation with SAEON, following a site visit:
 - Adjacent to water bodies (dams, pans and seepage areas) within the mining area and on Cleveland Game Reserve
 - The riparian zone of the Olifants and/or Selati Rivers
 - The terrestrial areas of undisturbed vegetation
 - The syenite koppies
 - The margin of at least one of the tailings dams
 - The active rock dump, at
 - The area of intact vegetation between the dams and dumps, but within the mined area of PMC
 - The built environment of the PMC operational area
 - The fenced and unfenced portions of Pompey farm.

Source additional environmental information from SAEON, directly from PMC, or from any other reliable source, needed for the interpretation of the survey data collected. Such data might include, but is not limited to, water quality, the distribution of other taxa on the study area, vegetation, meteorological data, SANBI red-data status of species recorded, expected

occurrence of species within the study area, soil and land-use history and management practices.

Produce a report summarizing the occurrence and abundance of small mammal (including bat) species at each survey site, including:

- the geographical coordinates of each site,
- the conservation status of each species following the SANBI red-data list for Southern Africa
- the expected distribution of all small mammal species with the study area
- an explanation of the absence of any species expected, with reference to land management practises that have taken place in and around the study area
- interpretation of current findings against previous small mammal survey data collected by PMC in 2006/2008.
- proposals for management actions that would improve the conservation of the surveyed species within the study area, if appropriate.

Produce an electronic copy of the all data collected. This will typically be in the form of an MS Excel spreadsheet for tabular data, and a GIS compatible file for spatial data”.

2. Survey methods

The aim of the small mammal monitoring study is to characterize the habitats and species in the existing environment as a basis for predicting and monitoring impacts of land use and mining operation on faunal composition and abundance as a result of project activities.

The mammal assessment will focus on the identification of small mammals (rodents and shrews) occurring within the study area, with emphasis placed on identifying mammals of conservation concern (species listed on the International Union for Conservation of Nature (IUCN) database, species that are endemic to the region and species that are of economic/traditional importance). The assessment will result in the compilation of a mammal species list for species identified within the study area and for species that are likely to occur within the study area.

The proposed methodology for the faunal study consists of the two main elements:

- the classification of biotopes as a basis for the selection of sampling areas; and
- the linking of the occurrence of fauna to each defined biotope.

The assessment will include the following components:

- Identification of mammal habitat types within the study area.
- Identification of mammal species using small mammal live traps, to establish the presence of mammals of less than 1kg.

Recording data from each sampling site to include the following:

- Locality of the sampling sites in degrees, minutes and seconds using a Global Positioning System (GPS).
- Mammals identified within each sampling site.
- The habitat of the sampling site.
- Visible disturbance in and around the sampling sites.

2.1 Habitat

The faunal component of the study area is largely reliant on the geomorphology and vegetation structure of the area to provide suitable habitat. Each species has a specific niche, which could be a very specific environment or a range of conditions that it selects as optimal habitat. These conditions are provided by both the geomorphological template and vegetation structure that serve as potential habitats. The geomorphological aspect has been changed considerably in the active mining area, however in the areas away from these activities, it is reasonably stable (except for erosion), whereas the vegetation aspects could be changed by human interference.

The habitat components that are usually under consideration when surveying a transect are sheltering components (trees, logs, stones, rocky outcrops, multi-stemmed shrubs, grass tussocks, etc) or substrates that permit subsurface activities (soft soils, leaf litter, existing holes, termite mounds, etc) by the small mammals. During the survey, these habitat components are listed and serve as an indication of the presence of the vertebrates that might utilize them.

To determine *habitat preference* of small mammals, an extensive literature study of all available information will be undertaken to provide each relevant organism with a preferred habitat profile.

The literature review will be prepared to link the *probable occurrence* of fauna to the specific biotopes. Historical and present distribution of the local fauna will also be obtained, where available, from existing distribution maps and other data. This will be used to consolidate long-term distribution data on the fauna.

2.2 Trapping

The secretive nature and physical size of the species to be studied make them difficult to inventorise by direct counts or quantification of signs left by them. For the most part, determining the presence of any of these species requires physical capture of individuals. For this reason, trapping is the most efficient means of inventorising individual small mammal species as well as entire small mammal communities.

Small mammal trapping can be accomplished by three means: live-trapping, pitfall-trapping and, in some restricted cases, snap-trapping. Live-capture trapping (accomplished by both live- and pitfall-trapping) is the most appropriate method for any studies and provides the most reliable and most informative data about population numbers and demography, and is the best method to determine differences between habitat types and for monitoring population changes following disturbance or over time. Due to limitations in time and budget, only live-trapping with Sherman traps is the method being used during the current surveys. Because the Sherman comes in a collapsible model (approximately 8cm x 7cm x 23 cm), it is easier to carry long distances.

One capture station (trap station) of 100 traps was set out per land type; 10 traps per each of 10 trap lines. As a general guideline a spacing of approximately 10 m between traps will provide for adequate coverage. Trapping took place over a period of 2 nights per land type, thus 200 trap nights per habitat (100 traps x 2 nights). Flagging tape is used to mark capture (trap) stations over the duration of the study.

Traps are set in the evening (after 4 pm) and checked the following morning before 8 am. Since we are conducting presence/absence (not detected) surveys with the emphasis on diversity, overnight trapping is sufficient given that trap mortalities will not affect analysis methods; however, effort is made to minimize trap mortalities. Traps are checked early in the

morning for the entire capture session (trapping session). During the day time, traps are left closed during the morning and early afternoon to minimize inadvertent capture and mortality due to heat stress.

Traps were baited with peanut butter mixed with rolled oats and golden syrup. Traps were set out of direct sunlight to prevent overheating. All animals were identified and later released at the original capture station. Sometimes measurements of external physical features, such as weights and lengths, and photographs were taken. Individuals that were not new or notable location records or needed for positive identification were released.

3. Survey results and discussion

3.1 Description of the biophysical environment

Mucina and Rutherford (2006) classify this vegetation type as Phalaborwa-Timbavati Mopaneveld (SVmp 7), which matches the Arid Lowveld (Acocks, 1953) and Mopane Bushveld (Low & Rebelo, 1996). It occurs in a band about 40 km west and east of Phalaborwa, into the Kruger Park and down to the Olifants River (Altitude 300-600 m).

The vegetation type consists of open tree savanna on undulating plains with the sandy uplands dominated by *Combretum apiculatum*, *Terminalia sericea* and *Colophospermum mopane* trees, with *T. sericea* disappearing and *C. apiculatum* becoming less common in the clayey bottomlands, and being replaced by trees such as *Acacia nigrescens* and increased dominance of *C. mopane*. The field layer is usually well developed. A feature of this unit is the large number of termite mounds on the uplands.

Quartz-feldspar rocks of the Makutswi Gneiss (Swazian) dominate this area. Sandy soils (usually less than 10% clay in the A-horizon) on the uplands (e.g. Clovelly soil form) and clay soils in the bottom-lands (e.g. Valsrivier and Sterkspruit soil forms).

The climate entails summer rainfall with very dry winters. Mean annual precipitation is 400-600mm. Generally frost-free. Mean monthly maximum and minimum temperatures for Phalaborwa - 38°C and 5.7°C for January and July respectively.

Conservation of the vegetation type: Least threatened. Target 19%. Some 38% statutorily conserved in the Kruger National Park, with similar proportion in the private game reserves. About 5% is transformed, mainly by development of human settlements as well as by mining (Mucina and Rutherford, 2006)

3.2 Small mammal trapping

3.2.1 Project sites – trap stations

During the current survey the following 12 sites (selected in deliberation with client) were surveyed for small mammals (Co-ordinates in Table 3(see also Figures 2 and 3)):

Site 1: *Acacia nilotica* dump site: The active rock dump, at PMC (Named: *Nilotica* site)

Site 2: Loole Creek drainage in the mining area: Adjacent to water bodies (dams, pans and seepage areas) within the mining area (Named: Loole Creek)

Site 3: Tailings Dam site: The margin of at least one of the tailings dams (Named: Tailings Dam)

Site 4: Old rehabilitated area on the eastern part of PMC (old rock dump): The built environment of the PMC operational area to be replaced by the old rehabilitated area (Named: Rehab area)

Site 5: Mopane site in Cleveland Reserve (undisturbed): The terrestrial areas of undisturbed vegetation (Named: Cleveland mopane)

Site 6: Syenite koppies in Cleveland Reserve (undisturbed): The syenite koppies (Named: Cleveland koppies)

Site 7: Spring site in Cleveland Reserve (undisturbed): Adjacent to water bodies (dams, pans and seepage areas) in Cleveland Game Reserve (Named: Cleveland spring)

Site 8: PMC Campsite in Cleveland Reserve (Olifants River - undisturbed): The riparian zone of the Olifants and/or Selati Rivers (Named: Cleveland Olifants)

Site 9: Pompey site (rehabilitated site): The fenced and unfenced portions of Pompey farm (Named: Pompey)

Site 10: Mopane site in KNP (undisturbed): The Mopane site as reference site (Named: KNP mopane)

Site 11: Syenite koppies in Kruger National Park (KNP) (undisturbed): The syenite koppie as reference site (Named: KNP koppie)

Site 12: The Olifants River in the KNP (undisturbed): The riparian zone of the Olifants as reference site (Named: KNP Olifants)

Of these sites, 8 sites were sampled previously as part of the PMC biodiversity studies. This study used the same sites or sites in the immediate surrounding area. The 3 sites in the KNP are new, as well as the Pompey site.

3.2.2 Aspects of habitat at the trap stations

The habitat composition has been assessed for each of these sites, and the results are shown in Table 1. A summary of the main elements are presented in the list below.

This list summarizes the dominant habitat types at the project sites (see also Appendix 4):

Site 1: *Acacia nilotica* dump site: Rocky (close to outcrop and dumped rocks); moderate woody vegetation cover (trees and shrubs); high incidence of grass clumps or patches.

Site 2: Loole Creek: Rocky due to washed open rocks on sandy/clay/loam slope, high presence of dead woody structures; moderate covering of multi-stemmed and toppled brushwood.

Site 3: Tailings Dam site: Sandy - clay dump; dense covering of multi-stemmed brushwood; moderate incidence of grass clumps or patches, and some leaf litter.

Site 4: Old rehabilitated area on the eastern part of PMC: High presence of dead woody structures on gravelly rehabilitation soils; moderate covering of multi-stemmed brushwood and high covering of toppled brushwood.

Site 5: Syenite koppies in Cleveland Reserve: Rocky outcrop with gravelly rocky loam, moderate presence of dead woody structures; good herbaceous cover; moderate woody vegetation cover (trees and shrubs); moderate covering of multi-stemmed brushwood.

Site 6: Mopane site in Cleveland Reserve: Moderate presence of dead woody structures on sandy seep line; moderate woody vegetation cover (trees and shrubs); moderate covering of multi-stemmed brushwood.

Site 7: Spring site in Cleveland Reserve: Rocky due to washed open boulders and bedrock with mud and loam soil, presence of dead woody structures; high woody vegetation cover (trees and shrubs); moderate covering of multi-stemmed brushwood; high incidence of sedge clumps or patches.

Site 8: PMC Campsite in Cleveland Reserve (Olifants River): Rock formations bared on the alluvial slope, high presence of dead woody structures; high woody vegetation cover (trees and shrubs); moderate covering of multi-stemmed and toppled brushwood.

Site 9: Pompey site: A gravelly-cobble rocky rehabilitated soil structure, low covering of multi-stemmed brushwood.

Site 10: Mopane site in KNP: Moderate presence of dead woody structures on a sandy to gravel slope seep line; good herbaceous cover; moderate covering of multi-stemmed and toppled brushwood.

Site 11: Syenite koppies in KNP: Rocky outcrop, moderate presence of dead woody structures on loam soil; good herbaceous cover; moderate woody vegetation cover (trees and shrubs); moderate covering of multi-stemmed brushwood; moderate incidence of grass clumps or patches.

Site 12: The Olifants River in the KNP: River alluvium with high presence of dead woody structures; high woody vegetation cover (trees and shrubs); moderate covering of multi-stemmed and toppled brushwood.

Figure 1: Trap stations used (some combined) during the 2006 and 2008 surveys.

