UNIVERSIDADE DE LISBOA
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Terrestrial mammals of Mozambique: current knowledge and future challenges for conservation

"Documento Definitivo"

Doutoramento em Biologia e Ecologia das Alterações Globais
Especialidade em Biologia e Ecologia Tropical

Isabel Maria Queirós das Neves

Tese orientada por:
Doutora Cristiane Bastos-Silveira
Professora Doutora Maria da Luz Mathias

Documento especialmente elaborado para a obtenção do grau de doutor

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Oh, as belas terras do meu áfrico país
e os belos animais astutos
ágeis e fortes dos matos do meu país
e os belos rios e os belos lagos e os belos peixes
e as belas aves dos céus do meu país
e todos os nomes que eu amo belos na língua ronga
macua, suaíli, changana, xítsua e bitonga
dos negros de Camunguine, Zavala, Meponda, Chissibuca
Zongoene, Ribáuè e Mossuril.
— Quissimajulo! Quissimajulo! Gritam as bocas autênticas no hausto da terra

José Craveirinha, "Hino à minha terra", 1974

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Abstract

Nations must know on what and where to conserve, as required by Convention on Biological Diversity. Only by knowing where we should trust our knowledge of species occurrence, we will be able to make accurate decisions and efficiently allocate the limited resources for improving quality and coverage of species occurrence and distribution and safeguarding biodiversity.

Existing knowledge about the biodiversity of Mozambique is scarce across most taxonomic groups. Long periods of armed conflict seriously affected wildlife and scientific research, contributing to this lack of knowledge. This doctoral thesis aimed to compile and map current knowledge about the occurrence of terrestrial mammal fauna in Mozambique, to discuss the challenges for biodiversity conservation in the country. To meet these objectives, an inventory on terrestrial mammal presence was compiling integrating primary species-occurrence data from 1) the GBIF portal; 2) natural history collections; 3) recent survey reports, and 4) scientific literature.

The first part of this thesis focuses on the update of the list of terrestrial mammal species reported for the country. The second part investigates the data bias and gaps in knowledge regarding the distribution of terrestrial mammals in Mozambique, providing priority areas for future surveys. The third part offers a first assessment on the effectiveness of Mozambique's conservation areas to protect the lesser-known taxa given global change and further suggests priority areas for conservation. As a final contribution of this research, we discuss the contribution of different data sources to the inventory and the importance of digitization and mobilization of biodiversity data in poorly studied countries.

Overall, the study developed in this thesis is an important starting point and a valuable resource for understanding the occurrence and distribution of terrestrial mammals in Mozam-

bique, contributing with a dataset now acessible for researchers and decision-makers.

Keywords

Africa; Mammalia; Knowledge gap; Digitisation; Natural history collections; Primary species-occurrence data; Data quality; Conservation areas

Resumo

A Convenção para a Diversidade Biológica requer que os países signatários reconheçam quais os componentes da biodiversidade que são importantes para a conservação e uso sustentável das espécies nos seus territórios. A tomada de decisões adequadas para proteção da biodiversidade, em particular na alocação eficiente dos recursos disponíveis, muitas vezes limitados, implica a mobilização de informação sobre a ocorrência das espécies e a sua distribuição. A falta de conhecimento sobre os diferentes componentes da diversidade de espécies num determinado local representa, portanto, uma barreira para a avaliação do estado de conservação e determinação de prioridades para a conservação e gestão ambientais.

A nível global, a conservação da biodiversidade depende, em grande parte, de uma gestão correta e planeada nas regiões do mundo com maior riqueza de espécies uma vez que são as que mais contribuem para alcançar esse objetivo geral. Geralmente, estas regiões são também as que têm menos documentação relativa à sua biodiversidade. Este é o caso da República de Moçambique, um país localizado na costa este de África, com grande diversidade de ecossistemas e habitats que se traduz numa alta riqueza de espécies de animais e plantas. O conhecimento existente e disponível sobre a biodiversidade deste país é referido como insuficiente para a maioria dos grupos taxonómicos.

Esta tese de doutoramento teve como objetivos a compilação e o mapeamento do conhecimento atual sobre a ocorrência da fauna de mamíferos terrestres em Moçambique, com o fim de contribuir para a conservação da biodiversidade no país, tanto a médio como a longo prazo. Para atingir estes objetivos, foi feita a integração da informação de várias fontes, digitais e não-digitais, de dados primários de ocorrência destas espécies. Estes dados foram obtidos a partir de: i) portal Global Biodiversity Information Facility (GBIF); ii) coleções de história natural; iii) relatórios recentes de monitorização da fauna; e iv) literatura científica. Foram compilados mais de 17000 registos de presença de espécies. Para a construção do inventário das espécies de mamíferos de Moçambique, estes dados assim obtidos foram sujeitos a processos de melhoria de qualidade, nomeadamente através de "limpeza de dados" e eliminação de erros, a sua georreferenciação e atualização taxonómica.

Na primeira parte deste estudo (Capítulo 2) foi feita a atualização da lista de espécies de mamíferos terrestres reportadas para o país. Esta atualização das espécies que ocorrem no país é crucial para apoiar os esforços que as autoridades locais têm feito no que respeita ao estudo e à conservação da biodiversidade. De acordo com a nossa compilação, são 217 as espécies de

mamíferos que têm a ocorrência em Moçambique bem documentada, representando 14 ordens e 39 famílias. Este número representou um aumento de 37 espécies reportadas para o país, quando comparado com o da última sinopse publicada por Reay H. N. Smithers e José Lobão Tello em 1976 para os mamíferos de Moçambique. No entanto, cerca de um terço das 217 espécies com ocorrência em Moçambique, tem menos de dez registos de presença no país e para cerca de um quarto não foram encontrados dados de presença recentes. Para este estudo foi desenhado um sistema metodológico que permitiu distinguir as espécies com ocorrências bem documentadas das espécies cuja presença no país é questionável. Assim, foi ainda compilada uma lista com as espécies de ocorrência não confirmada no país, composta por 23 espécies pertencentes a seis ordens diferentes. Embora tenham sido parcialmente suplantadas com este trabalho as lacunas historicamente identificadas no conhecimento da biodiversidade de Moçambique, tais como a falta de registos da região norte ou o baixo número de registos de pequenos mamíferos, foi mostrado que o número atual de espécies de mamíferos reportado para Moçambique continua subestimado.

Na segunda parte desta tese (Capítulo 3) foi estudado o enviesamento dos dados e as lacunas de conhecimento relativos à distribuição dos mamíferos terrestres de Moçambique. A avaliação das lacunas de conhecimento com base na distribuição dos dados primários de ocorrência de espécies pode ser uma estratégia valiosa e expedita para identificar e selecionar áreas para futuros levantamentos de biodiversidade. Para países com menos informação sobre a ocorrência de espécies e onde a falta de recursos para conservação é mais acentuada, o uso de dados primários de biodiversidade pode ser particularmente benéfico. Assim, neste capítulo, foram avaliadas e mapeadas as lacunas de conhecimento em relação à ocorrência de espécies de mamíferos terrestres, identificando áreas geográfica e ecologicamente diferentes. Ao comparar as lacunas baseadas apenas no conjunto de dados de ocorrência colhidos antes do ano 2000 ("antigos") com as lacunas baseadas no conjunto de os dados colhidos recentemente, identificaram-se: (i) lacunas de conhecimento ao longo do tempo, (ii) áreas com pouco conhecimento recente e (iii) áreas com potencial para estudos espácio-temporais. Os resultados mostraram que a fauna de mamíferos de Moçambique está apenas bem documentada em aproximadamente 5% do território, com amplas áreas do país pouco ou nada amostradas. As áreas de lacuna de conhecimento estão principalmente associadas a duas eco-regiões: bosques de miombo orientais e mosaico florestal costeiro de Zanzibar-Inhambane meridional. Para além disso, as províncias menos documentadas relativamente à sua diversidade de mamíferos coincidem com as áreas sobre-exploradas para recursos naturais, havendo por isso o risco de muitos desses locais nunca virem a ser documentados. É nosso entendimento que, ao priorizar, para futuros levantamentos de biodiversidade, as áreas com lacunas de conhecimento, se contribuirá com novos registos e espécies para o país, completando assim de forma eficaz o mapeamento da sua biodiversidade. Por outro lado, a continuação do estudo das regiões conhecidas garantirá o seu uso potencial para estudos espácio-temporais. A abordagem implementada para avaliar as lacunas de conhecimento dos dados primários de ocorrência de espécies provou ser uma

ferramenta útil para gerar informações essenciais para um plano de gestão e conservação de espécies.

A terceira parte desta tese (Capítulo 4) fornece uma primeira avaliação da eficácia das áreas de conservação de Moçambique na proteção dos mamíferos de pequeno porte, a grande maioria com distribuição pouco documentada, considerando as condições climáticas atuais e futuras e a pressão humana. Não se sabe até que ponto os mamíferos deste grupo estão protegidos na rede das áreas de conservação do país, uma vez que grande parte das reservas de vida selvagem foram inicialmente estabelecidas para a proteção da megafauna, resultando numa rede de conservação que cobre as regiões com grande riqueza de mamíferos de grande porte. O aumento da representatividade na biodiversidade protegida é uma das principais preocupações na seleção de áreas para a conservação, tornando-se por isso necessário perceber se a rede de conservação existente fornece a proteção adequada aos mamíferos de pequeno porte. Esta avaliação foi construída com base em previsões de riqueza de espécies e áreas de distribuição potenciais para 122 mamíferos com menos de 5 kg, pertencentes a oito ordens taxonómicas, usando técnicas de modelação do nicho das espécies. Os resultados demonstraram que a atual rede de áreas de conservação não garante a conservação da diversidade de mamíferos como um todo, uma vez que mais de 80% dos mamíferos de pequeno porte não estão suficientemente protegidos. Para garantir a preservação dos mamíferos no futuro, sugerimos novas zonas de conservação prioritárias, caracterizadas por alta riqueza e raridade de espécies, com baixa pressão humana e pouco impacto com as mudanças climáticas.

Como contribuição final deste estudo, discute-se no último capítulo a contribuição das diferentes fontes de dados para o inventário final das espécies de mamíferos terrestres e a importância da digitalização e da disponibilização de dados de biodiversidade em países com menos informação disponível.

O estudo desenvolvido nesta tese pretende ser um importante ponto de partida e um recurso válido para a compreensão da ocorrência e distribuição dos mamíferos terrestres em Moçambique, disponibilizando toda a informação obtida num "dataset" agora acessível a investigadores e decisores políticos.

Palavras Chave

África; Mamíferos; lacunas de conhecimento; Digitalização; Coleções de história natural; Dados primários de ocorrência de espécies; Qualidade dos dados; Áreas de conservação

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CHAPTER 1

General introduction

It is widely known that biodiversity is in crisis, with significant impacts on the well-being of both natural systems and human societies (Davis et al., 2018; Johnson et al., 2017; Pimm et al., 2014; Sarukhán et al., 2005). Biodiversity-related information is vital to assess the status of biodiversity, identify threats and determine priorities for the sustainable use of natural resources. Understanding biodiversity patterns and processes is crucial to assist conservation planning and to achieve, an effective network of protected areas (Margules and Pressey, 2000). Taking this into account, and because the lack of information on species and populations presents a significant barrier to successful policy development and implementation, the Convention for Biological Diversity (CBD), requires its signatory states to establish, by 2020, baseline information regarding their biodiversity, such as species distributions and threats[1].

Many areas of the world remain poorly-known for most taxa. The lack of reliable and accessible knowledge on species occurrence is particularly acute across the southern hemisphere (Boitani et al., 2011; Cayuela et al., 2009; Meyer et al., 2015; Verde Arregoitia, 2016). These information-poor regions are, more often than not, the species-rich regions of the world, whose management would contribute the most to secure the overall conservation of global biodiversity (Peterson et al., 2015).

The Republic of Mozambique is a species-rich yet still poorly known country. For most taxonomic groups, knowledge on the country's biodiversity is highly incomplete, and species distribution data is scarce (Conradie et al., 2016; Monadjem et al., 2010, e.g.).

Due to its geographic position, at the sub-equatorial and tropical zone of the South Hemisphere and east coast of southern Africa, Mozambique supports diverse landscape apprising coastal plains, grassland plateaus, woodlands and mountains, harbouring highly diverse fauna and flora (Figure 1.1). The country's terrestrial ecosystems are estimated to shelter more than 4.200 species of animals, with more than 3000 species of insects, and over 1000 vertebrates (MITADER, 2015).

Mozambique has experienced a turbulent history: from the disruption of socio-political systems, long war periods (Hatton et al., 2001) and rapid economic adjustment (Bocchino, 2008), to

[1] CBD's Target 19: By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.

exposure to weather extremes (Sietz et al., 2011), all of which with significant repercussions in the knowledge and status of its biodiversity. The country's pacification process, in 1992, along with an on-going recognition that biodiversity is a vital pillar for the country's development, is creating the appropriate setting for the reinforcement of scientific research and biodiversity monitoring.

However, information regarding the occurrence and distributions of the country's biota remains scarce and scattered (Conradie et al., 2016; Dalquest, 1965; Monadjem et al., 2010; Smithers and Tello, 1976, e.g.). The need for integrated and detailed accounts on the different taxonomic groups became evident in the past two decades. Recent national reports on biodiversity state that the limited awareness and knowledge on the country's biodiversity are hampering conservation planning and management; and also that conservation measures are not science-based or have not been thoroughly documented (MICOA, 2014; MITADER, 2015).

The country's political situation, cultural diversity and, more recently, the commitments to international policies have been determining biodiversity conservation actions and management. Also, biodiversity plays a crucial role in the sustenance of most of the Mozambican population, since 90% of the rural energy comes from wood and charcoal, and more than 80% of the population uses the goods and services offered by biodiversity for their survival, which is a further challenge for the preservation of biodiversity (MITADER, 2015). Hence, to understand the current status of Mozambique's biodiversity and knowledge, it is essential to consider its biogeography, as well as its socio-economic and political setting.

1.1 Mozambique: an overview

1.1.1 The environmental context

Geomorphology and landscape

Mozambique holds a vast territory of more than 800,000 square kilometres and shares borders with six countries: Tanzania, Malawi, Zambia, Zimbabwe, Swaziland, and South Africa. The country is admnistratively divided into 11 provinces – Niassa, Cabo Delgado, Nampula, Zambezia, Tete, Manica, Sofala, Inhambane, Gaza, Maputo and Maputo city Figure 1.1. Its coastline along the Indian Ocean is one of the longest African coastlines, approximately 2,600 km (INE, 2018).

Figure 1.1: Map of Mozambique with the indication of provinces and neighbour countries. Inset shows Mozambique's geographic location in Africa.

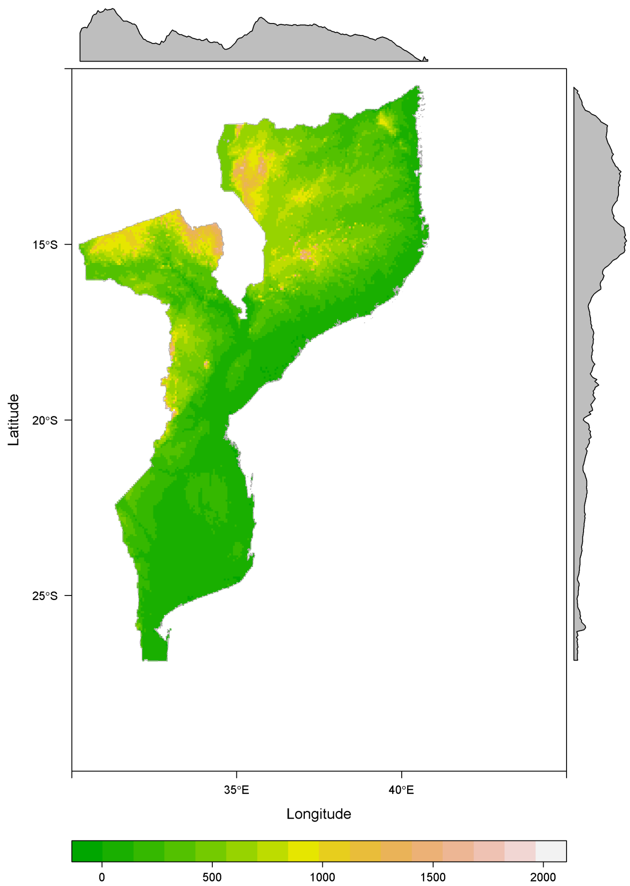

Figure 1.2: The topography of Mozambique, where the altitude is expressed in meters (m).

A large part of the country's topography is characterised by flat terrain (44%), extending from coastal plains, in the east, to mountain ranges, in the west, presenting a diverse landscape including coastal plains, savannah, woodlands and forests. The general topography of Mozambique is illustrated in Figure 1.2. Briefly, lowlands (0-200 meters) cover the provinces of Cabo Delgado, Nampula and Inhambane. Extensive plateaux, characterised by altitudes ranging between 200-600 meters, spread to the provinces of Manica and Sofala. Certain plateau zones reach up to even higher altitudes of around 1,000 meters and then evolve into mountainous regions. The highest points in the country are the mount Binga, in Manica province (2,436 meters), the foothills of Namuli, in the Zambézia province (2,419 meters) and the Serra Zuira, also in Manica province (2,277 meters) (INE, 2018).

From north to south, the main river basins that drain the country are Rovuma, Messalo, Montepuez, Lúrio, Monapo, Ligonha, Licungo, Zambeze, Púnguè, Búzi, Save, Govuro, Inharime, Limpopo, Incomáti, Umbelúzi, Tembe e Maputo (Figure 1.3). Many rivers flow from west to east into the ocean, with the Zambezi and Rovuma being the two largest. The Zambezi river is,

for its hydrological characteristics, the largest and the most important river that flows across the Mozambican territory. With approximately 2600 km of length, it is one of the longest rivers of the world, and the fourth largest river system in Africa (Moore et al., 2007). The Zambezi river flows into a vast delta – Zambezi River Delta – which covers approximately 7000 km2, with significant environmental importance as it holds one of the most extensive mangrove forests in eastern Africa (Shapiro et al., 2015).

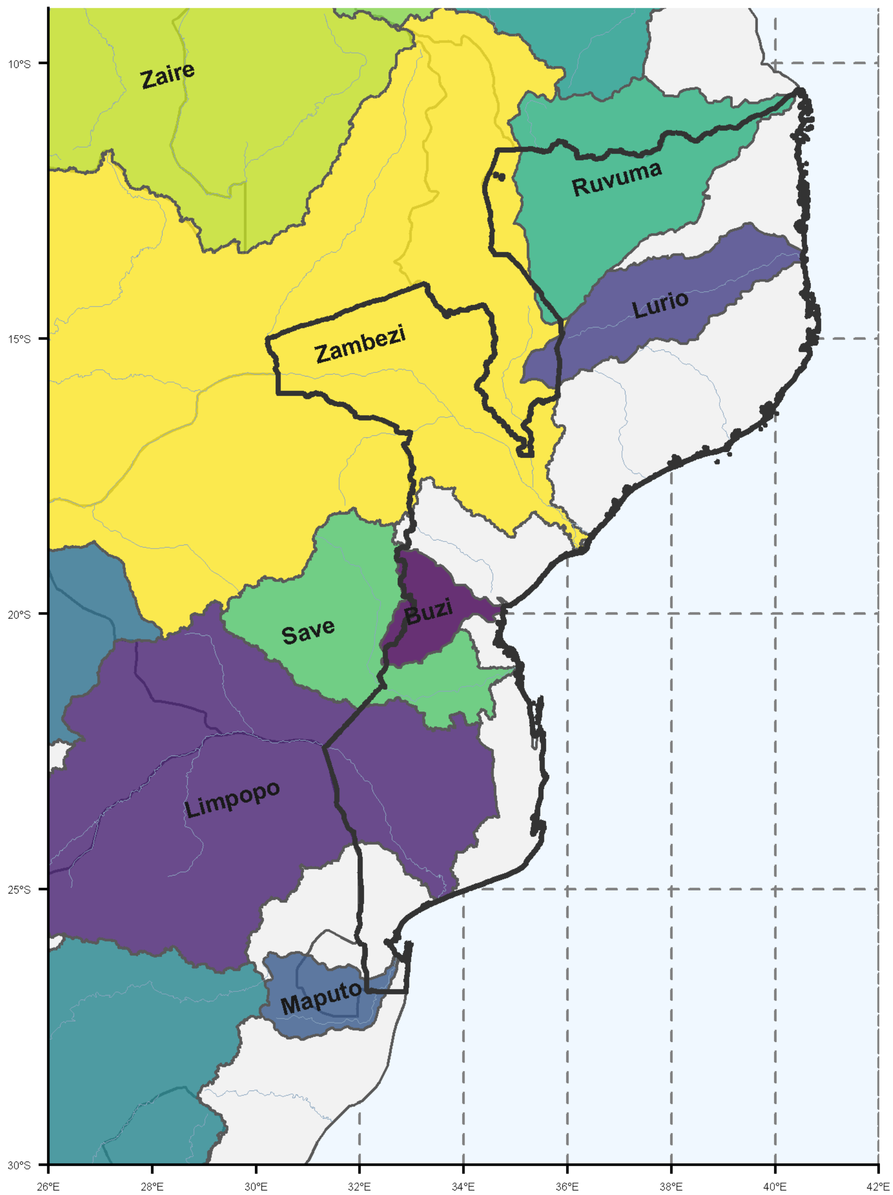

Figure 1.3: Main river basins of Mozambique.

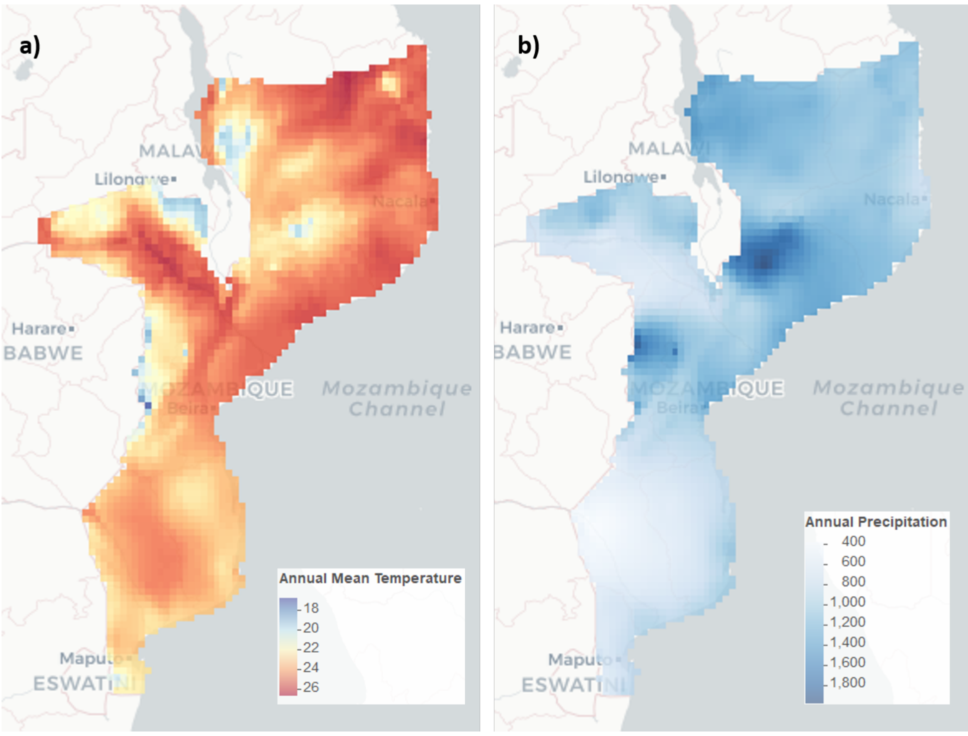

Figure 1.4: Climate of Mozambique: a) Annual mean temperatures (ºC), and b) Annual precipitation (mm) (after Hijmans et al., 2016).

Climate and weather

Mozambique has a tropical and subtropical climate. Generally, two seasons can be identified: a wet and warmer period between October and March; and a dry and mild period from April to September. Temperature and precipitation, however, are highly variable throughout the country (Figure 1.4). Temperatures are warmer near to the coastal lowland regions, with average annual temperatures exceeding 25°C, compared with the inland mountainous regions, where average annual temperatures can fall below 20°C. Annual precipitation is highest along the coast and in the central mountains, where the mean annual total exceeds 1,800 mm, and lowest in the south-west, where it averages below 400 mm per year (McSweeney et al., 2010). Most of the annual precipitation in Mozambique (95%) occurs during the warmer season and is generally inferior to 1000 mm (Uele et al., 2017).

Biomes and ecoregions

The topographic and climatic conditions play a central role in the flow regime and water flow at the river basins, and three ecological regions are distinguished: (1) the region north of the Zambezi river, (2) the region between Zambezi river and Save river basins, and (3) the region south of the Save river.

Many natural ecosystems occur in Mozambique, from terrestrial ecosystems to coastal and marine, and interior waters ecosystems. Approximately 70% of the country' territory is covered by vegetation; and plant diversity is high, estimated in 6,000 species across the country, approximately (MITADER, 2015).

Five biomes represent the terrestrial ecosystems across Mozambique (Burgess et al., 2004), and these are subdivided into 13 ecoregions (Table 1.1). The biomes represented in the country are: (1) tropical and subtropical moist broadleaf forests; (2) tropical and subtropical savannas and woodlands; (3) montane grasslands (4) flooded grasslands and savannas; and (5) mangroves (Figure 1.5).

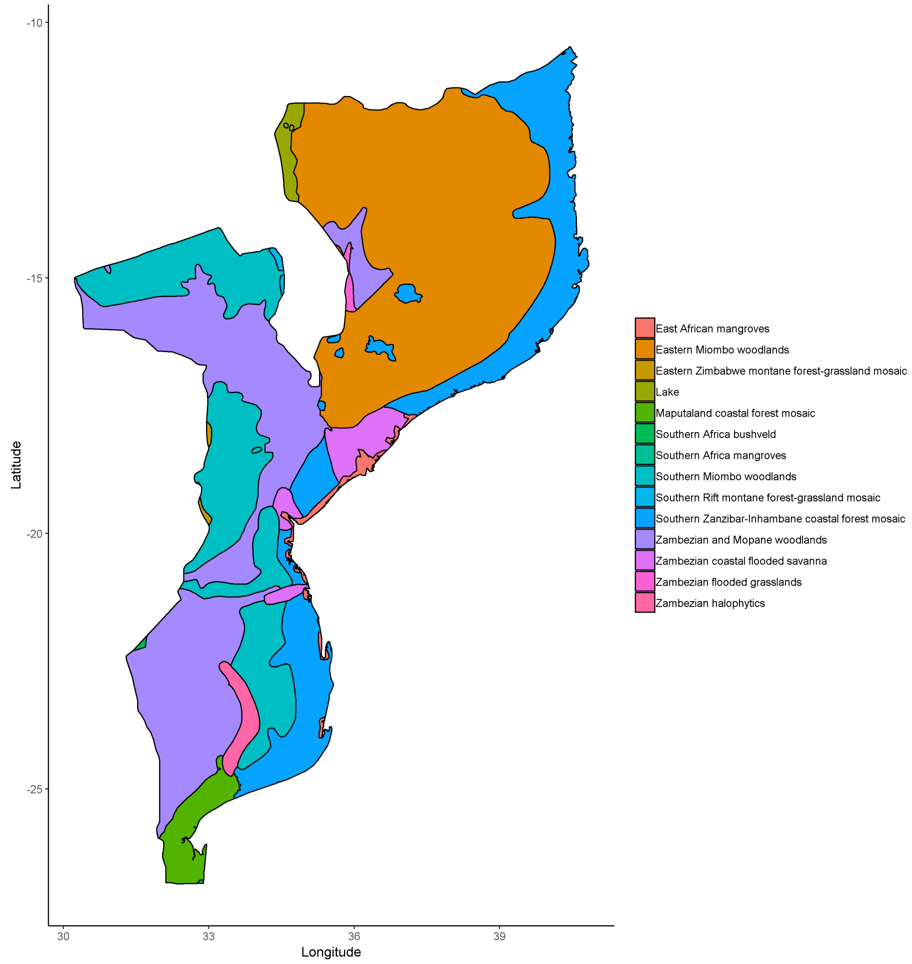

Figure 1.5: Ecoregions of Mozambique (after Burgess et al., 2004).

The tropical moist forests biome includes two ecoregions characterised by coastal forest mosaic, in the lowland coastal areas of Mozambique. These ecoregions support a wide range of ecosystems from coastal grasslands, to wetlands and forests; and are in a critical conservation status (Burgess et al., 2004). The tropical savanna-woodlands biome is represented mainly by miombo and mopane woodlands at mid-elevations in the western region of the country.

The montane grasslands biome is represented by two distinct ecoregions of montane forest-grassland mosaic across numerous chains of discontinuous mountains in the north and centre of Mozambique. The montane forest-grassland mosaics in southern Africa are particularly threatened due to acute deforestation actions and climate change (Grab and Knigth 2018). The flooded grasslands biome includes three ecoregions distributed along the Zambezi, the Pungué, the Buzi, and the Save rivers, and the Zambezi delta, central Mozambique. Last, the mangroves biome includes two ecoregions: one, along with the Zambezi delta and Limpopo, and another south of Maputo (Figure 1.5).

Table 1.1: African biomes and ecoregions represented in Mozambique, as well as their conservation status overall, as defined and assessed in Burgess et al. (2004)

Biome and its ecoregions	Conservation status
Tropical and subtropical moist broadleaf forests	
Southern Zanzibar-Inhambane coastal forest mosaic	Critical
Maputaland coastal forest mosaic	Critical
Tropical and subtropical grasslands, savannas, shrublands and woodlands	
Eastern miombo woodlands	Relatively stable
Southern miombo woodlands	Vulnerable
Zambezian and Mopane woodlands	Relatively stable
Southern Africa bushveld	Endangered
Montane grasslands and shrublands	
Southern-Rift montane forest-grassland mosaic	Endangered
Eastern Zimbabwe montane forest-grassland mosaic	Endangered
Flooded grasslands and savannas	
Zambezian flooded grasslands	Relatively stable
Zambezian coastal flooded savanna	Critical
Makgadikgadi halophytics	Relatively intact
Mangroves	
Southern Africa mangroves	Endangered
East Africa mangroves	Critical

1.1.2 The socio-political context

Political and socio-economic framing

Two long war periods mark the recent history of Mozambique: first, the war of national liberation from Portuguese rule[2] between 1964 and 1974, and shortly after, a civil war between 1978 and 1992. Only in 1994, after a long period of conflict and negotiation, did the first democratic multiparty election take place.

