Mystromys albicaudatus – White-tailed Rat

Red List status (2016)	**Vulnerable C2a(i)*†**
Red List status (2008)	Endangered A3c
Reasons for change	Non-genuine change: New information
Red List status (2004)	Endangered A3c
TOPS listing (NEMBA) (2007)	None
CITES listing	None
Endemic	No

*Watch-list Data †Watch-list Threat

This genus is monotypic and endemic to South Africa and Lesotho, where only one species is presently recognized, *Mystromys albicaudatus* (Monadjem et al. 2015).

Taxonomy

Mystromys albicaudatus (Smith 1834)

ANIMALIA - CHORDATA - MAMMALIA - RODENTIA - NESOMYIDAE - *Mystromys* - *albicaudatus*

Common names: White-tailed Rat, African White-tailed Rat, White-tailed Mouse (English), Southern African Hamster, Witstertmuis (Afrikaans)

Taxonomic status: Species

Taxonomic notes: Originally described in the genus *Otomys*, molecular studies have confirmed that *Mystromys* belongs in the Nesomyidae family and represents a separate ancient lineage (the Mystromyinae) divergent from the Cricetomyinae, Dendromurinae, Petromyscinae and Nesomyinae (Jansa et al. 1999). This genus is monotypic and only one species is presently recognized, so this species is a phylogenetic rarity.

Assessment Rationale

The White-tailed Rat is a Highveld grassland specialist (whilst also marginally occurring in Succulent Karoo and Fynbos biomes; Dean 1978) and is endemic to South Africa and Lesotho. Although it occurs widely across the assessment region, it has an extremely patchy and fragmented area of occupancy due to its preference for microhabitats within vegetation types and transitory habitats created after fire. Out of a total area of 417,452 km^2 broadly available to the species, we inferred an effective occupancy of only 3,719–12,061 km^2. They are one of the rarest species in the small mammal community, as demonstrated by consistently low trapping records. Given estimated densities ranging from 0.9–37 colonies (breeding pairs) / km^2, the most likely mature population size is 6,997–13,648 individuals. Using grassland vegetation type as a proxy for subpopulation delineation, subpopulation size averages 178 ± 177 colonies and ranges from 1–760 colonies, which means the largest subpopulation is likely to be 712–1,521 mature individuals. There is an inferred continuing decline from grassland habitat loss (due to expansion in crop agriculture, urban and industrial development, and climate change) and grassland habitat degradation, primarily from suppression of natural fire regimens. This may represent an emerging threat to this species if fire is increasingly suppressed or controlled with the rise of intensive wildlife breeding. Grasslands are the most threatened biome in the assessment region with at least 33% transformed already. Thus, we list this species as Vulnerable C2a(i) under a precautionary purview. Although it was listed as Endangered A3c in previous assessments, there is no evidence for a population decline of > 50% and overgrazing is a less severe a threat for this species than originally thought. Further field surveys are needed to estimate population size and trend more accurately, and this species should be reassessed once more data are available. Key interventions include protected area expansion of grassland habitat and the implementation of suitable grazing and fire management systems for nature reserves, livestock and wildlife ranches. Research and monitoring is desperately needed to test the effectiveness of such interventions and to produce baseline information on its ecology and biogeography.

Distribution

White-tailed Rats are endemic to South Africa and Lesotho, where they inhabit Highveld grasslands primarily, but also Succulent Karoo and fynbos (Dean 1978). Within South Africa, it occurs in the following provinces (Table 1): southern Mpumalanga, Free State, the high-lying areas of KwaZulu-Natal (KZN), Eastern Cape, southeastern North West, and marginally into Northern Cape (Skinner & Chimimba 2005; Avery & Avery 2011). There is a potentially relict subpopulation in the fynbos of the Western Cape where it probably once occurred extensively throughout the southern grasslands, heathlands and renosterveld of the Cape. There are no records from Swaziland, despite extensive surveys (Monadjem pers. comm. 2015). No recent range expansions or contractions have been documented. However, it is likely that the population is fragmented and will contract in the future as grasslands continue to decline

