Myosorex varius – Forest Shrew

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Regional Red List status (2016)	**Least Concern*†**
National Red List status (2004)	Data Deficient
Reasons for change	Non-genuine change
Global Red List status (2008)	Least Concern
TOPS listing (NEMBA)	None
CITES listing	None
Endemic	Yes

*Watch-list Data †Watch-list Threat

Despite the presumed generalist nature of the species, molecular research suggests the influence of rainfall regime and landscape heterogeneity on the genetic structuring of *M. varius* populations, with two predominant evolutionary lineages: northern, comprising grassland and savannah biomes, and southern, comprising the fynbos biome of the Cape Floristic Region (Willows-Munro & Matthee 2011).

Taxonomy

Myosorex varius (Smuts 1832)

ANIMALIA - CHORDATA - MAMMALIA - EULIPOTYPHLA - SORICIDAE - *Myosorex* - *varius*

Common names: Forest Shrew (English), Bosskeerbek, Bos-skeerbekmuis (Afrikaans)

Taxonomic status: Species complex

Taxonomic notes: Significant variation in size is found across its range (Meester et al. 1986). Corroborating this, a recent molecular study by Willows-Munro and Matthee (2011) detected several geographically correlated lineages within the species: A northern lineage, comprising individuals collected from the grassland and savannah habitats of Limpopo, Mpumalanga, Gauteng, Free State, KwaZulu-Natal and the Eastern Cape; and a southern lineage, comprising individuals collected from the Western and Eastern Cape provinces of South Africa, where there is genetic structuring between the western and eastern areas of the Cape Floristic Region. Lack of gene flow between these two lineages suggests that they could represent distinct species, but additional morphological data is needed to confirm this and it is the topic of an on-going study. Thus, the Forest Shrew may comprise a species complex of several species responding to differing rainfall conditions and landscape heterogeneity.

Assessment Rationale

This endemic species is listed as Least Concern as it has a very wide range within the assessment region, occurring in diverse habitats and many protected areas, and can exist in both intact and agricultural landscapes. It is threatened by ongoing habitat loss and degradation, caused primarily by coastal development, human settlement expansion, forest clear-cutting for agriculture and overgrazing from livestock farming. Although ongoing habitat loss may cause local declines, this is not expected to cause a net population decline for this widespread species in the near future. However, recent molecular work suggests distinct evolutionary lineages corresponding to the Grassland/Savannah and Fynbos biomes, and further molecular and morphological research is needed to resolve the potential species status. Furthermore, recent climate modelling work predicts an ambiguous response to climate change (depending on dispersal capacity), with area of occupancy ranging from a decline of 63–66% by 2050 (from 1975). However, the occupancy of the northern lineage is projected to decline by 23–43% and should be reassessed following taxonomic resolution. The range of the species overall is predicted to shrink in the interior and move towards the coast. However, coastal landscapes are increasingly fragmented by ongoing urban, rural and industrial expansion (for example, urban and rural settlements have expanded by 1.1–8% between 2000 and 2013), which thus represents an outright loss of habitat rather than a range shift. If this species is split into two species pertaining to Grassland/Fynbos evolutionary lineages, it will necessitate reassessment as both (especially the northern lineage) may be threatened by high levels of habitat loss within the contracted ranges.

Key interventions include the protection of forest habitats, and the creation of corridors between patches to facilitate gene flow and allow adaptation to climate change, as well as the enforcement of regulations restricting disturbance to protected forests.

Distribution

Forest Shrews are endemic to the assessment region, occurring widely across Lesotho, Swaziland and all provinces in South Africa (Table 1, Figure 1). They occur throughout montane grassland and fynbos habitats in South Africa, including savannah and the Highveld-bushveld transition zone (Power 2014), but not in dry areas. It is thought to be a generalist species better able to