[2] Mozambique became a non-continental territory of the Portuguese State in 1933, following the Berlin conference. Before the establishment of the Portuguese, in the 15th century, the territory of present-day Mozambique consisted of a series of communities from different ethnicities.

The post-war democratic phase, after 1994, witnessed an impressive macroeconomic and social development progress when compared to other post-conflict countries. Mozambique experienced a high rate of economic growth, around 7%, from 1994 to 2015, which was mainly due to exports of a limited set of products from the energy and extractive sector (gas, coal, base metals, e.g.) (Weimer and Carrilho, 2016).

In the last decade, the country has presented high rates of economic growth. The gross domestic product (GDP), in 2017, was US $12,334 billion (The World Bank, 2018). Even though a slight reduction in poverty is documented, with more than 46% below the poverty line, Mozambique remains one of the poorest countries in the world (The World Bank, 2018). The ranking in the Human Development Index, which combines development indicators, such as life expectancy, years of schooling and per capita income, has remained persistently low, fluctuating in the bottom ten countries (UNDP, 2016). The country's high rates of economic growth, the documented reduction in poverty and the substantial investment in social services are yet to translate into meaningful changes in the country's rankings. Recently, the country faced a generalised socio-economic crisis; due to large-scale government loans that ended up raising the country's debt burden to levels above 80% of the GDP.

In the space of a decade, since the census in 2007, the human population increased by an average of over 4% a year. Also, the population growth rate has been accelerating in the last decades. Between 1997 and 2007, the population growth rate was c.a. 2.7 per cent per year. Last estimations predict a human population of 28.9 million (INE, 2018).

Most of the Mozambican population lives in coastal areas and rural areas and has a moderate population density of 36.1 people per square kilometre. The most populous provinces are Nampula (6.1 million) and Zambézia (5.1 million) in northern Mozambique. Maputo is the capital and the largest city, with 1.1 million inhabitants (INE, 2018).

Historical and current human pressure on biodiversity

During war-periods, the country also suffered from major droughts, with consequential famines that along with constant armed conflicts led to repeatedly displacement of people from their local areas to urban areas or neighbour countries, and, consequently, frequent land-use transformation and degradation of essential ecosystems (Hatton et al., 2001; Newitt, 1995). Troops, as well as civilians looking for protection and resources, occupied many of the areas reserved for wildlife conservation by long periods. Therefore, wildlife was hunted extensively for suste-

nance as well as for the funding of military campaigns with ivory trade, leading to the depletion of the populations of several species and even local extinctions (Daskin et al., 2016; Dias and Rosinha, 1971). For example, in Gorongosa national park, elephant populations (*Loxodonta africana*) declined from 2200, in 1968, to four individuals in 1993, and buffalo populations (*Syncerus caffer*) from 14 000 to zero in the same period. Equally, in the Marromeu reserve, which was created for the protection of buffalo in 1961, this species population declined from c.a. 45 000 in 1977 to 2346 in 1994 (Daskin et al., 2016; Hatton et al., 2001). Biodiversity research and monitoring actions were not possible for decades due to the lack of trained experts and low accessibility to large parts of the country.

Shortly after both war-periods, the lack of infrastructures compromised the management of the country's natural resources and conservation areas. Much contributed to this scenario, from the ineffective protection by government or traditional authorities to reduced trained experts (Daskin et al., 2016; MITADER, 2015). These periods were also characterized by uncontrolled exploitation of forestry and wildlife (Bocchino, 2008; Hatton et al., 2001).

The unsustainable rate of use and extraction of natural resources are causing intense pressure on biodiversity (MITADER, 2018; Temudo and Silva, 2012). Additional strain on the natural resources is to be anticipated as Mozambique's population is projected to double by 2030.

Currently, one of the significant environmental threats faced in Mozambique is deforestation, which is threatening the wooded habitats: 138 000 ha of natural forests (approximately 0,3%) are lost every year, and erosion is pervasive (MITADER, 2018). Woodlands and forests are being cleared for charcoal manufacture, expansion of commercial agricultural (tobacco, tea, e.g.) and the export of timber (Silva et al., 2019; Temudo and Silva, 2012). Additionally, firewood and charcoal represent 90% of rural energy and large urban centres, and over 80% of the population uses medicinal plants and various non-timber products for their survival (MITADER, 2018). Even within conservation areas unsustainable levels of destruction of the territory have been reported (Mucova et al., 2018; Shapiro et al., 2015, e.g.). For example, a recent study regarding Quirimbas National Park indicates that the park has lost about 301,761.7 ha of vegetated land between 1979 and 2017 (Mucova et al., 2018). The impacts of land-change, on natural resources and biodiversity conservation, comprise the fragmentation of the territory, the isolation of habitats, the reduction of native forest, species extinction, and human conflicts.

In addition, Mozambique is noted as being disaster-prone and among the most vulnerable to climate change (Artur and Hilhorst, 2012; Brida et al., 2013; INGC, 2009). Mozambique is hit

by one disaster per year on average and ranks third on weather-related damage, after Bangladesh and Ethiopia (Buys et al., 2007). Furthermore, the sustenance of its human population as well as its biodiversity is likely to be severely affected by climate change and rising sea level (IPCC (Core Writing Team), 2014; Niquisse et al., 2017).

1.1.3 Biodiversity conservation actions and commitments

The Convention on Biological Diversity

The Convention on Biological Diversity (CBD) is a critical initiative that globally coordinates actions to halt biodiversity loss, with currently 196 nations as parties. In 2001, parties pledged in the VI Conference of the Parties of the Convention on Biological Diversity "to achieve by 2010 a significant reduction of the current rate of biodiversity loss" (Decision VI/26). Although this initiative attracted a considerable amount of attention and activity (Sarukhán et al., 2005), for many regions the absence and the difficulty in accessing relevant information was an impediment to the implementation and fulfilment of the 2010's CBD goals (Leadley et al., 2010; Soberón and Peterson, 2009).

Given these difficulties, for 2011-2020, during Conference of the Parties in 2010 (COP10), new and more multifaceted goals were proposed, internationally, to improve the guiding decisions on where to conserve or prioritise conservation efforts - the "Aichi Biodiversity Targets". The 20 biodiversity targets are intended to reduce the loss of species and natural habitats and safeguard ecosystem services, while also improving funding, planning and knowledge of the world's biodiversity. Moreover, the CBD's new strategic goals contemplate country-level targets, adapted to each country's knowledge of its biodiversity and its conservation status. The primary instruments for implementing this convention are the "National Biodiversity Strategy and Action Plan" (NBSAP). The convention requires countries not only to prepare the NBSAP but also streamline it to other sectors.

Legal instruments and international commitments

The first legislation for the protection of soil, flora and fauna in Mozambique was drawn during the Portuguese colonial administration (Decree nº 40 040 of 20 January 1955). By this decree, the government could create conservation areas, namely: National Parks, Integrated Natural Reserves, Partial Reserves, Special Reserves, Forest Reserves, and Zones under the regime of

Special Vigilance. During the colonial government, the Veterinary Department was responsible for protected areas and wildlife.

Soon after the first national elections, in 1997, following the commitment to Convention on Biological Diversity, a National Strategy and Action Plan for the conservation of biodiversity was prepared aiming to restore and manage a representative system of areas for the protection of habitats and maintenance of viable wildlife populations (MICOA, 1997). Until this landmark, only seven per cent of the country was formally under conservation areas while most of them lacked effective protection (Virtanen, 2002). Gradually, over time, conservation areas were rehabilitated, and new legislation and policies were implemented.

A broader legal framework for the environment and conservation was created, including the Land Act (Law 19/1997), the Environment Act (Law 20/1997), the Fisheries Act (Law 3/1990), and the Forest and Wildlife Act (Law 10/1999). This framework also comprises a series of regulations associated with those laws (e.g. Regulation on Environmental Impact Assessment, Regulation on Forest and Wildlife). More recently, the Conservation Act (Law 16/2014) was approved in order to bring biodiversity conservation issues under a single and integrated legal instrument (Biofund, 2014). The law calls for a national system of protected areas, which consists of (1) management bodies of conservation areas, (2) funding mechanisms for conservation areas, and (3) a national network of conservation areas.

In 2015, following COP10, Mozambique's authorities produced a first NBSAP for 20 years (2015-2035). National strategic goals and targets are presented in Table 1.2. The strategy was built on the following vision: "In 2035, the ecological, socioeconomic and cultural value of biodiversity in Mozambique will contribute directly to improve the quality of life of Mozambicans, derived from its integrated management, conservation and fair and equitable use" (MITADER, 2015).

Presently, Mozambique is a signatory of several other international conventions relevant to the conservation of biodiversity. Among these are: the African Convention on the Conservation of Nature and Natural Resources (Resolution 18/81), the Convention on International Trade of Endangered Species (CITES, Resolution 20/81), the Bamako Convention on the Protection of the Ozone Layer (resolution 8/93), the Framework Convention on Climate Change (UNFCCC, Resolution 1/94), the Convention on the Protection, Management and Development and Marine coastal East Africa Region (Resolution 17/96), and the Convention on Combating Drought and Desertification (UNCCD, Resolution 20/96).

Table 1.2: Summary of the strategic goals and national targets established by Mozambique as required by the Convention for Biological Diversity and adapted from the first NBSAP produced since COP-10 (MITADER, 2015).

Strategic goals and national targets	
A Reduce the direct and indirect causes of degradation and loss of biodiversity	
1	The latest, by 2020, increase by 30% the level of awareness of the Mozambican population about the values of biodiversity and the impacts that human activity can cause.
2	By 2020, there should be a better understanding of the value (economic, social and ecological) of biodiversity, to allow better integration in the decision-making and management.
3	By 2025, adopt and effectively implement policies and legal instruments for preventing and mitigating the impacts of human activities likely to cause degradation of biodiversity.
4	By 2025, define ecologically sustainable systems for production and consumption based on sustainable practices and adequate investment.
5	By 2035, reduce by at least 20% the area of critical ecosystems, or that provide essential goods and services under degradation and fragmentation.
6	By 2025, have at least 30% of habitats of endemic and threatened flora and fauna species with strategies and action plans for their conservation in place.
7	By 2020, catalogue/systematize, disseminate and encourage sustainable management practices in agriculture, livestock, aquaculture, forestry and wildlife.
8	By 2025, reduce pollution levels at critical locations and ecosystems by 20%.
9	By 2025, reduce in at least 10% the area of occurrence of invasive species and establish strategies for managing the impacts.
10	By 2035, put at least 20% critically affect ecosystems by climate change under adaptive ecosystem management.
B Improve the status of biodiversity by preserving the diversity of ecosystems, habitats, species and genes	
11 A	By 2025, evaluate and redefine 75% of current conservation areas, and include, formally, 100% of the Afromontane endemism centres (altitude >1.500m) and up to 5% of marine ecosystems and mountain in conservation areas.
11 B	By 2030, manage effectively and equitably, 50% of the protected areas.
12	By 2035, rehabilitate at least 15% of the degraded ecosystems /habitats, restoring their biodiversity and ensuring its sustainability, intending to mitigate the effects of climate change and combat desertification.
13	By 2030, complete the characterization and cataloguing the genetic diversity of cultivated plants and domestic animals and their threatened ancestors in natural habitats, including species of socio-economic and cultural value and defining strategies for their conservation.
C Improve the benefits sharing from biodiversity and ecosystem services for all sectors of the Mozambican society	
14	By 2030, create and integrate the national accounts a payment mechanism for environmental goods and services to promote fair, equitable and sustainable use of biological diversity.
15	By 2025, knowing and strengthen the contribution of biodiversity to increase the stock of carbon to mitigate and adapt to climate change.
16	By 2020, implement national legislation on access and benefit-sharing from the use of biodiversity and genetic resources.
D Enhance implementation through participatory planning, knowledge management and training	
17	By 2020, the sectors involved in biodiversity issues must develop, based on national targets, sectoral goals, integrate them into sectoral plans, and start implementing it.
18	By 2035, value and respect the knowledge and traditional uses of biodiversity, following national legislation.
19	By 2035, strengthen the capacity of key stakeholders and improve the integration of gender issues, to enable the effective implementation of national targets.
20	By 2020, strengthen national and international partnerships and establish innovative mechanisms for financing and support biodiversity programs.

Conservation areas: network and management

Mozambique's conservation areas network, as established by the Conservation Act (Law 16/2014), comprises total protection areas and sustainable conservation areas, some publicly managed parks and reserves and others privately managed such as hunting reserves and game farms (MITADER, 2015). Total protection areas include integral nature reserves; national parks; and cultural and natural monuments. Sustainable conservation areas include special reserves, envi-

ronmental protection areas, official game reserves, community conservation areas, sanctuaries, game farms, and municipal ecological parks.

The network of conservation areas is currently composed of seventeen national parks and national reserves plus several forest reserves, community reserves and official hunting areas (Figure 1.6). In recent years three National Reserves, a National Park and several game reserves and hunting concessions (Coutadas) and community conservation areas were created. Consequently, the total area for biodiversity conservation in Mozambique has increased significantly, currently covering 26% of the country's land area. In addition, five trans-frontier areas and parks - Great Limpopo, Lubombo, Niassa-Selous, Zimoza and Chimanimani - were established concomitantly with conservation areas in Zimbabwe, South Africa, Swaziland, and Tanzania (MITADER, 2015; PPF, 2016).

Conservation areas are managed by the State, through a designated Ministry, which is accountable for establishing appropriate mechanisms to ensure the participation of public, private and community entities in the management of conservation areas. Currently, the Ministry of Land, Environment and Rural Development (MITADER - Ministério da Terra, Ambiente e Desenvolvimento Rural) is the entity in charge (Presidential decree n.º 1/2015 de 16 de Janeiro). The National Administration for Conservation Areas (ANAC - Administração Nacional das Áreas de Conservação) is, in turn, the entity responsible for safeguarding the management of the conservation areas and the conservation of biodiversity, among other responsibilities. The Conservation Act also established a funding mechanism for biodiversity conservation: the Foundation for the Conservation of Biodiversity (BIOFUND). This foundation should support the conservation of terrestrial and aquatic biodiversity and the sustainable use of natural resources, including the consolidation of the national system of conservation areas (Conservation Act - Law 16/2014; Biofund, 2014).

1.2 Knowledge of biodiversity: the contribution of primary species-occurrence data

Data that places a particular species at a given point in time and space – primary biodiversity data - are essential to describe the distribution of species and biodiversity across the globe (Peterson et al., 2010; Soberón and Peterson, 2004). The core of primary data (taxon, date, and locality) are generally drawn from data associated with scientific specimens - such information

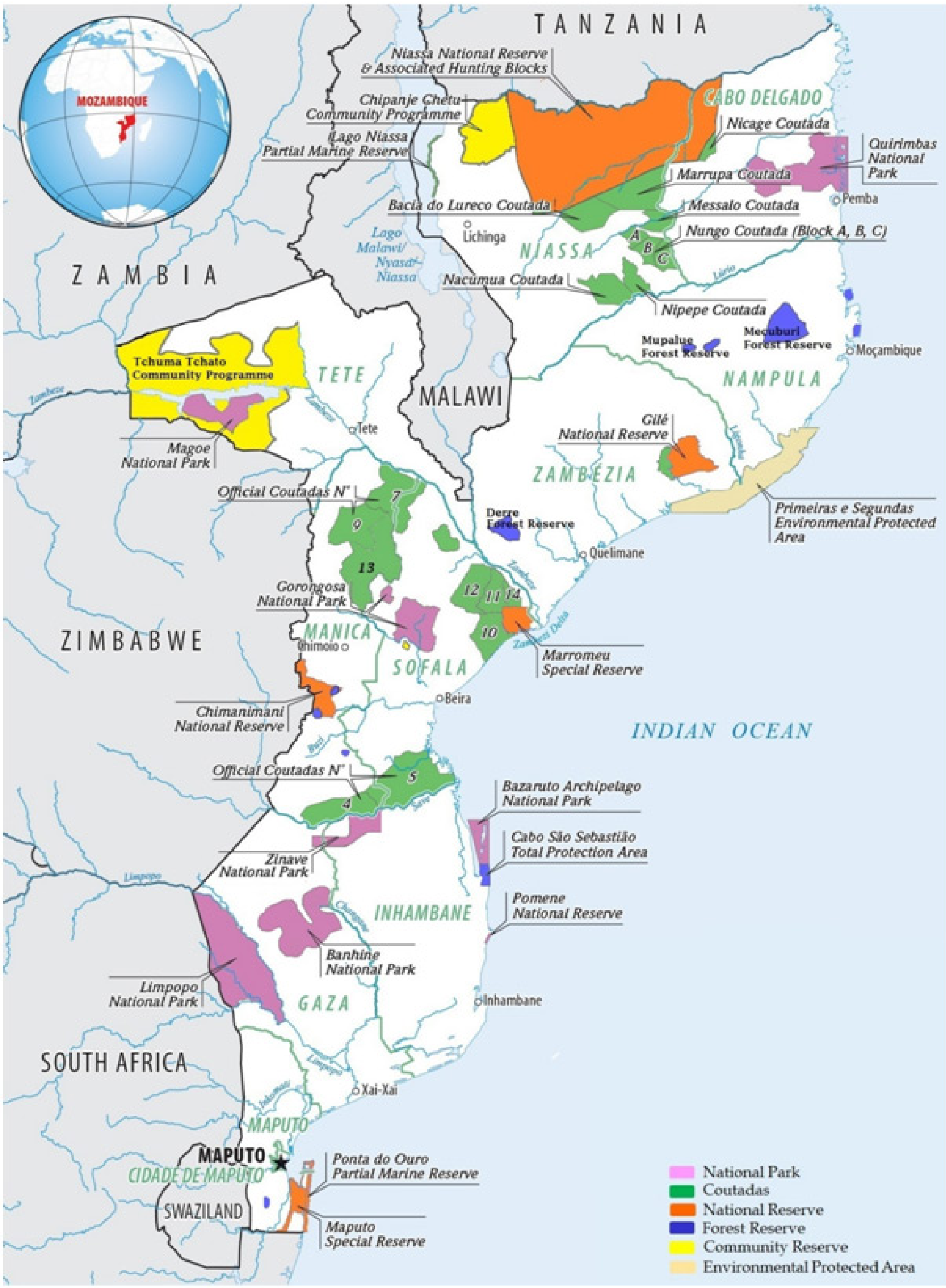

Figure 1.6: Network of Conservation Areas in Mozambique (image from: `http://www.biofund.org.mz/en/mozambique/conservation-areas-of-mozambique/`

involves little interpretation besides the species identification.

Scientific biological collections are the most important repositories of the world's biodiversity. Natural history museums have been playing a significant role in maintaining and conserving these biological collections and can be considered "essentially huge databases" of primary biodiversity data based on specimens (Ponder et al., 2001). Specimen-based records and associated data are crucial because they hold knowledge of species occurrence and taxonomy (Boakes et al., 2010; Holmes et al., 2016; Johnson et al., 2011; Lister, 2011). Museums' collected resources have been estimated at three billion specimens worldwide (Wheeler et al., 2012; Yeates et al., 2016).

One of the most notable initiatives to mobilise and aggregate primary occurrence data from a variety of sources worldwide is the online portal Global Biodiversity Information Facility (GBIF; Nelson and Ellis, 2018). Currently, GBIF facilitates open-access to more than 1.5 billion occurrence records representing more than 4 million species.

The need to extract a substantial amount of data from scientific collections and other sources has propelled and promoted the origin of "Biodiversity informatics". Primary biodiversity data are the key infrastructural element in this relatively new field, which applies information technologies to the management, algorithmic exploration, analysis and interpretation of primary data, particularly at the species level of organisation (Hardisty and Roberts, 2013; Soberón and Peterson, 2004). The emergence of this field led to developments in Geographic Information System (GIS) software, broad-scale environmental data layers (WorldClim, e.g.; Hijmans et al., 2016), refinement of statistical techniques (MaxEnt, e.g.; Phillips et al.), and refinement of data quality automated improvement (Otegui and Guralnick, 2016, e.g). This field currently allows better use of the already available data and provides a capacity to assess biodiversity indicators that is essential for the study of biodiversity trends. Along with the on-going international efforts to aggregate species-occurrence data (GBIF, e.g.), which allowed access to a large quantity of data, these considerable methodological advances have already proven to be useful in conservation and management studies (GBIF Secretariat, 2019). Their usefulness includes 1) modelling and interpreting of species distributions and its responses to environmental or human-induced changes (Faurby and Araújo, 2018; Guisan and Thuiller, 2005; Zacarias and Loyola, 2018), 2) the selection and management of conservation areas (Burgess et al., 2002; González-Maya et al., 2015; Monteiro et al., 2018), 3) tracking of invasive species expansion (Ficetola et al., 2010; Hardisty et al., 2019; Magona et al., 2018), and 4) the uncovering and mapping of

gaps in knowledge (Reddy and Dávalos, 2003; Sousa-Baena et al., 2013; Stropp et al., 2016).

Despite the rise in the global availability of biodiversity data, there remain essential regions that are poorly represented (Feeley and Silman, 2011; Nelson and Ellis, 2018; Peterson et al., 2015). The biases in the digitally accessible data are explained by historical patterns of data collection, which show roles of country-specific factors, for instance, the political and historical context (Meyer et al., 2015). Nevertheless, biodiversity informatics is able to render previously collected historical and present data into a more comprehensive knowledge of global and regional biodiversity (Peterson et al., 2015).

1.3 Main objectives and outline of the thesis

1.3.1 Aim and objectives of the thesis

The overall aim of this thesis is to assess the current state of knowledge regarding Mozambique's terrestrial mammals and build a more thorough and updated analysis of primary biodiversity data using biodiversity informatics tools. Additionally, by identifying knowledge gaps, this study also intends to propose research priorities aiming to improve mammal conservation in the country given climate change and the increasing demographic pressure.

Despite being one of the most studied groups (Godet and Devictor, 2018), comprehensive knowledge on mammals' occurrence and their conservation status is still lacking (Boitani et al., 2011). This context is especially true in scientifically overlooked countries, namely in Africa (Amano and Sutherland, 2013; Amori et al., 2012). Regarding Mozambique, information on mammal fauna occurrence and conservation status is particularly scarce in comparison to surrounding countries (Monadjem et al., 2010, e.g.). The only comprehensive 'atlas' regarding the mammal fauna of Mozambique was published 42 years ago by Smithers and Tello (1976) and lists 190 terrestrial species for the country. The authors state that their mammal list includes "a limited amount of data" that does not fully cover the country.

Mammal species are of great economic and conservation value in Mozambique and have been, over the years, targets of protection and research (Ntumi et al., 2009; Soto et al., 2001). This background, has not, however, prevented many species from being threatened with extinction or going extinct in the country (Hatton et al., 2001; Tello, 1989). Further, the lack of knowledge regarding mammal distribution and occurrence across the country is notably hindering the definition and implementation of effective conservation actions (MITADER, 2015;

Pereira and Nazerali, 2016). Thus, the establishment of data-based' biodiversity knowledge at the country-level is essential, particularly considering the complex dynamics of the economic, social and environmental context in Mozambique.

Aiming to assess the current state of knowledge regarding Mozambique terrestrial mammals, we delineated the following five specific objectives:

1. Compilation of a comprehensive dataset of primary species-occurrence data regarding terrestrial mammals reported for Mozambique;
2. Update of the country's terrestrial mammal checklist;
3. Identification of taxonomic and spatial knowledge gaps;
4. Assessment of the effectiveness and complementarity of the current conservation network to protect mammal diversity;
5. Propose additional areas for the adequate protection of mammal species in Mozambique.

1.3.2 Structure of the thesis

The work presented in this thesis is organised into five chapters. The specific objectives and key findings of each chapter are presented below.

In Chapter 1, a general introduction to the aims covered throughout this dissertation is presented. Here, we put into context the importance of primary biodiversity data for the description of biodiversity and conservation planning, particularly for information-poor and understudied regions. We also introduce Mozambique's context concerning biodiversity conservation by providing an overview of its physical geography and biodiversity, as well as an overview of the political and social background. Lastly, we introduce the specific objectives and structure of the thesis.

In Chapter 2, we present an updated list of terrestrial mammal species reported for Mozambique, based on the compilation of a comprehensive dataset of primary species-occurrence data. The chapter contains the details on the data sources, the methodological approach for the compilation and organisation of the primary occurrence data, and a brief characterisation of the final dataset of records. Briefly, occurrence data were obtained from biodiversity data online portals, natural history museums, scientific literature and wildlife survey reports. As outlined above, up-to-date knowledge of the country's biodiversity is crucial to establish the baseline information needed for conservation and management actions. The results achieved were published in the following paper: Queirós Neves, I., Mathias, M.L. and Bastos-Silveira,

C. (2018) 'The terrestrial mammals of Mozambique: Integrating dispersed biodiversity data', *Bothalia 48*(1), a2330. The dataset generated was made available in an online data repository (http://dx.doi.org/10.17632/3r2dg85nj5.1).

In Chapter 3, we map Mozambique's knowledge gaps regarding the terrestrial mammal species by the identification of the areas that are geographically distant and environmentally different from well-known sites. We also proposed future survey areas aiming to improve the knowledge of the country's mammal fauna. We showed that the increasing global accessibility to species-occurrence data allows a cost-effective manner to boost the knowledge on a country's biodiversity. Also, we propose that the assessment of knowledge gaps, based on this type of datasets, is an adequate strategy to support conservation planning by selecting areas for future biodiversity surveys. This analysis is especially beneficial for understudied countries where the lack of resources for conservation is more pronounced. The results achieved were published in the following paper: Queirós Neves, I., Mathias, M.L. and Bastos-Silveira, C. (2019) Mapping knowledge gaps of Mozambique's terrestrial mammals, *Scientific reports 9*(18184). Supplementary data generated was made available in an online data repository: http://dx.doi.org/10.17632/9bkjv99bdk.1.

In Chapter 4,we investigate whether Mozambique's conservation areas network adequately protects mammal diversity as a whole, currently and prospectively. Because, the firstly gazetted conservation areas in Mozambique were generally established for the preservation of large and charismatic mammal species, we raise the question of whether megafauna can act as an umbrella for the conservation of small-sized groups. In this chapter, we present the first assessment of conservation areas representativeness and effectiveness in Mozambique with the emphasis in small-sized mammals (less than 5 kg), as well as a proposal of priority zones to improve and ensure mammal conservation, given future global change projections (climate change and human pressure). The study was based on the analysis of the coverage of the country's conservation network of the species' suitable ranges. The work presented in this chapter was submitted for publication with the following title: Queirós Neves, I., Mathias, M.L. and Bastos-Silveira, C. Is the current conservation network in Mozambique effective for the preservation of mammal's diversity?

Finally, Chapter 5 synthesises the main findings of the thesis given the objectives established and explores potential research avenues as well as the challenges related to the use and mobilisation of biodiversity data.

2

Terrestrial mammals reported for Mozambique

Contents

CHAPTER 2

Terrestrial mammals reported for Mozambique

ABSTRACT

The most comprehensive synopsis of the mammal fauna of Mozambique was published in 1976, listing 190 species of terrestrial mammals. Up-to-date knowledge on the country's biodiversity is crucial to establish the baseline information needed for conservation and management actions. To present an updated list of terrestrial mammal species reported from Mozambique, we integrated dispersed primary occurrence data from dispersed sources of biodiversity data: Global Biodiversity Information Facility portal, natural history collections, survey reports, and literature. Data were updated and manually curated. However, none of the specimens upon which occurrences are based was directly observed. To partly overcome this impediment, we developed a 'species selection process' for specimen data. This process produced the country's species checklist and an additional list of species with questionable occurrence in the country. From these digital and non-digital sources, we compiled more than 17000 records. The data integrated resulted in a total of 217 mammal species (representing 14 orders, 39 families and 133 genera) with supported occurrence in Mozambique, and 23 species with questionable reported occurrence in the country. The diversity of species accounted for is considerable as more than 70% of species present in southern African sub-region are found in Mozambique. We consider that the current number of mammal species given for Mozambique is still underestimated. The methodological approach for species selection for specimen data can be adapted to update species checklists of crucial importance to countries facing similar lack of knowledge regarding their biodiversity.

Manuscript: Queirós Neves, I., Mathias, M.L., Bastos-Silveira, C. (2018) The terrestrial mammals of Mozambique: Integrating dispersed biodiversity data. *Bothalia - African Biodiversity & Conservation 48*(1), a2330. http://dx.doi.org/10.4102/abc.v48i1.2330

2.1 Introduction

Despite being one of the most studied groups, comprehensive knowledge on African mammals' occurrence and their conservation status are still lacking (Bland et al., 2015; Ripple et al., 2016; Schipper et al., 2008). This is especially true in scientifically overlooked countries such as Mozambique (Amano and Sutherland, 2013; Amori et al., 2012). The Republic of Mozambique holds a rich although poorly known biodiversity (Dalquest, 1965; Monadjem et al., 2010, e.g.).

Information on mammal occurrence and their conservation status in the country is particularly scarce, and the only comprehensive 'atlas' regarding the mammal fauna of the country was published 42 years ago by Smithers and Tello (1976). The authors state that their work includes 'a limited amount of data' and the information regarding the species occurring in northern provinces is incomplete. The country's political instability partially explains the lack of knowledge on Mozambique's biodiversity over the last decades. The Independence war (1964-1974), and especially the civil war (1978-1992), severely affected wildlife even inside protected areas (Hatton et al., 2001), hindering biodiversity studies in the country, and blocking the documentation of Mozambican fauna. The repercussions on large mammals have been disastrous, and include the local extinction of buffalo, hippopotamus and several antelope populations (Hatton et al., 2001). With the advent of peace, new efforts are being made by the local authorities to conserve the country's biodiversity, resulting in new policy guidelines, the reopening of protected areas, and the implementation of further monitoring actions (AGRECO, 2008, e.g.).

However, the lack of updated data on the diversity and distribution of Mozambican fauna still impedes the development of specific conservation actions and policies, as these strongly rely on reliable data to be effectively implemented. This problem is particularly challenging to overcome, as most of the available data on Mozambique's biodiversity dates to the colonial era (which ended in 1975), and it is scattered in foreign museums and institutions. Consequently, access to the data (especially old bibliography and specimens collected in the late nineteenth/early twentieth century) is challenging, both for researchers and for local authorities.

Presently, and due to an international movement to make biodiversity data available, a series of online open-access biodiversity databases (e.g., GBIF) provides extensive and immediate access to species data. Natural history collections, field surveys or monitoring reports are the primary sources of these datasets. These datasets, which in the most cases include both historical and recent species occurrences, allow integration and can be used for a myriad of purposes such as conservation strategies, biodiversity surveys, and taxonomic studies (Beaman and Celli-

nese, 2012; Soberón and Peterson, 2004, e.g.).