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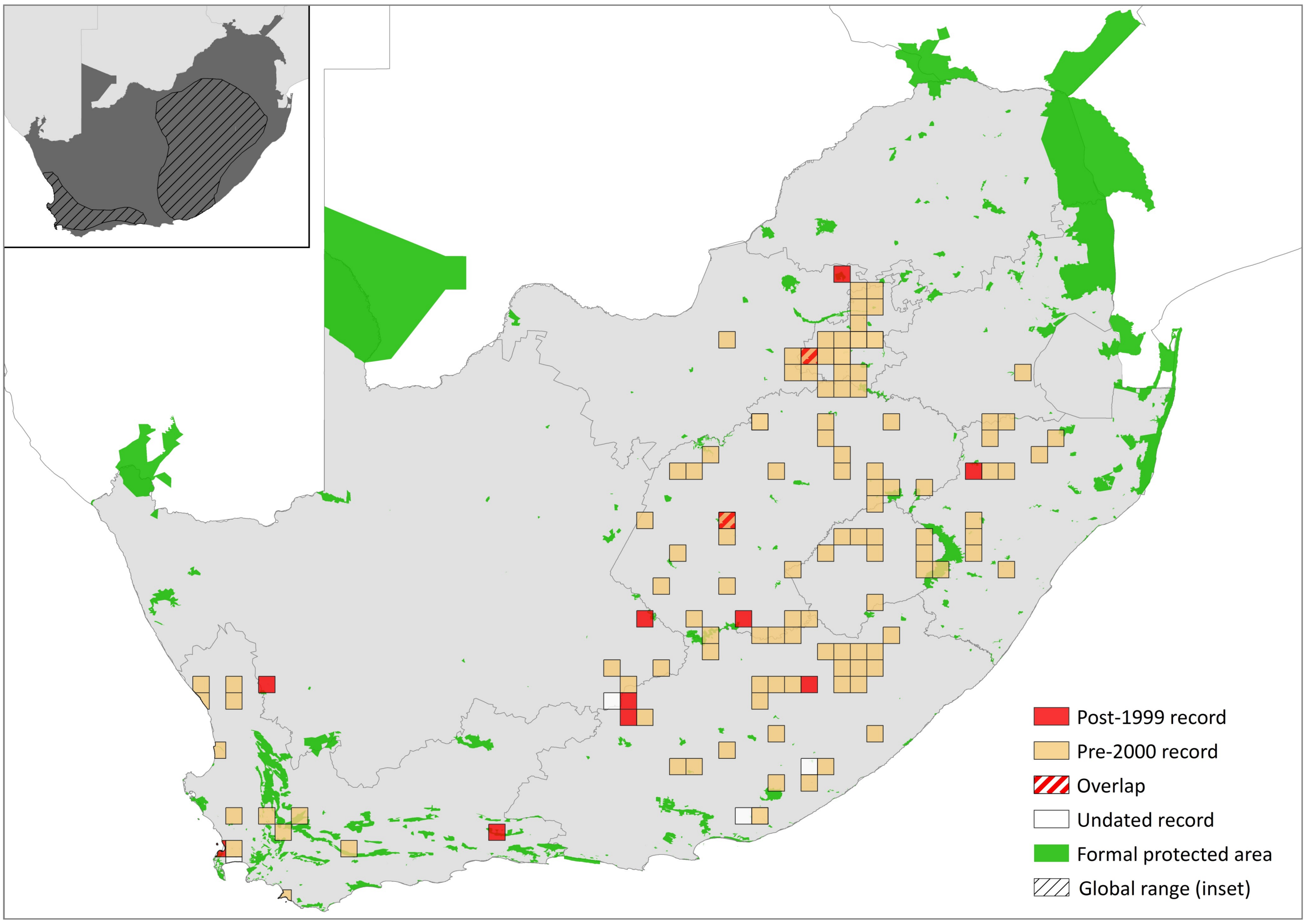

Figure 1. Distribution records for White-tailed Rat (*Mystromys albicaudatus*) within the assessment region

Table 1. Countries of occurrence within southern Africa

Country	Presence	Origin
Botswana	Absent	-
Lesotho	Extant	Native
Mozambique	Absent	-
Namibia	Absent	-
South Africa	Extant	Native
Swaziland	Absent	
Zimbabwe	Absent	

(Mucina & Rutherford 2006; Driver et al. 2012). Additionally, there is a suggestion that, historically, its range had already contracted southwards in the Northern Cape region: Owl pellet analysis reveals Pleistocene records from Equus and Wonderwerk Caves, as well as records of the species in 10 other localities in the Kuruman area and surrounds from the Holocene period, while more recent owl pellet records (1930 to present) only reveal localities from the previously-mentioned regions of the province (Avery & Avery 2011), which suggests a long-term range contraction.

This species is widespread across the assessment region but patchily distributed, and so estimating area of occupancy (AOO) is challenging. Since they are habitat specialists, we extracted all vegetation types in which they are recorded to occur (Mucina & Rutherford 2006), using the distribution data from Figure 1. This yielded an AOO of 417,452 km^2. However, we suspect this is a huge overestimate as they often occur in just one of the sampled sites in a region and often are not found in sites where they are expected to occur (for example, Vermeulen 2005; O'Farrell et al. 2008; Avenant 2011; Kok et al. 2012; N.L. Avenant, G. Palmer, B. Wilson unpubl. data). For example, although Rondeberg Private Nature Reserve shares similar habitat types with the Blaauwberg Conservation Area (BCA) in the Western Cape Province, and was identified as a site where the species should occur, they have only been recorded at BCA (Vermeulen 2005). More worryingly, a recent province-wide survey in the North West did not reveal a single record for the species, where the last museum record was from Boskop Dam Nature Reserve in 1990 (Power 2014). This is most likely due to the heavy transformation of the grassland biome in the province (Driver et al. 2012). Similarly, although an owl pellet indicating the presence of the species in Tygerberg Nature Reserve, Western Cape, was found in 1992, a recent survey did not find any individuals (Vermeulen 2005). Furthermore, they are suspected to exist in transitory habitats created after fire, having been found equally in burnt and unburnt patches in the Western Cape Province and in low to mid-successional habitats following fire in the Free State Province (Kuyler 2000; Kaiser 2006; Specker 2006; Avenant & Cavallini 2007; Avenant 2011; Avenant & Schulze 2012; Morwe 2013). For example, although they are predicted to occur widely in Gauteng Province, they have not been found in the Cradle of Humankind region, possibly because the area does not burn. Thus, this species likely occurs in microhabitats (see Habitats and Ecology) that are too fine-scale to be approximated by vegetation types and that occur in a shifting mosaic of patches following fire.