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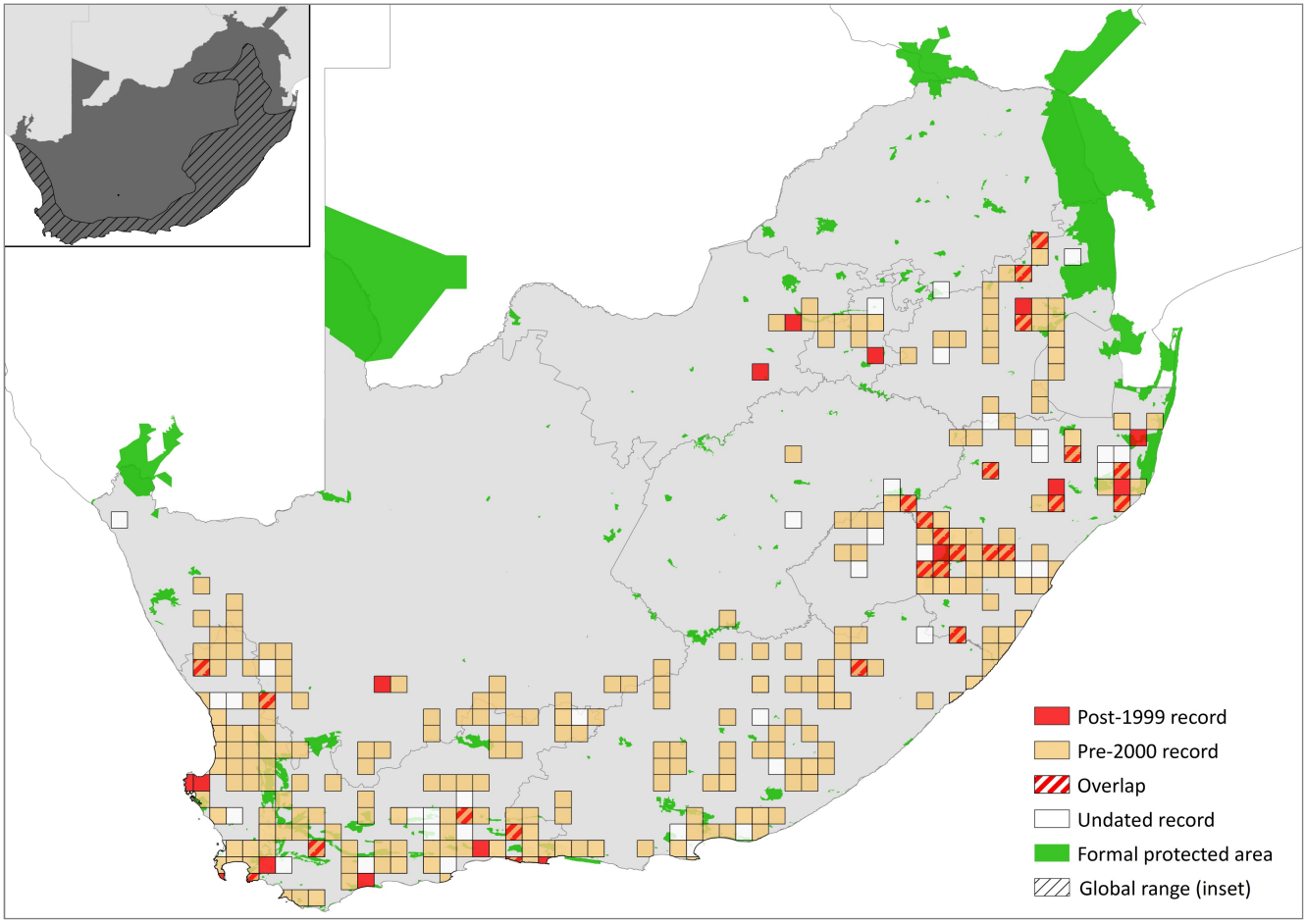

Figure 1. Distribution records for Forest Shrew (*Myosorex varius*) within the assessment region

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	Extant	Native
Zimbabwe	Absent	-

exist in transformed or agricultural landscapes and better able to tolerate marginal habitats than other *Myosorex* species (Meester 1958; Skinner & Chimimba 2005), which has enabled them to occupy both the drier fynbos regions of the Western Cape Province and the grasslands of the South African interior. However, although it has been recorded in a number of grassland, forest, savanna, semi-arid and fynbos habitats, it is typically found only in cool, moist microhabitats such as river banks or high-mist areas on the west coast of South Africa (Baxter & Dippenaar 2013). It is sympatric with all other *Myosorex* species. Recently, Taylor et al. (2013) established that *M. varius* does not occur in Limpopo Province, where it is replaced by *M.* cf. *tenuis*. Further vetting of museum records pertaining to *M. varius* in this province will be necessary.