In this chapter, we exploit this enhanced availability of biodiversity data and, and by integrating the existing knowledge from different sources of biodiversity occurrence data (natural history collections, surveys and literature), we present a list of terrestrial mammal species reported from Mozambique. By making this compilation, we aim at contributing to a more profound knowledge of Mozambique's fauna, which we hope will promote further research to clarify the occurrence and distribution of the country's biodiversity.

2.1.1 Brief history of mammal's studies in Mozambique

During the nineteenth century and beginning of the twentieth century, scientific expeditions to Mozambique contributed with important mammal collections presently held by European and North American museums. Due to their crucial contribution in the survey of Mozambique's biodiversity, some of these expeditions are worthy of mention.

Wilhelm Peters visited the country in the mid-nineteenth century (1842-1848) and, as a result of his work, several new species to science were described, along with first species' records for the country (Peters, 1852). Most of the specimens collected during W. Peters's expedition are currently held at the Museum fur Naturkunde (ZMB), Berlin. Later, at the beginning of the twentieth century, C. Grant for the 'Rudd Exploration of South Africa' expedition collected 129 specimens of 29 mammal species from central and south Mozambique (Thomas and Wroughton, 1908). Arthur Loveridge in his fifth expedition to East Africa (1948-1949) revisited the collection locality by W. Peters, Tete (Central Mozambique), and collected 11 mammal species.

Portuguese zoological expeditions (Missão Zoológica de Moçambique), in 1948 and 1955, coordinated by Fernando Frade, resulted in Mozambique's most significant vertebrate collection currently held by a Portuguese institution, the Instituto de Investigação Científica Tropical, University of Lisbon (IICT). The published catalogue of this collection indicates a total of 250 specimens representing 57 species and subspecies (Frade and Silva, 1981).

In 1965, an expedition sponsored by Jerry Vinson to the Zinave hunting camp, near the Save River (Central Mozambique), resulted in the collection of 54 species of mammals and with the description of two bat species new for science (Dalquest, 1965). Later, in 1968, a second expedition promoted by the same sponsor, to Panzila (Central Mozambique) resulted in the collection of 47 mammal species (Dalquest, 1968).

Around the same time (1961-1972), the Smithsonian Institution supported a project that targeted explicitly southern Africa's mammals, the 'African Mammal Project' (AMP)(Schmidt et al., 2008). Coordinated by H.W. Setzer, this project included an eight-month field survey covering most of the Central and South Mozambique. This expedition resulted in a valuable collection of over 3500 specimens, mainly comprised by small mammals, and most of which are housed at the National Museum of Natural History (USNM), Washington DC. In 1968, R. Van Gelder conducted an expedition that resulted in c.a. 200 specimens (Van Gelder, 1969), which are currently held by the American Museum of Natural History (AMNH), New York.

In 1976, R. Smithers and J. L. Tello published the 'Checklist and Atlas of the Mammals of Moçambique'. The authors compiled information from some of the expeditions here enumerated along with more than 100 literature references.

With the country's advent of peace in 1992, and the commitment to the United Nations Convention for the Biological Diversity (CBD), the government began promoting field surveys, mainly in protected areas (Dunham, 2004; Mesochina et al., 2008, e.g.). Expeditions to the montane regions of northern Mozambique, under the Darwin Initiative grant, registered the presence of mammal species and opportunistically collected small mammals (Bayliss et al., 2010; Timberlake et al., 2007, e.g.). The Royal Museum for Central Africa (RMCA), Belgium, supported the 'African Rodentia' project (Terryn et al., 2007) which includes a collection of rodents from Mozambique. Chicago Field Museum of Natural History (FMNH) also holds a collection of mammals from Mozambique. Also noteworthy is the study of bat species which resulted in a few new species for the country's fauna (Monadjem et al., 2010). Mozambique's universities and research centres have also been participating in biodiversity surveys and studies (Gomes, 2013; Schneider, 2004, e.g.)

2.1.2 Study area

The Republic of Mozambique, located in the Indian Ocean coast of southeast Africa, holds an extensive coastal territory of more than 800 000 square kilometres (Figure 2.1-b). A great part of the country's topography is characterized by flat terrain, extending from coastal plains, in the east, to mountain ranges, in the west. The climate is generally tropical and dry, but temperature and precipitation are highly variable throughout the country (McSweeney et al., 2010). Accounting for these regional differences, biodiversity studies (see Monadjem et al., 2010) tend to classify the country in three major biogeographic regions (Figure 2.1-a): 1) North Mozam-

bique, north of the Zambezi river; characterized by evergreen forests or deciduous woodlands; 2) Central Mozambique, between the Save and Zambezi rivers; vegetation in this region varies from evergreen forest and moist deciduous forest, scrub and grasslands to a semi-arid woodland and savannah; and 3) South Mozambique, south of Save River; mostly flat terrain characterized by deciduous woodlands ranging from moist to semi-arid forests and savannah.

Since the commitment to the CBD, ratified in 1994 (Resolution 2/94 of 24 August 1994), the total protected area for biodiversity in Mozambique has increased from 15% to 26% of the territory (MICOA, 2014). Some of the already existent protected areas were extended (e.g., Niassa National Reserve) and new areas such as the Mágoè National Park, the only protected area in the Tete province, were also created. In total, 17 national parks (NP) and national reserves (NR) currently make the conservation areas network of Mozambique (Figure 2.1-a).

2.2 Research method and materials

2.2.1 Species data

Information on species occurrence was obtained by compiling data from the following sources: (i) the Global Biodiversity Information Facility portal (GBIF, 2009; GBIF, 2018), (ii) Natural history collections (NHC) – museums were contacted via e-mail or data was directly downloaded from the institutions' online databases, (iii) Recent survey reports of the main protected areas and other places of ecological interest available online, and (iv) Literature - including the species checklist of Smithers and Tello (1976).

Reference details on data sources are in Appendix A. The search of primary data, from online data sources, was performed using combinations of the following keywords: 'Mozambique', 'mammal', 'biodiversity', 'specimen', 'species'; 'occurrence' and their translations into Portuguese, the official language of Mozambique.

2.2.2 Data cleaning and organization

Data from GBIF and natural history museums were provided in a computer-readable table format. Data from analogue sources, such as books, scientific articles and reports, were digitized to a table. When provided graphically on maps or grids the data was georeferenced and localities of occurrence were digitised to shapefiles using geographic information system software

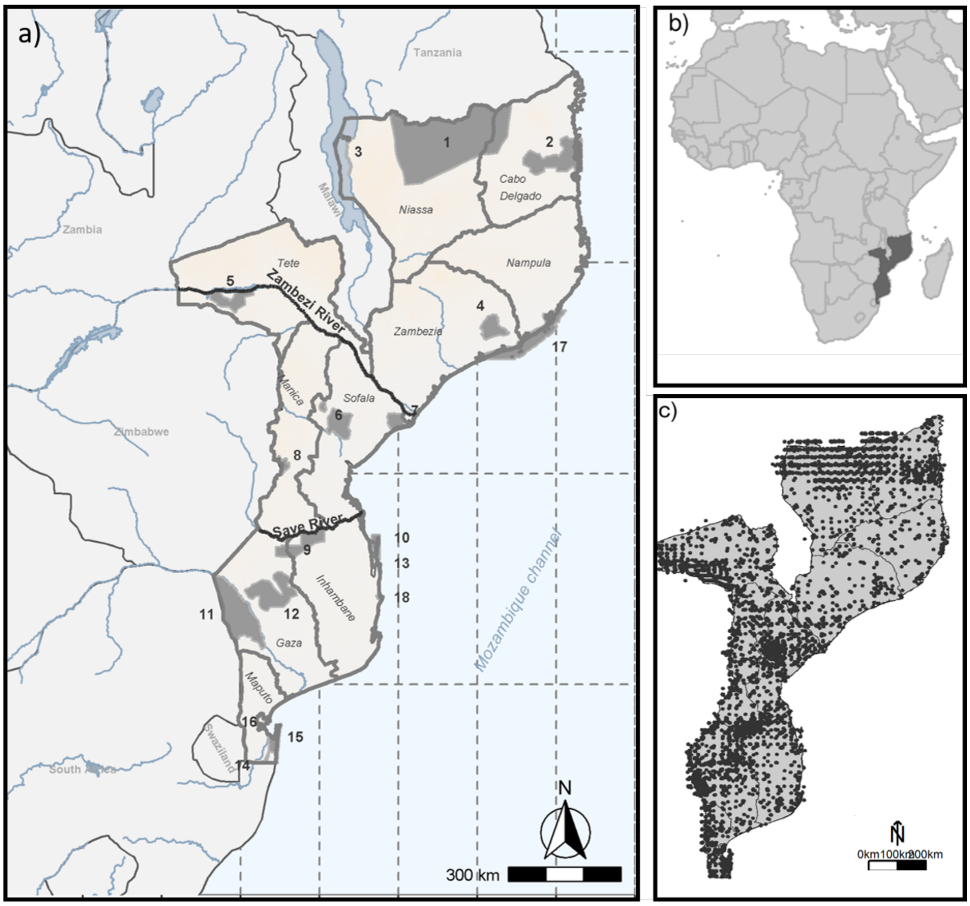

Figure 2.1: (a) Map of Mozambique, with protected areas in dark grey and two rivers as dark lines that divide the country into three major biogeographical areas: North Mozambique, Central Mozambique and South Mozambique, (b) Inset with the location of Mozambique in the African continent, (c) Spatial representation of 8149 unique localities of occurrence of the primary species-occurrence data used to produce the species checklist of terrestrial mammal species reported from Mozambique.

Notes: The country's protected areas are indicated with a number: 1. Niassa national reserve, 2. Quirimbas national park, 3. Lake Niassa partial reserve, 4. Gilé national reserve, 5. Mágoè national park, 6. Gorongosa national park, 7. Marromeu national reserve, 8. Chimanimani national reserve, 9. Zinave national park, 10. Bazaruto national park, 11. Limpopo national park, 12. Banhine national park, 13. Cabo São Sebastião Total protection area, 14. Maputo special reserve, 15 – Ponta do Ouro national reserve, 16-Malhazine national reserve, 17. Primeiras e Segundas islands environmental protection area, 18. Pomene national reserve. Protected areas shapefile was downloaded from Biofund platform of conservation areas (http://www.biofund.org.mz/en/database/platform-of-the-conservation-areas/. km, kilometres

Quantum GIS 1.7.4. 'Wroclaw' (QGIS-Development-Team, 2013). All data was organized and stored following Darwin Core's protocols for standardization of biological diversity documentation regarding taxonomic, geographic, and temporal information (Wieczorek et al., 2012).

Firstly, the retrieved records that fulfil the following requisites were discarded: a) did not contain taxonomic identification at the species level; b) represented introduced or commensal species; c) had incomplete or no information regarding the location of collection event; d) were not collected in Mozambique, or e) were duplicates.

Secondly, to improve data quality, taxonomic and geographic information associated with each record were cleaned and standardized manually (Chapman, 2005). Nomenclatural and taxonomic classification of species was standardized following Wilson and Reeder (2005), and variants in the scientific name of a species, either synonyms or orthographic errors, were referred to a valid scientific name. The names were then compared against the Integrated Taxonomic Information System database (ITIS, 2017) to ensure that the most current name was being used.

Thirdly, locality of occurrence and other geographic information were updated or complemented by using the database on the GeoNames (GeoNames), and georeferenced in the statistical software R (R-Core-Team, 2018) using the dismo package's function 'geocode' that sends requests to the Google API for geographical coordinates and corresponding uncertainty (Hijmans et al., 2016). Afterwards, the coordinates of all localities of occurrence were manually curated. These were considered identical when latitude and longitude information (with 2-digit precision) coincides. Records collected after the year 2000 were classified as 'recent records'.

2.2.3 Species selection process

The list of species obtained, in our study, is a result of the species-occurrence data gathered from the GBIF, NHC, survey reports and literature; and none of the specimens, upon which occurrences are based, were directly examined. To partly overcome this impediment, we developed a 'Species selection process' for specimen data from GBIF records and museums. The purpose of this refinement process is an attempt to distinguish between certainly found species and species with questionable occurrence in the country.

The aim of the species selection process is, as in other studies (Amori et al., 2016, e.g.), to categorize the species detected in more than one data source as species with well-supported occurrence. Here, besides the number of collectors, we also accounted for the number of records

collected, and the presence in Smithers and Tello (1976) (Figure 2.2 shows the decision framework). At the end of the selection process, two species lists were produced: 'Species checklist' and 'Questionable occurrence' list. A species-occurrence record was considered well-supported and enter the 'Species checklist' when: i) different collectors independently recorded the species; or ii) the species was recorded by a single collector, but was listed in Smithers and Tello (1976). The additional list that resulted from the selection process contains species with 'Questionable occurrence' in the country. The criteria upon which a species was included in this list were: i) the species was not listed in Smithers and Tello (1976), and a single record only supported its presence; ii) the species was not listed in Smithers and Tello (1976), and multiple records exist, but were all cited by a single author, or iii) the species was listed with a single record in Smithers and Tello (1976).

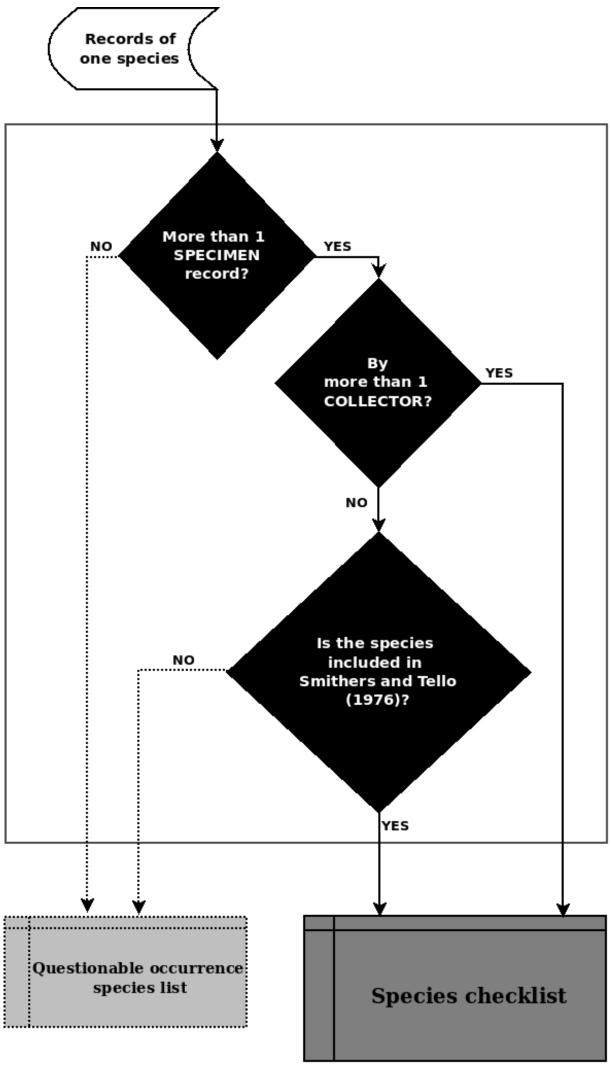

Figure 2.2: Species selection process - Decision framework followed to establish if a species occurrence in the country was well supported.

For each taxon, we compiled the information on species authority, species global conservation status by the *International Union for the Conservation of Nature* 's Red List of Threatened Species (IUCN, 2018), number of records collected, biogeographical areas of occurrence, and information on last reference/record. Table 2.3 with 'Species checklist' and Table 2.4 with 'Questionable occurrence' species list are presented in the end of the chapter. Species accounts with detailed information regarding literature and museum references, recorded synonyms, and the reported distribution in Mozambique are compiled in Appendix B. Orders, families and species names are presented in alphabetical order.

2.2.4 Taxonomic completeness

To assess the degree of taxonomic completeness of the "Species checklist," we used Species Accumulation Curves (SAC) (Moreno and Halffter, 2000). We computed SAC for the complete set of mammal records from the "Species checklist", and for each mammal order with more than two species listed.

Species-occurrence records were aggregated to a 0.25° spatial resolution grid, and the total number of grid cells across the country was 1217. Using the grid cells as a surrogate measure of sampling effort, we calculated the cumulative number of species with the increase in the number of records for each of the country's cells (Lobo, 2008). SAC are expected to reach an asymptote when the probability of adding a new species to the list approaches zero. To smoothen the curve of species richness, the number of species accumulated was obtained by adding cells in random order with 100 permutations (Lobo, 2008). SAC were computed with the function *specaccum* in R package: *vegan* (Oksanen, 2013).

To calculate the overall taxonomic completeness, we extrapolated the total species richness, for the country, applying the non-parametric species richness estimator, first-order Jackknife (Colwell et al., 2004). The results were then compared to the total number of species in the "Species checklist". This non-parametric first-order Jackknife was selected because it is less affected than other estimators to incidence-based data (Hortal et al., 2006). The extrapolated species richness was calculated with the *specpool* function (R package: vegan).

2.3 Results

2.3.1 Data summary

The integration of species-occurrence data from the different data sources resulted in 17014 records compiled, and, of these, approximately 12% were discarded. In total, 15011 records of native terrestrial mammals, representing 8149 localities of occurrence reported from Mozambique, were used to produce the present ”Species checklist”.

From GBIF, the yielded data was provided by 35 institutions in a total of 4265 suitable records (Appendix A). Eight national history museums contributed with 745 records, non-redundant with the retrieved GBIF data. Eleven national survey reports, representing the recent wildlife surveys, were selected: one at country level; two from national reserves (Matthews and Nemane, 2006; Mesochina et al., 2008); and eight from national parks (Appendix A). In total, these reports contributed with 5012 suitable records. Four additional reports from expeditions to montane areas in North Mozambique were included: Mount Chiperone, Mount Mabu, and Mount Namuli, Zambezia province; and Mount Inago, Nampula province; generating 84 suitable records (Appendix A). Data digitized from Smithers and Tello (1976) ’s checklist represents 4577 records. A total of 17 research articles contributes with further 328 suitable records (Appendix A).

The geographical distribution of the localities of occurrence and the temporal coverage of data were analysed for patterns. Localities of occurrence are mainly distributed across Central Mozambique and southern Mozambique, inside and near protected areas (Figure 2.1-c). Localities of occurrence in northern Mozambique are mostly located inside and near protected areas and areas of scientific interest, such as the inselbergs and hills in the eastern Afromontane north of the Zambezi River. Northern Mozambique was already identified as the central gap in the knowledge of Mozambique biodiversity back in 1976 (Smithers and Tello, 1976). By that time, North Mozambique was an inaccessible region. During the nineteenth and the twentieth centuries, species collections took place mostly in the southern areas and those around the Zambezi River. In recent years, however, growing political stability along with an increase in accessibility to North Mozambique, enabling more surveys and expedition events. Moreover, these new surveys to North Mozambique, revealed many new species and records for the country, for various taxonomic groups (Conradie et al., 2016; Monadjem et al., 2010; Portik et al., 2013; Van Noort et al., 2007, e.g.).

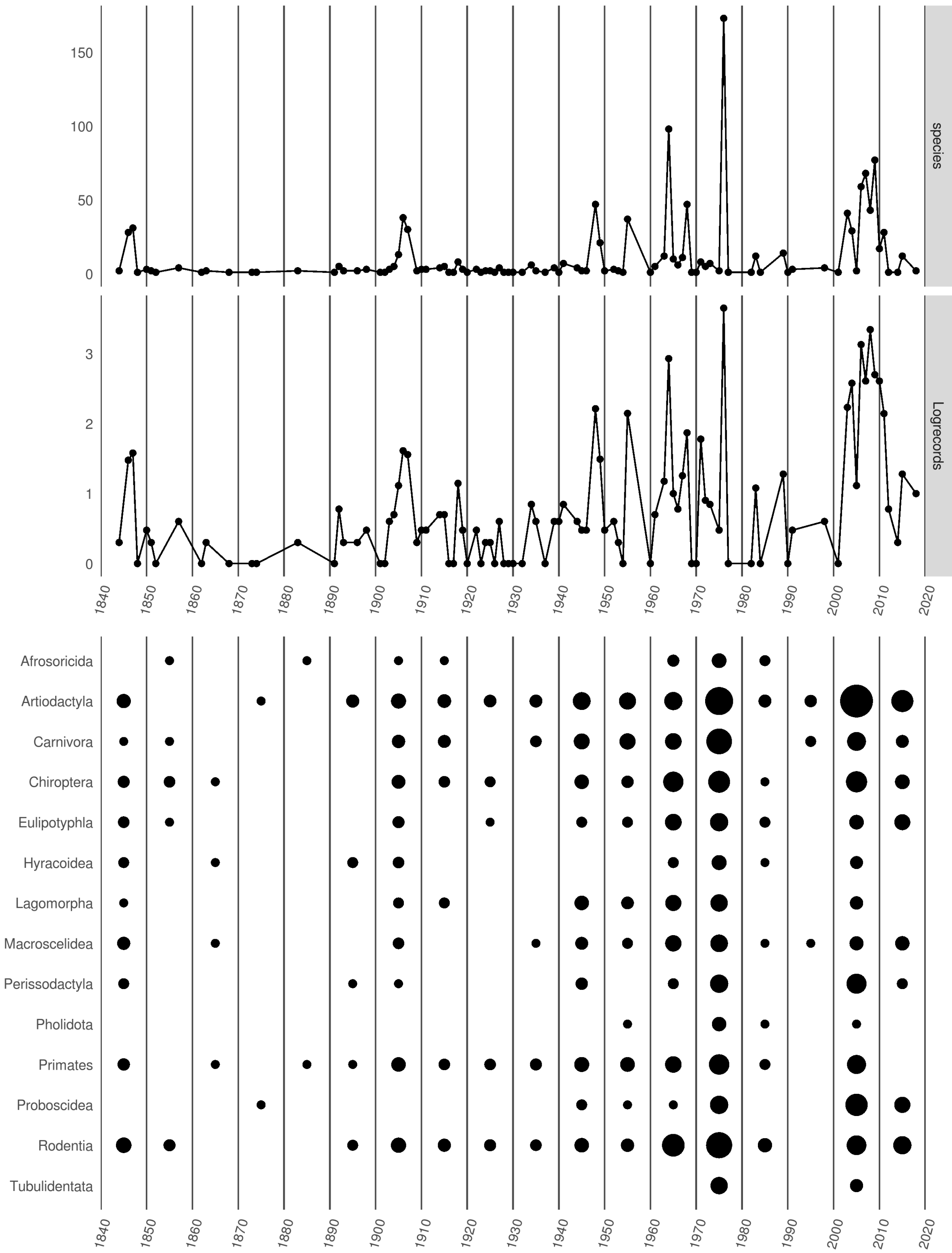

Figure 2.3: Description of the primary species-occurrence records of terrestrial mammal species from Mozambique per 10-year period from 1840 until April 2018 based in: the number of species (top), the number of records (log10; middle), and mammal orders collected (down). Size of points in the last graph reflects the amount of records per mammal order, per decade.

Regarding the temporal coverage of the data, the earliest records compiled are from 1842 to 1848 and were collected during Wilhelm Peters expedition. The latest records refer to a recent publication by Taylor et al. (2018) (Figure 2.3). Records retrieved through GBIF were collected between 1892 and 2015. Period of the records from the other NHC is 1845-1991. Scientific literature included, besides the Smithers and Tello's species checklist (1976), ranges from 1985 to 2018. Moreover, the reports of surveys and expeditions to montane areas in North Mozambique were all published after the year 2000, between 2004-2010.

When we group the records in decades, the collecting effort is not regularly distributed over the years (Figure 2.3). Starting in 1840, there are peaks of collecting effort located in the decades of 1960, 1970 and 2000, during these peaks species from all mammal orders were reported. On the other hand, for the periods between 1860-1890 and 1990-2000, very few records of mammal occurrence were available, and very few species were reported.

2.3.2 The species lists

Following our compilation and species' selection criteria, a total of 217 mammal species, representing 14 orders, 39 families and 133 genera, were reported with supported occurrence in Mozambique (Table 2.1). The diversity of species is considerable as all families accounted for the southern Africa sub-region (Skinner and Chimimba, 2005) are found in Mozambique, as well as above 87% of genera and approximately 71% of species (Table 2.1). Thirteen of the reported species are threatened of extinction (IUCN, 2018) (Table 2.2).

The "Species checklist" comprises 14981 records, representing 8141 localities of occurrence (Table 2.3). Nearly a third of the species present less than ten records; and, approximately, a quarter of the species did not present recent records (Table 2.2).

When compared with Smithers and Tello (1976), our work resulted in the addition of 37 species. Also, one extinct species and one exotic species were removed from the 1976 's checklist, and the exclusion of 9 species was included in our "Questionable occurrence" species list. The species added to Mozambique's checklist since Smithers and Tello (1976) belong to the following orders: Carnivora (2 species), Chiroptera (19 species), Eulypotyphla (2 species), Lagomorpha (1 species), Primata (2 species), and Rodentia (12 species) (Table 2.1). For 17 species included in our "Species checklist", the only evidence of occurrence in Mozambique is based on Smithers and Tello (1976). They are Artiodactyla (1 species), Carnivora (6 species), Chiroptera (3 species), Eulipotyphla (1 species), Lagomorpha (1 species), Macroscelidea (1

Table 2.1: Comparison of the number of terrestrial mammals from Mozambique in the present study with the last checklist published for Mozambique (Smithers and Tello, 1976), and the mammal diversity in the southern Africa sub-region, according to Skinner and Chimimba (2005), per mammal order.

Order	Mozambique			Smithers & Tello (1976)			Southern Africa sub-region		
	Families	Genera	Species	Families	Genera	Species	Families	Genera	Species
Afrosoricidae	1	2	2	1	2	2	1	8	18
Cetartiodactyla	4	20	25	4	20	26	4	24	37
Carnivora [a]	7	28	33	6	25	31	7	32	38
Chiroptera	7	28	71	7	21	56	7	27	77
Eulipotyphla	1	3	9	1	3	10	2	5	18
Hyracoidea	1	3	3	1	3	3	1	3	3
Lagomorpha	1	2	4	1	2	3	1	3	7
Macrocelidea	1	3	5	1	3	5	1	3	8
Perissodactyla	2	3	3	2	3	3	2	3	4
Pholidota	1	1	1	1	1	1	1	1	1
Primates	2	6	8	2	3	6	2	5	6
Proboscidea	1	1	1	1	1	1	1	1	2
Rodentia [b]	9	32	51	9	29	41	8	38	85
Tubulidentata	1	1	1	1	1	1	1	1	1
Total [c]	39	133	217	38	117	189	39	154	305

[a] Family Phocidae not included
[b] Commensal species were not included
[c] Orders Cetacea, Sirenia not included

species), and Rodentia (4 species).

We additionally identified 73 taxonomic changes defined as changes in the scientific names; and 43 distributional changes from Smithers and Tello (1976). We considered a distributional change when we gather for a species a location of occurrence in a biogeographical region not reported in Smithers and Tello (1976). Most of the distributional changes (25 species) reflect new species-records reported from North Mozambique. Also, since the publication of Smithers and Tello (1976), eleven species had their occurrence extended to Central Mozambique, and seven species had their occurrence extended to South Mozambique.

We further present a list of reported species with 'questionable occurrence' in the country, composed by 23 species from six orders: Artiodactyla (3 species), Chiroptera (8 species), Eulipotyphla (4 species), Macroscelidea (1 species), Pholidota (1 species), Rodentia (6 species) (Table 2.4).

2.3.3 Taxonomic completeness

The total species richness extrapolated for Mozambique resulted in approximately 232 species. Hence, our "Species checklist", given the total of 217 species, is approximately 93.5% taxonomic complete (Table 2.2).

Table 2.2: Summary description of the reported species in the species checklist of terrestrial mammals from Mozambique, extrapolated species richness and taxonomic completeness. Shown are the total number of species, the number of threatened species, the number of species reported with fewer than 10 records, the number of species reported from Mozambique after the year 2000 ('recent'), per mammal order.

Order	Total	Threatened [a]	<10 records	Recent	Species richness[b]	Comp.[d]
Afrosoricidae	2	1	1		-	-
Cetartiodactyla	25		1	24		100
Carnivora	33	4	6	21	33	100
Chiroptera	71	1	41	58	84 (±4.6)	84.5
Eulipotyphla	9		3	7	10 (±1)	90.0
Hyracoidea	3		1	2	3	100
Lagomorpha	4		2	2	4	100
Macrocelidea	5			2	5	100
Perissodactyla	3	1		3	3	100
Pholidota	1	1		1	-	-
Primates	8		1	7	8	100
Proboscidea	1	1		1	-	-
Rodentia	51	1	17	33	52 (±1)	98.1
Tubulidentata	1			1	-	-
Total	217	13	73	162	232 (±4.7)	93.5

[a] Species are considered 'threatened' species when are classified as 'Vulnerable', 'Endangered' or 'Critically endangered' by IUCN (2018) Red List.
[b] Species richness calculated using jack-knife estimator; standard deviation in brackets.
[c] **Comp.**, taxonomic completeness.
[d] Taxonomic completeness calculated as: (total number of species/ species richness) x 100.

According to the extrapolated richness of each mammal order considered, the "Species checklist" is incomplete for Chiroptera, with taxonomic completeness of 84.5%, and close to completion for Eulipothyla, and Rodentia with 90.0%, and 98.1%, respectively (Table 2.2). For the other mammal orders, the extrapolated richness was equal to the number of species in the "Species checklist". For Artiodactyla and Carnivora, the species accumulation curves support this result by presenting a close asymptote shape, which indicates that these are well-represented groups (Figure 2.S1).

2.3.4 Mammal orders accounts

Below we present a systematic account for each mammal order represented in our dataset, with detailed and specific comments.

Afrosoricida (golden moles and tenrecs)

This order is represented by two species of golden moles (Family Chrysochloridae), *Calcochloris obtusirostris* (Peters, 1851) and *Carpitalpa arendsi* Lundholm, 1955. Data for both species is scarce (Table 2.3).

The first records of *C. obtusirostris* resulted from the W. Peters expedition (Peters 1852) and represent the species type-locality 'Coastal Mozambique, Inhambane, 24°S', South Mozambique. This species is listed in Smithers and Tello (1976) and was lastly collected in 1989 (Downs and Wirminghaus, 1997).

The presence of the other golden mole *C. arendsi*, a vulnerable species (IUCN 2017), is based on six records: five records compiled by Smithers and Tello (1976) and a single specimen collected in Central Mozambique during the Smithsonian expedition (USNM 365001).