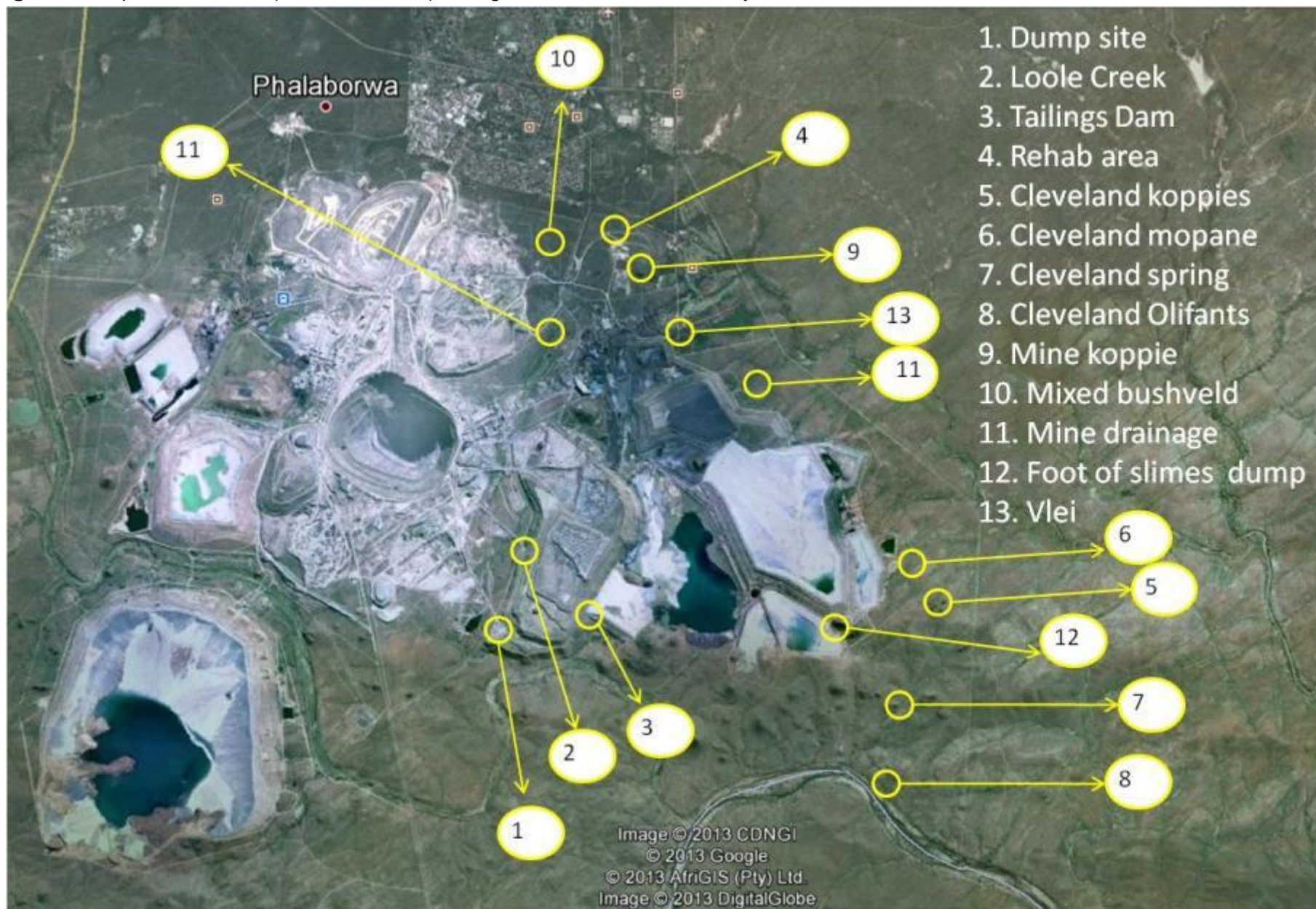


Figure 2: Trap stations used during the 2012 surveys, also indicating the position of the Pompey and Masorini sites.



Figure 3: Trap stations used during the 2012 surveys (excluding the Pompey and Masorini sites).



Table 1: A source list of habitat related parameters that is used to serve as indicators or surrogates for faunal presence.

Vegetation unit	1 Nilotica dump site	2 Loole Creek	3 Tailings Dam	4 Rehab area	5 Cleveland koppies	6 Cleveland mopane	7 Cleveland spring	8 Cleveland Olifants	9 Pompey	10 KNP mopane	11 KNP koppie	12 KNP Olifants
Terrain unit	Rock dump crest	Valley drainage line	Tailings Dam slope	Rehabilitated crest	Rocky outcrop	Level savanna	Valley drainage line	Macro-channel bank	Rehabilitated slope	Slope seep line	Rocky outcrop	Macro-channel bank
Survey transect length (m)	526	238	200	190	260	260	120	120	350	300	150	110
% Herbaceous cover	30%	45%	30%	40%	60%	15%	40%	30%	15%	60%	80%	30%
Grass height	Ankle	Ankle	Ankle	Ankle	Ankle	Knee	Ankle	Ankle	Ankle	Knee	Knee	Ankle
% Stone/rock cover	4%	15%	5%	3%	40%	0%	10%	4%	5%	1%	40%	0%
Soil	Gravelly, silty dump	Sandy-clay-loam	Sandy, clay dump	Gravelly	Gravelly, rocky loam	Sandy seep line	Mud, loam	River alluvium to rocky soil	Gravel/Cobble rocky mix	Sandy gravel	Loam soil, rocky	River alluvium soil
Slope	<1% level	3-10% undulating	35 ^u	<1% level	45 ^u	<1% level	5 ^u	15 ^u	3 ^u	<1% level	45 ^u	25 ^u
Woody structure (Absent; Open, Moderate, Dense):												
Shrub (<2m)	Open	Moderate	Dense	Moderate	Dense	Moderate	Open	Moderate	Moderate	Moderate	Dense	Moderate
Small tree (2-4m)	Moderate	Moderate	Open	Moderate	Moderate	Dense	Moderate	Moderate	Open	Open	Moderate	Dense
Medium tree (4-8m)	Open	Moderate	Open	Moderate	Moderate	Moderate	Open	Moderate	Open	Open	Moderate	Dense
Large tree (>8m)	Absent	Open	Absent	Absent	Open	Absent	Moderate	Open	Open	Absent	Moderate	Moderate
Special habitat: Rocky outcrop	Close by			Close by	Present			Close by			Present	
Sodic patch/site												
Pan or vlei: No marginal vegetation												
Trees surrounding							Present					
Long grass, sedges, reeds							Present					
Mixed vegetation (trees & other)												
Flowing water: Pools							Present	Present				Present
Rapids & riffles								Present				Present
Overhanging vegetation								Present				Present
Run/channel								Present				Present
	Per Hectare	Per Hectare	Per Hectare	Per Hectare	Per Hectare	Per Hectare	Per Hectare	Per Hectare	Per Hectare	Per Hectare	Per Hectare	Per Hectare
Holes small (5x5cm)	9		16			13			19	17		
Holes medium (10x10cm)					6	6		14	5			30
Holes large (>10x10cm)												
Stones & rocks: Loose stones (30x40cm)	102		141	35	32							
Loose boulders (>40x40cm)	502	493	83	35	928	6	500	276	38	6	899	
Bedrock with cracks & hollows (3-5m patches)	6	100	8		441		208	222		11	754	

3.2.3 Mammals trapped at the trap stations

Table 2 supplies a summary of the rodents collected during the 2012 survey period, with Table 3 comparing this data with the 2006 and 2008 survey data. Table 4 compares notes related to the current and historical trapping data.

During the 2012 surveys, 7 rodent species were captured in the traps (Table 2), which compared with the 8 species during 2006 and the 6 species in 2008 (Table 4). The most abundant species were the Bushveld Namaqua Rockmouse (*Micaelamys namaquensis* subsp. *alborarius*) and Tete veld rat (*Aethomys ineptus*) in all three the surveys.

During the 2006 survey, in 980 trap nights, 358 rodents (8 species) were caught, while during 2008, 177 rodents (6 species) were sampled in the 980 trap nights (trap night = each trap set out per night for the period). During the current survey, only 31 rodents (7 species) were trapped in 800 trap nights.

Despite the low abundance of rodents caught during the 2012 period, a similar species richness was obtained. There is no clear-cut reason for the low trap rate experienced in 2012, but the recovery of all species from previous surveys and the fact that this study was designed to capture maximal habitat diversity, renders the survey effective. The discussion in (Table 5) presents trends, even though it is a first survey at the current sites. The historical surveys (2006 and 2008) made use of 15 sites (some coinciding with the 2012 survey sites), although no sites were done at Pompey and the KNP during those historical surveys.

Table 2: The capture data for the 2012 small mammal survey.

Date	Site	Tete veld rat (<i>Aethomys inepus</i>)	Bushveld Namaqua Rockmouse (<i>Micaelamys namaquensis</i> subsp. <i>alborarius</i>)	Multimammate Mouse (<i>Mastomys</i>)	Bushveld Gerbil (<i>Gerbilliscus leucogaster</i>)	Spiny Mouse (<i>Acomys spinosissimus</i>)	Pouched Mouse (<i>Saccostomus campestris</i>)	Pygmy Mouse (<i>Mus minutoides</i>)
6 November 2012	1 <i>Nilotica</i> site	1	1					
7 November 2012	1 <i>Nilotica</i> site							
7 November 2012	2 Loole Creek	2	1					
8 November 2012	2 Loole Creek		1					
8 November 2012	3 Tailings Dam	1					1	
8 November 2012	4 Rehab area		1					
9 November 2012	3 Tailings Dam		1					
9 November 2012	4 Rehab area						1	
26 November 2012	5 Cleveland koppies	2	1					
26 November 2012	6 Cleveland mopane							
27 November 2012	5 Cleveland koppies	1	2			1		
27 November 2012	6 Cleveland mopane							
28 November 2012	7 Cleveland spring							
28 November 2012	8 Cleveland Olifants	1	1					
29 November 2012	7 Cleveland spring							
29 November 2012	8 Cleveland Olifants	1	1	1				
11 November 2012	9 Pompey							
11 November 2012	10 KNP mopane							
12 December 2012	9 Pompey				1			
12 December 2012	10 KNP mopane							1
13 December 2012	11 KNP koppie		2					
13 December 2012	12 KNP Olifants	1						
14 December 2012	11 KNP koppie					1		
14 December 2012	12 KNP Olifants	1	1	1				

Table 3: A comparison of the data collected during the 2006, 2008 and 2012 surveys; see also Figures 1-3 (N/s = not surveyed).

Sites 2012 survey	Sites 2006/8 surveys	Co-ordinates (2012)	2006	2008	2012
1 <i>Nilotica</i> dump site (200 trap nights)	7 Rock dump, Transect 8. (60 trap nights) (2008)	24° 00'50.87"S 31° 08'58.02"E	Bushveld Gerbil Bushveld Namaqua rockmouse	3 Bushveld Namaqua rockmouse	1 Tete veld rat 1 Bushveld Namaqua rockmouse
2 Loole Creek (200 trap nights)	8 Mine Loole Dam and 9 <i>Acacia / Dichrostachys</i> veld above Loole Dam; Transect 9 and 10; (180 trap nights) (2008)	24° 00'37.16"S 31° 08'43.12"E	Bushveld Gerbil	7 Bushveld Namaqua rockmouse 4 Tete veld rat 1 Multimammate Mouse 9 Bushveld Gerbil	2 Tete veld rat 2 Bushveld Namaqua rockmouse
3 Tailings Dam (200 trap nights)	9 Cleveland slimes dump Tailings Dam side wall (60 trap nights) (2006 and 2008)	23°59'57.31"S 31°11'24.98"E	6 Bushveld Gerbil 1 Multimammate Mouse	9 Bushveld Namaqua rockmouse 2 Tete veld rat 4 Spiny Mouse	1 Tete veld rat 1 Pouched Mouse
4 Rehab area (200 trap nights)	1 Rock Dump (rehabilitated) Transects 1 & 2; 2008 (120 trap nights)	23°57'48.71"S 31° 09'37.10"E	Bushveld Gerbil Multimammate Mouse Bushveld Namaqua rockmouse Pouched Mouse Tete veld rat Single-striped Grass Mouse	1 Multimammate Mouse 17 Tete veld rat 23 Bushveld Gerbil 3 Bushveld Namaqua rockmouse	1 Bushveld Namaqua rockmouse 1 Pouched Mouse
N/s	2 Koppie (Rocky outcrop) on Mine; Transect 3; (60 trap nights) (2008)	23°58'07.38"S 31° 09'38.84"E	Bushveld Gerbil Bushveld Namaqua rockmouse Spiny Mouse Tete veld rat	6 Multimammate Mouse 11 Bushveld Namaqua rockmouse 1 Single-striped Grass Mouse 2 Tete veld rat 2 Spiny Mouse	N/s
N/s	3 Mine - mixed bushveld Sparse grass cover. Transect 4 (60 trap nights) (2008)	23°57'58.86"S 31° 08'56.65"E	Bushveld Gerbil Multimammate Mouse Bushveld Namaqua rockmouse	11 Bushveld Gerbil Multimammate Mouse 2 Bushveld Namaqua rockmouse 3 Tete veld rat	N/s
N/s	4, 5 & 6 Mine Drainage Dense vegetation alongside vlei; Transects 5, 6, 11 and 7 (180 trap nights) (2008)	23°58'56.85"S 31° 08'51.96"E	Bushveld Gerbil Bushveld Namaqua rockmouse Climbing mouse Tete veld rat Single-striped Grass Mouse	27 Bushveld Namaqua rockmouse 2 Pouched Mouse 20 Tete veld rat 2 Multimammate Mouse	N/s
N/s	Cleveland foot of slimes	24°00'47.82"S	2 Bushveld Gerbil		N/s