The northern lineage is distributed across the grassland and savannah biomes, from Mpumalanga to Eastern Cape provinces, while the distribution of the southern lineage broadly follows the Cape Fold Mountains of the Western Cape Province (Willows-Munro & Matthee 2011). The contact zone between the two lineages occurs within the Albany thicket region along the Eastern Cape coast, around Port Elizabeth, which corresponds to the meeting point of five biomes (Willows-Munro & Matthee 2011).

Population

In some areas this species can be the dominant small mammal at higher elevations, with abundance dropping off towards the coast. For example, trapping data along an elevational gradient in the Eastern Cape revealed a linear increase in relative abundance (frequency of occurrence in traps) from around 2% at 600 m, 3–8% at 1,500 m to 6–12% at 1,800 m (Baxter & Dippenaar 2013). Similarly, they were found to be significantly less abundant than *M. sclateri* in the lowland Dukuduku Forest of KwaZulu-Natal Province (Perrin & Bodbijl 2001). At Seekoeivlei Nature Reserve in Free State Province, it was the third most abundant small mammal sampled, constituting 22% of samples after *Crocidura mariquensis* (41%) and *Rhabdomys pumilio* (28%) (Wandrag et al. 2002).

It is an adaptable species, able to adjust reproductive cycles to suit environmental conditions (Baxter 2005). As such, it is thought to be a generalist and thus less affected by habitat fragmentation, which is supported by the lack of population structure in the northern lineage (Willows-Munro & Matthee 2011). However, the varying rainfall regimes and landscape heterogeneity have been shown to correspond to distinct evolutionary lineages (Willows-Munro & Matthee 2011), and, if split into multiple species, the assumption of its generalist nature should be refined.

This may particularly be true for the southern lineage where population structure is apparent between eastern and western populations and which may feel the brunt of fragmentation as suitable habitats shift towards the transformed coast.

Current population trend: Declining. Inferred and projected from ongoing habitat loss and degredation.

Continuing decline in mature individuals: Unknown

Number of mature individuals in population: Unknown

Number of mature individuals in largest subpopulation: Unknown

Number of subpopulations: Unknown

Severely fragmented: No. Thought to be a generalist species that is less affected by habitat fragmentation. However, the southern lineage may be more susceptible to the fragmenting effects of climate change as suitable habitats shift towards the coast.

Habitats and Ecology

Forest Shrews occur in every biome in South Africa including coastal forests, thickets, grasslands, savannah, Nama Karoo, Succulent Karoo and Fynbos. As such, its name is somewhat a misnomer as it is not restricted to forests (Skinner & Chimimba 2005). It is present in both primary habitats and degraded areas. For example, it was recently sampled in grasslands (wet and dry), Kikuyu (*Pennisetum clandestinum*) pastures and disturbed grasslands in Umvoti Vlei Conservancy, Kwazulu-Natal Province (Fuller & Perrin 2001). However, it prefers dense moist grasslands (Rautenbach 1982; Rowe-Rowe & Meester 1982; Taylor 1998; Baxter & Dippenaar 2013), commonly along the banks of rivers or dams. They have also been collected from Afromontane forest habitats, such as in the Drakensberg (Rowe-Rowe & Meester 1982). It occurs in coastal mountains of the Eastern, Northern and Western Cape provinces. It is also associated with rocky, high-altitude grassland slopes, occurring at higher altitudes than any other shrew species within the assessment region, from 1,500–2,200 m asl (Rowe-Rowe & Meester 1982, 1985; Lynch 1994). In Dukuduku Forest, KwaZulu-Natal Province, they occurred only in dwarf shrubland (Perrin & Bodbijl 2001).

Captive animals are predominantly nocturnal (Baxter et al. 1979), although they may become predominantly diurnal during winter (Brown et al. 1997). When there is a pair in the nest, they sleep head to tail (Baxter & Meester 1980). They excavate shallow blind tunnels under rocks or other objects, or use existing burrows (such as those from Mole-rats). They feed predominantly on invertebrates but are also cannibalistic and feed on conspecific and rodent carcasses (Skinner & Chimimba 2005).

Ecosystem and cultural services: This species is an important prey item for the Barn Owl (*Tyto alba*), the Water Mongoose (*Atilax paludimosus*), the African Striped Weasel (*Poecilogale albimucha*) and the Striped Polecat (*Ictonyx striatus*).

Use and Trade

There is no known subsistence or commercial use of this species.