Given the information above, we subsequently revised the AOO estimate by summing the area of the occupied quarter degree grid cells (using both historical and current records), which yielded 78,470 km^2. We then subtracted the amount of transformed habitat as of 2014 (agricultural and urban areas, 57% of the total) and non-grassland habitat, which yielded 34,026 km^2 (GeoTerraImage 2015). Finally, we used recent survey data from game farms, wildlife ranches and private conservation areas (A. Taylor unpubl. data) within White-tailed Rat habitat to estimate the proportion of natural habitat that is never burned, burned occasionally and burned using a mosaic or patch approach (which is suspected to be the best fire management system for the species, see Habitats and Ecology). Using data from Free State Province alone (within the core range of the species), only an estimated 14% of the land occasionally burns (30 km^2 of a total 212 km^2 sampled, N = 13 total properties). Extrapolating this proportion to the total estimated natural grassland habitat available to the species overall yields 4,764 km^2. Similarly, if we use the nationwide sample, the proportion of land that burns occasionally increases to 35% (4,094 km^2 of a total 11,546 km^2 sampled, N = 204 total properties). This yields an effective AOO of 12,061 km^2 (extrapolating across the range of the species). Lastly, using only the properties that employ mosaic burning (11% of total sampled area, N = 6 properties; 1,262 km^2 of a total 11,546 km^2 sampled), the effective AOO is reduced to an extrapolated 3,719 km^2. These parameters and corresponding population size estimates are summarised in Table 2. We feel that measuring AOO at the quarter degree grid scale and using both old and recent records approximates the dynamic and patchy distribution of the species better than coarse vegetation types. Further research should determine in more detail its habitat preference and distribution so as to improve the measurement of AOO.

Population

Dean (1978) regards the White-tailed Rat as a relict species. Although conservationists have been concerned with it for over forty years, it still persists at low densities. While no empirical population estimates or trends are available, they are consistently one of the rarest species encountered and infrequent capture rates during surveys indicate that population size is low. Friedmann and Daly (2004) reported 5–10 specimens in 15–20,000 trap nights / year in the Free State Province (but only a small percentage of those trap nights took place in habitats where one expected to find the species). Similarly, with over 7,500 small mammal records collected over the current Northern Cape (concentrating in the old demarcated provincial boundaries) and current North West (the western areas which used to be Northern Cape) provinces, only two records (from Benfontein Farm, near Kimberley) have been archived in the McGregor Museum (0.03% reporting rate, B. Wilson unpubl. data). The most recent museum record from North West Province was from Boskop Dam Nature Reserve (de Beer 1990), but a trapping effort of 240 trap nights in 2013 did not detect the species (Power 2014). Recently, in the Blaauwberg Conservation Area, Western Cape, two studies had a trap success of 1.9% and 1.3% respectively (900 and 800 trap nights corresponding to 17 and 10 individuals respectively) (Vermeulen 2005; Specker 2006). The species may have a low sighting record as it is naturally rare and uses a burrow system.

Their patchy distribution may explain the lack of trapping success, but once a patch is found they are trapped easily if present. No home range or dispersal rate data are available, but records indicate a clumped distribution within suitable habitats. The two individuals trapped on Benfontein Farm, just east of Kimberley, were trapped in the same area, although several years apart, despite consecutive annual surveys at similar trapping effort (B. Wilson, unpub. data). Within the Free State Province, colonies do not seem to be in close proximity as, within a homogenous area-trap plot of 0.027 km^2 (100 traps spaced 5 m apart with a border area of 25 m around the traps), a maximum of one colony is present (N.L. Avenant unpubl. data). Furthermore, a colony is found in approximately one in every 20 area-trap plots, which means colony density can be preliminarily estimated at one colony / 0.55 km^2 or 1.8 colonies / km^2 (N.L. Avenant unpubl. data). We can assume a minimum of 2 mature adults / colony (colonies are small, consisting of < 10 individuals). If we use maximum density as 1 colony / 0.027 km^2 and minimum density as 1 colony / 1.05 km^2 (assumed to be the positive interval between the maximum and medium density estimates), a range of population sizes can be estimated for the different AOO parameters described in **Distribution** (Table 2). Colony numbers and corresponding mature population size ranges over orders of magnitude, depending on the AOO estimate. The most likely density estimates (medium and minimum) range from 3,499 colonies (6,997 mature individuals) to 22,131 colonies (44,262 mature individuals). Given that colonies (breeding pairs) are suspected to be isolated and may effectively represent a single breeding unit, colony number is probably a more accurate measure of mature population size (*sensu* IUCN Standards and Petitions Subcomittee 2014).

Table 2. Summary of population size estimates. The area of occupancy (AOO) estimates refers to the analysis described in Distribution. Density estimates are based on information from area-trap plots from the Free State Province (N.L. Avenant unpubl. data), where max = 1 colony / 0.027 km^2, medium = 1 colony / 0.55 km^2 and min = 1 colony / 1.05 km^2. QDS = quarter degree squares.

