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A conservation assessment of *Rhabdomys* spp.

Nina Du Toit,, Neville Pillay, Guila Ganem, C Relton

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Rhabdomys spp. – Four-striped Grass Mouse



Rhabdomys is currently treated as a species complex, consisting of four distinct species within the assessment region (du Toit et al. 2012). These species, all known commonly as the Four-striped Grass Mouse, can be recognised by the four characteristic black stripes running along the dorsal length of their bodies (De Graaf 1997).

Taxonomy

Rhabdomys bechuanae (Thomas 1893)

Rhabdomys dilectus (De Winton 1897)

Rhabdomys intermedius (Wroughton 1905)

Rhabdomys pumilio (Sparrman 1784)

ANIMALIA - CHORDATA - MAMMALIA - RODENTIA - MURIDAE - *Rhabdomys*

Common names: Four-striped Grass Mouse, Four-striped Grass Rat, Striped Field Mouse, Striped Mouse (English), Streepmuis (Afrikaans)

Taxonomic status: Species complex

Taxonomic notes: Initially the single, monotypic species *R. pumilio* was recognised (Sparrman 1784). Several subspecies have been proposed based on extensive variation in pelage colour and morphology across the distribution. Within southern Africa, Roberts (1951) proposed 20 subspecies of which Meester et al. (1986) regarded only seven as being valid. Rambau et al. (2003) recommended the recognition of two species based on cytogenetic and mitochondrial sequence data, the xeric *R. pumilio* and mesic *R. dilectus*, which was adopted by Musser and Carleton (2005). The authors further suggested the presence of two subspecies, *R. d. dilectus* and *R. d. chakae* within the latter taxon. This was confirmed in a recent molecular and chromosomal analysis of *R. dilectus*, which revealed high genetic divergence within the species, and the presence of three distinct clades (Castiglia et al. 2012). The basal clade, recognised as *R. d. chakae* is endemic to South Africa, while the two distinct sister clades (*R. d. dilectus*) are distributed allopatrically across northern parts of its range, into East Africa, including a new divergent karyotype found in the high altitudes of Mt. Meru and Mt. Kilimanjaro (Castiglia et al. 2012). Reproductive isolation due to pre- and post-mating barriers have been found among *R. pumilio* and *R. dilectus*, as well as among the proposed subspecies within the latter taxon (Pillay 2000; Pillay et al. 2006). Subsequently, du Toit et al. (2012) indicated three genetic lineages with distinct distributions related to biome boundaries within the xeric *R. pumilio*. Based on deep mitochondrial genetic divergence, paraphyly of *R. pumilio* with respect to *R. dilectus* and different ecological preferences of the three genetic lineages within *R. pumilio*, the recognition of four species (*R. dilectus*, *R. pumilio*, *R. bechuanae*, and *R. intermedius*) was suggested

Regional Red List status (2016)

<i>Rhabdomys bechuanae</i>	}	Least Concern
<i>Rhabdomys dilectus</i>		
<i>Rhabdomys intermedius</i>		
<i>Rhabdomys pumilio</i>		

National Red List status (2004)

<i>Rhabdomys bechuanae</i>	}	Not Evaluated
<i>Rhabdomys dilectus</i>		
<i>Rhabdomys intermedius</i>		
<i>Rhabdomys pumilio</i>		Least Concern

Reasons for change

<i>Rhabdomys bechuanae</i>	}	Non-genuine change: Taxonomic revision
<i>Rhabdomys dilectus</i>		
<i>Rhabdomys intermedius</i>		
<i>Rhabdomys pumilio</i>		No change

Global Red List status (2008)

<i>Rhabdomys bechuanae</i>	}	Not Evaluated
<i>Rhabdomys dilectus</i>		
<i>Rhabdomys intermedius</i>		
<i>Rhabdomys pumilio</i>		Least Concern

TOPS listing (NEMBA)

None

CITES listing

None

Endemic

<i>Rhabdomys bechuanae</i>	}	No
<i>Rhabdomys dilectus</i>		
<i>Rhabdomys intermedius</i>		
<i>Rhabdomys pumilio</i>		Yes