Cetartiodactyla (Even-toed ungulates)

Four families, comprising 25 terrestrial species from 20 genera, occur in Mozambique: Bovidae (21 species), Giraffidae (1 species), Hippopotamidae (1 species) and Suidae (2 species). All of the species were previously reported from Mozambique in Smithers and Tello (1976). Except for the endangered *Redunca fulvorufula* (Afzelius, 1815), most species have been recently recorded (Table 2.3). A total of three species are included in the 'questionable occurrence' list (Table 2.4). These are discussed, in detail, below.

Bovidae is the most documented family with the highest number of records compiled, resulting in good coverage of the species' spatial distribution in the country (Table 2.3). Three bovids were considered to have 'questionable occurrence': *Antidorcas marsupialis* (Zimmermann, 1780), *Litocranius walleri* (Brooke, 1879), and *Tragelaphus spekii* Sclater, 1863. These species have their occurrence in Mozambique based on a single museum specimen (see Table 2.4 for references). Only the sitatunga, *T. spekii*, is denoted by Wilson and Reeder (2005) as having a distribution in Mozambique.

Damaliscus lunatus Burchell, 1824, was given as extinct in Mozambique around the late 1970s (Tello, 1989). For this reason, it was not included in this study's species checklist, albeit records of its past occurrence in the country (12 records) (Smithers and Tello, 1976).

Several species have suffered from considerable range contractions and local extinctions in Mozambique. *Giraffa camelopardalis* (Linnaeus, 1758), recently ranked as vulnerable by IUCN (2018), was considered 'probably extinct' in the 90's (East, 1999), but re-introduction programs

since 2002 have returned the species to the country (AGRECO, 2008; Dunham, 2010; MICOA, 2014; Whyte and Swanepoel, 2006). *Hippopotamus amphibius* Linnaeus 1758, also a vulnerable species (IUCN, 2018), had a widespread distribution across all biogeographical regions in the 1970s (Smithers and Tello, 1976), but recent aerial surveys indicate a more restricted distribution, along rivers inside protected areas and the Zambezi River basin (AGRECO, 2008).

Two Suidae species occur throughout the country: the wart-hog, *Phacochoeurs africanus* (Gmelin, 1788), and the bush-pig, *Potamochoerus larvatus* (F. Cuvier, 1822). The occurrence of both species has been confirmed since the mid-nineteenth century. From the year 2000 onwards, their presence has been observed in nine protected areas and their surroundings across all biogeographical areas (e.g. Agreco 2008)

Carnivora (foxes, weasels, hyenas, cats, civets…)

Seven families, including 33 species from 28 genera, were identified to occur in Mozambique: Canidae (4 species), Felidae (6 species), Herpestidae (9 species), Hyaenidae (3 species), Mustelidae (5 species), Nandiniidae (1 species) and Viverridae (5 species). Most carnivores reported were previously listed in Smithers and Tello (1976). Recent records are mainly based on sightings from surveys in protected areas (GRNB, 2010; Mesochina et al., 2008, e.g.). These surveys reveal the presence of only 21 carnivores (Table 2.2); moreover, some of these species were observed just a few times (Table 2.3).

Most canids reported have recent records except for the bat-eared fox, *Otocyon megalotis* (Desmarest, 1822). This species was only mentioned for South Mozambique (Banhine NP and adjacent areas) by Smithers and Tello (1976), and its current occurrence status in the country should be further investigated.

All six felids were previously mentioned in the Smithers and Tello (1976), and had their occurrence confirmed by recent surveys in four protected areas (Dunham, 2004; GRNB, 2010; Mesochina et al., 2008; Stalmans and Peel, 2009).

Nine species of Herpestidae are reported to occur in Mozambique. Four mongoose species have their current occurrence confirmed in the country (GRNB, 2010; Mesochina et al., 2008; Stalmans and Peel, 2009, e.g.). The remaining five were lastly recorded before 1976 (Smithers and Tello, 1976). Among these, two species' occurrences are based on few records: *Paracynictis selousi* (de Winton, 1896), with just two records; *Bdeogale crassicauda* Peters, 1852, firstly collected in Mozambique by W. Peters, with ten records.

Three Hyaenidae species are listed to occur in Mozambique (Table 2.3). The hyaena *Crocuta crocuta* (Erxleben, 1777), with a high number of records in past and across the entire country (Smithers and Tello, 1976), is the only species for which recent records exist, though only two records were found (Quirimbas NP; GRNB, 2010). Only mentioned in Smithers and Tello (1976), the other two species present less than ten records each: the near-threatened *Hyaena brunnea* (Thunberg, 1820), and the aardwolf, *Proteles cristata* (Sparrman, 1783), in Central and South Mozambique.

From the five Mustelidae species listed, two – *Aonyx capensis* (Schinz, 1821), and *Hydrictis maculicollis* (Lichtenstein, 1835) – were not mentioned since Smithers and Tello (1976), but the remaining three mustelids present recent records in North Mozambique (GRNB, 2010; Mesochina et al., 2008) (Table 2.3).

The family Viverridae is represented by the subfamily Viverrinae with two genera: *Civettictis* Pocock, 1915 (1 species) and *Genetta* Cuvier, 1816 (4 species). The genus *Genetta* is taxonomically problematic with many nomenclatural changes over time (e.g., Coetzee 1977, Crawford-Cabral & Fernandes 2001). Therefore, in the present study, we followed the taxonomy and nomenclatural approach of Mills & Bester (2005) in which five genets are listed for the southern Africa region. Smithers and Tello (1976) considers just two species for Mozambique: *G. genetta pulchra* Matschie, 1902; and *G. tigrina rubiginosa* Pucheran, 1855.

Chiroptera (bats)

Bats are the most species-rich order in Mozambique, comprising 71 species from 28 genera (Table 2.1). Seven families occur in the country: Emballonuridae (2 species), Hipposideridae (5 species), Molossidae (10 species), Nycteridae (5 species), Pteropodidae (7 species), Rhinolophidae (16 species), and Vespertilionidae (26 species). Most of the species have been recently recorded in the country (58 species; Table 2.2). Three bats are only reported by Smithers and Tello (1976): *Cloeotis percivali* Thomas, 1901 (2 records), *Tadarida ventralis* (Heuglin, 1861; 2 records), and *Myotis welwitschii* (Gray, 1866; 3 records).

The occurrence of *Rhinolophus capensis* Lichtenstein, 1823 in Mozambique is rejected in Monadjem et al. (2010). The authors consider that specimens labelled as R. capensis (Smithers and Tello, 1976, e.g.) were based in misidentifications, as the species is endemic to South Africa. However, following the methodology herein proposed, and given that this species was listed by Smithers and Tello (1976) and was reported in 2003 (FMNH 177108; FMNH 177109;

FMNH 177214), this species is still included in the 'Species checklist'. Nevertheless, we advise a reappraisal of the previously listed specimens in other to clarify their taxonomic identification.

Additional eight bat species were considered as having 'questionable occurrence': *Epomophorus gambianus* (Ogilby, 1835), *Mops thersites* Thomas, 1903; *Nyctalus noctula* Schreber, 1774; *Nycteris woodi* K. Andersen, 1914; *Pipistrellus rueppellii* (J. Fisher, 1829); *Scotoecus albofuscus* (Thomas, 1890); *Tadarida lobata* (Thomas 1891), and *Taphozous perforatus* E. Geoffroy, 1818 (Table 2.4). Two of these species (*N. noctula* and *M. thersites*) are also rejected as being part of the Mozambican fauna by Monadjem et al. (2010).

Eulipotyphla (shrews, moles, and solenodons)

Nine shrew species are known to occur in Mozambique (suborder Soricomorpha; family Soricidae; Table 2.1). Among those, seven species were recently recorded in the country: *Crocidura hirta* Peters, 1852; *C. luna* Dollman, 1910; *C. mariquensis* (A. Smith, 1844); *C. olivieri* (Lesson, 1827); *C. silacea* Thomas, 1895; *Myosorex meesteri* Taylor et al. 2013; and *Suncus megalura* Jentink, 1888 (Table 2.3). The recent records of *Crocidura* Wagler, 1832: 1) by the FMNH in 2003 and 2011 (FMNH 177083 - 177087; FMNH 177197 – 177207); 2) during surveys taken in Mount Namuli (Bayliss et al., 2014); and, 3) during surveys inside Quirimbas NP (GRNB, 2010; Schneider, 2004).

The forest shrew *M. meesteri* was recently described as a new species (Taylor et al., 2013). The authors described this species based on three records, two from Gorongosa national park, Mozambique, and one from Mutare, Zimbabwe, and no records of *M. cafer* (Sundevall 1846) in Mozambique. In the past, the only species of the genus *Myosorex* Gray, 1837 included as part of Mozambique's fauna was *M. cafer*, with records from the same areas (Smithers and Tello, 1976). The recent work by Taylor et al. (2013) proposed that populations formerly classified as *M. cafer* should be renamed as *M. meesteri*. Given this, we only included in our "Species checklist" the species *M. meesteri*. Another species, the musk shrew, *C. silacea*, was not previously listed in Smithers and Tello (1976) (Table 2.3).

Four shrew species were considered as having 'questionable occurrence', each one with a single record: identified as the black shrew, *C. nigrofusca* Matschie, 1895, collected in North Mozambique (USNM 365077); *Crocidura flavescens* (I. Geoffroy, 1827) reported by Smithers and Tello (1976); and two species of dwarf shrews *Suncus lixus* (Thomas 1898) and *S. varilla* (Thomas, 1895) also reported by Smithers and Tello (1976) from Central and southern Mozam-

bique without reference to specimen records (Table 2.4).

Hyracoidea (hyraxes)

This order is represented by three species, all from the Procaviidae family, which are all listed in Smithers and Tello (1976) (Table 2.1). Two of these species were recently reported from North Mozambique (Table 2.2): *Heterohyrax brucei* (Gray, 1868) at Mount Inago and Mount Namuli (Timberlake et al., 2009; Bayliss et al., 2010; FMNH 177240); and *Procavia capensis* (Pallas, 1766) at Mount Mabu, Quirimbas NP, Gilé NP (Bayliss et al., 2014; Dowsett-Lemaire and Dowsett, 2009; GRNB, 2010; Mesochina et al., 2008; Schneider, 2004) (Table 2.3). Evidence of occurrence of the third species *Dendrohyrax arboreus* (A. Smith, 1827), is based on three specimens collected in mid-nineteenth century in Central Mozambique, one deposited in the ZMB, Berlin (ZMB 1984); a second in the *Muséum National d'Histoire Naturelle* (MNHN), Paris (MNHN 1897-654); and a third at the National Museum of Zimbabwe, Zimbabwe (NMZB-MAM-0068820).

Lagomorpha (rabbits, hares and pikas)

Four lagomorph species were listed for Mozambique (Table 2.2). The hare *Lepus microtis* Euglin, 1865 which has been recorded both in past expeditions to Mozambique (e.g., W. Peters expedition and Smithsonian Institute's AMP) and in recent surveys to Gilé NR and Quirimbas NP (GRNB, 2010; Mesochina et al., 2008). The Cape hare, *L. capensis* Linnaeus, 1758, although with consistent sampling in the past, do not present recent records being its last reference the Smithers and Tello (1976) (Table 2.3). *Pronolagus crassicaudatus* (I. Geoffroy, 1832) is only listed in Smithers and Tello (1976) with three localities without reference to specimen material (Table 2.3). The fourth hare species *P. rupestris* (A. Smith, 1834) was recently collected and identified in North Mozambique (Bayliss et al., 2010; Bayliss et al., 2014; Timberlake et al., 2009; FMNH 177246). This species distribution is not designated for Mozambique, but for the adjacent countries South Africa, Tanzania, Zambia (Wilson and Reeder, 2005). The species name *P. rupestris* was previously incorporated in *P. crassicaudatus* (Wilson and Reeder, 2005), thus a taxonomic revision is required to determine its taxonomic validity and identity.

Macroscelidea (elephant-shrews)

Five species belonging to three different genera, all from the Macroscelidae family, are reported from Mozambique (Table 2.1). Three of these species were firstly described by W. Peters based on specimens collected during his expedition to Mozambique (Peters, 1852): *Elephantulus fuscus* (Peters, 1852); *Petrodromus tetradactylus* Peters, 1846; and *Rhynchocyon cirnei* Peters, 1847. Two of these, the elephant-shrew *P. tetradactylus*, and the near threatened *R. cirnei*, have been recently recorded as present in North Mozambique (Bayliss et al., 2014; Coals and Rathbun, 2012; Mesochina et al., 2008) (Table 2.3). Regarding the three species of the genus *Elephantulus* Thomas & Schwann, 1906 - *E. brachyrhynchus* (A. Smith, 1836); *E. fuscus*; and *E. myurus* Thomas & Schwann, 1906 - no recent records have been reported since the reference in Smithers and Tello (1976).

One species, *Elephantulus intufi* (A. Smith 1836), was classified as having 'questionable occurrence' in the country based on a single specimen from 'Tette' (Central Mozambique) housed in ZMB, Berlin (ZMB 84906) (Table 2.4). This species is designated to occur in southwest Angola, Namibia, Botswana and North of South Africa (Wilson and Reeder, 2005). Due to lack of recent or additional records, a reassessment of the taxonomic identification of that specimen is needed.

Perissodactyla (Odd-toed ungulates)

In Mozambique, this order is represented by three species from the families Equidae (1 species) and Rhinocerotidae (2 species) (Table 2.3). All species are listed in Smithers and Tello (1976) and have been recently reported in survey reports (AGRECO, 2008; Dunham, 2010; Dunham et al., 2010; GRNB, 2010; Whyte and Swanepoel, 2006).

The survival of the rhinoceros in the country is jeopardized. At the countrywide aerial survey in 2008 less than ten individuals of the white rhinoceros *Ceratotherium simum* (Burchell, 1817), and a single individual of the Critically Endangered *Diceros bicornis* (Linnaeus, 1758) (Black rhinoceros) were reported (AGRECO, 2008).

Pholidota (pangolins)

A single pangolin species was reported from Mozambique, the ground pangolin *Manis temminckii* Smuts, 1832. A total of 17 records are reported by Smithers and Tello (1976) and its presence was recently found in Gilé NP (Mesochina et al., 2008) (Table 2.3). One species, the

pangolin *M. tricupis* Rafinesque, 1821, was classified as having 'questionable occurrence' in the country as its presence is based on a single specimen housed in the MNHN, Paris (MNHN 1851-519) (Table 2.4). Little information is associated with this specimen, and as such, the occurrence of this species in Mozambique deserves further investigation.

Primates (monkeys, apes, e.g.)

Both families of non-human primates occurring in southern Africa, the Cercopithecidae and the Galagidae, are represented in Mozambique. A total of eight species from six genera occur in the country (Table 2.1). Most of the species (7 species) have been previously reported by Smithers and Tello (1976) and were recently recorded in many protected areas (p.e. Agreco 2008; Dunham et al. 2010).

The small-eared galago, *Otolemur garnettii* (Ogilby, 1836), is the only species that is neither listed in Smithers and Tello (1976) nor reported recently. Five specimen records of this species were compiled: three collected by W. Peters with unknown collection locality (ZMB 64281 – ZMB 64283); one specimen collected in 1948 during a Portuguese zoological expedition (IICT: CZ000000502); and another specimen was collected during the Smithsonian Institute's AMP (USNM 352255). These latter two specimens are from South Mozambique.

Proboscidea (elephants)

The compiled data on the occurrence of the elephant *Loxodonta africana* (Blumenbach 1797) in Mozambique are mainly based on observation records. Specimen data from expeditions during the nineteenth and the twentieth century also exist, but in low numbers (14 specimens from six institutions) (Table 2.4). In a national monitoring report, six elephant populations were identified (AGRECO, 2008). The species has been poached over the years, and even inside protected areas, this species is in danger of extinction (Ntumi et al., 2009).

Rodentia (mice, rats, squirrels, porcupines, e.g.)

This order is one of the most species-rich in Mozambique, with 51 species from 31 genera (Table 2.1). Nine families were identified in the country: Anomaluridae (1 species), Bathyergidae (3 species), Gliridae (3 species), Hystricidae (1 species), Muridae (27 species), Nesomyidae (8 species), Pedetidae (1 species), Sciuridae (5 species), and Thryonomyidae (2 species).

About half of the rodent species have recent records of occurrence (Table 2.2). Four rodent species are only referred in Smithers and Tello (1976) and with few records: *Anomalurus derbianus* (Gray 1842); *Gerbilliscus boehmi* (Noack, 1887); *Otomys auratus* Wroughton, 1906; and *Thryonomys gregorianus* (Thomas, 1894). On the other hand, seven listed species were not previously reported by Smithers and Tello (1976): *Dendromus nyikae* Wroughton, 1909; *Graphiurus microtis* (Noack, 1887); *Grammomys macmillani* (Wroughton, 1907); *Mus neavei* (Thomas, 1910); *Aethomys ineptus* (Thomas & Wroughton, 1908); *Beamys major* Dollman, 1914; and *Praomys delectorum* (Thomas, 1910).

The presence of the Mozambican endemic *Paraxerus vincenti* Hayman, 1950 was recently confirmed (FMNH 183736; FMNH 183737; Timberlake et al., 2009). Known records of this Endangered species are from Mount Namuli (North Mozambique) (Wilson and Reeder, 2005).

A total of four Muridae and two Nesomyidae species were classified as having 'questionable occurrence': *Aethomys kaiseri* (Noack, 1887); *A. silindensis* Roberts, 1938; *Gerbilliscus validus* (Bocage, 1890); *Mastomys coucha* (Smith, 1834); and *Dendromus mesomelas* (Brants, 1827); *Steatomys krebsii* Peters, 1852 (Table 2.4).

As it was not our objective to compile introduced species or commensal species, they were not incorporated in the Species checklist. However, we would like to mention that records from three non-native species were gathered during this study. These were recently recorded during the 'African Rodentia' project: *Rattus rattus* (Linnaeus, 1758) with 75 records; *R. norvegicus* (Berkenhout, 1769) with 18 records; and *Mus musculus* Linnaeus, 1758 with 248 records (see Appendix B for specimens' identifiers). The three species were recorded through all biogeographical regions indicating that respective populations are well established in the country.

Tubulidentata (Aardvarks)

This order is represented in Mozambique by a single species, the aardvark, *Orycteropus afer* (Pallas, 1766). Most of the records compiled for the species are listed in Smithers and Tello (1976). Recent reports refer its presence at Quirimbas NP and Gilé NR, North Mozambique (GRNB, 2010; Mesochina et al., 2008).

2.4 Discussion

The present study integrated mammal occurrence records from several data sources and, thus, contributed to the update of Mozambique's terrestrial mammals' checklist, pinpointing to species and specimens in need of occurrence and taxonomic re-evaluation. Additionally, the methodological approach here presented can be easily adapted to produce species checklists of crucial importance to countries facing a similar lack of knowledge regarding the elements of their biodiversity. The diversity of terrestrial mammals found for Mozambique is yet most likely an underestimation of the country's mammal diversity, despite the 14% increment in the number of species in comparison with Smithers and Tello (1976). When compared with the number of species listed for adjacent countries, such as South Africa (247 species; Groombridge and Jenkins, 1994) or Zimbabwe (270 species; Groombridge and Jenkins, 1994), again, it is apparent that there is still a considerable number of species unaccounted for.

To uncover the potential mammal diversity of Mozambique, further surveys are critical, primarily surveys aiming at specific groups, namely to the less-known ones. Our study shows that Afrosoricidae, Hyracoidea, Lagomorpha, Macroscelidea, and Rodentia were less sampled over the years; also, only half of these smaller mammals were recently reported, and most of them with less than ten records across the country. The work of Monadjem et al. (2010), which targeted the order Chiroptera, shows how surveys aiming specific groups are essential to fill the gaps in knowledge. This work identified 50 bat species, with seven being new records for the country.

Although most mammal orders present a relatively stable taxonomy, our data highlights the need of a re-evaluation of the identity of some species reported from Mozambique. For example, as described before, some of the listed species of the problematic Viverridae family do not have their identity and occurrence confirmed due to lack of specimen reappraisal; also, for the hare species *Pronolagus rupestris* we are cautious on its taxonomic validity and identity. Indeed, when a species presence is based on museum specimens, their reappraisal is possible. Nowadays, this evaluation can count on techniques spanning from classical morphometric analysis to modern molecular analysis (Ceríaco et al., 2016; Moratelli and Wilson, 2014). The reappraisal of these already collected specimens will state their identity, clarify the species' occurrence throughout the country, and contribute to an augmented knowledge on the country's conservation value. In this way, to increase the knowledge of Mozambique's mammal diversity, we plead the attention from mammalogists to the need to study these specimens.

Lastly, and considering that most records integrated into our compilation are from European and North American institutions, the work at this moment presented would significantly improve with the integration of data from African institutions. Therefore, an effort should be made to make these essential collections accessible online in the light of what is surfacing with natural history museums in South Africa and Zimbabwe, currently, contribute with information to the GBIF data portal (Coetzer et al., 2012).

2.4.1 Final remarks

The establishment of species checklists is of utmost importance to the definition of conservation policies and promote the documentation and protection of biodiversity (Amori et al., 2012). We hope that the species checklist here compiled should serve as a taxonomic resource and baseline for researchers, decision-makers, conservationists, and students interested in the Mozambican fauna. The data presented is crucial for biodiversity assessments, as required by the CBD, and furthermore highlights the potential mammal diversity still to uncover in the Republic of Mozambique.

Table 2.3: Checklist of the terrestrial mammals reported for Mozambique.The table presents, for each species, information on the conservation status according to the IUCN (2017); the number of records compiled; the documented distribution given the biogeographical areas: N, North Mozambique; C, Central Mozambique; S, South Mozambique; and the last known reference of occurrence. As assessed by the IUCN, the following labels are used to indicate each species' conservation status: CR, critically endangered; EN, endangered; VU, vulnerable; NT, near threatened; LC, least concern; and DD, data deficient. Source references are detailed in Appendix A.IUCN, International Union for the Conservation of Nature.

Higher taxonomic level and valid species name		Authors/Year	Status	Records	Occurrence	Last reference
Order	**Afrosoricida**					
Family	**Chrysochloridae**					
	Calcochloris obtusirostris	(Peters, 1851)	LC	39	C, S	Downs & Wirminghaus (1997)
	Carpitalpa arendsi	Lundholm, 1955	VU	6	C	Smithers & Tello (1976)
Order	**Cetartiodactyla**					
Family	**Bovidae**					
	Aepyceros melampus	(Lichtenstein, 1812)	LC	334	N, C, S	GNRB (2010)
	Alcelaphus lichtensteinii	(Peters, 1849)	LC	187	N, C, S	AGRECO (2008)
	Cephalophus natalensis	A. Smith, 1834	LC	180	N, C, S	GNRB (2010)
	Connochaetes taurinus	(Burchell, 1823)	LC	185	N, C, S	GNRB (2010)
	Hippotragus equinus	(É. Geoffroy Saint-Hilaire,1803)	LC	45	N, C, S	Dunham (2010)
	H. niger	(Harris, 1838)	LC	283	N, C, S	GNRB (2010)
	Kobus ellipsiprymnus	(Ogilbyi 1833)	LC	280	N, C, S	
	Neotragus moschatus	(Von Dueben, 1846)	LC	115	N, C, S	GNRB (2010)

Table 2.3 continued from previous page

Higher taxonomic level and valid species name		**Authors/Year**	**Status**	**Records**	**Occurrence**	**Last reference**
	Oreotragus oreotragus	(Zimmerman, 1783)	LC	59	N, C, S	GNRB (2010)
	Ourebia ourebi	(Zimmerman, 1783)	LC	157	N, C, S	GNRB (2010)
	Philantomba monticola	(Thunberg, 1789)	LC	24	N, C	GNRB (2010)
	Raphicerus campestris	(Thunberg, 1811)	LC	139	N, C, S	GNRB (2010)
	R. sharpei	Thomas, 1897	LC	71	N, C, S	Dunham et al. (2010)
	Redunca arundinum	(Boddaert, 1785)	LC	684	N, C, S	Stalmans & Peel (2009)
	R. fulvorufula	(Afzelius, 1815)	EN	4	S	Smithers & Tello (1976)
	Sylvicapra grimmia	(Linnaeus, 1758)	LC	963	N, C, S	GNRB (2010)
	Syncerus caffer	(Sparrman, 1779)	LC	229	N, C, S	GNRB (2010)
	Taurotragus oryx	(Pallas, 1766)	LC	202	N, C, S	GNRB (2010)
	Tragelaphus angasii	Gray, 1849	LC	338	N, C, S	Dunham et al. (2010)
	T. scriptus	(Pallas, 1766)	LC	225	N, C, S	GNRB (2010)
	T. strepsiceros	(Pallas, 1766)	LC	475	N, C, S	GNRB (2010)
Family	**Giraffidae**					
	Giraffa camelopardalis	(Linnaeus, 1758)	VU	46	C, S	GNRB (2010)
Family	**Hippopotamidae**					
	Hippopotamus amphibius	Linnaeus, 1758	VU	290	N, C, S	GNRB (2010)
Family	**Suidae**					

Table 2.3 continued from previous page

Higher taxonomic level and valid species name		Authors/Year	Status	Records	Occurrence	Last reference
	Phacochoerus africanus	(Gmelin, 1788)	LC	463	N, C, S	GNRB (2010)
	Potamochoerus larvatus	(F. Cuvier, 1822)	LC	203	N, C, S	GNRB (2010)
Order	**Carnivora**					
Family	**Canidae**					
	Canis adustus	Sundevall, 1847	LC	28	N, C, S	GNRB (2010)
	C. mesomelas	Schreber, 1775	LC	38	N, C, S	GNRB (2010)
	Lycaon pictus	(Temminck, 1820)	EN	56	N, C, S	GNRB (2010)
	Otocyon megalotis	(Desmarest, 1822)	LC	5	S	Smithers & Tello (1976)
Family	**Felidae**					
	Acinonyx jubatus	(Schreber, 1775)	VU	53	N, C, S	Andresen et al. (2012)
	Caracal caracal	(Schreber, 1776)	LC	42	N, C, S	Stalmans & Peel (2009)
	Felis silvestris	Schreber, 1775	LC	56	N, C, S	GNRB (2010)
	Leptailurus serval	(Schreber, 1776)	LC	70	N, C, S	Mesochina et al. (2008)
	Panthera leo	(Linnaeus, 1758)	VU	98	N, C, S	GNRB (2010)
	P. pardus	(Linnaeus, 1758)	VU	137	N, C, S	GNRB (2010)
Family	**Herpestidae**					
	Atilax paludinosus	(G. [Baron] Cuvier, 1829)	LC	31	N, C, S	Smithers & Tello (1976)
	Bdeogale crassicauda	Peters, 1852	LC	10	N, C	Smithers & Tello (1976)

Table 2.3 continued from previous page

Higher taxonomic level and valid species name		Authors/Year	Status	Records	Occurrence	Last reference
	Galerella sanguinea	Ruppell, 1836	LC	75	N, C, S	Timberlake et al. (2009)
	Helogale parvula	(Sundevall, 1847)	LC	27	N, C, S	Mesochina et al. (2008)
	Herpestes ichneumon	(Linnaeus, 1758)	LC	18	N, C, S	Stalmans & Peel (2009)
	Ichneumia albicauda	(G. [Baron] Cuvier, 1829)	LC	32	N, C, S	Smithers & Tello (1976)
	Mungos mungo	(Gmelin, 1788)	LC	79	N, C, S	Timberlake et al. (2009)
	Paracynictis selousi	(de Winton, 1896)	LC	2	C	Smithers & Tello (1976)
	Rhynchogale melleri	(Gray, 1865)	LC	17	N, C, S	Smithers & Tello (1976)
Family	**Hyaenidae**					
	Crocuta crocuta	(Erxleben, 1777)	LC	95	N, C, S	GNRB (2010)
	Hyaena brunnea	(Thunberg, 1820)	NT	7	C, S	Smithers & Tello (1976)
	Proteles cristata	(Sparrman, 1783)	LC	8	C, S	Smithers & Tello (1976)
Family	**Mustelidae**					
	Aonyx capensis	(Schinz, 1821)	NT	14	N, C, S	Smithers & Tello (1976)
	Hydrictis maculicollis	(Lichtenstein, 1835)	NT	4	C, S	Smithers & Tello (1976)
	Ictonyx striatus	(Perry, 1810)	LC	42	N, C, S	Mesochina et al. (2008)
	Mellivora capensis	(Schreber, 1776)	LC	43	N, C, S	GNRB (2010)
	Poecilogale albinucha	(Gray, 1864)	LC	8	N, C, S	FMNH: 177236
Family	**Nandiniidae**					

Table 2.3 continued from previous page

Higher taxonomic level and valid species name		Authors/Year	Status	Records	Occurrence	Last reference
	Nandinia binotata	Gray, 1830	LC	23	N,C	FMNH: 177254
Family	**Viverridae**					
	Civettictis civetta	(Schreber, 1776)	LC	75	N, C, S	GNRB (2010)
	Genetta angolensis [a]	Bocage, 1882	LC	2	N, C	Mesochina et al. (2008)
	G. genetta	(Linnaeus, 1758)	LC	9	C, S	Smithers & Tello (1976)
	G. maculata [a]	Pucheran, 1855	LC	53	N, C, S	IICT: CZ000000579
	G. tigrina	(Von Schreber, 1776)	LC	94	N, C, S	Timberlake et al. (2009)
Order	**Chiroptera**					
Family	**Emballonuridae**					
	Coleura afra	(Peters, 1852)	LC	14	N	Smithers & Tello (1976)
	Taphozous mauritianus	E. Geoffroy, 1818	LC	8	N, C, S	Smithers & Tello (1976)
Family	**Hipposideridae**					
	Cloeotis percivali	Thomas, 1901	LC	2	N, C	Smithers & Tello (1976)
	Hipposideros caffer	(Sundevall, 1846)	LC	112	N, C, S	Monadjem et al. (2010)
	H. ruber [a]	(Noack, 1893)	LC	73	N	Bayliss et al. 2014
	H. vittatus	Peters, 1852	NT	31	N, C, S	Monadjem et al. (2010)
	Triaenops persicus	Dobson, 1871	LC	95	N, C, S	Monadjem et al. (2010)
Family	**Molossidae**					