	dump (60 trap nights) (2006)	31° 11'22.55"E	2 Multimammate Mouse 3 Bushveld Namaqua rockmouse 2 Pouched Mouse		
N/s	1 Cleveland mopanebushveld; Transects 1 and 3. (120 trap nights) (2008)	23°58'50.34"S 31°10'20.72"E	5 Bushveld Gerbil 4 Multimammate Mouse 1 Chestnut climbing mouse 1 Pouched Mouse	4 Bushveld Gerbil 26 Multimammate Mouse 1 Tete veld rat 5 Pouched Mouse	N/s
N/s	2 Vlei (reed beds) Transect 2. (60 trap nights) (2008)	23°58'59.49"S 31°10'37.92"E	Bushveld Gerbil Multimammate Mouse Pouched Mouse Climbing mouse	N/s	N/s
5 Cleveland koppies (200 trap nights)	5 Cleveland Koppie; Transects 5, 6 and 9. (180 trap nights) (2006 and 2008)	24°01'14.17"S 31°11'25.99"E	4 Bushveld Namaqua rockmouse 3 Spiny Mouse	5 Bushveld Namaqua rockmouse 1 Pouched Mouse	3 Tete veld rat 3 Bushveld Namaqua rockmouse 1 Spiny Mouse
6 Cleveland mopane (200 trap nights)	3&4 Cleveland mopane and <i>Terminalia</i> (120 trap nights) (2008)	24°00'20.55"S 31°12'18.80"E	Bushveld Gerbil Multimammate Mouse Bushveld Namaqua rockmouse Pouched Mouse	4 Bushveld Gerbil 5 Pouched Mouse	None
N/s	6 Cleveland Koppie; Transect 9 (60 trap nights) (2008)	24°01'20.68"S 31°12'00.15"E	8 Bushveld Namaqua rockmouse 1 Tete veld rat 3 Spiny Mouse	8 Bushveld Namaqua rockmouse 1 Pouched Mouse 7 Spiny Mouse	N/s
7 Cleveland spring (200 trap nights)	Vlei Transect 10 (2006)	24°01'22.74"S 31°12'00.56"E	Bushveld Namaqua rockmouse Tete veld rat	N/s	None
8 Cleveland Olifants (200 trap nights)	6 Cleveland Olifants river Bank; (60 trap nights) (2006 and 2008)	24° 02'02.67"S; 31°11'59.04"E	5 Multimammate Mouse 2 Tete veld rat	10 Tete veld rat 2 Bushveld Namaqua rockmouse	2 Tete veld rat 2 Bushveld Namaqua rockmouse 1 Multimammate Mouse
9 Pompey (200 trap nights)	N/s	23° 49'52.61"S; 31°05'13.80"E	N/s	N/s	1 Bushveld Gerbil
10 KNP mopane (200 trap nights)	N/s	23° 58'31.79"S; 31°10'51.15"E	N/s	N/s	1 Pygmy Mouse
11 KNP koppie (200 trap nights)	N/s	23°55'27.75"S; 31°15'57.03"E	N/s	N/s	2 Bushveld Namaqua rockmouse 1 Spiny Mouse
12 KNP Olifants (200 trap	N/s	24°02'27.42"S; 31°12'27.21"E	N/s	N/s	2 Tete veld rat

nights)					1 Bushveld Namaqua rockmouse
					1 Multimammate Mouse

Table 4: A summary of the notes related to the trapping of small mammals, obtained from the present and historical reports (N/s = not surveyed).

Parameter	2006	2008	2012
Time of the year	26-31 July 2006	15-21 February 2008	November & December 2012
Season	Winter	Summer	Summer
Traps	Willan PVC Live-traps	Willan PVC Live-traps	Sherman Live-traps
Traps at mine	540 trap nights	660 trap nights	800 trap nights
Transects	11	11	4
Trapped	231 animals	168 animals	10 animals
Traps at Cleveland	440 trap nights	540 trap nights	800 trap nights
Transects	11	9	4
Trapped	127 animals	95 animals	12 animals
Traps in Pompey and KNP	N/s	N/s	800 trap nights
Trapped	N/s	Trapped/s	9
Species trapped	8	6	7
1 <i>Nilotica</i> site	3 species – surprising, pioneers.	Only 1 species - the diversity of the grass species is very low.	2 species – pioneers
2 Loole Creek		4 species - grass cover was dense.	2 species – baboons interfered by stealing bait and setting off traps.
3 Tailings Dam	It was surprising to see the amount of small mammal activity on the tailings dam slopes. The grass species here are mostly pioneers or exotics and the cover sparse. The soils on the slopes are well suited for burrow requirements and it is possible that the animals move down the slopes fair distances during the night to forage below in the natural veld.		2 species – Pouched mouse seems to do well in rehabilitated areas. Also one pioneer species.
4 Rehab area	6 species - results indicate that succession is well advanced.	3 species - better grass cover and grass species diversity.	2 species – Also pouched mouse and another pioneer species.
5 Cleveland koppies	2 species (rock-dwelling)	5 species - a Koppie provides more shelter for small mammals therefore more diversity.	3 species – rock-loving species
6 Cleveland mopane	4 species.	Only 1 species - very poor and sparse grass cover	None
7 Cleveland spring	4 species.	3 species - A vlei provides a good grass cover and grass species diversity	None
8 Cleveland Olifants	Only 2 species.	Only 2 species - sparse grass cover	3 species – pioneer species due to bank changes with every flood.
9 Pompey	N/s	N/s	1 species – Bushveld Gerbil, only one caught during the survey – utilizes the recovering soil structure.
10 KNP mopane	N/s	N/s	1 species – Only pygmy mouse caught; poor reaction to good habitat.
11 KNP koppie	N/s	N/s	2 species – rock-loving species

12 KNP Olifants	N/s	N/s	3 species – pioneer species due to bank changes with every flood.
Tete veld rat	Mine: There were many more Red veld rat / Tete veld rat, <i>Aethomys chrysophilus</i> / <i>ineptus</i> on the mine site than at Cleveland. This is possibly because of the man made rock dumps that create suitable habitat for their requirements. Cleveland: Not many Tete veld rat were captured at the Cleveland transects. They also prefer rocky areas, but are found among rocks in the low-lying areas.	Mine: There were many more Tete veld rats, on the mine site than at Cleveland. This is possibly because of the man made rock dumps that create suitable habitat for their requirements. They were found at 8 of the 11 transects. Cleveland: The Tete veld rat was the third most abundant species. They also prefer rocky areas, but are found among rocks in the low-lying areas and not high up on koppies.	Mine: Common pioneer species on disturbed land. Cleveland: Common in all habitats. KNP: Along the Olifants River.
Bushveld Namaqua rockmouse	Mine: The most captured species here was the Namaqua rock mouse, The koppie at transect 3 delivered the most, but they were found at 9 of the 11 transects. Most of the transects in the mine area had some rocky habitat or dense vegetation supplying the requirements for this species to thrive. Cleveland: The Namaqua rock mouse was the third most abundant species but was restricted to koppies and rocky terrain (transect 6 and 7 on koppies and transect 8 with scattered rocks). There were some at transect 1 with scattered rocks on the tailings dam slope. The one captured at transect 4 was unusual, but they also use bush clumps or fallen dead tree trunks under which to make their grass nests.	Mine: The most captured species here was the Namaqua rock mouse. The Koppie at transect 3 delivered the most, but they were found at 8 of the 11 transects. Most of the transects in the mine area had some rocky habitat or dense vegetation supplying the requirements for this species to thrive. Cleveland: The second most abundant species was the Namaqua rock mouse. They were restricted to the 3 koppies (transect 5, 6 and 9) and the dry riverbed with scattered rocks. This is their preferred habitat.	Mine: Common pioneer species on disturbed land, abundant in rocky areas. Cleveland: Abundant in rocky areas. KNP: Common pioneer species the along the Olifants River, abundant in rocky areas.
Multimammate Mouse	Mine: The Multimammate mouse, <i>Mastomys</i> spp. was abundant. They occur in almost all habitat types and are even found in disturbed places and buildings. It is regarded as a pioneer species. Cleveland: The Multimammate mouse, <i>Mastomys</i> spp. was the most abundant species. They occur in most habitat types and were found at 7 of the 11 transects. They are not common on koppies or rocky outcrops and prefer a fairly good grass cover.	Mine: The Multimammate mouse, <i>Mastomys</i> sp. is regarded as a pioneer species, because they normally occur in almost all habitat types and are even found in disturbed places and in and around buildings. Their numbers can fluctuate a lot and they can experience a population explosion and then the numbers can drop dramatically again. Although this was not the case here on the Mine site, they were only found at 4 of the 11 transects Cleveland: The Multimammate mouse was the most abundant species. In 2006 they were found at 7 of the 11 transects and this year only at 2 of the 9. Except for one animal at transect 8 the other 27 Multimammate mouse were found at transect 2 which was in the vlei area. A good grass cover and plenty of food.	Mine: A pioneer species which was absent on the mine during this survey. Cleveland: One trapped along the Olifants River, pioneer on disturbed river bank. KNP: One trapped along the Olifants River, pioneer on disturbed river bank.
Bushveld Gerbil	Mine: Many Bushveld gerbil, were	Mine: Many Bushveld gerbils, <i>Tatera leucogaster</i> were captured on	Only one Bushveld gerbil was captured on

	<p>captured on the mine site at 8 of the 11 transects with the exception of the 2 vlei transects and Looie dam transect. They are not common near water.</p> <p>Cleveland: The Bushveld gerbil, <i>Tatera leucogaster</i> was found at 7 of the 11 transects. It is predominantly associated with light sandy soils or sandy alluvium but has been collected on hard ground. Where it occurs on hard ground, for example in Mopane woodland, it uses holes in termitaria or under tree roots.</p>	<p>the mine site at 6 of the 11 transects.</p> <p>Cleveland: Not many Bushveld gerbils were found here, much less than on the Mine and much less than in 2006. It is predominantly associated with light sandy soils or sandy alluvium but has been collected on hard ground. Where it occurs on hard ground, for example in Mopane woodland, it uses holes in termitaria or under tree roots. They are not common near water and rocky outcrops.</p>	<p>Pompey. It is predominantly associated with light sandy soils or sandy alluvium but has been collected on hard ground at Pompey.</p>
Spiny Mouse	<p>Mine: One Spiny mouse, <i>Acomys spinosissimus</i> were captured on the mine site simply because there was only one transect at a koppie (the preferred habitat of this species).</p> <p>Cleveland: The Spiny mouse was captured only on the 2 koppies (transects 6 and 7). It is confined to such koppies and is usually found higher up in-between the boulders.</p>	<p>Mine: Three Spiny mouse, <i>Acomys spinosissimus</i> were captured on the mine site simply because there was only one transect at a Koppie (the preferred habitat of this species). The Spiny mouse is usually recorded higher up on rocky koppies in-between the boulders.</p> <p>Cleveland: The Spiny mouse was only found on the koppies. They are confined to such koppies as previously mentioned.</p>	<p>Cleveland & KNP: Two Spiny mice, <i>Acomys spinosissimus</i> were captured during the survey; both on the koppies sites: Cleveland koppie & KNP koppie</p>
Pouched Mouse	<p>The Pouched mouse, occur in almost all habitat types but are more common in areas with a sandy substrate with scrub bush or cover in open woodland.</p>	<p>Mine: Only two Pouched mouse, <i>Saccostomus campestris</i>, were found this year as well as in 2006. They are common in areas with a sandy substrate with scrub bush or cover in open woodland. Most transects on the Mine were among rocks or near water, and this is not the preferred habitat for the Pouched mouse.</p> <p>Cleveland: A few Pouched mice were found on Cleveland.</p>	<p>Mine: A species that easily adapted to rehabilitated terrain, maybe not a pioneer, but utilizes changed soil structure or plant composition.</p>
Pygmy Mouse	<p>None captured</p>	<p>Were trapped in the reptile pitfalls and funnels in March/April 2007</p>	<p>None captured</p>
Single-striped grass mouse	<p>Mine: The Single-striped grass mouse, <i>Lemniscomys rosalia</i> prefers grassland areas in a wide variety of vegetational associations. They occur in the ecotone of vleis and woodland and in stands of high grass surrounding agricultural lands, preferring areas where there is a good cover of grass, herbs or reeds. It is uncertain why it was not captured on Cleveland. It was however found at the Mine site, mostly at the vlei transect (6), which falls within the above description of their preferred requirements.</p>	<p>None captured</p>	<p>None captured</p>
Climbing mouse <i>Dendromus</i> sp.	<p>The Climbing mouse, is associated with</p>	<p>None captured</p>	<p>None captured</p>

	rank vegetation, especially stands of tall grass. They are granivorous (grass seeds) but also very much insectivorous. They use their long prehensile tails to climb tall grasses to feed at night - trap-shy.		
Fat mouse	None captured	Were trapped in the reptile pitfalls and funnels in March/April 2007 Mine: Cleveland:	None captured

Table 5: Small mammal species presence and habitat assessment following the 2012 survey.