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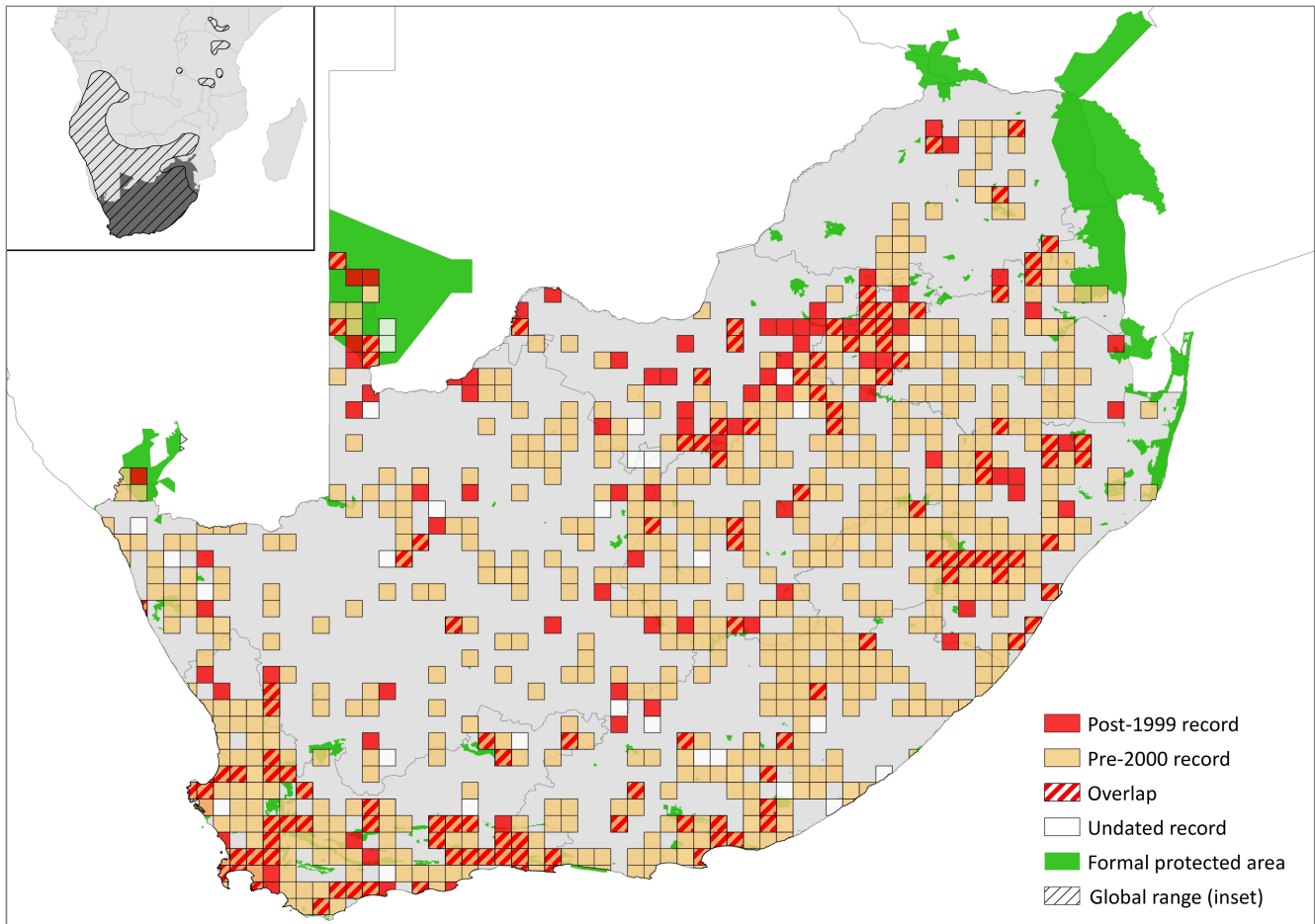


Figure 1. Distribution records for Four-striped Grass Mouse (*Rhabdomys* spp.) within the assessment region