AOO description	AOO size (km^2)	Colony density			Mature population size (breeding pairs)		
		Max	*Med*	*Min*	*Max*	*Med*	*Min*
Total vegetation type area	417,452	15,461,185	765,967	392,711	30,922,370	1,531,934	785,422
Total QDS area	78,470	2,906,296	143,982	73,819	5,812,593	287,963	147,639
Natural QDS area	34,026	1,260,222	62,433	32,009	2,520,444	124,866	64,019
Natural QDS area that burns	12,061	446,713	22,131	11,346	893,427	44,262	22,693
Natural QDS area burns (mosaic)	3,719	137,741	6,824	3,499	275,482	13,648	6,997

Defining subpopulations for this species is difficult as we lack basic information about its ecology and distribution. However, we suspect that using vegetation types as proxies for subpopulation distribution may be an adequate approximation since the species may rely on fire to create suitable habitat patches and fire frequency will depend on the fuel load and climate of the vegetation type or bioregion. Subpopulations are suspected to be severely fragmented due to the fragmented nature of the grassland biome (Neke & du Plessis 2004), as well as the prevention of fire as an ecological process or cessation of burning as a management tool by landowners in many areas (A. Taylor unpubl. data). By treating each vegetation type within the grassland biome as a subpopulation (N = 71 subpopulations), and using the medium density estimate from Table 2 (as well as adjusting for the likely proportion of land that is occasionally burnt), average subpopulation size is 178 ± 177 colonies (357 ± 355 mature individuals), with a maximum of 760 colonies (1,521 mature individuals) in a subpopulation. However, we feel that these are overestimates given that the remaining area of the vegetation types were calculated using 1997 satellite data integrated with more recent regional data where possible, and thus mostly do not reflect the habitat lost over at least the past decade. The area currently available to each subpopulation is likely to be significantly less and thus subpopulation sizes are likely to be smaller or even locally extinct (Power 2014).

Current population trend: Decreasing (inferred from decreased trap success in North West Province and continuing loss of grassland habitat).

Continuing decline in mature individuals: Unknown

Number of mature individuals in population: 6,997–13,648

Number of mature individuals in largest subpopulation: 712–1,521

Number of subpopulations: Possibly 71 based on vegetation types.

Severely fragmented: Yes. Loss of grassland habitat and suppression of fire are suspected to have severely fragmented the population. Individuals appear to move with succession, entering a specific area after disturbance and leaving when plant basal cover increase above a certain level (see **Habitats and Ecology**). When these patches become too far apart, dispersal and recolonisation is expected to become compromised.

Habitats and Ecology

Very little is known about this rare species in the wild. The colloquial and scientific names refer to its pure white tail (Photo 1). Typically somewhat hamster-like in appearance, this stocky grey-coloured rat has a very short tail (about 35–40% of its head and body length) covered in dense short white hairs from which it derives its name. It is terrestrial and nocturnal and has several unusual physiological features: Their stomachs are adapted, via a complex microfauna and ruminant-like digestive system, to digest a wide range of plant foods that contain chemical defences and are thus not eaten by other species (Perrin & Maddock 1983; Downs & Perrin 1995), but there are no available data on preferred plant species from wild populations. It has a high metabolic rate well adapted to the Highveld winter (Monadjem et al. 2015), during which it reduces its activity and foraging times. However, there is

Photo 1. The White-tailed Rat (*Mystromys albicaudatus*) showing its characteristic white tail (Cliff & Suretha Dorse)

no evidence suggesting that White-tailed Rats enter torpor (Perrin 2013). There remains no information about social and reproductive behaviour in the wild, and most data come from captive individuals which breed easily. Litter sizes vary between 1 and 6 and it is suspected that breeding takes place year round. They construct high-sided, cup-shaped nests which "look like Elizabethan neck ruffs" (Skinner & Chimimba 2005: 191), which is probably why the generic name is derived from the Greek *mystron* (meaning "spoon") and *mys* (meaning "mouse").

The habitat requirements and ecology of White-tailed Rats merits further research. They are often associated with calcrete soils within grasslands. They are never found on soft, sandy substrate, rocks, wetlands or river banks. Furthermore, records from the Free State Province and Borakalalo Nature Reserve, North West Province show that they can occur in disturbed areas (heavily grazed, D. MacFadyen pers. obs.) and in sparse grasslands (Kuyler 2000; Kaiser 2006; Avenant & Cavallini 2007; Avenant & Schulze 2012; Morwe 2013); for example, on shallow limestone substrate (Kuyler 2000; Morwe 2013, N.L. Avenant unpubl. data). Similarly, Vermeulen (2005) surveyed the Blaauwberg Conservation Area (BCA), Western Cape Province and found they had a preference for Dune Thicket on sloped clay soils, which disproves Friedmann and Daly's (2004) assertion that they require sandy soils. In the Transvaal region, they were recorded from areas of dense grass, as well as rocky areas with grass (Rautenbach 1978). In Lesotho and KZN, they are found along dolerite ridges, rocky slopes, basalt koppies (Lynch 1994; Taylor 1998). In the Maclear district of the Eastern Cape Province, it was found in habitats with crests and ridges and trapped on bare patches with sparse vegetation (Armstrong & van Hensbergen 1996a). They may have a preference for the Carletonville Dolomite Grasslands in North West Province as is suggested by the museum records (Power 2014). On the Bokkeveld Plateau near Nieuwoudtville, Northern Cape, it was trapped in Dolerite Plains vegetation (O'Farrell et al. 2008). They do not occur in transformed habitat (croplands, fallow fields, or old fields). However, as they select microhabitats, such as slopes and ridges, small numbers may survive in non-arable patches within an agricultural matrix.