Table 2.3 continued from previous page

Higher taxonomic level and valid species name		Authors/Year	Status	Records	Occurrence	Last reference
	Chaerephon ansorgei	(Thomas, 1913)	LC	3	N, S	Monadjem et al. (2010)
	C. bivittatus	(Heuglin, 1861)	LC	4	C, S	Smithers & Tello (1976)
	C. nigeriae	Thomas, 1913	LC	10	-	NMZB series
	C. pumilus	(Cretzschmar, 1826)	LC	194	N, C, S	Monadjem et al. (2010)
	Mops condylurus	(A. Smith, 1833)	LC	389		Monadjem et al. (2010)
	M. niveiventer	Cabrera & Ruxton, 1926	LC	3		Smithers & Tello (1976)
	Sauromys petrophilus	(Roberts, 1917)	LC	16		Monadjem et al. (2010)
	Tadarida aegyptiaca	(E. Geoffroy, 1818)	LC	44		Monadjem et al. (2010)
	T. fulminans [a]	(Thomas, 1903)	LC	8		Taylor et al. 2013
	T. ventralis	(Heuglin, 1861)	DD	2		Smithers & Tello (1976)
Family	**Nycteridae**					
	Nycteris grandis	Peters, 1865	LC	2	N, C	Monadjem et al. (2010)
	N. hispida	(Schreber, 1775)	LC	9	N, C, S	Monadjem et al. (2010)
	N. macrotis [a]	Dobson, 1876	LC	4	N, C, S	Monadjem et al. (2010)
	N. thebaica	E. Geoffroy, 1818	LC	166	N, C, S	Monadjem et al. (2010)
	N. vinsoni	Dalquest, 1965	DD	2	C	Smithers & Tello (1976)
Family	**Pteropodidae**					
	Eidolon helvum	(Kerr, 1792)	NT	8	N, C, S	Timberlake et al. (2009)

Table 2.3 continued from previous page

Higher taxonomic level and valid species name		Authors/Year	Status	Records	Occurrence	Last reference
	Epomophorus crypturus	Peters, 1852	LC	37	N, C, S	Monadjem et al. (2010)
	E. labiatus [a]	(Temminck, 1837)	LC	1	N	Monadjem et al. (2010)
	E. wahlbergi	(Sundevall, 1846)	LC	117	N, C, S	Bayliss et al. (2014)
	Lissonycteris angolensis	Bergmans, 1997	LC	9	N, C	Monadjem et al. (2010)
	Myonycteris relicta [a]	Bergmans, 1980	LC	1	C	Monadjem et al. (2010)
	Rousettus aegyptiacus	(E. Geoffroy, 1810)	LC	65	N, C, S	Bayliss et al. 2014
Family	**Rhinolophidae**					
	Rhinolophus blasii	Peters, 1866	LC	9	N, C	Bayliss et al. 2014
	R. capensis	Lichtenstein, 1823	LC	4	N, C	FMNH: 177109
	R. clivosus	Cretzschmar, 1828	LC	17	N, C	Bayliss et al. 2014
	R. darlingi	K, Andersen, 1905	LC	5	N, C	Smithers & Tello (1976)
	R. deckenii [a]	Peters, 1837	NT	1	C	Monadjem et al. (2010)
	R. denti	Thomas, 1904	LC	3	N, C	Smithers & Tello (1976)
	R. fumigatus	Ruppell, 1842	LC	12	N, C	Monadjem et al. (2010)
	R. gorongosae	Taylor et al. 2018		1	C	Taylor et al. (2018)
	R. hildebrandtii	Peters, 1878	LC	79	N, C, S	Bayliss et al. (2010)
	R. lobatus	Peters, 1852	LC	60	N, C, S	Monadjem et al. (2010)
	R. mabuensis [a]	Taylor et al. 2012		3	N	Taylor et al. (2012)

Table 2.3 continued from previous page

Higher taxonomic level and valid species name		Authors/Year	Status	Records	Occurrence	Last reference
	R. cf. maendeleo [a]	Kock, Csorba, Howell, 1999	DD	1	N	Monadjem et al. (2010)
	R. mossambicus [a]	Taylor et al. 2012	LC	6	N,C	Taylor et al. (2012)
	R. rhodesiae	Roberts, 1946		1	C	Taylor et al. (2018)
	R. simulator	K, Andersen, 1904	LC	11	N, C	Monadjem et al. (2010)
	R. swinnyi	Gough, 1908	LC	19	N, C, S	Bayliss et al. (2010)
Family	**Vespertilionidae**					
	Eptesicus hottentotus	(A. Smith, 1833)	LC	8	N	Monadjem et al. (2010)
	Glauconycteris variegata	(Tomes, 1861)	LC	7	C, S	Monadjem et al. (2010)
	Kerivoula argentata	Tomes, 1861	LC	6	N, C, S	Monadjem et al. (2010)
	K. lanosa	(A. Smith, 1847)	LC	2	C,S	Monadjem et al. (2010)
	K. cf. phalaena [a]	Thomas, 1912	LC	2	N	Bayliss et al. 2014
	Laephotis botswanae [a]	Setzer, 1971	LC	3	N	Bayliss et al. 2014
	Miniopterus fraterculus	Thomas & Schwann, 1906	LC	23	N, C, S	Bayliss et al. 2014
	M. inflatus	Thomas, 1903	LC	34	N, C	Monadjem et al. (2010)
	M. mossambicus	Monadjem et al., 2013		6	N	Monadjem et al. (2013)
	M. natalensis	(A. Smith, 1833)	LC	79	N, C, S	Bayliss et al. 2014
	Myotis bocagii	(Peters, 1870)	LC	10	N, C	Monadjem et al. (2010)
	M. tricolor	(Temminck, 1832)	LC	15	N, C	Bayliss et al. 2014

Table 2.3 continued from previous page

Higher taxonomic level and valid species name		Authors/Year	Status	Records	Occurrence	Last reference
	M. welwitschii	(Gray, 1866)	LC	3	C, S	Smithers & Tello (1976)
	Neoromicia capensis	A. Smith, 1829	LC	8	C, S	Monadjem et al. (2010)
	N. melckorum	(Roberts, 1919)	DD	3	C	Smithers & Tello (1976)
	N. nana	Peters, 1852	LC	257	N, C, S	Monadjem et al. (2010)
	N. rendalli	Thomas, 1889	LC	3	N, C, S	Monadjem et al. (2010)
	N. zuluensis [a]	Roberts, 1924	LC	4	N, C	Monadjem et al. (2010)
	Nycticeinops schlieffenii	(Peters, 1859)	LC	38	N, C, S	Monadjem et al. (2010)
	Pipistrellus hesperidus	Temmink, 1840	LC	11	N, C, S	Monadjem et al. (2010)
	P. rusticus	(Tomes, 1861)	LC	1	N	Timberlake et al. (2009)
	Scotoecus albigula [a]	Thomas, 1909	LC	4	N, C, S	Monadjem et al. (2010)
	Scotophilus dinganii	(A. Smith, 1833)	LC	41	N, C, S	Monadjem et al. (2010)
	S. leucogaster [a]	Cretzschmar, 1830	LC	1	S	Monadjem et al. (2010)
	S. nigrita	(Schreber, 1774)	LC	4	C	Smithers & Tello (1976)
	S. viridis	(Peters, 1852)	LC	56	N, C, S	Monadjem et al. (2010)
Order	**Eulipotyphla**					
Family	**Soricidae**					
	Crocidura cyanea	(Duvernoy, 1838)	LC	14	N, C, S	Smithers & Tello (1976)
	C. fuscomurina	(Heuglin, 1865)	LC	9	N, C, S	Smithers & Tello (1976)

Table 2.3 continued from previous page

Higher taxonomic level and valid species name		Authors/Year	Status	Records	Occurrence	Last reference
	C. hirta	Peters, 1852	LC	144	N, C, S	GNRB (2010)
	C. luna	Dollman, 1910	LC	72	N, C	Bayliss et al. 2014
	C. mariquensis	(A. Smith, 1844)	LC	9	N, C, S	Timberlake et al. (2009)
	C. olivieri	(Lesson, 1827)	LC	23	N, C	FMNH: 177207
	C. silacea [a]	Thomas, 1895	LC	26	N, C, S	Bayliss et al. 2014
	Myosorex meesteri	Taylor et al., 2013		33	N, C	Taylor et al. (2013)
	Suncus megalura	Jentink, 1888	LC	4	N, C	Smithers & Tello (1976)
Order	**Hyracoidea**					
Family	**Procaviidae**					
	Dendrohyrax arboreus	(A. Smith, 1827)	LC	9	C	Smithers & Tello (1976)
	Heterohyrax brucei	(Gray, 1868)	LC	22	N, C, S	Bayliss et al. (2010)
	Procavia capensis	(Pallas, 1766)	LC	30	N, C, S	Bayliss et al. 2014
Order	**Lagomorpha**					
Family	**Leporidae**					
	Lepus capensis	Linnaeus, 1758	LC	45	N, C, S	Smithers & Tello (1976)
	L. victoriae	Thomas, 1893	LC	143	N, C, S	GNRB (2010)
	Pronolagus crassicaudatus	(I. Geoffroy, 1832)	LC	3	N, C, S	Smithers & Tello (1976)

Table 2.3 continued from previous page

Higher taxonomic level and valid species name		Authors/Year	Status	Records	Occurrence	Last reference
	P. rupestris [a]	(A. Smith, 1834)	LC	4	N	Bayliss et al. 2014
Order	**Macroscelidea**					
Family	**Macroscelididae**					
	Elephantulus brachyrhynchus	(A. Smith, 1836)	LC	53	N, C, S	Smithers & Tello (1976)
	E. fuscus	(Peters, 1852)	DD	18	N, C	Smithers & Tello (1976)
	E. myurus	Thomas & Schwann, 1906	LC	11	N, C, S	Smithers & Tello (1976)
	Petrodromus tetradactylus	Peters, 1846	LC	122	N, C, S	Timberlake et al. (2009)
	Rhynchocyon cirnei	Peters, 1847	LC	32	N	Bayliss et al. 2014
Order	**Perissodactyla**					
Family	**Equidae**					
	Equus quagga burchelli	(Gray, 1824)	NT	257	N, C, S	GNRB (2010)
Family	**Rhinocerotidae**					
	Ceratotherium simum	(Burchell, 1817)	NT	15	C, S	AGRECO (2008)
	Diceros bicornis	(Linnaeus, 1758)	CR	38	N, C, S	AGRECO (2008)
Order	**Pholidota**					
Family	**Manidae**					
	Manis temminckii	Smuts, 1832	VU	21	N, C, S	Mesochina et al. (2008)
Order	**Primates**					

Table 2.3 continued from previous page

Higher taxonomic level and valid species name		Authors/Year	Status	Records	Occurrence	Last reference
Family	**Cercopithecidae**					
	Cercopithecus mitis	Wolf, 1822	LC	64	N, C, S	GNRB (2010)
	Chlorocebus pygerythrus	Cuvier, 1821	LC	129	N, C, S	GNRB (2010)
	Papio cynocephalus	(Linnaeus, 1766)	LC	60	N, C	GNRB (2010)
	P. ursinus	(Kerr, 1792)	LC	101	N, C, S	Dunham et al. (2010)
Family	**Galagidae**					
	Galago moholi	A. Smith, 1836	LC	57	N, C, S	GNRB (2010)
	Otolemur crassicaudatus	(E. Geoffroy, 1812)	LC	186	N, C, S	Dowsset-Lemaire et al (2009)
	O. garnettii [a]	(Ogilby, 1836)	LC	5	S	USNM: 352255
	Paragalago granti [b]	(Thomas & Wroughton 1907)	LC	54	N, C, S	Timberlake et al. (2009)
Order	**Proboscidea**					
Family	**Elephantidae**					
	Loxodonta africana	(Blumenbach, 1797)	VU	545	N, C, S	GNRB (2010)
Order	**Rodentia**					
Family	**Anomaluridae**					
	Anomalurus derbianus	(Gray, 1842)	LC	2	N	Smithers & Tello (1976)
Family	**Bathyergidae**					
	Cryptomys darlingi	Thomas, 1895	LC	60	C, S	Smithers & Tello (1976)

Table 2.3 continued from previous page

Higher taxonomic level and valid species name		Authors/Year	Status	Records	Occurrence	Last reference
	C. hottentotus	(Lesson, 1826)	LC	12	C, S	FMNH: 214827
	Heliophobius argenteocinereus	Peters, 1846	LC	16	N	FMNH: 183861
Family	**Gliridae**					
	Graphiurus microtis [a]	(Noack 1887)	LC	7	C, S	USNM: 352929
	G. murinus	(Desmarest, 1822)	LC	25	N, C, S	FMNH: 183735
	G. platyops	Thomas, 1897	LC	3	C, S	Smithers & Tello (1976)
Family	**Hystricidae**					
	Hystrix africaeaustralis	Peters 1852	LC	52	N, C, S	GNRB (2010)
Family	**Muridae**					
	Acomys ngurui	Verheyen et al. ,2011		12	N	Petruzela et al. (2018)
	A. selousi	de Winton, 1896		1	S	Petruzela et al. (2018)
	A. spinosissimus	Peters, 1852	LC	264	N, C, S	Petruzela et al. (2018)
	Aethomys chrysophilus	(de Winton, 1897)	LC	272	N, C, S	Mazoch et al. (2017)
	A. ineptus	(Thomas & Wroughton, 1908)	LC	2	C, S	Mazoch et al. (2017)
	Dasymys incomtus	(Sundevall, 1847)	LC	43	N, C, S	Timberlake et al. (2009)
	Gerbilliscus boehmi	(Noack, 1887)	LC	4	N	Smithers & Tello (1976)
	G. inclusus	Thomas & Wroughton, 1908	LC	21	N, C	FMNH: 214890
	G. leucogaster	(Peters, 1852)	LC	148	N, C, S	RMCA: 100289

Table 2.3 continued from previous page

Higher taxonomic level and valid species name	Authors/Year	Status	Records	Occurrence	Last reference
Gerbillurus paeba	(A. Smith, 1836)	LC	3	C, S	Smithers & Tello (1976)
Grammomys cometes	(Thomas & Wroughton, 1908)	LC	25	C, S	FMNH: 214896
G. dolichurus	(Smuts, 1832)	LC	90	N, C, S	FMNH: 214907
G. macmillani [a]	(Wroughton, 1907)	LC	8	C	USNM: 366061
Lemniscomys rosalia	(Thomas, 1904)	LC	171	N, C, S	FMNH: 214908
Lophuromys flavopunctatus	Thomas, 1888	LC	35	N	Bayliss et al. (2014)
Mastomys natalensis	(Smith, 1834)	LC	212	N, C, S	Colangelo et al (2013)
Micaelamys namaquensis	(A. Smith, 1834)	LC	35	N, C, S	Timberlake et al. (2009)
Mus minutoides	Smith, 1834	LC	103	N, C, S	Timberlake et al. (2009)
M. neavei [a]	(Thomas, 1910)	DD	4	N	USNM: 366998
M. triton	(Thomas, 1909)	LC	99	N, C, S	Bayliss et al. (2014)
Otomys angoniensis	Wroughton, 1906	LC	26	N, C, S	Timberlake et al. (2009)
O. auratus[c]	Wroughton, 1906	NT	5	C	Smithers & Tello (1976)
Pelomys fallax	(Peters, 1852)	LC	50	N, C, S	FMNH: 183810
Praomys delectorum [a]	(Thomas, 1910)	LC	83	N	Bayliss et al (2014)
Rhabdomys dilectus	(de Winton, 1897)	LC	32	C, S	FMNH: 214913
Thallomys paedulcus	(Sundevall, 1846)	LC	25	N, C, S	Smithers & Tello (1976)
Uranomys ruddi	Dollman, 1909	LC	11	C	Smithers & Tello (1976)

Table 2.3 continued from previous page

Higher taxonomic level and valid species name		Authors/Year	Status	Records	Occurrence	Last reference
Family	**Nesomyidae**					
	Beamys major	Dollman, 1914	LC	7	N	Bayliss et al. 2014
	Cricetomys gambianus	Waterhouse, 1840	LC	32	N, C, S	FMNH: 214880
	Dendromus melanotis	Smith, 1834	LC	22	N , C, S	FMNH: 214883
	D. mystacalis	Heuglin, 1863	LC	12	N, C, S	Timberlake et al. (2009)
	D. nyikae [a]	Wroughton, 1909	LC	3	C, S	USNM: 367214
	Saccostomus campestris	Peters, 1846	LC	259	N, C, S	FMNH: 214881
	Steatomys parvus	Rhoads, 1896	LC	2	N	Smithers & Tello (1976)
	S. pratensis	Peters, 1846	LC	40	N, C, S	Smithers & Tello (1976)
Family	**Pedetidae**					
	Pedetes capensis	(Forster 1778)	LC	52	C, S	Smithers & Tello (1976)
Family	**Sciuridae**					
	Heliosciurus mutabilis	(Peters, 1852)	LC	50	N, C, S	Bayliss et al. (2014)
	Paraxerus cepapi	(A. Smith, 1836)	LC	98	N, C, S	FMNH: 89995
	Paraxerus flavovittis	(Peters, 1852)	LC	15	N	FMNH: 34140
	P. palliatus	(Peters, 1852)	LC	62	N, C, S	GNRB (2010)
	P. vincenti	Hayman, 1950	EN	5	N	Timberlake et al. (2009)
Family	**Thryonomyidae**					

Table 2.3 continued from previous page

Higher taxonomic level and valid species name		Authors/Year	Status	Records	Occurrence	Last reference
	Thryonomys gregorianus	(Thomas, 1894)	LC	3	C	Smithers & Tello (1976)
	T. swinderianus	(Temminck, 1827)	LC	34	N, C, S	GNRB (2010)
Order	**Tubulidentata**					
Family	**Orycteropodidae**					
	Orycteropus afer	(Pallas, 1766)	LC	77	N	GNRB (2010)

a Species not included in Smithers and Tello (1976).

b Recent taxonomic change: Masters, J.C. et al., 2017, ‘A new genus for the eastern dwarf galagos (Primates: Galagidae)’, Zoological Journal of the Linnean Society (e-published).

c Recent taxonomic change: Engelbrecht, A., Taylor, P.J., Daniels, S.R. and Rambau, R.V., 2011, ‘Cryptic speciation in the southern African vlei rat *Otomys irroratus* complex: evidence derived from mitochondrial cyt b and niche modelling’, Biological Journal of the Linnean Society 104, 192–206.

Table 2.4: List of terrestrial mammals with questionable occurrence reported for Mozambique. The table presents, for each species, information on the conservation status according to the IUCN (2017); the number of records compiled; the documented distribution given the biogeographical areas: N, North Mozambique; C, Central Mozambique; S, South Mozambique; and the last known reference of occurrence. As assessed by the IUCN, the following labels are used to indicate each species' conservation status: CR, critically endangered; EN, endangered; VU, vulnerable; NT, near threatened; LC, least concern; and DD, data deficient. Source references are detailed in Appendix 1. IUCN, International Union for the Conservation of Nature.

Higher taxonomic level and valid species name	**Authors/Year**	**Status**	**Records**	**Occurrence**	**Last reference**
Order Cetartiodactyla					
Antidorcas marsupialis	(Zimmermann, 1780)	LC	1	N	MNCN: 5124
Litocranius walleri [a]	(Brooke, 1879)	NT	1	-	SNOMNH: 19828
Tragelaphus spekii [a]	Sclater, 1863	LC	1	N	UNSM: 15192
Order Chiroptera					
Epomophorus gambianus	(Ogilby, 1835)	LC	1	N	MHNG-MAM-1971.002
Mops thersites [b]	Thomas, 1903	LC	1	N	Smithers & Tello (1976)
Nyctalus noctula [b]	Schreber, 1774	LC	1	N	Smithers & Tello (1976)
Nycteris woodi [a]	K. Andersen, 1914	LC	1	C	USNM: 365176
Pipistrellus rueppellii [a]	(J. Fischer, 1829)	LC	1	C	ROM: 51088
Scotoecus albofuscus	(Thomas, 1890)	DD	1	S	Smithers & Tello (1976)
Tadarida lobata	(Thomas, 1891)	LC	1	C	FMNH: 214722

Table 2.4 continued from previous page

Higher taxonomic level and valid species name		Authors/Year	Status	Records	Occurrence	Last reference
	Taphozous perforatus	E. Geoffroy, 1818	LC	1	C	Smithers & Tello (1976)
Order	**Eulipotyphla**					
	Crocidura nigrofusca [a]	Matschie, 1895	LC	1	N	USNM: 365077
	Crocidura flavescens	(I. Geoffroy, 1827)	LC	1	S	Smithers & Tello (1976)
	Suncus lixus	(Thomas, 1898)	LC	1	S	Smithers & Tello (1976)
	S. varilla	(Thomas, 1895)	LC	1	C	Smithers & Tello (1976)
Order	**Macroscelidea**					
	Elephantulus intufi [a]	(A. Smith, 1836)	LC	1	C	ZMB: 84906
Order	**Pholidota**					
	Manis tricuspis [a]	Rafinesque, 1821	VU	1	N	MNHN: 1851-519
Order	**Rodentia**					
	Aethomys kaiseri [a]	(Noack, 1887)	LC	1	N	USNM: 366090
	A. silindensis	Roberts, 1938	DD	1	C	Smithers & Tello (1976)
	Dendromus mesomelas	(Brants, 1827)	LC	1	C	Smithers & Tello (1976)
	Gerbilliscus validus [a]	(Bocage, 1890)	LC	1	C	IICT: CZ000000397

Table 2.4 continued from previous page

Higher taxonomic level and valid species name	Authors/Year	Status	Records	Occurrence	Last reference
Mastomys coucha	(Smith, 1834)	LC	1	C	MCZ: 46303
Steatomys krebsii [a]	Peters, 1852	LC	2	C	USNM: 367225

a Species not included in (Smithers and Tello, 1976)

b Species identified as errors in taxa identification (Monadjem et al., 2010)

2.5 Supplementary figures

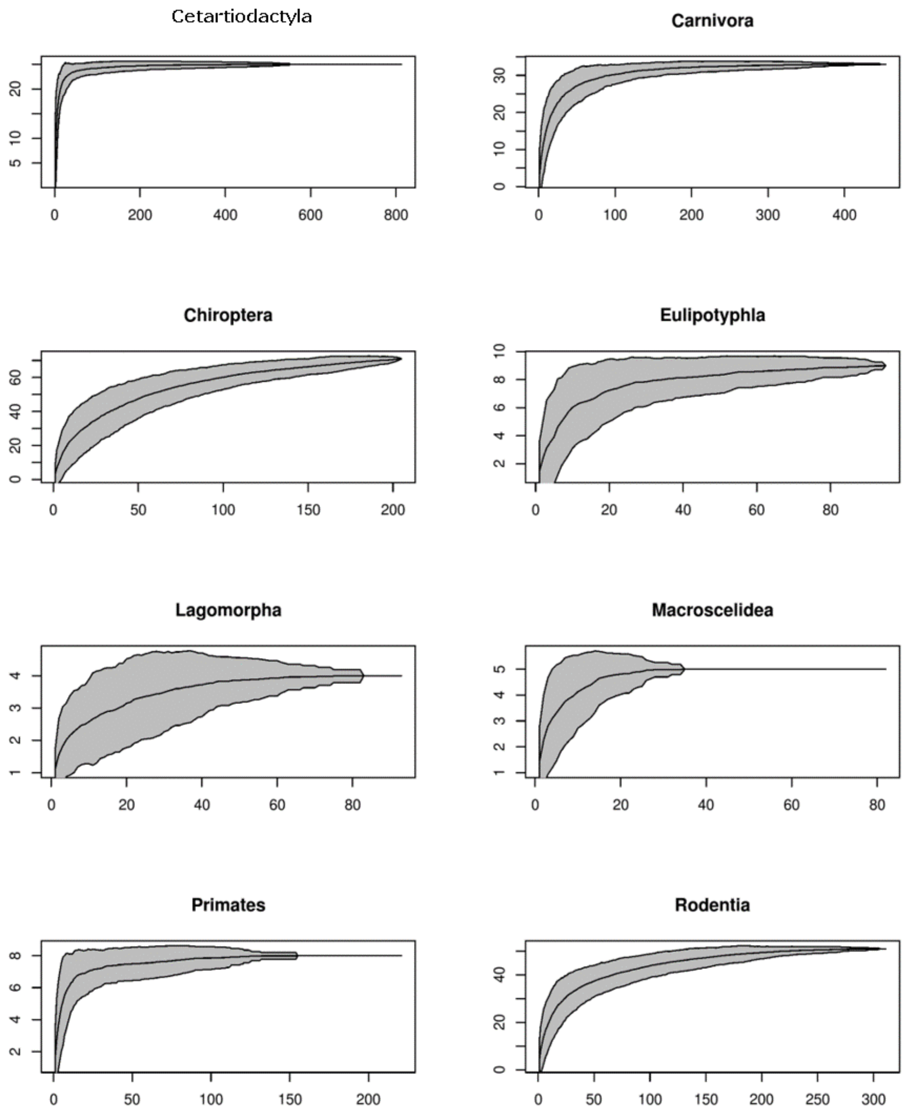

Figure 2.S1: Species accumulations curves (SAC) representing the cumulative number of species with the increase in the number of records for Mozambique's grid-cells (0.25º), for each mammal order with more than two species of terrestrial mammals reported from Mozambique. SACs were computed using the grid cells as a surrogate measure of sampling effort. To smoothen the curve of species richness the number of species accumulated was obtained by adding cells in a random order with 100 permutations.

3

Mapping gaps in knowledge

Contents

CHAPTER 3

Mapping gaps in knowledge

"To know that we know what we know, and that we do not know what we do not know, this is true knowledge."

Henry David Thoreau, Walden, 1854

ABSTRACT

A valuable strategy to support conservation planning is to assess knowledge gaps regarding primary species occurrence data to identify and select areas for future biodiversity surveys. Currently, increasing accessibility to these data allows a cost-effective method for boosting knowledge about a country's biodiversity. For understudied countries where the lack of resources for conservation is more pronounced to resort to primary biodiversity data can be especially beneficial. Here, using a primary species occurrence dataset, we assessed and mapped Mozambique's knowledge gaps regarding terrestrial mammal species by identifying areas that are geographically distant and environmentally different from well-inventoried sites. By comparing gaps from old and recent primary species occurrence data, we identified:(i) gaps of knowledge over time, (ii) the lesser-known taxa, and (iii) areas with potential for spatiotemporal studies.Our results show that Mozambique's mammal fauna is well documented in less than 5% of the territory, with broad areas of the country poorly sampled or not sampled at all. The knowledge gap areas are mostly associated with two ecoregions. The provinces lacking documentation coincide with areas over-explored for natural resources, and many such sites may never be documented. It is our understanding that by prioritising the survey of the knowledge-gap areas will likely produce new records for the country and, continuing the study of the well-known regions will guarantee their potential use for spatiotemporal studies. The implemented approach to assess the knowledge gaps from primary species occurrence data proved to be a powerful strategy to generate information that is essential to species conservation and management plan. However, we are aware that the impact of digital and openly available data depends mostly on its completeness and accuracy, and thus we encourage action from the scientific community and government authorities to support and promote data mobilisation.

Manuscript: Queirós Neves, I., Mathias, M.L., Bastos-Silveira, C. (2019) Mapping knowledge gaps of Mozambique's terrestrial mammals. *Scientific Reports 9*(18184). https://doi.org/10.1038/s41598-019-54590-4

3.1 Introduction

Effective conservation planning relies on insightful knowledge and data acquisition about species occurrence and distribution (Boitani et al., 2011). Primary species-occurrence data across dispersed data sources can be a cost-effective resource for boosting knowledge about a country's biodiversity (Sousa-Baena et al., 2014). Particularly for poorly documented countries filling data gaps is crucial for new and broad insights for biodiversity research and conservation. Research-neglected regions, which lack quality information, are mainly the species-rich and developing nations (Gaikwad and Chavan, 2006).

Mozambique, in Southeastern Africa (Figure 3.1), holds a rich, but poorly documented, biodiversity (Monadjem et al., 2010; Sitoé et al., 2015). One of the main contributing factor for this scenario is the country's political instability from 1964 to 1992, due to a long period of war, leading to species extirpations and irregular migrations, degradation of important ecosystems and a scarcity of biodiversity studies (Hatton et al., 2001). Despite recent monitoring efforts, mainly in protected areas, and contributions that greatly improved current knowledge on several taxonomic groups, there remains a significant lack of knowledge regarding the occurrence and distribution of most Mozambican species (Chapter 2). The inventory of terrestrial mammals from Mozambique compiled in Chapter 2 reports a total of 217 species for the country. From that compilation of primary biodiversity data, we detected a taxonomic bias in the data towards large mammal groups, with only half of the small mammal species recorded during the last two decades.

The extent of biases in primary species occurrence data, in general, for different regions or taxa, often results in over-representation of particular species or localities, concealing the real patterns of species distribution (Boitani et al., 2011; Graham et al., 2007; Hortal et al., 2015, 2007; Lobo, 2008; Stockwell and Peterson, 2002; Stropp et al., 2016). These biases are frequently a result of the historical, scientific interest in some areas, such as protected areas, and the inaccessibility of the other regions far from roads or river networks (Chapman, 2005). In the last decade, to overcome these data challenges, several authors made an effort to develop tools to analyse and describe biases and knowledge gaps in primary species-occurrence data (García Márquez et al., 2012; Ladle and Hortal, 2013; Robertson et al., 2016; Ruete, 2015; Sousa-Baena et al., 2014). The premise is that knowledge of data biases and uncertainty is fundamental to interpreting the mapped species distribution adequately (Lütolf et al., 2006; Stockwell and Peterson, 2002; Yang et al., 2013). Despite these efforts, biased data for a large

number of species weakens the utility of the compiled species distribution maps, especially for the species-rich countries in the tropics (Anderson, 2012; Cayuela et al., 2009).

A useful strategy to support conservation planning is the assessment of knowledge gaps from primary species occurrence data to select areas for future biodiversity surveys. The evaluation of gaps from primary data can be achieved by calculating inventory completeness (i.e. the fraction of species in a given location that has been sampled) and by selecting areas with insufficient sampling and that are geographically distant and environmentally different from the well-known areas (Asase and Peterson, 2016; Koffi et al., 2015; Sousa-Baena et al., 2014). For understudied countries where the lack of resources for conservation is pronounced (Balmford et al., 2003), this strategy is particularly beneficial as survey effort focused on areas less visited and unique will likely produce new records or new species (Sousa-Baena et al., 2014; Stropp et al., 2016).

In the present work, we assessed knowledge gaps on terrestrial mammal species from Mozambique aiming to provide baseline information for conservation planning. To achieve this goal, we evaluated:

1. the spatial and environmental biases of the mammal inventory in Mozambique;
2. cell-wide inventory completeness, and
3. sites with incomplete sampling that are geographically and environmentally unique.