Table 1. Countries of occurrence within southern Africa

Country	Presence	Origin
Botswana	Extant (<i>R. bechuanae</i>)	Native
Lesotho	Extant (<i>R. dilectus</i>)	Native
Mozambique	Extant (<i>R. dilectus</i>)	Native
Namibia	Extant (<i>R. bechuanae</i>)	Native
South Africa	Extant (all)	Native
Swaziland	Extant (<i>R. dilectus</i>)	Native
Zimbabwe	Extant (<i>R. dilectus</i>)	Native

(du Toit et al. 2012). However, Monadjem et al. (2015) recognise *R. chakae* as a valid species due to at least one case of known sympatry between *R. d. dilectus* and *R. d. chakae*. Further molecular research (particularly including more nuclear data) and cranial morphometric analyses would be useful to fully resolve the taxonomy of the genus. Until such time, it is recommended that *Rhabdomys* be treated as a species complex.

Assessment Rationale

Rhabdomys spp. are widespread, versatile and common species, coexisting with humans in disturbed, semi-urban and agricultural landscapes. Thus, all species are listed as Least Concern. *Rhabdomys dilectus* has a wide distribution across the northeastern interior and coastal regions of South Africa, including Lesotho and Swaziland and occurs in many protected areas. Similarly, *R. intermedius* and *R. bechuanae* have a wide distribution

across the interior of South Africa, in arid habitats that are unlikely to be rapidly transformed on a broad scale, and occur in many protected areas. *Rhabdomys bechuanae* occurs in the Free State Province and northern reaches of the Northern Cape Province. *Rhabdomys pumilio* is restricted to the low-altitude coastal region within the Fynbos and Succulent Karoo Biomes from the Richtersveld in the west to Port Elizabeth in the Eastern Cape Province.

Overgrazing may reduce the ground cover on which *R. dilectus* and *R. intermedius* depend and thus lead to local declines, but this is not expected to impact the population overall. *Rhabdomys bechuanae* and *R. pumilio* do not rely on ground cover as much and are thus not as adversely affected by overgrazing. Managers should be encouraged to retain ground cover by de-stocking for *R. dilectus* and *R. intermedius*. However, *R. bechuanae* and *R. pumilio* appear to require no direct intervention at present. Research should focus on delimiting the geographical extent of all species and researching their ecological differences. The subspecies *R. d. chakae* is recognised as a full species by some and may need separate assessment once consensus is reached as it is endemic to the assessment region.

Regional population effects: Dispersal between regions is possible for *R. dilectus* and *R. bechuanae* as these species occur in a wide array of habitats.

Distribution

Rhabdomys spp. are broadly distributed across the assessment region. Their extent of occurrence is wide,