A controlled and replicated study analysing the effects of fire on the species in the BCA showed that about half the individuals trapped occurred in unburnt versus burnt habitats (60% in unburnt) whereas > 90% of other small mammals were recorded in unburnt areas (Specker 2006). This may indicate that the species is fire-adapted and

Specker (2006) suggests that fire may trigger breeding. However, the study also suggests that unburnt areas are utilised in tandem with burnt areas and are perhaps needed as refuges from predation. Thus, a patch mosaic burning regimen, rather than a block-burn, may create the most desirable micro-habitat for this species (but see Parr & Andersen 2006). The species may require phase diversity, as observations suggest it exists in transitory habitat post-fire: they appear to enter grassland habitat about six months after a patch has burned and exit as the vegetation recovers (Kuyler 2000; Kaiser 2006; Avenant & Schulze 2012). Thus, the species follows plant succession closely, making disturbance important.

As they are nocturnal, they are often preyed on by Barn Owls (*Tyto alba*) as documented in studies analysing owl pellets (Avenant 2005; Avery et al. 2005). They live in burrows or crevices (de Graaf 1981; Armstrong & van Hensbergen 1996b), and can also swim (Hickman & Machiné 1986).

Ecosystem and cultural services: They have been recorded as a forage species for owls (Dean 1978; Avery et al. 2002, 2003, 2005; Avery & Avery 2011). Previously they were considered susceptible to plague which occurs sporadically in free-living populations but the National Institute for Communicable Diseases (2005) did not list them as plague-carrier.

Use and Trade

They are used extensively in laboratory research (Hall 3rd et al. 1967). They may occasionally be utilised as bushmeat but are not a target species.

Threats

Habitat loss of grasslands, both from agricultural and industrial or urban expansion (accounting for 97% of the transformed land in North West Province, NW READ 2014), as well as in the future from climate change (through bush encroachment, van Jaarsveld & Chown 2001), is the greatest threat to this species. This species is also threatened by afforestation of Highveld grasslands (Armstrong & van Hensbergen 1996b); for example, Mpumalanga has already lost at least 9% of its natural vegetation to forestry plantations (Lötter et al. 2014). Mining is also a major ongoing cause of habitat loss, where 25% of the surface of Mpumalanga is under mining application (Lötter et al. 2014), most of which is coal mining.

It appears as if this species has adapted to a mosaic of disturbances, such as that brought about through patch burns (through natural veld fires) and/or overgrazing (perhaps from when herds were migratory across the Highveld). Even in formally protected areas, most of these disturbances are managed, thereby prohibiting natural fluctuations. Suppression of fire is thus suspected to be the next most severe threat, as the microhabitats that the species requires are not created or recycled. Although Coetzee & Monadjem (2008) list grazing pressure as contributing to habitat loss, data from Lesotho indicate that the species occurs in overgrazed areas (Avenant 2011, N.L. Avenant unpubl. data).

Current habitat trend: Grasslands are continuing to be lost (Driver et al. 2012). In the North West Province, from 2006 to 2010, 2,500 km^2 (approximately 2% of the remaining natural vegetation) was irreversibly transformed (NW READ 2014). Similarly, in the Free State Province, 6%

Table 3. Threats to the White-tailed Rat (*Mystromys albicaudatus*) 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	*2.1 Annual & Perennial Non-Timber Crops*: grassland habitat loss from crop agriculture.	NW READ (2014)	Indirect (land cover change from remote sensing)	Regional	Decelerating
2	*1.1 Housing & Urban Areas* and *1.2 Commercial & Industrial Areas*: grassland habitat from urban and industrial development.	NW READ (2014)	Indirect (land cover change from remote sensing)	Regional	Increasing
3	*2.2.2 Agro-industry Plantations*: grassland habitat loss from afforestation.	Armstrong & van Hensbergen 1996a,b	Empirical (presence/ absence)	Regional	Unknown
		Lötter et al. 2014	Indirect (land cover change from remote sensing)	Regional	Unknown
4	*3.2 Mining & Quarrying*: grassland habitat loss from mining.	Lötter et al. 2014	Indirect (area affected by mining applications)	Regional	Increasing (based on application numbers)
5	*11.1 Habitat Shifting & Alteration*: grassland habitat loss from bush encroachment caused by climate change.	van Jaarsveld & Chown 2001	Indirect	National	Increasing (modelled)
6	*7.1.2 Suppression in Fire Frequency/ Intensity*: microhabitat loss from incorrect burning regime. Current stress *1.2 Ecosystem Degradation*: habitat degradation.	Avenant et al. (2011)	Anecdotal	Local	Increasing (based on unpubl. data on lack of fire management)

of natural vegetation was lost from 1994 to 2009, where the greatest loss occurred in the grasslands (6.4%, N. Collins unpubl. data). Additionally, since it may have a degree of habitat tolerance for overgrazing, it potentially could exist on wildlife ranches (which are expanding throughout South Africa) and livestock areas. However, this must be weighed against the predominant absence of fire management in such areas, and the net effect assessed.