The approach here followed, which can be applied to other understudied countries, has the potential to generate reliable biodiversity information that can contribute towards effective conservation and management planning.

3.2 Material and methods

3.2.1 Study area

The Republic of Mozambique, located on the Indian coast of southeast Africa, holds an extensive coastal territory of more than 800,000 square kilometers (Figure 3.1). The climate is generally tropical and dry, but temperature and precipitation are highly variable throughout the country (McSweeney et al., 2010). The country is considered vulnerable to natural disasters and currently presents an increasing incidence of flood and drought events Brida et al. (2013); INGC (2009). The centre of the country, recently impacted by cyclone Idai, is more prone to floods and tropical cyclones, followed by the south and the north (Brida et al., 2013).

Figure 3.1: a) Map of Mozambique, with the indication of the protected areas and the rivers that divide the country into three major biogeographical areas (dark line): North Mozambique, Central Mozambique and South Mozambique; and b) Inset with the location of the Republic of Mozambique on the African continent.

Notes: The country's protected areas are indicated with a number: 1. Niassa national reserve, 2. Quirimbas national park, 3. Lake Niassa partial reserve, 4. Gilé national reserve, 5. Mágoè national park, 6. Gorongosa national park, 7. Marromeu national reserve, 8. Chimanimani national reserve, 9. Zinave national park, 10. Bazaruto national park, 11. Limpopo national park, 12. Banhine national park, 13. Cabo São Sebastião Total protection area, 14. Maputo special reserve, 15 – Ponta do Ouro national reserve, 16-Malhazine national reserve, 17. Primeiras e Segundas islands environmental protection area, 18. Pomene national reserve. Protected areas' shapefile was downloaded from Biofund platform of conservation areas (http://www.biofund.org.mz/en/database/platform-of-the-conservation-areas/). km, kilometres

A large part of Mozambique's topography is characterised by flat terrain extending from coastal lowlands in the east to mountain ranges in the west (Figure 3.1). The country has a high diversity of terrestrial ecosystems representing five biomes subdivided into 13 ecoregions (Burgess et al., 2004). The Eastern miombo woodlands ecoregion covers a large area of the country, mostly in northern Mozambique, followed by the Zambezian and Mopane woodlands ecoregion, in central and southern Mozambique, the Southern Miombo woodlands ecoregion, in central Mozambique, and the Southern Zanzibar-Inhambane coastal forest ecoregion, along most of the coast of the country.

3.2.2 Terrestrial mammal inventory

We used the primary species occurrence data on terrestrial mammals from Mozambique compiled and validated in Chapter 2. The following sources of species occurrence data were considered in that compilation: (i) natural history collections, mainly data from the Global Biodiversity Information Facility portal (GBIF), (ii) survey reports on the main protected areas and other areas of ecological interest; and (iii) literature, including the first published species checklist of Mozambican mammals (Smithers and Tello, 1976).

As described in Chapter 2, data was validated by thorough data cleaning and filtering processes. Here, we analysed the underlying data that made up the species checklist, holding a total of 14981 records (Table 3.1). Approximately, 34.2% of the records were reported from surveys, 33.1% from natural history collections, and the remaining 32.7% from the literature.

The species-occurrence data were reduced to unique records to avoid duplication of information. Accordingly, each unique record represents a pool of registries from a single species collected in the same locality, by the same collector, on the same day. Localities of occurrence were considered identical when latitude and longitude (with 2-digit precision) coincided.

3.2.3 Data treatment

Records were aggregated to a 0.25° spatial resolution grid, and the total number of grid cells across the country was 1217. This spatial resolution was selected by assessing the balance between the accuracy of aggregated data versus the loss of spatial resolution, as in Asase and Peterson (2016) and Hortal et al. (2007) (Figure 3.S1 shows three different data resolutions). All analyses and mapping in this study were carried out in the R programming environment (R-Core-Team, 2018).

To obtain general information on the proportion of each ecoregion cover across the country and the respectively assigned species richness, we extracted the terrestrial ecoregion (and associated biome) at the centroid of each 0.25° cell by overlaying the grid on the ecoregions map (Burgess et al., 2004). Thus, each grid cell was attributed to a terrestrial ecoregion. A sensitivity analysis using other assignment rules was performed (Figure 3.S8). Even though we observed a slight variation in the number of cells assigned to each ecoregion, which is higher for the ecoregions with smaller cover in the country, the results suggested that the "Cell centroid method" is robust for our analysis, with little variation in the final results (Figure 3.S8, Figure 3.S9). The ecoregions and biomes considered for Mozambique in this study followed the work on African terrestrial biomes, ecoregions and habitats by Burgess et al. (2004). We obtained data on ecoregions from the World-Wide Foundation Terrestrials Ecoregions of the World dataset (WWF; `www.worldwildlife.org/publications/terrestrial-ecoregions-of-the-world`).

Different sampling intensity and methods can influence data bias and gaps (Phillips et al., 2006). Overall, mammals, with such a wide range in size, can be targeted by many different sampling techniques; from the aerial census for megafauna or trapping for smaller species. To capture the potential bias in the knowledge generated by different approaches, records were classified according to the corresponding species size. Thus, records were organised according to mammal size taking into account adult average body mass:

1. small mammals with an average body mass of fewer than five kilograms(Stoddart 1979)
2. large mammals with an average body mass over 25 kilograms and
3. medium mammals with a body size between the previous classes.

Most data on species adult average body mass were retrieved from the species traits database, PanTHERIA (Jones et al., 2009).

3.2.4 Record density and bias analysis

The examination of the biases underlying primary species occurrence data can avoid erroneous interpretations of the resultant spatial patterns (Hortal et al., 2015). Therefore, firstly, record density estimates (RDE) were investigated to understand how the inventory's records are distributed across the country. RDE were determined through point pattern analysis, as proposed in García Márquez et al. (2012). Geographical coordinates of the localities of occurrence represented the "points" in the analysis. First, we calculated RDE as the average number of localities per 0.25° grid cell and, subsequently, we created density maps using an isotropic Gaussian ker-

nel.

Next, we performed a bias analysis. This assessment will allow a better understanding not only of which factors may contribute to spatial bias but also check whether spatial biases represent environmental biases as well. The magnitude of spatial bias in the records was defined by splitting each bias factor into four intervals, using the Fisher algorithm, based on the range of the measured distances to the factor analysed (Fisher, 1958). The Fisher algorithm selects classes in which both similar values are grouped, and the difference between classes area is maximized (García Márquez et al., 2012). Hence, "interval 1" represented the area where distances to the bias factor are smallest, while in "interval 4" distances were highest.

The spatial variables considered as potential bias factors were: i) distance to protected areas; ii) distance to main roads; and iii) distance to province capital cities. The bias was quantified for each interval following Kadmon et al. (2004) and García Márquez et al. (2012):

$$Bias_i = \frac{n_i - p_i N}{\sqrt{p_i(1-p_i)N}} \tag{3.1}$$

Where,

n_i is the number of localities of occurrence within a specified interval i;

N is the total number of localities of occurrence in the database; and,

p_i is the independent probability that a given locality of occurrence will lie within an interval – the Kadmon's bias index.

The Equation (3.1) is derived from a normal approximation to the binomial distribution. Thus, since the value of the index is distributed like a standard normal variable (Z), the bias becomes statistically significant for values greater than 1.64 (at $\alpha = 0.05$). Hence, for each interval of distances to the bias factors, bias values greater than 1.64 characterise over-represented areas, that is areas with more localities of occurrence than expected from a random sampling design. On the other hand, bias values less than –1.64 show under-sampled areas. The Kadmon's bias index (p) was estimated by generating the same number of random replacement points (i.e. localities of occurrence) as in the inventory and calculating the fraction of points on each interval. The formulation of random points and the estimation of the bias index were repeated 100 times, and bootstrap statistics and confidence intervals were calculated.

Subsequently, we assessed whether the localities of occurrence of the inventory's unique records covered the country's environmental conditions randomly. The environmental bias factors analysed were: i) annual mean temperature, ii) annual precipitation; and iii) altitude. These

three variables were compiled from the Worldclim database (Fick and Hijmans, 2017). The bias was evaluated by comparing the distribution of the localities of occurrence to the distribution of the background environment for each variable. The background environment was based on randomly generated points (with replacement) across the study area. Next, for both sets of points, we extracted the corresponding values of the selected bioclimatic variables. Those values were then compared using the Kolmogorov-Smirnov test (KS). The KS assesses the null hypothesis that the frequency distribution of two samples is drawn from the same continuous distribution (Marsaglia et al., 2003). The KS D-statistic was used as an index of congruence between the localities of occurrence and the background environment (Loiselle et al., 2008). The KS was computed using the ks.test function (R package: dgof).

3.2.5 Spatial distribution of inventory completeness and "well-known" cells

Inventory completeness was computed for each grid cell. The method applied was proposed by Stropp et al. (2016), and is an adaptation of the Chao and Jost (2012) method; given by:

$$C_i = \frac{f_{1i}}{n_i} \times \frac{(n_i - 1) \times f_{1i}}{(n_i - 1) \times (f_{1i} + f_{2i})} \tag{3.2}$$

Where,

C_i is the estimated inventory completeness. C_i ranges from zero to one, with one indicating a complete inventory;

n_i is the number of records (observations or specimens) found in grid cell i, among the N_i grid cells;

f_{1i} is the number of singletons found in grid cell i, among the N_i grid cells; and,

f_{2i} is the number of doubletons found in grid cell i, among the N_i grid cells.

Two additional approaches to calculating inventory completeness were tested: the inventory completeness based on Sousa-Baena et al. (2014) and species accumulation curves as in Yang et al. (2013). However, the adapted Chao and Jost (2012) method was the only one that resulted in a monotonic relationship between inventory completeness and the number of records (Figure 3.S2).

We analysed the cell-wide inventory completeness to define the "well-known" areas of the country. Since the sample size was low for several grid cells, we obtained artefactual high

values of completeness. To define a more reliable range of completeness values we selected a minimum sample size looking for a monotonic relationship between the number of unique records and the number of species per grid cell (Hortal et al., 2007), and between the number of unique records and the values of completeness (Sousa-Baena et al., 2014).

3.2.6 Knowledge gap areas

Knowledge about species occurrence and distribution, following the rationale of the principle of distance-decay of similarity in community composition, is expected to be limited in areas progressively distant from well-sampled areas (Ladle and Hortal, 2013; Stropp et al., 2016). Accordingly, here, knowledge gap areas were defined not merely as sites with low inventory completeness but also as sites that are both geographically remote and climatically different from the well-known areas (Sousa-Baena et al., 2014). To find the knowledge gap areas we determined: i) geographical distances from all grid cells in Mozambique to the nearest "well-known" cells; ii) climatic space based on the bioclimatic variables that retained the gradient of variation of the country's climatic conditions; and iii) minimum Euclidean distances among cells in the computed climatic space. Thus, firstly, we determined the geographical distances from all grid cells in Mozambique to the nearest "well known" cells.

Secondly, we selected the bioclimatic variables that retained the gradient of variation of the country's climatic conditions. Climatic space was characterised in terms of the most representative and uncorrelated variables of the 19 bioclimatic variables of the WorldClim database (Fick and Hijmans, 2017) for Mozambique. WorldClim's variables are based on the average monthly temperature and rainfall registered from 1970 to 2000. The selection of the variables that best described the climatic space with minimal multicollinearity was computed using a Principal Component Analysis (PCA). We selected first the number of principal components required to account for 80% of the total explained variance. Then, we chose bioclimatic variables that contributed most to each principal component dimension with minimal correlation to one another.

Thirdly, we determined the environmental distances to the well-known cells by calculating the minimum Euclidean distances among the country's cells in the computed climatic space. Next, the geographical and environmental distances were scaled from 0 to 10 and multiplied to produce a map of "space and environment uniqueness" creating a parallel view of the environmental distances from well-known cells. Finally, we considered as knowledge-gap areas the sites of "space and environment uniqueness" that showed several adjacent cells with distance

values above the third quantile in the range of distances to the “well-known” areas.

Considering that in Mozambique the historical data is mainly based on natural history collections originating from opportunistic or highly localised expeditions and that, in the last two decades, the sources of data were mainly reports of biodiversity surveys focussed on protected areas (Chapter 2), we assumed that different knowledge gap patterns might arise for historical and recent data. Thus, it was not only essential to understand the existing bulk of knowledge considering the full temporal coverage of the dataset (1842-2018), but also to examine whether and how sampling effort presented a different pattern temporally. For this purpose, records were grouped as: i) “old data” if collected before the year 2000, and ii) “recent data” if collected after the year 2000. Next, we performed a comparison of knowledge gaps for these two different temporal windows. To inspect changes in the spatial patterns of the knowledge gaps between the two temporal windows, we superimposed the gaps obtained with data collected before the year 2000 and the following two decades.

Additionally, to identify the ecoregions within knowledge gap areas and to determine their proportion of cover, we intersected the knowledge gap areas with the African ecoregions map and extracted for each ecoregion the number of cells with their centroid within the gap areas.

3.3 Results

3.3.1 Data description

The reduction of species occurrence data to unique records resulted in 14201 records of 215 species. Two species did not pass the data reduction process because the corresponding records did not contain enough information to be allocated to a country grid. These species were the bats *Chaerephon nigeriae* Thomas, 1913 and *Rhinolophus rhodesiae* Roberts, 1946.

The total number of grid cells across Mozambique that held unique mammal records was 1014, corresponding to 83.3% of the country (Figure 3.2; Table 3.1). Most of the inventory data (almost 60%) were collected before the year 2000 (“old data”). These data correspond to a total of 204 species and are distributed across almost 68% of the country’s territory. The primary sources of these old data were literature (56.7%) and natural history collections (43.2%). On the other hand, records collected after the year 2000 (“recent data”) included 156 species and covered less than 50% of the country’s territory. These recent data were mainly derived from survey reports (85.1%), followed by natural history collections (10.7%) and literature (4.2%)

Table 3.1: Summary of Mozambique's terrestrial mammal inventory. The number of records, the number of species, number of cells across the country with information, the number of well-known cells, and the point-density mean for the whole inventory, for each mammal group and for old and recent data. The total number of cells across the country at 0.25º resolution is 1217. Old data refers to data collected before the year 2000 and recent data to data collected after the year 2000.

	Records	Species	Cells with information	Well-known cells	Point-density mean
Whole inventory	14201	215	1014	54	109
Large mammals	5847	29	851	27	78.6
Medium mammals	2632	37	605	18	37.3
Small mammals	5722	149	458	42	76.4
Old data	8171	204	826	30	-
Recent data	6030	156	582	23	-

(Table 3.1).

Per ecoregion, our results show a mean number of species of approximately 75.5; ranging from 4 species in the Zambezian flooded grasslands ecoregion, which covers less than 1% (0.52 +/- 0.05%) of the country, to 168 species in the Southern Miombo woodland ecoregion, which includes more than 16% of the country (16.5 +/- 0.19%) (Figure 3.3). The Zambezian and Mopane woodlands ecoregion also had a considerable number of species reported (167 species), as well as the Southern Zanzibar Inhambane coasta%), had 116 species reported.

The most considerable portion of the records, approximately 41.2%, pertained to large mammals represented by 29 species distributed across ca. 70% of Mozambique's territory. Large mammals were recorded in most of the ecoregions (Figure 3.3). All species were recorded in the Zambezian and Mopane woodlands ecoregion, and most were recorded in the Southern Miombo woodlands ecoregion (27 species), and the Southern Zanzibar-Inhambane coastal forest mosaic (25 species). Most of these records were obtained from survey reports (64.5%), followed by literature and natural history collections (Figure 3.2).

Medium mammal data corresponds to 18.5% of the inventory, with 37 species registered in almost 50% of the territory. Medium mammals were recorded in all ecoregions, with most species documented in the Zambezian and Mopane woodlands ecoregion (35 species), and in the Southern Miombo woodlands ecoregion (32 species) (Figure 3.3). Most of these records (45.3%) were obtained from survey reports, followed by literature and natural history collections.

Small mammals make up 40.3% of the records, 149 species catalogued in less than 40% of the country's territory (Table 3.1). Small mammals were recorded in 12 out of 13 ecoregions in the country, with a considerable number of species recorded in the Southern Miombo wood-

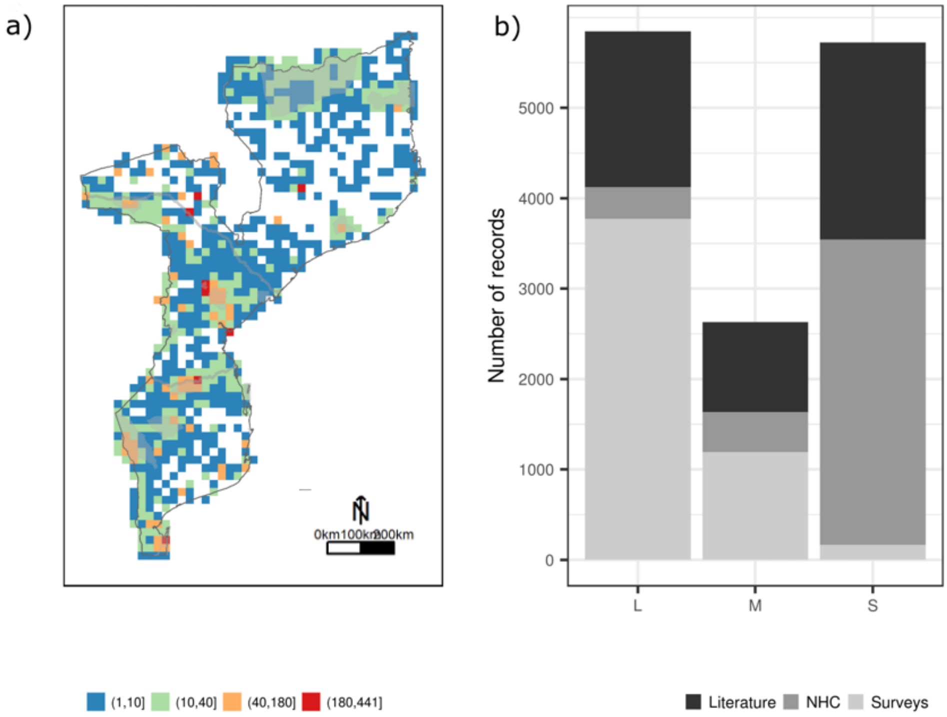

Figure 3.2: The number of records of Mozambique's terrestrial mammals. a) Number of unique records across Mozambique based on a 0.25° resolution grid. B) Bars showing the number of unique records per mammal group and the contribution of data sources.

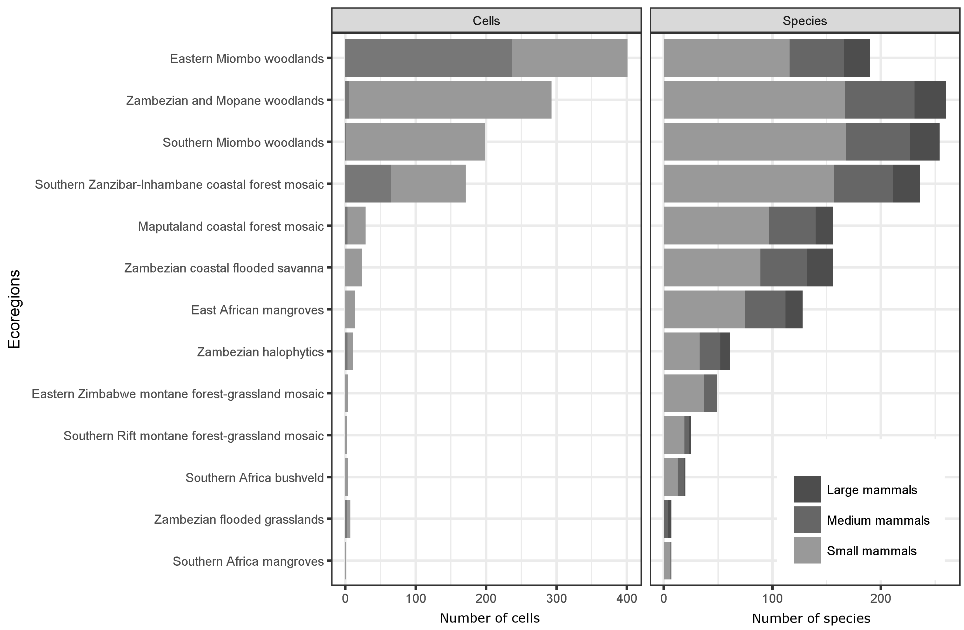

Figure 3.3: Knowledge of terrestrial mammals across Mozambique's ecoregions. Panel "Cells" shows the number of cells at 0.25° resolution occupied by each ecoregion. Dark grey bars show the proportion of cells in each ecoregion that fall within the knowledge gap areas. Panel "Species" shows the number of known species in each of Mozambique's ecoregions. The definition of the country's ecoregions followed Burgess et al. (2004).

lands ecoregion (109 species), in the Southern Zanzibar-Inhambane coastal forest mosaic (103 species), and in the Zambezian and Mopane woodlands ecoregion (103 species; Figure 3.3). Most of these records were obtained from natural history collections (59.1%), followed by literature (38%; Figure 3.2).

3.3.2 Inventory's record density and biases

When considering data across the entire country and all mammal groups, most species occurrence records were registered in the central and southern provinces of Mozambique, with a high record density in the Maputo province (Figure 3.2-A; Figure 3.S3). The mean record density was 109 records per 0.25º resolution grid cell (Table 3.1). This unequal distribution of records across the country indicates spatial bias.

Our results indicated an apparent over-representation of mammal records in areas close to the protected area (Figure 3.S4). On the other hand, areas close to roads and the main cities were under-represented (Figure 3.S5, Figure 3.S6).

To assess whether the inventory's data covered the country's environmental conditions, the distribution of records across selected environmental variables (annual mean temperature, annual precipitation, and altitude) was compared to environmental values from points generated randomly throughout the study area (i.e. background data). Even though, based on visual inspection, the distribution of records and background data presented a similar shape for the three variables assessed (Figure 3.4); our results indicate climatic bias for the three environmental variables, with significant differences between the inventory's and the background data environmental distributions (Kolmogorov-Smirnov test, KS test, $D > 0.063$, $p < 0.001$ in all cases). In general, collecting effort was lower than expected in areas of higher annual mean temperature (>24ºC), in areas of higher annual precipitation (>1000 mm), as well as in areas with an altitude between 400 and 750 meters (Figure 3.4).

With regards to the three mammal groups considered, the density maps showed parallel patterns to those found for the full inventory, i.e., high record incidence in central and southern Mozambique (Figure 3.S3). Mean record densities were higher for large mammals (79 records) and small mammals (76 records) and, lower for medium mammals (37 records). Records of both large and medium mammal spatial distributions were over-represented in protected areas. Small mammal spatial distribution was slightly over-represented in protected areas and strongly over-represented near the main cities and roads.

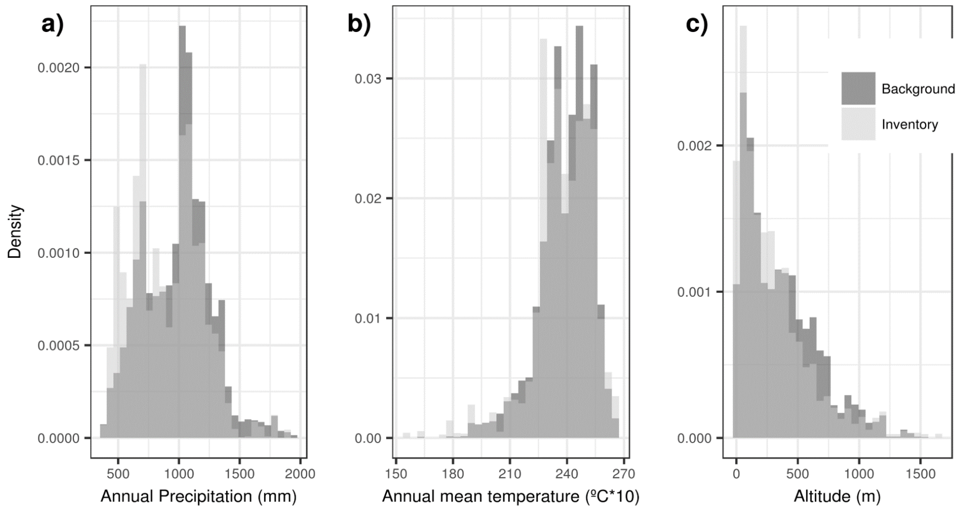

Figure 3.4: Environmental bias in Mozambique's terrestrial mammal inventory across the variables: (a) Annual mean temperature, (b) Annual precipitation, and (c) Altitude.

Regarding the coverage of the country's environmental conditions by each mammal group data, we observed, for the three groups, and with significant differences, substantial departures from background environment distributions for the three variables (KS test, $D > 0.088$, $p < 0.001$).

3.3.3 Inventory completeness and well-known areas

Monotonic relationships both between the number of unique records and the values of completeness and between the number of unique records and the number of species per grid cell were found for values above 40 records, approximately. Accordingly, we restricted "well-known" cells to those presenting more than 40 unique records and values of completeness above 0.7 (Figure 3.S5). The spatial distribution of inventory completeness at 0.25º resolution showed that 4.4% (54/1217) of cells are "well-known" (Figure 3.5). Most of these "well-known" areas are located inside or near protected areas.

For the analysis per mammal group, we determined another minimum sample size by inspecting the relationship between the number of unique records and the values of completeness as previously for the full inventory. Following this criterion, and because each of these sets of records encompasses a lower record density per grid cell on average, for each mammal group cells were considered "well-known" when they presented more than 20 unique records and values of completeness above 0.7. The spatial distribution of inventory completeness showed that: 2.2% of the country's cells are "well-known" regarding large mammals, 1.5% for medium, and

3.4% for small mammals (Table 3.1). Shared "well-known" cells between the three groups are located at: (i) Gorongosa National Park, (ii) Beira city, and (iii) Zinave NP, near the Save river (Figure 3.6).

3.3.4 Knowledge gap areas

The knowledge-gap areas were defined as areas with insufficient sampling and that are geographically distant and climatically different from the well-known areas. Diverse studies followed this rationale (Asase and Peterson, 2016; Koffi et al., 2015; Sousa-Baena et al., 2014). The selection of the variables that best described Mozambique's climatic space with minimal multicollinearity was computed using a Principal Component Analysis (PCA). The first three components of the PCA accounted for 83.8% of the variability of the country's climatic conditions. Three variables were selected to define the "bioclimatic space", one for each component. The more representative and uncorrelated bioclimatic variables (Fick and Hijmans, 2017) were the mean temperature of the wettest quarter, temperature seasonality, and precipitation of the driest quarter. Given the selected variables, Mozambique displays relatively homogeneous climatic conditions. Nevertheless, some sites, in northern and southern Mozambique, stand out with unique and diverse environmental conditions, such as the area of inselbergs and hills in Zambézia province, the coast of Nampula and Cabo Delgado provinces, and along the Limpopo River, Gaza province (Figure 3.S7).

For the whole inventory, the combination of the distance in the "bioclimatic space" with the distance to well-sampled areas showed the broadest knowledge gap area located in northeastern Mozambique (Niassa, Cabo Delgado and Nampula provinces), and two smaller knowledge gap areas, one in western Zambézia, at the inselbergs area, and the other in the coastal Gaza province, southern Mozambique (Figure 3.5). Almost 60% of the Eastern Miombo woodlands ecoregion area is within the gap areas in northern Mozambique (58.8 +/- 0.23%). More than 35% of the Southern Zanzibar-Inhambane coastal forest mosaic ecoregion is within the three identified gap areas (35.73 +/- 3.75%) (Figure 3.3).

For the three mammal size categories, the following knowledge-gap areas were detected: (i) one large area shared by coastal Cabo Delgado and Nampula provinces, and two narrow areas; (ii) north of the Niassa province; (iii) the inselbergs area at Zambézia province; and (iv) the coastal Gaza province.

Data compiled on small mammals showed more dispersed knowledge gap areas and an

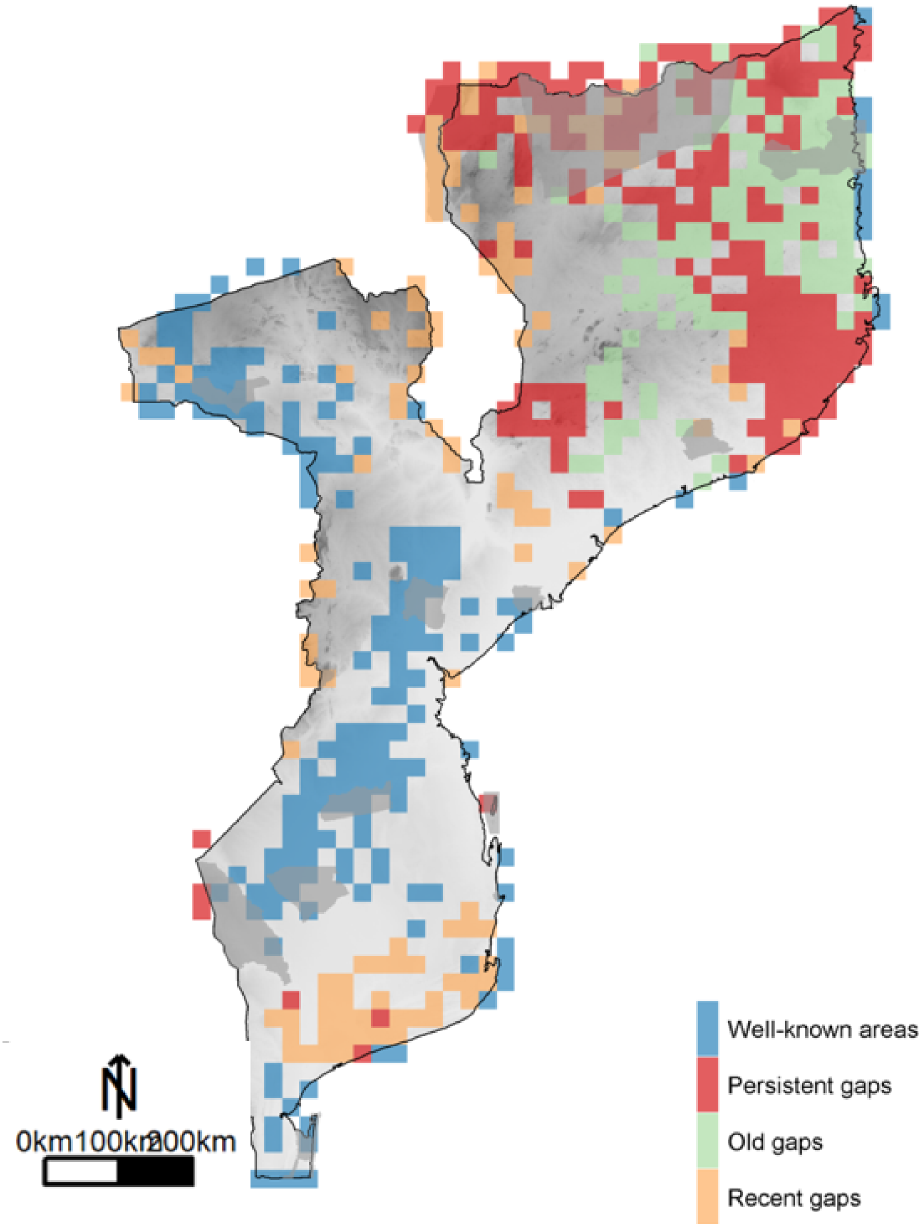

Figure 3.5: Spatial knowledge gap areas on Mozambique's terrestrial mammals through time. Knowledge gap areas result from the combination of the climatic and geographical distance to the "well-known" cells (N >40 unique records and Inventory completeness >0.6), at 0.25° resolution. Knowledge gaps for old data and recent data were superimposed. We refer to old data when it was collected before the year 2000; and recent data if collected after the year 2000.