Site	Prominent habitat	Species observed and habitat preference	Species presence explained	General discussion
1 <i>Nilotic</i> dump site	Site 1: <i>Acacia nilotica</i> dump site: <u>Rocky</u> (close to outcrop and dumped rocks); moderate <u>woody vegetation</u> cover (trees and shrubs); high incidence of <u>grass clumps</u> or patches.	1 Tete veld rat (Widespread – Sandy ground or sandy alluvium, or hard. Associated with cover: rocky crevices, piles of debris, piles of boulders, clumps of grass or fallen trees. Dry Acacia scrub. Sheltering in burrows under bush on the plains. May frequent old termite mounds. High reproductive potential under favourable conditions.) 1 Bushveld Namaqua rockmouse (Widespread – where there are rocky koppies, outcrops or boulder-strewn hillsides - preferred areas. Cracks and rock crevices of rocky koppies or outcrops (prefers crevices and does not burrow), or on piles of stones in the veld, low lying ridges and stony country. In the absence of outcrops, may nest in holes or forks in trees or under bushes. Calcareous outcrops.)	2 species 1 Tete veld rat – the rocky ground (rehabilitated site) and the outcrop in the vicinity explain the presence of this species, however it also benefits from the clumps of grass planted as part of rehabilitation. 1 Bushveld Namaqua rockmouse – a similar situation to the above species creates habitat for this pioneer species.	The reasonably established rehabilitated terrain already creates favourable habitat for these two pioneer rodent species.
2 Loole Creek	Site 2: Loole Creek: <u>Rocky</u> due to washed open rocks on sandy/clay/loam slope, high presence of <u>dead woody structures</u> ; moderate covering of <u>multi-stemmed and toppled brushwood</u> .	2 Tete veld rat (Widespread – Sandy ground or sandy alluvium, or hard. Associated with cover: rocky crevices, piles of debris, piles of boulders, clumps of grass or fallen trees. Dry Acacia scrub. Sheltering in burrows under bush on the plains. May frequent old termite mounds. High reproductive potential under favourable conditions.) 2 Bushveld Namaqua rockmouse (Widespread – where there are rocky koppies, outcrops or boulder-strewn hillsides - preferred areas. Cracks and rock crevices of rocky koppies or outcrops (prefers crevices and does not burrow), or on piles of stones in the veld, low lying ridges and stony country. In the absence of outcrops, may nest in holes or forks in trees or under bushes. Calcareous outcrops.)	2 species 1 Tete veld rat – the rocky slope and the fallen trees creates good habitat for this species. 1 Bushveld Namaqua rockmouse – the rocky slope and moderate covering of multi-stemmed and toppled brushwood, create good habitat for this species.	This drainage line will be affected by flash floods, thus supporting the presence of pioneer species. However higher up on the slope good habitat is present and more species are <u>expected</u> to colonize this area.
3 Tailings Dam	Site 3: Tailings Dam site: <u>Sandy</u> - clay dump; dense covering of <u>multi-stemmed brushwood</u> ; moderate incidence of <u>grass clumps</u> or patches, and some <u>leaf litter</u> .	1 Tete veld rat (Widespread – Sandy ground or sandy alluvium, or hard. Associated with cover: rocky crevices, piles of debris, piles of boulders, clumps of grass or fallen trees. Dry Acacia scrub. Sheltering in burrows under bush on the plains. May frequent old termite mounds. High reproductive potential under favourable conditions.) 1 Pouched Mouse (Wide habitat tolerance: In burrows, sandy soil or sandy alluvium, open short grass fringes of pans, rocky koppies, fringes of lowland forests.)	2 species 1 Tete veld rat – this widespread species is already making use of the sandy component of the tailings dam to burrow in. The dense covering of multi-stemmed brushwood and the moderate incidence of grass clumps create good cover. 1 Pouched Mouse – this species also utilize the sandy component of the tailings dam to burrow in, and at PMC this rodent has only been found on rehabilitated areas during the current survey.	The sandy silt of the dump with associated scrub and grass clumps creates favourable habitat to these two rodents. The veld rat is a pioneer, but it seems that the Pouched Mouse favours rehabilitated areas on the mine.

4 Rehab area	Old rehabilitated area on the eastern part of PMC: High presence of <u>dead woody structures</u> on gravelly rehabilitation soils; moderate covering of <u>multi-stemmed brushwood</u> and high covering of <u>toppled brushwood</u> .	1 Bushveld Namaqua rockmouse (Widespread – where there are rocky koppies, outcrops or boulder-strewn hillsides - preferred areas. Cracks and rock crevices of rocky koppies or outcrops (prefers crevices and does not burrow), or on piles of stones in the veld, low lying ridges and stony country. In the absence of outcrops, may nest in holes or forks in trees or under bushes. Calcareous outcrops.) 1 Pouched Mouse (Wide habitat tolerance: In burrows, sandy soil or sandy alluvium, open short grass fringes of pans, rocky koppies, fringes of lowland forests.)	2 species 1 Bushveld Namaqua rockmouse – this adaptable species is making use of the rocky outcrop adjacent to the site. The dense covering of multi-stemmed brushwood and toppled brushwood creates good cover. 1 Pouched Mouse – this species probably also utilizes the site for the adjacent rocky outcrop. At PMC this rodent has only been found on rehabilitated areas during the current survey.	The adjacent rocky outcrop creates favourable habitat to the Bushveld Namaqua rockmouse and Pouched Mouse from where it will forage in the well-rehabilitated area with good woody components. It seems that the Pouched Mouse favours rehabilitated areas on the mine.
5 Cleveland koppies	Site 5: Syenitekoppies in Cleveland Reserve: <u>Rocky outcrop</u> with gravelly rocky loam, moderate presence of <u>dead woody structures</u> ; good <u>herbaceous cover</u> ; moderate <u>woody vegetation cover</u> (trees and shrubs); moderate covering of <u>multi-stemmed brushwood</u> .	3 Bushveld Namaqua rockmouse (Widespread – where there are rocky koppies, outcrops or boulder-strewn hillsides - preferred areas. Cracks and rock crevices of rocky koppies or outcrops (prefers crevices and does not burrow), or on piles of stones in the veld, low lying ridges and stony country. In the absence of outcrops, may nest in holes or forks in trees or under bushes. Calcareous outcrops.) 1 Spiny Mouse Spiny Mouse (Associated with rocky areas/terrain: More common habitat - among boulders in rocky habitat, sheltered overhanging rocks, in rock crevices, under exfoliated slabs and in other sheltered crannies. When rocky areas are absent - sandy alluvium along rivers, dry woodland and in thickets; use cover of roots of trees exposed by erosion; under tree roots, or holes in termite mounds. Nests made of grass and other debris in crannies or under foliated slabs of rock.) 3 Tete veld rat (Widespread – Sandy ground or sandy alluvium, or hard. Associated with cover: rocky crevices, piles of debris, piles of boulders, and clumps of grass or fallen trees. Dry Acacia scrub. Sheltering in burrows under bush on the plains. May frequent old termite mounds. High reproductive potential under favourable conditions.)	3 species 2 Bushveld Namaqua rockmouse – this species is at home in its favourite abode: rocky koppies. 1 Spiny Mouse – this is another rodent species that prefers rocky koppies as habitat. 3 Tete veld rat – although not as strictly associated with rocky outcrops as the previous two species, this rat also associates with rocky crevices and piles of boulders that create good shelter.	The three rodent species present at this site, are all animals that favour rocky terrains, the Bushveld Namaqua rockmouse and Spiny Mouse in particular prefer rocky outcrops as habitat.
6 Cleveland mopane	Site 6: Mopane site in Cleveland Reserve: Moderate presence of <u>dead woody structures</u> on sandy seep line; moderate <u>woody vegetation cover</u> (trees and shrubs); moderate covering of <u>multi-stemmed brushwood</u> .	None	None	With the moderate diverse habitat present, it was strange not to find rodents at this site.
7 Cleveland spring	Site 7: Spring site in Cleveland Reserve: Rocky due to washed open <u>boulders and bedrock</u> with mud and loam soil, presence of <u>dead woody</u>	None	None	With the good wetland and rocky habitat present, it was unexpected not to find rodents at this site

	<u>structures</u> ; high <u>woody vegetation</u> cover (trees and shrubs); moderate covering of <u>multi-stemmed brushwood</u> ; high incidence of <u>sedge clumps</u> or patches.			
8 Cleveland Olifants	Site 8: PMC Campsite in Cleveland Reserve (Olifants River): <u>Rock formations</u> bared on the alluvial slope, high presence of <u>dead woody structures</u> ; high <u>woody vegetation</u> cover (trees and shrubs); moderate covering of <u>multi-stemmed and toppled brushwood</u> .	2 Tete veld rat (Widespread – Sandy ground or sandy alluvium, or hard. Associated with cover: rocky crevices, piles of debris, piles of boulders, clumps of grass or fallen trees. Dry Acacia scrub. Sheltering in burrows under bush on the plains. May frequent old termite mounds. High reproductive potential under favourable conditions.) 2 Bushveld Namaqua rockmouse (Widespread – where there are rocky koppies, outcrops or boulder-strewn hillsides - preferred areas. Cracks and rock crevices of rocky koppies or outcrops (prefers crevices and does not burrow), or on piles of stones in the veld, low lying ridges and stony country. In the absence of outcrops, may nest in holes or forks in trees or under bushes. Calcareous outcrops.) 1 Multimammate Mouse (Wide habitat tolerance (pioneer species) from sea level to high-lying ground, absent from arid areas. In dry watercourses. Partial to sandy ground, overgrown with scrub and grass. Under fallen logs, crevices between rocks, cavities inside pile of stones or debris or even holes in termite mounds. Households; fringes of agricultural land, degraded forests, fields. Often occurs in high numbers. Constructs its own burrows but often uses existing burrows of other rodents.)	3 species 2 Tete veld rats – these rodents utilize the sandy alluvial soils of the river macro channel bank, as well as the rock formations and toppled brushwood. Conditions are favourable for these species at this site. 2 Bushveld Namaqua rockmouse - the rock formations along the low lying ridges will be used by this rodent together with the multi-stemmed and toppled brushwood. 1 Multimammate Mouse – the sandy alluvium for burrowing, and the high presence of dead woody structures, rock formations and covering of multi-stemmed and toppled brushwood as shelter, renders this site favourable for this pioneer rodent.	The variety of habitat aspects creates a favourable environment for different rodents. Since the riverine ecosystem is changing constantly due to flooding and drying out, it is not strange to find three pioneer species well-presented at the site.
9 Pompey	Site 9: Pompey site: A gravelly-cobble rocky rehabilitated soil structure, low covering of <u>multi-stemmed brushwood</u> .	1 Bushveld Gerbil (Survives regardless of vegetation type or degree of cover present, recorded in mopane woodland. Occur on hard ground, but prefer light sandy soils or sandy alluvium. Does not usually excavate its own burrows but uses holes in termitaria or under tree roots, however, can excavate burrows in sandy soils. Burrows are usually found at the base of small shrubs. Independent of water, but does not tolerate waterless conditions.)	1 species 1 Bushveld Gerbil – the soil here is hard due to the fact that it is a rehabilitated site and still in the process of succession. The gerbil probably is making use of the low covering of multi-stemmed brushwood where its burrow is found at the base of these small shrubs.	The rehabilitated site is still recovering and in the process of succession, therefore not very attractive to most of the rodents. The soil is hard and compacted and the herbaceous cover low. The Bushveld Gerbil is a pioneer that makes use of available habitat. The pouched mouse that also is a pioneer, need soft sandy soils, which explains its absence here.
10 KNP mopane	Site 10: Mopane site in KNP: Moderate presence of <u>dead woody structures</u> on a sandy to gravel slope seep line; good <u>herbaceous cover</u> ; moderate covering of <u>multi-stemmed and toppled brushwood</u> .	1 Pygmy Mouse (In all types of vegetation. Wide variety of habitats. Fairly damp country where there is high grass, bush or other cover. Makes its own burrows in soft ground. Normally finds shelter under piles of debris, fallen tree trunks/logs and similar type of cover, also boulders or holes in termite mounds.)	1 species 1 Pygmy Mouse – present in this area due to the sandy soil to burrow in, as well as the good herbaceous cover and many dead wood piles for shelter.	The habitat is good and more animals were expected. The Pygmy Mouse caught here was the only of its kind trapped during the survey. The 2006/8 surveys did not find any in their traps, only one was inadvertently trapped in reptile pitfalls.
11 KNP koppie	Site 11: Syenitekoppies in KNP: <u>Rocky outcrop</u> , moderate presence	2 Bushveld Namaqua rockmouse (Widespread – where there are rocky koppies, outcrops	2 species 2 Bushveld Namaqua rockmouse	Similar to the 5 Cleveland koppies, the two rodent species present at this site are both