Conservation

Due to its patchy distribution, this species often does not occur in protected areas that one would expect to find them (for example, De Graaff 1974; Vermeulen 2005). Further surveys should document the full list of protected areas in which it occurs. Currently (post-2000 records, Figure 1), there are confirmed records for Tussen-die-Riviere Nature Reserve (Ferreira & Avenant 2003), Maria Moroka NR, Soetdoring NR, Erfenisdam NR and De Brug Army Training Camp in the Free State Province; Blaauwberg Conservation Area (BCA) in the Western Cape Province; and Abe Bailey Nature Reserve in Gauteng Province and Boskop Dam Nature Reserve in the North West.

Conservation of grasslands through protected area expansion and biodiversity stewardship schemes is suspected to be the most important intervention for this species. For example, the Maloti-Drakensberg Transfrontier Conservation and Development Area, established in 2001, accounts for the majority of the *c.* 2% of the protected grassland within the assessment region (Carbutt et al. 2011) and has higher levels of species richness than neighbouring communally grazed areas (Everson & Morris 2006).

Similarly, biodiversity stewardship schemes are suspected to be conserving grassland patches that would benefit this species. For example, a study in the Little Karoo region (overlapping with White-tailed Rat distribution) found that private conservation areas conserved almost three times the amount of land as formally protected areas for both Succulent Karoo and Rensoterveld vegetation types (Gallo et al. 2009), both habitats where the species occurs (albeit marginally).

Grassland condition must also be conserved through correct grazing and fire management. Anecdotal observations suggest that overgrazing is not detrimental to White-tailed Rats (N.L. Avenant unpubl. data). Interestingly, research suggests that continuous cattle grazing systems may have the least negative effect on grasslands (as opposed to continuous sheep grazing or high stocking levels and rotational grazing systems, O'Connor et al. 2010), because continuous grazing dissipates impact across the landscape whereas rotational grazing concentrates impacts on small areas while also leading to fragmentation of the landscape through fencing and infrastructure. Thus, depending on stocking level, game and livestock can be the best land use for grasslands (as opposed to intensive dairy farming, crop agriculture, or rural settlements, O'Connor & Kuyler 2009), which supports the occurrence of this species on such land uses, and should be promoted to limit the sprawl of alternative, damaging land uses.

As this species may be connected with post-fire patches, the pristine condition of the grassland may not be as limiting as the lack of ecosystem functioning and thus phase diversity. Landscapes that burn occasionally are suspected to have greater conservation value. Thus mosaic burning, within the natural fire frequency of the landscape and within the goals of grazing management for the relevant ungulate species, should be used by managers to promote the persistence of White-tailed Rats, and the effects should be monitored.

Table 4. Conservation interventions for the White-tailed Rat (*Mystromys albicaudatus*) 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 Site/Area Protection*: protected area expansion of grassland habitats.	Everson & Morris 2006	Indirect	Local	Higher species richness on protected grassland than communally grazed area.	Maloti-Drakensberg Transfrontier Conservation and Development Area (Peace Parks Foundation, Global Environment Facility, SANParks)
2	*1.2 Resource & Habitat Protection*: grassland conservation through biodiversity stewardship and private land.	Gallo et al. 2010	Indirect (Landsat imagery)	Regional	Private conservation areas conserved three times more Succulent Karoo and Rensoterveld than formally protected areas.	Threatened Grassland Species Programme, Endangered Wildlife Trust; Enkangala Grasslands Programme, World Wide Fund for Nature – South Africa
3	*2.3 Habitat & Natural Process Restoration*: employ the best grazing system for grasslands.	O'Connor et al. 2009, 2010	Attitudinal	Regional	Continuous cattle/ wildlife grazing the best system for grassland ecosystem functioning.	-
4	*2.3 Habitat & Natural Process Restoration*: employ appropriate fire management for grasslands.	-	Anecdotal	-	-	University of Free State/ National Museum, Bloemfontein research (N.L. Avenant)

Further field research is needed to produce evidence for the conservation effectiveness of the proposed interventions for this species specifically (see **Research Priorities**).

Recommendations for land managers and practitioners:

- Incorporate monitoring the species as a possible indicator of disturbed grassland patches (Avenant 2011), as its presence may indicate that the ecosystem is functioning and that patch heterogeneity exists in the landscape.
- Managers must use fire as a management tool.
- Managers should not over-stock ranch lands and should be encouraged to switch to cattle or wildlife.
- Survey work, including the collection of owl pellets, is needed to determine its occurrence in different land-management areas.

Research priorities:

- Basic ecological research on habitat requirements (and ability to exist on modified landscapes), movement/dispersal capacity between patches, and biogeography.
- Research on the effects of different management systems on presence and abundance. This should be compared to a baseline subpopulation in suitable protected habitat (control).
- Research to test the effectiveness of utilising best management practices as identified or hypothesised above.
- Research to determine colony size, reproduction, dispersal/movement between patches.