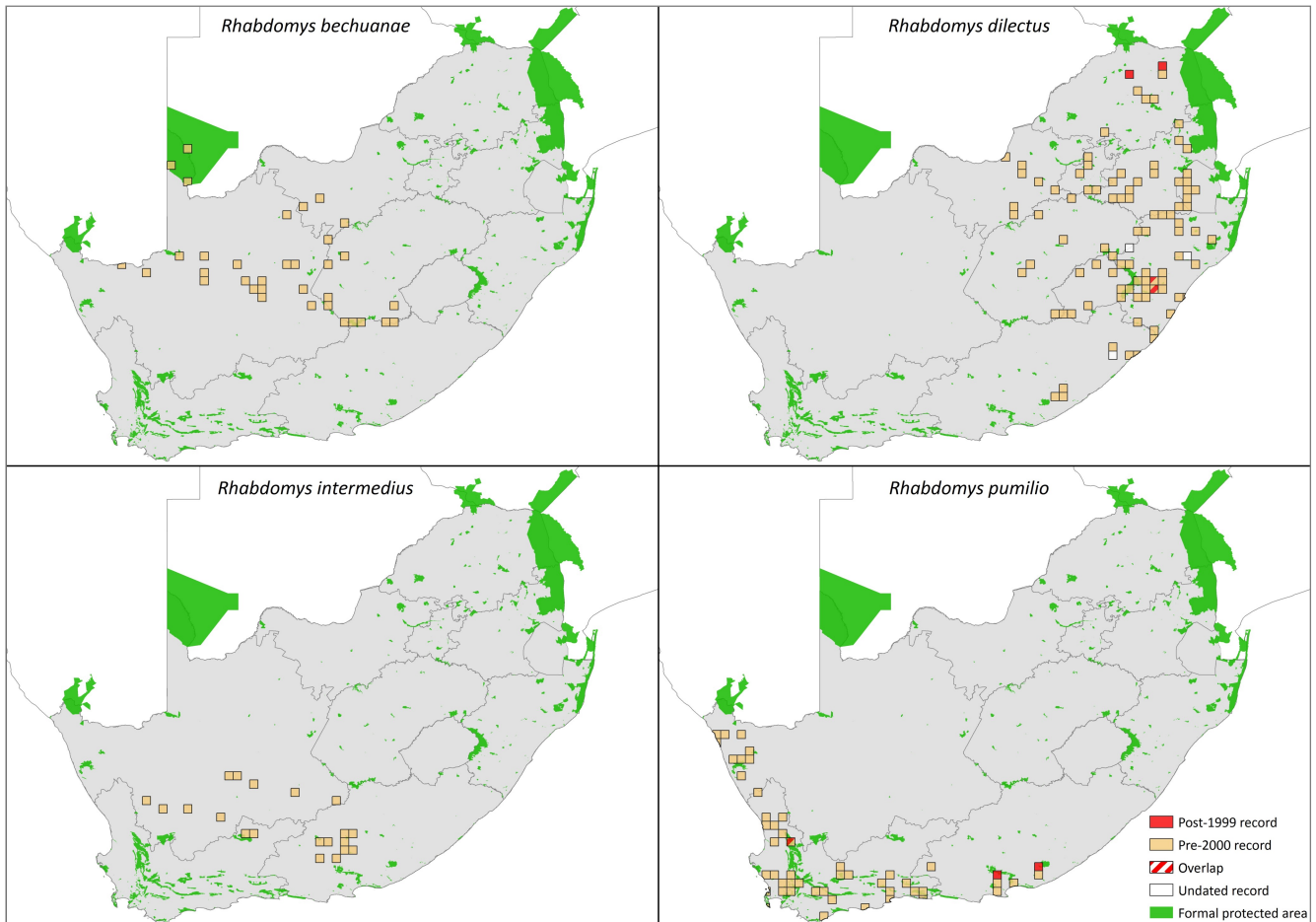


Figure 2. Distinct distribution records for the *Rhabdomys* species complex (Monadjem et al. 2015), including *R. bechuanae*, *R. dilectus*, *R. intermedius*, and *R. pumilio* within the assessment region.

while the distribution at the local scale is probably patchy and discontinuous. It cannot be stipulated with certainty whether the current distribution differs significantly from the historical distribution. *Rhabdomys*, however, appears to be well adapted to agricultural and semi-urban areas, therefore human activities probably would not have led to a significant reduction in distribution range. Within the assessment region, *R. dilectus* occurs within the Grassland and Savannah Biomes along the mesic eastern region of South Africa, Swaziland and Lesotho, while the xeric clades (*R. pumilio*, *R. intermedius* and *R. bechuanae*) occur within more arid to savannah habitats in central and western South Africa (Monadjem et al. 2015). Specifically:

- Within the *R. dilectus* clade, *R. d. chakae*, which is endemic to the assessment region, occurs in the eastern regions of South Africa from the Soutpansberg Mountains in the north to the Eastern Cape Province in the south, extending into Swaziland and Lesotho (Castiglia et al. 2012; du Toit et al. 2012); while *R. d. dilectus* occurs in northern South Africa northwards through Zimbabwe, Malawi to East Africa, with an apparently isolated population on the plateau of Angola (Castiglia et al. 2012). The two subspecies appear parapatric (Happold 2013), but there is a known case of sympatry (Monadjem et al. 2015).
- *Rhabdomys bechuanae* occurs widely in the central and western regions of South Africa (Free State, North West and Northern Cape provinces), mostly north of the Gariiep (Orange) River, northwards and westwards through Botswana to Namibia and

extreme southwestern Angola (Monadjem et al. 2015).