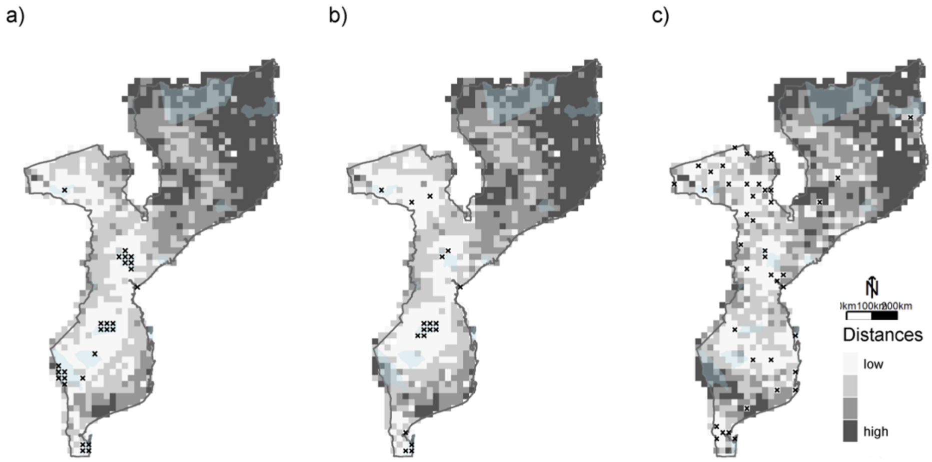

Figure 3.6: Spatial knowledge gap areas on Mozambique's terrestrial mammal groups: (a) for large mammals, (b) for medium mammals, and (c) for small mammals. Knowledge gap areas result from the combination of the climatic and geographical distance to the "well-known" cells (N >20 unique records and Inventory completeness >0.6), at 0.25º resolution. Cells that fit the criterion of well-known grid cells for each mammal group are marked with a cross.

additional location with lacking information was detected at the Limpopo NP, Gaza province (Figure 3.6).

The results from the comparison of knowledge gaps for the two temporal windows selected revealed, as expected, different distribution patterns for old and recent data. For old data, before the year 2000, the "well-known" areas are scattered across central and southern Mozambique close to the main cities or main roads. For recent data, collected after the year 2000, the "well-known" cells are all located within protected areas and Mount Namuli.

The map of the geographical and environmental distances relative to "old data" confirms the limited knowledge from northern Mozambique (Figure 3.5). The analysis of "recent data" unveiled same additional low-information areas: (i) a broad area in coastal Gaza and Inhambane provinces; and scattered sites (ii) along the Chimanimani mountains, on the border with Zimbabwe, and (iii) along the left margin of the Zambezi river (Figure 3.5).

3.4 Discussion

Our study clearly shows that, in Mozambique, mammal records are not equally distributed in space. More precisely, we found that Mozambique's mammal fauna is well-known in less

than 5% of the territory, with broad areas of the country poorly sampled or not sampled at all (Figure 3.5). The pattern observed from past and recent data, for all mammal groups, indicates that significant areas in northern Mozambique remain in need of further data collection, and data on large and medium mammals are over-represented in protected areas due to biases in census methods. We discuss these findings and, in light of economic growth and conservation concerns, recommend some priority areas to improve knowledge about the country's mammal fauna.

3.4.1 Inventory completeness

Our analysis exposed that the "well-known" areas in the country are related to accessibility and the existence of supporting infrastructures. For data collected before the year 2000, the "well-known" areas are located near urban areas and main roads, all in central and southern Mozambique. "Recent data" are mostly associated with protected areas across the country (including sites in north Mozambique), which are of scientific interest.

During the nineteenth and twentieth centuries, geopolitical interests in southern Africa guided European and North American scientific expeditions to preferentially survey the areas surrounding and south of the Zambezi River. These circumstances, along with the lack of transport infrastructures in the north, has meant that species in Mozambique have mostly been collected from the central and southern provinces. However, in recent years, growing political stability along with an increase in northern Mozambique's accessibility, and political interest in biodiversity conservation have boosted monitoring effort, particularly in protected areas, which had a positive effect on inventory completeness. These events may explain the patterns detected by our analysis.

Combining the geographical and environmental survey gaps across the country, northern Mozambique emerges consistently with several knowledge gap areas. More precisely, the analysis of data collected before the year 2000 reveals a vast and contiguous area in the coastal provinces Cabo Delgado and Nampula, which falls in the Coastal forest mosaic and Eastern miombo woodlands ecoregions. A further knowledge gap area is a smaller area associated with the inselbergs and hills, the "sky island forests" (Mount Namuli, Mount Mabu, Mount Chiperone), on the western border of the Zambézia province. Increasing scientific interest in studying northern Mozambique's inselbergs and hills, through various expeditions and surveys (e.g., Mount Mabu, Mount Inago, Mount Namuli), led to the description of new species from sev-

eral taxonomic groups. From these areas with unique environmental conditions, new species of reptiles (Portik et al., 2013), butterflies (Timberlake et al., 2012), bats (Monadjem et al., 2010) and plants (Van Noort et al., 2007) have been recently described. These findings highlight how diverse and understudied the Afromontane forest is and support the rationale that prioritising lesser-known and environmentally unique areas for survey in Mozambique will likely locate additional records or species.

3.4.2 Priorities to improve knowledge of mammal fauna from Mozambique

Increasing accessibility to primary species occurrence data allows researchers and conservationists to improve knowledge about a country's biodiversity. The terrestrial mammal inventory used in this study was based compiled primary species occurrence data collected during expeditions from the mid-eighteen hundreds to recent years (Chapter 2).

Collection dates for records associated with specimens in NHC ranged from 1845 to 2015, and scientific literature from 1985 to 2018. Data from survey reports were all published after the year 2000 (2004-2010). For the period 1990-2000, very few records of mammal occurrence were available, and very few species were reported. Mozambique experienced critical changes in this period, namely, the arrival of peace in the country in 1992, and the country's commitment to the Convection for Biological Diversity (CBD) targets in 1994. These events influenced the amount of biodiversity data available after the year 2000, with a peak in species occurrence data from Mozambique detected in 2008, when a country-wide wildlife census was carried out (AGRECO, 2008). However, the limited use of science for decision-making and limited knowledge about biodiversity and its potential to increase human well-being are considered indirect causes of biodiversity loss and habitat degradation in Mozambique by the Ministry of Land, Environment and Rural Development (MITADER, 2015).

Here, by examining similar and different knowledge gap areas in the past and recent years, we provide baseline information for terrestrial mammal species conservation and management plans.

Targeting unknown areas - Knowledge discovery

A large part of Mozambique remains insufficiently documented in terms of its mammal fauna (Figure 3.5; Figure 3.6). The knowledge-gap areas recognised in our study are mostly associated

with two ecoregions (Figure 3.2). The Southern Zanzibar-Inhambane coastal forest mosaic has long been described as a poorly known ecoregion regarding its mammal fauna (Burgess et al., 2004; Pascal, 2011). For Mozambique, our study indicates that 157 mammal species were reported for this ecoregion (Figure 3.2). The Eastern Miombo woodlands ecoregion, the largest in Mozambique, is also poorly known regarding mammal occurrence. When compared with Southern Miombo, located in southern and central areas of the country, Eastern Miombo woodlands present a lower number of species (116 species) than the former (168 species). Henceforward, true species richness may be higher than presently estimated, especially in northern Mozambique.

Although the lack of accessibility and infrastructure in the north were partially resolved, the last two decades of studies on biodiversity were not sufficient to change this pattern of less knowledge for this region. Consequently, there is an urgent need to prioritise these areas in future field surveys. It is worth noting that a significant part of the knowledge gap falls in the Niassa NR, which reportedly supports the major remaining concentrations of carnivores and ungulates in Mozambique (AGRECO, 2008; Clark and Begg, 2010; Niassa Carnivore Project, 2014). Despite the recent surveys in Niassa NR, none investigated small mammal diversity.

Targeting the lesser known mammal groups

Overall, less information has been gathered on small and inconspicuous fauna, because recent surveys in Mozambique are almost exclusively based on aerial counts, which mostly detect the conspicuous medium and large species (Dunham, 2004; Stalmans and Peel, 2009, e.g.) (Chapter 2). Accordingly, spatial distributions of large and medium mammal records were over-represented in protected areas.

When multiple census methods were used in recent surveys, we observed a shift from gap to well-known areas. This scenario occurred in 9% of the country, mainly due to broad surveys taken in Quirimbas NP and Mount Namuli (Chapter 2, see) (Figure 3.5), and shows that more complete inventories depend on the inclusion of varied census methods to register the presence of mammal groups, which are highly variable in terms of size, behaviour and habitat preferences.

For small mammals, well-known areas are scattered across the country and data is biased towards the main cities and roads (Figure 3.4; Figure 3.6). Some protected areas present an evident lack of knowledge for this group, with wide gaps in Limpopo NP, Niassa NR, and small

areas in Maputo Special Reserve. Large and medium mammals are well-known groups in the protected areas of southern and central Mozambique. However, in the north, there is still a lack of knowledge of these groups in Niassa NR and Quirimbas NP. Increasing the surveys' taxonomic extent inside the protected areas is a resource-efficient way towards the achievement of international commitments such as the CBD's Aichi targets (Leadley et al., 2014; Meyer et al., 2015), namely to protect the complete range of biodiversity present in areas of importance for biodiversity (CBD's Strategic Objective B - Target 11).

Targeting known areas – Spatiotemporal studies

Our work pinpoints poorly known environmentally different areas while recognising similar environmental areas that were regularly visited over time. These areas correspond to 14% of the country, mostly across the protected areas (Figure 3.6). As examples, Gorongosa NP and Zinave NP are well-known areas for the three mammal groups. It is essential to continue to collect data from these sites because this will enhance the collective knowledge on biodiversity through retrospective and comparative studies. The existence of historical and recent data enables the evaluation of changes in biodiversity and the analysis of drivers of distribution changes (Craig et al., 2018), or the selection of areas of interest for species reintroduction (Miller et al., 2012). For instance, by comparing data from a recent survey and an expedition in the mid-1920s, the authors of a study in the Ethiopian highlands were able to document shifts associated with climate change in the former ranges of five small mammal species over approximately 90 years (Craig et al., 2018).

Our study also detected that, for some areas of Mozambique, the potential of spatiotemporal studies could be lost. Over the last two decades, some unique climatic areas in central and southern Mozambique emerged as less surveyed. Notably, there was a broad knowledge gap area on the coast of Gaza province (Figure 3.6), which was recently described as having undergone extensive habitat loss (Sitoé et al., 2015). Although this finding may be conjectural, an effort should be made to avoid the discontinuity of monitoring effort in this area, thus preserving the potential for spatiotemporal studies.

Improving knowledge - Data accessibility

The usefulness of primary species-occurrence data to improve biodiversity knowledge can be fully realised by increasing the availability of useful quality data. The work of compilation,

digitalisation, cleaning and validation performed in Chapter 2 was pivotal to identify survey priorities and to improve knowledge. Nonetheless, it should be noted that the identified knowledge gap areas may not solely reflect the lack of collection effort but may also correspond to existing knowledge not included or not easily accessible. Thus, besides the enhancement of sampling effort, improved access to further biodiversity data, along with the digitisation of existing natural history collections data and better overall dissemination of recent internal research will address more complex biological questions and will provide the foundation for the effective conservation of biodiversity. This strategy could be an effective way to rapidly close gaps and reduce data biases in poorly documented and research-neglected countries(Meyer et al., 2015; Peterson et al., 2015).

3.4.3 Biodiversity data

Filling biodiversity knowledge gaps requires prioritisation of efforts not only to compile additional data but also to evaluate and enhance the quality of the data already available and to make it accessible. Works from Ballesteros-Mejia et al. (2013); Marques et al. (2018); Stropp et al. (2016) as well as the work in Chapter 2 are recent examples for African countries.

Many developing countries are understudied and present a severe lack of species-occurrence data (Peterson et al., 2015), which is worsened by the poor dissemination of these research data. Thus, improving knowledge of the biodiversity of poorly documented countries can only be achieved by allocating resources to expand and promote national and international initiatives, with a strong emphasis on capacity-building of national and local institutions. Positive progress has been made in this direction. For example, Biodiversity Information for Development (BID) is a multi-year programme funded by the European Union and led by GBIF to increase the amount of biodiversity information available in the nations of sub-Saharan Africa, the Caribbean and the Pacific (`https://bid.gbif.org`). Of the 23 projects financed thus far, Mozambique is participating in an "African Insect Atlas", which aims to unleash the potential of insects in conservation and sustainability research (`https://www.gbif.org/project/82632/african-insect-atlas`).

3.5 Conclusion

It is most important to fill knowledge gaps on species occurrence and distribution, especially if the aim is to expand the taxonomic extent of conservation planning. A conservation planning based on accurate species occurrence data is even more crucial in countries where high poverty rates, sporadic armed conflicts, intensive exploration of natural resources and extreme weather events accrue. Deprived of reasonable information regarding species occurrence, it is unmanageable to concentrate efforts to preserve diversity and guide conservation actions.

Based on primary species occurrence data, which span the years from 1845 to today, we identified provinces in Mozambique that are poorly documented regarding terrestrial mammal fauna (e.g., Niassa, Cabo Delgado, Nampula and Tete). These provinces are vastly explored for oil, coal, hydrocarbons and minerals (Guedes et al., 2018), presenting severe challenges for biodiversity conservation. Moreover, the high population growth observed in the northern provinces is associated with agricultural development and habitat degradation (Niquisse et al., 2017; Timberlake, 2011). Given that habitat loss is a leading cause of biodiversity decline, there is an urgency to study and survey the provinces identified in this study since some economic activities, such as mine-exploration and plantation forestry, without proper impact studies may lead to irreversible biodiversity loss (Ceballos et al., 2017; Chaudhary et al., 2016). Hence, we encourage action from the scientific community and government authorities to continue improving the country's biodiversity knowledge.

Finally, the assessment of the knowledge gaps from primary species occurrence data showed to be a powerful strategy to generate information that is essential to species conservation and management plan, particularly for understudied countries.

3.6 Supplementary figures

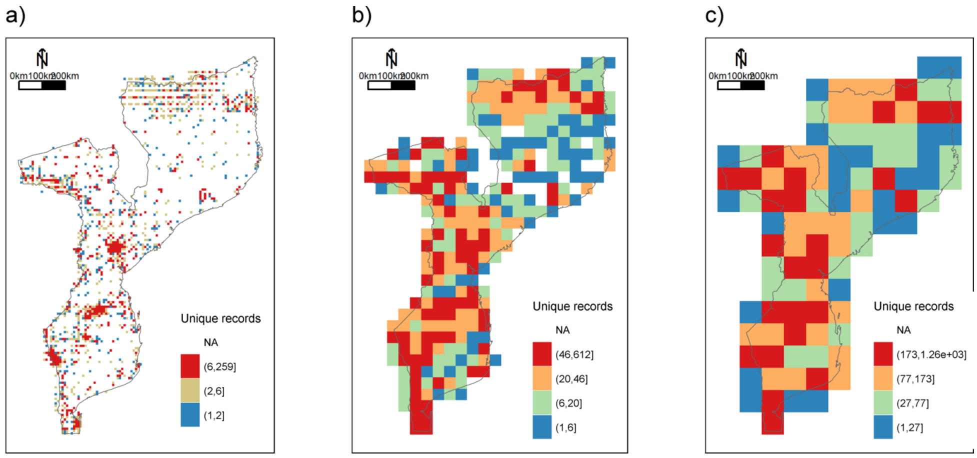

Figure 3.S1: Visualization of the number of unique records across Mozambique based on grids of differing spatial resolutions: a) 0.1°; b) 0.5°; c) 1°.

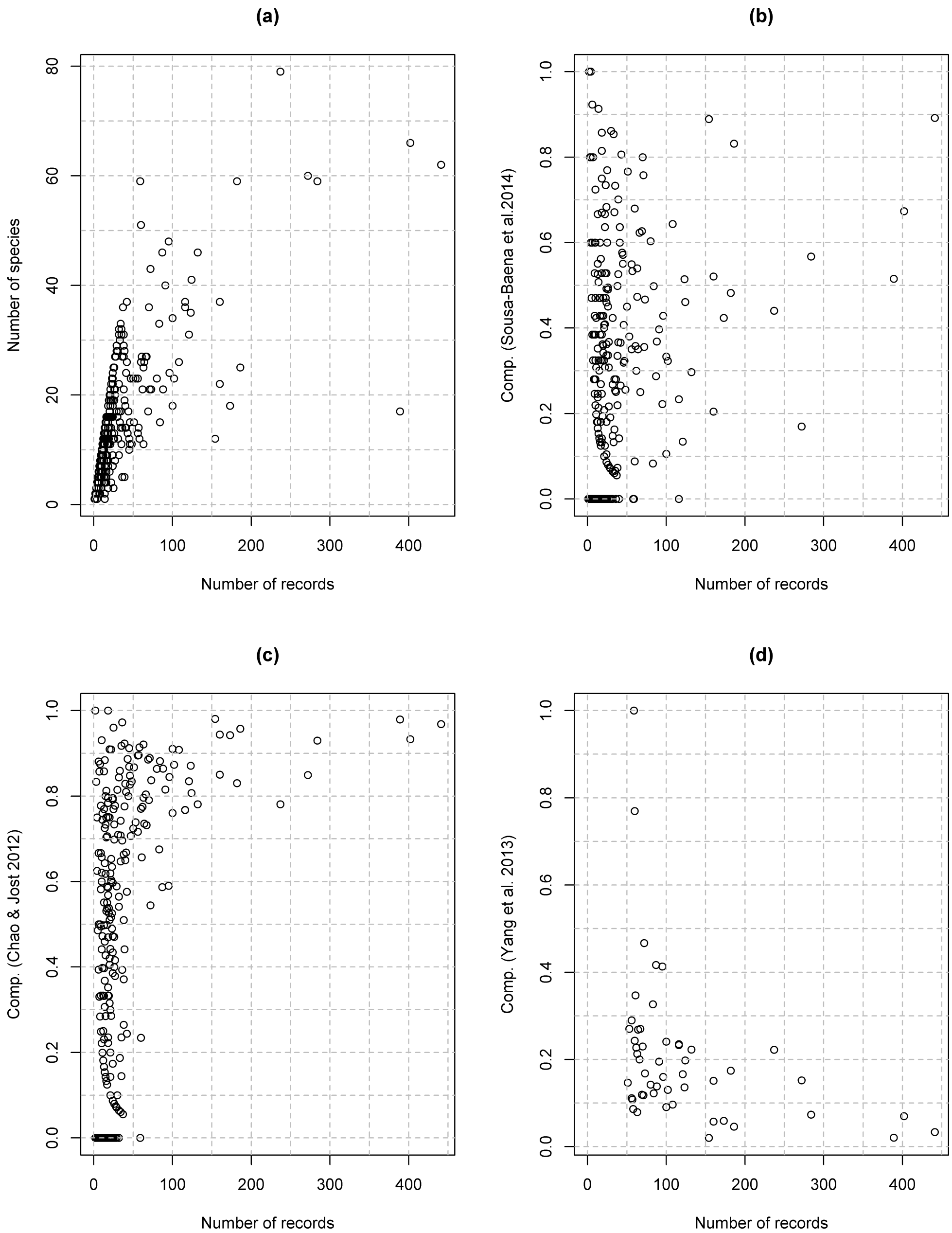

Figure 3.S2: Relationship between the number of unique records (i.e. unique combination of date, location of collection and species name) per grid cell and (a) number of species, and between the number of unique records and the estimates of inventory completeness ("Comp.") obtained according to according to the three methods tested in this study: (b) Sousa-Baena et al. (2014), (c) Chao and Jost (2012) and (d) the curvilinearity of species accumulation curves according to Yang et al. (2013)

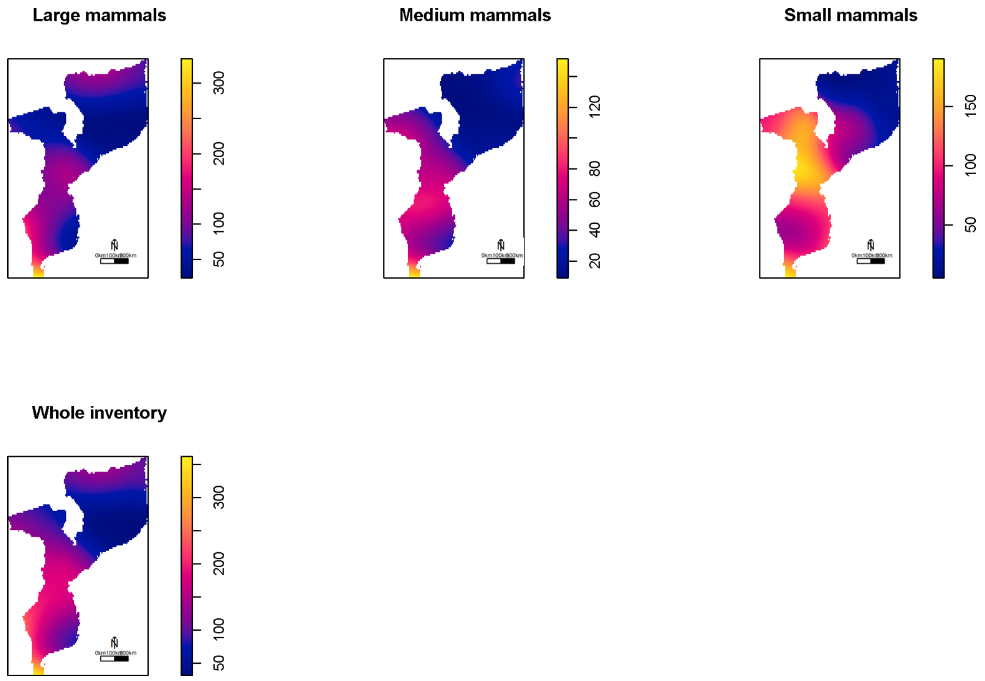

Figure 3.S3: Visualization of the records' density patterns estimated based on the isotropic Gaussian kernel of the whole inventory, and per mammal group.

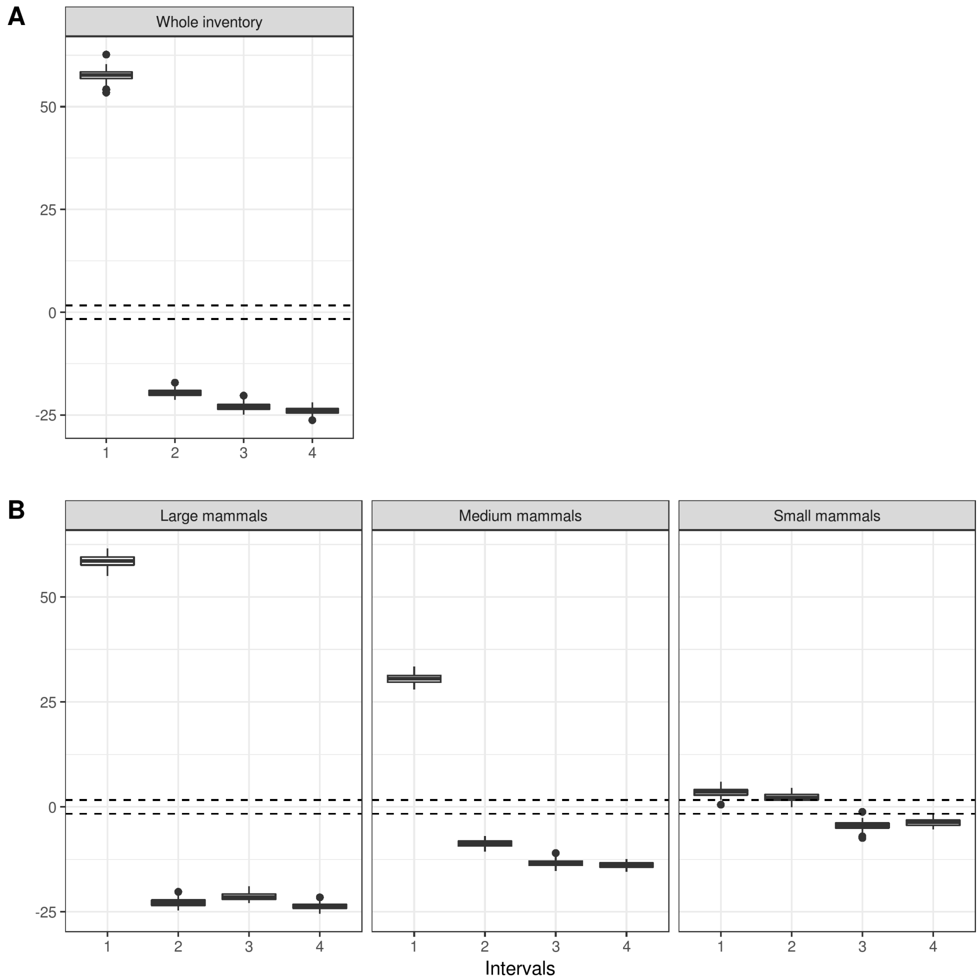

Figure 3.S4: Bias estimates to “distance to protected areas” for A) the whole inventory, and B) “mammal size”. Bias estimates were calculated following Kadmon et al (2004) for each distance interval from “interval 1” for short distance to “interval 4” for largest distance. The dashed lines mark the range of values where no bias is expected (between -1.64 and 1.64). If the boxplots are within the lines than the number of localities is as expected from a random sampling scheme. Boxplots above and below this area are an over or under-representation of records’ localities in that interval, respectively.

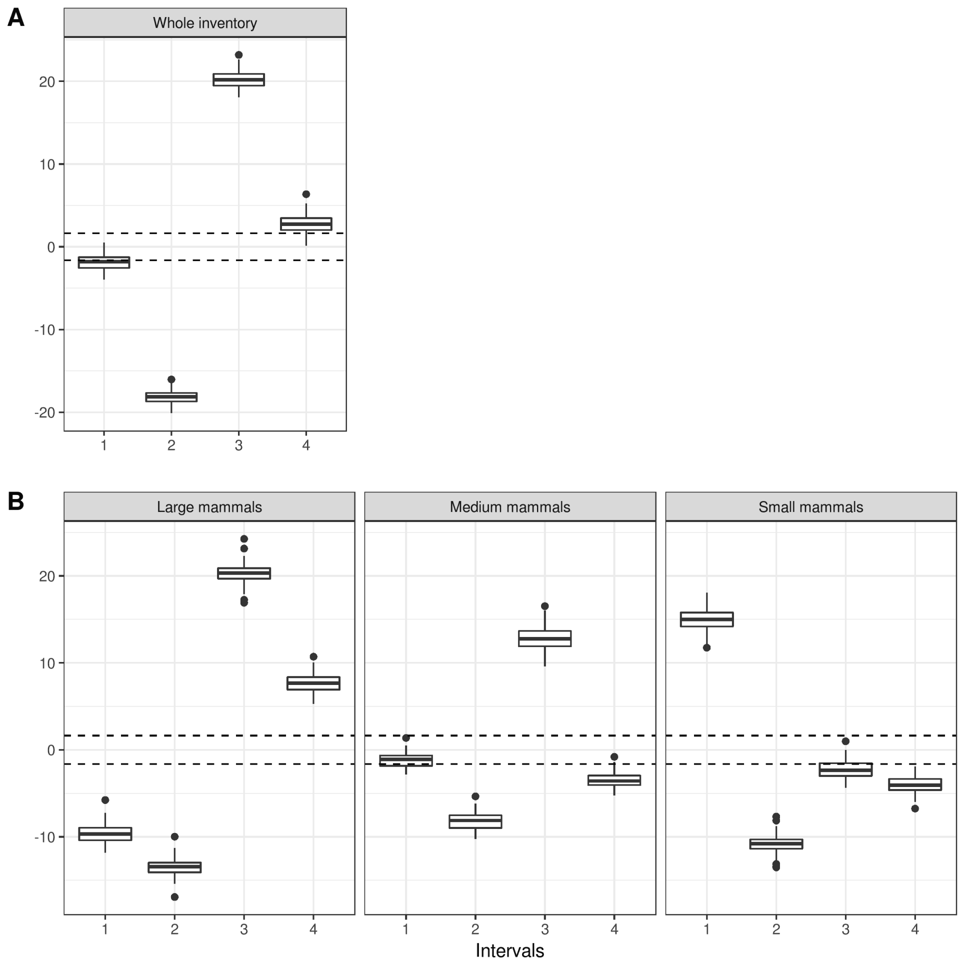

Figure 3.S5: Bias estimates to "distance to main cities" for A) the whole inventory, and B) the mammal groups. Bias estimates were calculated following Kadmon et al (2004) for each distance interval from "interval 1" for short distance to "interval 4" for largest distance. The dashed lines mark the range of values where no bias is expected (between -1.64 and 1.64). If the boxplots are within the lines than the number of localities is as expected from a random sampling scheme. Boxplots above and below this area are an over- or under-representation of records' localities in that interval, respectively. The cities included in this factor are the provinces capitals.