Encouraged citizen actions:

- Report sightings on virtual museum platforms (for example, iSpot and MammalMAP). As this species is easily identified from its white tail and white-grey fur (Photo 1), photographs and coordinates of this species, especially outside of protected areas (for example, livestock and wildlife ranches), will help us to determine its habitat preferences and ecology more accurately.
- Collect and submit owl pellets to relevant museums.
- If a game farm or conservancy landowner, use a mosaic fire management as a tool to create microhabitats for this species. Its occurrence should be monitored.

Data Sources and Quality

Table 5. Information and interpretation qualifiers for the White-tailed Rat (*Mystromys albicaudatus*) assessment

Data sources	Field study (unpublished), indirect information (literature, unpublished, expert knowledge), museum records
Data quality (max)	Inferred
Data quality (min)	Suspected
Uncertainty resolution	Maximum/minimum values
Risk tolerance	Precautionary

References

Armstrong AJ, van Hensbergen HJ. 1996a. Small mammals in afforestable montane grasslands of the northern Eastern Cape Province, South Africa. South African Journal of Wildlife Research **26**:11–18.

Armstrong AJ, van Hensbergen HJ. 1996b. Impacts of afforestation with pines on assemblages of native biota in South Africa. South African Forestry Journal **175**:35–42.

Avenant N. 2011. The potential utility of rodents and other small mammals as indicators of ecosystem "integrity" of South African grasslands. Wildlife Research **38**:626–639.

Avenant N, Schulze E. 2012. Rodent succession in post-fire grassland, Erfenis Dam Nature Reserve, Free State Province, South Africa. Page 183 in Henttonen H, Huitu O, editors. The 13th Rodens et Spatium Conference – Abstracts.

Avenant NL. 2005. Barn owl pellets: a useful tool for monitoring small mammal communities. Belgian Journal of Zoology **135**:39–43.

Avenant NL, Cavallini P. 2007. Correlating rodent community structure with ecological integrity, Tussen-die-Riviere Nature Reserve, Free State province, South Africa. Integrative Zoology **2**:212–219.

Avery DM, Avery G. 2011. Micromammals in the Northern Cape Province of South Africa, past and present. African Natural History **7**:9–39.

Avery DM, Avery G, Colahan BD. 2003. Micromammals and barn owls in the Free State, South Africa: Prey distribution and predator behaviour. Navorsinge van die Nasionale Museum Bloemfontein **19**:2–18.

Avery DM, Avery G, Palmer NG. 2005. Micromammalian distribution and abundance in the Western Cape Province, South Africa, as evidenced by Barn owls *Tyto alba* (Scopoli). Journal of Natural History **39**:2047–2071.

Avery DM, Avery G, Roberts A. 2002. A contribution from barn owl pellets to known micromammalian distributions in KwaZulu-Natal, South Africa. African Zoology **37**:131–140.

Carbutt C, Tau M, Stephens A, Escott B. 2011. The conservation status of temperate grasslands in southern Africa. Grassroots **11**:17–23.

Coetzee, N. & Monadjem, A. 2008. *Mystromys albicaudatus*. The IUCN Red List of Threatened Species 2008: e.T14262A4428195.

de Beer T. 1990. Kleinsoogdieropname: Boskop dam natuurreservaat. Internal report. Transvaal Provincial Administration, Pretoria, South Africa.

de Graaf G. 1981. The Rodents of Southern Africa. Butterworths & Co. Publishing, Durban, South Africa.

de Graaff G. 1974. Notes on the occurrence of rodents in South African National Parks. Koedoe **17**:173–183.

Dean WRJ. 1978. Conservation of the white-tailed rat in South Africa. Biological Conservation **13**:133–140.

Downs CT, Perrin MR. 1995. The thermal biology of the white-tailed rat *Mystromys albicaudatus*, a cricetine relic in southern temperate African grassland. Comparative Biochemistry and Physiology **110A**:65–69.

Driver A, Sink KJ, Nel JN, Holness S, van Niekerk L, Daniels F, Jonas Z, Majiedt PA, Harris L, Maze K. 2012. National Biodiversity Assessment 2011: An assessment of South Africa's biodiversity and ecosystems. Synthesis Report. South African National Biodiversity Institute and Department of Environmental Affairs, Pretoria, South Africa.

Everson TM, Morris CD. 2006. Conservation of Biodiversity in the Maloti-Drakensberg Range. Pages 285–291 in Spehn EM, Liberman M, Körner C, editors. Land Use Change and Mountain Biodiversity. Taylor and Francis, Florida, USA.

Ferreira SM, Avenant NL. 2003. Modelling the Effects of Trap-spacing on Small Mammal Community Descriptors in Grasslands at Tussen-die-Riviere Nature Reserve, Free State Province, South Africa. Navorsinge van die Nasionale Museum, Bloemfontein **19**:21–30.

Friedmann Y, Daly B, editors. 2004. Red Data Book of the Mammals of South Africa: A Conservation Assessment. IUCN SSC Conservation Breeding Specialist Group and Endangered Wildlife Trust, South Africa.

Gallo JA, Pasquini L, Reyers B, Cowling RM. 2009. The role of private conservation areas in biodiversity representation and target achievement within the Little Karoo region, South Africa. Biological Conservation **142**:446–454.

GeoTerraImage. 2015. Quantifying settlement and built-up land use change in South Africa.