- *Rhabdomys intermedius* is endemic to the southern interior regions of South Africa where it occurs in a narrow band through the Karoo, wedged between *R. pumilio* on the coast and *R. bechuanae* further north (du Toit et al. 2012).
- *Rhabdomys pumilio* is endemic to South Africa where it occurs along a narrow coastal strip within the Fynbos and Succulent Karoo Biomes from Port Elizabeth/Fort Beaufort in the east (Eastern Cape) to the mouth of the Gariiep (Orange) River in the Richtersveld in the west (Northern Cape) (du Toit et al. 2012).

The proposed species within the xeric clades have mostly allopatric distributions with several zones of sympatry at the distribution margins with *R. dilectus* (see du Toit et al. 2012; Ganem et al. 2012). There are several sampling sites where more than one species was present, so-called contact zones. At this stage of our knowledge, these contact zones are in Fort Beaufort (Eastern Cape), Sandveld Nature Reserve, Soetdoring, Tussen-Die-Riviere (Free State), and Ezemvelo Nature Reserve, Rietvlei Nature Reserve, Irene and Carltonville (Gauteng). In the Sandveld Nature Reserve, *R. bechuanae* occurs in sympatry with *R. d. dilectus* and *R. d. chakae*. *Rhabdomys intermedius* was described from Cradock and Port Elizabeth in the Eastern Cape, as well as Deelfontein in the Northern Cape; this species mostly represents the central clade, when *R. pumilio* was split into three geographically distinct groups (du Toit et al. 2012).

Likewise, the distribution of *R. bechuanae* is mostly represented by the northern clade, which is known from Namibia, Botswana, as well as the Northern Cape and North West provinces of South Africa (du Toit et al. 2012).

Further molecular research and vetting of museum specimens is needed to more accurately delineate the distribution ranges of the various species.

Population

No national abundance information is available for these species and, although they can be locally and temporally abundant, their densities are known to fluctuate (Happold 2013). Fast growth, followed by population crashes, occur frequently. The species commonly occur in high numbers, often significantly higher than all other co-occurring small mammal species (Happold 2013). A comparative study between the *Rhabdomys* spp. in the arid Succulent Karoo and those in the moist grassland habitats of South Africa found that, as a result of increased rainfall levels, *Rhabdomys* in grassland regions exhibited much longer breeding seasons (Schradin & Pillay 2005). Additionally, high annual survival rates in the Succulent Karoo resulted in significantly higher population densities compared to drier grassland regions (Schradin & Pillay 2005). In the Succulent Karoo, average population densities of 36.6 ± 21.2 mice / ha (N = 5 groups) were reported in September, increasing to a peak of 171.1 ± 40.9 mice / ha (N = 7 groups) in December, and then declining through the rest of summer and into winter (Schradin & Pillay 2005). In other parts of South Africa, densities of 35–93 individuals / ha, and 30–300 individuals / ha were recorded in the Highveld grasslands (Brooks 1974) and the Cape Flats (David & Jarvis 1985), respectively.

Current population trend: Stable

Continuing decline in mature individuals: No

Number of mature individuals in population: Unknown

Number of mature individuals in largest subpopulation: Unknown

Number of subpopulations: Unknown

Severely fragmented: No

Habitats and Ecology

Generally, *Rhabdomys* species have a wide habitat tolerance, and are commensal species occasionally found in agricultural lands and in houses, and are sometimes considered pests. For example, they ring-bark young *Pinus* saplings (Monadjem et al. 2015). *Rhabdomys* were sampled in grasslands (wet and dry), Kikuyu (*Pennisetum clandestinum*) pastures and disturbed grasslands in Umvoti Vlei Conservancy, KwaZulu-Natal Province (Fuller & Perrin 2001). The three proposed arid-adapted species within what is currently regarded as the xeric *R. pumilio* clades appear to be specific to different biomes (du Toit et al. 2012). *Rhabdomys pumilio* occurs in the Fynbos and Succulent Karoo Biomes; *R. intermedius* occurs within the Nama-Karoo Biome; and *R. bechuanae* occurs within the Nama-Karoo and Savannah Biomes, with its distribution towards the east being restricted by an increase in annual rainfall. *Rhabdomys dilectus* favours mesic habitats within the Grassland and Savannah Biomes, and relies strongly on ground cover (Ganem et al. 2012; Meynard et al. 2012; Dufour et al. 2015). For *R. dilectus* and *R. intermedius*

only, overstocking in agricultural areas, and the reduction of grassland cover is likely to negatively impact the survival success and distributional range of these species.