	<p>of <u>dead woody structures</u> on loam soil; good <u>herbaceous cover</u>; moderate <u>woody vegetation</u> cover (trees and shrubs); moderate covering of <u>multi-stemmed brushwood</u>; moderate incidence of <u>grass clumps</u> or patches.</p>	<p>or boulder-strewn hillsides - preferred areas. Cracks and rock crevices of rocky koppies or outcrops (prefers crevices and does not burrow), or on piles of stones in the veld, low lying ridges and stony country. In the absence of outcrops, may nest in holes or forks in trees or under bushes. Calcareous outcrops.) 1 Spiny Mouse (Associated with rocky areas/terrain: More common habitat - among boulders in rocky habitat, sheltered overhanging rocks, in rock crevices, under exfoliated slabs and in other sheltered crannies. When rocky areas are absent - sandy alluvium along rivers, dry woodland and in thickets; use cover of roots of trees exposed by erosion; under tree roots. or holes in termite mounds. Nests made of grass and other debris in crannies or under foliated slabs of rock.)</p>	<p>– this species is at home in its favourite abode: rocky koppies. 1 Spiny Mouse – this is another rodent species that prefers rocky koppies as habitat.</p>	<p>animals that prefer rocky outcrops as habitat.</p>
<p>12 KNP Olifants</p>	<p>Site 12: The Olifants River in the KNP: <u>River alluvium</u> with high presence of <u>dead woody structures</u>; high <u>woody vegetation</u> cover (trees and shrubs); moderate covering of <u>multi-stemmed and toppled brushwood</u>.</p>	<p>2 Tete veld rat (Widespread – Sandy ground or sandy alluvium, or hard. Associated with cover: rocky crevices, piles of debris, piles of boulders, clumps of grass or fallen trees. Dry Acacia scrub. Sheltering in burrows under bush on the plains. May frequent old termite mounds. High reproductive potential under favourable conditions.) 1 Bushveld Namaqua rockmouse (Widespread – where there are rocky koppies, outcrops or boulder-strewn hillsides - preferred areas. Cracks and rock crevices of rocky koppies or outcrops (prefers crevices and does not burrow), or on piles of stones in the veld, low lying ridges and stony country. In the absence of outcrops, may nest in holes or forks in trees or under bushes. Calcareous outcrops.) 1 Multimammate Mouse (Wide habitat tolerance (pioneer species) from sea level to high-lying ground, absent from arid areas. In dry watercourses. Partial to sandy ground, overgrown with scrub and grass. Under fallen logs, crevices between rocks, cavities inside pile of stones or debris or even holes in termite mounds. Households; fringes of agricultural land, degraded forests, fields. Often occurs in high numbers. Constructs its own burrows but often uses existing burrows of other rodents.)</p>	<p>3 species 2 Tete veld rats – these rodents utilize the sandy alluvial soils of the river macro channel bank, as well as the rock formations and toppled brushwood. Conditions are favourable for these species at this site. 1 Bushveld Namaqua rockmouse - the rock formations along the low lying ridges will be used by this rodent together with the multi-stemmed and toppled brushwood. 1 Multimammate Mouse – the sandy alluvium for burrowing, and the high presence of dead woody structures, rock formations and covering of multi-stemmed and toppled brushwood as shelter, renders this site favourable for this pioneer rodent.</p>	<p>The situation here is a repeat of what is happening at the upstream site, 8 Cleveland Olifants. The variety of habitat aspects creates a favourable environment for different rodents. Since the riverine ecosystem is changing constantly due to flooding and drying out, it is not strange to find three pioneer species well-presented at the site.</p>

4. Discussion and Recommendations

From the historical surveys of 2006 and 2008, the report stated that it was difficult to understand why some expected species were not encountered, and why some species that were caught in 2006 were not caught in 2008. Also, variable abundance levels were not explained.

Small mammal populations fluctuate annually with low populations occurring late in winter and high populations occurring after the breeding season after the first good rains in spring/summer. Along with this annual fluctuation are general population movements. As populations increase, subordinate individuals may be displaced from optimal habitat in species that have strong social structures. This displacement results in individuals potentially occupying habitat that cannot be considered optimal or preferred for the species. The actual timing of surveys should be carefully considered to determine how it will affect the overall study objectives.

Additionally, some animals are trap-shy (the Climbing mouse, Fat mouse and the Dormouse). Food availability can be a factor, because if food is available in excess, the chances that rodents enter traps are lower; they do not seek food as actively. Many rodents also eat insects and during the winter months there is limited insect activity relative to the summer (Newbery, 2006).

Newbery (2006) commented on the high incidence of small mammal activity on the tailings dam slopes. The grass species here are mostly pioneers, or exotics, and the cover sparse. The soils on the slopes are well suited for burrow requirements and it is possibly the reason that the Pouched Mouse is so successful at these sites.

For presence/absence surveys involved in establishing range of a species, sampling in late summer or early fall after the breeding season when populations are generally at their yearly maximum will likely result in the greatest probability of capturing any species. If the presence/absence survey is being conducted to document habitat associations, then sampling should probably occur earlier in the year prior to juvenile dispersal when individuals are more likely to occur in their preferred habitats.

Both the assessment of abundance and diversity of small mammal species were required in the project brief. The results of the 2012 study suggested that abundances of especially rodents can vary considerably throughout the different seasons. These changes invariably are not a indication of mining activities, but rather of climate changes (rain and temperature). The diversity of species at different sites and reacting to habitat aspects seems to be a better indication of rodents reacting to changed or intact habitats. Therefore it is suggested that more emphasis should be put on diversity, and not on abundance. This approach will also be more appropriate to the mine's interest in rehabilitated areas and biodiversity.

It is proposed that the future surveys are conducted in late winter when food is scarce and even trap-shy species will be more likely to enter traps. It is also proposed that the number of traps is increased per trap station.

It is important to note that the bat surveys did not take place as planned. With revised methods it will become more feasible in future surveys and will definitely enhance the diversity of small mammal species recorded. More emphasis should be placed on other small mammal species (diurnal species), however time is a factor and these observations will be mostly incidental observations during trapping operations. Trapping methods should be improved by adding bait that will attract shrews and elephant shrews.

To summarise the proposed improvement to the future studies:

- The same sites should be surveyed for small mammals (other than bats) during August and September
- Rodents and shrews will be sampled with Sherman traps and bait will be added for both rodents and insectivores
- More emphasis should be placed on incidental observations of other small mammals (mongoose, squirrels, etc)
- Bat surveys should be done during the warmer summer nights of November to January, using bat echo-location methods instead of cumbersome netting.

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Appendices

Appendix 1: A summary of the small mammal species trapped in the study area, with a synopsis of preferred habitat, status in South Africa, and diet per species.

MAMMAL	HABITAT	Status (SA)	Diet
Bushveld Gerbil (<i>Gerbilliscus leucogaster</i>)	Widespread – Survives regardless of vegetation type or degree of cover present, having been recorded in open grasslands, Acacia woodland or scrub, and mopane woodland. Commonly encountered on old cultivated lands. Occur on hard ground, but prefer light sandy soils or sandy alluvium. Nocturnal and terrestrial. Does not usually excavate its own burrows but uses holes in termitaria or under tree roots, however, can excavate burrows in sandy soils. These burrows are usually found at the base of small shrubs, but also in the open, and they have resting chambers floored with vegetable debris. A fresh ramp of sand is left at the entrances to the burrows in the morning, following night-time activity. Independent of water, but does not tolerate waterless conditions.	Data deficient	Granivorous and insectivorous. Insects (40%), seeds (25%) and herbage (30%). Insects and seeds predominate in summer. Grasses, sometimes rhizomes and bulbs.
Spiny mouse (<i>Acomys spinosissimus</i>)	Widespread – associated with rocky areas/terrain: Nocturnal and terrestrial (single or groups) – rests in rock crevices, under tree roots. More common habitat: among boulders in rocky habitat. Sheltered overhanging rocks, under exfoliated slabs and in other sheltered crannies. Also sandy alluvium along rivers, dry woodland and in thickets; use cover of roots of trees exposed by erosion; or holes in termite mounds. Nests made of grass and other debris in crannies or under foliated slabs of rock.	Least concern	Grass, fruit and seeds. Also termites and other insects. Spiders, millipedes and small snails.
Pouched mouse (<i>Saccostomus campestris</i>)	Widespread and catholic, wide habitat tolerance: In burrows, sandy soil or sandy alluvium, open short grass fringes of pans, rocky koppies, fringes of lowland forests. Exclusively terrestrial, predominantly solitary and nocturnal.	Least concern	Subsists on the seeds of a diversity of plant species.
Veld Rat species (<i>Aethomy sineptus & chrysophilus</i>)	Widespread – Grassland with open shrub association, open woodland, fringes of pans. Sandy ground or sandy alluvium, or hard ground – holes or rock crevices and piles of boulders. Associated with cover: rocky crevices, piles of debris, clumps of grass or fallen trees. Dry Acacia scrub, as well as in the fringe vegetation of evergreen forests. Sheltering in burrows under bush on the plains. Lives in burrows with interconnecting runways; may frequent old termite mounds. High reproductive potential under favourable conditions. Not gregarious; shelters are used at most by a pair or a family party.	Least concern	Primarily a seed-eater, but will also know on kernels of nuts, takes insects.
Bushveld Namaqua rockmouse (<i>Micaelamys namaquensis subsp. alborarius</i>)	Widespread – where there are rocky koppies, outcrops or boulder-strewn hillsides - preferred areas. Cracks and rock crevices of rocky koppies or outcrops (prefers crevices and does not burrow), or on piles of stones in the veld, low lying ridges and stony country and is often plentiful in old ruins. In the absence of outcrops, may nest in holes or forks in trees or under bushes. Piles plant debris over the entrances to its shelters. Calcareous outcrops. Nocturnal, terrestrial and communal.	Least concern	Omnivorous, prefer seeds of grass and other vegetation when available.
Multimammate mouse species (<i>Mastomys spp coucha & natalensis</i>)	Wide habitat tolerance (pioneer species - drought, burn, ploughing) from sea level to high-lying ground, absent from arid areas. Fond of grassland where there is some cover of low scrub. In riverine associations running westwards into arid country - in dry watercourses or fringes of swamps. Frequents the fringes of pans where there are calcareous outcrops nearby. Partial to sandy ground, overgrown with scrub and grass. Under fallen logs, crevices between rocks, cavities inside pile of stones or debris or even holes in termite mounds. Households; fringes of agricultural land, degraded forests, fields. Communal, terrestrial and nocturnal. Often occurs in high numbers. Constructs its own burrows but often uses existing burrows of other rodents.	Least concern	Variety of grass and seeds, including Acacia seeds, dry pods, and the pulpy parts of wild fruits; when populations reach high levels, they may resort to cannibalism. Insects are also take.