Threats

The main threat this species is the loss or degradation of moist, productive areas such as wetlands and rank grasslands. The two main drivers behind this are abstraction of surface water and draining of wetlands through industrial and residential expansion, and overgrazing of moist grasslands, which leads to the loss of ground cover and decreases small mammal diversity and abundance (Bowland & Perrin 1989). Suppression of natural ecosystem processes, such as fire, can also lead to habitat degradation through bush encroachment or loss of plant diversity through alien invasives, and is suspected to be increasing with human settlement expansion. There are also clear overlaps and synergistic effects between these threats. Shrews have a high metabolic rate and thus rely on highly productive and complex environments, where small mammal diversity is highest (Bowland & Perrin 1993). Wetlands are the most threatened ecosystem within the assessment region: 65% of wetland ecosystem types are threatened (48% Critically Endangered, 12% Endangered and 5% Vulnerable; Driver et al. 2012). Overall, 45% of our remaining wetland area exists in a heavily modified condition, due primarily to onsite modification from crop cultivation, coal mining, urban development, dam construction, and overgrazing (and thus erosion) and off-site modifications from disruptions to flow regime and deterioration of water quality (Driver et al. 2012).

Climate change is considered to be the principal emerging threat to this species (Ogony 2014), both due to loss of habitat and habitat degradation from drying out of wetlands and because shrews cannot tolerate extremes of temperature for long and thus their foraging time will be reduced. Due to their small size, low dispersal capacity, high metabolism, short life span and sensitivity to temperature extremes, climate change will reduce the amount of suitable habitat available. This is particularly true for the southern lineage that occupies Afromontane grasslands as these areas are likely to become increasingly fragmented.

Current habitat trend: Climate modelling predicts an ambiguous response to climate change (depending on dispersal capacity), with area of occupancy ranging from a decline of 66% to an increase of 36% by between 1975 and 2050 (Taylor et al. 2016). However, the projected increase is an unlikely scenario due to under-prediction of the model because the species comprises both a northern and southern lineage. Indeed, when the two lineages are modelled separately, model fit is much improved and reveals that the northern (grassland) lineage is more threatened, as it is projected to decline by 23–43%, while the southern (fynbos) lineage shows a mixed response ranging from a decline of 33% to an increase in occupancy.

Predictions show a range shift from high-altitude grasslands towards the coast, but the coast is highly developed and will not result in an occupancy substitution. For example, urban areas have expanded at rates of 5.6–8.6% in KwaZulu-Natal, Eastern and Western Cape provinces between 2000 and 2013 (GeoTerraImage 2015). Thus, unfettered urban expansion, especially coastal development, is likely to synergise with climate change in being the major threat to this species.

Table 2. Threats to the Forest Shrew (*Myosorex varius*) ranked in order of severity with corresponding evidence (based on IUCN threat categories, with regional context)

Rank	Threat description	Evidence in the scientific	Data quality	Scale of study	Current trend
1	*11.1 Habitat Shifting & Alteration*: most microhabitats lost from loss of Afromontane forest cover.	Taylor et al. 2016	Simulation	National	Increasing: a potential reduction in area of occupancy by 2050, especially for the northern lineage.
2	*1.1 Housing & Urban Areas*: forest habitat lost to residential and commercial development. Current stress *1.3 Indirect Ecosystem Effects*: fragmentation and isolation of remaining forest patches with limited dispersal between.	GeoTerraImage 2015	Indirect (land cover change from remote sensing)	Regional	Continuing. Area of urban expansion has increased by 5.6-8.6% between 2000 and 2013 respectively.
3	*7.2 Water Management/Use*: wetland loss through drainage / water abstraction during agricultural, industrial and urban expansion.	Driver et al. 2012	Indirect (land cover change from remote sensing)	National	65% of wetland ecosystem types threatened.
4	*2.3.2 Small-holder Grazing, Ranching or Farming*: wetland and grassland degradation through overgrazing (removal of ground cover).	Bowland & Perrin 1989	Empirical	Local	Possibly increasing with human settlement expansion and intensification of wildlife farming.
		Driver et al. 2012	Indirect	National	45% of remaining wetland area exists in a heavily modified condition.
5	*7.1.2 Suppression in Fire Frequency/Intensity*: human expansion around forests has decreased natural fire frequency. Current stress *1.2 Ecosystem Degradation*: altered fire regime leading to bush encroachment (including alien vegetation invasion) and thus loss of moist grasslands.	-	Anecdotal	-	-

Conservation

The main intervention for this species is the protection and restoration of wetlands and grasslands within and around forest patches. Protected area expansion should attempt to create corridors between high-altitude and coastal habitats. Biodiversity stewardship schemes should be promoted if landowners possess wetlands or grasslands close to core protected areas or remaining forest patches, and the effects on small mammal subpopulations should be monitored. Protecting such habitats may create dispersal corridors between forest patches that will enable adaptation to climate change.