Rhabdomys are diurnal and crepuscular omnivores with a diet of seeds, fruits, green plant material, *Acacia* pods, *Protea* flower bracts, *Pinus* bark and arthropods (Fuller & Perrin 2001; Skinner & Chimimba 2005; Monadjem et al. 2015). They are primarily granivorous, but depending on the season, are known to be opportunistically omnivorous, occasionally consuming insects (Perrin & Curtis 1980). Research suggests that the mesic-adapted *R. dilectus* is mostly solitary whereas the more arid-adapted species appear to be more communal (Schradin & Pillay 2005). The genus as a whole has been frequently described as a niche generalist. The four proposed species, however, appear to present different niche requirements, some of them appearing as specialists (du Toit et al. 2012; Meynard et al. 2012). Ecological niche modelling supports the separation of the xeric and the mesic species along a precipitation and temperature gradient from east to west (du Toit et al. 2012; Meynard et al. 2012).

The breeding season of the Four-striped Grass Mouse commences in August (Schradin & Pillay 2005), and terminates at the start of November in the Succulent Karoo, although extends until March/April in other parts of their range, due to spatiotemporal variation in rainfall patterns (Schradin & Pillay 2005). The start of the breeding season is dependent on a combination of food availability, temperature and rainfall (Brooks 1974; Perrin 1980a, 1980b; Rowe-Rowe & Meester 1982). Young are generally born in the summer months between September and April (Smithers & Wilson 1979; Perrin 1980b; Rowe-Rowe & Meester 1982; Nel et al. 1984; David & Jarvis 1985; Wirminghaus & Perrin 1992; Lynch 1994). A mean gestation period of 25.4 days has been suggested (Brooks 1974, 1982). Litter size is affected by female age and body mass, and females produce an average of two (and maximum of five) litters per season (David & Jarvis 1985). Litter size averaged at 4.9 (range, 2–9) on the Cape Flats (David & Jarvis 1985), 5.8 (range, 3–8) in Lesotho (Lynch 1994), 4.6 (range, 3–7) in the Drakensberg (Rowe-Rowe & Meester 1982), 5.9 (range, 2–9) in Gauteng (Brooks 1974), and 6.1 (range, 1–11) in KwaZulu-Natal (Taylor 1998). In the wild, average life expectancy is documented as 1.5 months (David & Jarvis 1985), but individuals may live for up to 24 months in captivity (Brooks 1974).

Ecosystem and cultural services: *Rhabdomys* species are particularly important forage species for diurnal raptors, snakes and small mammals, including Caracal (*Caracal caracal*), Black-backed Jackal (*Canis mesomelas*), African Wildcat (*Felis silvestris*) and several species of mongoose (De Graaf 1997), as they are one of the few diurnal rodent species. Since different species of the complex have different ecological requirements, they may be used as bio-indicators of changes in aridity. *Rhabdomys dilectus* is thought to rely strongly on water and vegetation cover, unlike *R. bechuanae*. Additionally, *R. pumilio* is a pollination agent in the Cape Fynbos.

Use and Trade

Rhabdomys is currently only being utilised for research and museum collections. It is an important research model to assess social evolution and ecological diversification.

Table 2. Threats to the Four-striped Grass Mouse (*Rhabdomys* spp.) ranked in order of severity with corresponding evidence (based on IUCN threat categories, with regional context)

Rank	Threat description	Evidence in the scientific literature	Data quality	Scale of study	Current trend
1	11.1 <i>Habitat Shifting & Alteration</i> : climate change leading to a possible decline or shift in suitable habitat and resources. Current stress 1.3 <i>Indirect Species Effects</i> .	Rymer et al. 2013	Anecdotal	Regional	A drier climate in southern Africa is likely to cause both the xeric and mesic clades to be vulnerable to environmental change, which may lead to extinction, range expansion and displacement or behavioural adaptation.