Hall 3rd A, Persing RL, White DC, Ricketts Jr RT. 1967. *Mystromys albicaudatus* (the African white-tailed rat) as a laboratory species. Laboratory Animal Care **17**:180.

Hickman GC, Machiné C. 1986. Swimming behaviour in six species of African rodents (Cricetidae, Muridae). Acta Theriologica **31**:449–466.

IUCN Standards and Petitions Subcomittee. 2014. Guidelines for using the IUCN Red List categories and Criteria. Version 11. Prepared by the IUCN Standards and Petitions Subcommittee.

Jansa SA, Goodman SM, Tucker PK. 1999. Molecular phylogeny and biogeography of the native rodents of Madagascar (Muridae: Nesomyinae): a test of the single-origin hypothesis. Cladistics **15**:253–270.

Kaiser W. 2006. The characteristics of insect and small mammal communities as a reflection of the ecological value of grasslands. M.Sc. Thesis. University of the Free State, Bloemfontein, South Africa.

Kok AD, Parker DM, Barker NP. 2012. Life on high: the diversity of small mammals at high altitude in South Africa. Biodiversity and Conservation **21**:2823–2843.

Kuyler P. 2000. Veld condition assessment and small mammal community structure in the management of Soetdoring Nature Reserve, Free State, South Africa. M.Sc. Thesis. University of the Free State, Bloemfontein, South Africa.

Lötter MC, Cadman MJ, Lechmere-Oertel RG. 2014. Mpumalanga Biodiversity Sector Plan Handbook. Mpumalanga Tourism & Parks Agency, Mbombela, South Africa.

Lynch CD. 1994. The mammals of Lesotho. Navorsinge van die Nasionale Museum Bloemfontein **10**:177–241.

Monadjem A, Taylor PJ, Denys C, Cotterill FPD. 2015. Rodents of Sub-Saharan Africa: A Biogeographic and Taxonomic Synthesis. De Gruyter, Berlin, Germany.

Morwe BJ. 2013. Determining the direct impact of the Black-backed Jackal (*Canis mesomelas*) on the Springbok (*Antidorcas marsupialis*) population at Maria Moroka Nature Reserve, Free State, South Africa. B.Sc. Hons. Mini-thesis. University of the Free State, Bloemfontein, South Africa.

Mucina L, Rutherford MC, editors. 2006. The Vegetation of South Africa, Lesotho and Swaziland. South African National Biodiversity Institute, Pretoria, South Africa.

National Institute for Communicable Diseases. 2005. Plague Control Guidelines for South Africa. Department of Heath, South Africa.

Neke KS, du Plessis MA. 2004. The threat of transformation: quantifying the vulnerability of grasslands in South Africa. Conservation Biology **18**:466–477.

NW READ. 2014. North West Environment Outlook Report 2013. North West Provincial Government, Mahikeng, South Africa.

O'Connor TG, Kuyler P. 2009. Impact of land use on the biodiversity integrity of the moist sub-biome of the grassland biome, South Africa. Journal of Environmental Management **90**:384–395.

O'Connor TG, Kuyler P, Kirkman KP, Corcoran B. 2010. Which grazing management practices are most appropriate for maintaining biodiversity in South African grassland? African Journal of Range & Forage Science **27**:67–76.

O'Farrell PJ, Donaldson JS, Hoffman MT, Mader AD. 2008. Small mammal diversity and density on the Bokkeveld escarpment, South Africa-implications for conservation and livestock predation: short communications. African Zoology **43**:117–124.

Parr CL, Andersen AN. 2006. Patch mosaic burning for biodiversity conservation: a critique of the pyrodiversity paradigm. Conservation Biology **20**:1610–1619.

Perrin M. 2013. *Mystromys albicaudata* African White-tailed Rat. Pages 201–203 in Happold DCD, editor. Mammals of Africa vol. III: Rodents, Hares and Rabbits. Bloomsbury Publishing, London, UK.

Perrin MR, Maddock AH. 1983. Preliminary investigations of the digestive processes of the white-tailed rat *Mystromys albicaudatus* (Smith 1834). South African Journal of Zoology **18**:128–133.

Power RJ. 2014. The Distribution and Status of Mammals in the North West Province. Department of Economic Development, Environment, Conservation & Tourism, North West Provincial Government, Mahikeng, South Africa.

Rautenbach IL. 1978. Ecological distribution of the mammals of the Transvaal (Vertebrata: Mammalia). Annals of the Transvaal Museum **31**:131–156.

Skinner JD, Chimimba CT. 2005. The Mammals of the Southern African Subregion. Third edition. Cambridge University Press, Cambridge, UK.

Specker S. 2006. Determining the effects of fire on *Mystromys albicaudatus* within the Blaauwberg Conservation Area. Cape Peninsula University of Technology, Cape Town, South Africa.

Taylor PJ. 1998. The smaller mammals of KwaZulu-Natal. University of Natal Press, Pietermaritzburg, South Africa.

van Jaarsveld AS, Chown SL. 2001. Climate change and its impacts in South Africa. Trends in Ecology & Evolution **16**:13–14.

Vermeulen I. 2005. Determining the abundance, habitat preference and distribution of *Mystromys albicaudatus* within the Blaauwberg Conservation Area. Cape Peninsula University of Technology, Cape Town, South Africa.

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