Pygmy Mouse (<i>Mus minutoides</i>)	In all types of vegetation. Wide variety of habitats. Nocturnal and terrestrial, not communal. Fairly damp country where there is high grass, bush or other cover. Makes its own burrows in soft ground. Normally finds shelter under piles of debris, fallen tree trunks/logs and similar type of cover, also boulders or holes in termite mounds.	Least concern	Grass seeds and insects.
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Appendix 2: A summary of the expected small mammal species to the area, preferred habitat and status in South Africa. Mammals sampled are indicated in bold text.

MAMMAL	HABITAT	Status (SA)
Order: Insectivora		
Family: Soricidae		
Dark-footed forest shrew (<i>Myosorex cafer</i>)	Montane grasslands; wet sponges in mistbelt. Dense scrub and grass in damp areas fringing mountain streams. Moist densely vegetated habitat, mountainous country. Nest on bank of stream in heavy overhead cover of grass and undergrowth. Runways of vlei rats.	Data deficient
Greater dwarf shrew (<i>Suncus lixus</i>)	Very little known of this species	Data deficient
Least dwarf shrew (<i>Suncus infinitesimus</i>)	Commonly associated with termitaria. Terrestrial.	Intermediate
Swamp musk shrew (<i>Crocidura mariquensis</i>)	Moist habitats, thick grass along riverbanks, in reedbeds and in swamp. Tangled masses of semi-aquatic grasses along fringes of water. Litter piles deposited by receding floods. Runways of vlei rats. Nests deep in clumps of tussock grasses on slightly raised patches of ground on fringes of swamp.	Data deficient
Tiny musk shrew (<i>Crocidura fuscomurina</i>)	All latitudes, wide tolerance. Terrestrial. Cover such as debris, fallen trees, wood piles or dense grass clumps.	Data deficient
Reddish-grey musk shrew (<i>Crocidura cyanea</i>)	Dry terrain: Among rocks, in dense scrub and grass. Grassland and thick shrub bordering streams. Wet vleis with good grass cover.	Data deficient
Greater red musk shrew (<i>Crocidura flavescens</i>)	Broken country with a dense cover of vegetation, areas of decaying leaf litter in damp places, thick undergrowth in vleis or along the banks of streams.	Least concern. Population trend: Unknown
Lesser grey-brown musk shrew (<i>Crocidura silacea</i>)	Catholic in habitat requirements; damp places.	Data deficient
Lesser red musk shrew (<i>Crocidura hirta</i>)	In damp situations along rivers and streams. Low bushes, dense undergrowth, piles of debris and fallen logs.	Data deficient
Family: Pteropodidae		
Wahlberg's fruit bat (<i>Epomophorus wahlbergi</i>)	Tropical forests and evergreen riverine forests; thickets where there are fruit-bearing trees. Penetrate up river valleys carrying evergreen forests. Hang during day in dense canopy of evergreen trees.	Least concern
Gambian epauletted fruit bat (<i>Epomophorus gambianus</i>)	Open savanna woodland and forests.	
Egyptian fruit bat (<i>Rousettus aegyptiacus</i>)	Almost all habitats. Availability of caves	Least concern
Family: Emballonuridae		
Mauritian tomb bat (<i>Taphozous mauritanus</i>)	Savanna: Vertical surfaces of tree trunks, rock faces	Least concern
Family: Molossidae		
Little free-tailed bat (<i>Chaerephon (Tadarida) pumila</i>)	Rocky environment with an abundance of crevices.	Least concern
Midas free-tailed bat (<i>Tadarida (Mops) midas</i>)	Woodland. Cracks in tree trunks.	
Angola free-tailed bat (<i>Tadarida (Mops) condylura</i>)	Catholic in habitat requirements.	

Ansorge's free-tailed bat (<i>Chaerephon ansorgei</i>)		
Egyptian free-tailed bat (<i>Tadarida aegyptiaca</i>)	Open grassland: Rock crevices, caves, hollow trees, behind loose bark of trees	Least concern
Family: Vespertilionidae		
Schreibers' long-fingered bat (<i>Miniopterus schreibersii</i>)	Cave dweller: Caves and subterranean habitats. Wide range of vegetational association.	
Welwitsch's hairy bat (<i>Myotis welwitschii</i>)	Savanna woodland	Least concern; Population trend: Unknown
Temminck's hairy bat (<i>Myotis tricolor</i>)	Savannah woodland: Cave dweller- availability govern distribution.	Least concern; Population trend: Unknown
Rusty bat (<i>Pipistrellus rusticus</i>)	Savanna woodland: riverine associations.	
African pipistrelle (<i>Pipistrellus hesperidus</i>)	Roosts in trees and man-made structures.	Least concern
Yellow house bat (<i>Scotophilus dinganii</i>)	Savanna & mixed bushland: Narrow crevices, hollow trees.	Least concern
Lesser yellow house bat (<i>Scotophilus viridis</i>)	Savanna woodland. Riverine conditions.	
Cape serotine bat (<i>Neoromicia (Eptesicus) capensis</i>)	Savannah: Under bark of trees, base of aloe leaves.	Least concern
Aloe bat (<i>Neoromicia zuluensis</i>)	Roosts among dead leaves of aloes.	Least concern
Banana bat (<i>Neoromicia (Pipistrellus) nanus</i>)	Forest and woodland savanna: Near bananas or Strelitzia trees, rolled-up terminal leaves of banana plants.	
Schlieffen's bat (<i>Nycticeinops schlieffenii</i>)	Savannah woodland: not in forests	
Family: Nycteridae		
Egyptian slit-faced bat / Common slit-faced bat (<i>Nycteris thebaica</i>)	Open savannah woodland: caves, hollow trees or holes in the ground. Caves and subterranean habitats; temperate savanna and shrubland. Man-made structures.	Least concern
Family: Rhinolophidae		
Hildebrandt's horseshoe bat (<i>Rhinolophus hildebrandti</i>)	Woodland; caves, cavities in rocks or large hollow trees	
Darling's horseshoe bat (<i>Rhinolophus darlingi</i>)	Woodland savanna: Caves, and amongst piles of loose boulders.	Least concern. Population trend: Unknown
Ruppels horseshoe bat (<i>Rhinolophus fumigatus</i>)	Open savanna woodland; fringes of forests. Absent from forests, desert and semi-deserts.	
Geoffroy's horseshoe bat (<i>Rhinolophus clivosus</i>)	Savannah woodland: Forest fringes. Caves, rock crevices.	Least concern. Population trend: Unknown
Lander's horseshoe bat (<i>Rhinolophus landeri</i>)	Forests and savanna woodlands. Riverine conditions and with well-watered terrain. Cave dweller.	
Bushveld horseshoe bat (<i>Rhinolophus simulator</i>)	Savanna woodland; dependent on substantial shelter in form of caves & mine shafts.	Least concern
Family: Hipposideridae		
Sundevall's leaf-nosed bat (<i>Hipposideros caffer</i>)	Savanna woodland: Caves and subterranean habitats	Data deficient
Short-eared trident bat (<i>Cloeotis percivalli</i>)	Savanna woodland. Rest in caves. Sufficient cover in the form of caves and mine tunnels for day roosting.	Very sensitive to disturbance
Family: Procaviidae		
Yellow-spotted dassie (<i>Dendrohyrax brucei</i>)	Rocky hills and krantzes or among piles of boulders.	
Rock dassie (<i>Procavia capensis</i>)	Widespread where there is rocky habitat. Outcrops of rock – rocky crevices. Krantzes, rocky koppies, hillsides,	Least concern

	piles of loose boulders – accompanied with bushes and trees to provide browse. Crannies and crevices provide shelter. Granite formations with piles of huge boulders, from which overlying soil has been washed away. Sandstone kranztes with loose, rocky, overhanging slabs. Erosion gulleys.	
Order: Rodentia		
Family: Hystricidae		
Cape Porcupine (<i>Hystrix africaeaustralis</i>)	Widespread: All types of country apart from swampy areas, very moist forests and barren desert areas. Nocturnal. Shelter - resting in caves, rock cavities, holes in ground. Absent from forest. Use abandoned antbear and other types of holes in the ground or lie up under the roots of trees exposed by erosion.	Least concern
Family: Pedetidae		
Springhare (<i>Pedetes capensis</i>)	Widespread on sandy soils: Nocturnal – resting in burrows. Avoid hard ground or heavy clay soils. Savanna.	Least concern
Family: Sciuridae		
Tree squirrel (<i>Paraxerus cepapi</i>)	Widespread in woodland: Diurnal – resting in holes in trees.	Least concern
Family: Thryomyidae		
Greater Canerat (<i>Thryonomys swinderianus</i>)	Forest belts and open woodland wherever there is tall and matted grass or reeds growing in damp or wet places. Reedbeds or areas of dense tall grass with thick reed or cane-like stems. In vicinity of rivers, lakes and swamps - never found far from water. Resting place densest part of reed bed. Cover - matted tussock grasses, holes in stream banks, under root systems of trees adjacent to grass and reeds. Use existing holes or simply use matted vegetation.	Least concern
Family: Bathyergidae		
Common Molerat (<i>Cryptomys hottentotus</i>)	Loose sandy soils to stony soils and hills to montane and escarpment conditions. Tendency to loose sandy soil - especially alluvial soils along major rivers and streams. Karroidveldtypes, coastal renosterbushveld, coastal forests, thornveld, mopaneveld, savanna and pure grassveld, as well as temperate and transitional forests, scrub and bushveld. Savanna, cultivated fields.	Least concern
Family: Crictidae		
Bushveld Gerbil (<i>Gerbilliscus leucogaster</i>)	Widespread – Survives regardless of vegetation type or degree of cover present, having been recorded in open grasslands, Acacia woodland or scrub, and mopane woodland. Commonly encountered on old cultivated lands. Occur on hard ground, but prefer light sandy soils or sandy alluvium. Nocturnal and terrestrial. Does not usually excavate its own burrows but uses holes in termitaria or under tree roots, however, can excavate burrows in sandy soils. These burrows are usually found at the base of small shrubs, but also in the open, and they have resting chambers floored with vegetable debris. A fresh ramp of sand is left at the entrances to the burrows in the morning, following night-time activity. Independant of water, but does not tolerate waterless conditions.	
Vlei Rat (<i>Otomys irroratus</i>)	Grass-covered ground in proximity to streams and marshes. Associated with wet habitat. Lush grasses, sedges, herbaceous vegetation associated with damp soil in vleis; similar habitat along streams and rivers or on fringes of swamps. Nests: seldom burrow; nest of rising dry ground or in clump of grass	Least concern
AngoniVlei Rat (<i>Otomysangoniensis</i>)	Savanna woodlands and grasslands – in drier areas in wet vleis, swamps and swampy areas along rivers. Fringes of rivers with reed beds, sedges and semi-aquatic grasses. Nests in tussock grass near permanent water; above water level on raised ground.	Least concern
Family: Muridae		
Spiny mouse (<i>Acomys spinosissimus</i>)	Widespread – associated with rocky areas/terrain: Nocturnal and terrestrial (single or groups) – rests in rock crevices, under tree roots. More common habitat: among boulders in rocky habitat. Sheltered overhanging rocks, under exfoliated slabs and in other sheltered crannies. Also sandy alluvium along rivers, dry woodland and in thickets; use cover of roots of trees exposed by erosion; or holes in termite mounds. Nests made of grass and other debris in crannies or under foliated slabs of rock.	Least concern