All forests in South Africa are protected by law, although the degree to which they are enforced may vary. Legislation should be enforced to prevent development or human encroachment in key habitats, which includes increased enforcement of forest-related transgressions to minimise disturbance to existing forest patches, as well as stricter zonation on development to decrease fragmentation of remaining forests.

At the local scale, landowners and managers should be educated, encouraged and incentivised to conserve the habitats on which shrews and small mammals depend. Retaining ground cover is the most important management tool to increase small mammal diversity and abundance. This can be achieved through lowering grazing pressure (Bowland & Perrin 1989), or by maintaining a buffer strip of natural vegetation around wetlands (Driver et al. 2012). Research will be needed to set the recommended length of the buffer strip in various habitats, but 500 m may provide a good indication of ecological integrity (Driver et al. 2012). Small mammal diversity and abundance is also higher in more complex or heterogeneous landscapes, where periodic burning is an important tool to achieve this (Bowland & Perrin 1993). Similarly, the specific fire regime thresholds should be calibrated by research. Removing alien vegetation from watersheds, watercourses and wetlands is also an important intervention to improve flow and water quality, and thus habitat quality, for shrews. This can be achieved through the Working for Water programme (for example, Marais et al. 2004). However, the subsequent effects on shrew subpopulations must be monitored to demonstrate success (sensu Richardson & van Wilgen 2004). Education and awareness campaigns should be employed to teach landowners and local communities about the importance of conserving wetlands and moist grasslands.

Recommendations for land managers and practitioners:

- Enforce regulations on developments that potentially impact on the habitat integrity of forests.
- Landowners should be incentivised to stock livestock or wildlife at ecological carrying capacity and to maintain a buffer of natural vegetation around wetlands.

Research priorities:

- Molecular and morphological studies to resolve the taxonomic resolution of the two putative evolutionary lineages.

Table 3. Conservation interventions for the Forest Shrew (*Myosorex varius*) 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 to connect high-altitude and coastal habitats thus allowing adaptation to climate change range shifts.	-	Anecdotal	-	-	-
2	*1.2 Resource & Habitat Protection*: stewardship agreements with private landowners to conserve wetlands and grasslands.	-	Anecdotal	-	-	-
3	*5.4 Compliance & Enforcement*: minimising disturbance to core forest patches by enforcing compliance with forest protection laws, and preventing illegal development.	-	Anecdotal	-	-	-
4	*2.2 Invasive/Problematic Species Control*: maintain stocking rates of livestock and wildlife at ecological carrying capacity.	Bowland & Perrin 1989	Empirical	Local	Small mammal diversity and abundance significantly higher after decrease in grazing pressure.	-
5	*2.1 Site/Area Management*: maintain / restore natural vegetation around wetlands.	-	Anecdotal	-	-	-
6	*2.2 Invasive/Problematic Species Control*: clear alien vegetation from watersheds and wetlands to restore habitat quality.	-	Anecdotal	-	-	Working for Water, Department of Environmental Affairs
7	*4.3 Awareness & Communications*: educating landowners in the importance of wetlands and grasslands.	-	Anecdotal	-	-	-

- Research should be conducted to determine disturbance thresholds in various habitats (for example, ecological stocking rates, amount of natural vegetation needed to sustain a viable subpopulation, and fire intensity and frequency needed to sustain habitat complexity) needed by managers to conserve shrew species.

Encouraged citizen actions:

- Citizens are requested to submit any shrews killed by cats or drowned in pools to a museum or a provincial conservation authority for identification, thereby enhancing our knowledge of shrew distribution (carcasses can be placed in a ziplock bag and frozen with the locality recorded).

Data Sources and Quality

Table 4. Information and interpretation qualifiers for the Forest Shrew (*Myosorex varius*) assessment

Data sources	Museum records, field study (literature, unpublished), indirect information (literature, unpublished)
Data quality (max)	Inferred
Data quality (min)	Suspected
Uncertainty resolution	Consensus
Risk tolerance	Evidentiary

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