Threats

No major threats have been recognised for this species complex, and given the extensive occurrence of these species and their ability to coexist with humans in agricultural and semi-urban areas, they are unlikely to be threatened in the near future. However, the various proposed species may be susceptible to range declines or shifts due to climate change (Rymer et al. 2013). Considering the lack of information regarding the ecology and distribution of this species complex, the extent to which each species may be affected by habitat shifts is largely uncertain.

Current habitat trend: Stable

Conservation

These species are located in many protected areas throughout their range. For example, *R. bechuanae* is present within Kgalagadi Transfrontier Park, Richtersveld National Park, Tussen-die-Riviere Nature Reserve and Sandveld Nature Reserve; *R. dilectus* has been located within Willem-Pretorius Game Reserve, Sandveld Nature Reserve, Suikerbosrand Nature Reserve and Van Riebeeck Nature Reserve. No conservation interventions are deemed necessary for this species complex, although all *Rhabdomys* species are likely to benefit from the expansion of protected areas into suitable habitats. This is especially true for *Rhabdomys pumilio* and the expansion of lowland fynbos protected areas in the Western Cape.

Recommendations for land managers and practitioners:

- *R. dilectus* and *R. intermedius* would benefit from suitable land management: land owners should leave corridors of grassland between grazed areas and decrease stocking rates.

Research priorities:

- Rate of future habitat loss in the Western Cape.
- Species geographical distribution, morphometrics, genotyping of populations and taxonomic assessment. This includes vetting of existing museum specimens.

- Species social and general biology.
- Ecology and mechanisms of coexistence with other *Rhabdomys* species.
- Continued research into the status of the subspecies *R. d. chakae*, which may need to be enhanced to species status, and thus reassessed, following additional molecular analysis.

A multidisciplinary study (Eco-Rhab) into the adaptive ecological radiation of the *Rhabdomys* genus is currently (2014–2017) being conducted by Guila Ganem (Institute of Evolutionary Sciences), Neville Pillay (University of the Witwatersrand), Nico Avenant (The National Museum Bloemfontein), and Teresa Kearney (The Ditsong Museum of Natural History). More information is available at: <http://www.southern-africa.aird.fr/science-in-southern-africa/research-projects/unravelling-the-ecology-of-radiation-in-the-african-striped-mouse>.

Encouraged citizen actions:

- Report sightings on virtual museum platforms (for example, iSpot and MammalMAP), especially outside protected areas. However, due to their morphological similarities, identification to species level may prove difficult, especially in zones of sympatry.

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Table 3. Conservation interventions for the Four-striped Grass Mouse (*Rhabdomys* spp.) ranked in order of effectiveness with corresponding evidence (based on IUCN action categories, with regional context)

Rank	Intervention description	Evidence in the scientific literature	Data quality	Scale of evidence	Demonstrated impact	Current conservation projects
1	1.1 <i>Site/Area Protection</i> : protected area expansion, especially in the Western Cape to include lowland fynbos areas for <i>Rhabdomys pumilio</i> .	-	Anecdotal	-	-	-

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Data Sources and Quality

Table 4. Information and interpretation qualifiers for the Four-striped Grass Mouse (*Rhabdomys* spp.) assessment

Data sources	Field studies (unpublished), museum records, indirect information (literature)
Data quality (max)	Inferred
Data quality (min)	Inferred
Uncertainty resolution	Best estimate
Risk tolerance	Evidentiary

Assessors and Reviewers

Nina du Toit¹, Neville Pillay², Guila Ganem³, Claire Relton⁴

¹Stellenbosch University, ²University of the Witwatersrand, ³Université Montpellier, ⁴Endangered Wildlife Trust

Contributors

Matthew F. Child¹, Nico L. Avenant², Margaret Avery³, Rod Baxter⁴, Duncan MacFadyen⁵, Ara Monadjem⁶, Guy Palmer⁷, Peter Taylor⁴, Beryl Wilson⁸

¹Endangered Wildlife Trust, ²National Museum, Bloemfontein, ³Iziko South African Museums, ⁴University of Venda, ⁵E Oppenheimer & Son, ⁶University of Swaziland, ⁷Western Cape Nature Conservation Board, ⁸MacGregor Museum

Details of the methods used to make this assessment can be found in *Mammal Red List 2016: Introduction and Methodology*.