Water Rat (<i>Dasymys incomtus</i>)	Wet habitat: Streams, rivers, reed beds, swamps and is partially aquatic. Long grass close to water, semi-aquatic grasses, in swampy areas along rivers and streams, or in in grassy or bracken covered areas close to water. Between reeds and among rotting vegetation. Fringes of marshes and backwaters. Nest: Constructed in a depression on the sloping ground bordering the swampy edge of the river.	IUCN: Least concern. Population trend: Unknown.
Pouched mouse (<i>Saccostomus campestris</i>)	Widespread and catholic, wide habitat tolerance: In burrows, sandy soil or sandy alluvium, open short grass fringes of pans, rocky koppies, fringes of lowland forests. Exclusively terrestrial, predominantly solitary and nocturnal.	Least concern
Grey climbing mouse (<i>Dendromus melanotis</i>)	Grassland with high grass.	
Chestnut climbing mouse (<i>Dendromus mystacalis</i>)	Grassland with high grass.	
Brant's climbing mouse (<i>Dendromus mesomelas</i>)	Tall grass or rank vegetation near water.	Least concern
Fat mouse (<i>Steatomys pratensis</i>)	Grassland and savannas over sandy soils or sandy alluvium. On sandy ground in scrub or in sandy alluvium on the fringes of swamps, streams and rivers. Open woodland and abandoned cultivated lands.	Least concern
Red Veld Rat (<i>Aethomys chrysophilus</i>)	Widespread – Grassland with open shrub association, open woodland, fringes of pans. Sandy ground or sandy alluvium, or hard ground – holes or rock crevices. Associated with cover: rocky crevices, piles of debris, clumps of grass or fallen trees. Dry Acacia scrub, as well as in the fringe vegetation of evergreen forests. Sheltering in burrows under bush on the plains. Lives in burrows with interconnecting runways; may frequent old termite mounds. Dry forest, linear forest (DRC). High reproductive potential under favourable conditions. Not gregarious; shelters are used at most by a pair or a family party.	Least concern
Tete Veld Rat (<i>Aethomys ineptus</i>)	Temperate grassland and savanna: Rocky crevices and piles of boulders.	Least concern
Veld Rat species (<i>Aethomys ineptus</i> & <i>chrysophilus</i>)	Widespread – Grassland with open shrub association, open woodland, fringes of pans. Sandy ground or sandy alluvium, or hard ground – holes or rock crevices and piles of boulders. Associated with cover: rocky crevices, piles of debris, clumps of grass or fallen trees. Dry Acacia scrub, as well as in the fringe vegetation of evergreen forests. Sheltering in burrows under bush on the plains. Lives in burrows with interconnecting runways; may frequent old termite mounds. High reproductive potential under favourable conditions. Not gregarious; shelters are used at most by a pair or a family party.	
Bushveld Namaqua rockmouse (<i>Micaelamys namaquensis</i> subsp. <i>alborarius</i>)	Widespread – where there are rocky koppies, outcrops or boulder-strewn hillsides - preferred areas. Cracks and rock crevices of rocky koppies or outcrops (prefers crevices and does not burrow), or on piles of stones in the veld, low lying ridges and stony country and is often plentiful in old ruins. In the absence of outcrops, may nest in holes or forks in trees or under bushes. Piles plant debris over the entrances to its shelters. Calcareous outcrops. Nocturnal, terrestrial and communal.	Least concern
Tree Rat/mouse (<i>Thallomys paedulus</i>)	Acacia woodland: Living in crevices in the trunks, under loose strips of bark or in holes in the ground between the roots of the tree (Especially Acacia). Nocturnal.	Least concern
Single-striped Mouse (<i>Lemniscomys rosalia</i>)	Savanna woodland to dry open scrub. Common factor: Grassland - excavates burrows under the cover of matted grass.	Data deficient
Multimammate mouse (<i>Mastomys coucha</i>)	Wide habitat tolerance (pioneer species - drought, burn, ploughing), fond of grassland where there is some cover of low scrub. In dry watercourses or fringes of swamps. Frequents the fringes of pans where there are calcareous outcrops nearby. Partial to sandy ground, overgrown with scrub and grass. Under fallen logs, crevices between rocks, cavities inside pile of stones or debris or even holes in termite mounds. Nocturnal.	Least concern
Multimammate mouse (<i>Mastomys natalensis</i>)	Wide habitat tolerance (pioneer species - drought, burn, ploughing), from sea level to high-lying ground, absent from arid areas: Fond of grassland where there is some cover of low scrub. Households; fringes of agricultural land; In riverine associations running westwards into arid country. Degraded forests, fields. Often occurs in high numbers. Communal, terrestrial and nocturnal. Constructs its own burrows but often uses existing burrows of other rodents.	

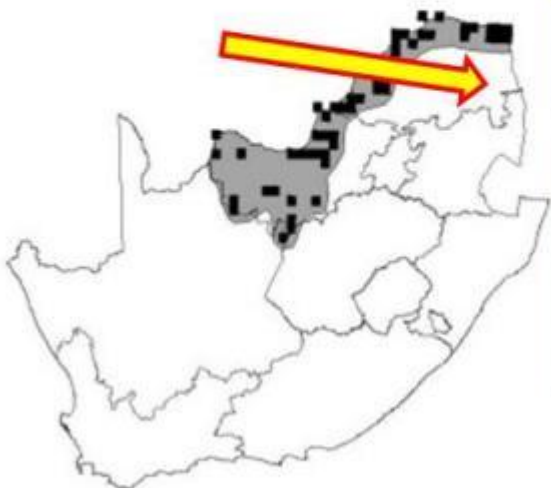
Multimammate mouse species (<i>Mastomys spp coucha & natalensis</i>)	Wide habitat tolerance (pioneer species - drought, burn, ploughing) from sea level to high-lying ground, absent from arid areas. Fond of grassland where there is some cover of low scrub. In riverine associations running westwards into arid country - in dry watercourses or fringes of swamps. Frequents the fringes of pans where there are calcareous outcrops nearby. Partial to sandy ground, overgrown with scrub and grass. Under fallen logs, crevices between rocks, cavities inside pile of stones or debris or even holes in termite mounds. Households; fringes of agricultural land, degraded forests, fields. Communal, terrestrial and nocturnal. Often occurs in high numbers. Constructs its own burrows but often uses existing burrows of other rodents.	
Woodland mouse (<i>Grammomys dolichurus</i>)	Predominantly arboreal: in forests and thickets, usually in damp places; constructs nests of grass or leaves in dense underbrush	Least concern
Pygmy Mouse (<i>Mus minutoides</i>)	In all types of vegetation. Wide variety of habitats. Nocturnal and terrestrial, not communal. Fairly damp country where there is high grass, bush or other cover. Makes its own burrows in soft ground. Normally finds shelter under piles of debris, fallen tree trunks/logs and similar type of cover, also boulders or holes in termite mounds.	Least concern
Family: Gliridae		
Rock Dormouse (<i>Graphiurus platyops</i>)	Rocky terrain. A rock-frequenting dormouse. Near or on rocky outcrops. In association with dassies. Also dry scrub thickets or dry riverbeds, frequenting trees when no rocks available. Live in rock crevices, under exfoliation of granite bosses and in piles of boulders.	Data deficient
Woodland Dormouse (<i>Graphiurus murinus</i>)	Widespread in woodland. Wooded areas. Large trees provide holes for shelter. Live in holes in trees or under loose bark.	Least concern
Family: Leporidae		
Scrub hare (<i>Lepussaxatilis</i>)	Savannah woodland and in scrub, tall grass. Absent from forest, desert and open grass. Open forest, savanna.	Least concern
Natal red rock rabbit (<i>Pronolagus crassicaudatus</i>)	Rocky habitat: Rocky terrain or boulder-strewn areas – rest deep in rock crevices	Least concern
Cape hare (<i>Lepus capensis</i>)	Grassland. Dry open country, open woodlands and especially round cultivated ground.	Least concern
Family: Macroscelididae		
Short-snouted elephant-shrew (<i>Elephantulus brachyrhynchus</i>)	Favour dry woodland, thicket or the denser vegetation around termite mounds or along water courses or gullies. Sandy ground with scrub or grass cover; fallen logs, piles of debris or holes in ground.	Data deficient
Rock elephant shrew (<i>Elephantulus myurus</i>)	Rocky areas: Rocky koppies or piles of boulders – sufficient holes crannies and crevices in rocks for shelter. Absent on granite domes. Needs broken and exfoliated granite. Prefer rocky habitat with overhanging ledges or vegetation. Cover from aerial predation. Keep to shady cover of overhanging rocks or bushes/trees.	Least concern

Appendix 3: Distribution of the small mammal species trapped during the 2012 survey.

Tete veld rat (*Aethomys ineptus*)

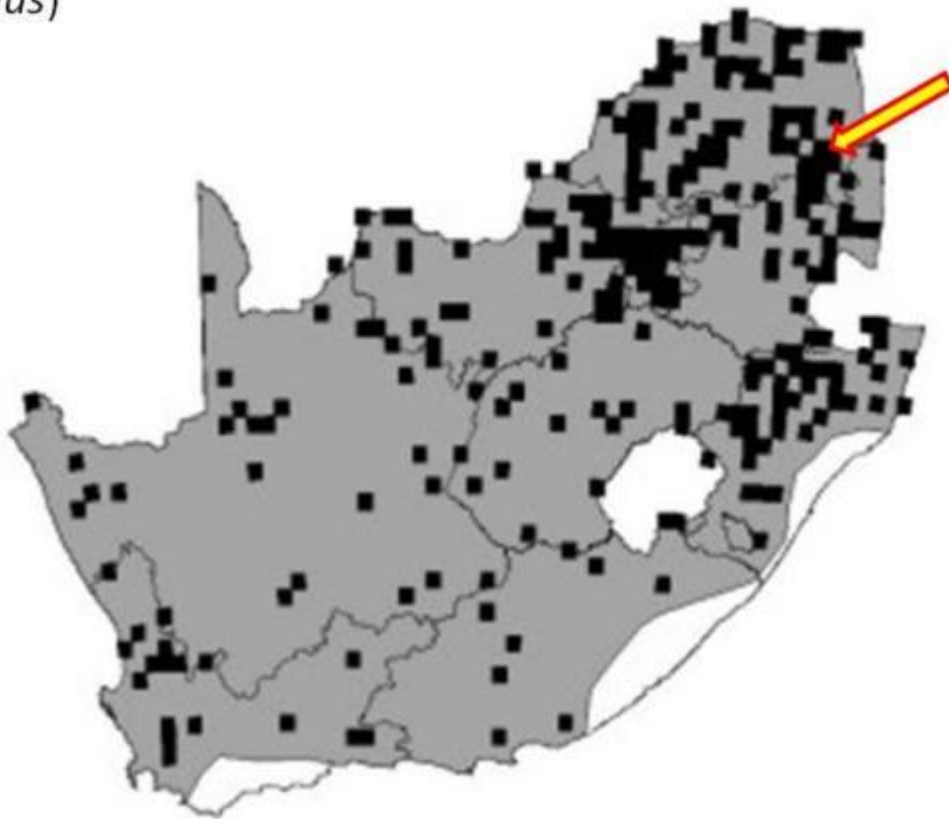


Tete Veld Rat
Aethomys ineptus



Red Veld Rat
Aethomys chrysophilus

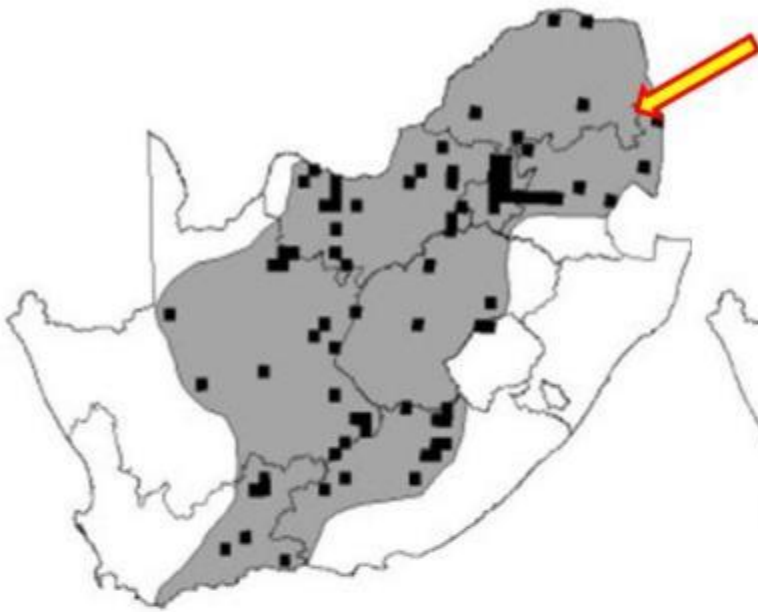
Bushveld Namaqua Rockmouse (*Micaelamys namaquensis* subsp. *alborarius*)



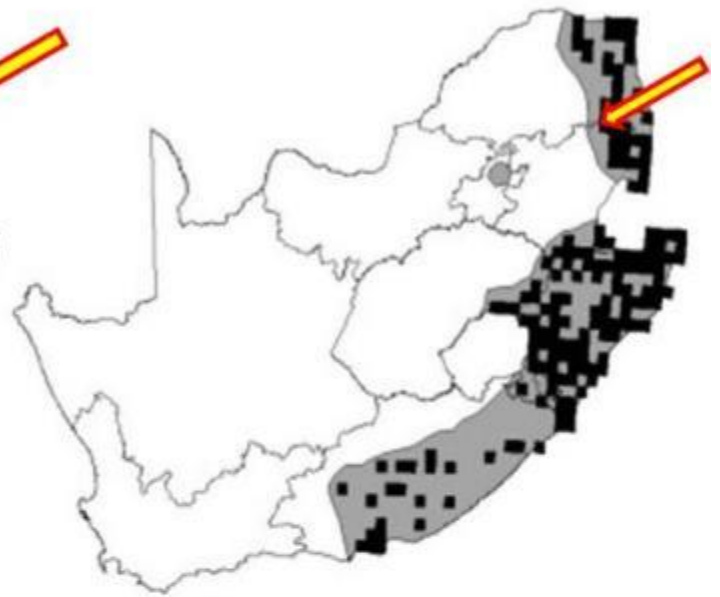
Namaqua Rock Mouse
Aethomys namaquensis



Multimammate Mouse (*Mastomys*)



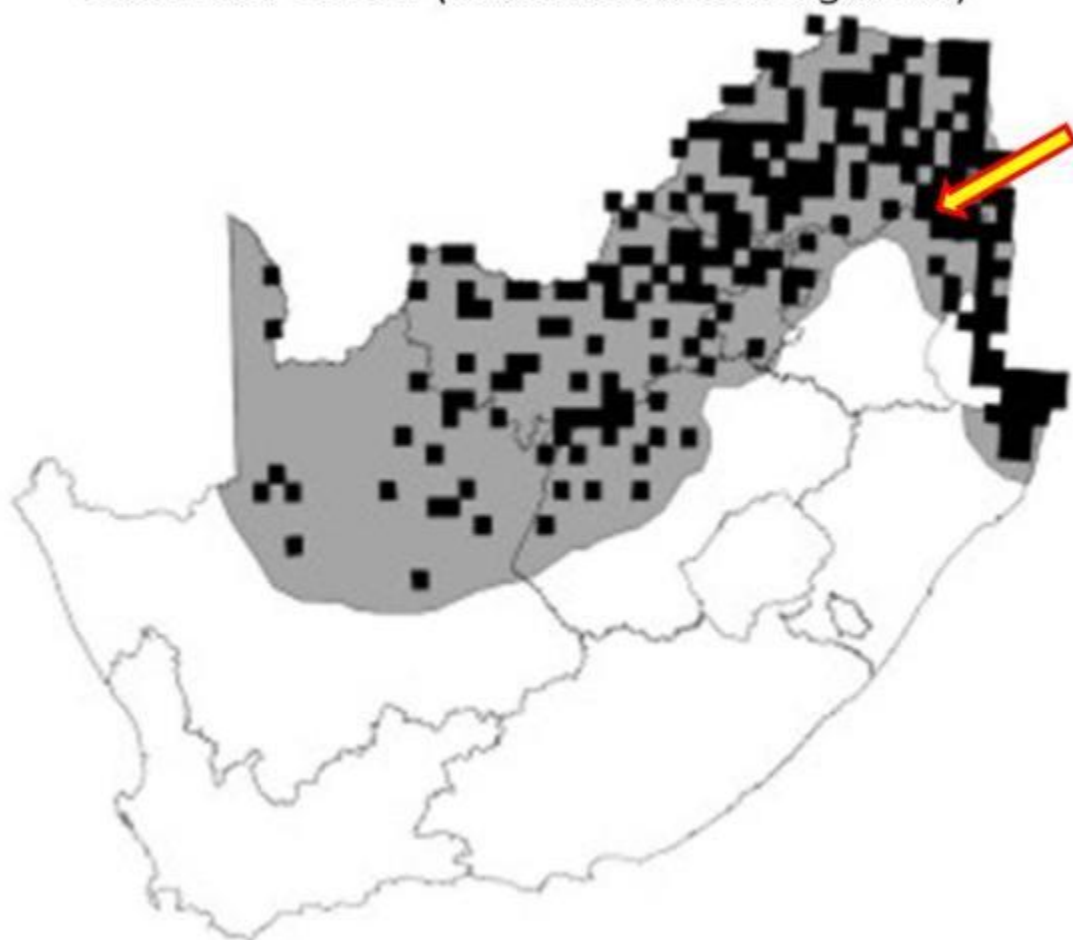
Multimammate Mouse
Mastomys coucha



Natal Multimammate Mouse
Mastomys natalensis



Bushveld Gerbil (*Gerbilliscus leucogaster*)



Bushveld Gerbil
Tatera leucogaster



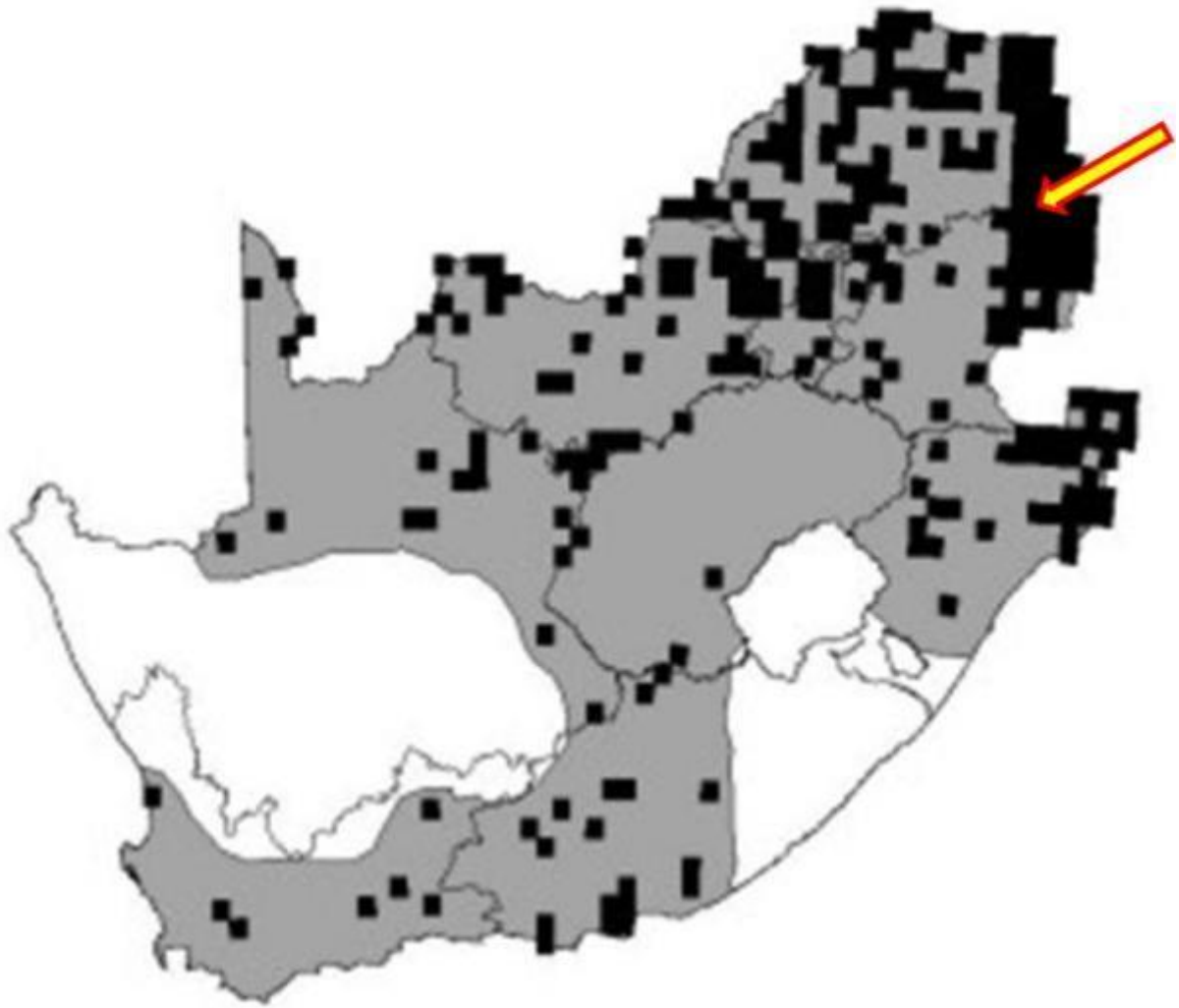
Spiny Mouse (*Acomys spinosissimus*)



Spiny Mouse
Acomys spinosissimus



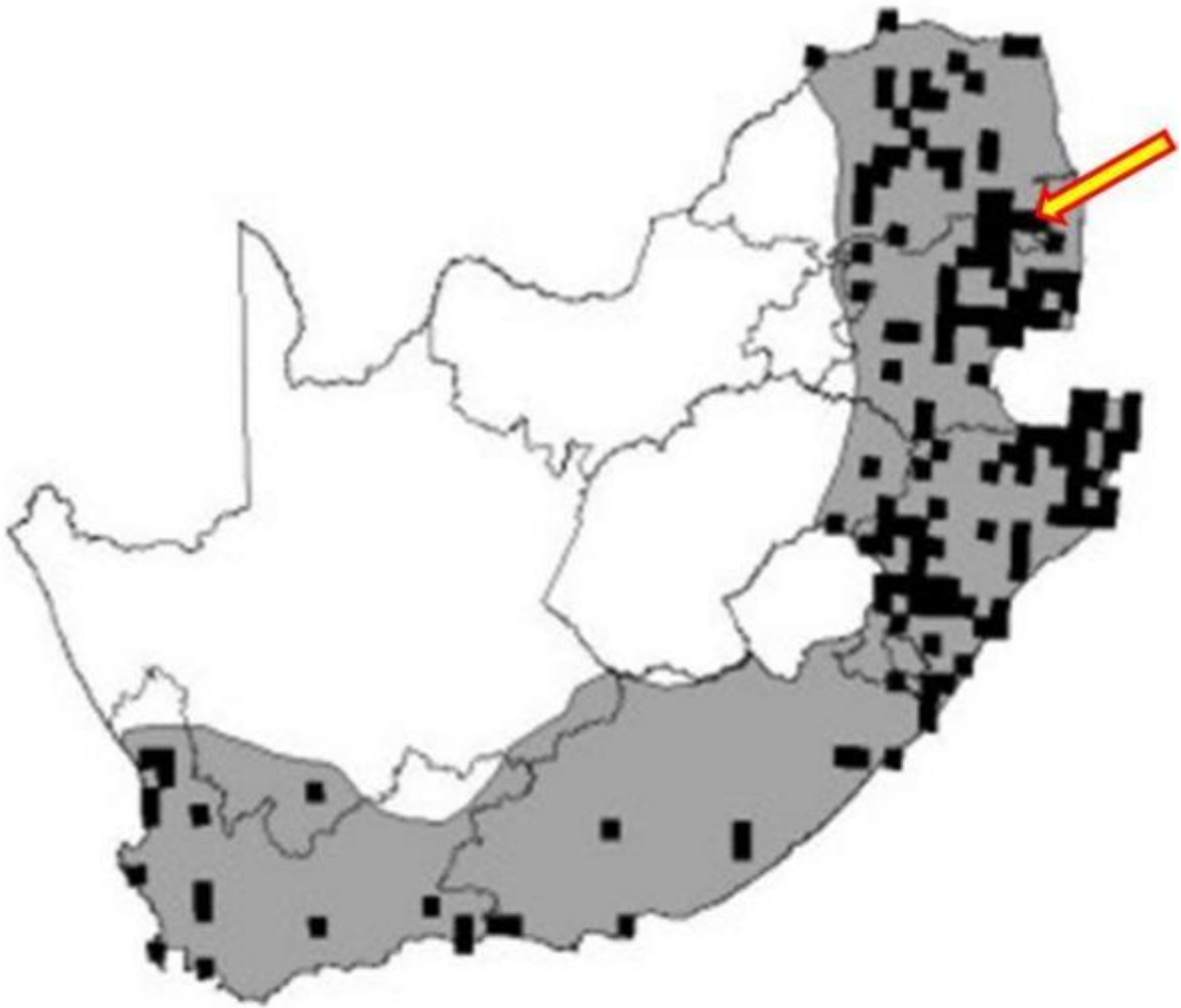
Pouched Mouse (*Saccostomus campestris*)



Pouched Mouse
Saccostomus campestris



Pygmy Mouse (*Mus minutoides*)



Pygmy Mouse
Mus minutoides



Appendix 4: Sampling sites for the 2012 Small Mammal project.

1 *Neotoma* dump site



3 Tailings Dam



4 Rehab area



5 Cleveland koppies



5 Cleveland koppies



5 Cleveland mopane



7 Cleveland spring



8 Cleveland Olifants



8 Cleveland Olifants



9 Pompey



9 Pompey



10 KNP mopane



11 KNP koppie



12 KNP Olifants



12 KNP Olifants