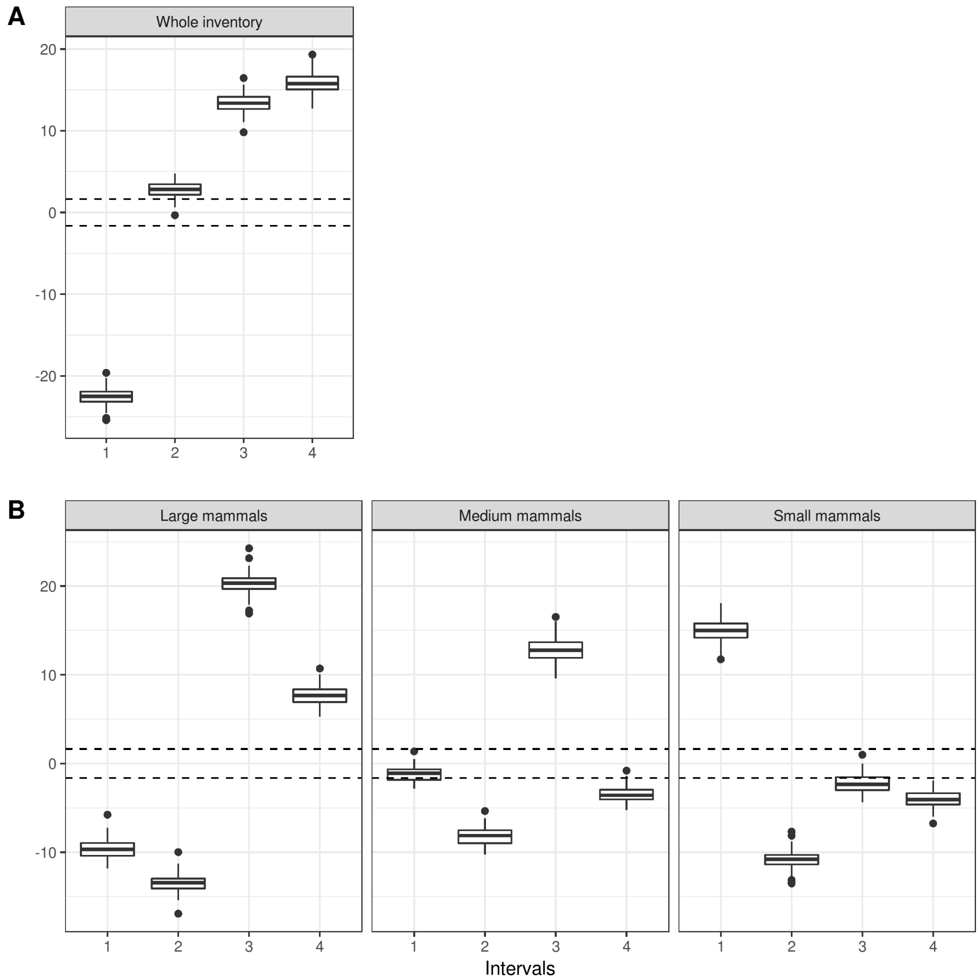

Figure 3.S6: Bias estimates to "distance to main primary roads" for A) the whole inventory, and B) the mammal groups. Bias estimates were calculated following Kadmon et al (2004) for each distance interval from "interval 1" for short distance to "interval 4" for largest distance. The dashed lines mark the range of values where no bias is expected (between -1.64 and 1.64). If the boxplots are within the lines than the number of localities is as expected from a random sampling scheme. Boxplots above and below this area are an over- or under-representation of records' localities in that interval, respectively.

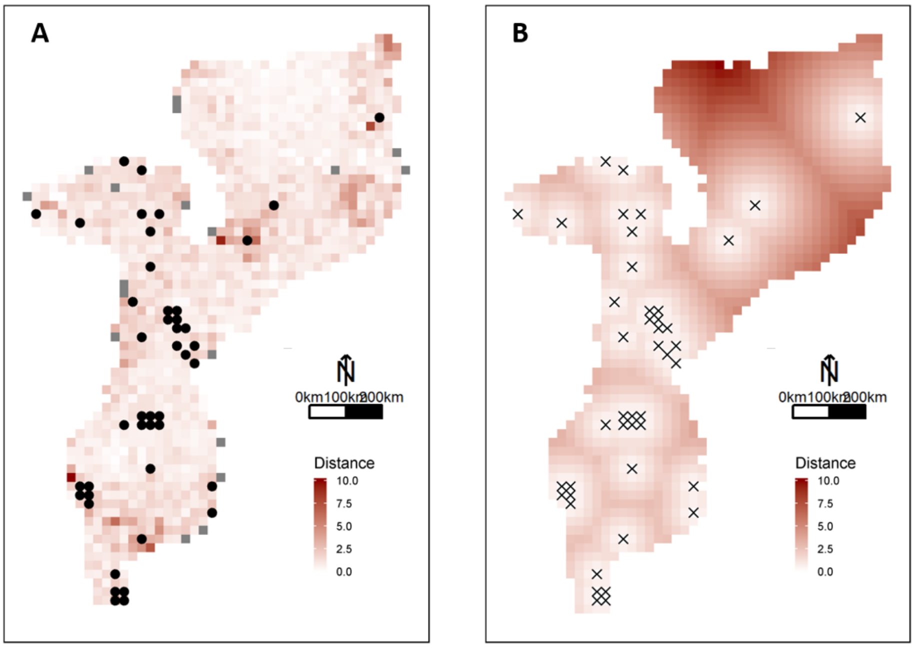

Figure 3.S7: Spatial visualisation of the (A) distance in the bioclimatic space between the country's cells and (B) geographical distance from the well-known cells regarding terrestrial mammal sampling in Mozambique, at 0.25º resolution. The country's bioclimatic space was defined by the following variables: Mean temperature of the wettest quarter, Temperature seasonality, and Precipitation of the driest quarter. These variables were obtained from the WorldClim database (Fick and Hijmans, 2017). Cells that fit the criteria of well-known grid cells are marked with a dark point in (A) and with a cross in (B).

Figure 3.S8: Sensitivity analysis for different assignment methods of ecoregions to grid cells: (a) for each ecoregion with cover in Mozambique; and (b) for each ecoregion with cover in Mozambique, with the less extensive ecoregions aggregated in biomes. Sensitivity was measured as the ratio between the proportion of cells within a specific ecoregion using another assignment methods and the assignment method used in our study. For this study, we assign the terrestrial ecoregions (and associated biome) by overlaying ecoregions map onto the country's grid, and the ecoregion that overlaps each cell centroid is assigned to the cells ("Cell centroid method"). Two assignment methods were tested and compared to "Cell centroid rule": "Maximum area rule" and "Majority rule". In the "Maximum area rule" the largest ecoregion is assigned to the cells; and in the "Majority rule" the ecoregion that overlaps by at least 50 per cent is assigned to the cell, or, when multiple ecoregions overlap a cell, the largest overlapping area must be greater than the area in the cell that is not covered by any ecoregion. Values of sensitivity close to 1 reveal a result that is robust independently of the method chosen for assigning cells to ecoregions. The ecoregions and biomes considered for Mozambique in this study followed a last comprehensive assessment of African terrestrial biomes, ecoregions and habitats (Burgess et al., 2004). Spatial data was downloaded from WWF Terrestrials Ecoregions of the World dataset (`www.worldwildlife.org/publications/terrestrial-ecoregions-of-the-world`).

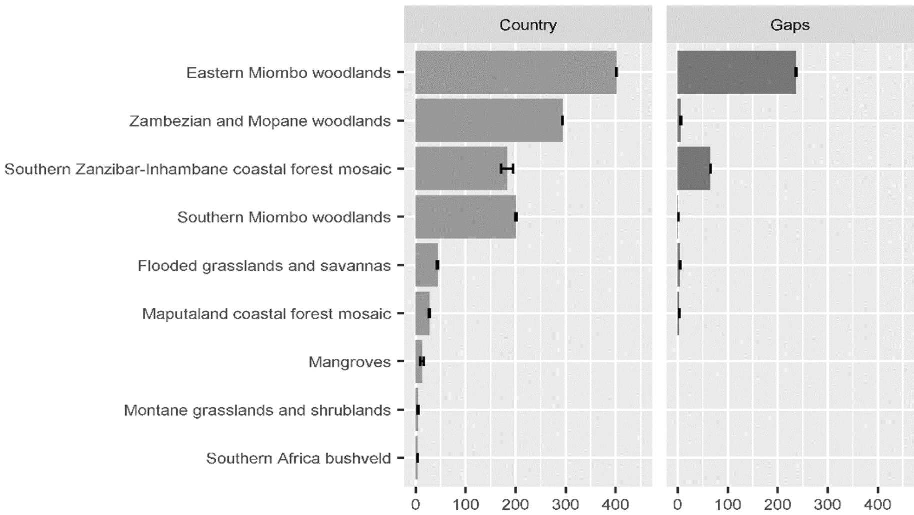

Figure 3.S9: Barplot showing the number of country's cells and the number of gap cells at 0.25º resolution occupied by each ecoregion with different polygon-cell assignment rules.

4

Conservation areas effectiveness

Contents

CHAPTER 4

Conservation areas effectiveness

"Conservation is the technology by which preservation is achieved."

Philip Ward, 1986

ABSTRACT

Conservation area networks are a key strategy in the efforts to halt the current extensive loss of biodiversity. One of the main concerns in conservation planning and in the selection of conservation areas (CA) is to increase the representativeness of biodiversity. In Mozambique, as in other African countries, several of the current wildlife reserves were initially gazetted for the protection of megafauna, resulting in a conservation network covering regions of high large mammal richness. However, the extent to which this network safeguards overall mammal diversity is not known, particularly regarding smaller mammals. Here, we provide a first assessment of Mozambique's conservation areas effectiveness to protect small-sized mammals (less than 5kg) given current and future climatic conditions and human pressure. The assessment was built on predictions of species richness and suitable ranges for 122 mammals (eight taxonomic orders) using niche modelling. Results demonstrate that the current CAs network does not assure the conservation of mammal diversity as a whole. Less than 30% of the country's small-sized mammals are sufficiently protected and the restricted-range species are the least well-represented in the conservation network. To ensure mammal preservation in the future, we suggest new priority conservation zones characterised by high species richness and rarity with low human pressure and climate change impact.

Manuscript: Queirós Neves, I., Bastos-Silveira, C., Mathias, M.L. (submitted) Are conservation areas designed for megafauna effectively protecting small-sized mammals?

4.1 Introduction

Mammal populations are declining rapidly worldwide (Ceballos et al., 2017; Davis et al., 2018). To contribute to halting the current extensive loss of biodiversity, the Convention on Biological Diversity (CBD) established the Aichi targets to be met by 2020. Considering that conservation areas (CAs) are a primary strategy for preserving biodiversity, CBD's call prompted nations to guarantee the protection of at least 17% of terrestrial environments globally through "ecologically representative" and well-connected areas.

In many African countries, CAs were initially set up as hunting reserves at sites of high large mammal density which became national parks or reserves from the 1950s to the 1970s (Balme et al., 2014; Greve et al., 2011; Huntley et al., 2019). In parallel, the disproportional attention that large-sized species receive in research and conservation funding is global (Amori and Gippoliti, 2000; Trimble and Van Aarde, 2010). Moreover, most small-sized mammals are internationally under-represented in conservation policies (Verde Arregoitia, 2016; Yu and Dobson, 2000), hindering critical biodiversity conservation across various taxonomic levels.

Conservation strategies that focus only on large-bodied wide-range species can be insufficient for the adequate protection of several small-bodied and less mobile taxa (Gardner et al., 2007). Africa's CAs have already been noted as ineffective in protecting smaller mammals (Fjeldså et al., 2004). The fact that many of these areas were firstly designated for the preservation of large and charismatic species raises the question of whether megafauna can act as an umbrella for the conservation of small-sized taxa.

We address this issue by focusing on a south-eastern African country, Mozambique, where some CAs were delineated using emblematic species that we could consider today as umbrella species (Table 4.1). Biodiversity conservation in Mozambique was profoundly affected by two sequential protracted armed conflicts. After the country's civil war, which ended in 1992, only 7% of the territory was formally under conservation (Virtanen, 2002) and, because of excessive poaching for consumption and trade, wildlife populations had become depleted in CAs (Hatton et al., 2001).

A "national strategy and action plan" (NSBAP) directed at biodiversity protection in Mozambique were prepared in 1997 to accomplish a representative network of areas for the protection of habitats and maintenance of species therein (MICOA, 1997). CAs were gradually rehabilitated or newly created and new legislation implemented. Currently, the CAs network in the country comprises seven national parks (NP) and 12 national reserves (NR), making up 26% of

Table 4.1: List of conservation areas of Mozambique, their corresponding province, the date of the first designation as a reserve, the date of the last alteration (either to boundaries or designation), their current area, and the basis for the first designation as a reserve. Further, for each conservation area is listed the predicted number of small-sized mammals (body mass<5kg) with potential occurrence therein, according to the results of this study.

Name	Province	Date of 1st designation	Date of last alteration	Area (Km2)	Basis for area reservation	Potential species (n)
Gorongosa NP	Sofala	1960	2010	4086		103
Limpopo NP	Gaza	1961	2001	11233	Hunting reserve (Coutada nº16)	68
Bazaruto Archipelago NP	Inhambane	1971	2001	1430	Protection of dugong and sea turtle	74
Banhine NP	Gaza	1973	2013	7250	Protection of giraffe and ostrich, and arid zone habitats	69
Zinave NP	Gaza	1973	2013	4000	Protection of giraffe, other large herbivores and ostrich	88
Quirimbas NP	Cabo Delgado	2002		7500		58
Mágoè NP	Tete	2013		3745		45
Niassa NR	Niassa	1954	1999	42000	Hunting concession (Coutada do Niassa)	68
Marromeu NR	Sofala	1954	1961	1500	Hunting reserve	85
Gilé NR	Zambézia	1960	2011	2861	Hunting Partial Reserve of Gilé	85
Maputo SR	Maputo	1960	2011	1040	Protection of Maputo's elephants	59
Pomene NR	Inhambane	1972		200	Partial hunting reserve	77
Chimanimani NR	Manica	2003	2013	655		107
Malhazine NR	Maputo	2012		5,68	Military-use area ("Paiol")	66
Cape of São Sebastião TPZ	Inhambane	2003		300	Protection of turtles and natural resources	-
Ponta do Ouro Partial MR	Maputo	2009		678		73
Lago Niassa PR	Niassa	2011		478	Preservation of fish stocks	35
Primeiras Segundas islands EPA	Nampula	2012		10409	Protection of coastal and marine species and habitats	77

Notes:Information on conservation areas' designation and size was obtained from the webpage of Biofund, Foundation for the Conservation of Biodiversity in Mozambique (`http://www.biofund.org.mz/base-de-dados/plataforma-sobre-as-ac/`). Abbreviations: NP – National Park, NR - National Reserve, SP - Special Reserve, PR – Partial Reserve, MR – Marine Reserve, EPA – Environmental protection area, TPZ – Total Protection Zone.

the territory (MITADER, 2015; Table 4.1; Figure 4.1A).

However, knowledge on mammal occurrence and distribution across Mozambique is biased towards large mammals since conservation efforts have been mainly focused on preserving and rehabilitating megafauna populations (Chapter 3), with regular aerial censuses carried out in most CAs (Chapter 2). Only a few of these censuses have targeted the small-sized and restricted-range species. Recent reports on these species result mainly from opportunistic observations (Chapter 3), exacerbating knowledge scarcity regarding the occurrence and distribution of small-sized mammals in the country (Smithers and Tello, 1976; Chapter 2).

Given the need for assessing CAs effectiveness at various biodiversity levels, and to meeting the CBD's goal for 2020, we investigated whether Mozambique's CAs network adequately protects small-sized mammals. Specifically, we examined: i) species diversity and complementarity within the CAs, ii) representativeness of the CAs network based on protection targets, and iii) mammal conservation under scenarios of climate change and human pressure. Moreover, we suggest priority zones for conservation to ensure mammal preservation in the future. In this context, we provide the first assessment of Mozambique's CAs effectiveness to protect a substantial part of the country's mammal diversity, currently and prospectively.

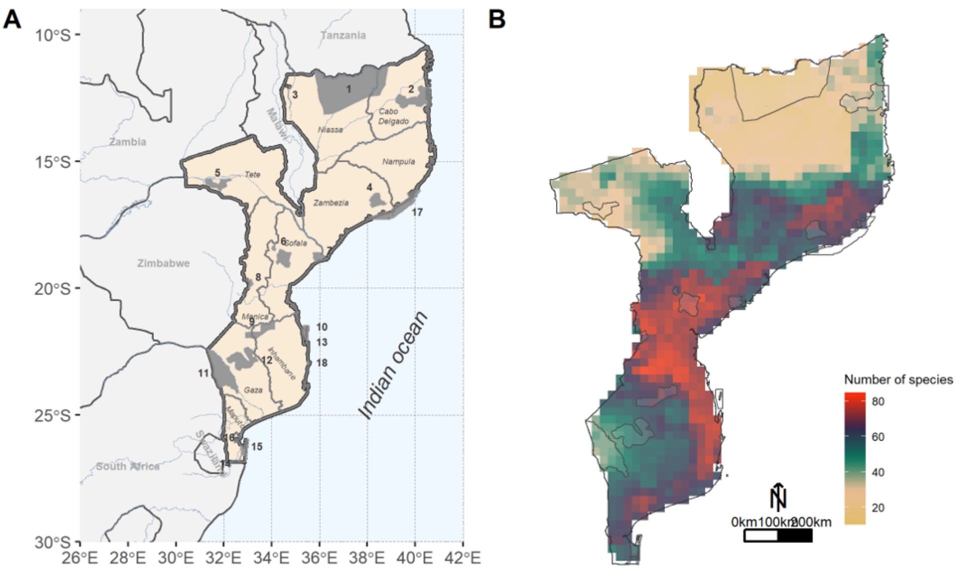

Figure 4.1: Conservation areas network and mammal richness in Mozambique. (A) Map of Mozambique, showing the current network of national parks and reserves, as well as provinces and major rivers. (B) Spatial representation of the potential species richness regarding 122 mammal species under five kilograms, based on suitable ranges modelling results for current climatic conditions at 0.25º resolution. The considered map of Mozambique's CAs was downloaded from the webpage of BIOFUND, a Foundation for the Conservation of Biodiversity in Mozambique. The country covers 786,380 square kilometres of land. (http://www.biofund.org.mz/base-de-dados/plataforma-sobre-as-ac/), which makes available spatial data on the country's current CAs. The country's CA considered in this study are indicated with a number: 1. Niassa national reserve, 2. Quirimbas national park, 3. Lake Niassa partial reserve, 4. Gilé national reserve, 5. Mágoè national park, 6. Gorongosa national park, 7. Marromeu national reserve, 8. Chimanimani national reserve, 9. Zinave national park, 10. Bazaruto national park, 11. Limpopo national park, 12. Banhine national park, 13. Cabo São Sebastião Total protection area, 14. Maputo special reserve, 15 – Ponta do Ouro national reserve, 16-Malhazine national reserve, 17. Primeiras e Segundas islands environmental protection area, 18. Pomene national reserve.

4.2 Material and methods

4.2.1 Study area

Mozambique is located in south-eastern Africa between 10º and 27ºS and 30º and 41ºE, sharing borders with six countries: Tanzania, Malawi, Zambia, Zimbabwe, South Africa and Swaziland from north to south, respectively. It covers 786,380 square kilometres of land.

Mozambique's system of conservation areas, as defined in the national Conservation Law (nº16/2014), comprises "total conservation areas", which are areas of public domain without permissions for resource extraction, and "sustainable use conservation areas", which are areas of public or private domain with permissions for certain levels of resource extraction, such as

official hunting reserves, game farms and community conservation areas. In the last decades, five trans-frontier parks were established: Great Limpopo, Lubombo, Niassa-Selous, Chimanimani and Zimoza (Peace Parks Foundation 2016). Currently, Mozambique's conservation areas cover approximately 26% of the territory (Table 4.1; MICOA, 2014). There are seven national parks under the direct domain of Mozambique's state, namely Quirimbas, Gorongosa, Mágoè, Bazaruto, Limpopo, Zinave and Banhine, as well as 12 national reserves, namely Niassa, Gilé, Marromeu, Lake Niassa, Chimanimani, Pomene, Malhazine, Ponta de Ouro and the Inhaca Biological Reserve, the Maputo special reserve, the Cape São Sebastião Total Protection Zone, and the Environmental Protection Area of the First and Second Islands (Table 4.1, Figure 4.1).

4.2.2 Data sources and niche modelling

Species and conservation area data

The species selected for this study were the Mozambican mammal species with a bodyweight of less than 5 kg, hereafter called "small-sized species". Weight data was retrieved from Jones et al. (2009). The occurrence records of each species were used to estimate their ranges through niche models. These models combine the locations of each species with the values of a set of environmental variables in those locations, quantify the relationships and extrapolate an index of habitat suitability over the study area (i.e., the species "potential niche") (Guisan and Zimmermann, 2000). All subsequent spatial and statistical analyses were performed in the R environment version 3.4.4 (R-Core-Team, 2018).

Species data are from the primary species occurrence dataset of Mozambican terrestrial mammals collated in Chapter 2. To maximise the potential of the modelling procedure to capture the fundamental niche of the species and potentially include the limits of species' tolerance and needs for determined abiotic conditions, we complemented data for each species with records of occurrence from Mozambique's neighbouring countries. Only data from within the rectangle with the following spatial extent between -30º and -7º latitude, and 24º and 42º longitude were maintained for further analysis. This spatial extent will be hereafter referred to as "extended study area" as it includes parts of neighbouring countries in addition to the land within Mozambique's borders. These additional data were retrieved from the Global Biodiversity Information Facility (GBIF, www.gbif.org; downloaded on 8 October 2018). Only records based on preserved specimens or observations, with complete information on the geographical coordinates, and not flagged with "spatial issues" by GBIF's internal record interpretation, were

kept for analyses. For data search and retrieval, we use the "rgbif" package (Chamberlain et al., 2018).

To improve model performance and reduce the effect of data sampling bias, we only used records that were located more than 28 km apart. This value is approximately the distance between the midpoint of two adjacent cells with the same longitude using the resolution 0.25 by 0.25 degrees, which is the resolution selected for niche modelling (see Section 4.2.2). This filtering procedure was carried out with the function "Thin" implemented in the "spThin" R package (Aiello-Lammens et al., 2015).

In addition, only species with more than five reliable and spatially separated presence records were maintained, since it has been shown that at least five records are needed to model suitable ranges accurately (Pearson et al., 2007). Applying all preceding criteria, we obtained 122 species: Chiroptera (53 species), Rodentia (38 species), Carnivora (10 species), Eulipotyphla (9 species), Macroscelidae (5 species), Primates (4 species), Lagomorpha (2 species), and Afrosoricidae (1 species).

The map of Mozambique's CA was downloaded from the webpage of BIOFUND, a Foundation for the Conservation of Biodiversity in Mozambique (`http://www.biofund.org.mz/base-de-dados/plataforma-sobre-as-ac/`), which holds the most current database for conservation areas in Mozambique. For the sake of clarity, the CA network considered here refers to the public domain CA under the State's direct management, which includes the national parks (NP) and national reserves (NR). Furthermore, we acquired species' global conservation statuses from the IUCN Red List (IUCN, 2018). Most of the selected species (96.7%; 118 species) are categorised as Least Concern (LC) on the IUCN Red List (IUCN, 2018). Three species are listed as Near-threatened (NT), *Eidolon helvum* (Chiroptera: Pteropodidae), *Hipposideros vittatus* (Chiroptera: Hipposideridae), and *Rhinolophus deckenii* (Chiroptera: Rhinolophidae), and one as Data-deficient (DD), *Elephanthulus fuscus* (Macroscelidae: Macroscelididae).

Bioclimatic and human pressure data

Bioclimatic variables from the WorldClim database – version 2 (Fick and Hijmans, 2017), for the current period and future scenarios, have been widely used in niche modelling as they represent the characteristics of temperature and precipitation and their seasonal variation characteristics. We selected 14 bioclimatic variables for the niche modelling procedures, either for the

current period or for future projections (see Supplementary material, Table 4.S1). These variables were previously identified as meaningful for capturing Mozambique's climatic variability (Chapter 3) and for predicting mammal species distribution (Cianfrani et al., 2018; Cooper-Bohannon et al., 2016; Faurby and Araújo, 2018).

For future projections, we considered the climatic projections for 2050 based on the UN's Intergovernmental Panel on Climate Change scenarios (IPCC (Core Writing Team), 2014). The Fifth Assessment Report released by the IPCC published four scenarios for climate change, given different representative concentration pathways (RCP). Since in most countries the carbon intensity has not declined fast enough to limit warming to two degrees (Raftery et al., 2017), for the 2050 predictions we only show results for the business-as-usual scenario (the concentration pathway scenario RCP 8.5.), which assumes a continuous rise in greenhouse gas emissions through the 21st century. We used the global circulation model MIROC5. All downloaded bioclimatic variables, for current and future scenarios, were in raster format and were converted into a grid at a resolution of 0.25×0.25 degrees (approximately 28 km2) with spatial dimensions of the extended study area.

To measure human pressure on the natural environment, we used the updated Human Footprint index (Venter et al., 2016), which is a globally-standardised measure of cumulative human pressure on the terrestrial environment, and was used here as a spatial proxy of anthropogenic impact on species. The Human Footprint (HF) derives from global data that summarises the ecological footprint of the human population (built environments, croplands, pasture lands, population density, night lights, railways, major roadways and navigable waterways), and derives from the cumulative pressures on the environment in 2009. HF values range from 0 (no human impact) to 50 (maximum human impact). We assume areas with high HF to remain the same in the future.

HF's global rate of expansion is slower than the underlying rates of population and economic growth (Venter et al., 2016). For this reason, we opted to include in our analysis data on the spatial distribution of human population densities for the years 2015 and 2020 from the Gridded Population of the World, Version 4 (GPW v.4.10; 2017; `http://sedac.ciesin.columbia.edu/`). The GPW's Human population density estimates (people per square kilometre) were based on counts from 2010's censuses that were extrapolated to 2015 and 2020.

These "human pressure" variables (HF, Population densities for 2015, and Population Densities for 2020 grids) were in raster format and were converted to match the resolution of the

bioclimatic variables and cropped to match Mozambique's spatial extent.

Niche modelling

The climatic niches of the 122 species were modelled using the ensemble forecasting approach embedded in the biomod2 R package (Thuiller et al., 2009). Ensemble models were computed by averaging the predictions of four commonly used modelling techniques: two regression-based models – generalised linear models (GLM) and multivariate adaptive regression splines (MARS) – and two machine learning methods – gradient boosting machine (GBM) and the maximum entropy model (MAXENT; (Phillips et al., 2006) – weighted by their respective accuracy. Default parameters in Biomod2 were used in each model run.

For each species, we generated pseudo-absences through the random selection of points within the extended study area. Since the use of a large number of pseudo-absences often increases precision in models (Barbet-Massin et al., 2012), we used ten times as many pseudo-absences as presences. Ten replicates of the random pseudo-absence generation process were performed.

Models were executed for a larger spatial extent, which included Mozambique and part of its neighbouring countries, for the following reasons: (1) many species were broadly distributed throughout sub-Saharan Africa, and so we had to include an environmentally significant geographical context to capture their climatic niche completely; and (2) it was required because we used a coarse spatial resolution .

To avoid highly correlated and redundant information, . for each species, we excluded the highly correlated variables from the initial set of bioclimatic variables through a stepwise procedure implemented in the R package "usdm" using the "vifstep" function (Naimi et al., 2014). The function "vifstep" calculates the Variation Inflation Factor (VIF) for all variables, and excludes the one with highest VIF, and repeats the procedure until no variables with VIF that exceeded a threshold value of 10 remains (Cohen et al., 2003). Further, we limited the number of predictor variables to a maximum of five per species.

For each modelling technique, and for each replicate of pseudo-absences, three repetitions were performed using random sets of 80% of the initial occurrences to calibrate the model and using the remaining 20% to evaluate the models. Models were evaluated with the "True skill" statistic (TSS). Once species niche models were fit, they were combined into a weighted average consensus according to the level of matching between predicted distributions and observed

distributions in the test data using TSS. Only models with TSS scores greater than 0.6 were used to produce the total consensus model for each species.

Finally, each final ensemble model was then re-projected using current climate conditions (1970-2000) and future climate conditions (scenario of business-as-usual for 2050) within Mozambique's territory. Binary predictions were obtained by thresholding the continuous probabilities at a value that maximises TSS evaluation scores. The ensemble model of each species reflects the geographical range of suitable climatic conditions for that species, referred to here as the suitable range. The present and future species' suitable ranges were then used in all further analyses of CA effectiveness for representing the species targeted by this study.

4.2.3 Data analysis

Species richness and complementarity within the CA network

To obtain a potential richness map, we overlapped the suitable range maps of the 122 target-mammals and summed for each cell of the country's grid the species predicted to have suitable climatic conditions therein. The map of Mozambique's CA was also intersected with the country's grid. Grid cells overlapping with CA were considered "protected cells", and grid cells outside the CA network were classified as "non-protected cells".

To assess the number of species within the existing CA network, we overlaid the CA map with the potential richness map. For each conservation area and the complete set of "protected cells", we extracted the potential diversity and identity of species therein. We calculated the average potential richness and standard deviation for both the "protected cells" and the "non-protected cells". Statistical differences in total species richness between protected and non-protected cells were tested with non-parametric Kruskal Wallis tests.

Complementarity between the existing CA was assessed as high or low redundancy in species diversity, by calculating similarities in species composition among the conservation areas. The assessment was based on a cluster analysis using the Jaccard similarity coefficient. The Jaccard coefficient measures spatial turnover by comparing all pair sites, clustering similar sites until a complete dendrogram is constructed (Magurran, 2004).

Representativeness of the CA network and protection targets

The extent of the suitable range for each species was measured as the number of the country's grid cells overlapping with the species' suitable range. In addition, for each species, we determined their "protected range" as the extent of their suitable range within the "protected cells". Here, we determined the representativeness of the CA network, for each species, as the proportion of the protected range in relation to the suitable range.

To assess if a species is adequately protected, we followed thresholds proposed by Rodrigues et al. (2004). Thresholds established based on the proportion of range covered by CA networks have been used extensively (Butchart et al., 2015; González-Maya et al., 2015, e.g.). A species with more restricted ranges should have a more significant percentage of its range protected, i.e. within conservation areas. Accordingly, a 100% protection target was set for species with ranges under 1000 km2, and a 10% protection target was set for species with ranges above 250000 km2. A linear decline in the target was established for ranges between these extremes (Rodrigues et al., 2004). Species presenting a "protected range" lower than these protection targets set a priori were identified as "under-protected species". Additionally, species not represented in any conservation area were considered "gap species" (Rodrigues et al., 2004).

Range size was previously identified as an important predictor of extinction risk of terrestrial mammals (Crooks et al., 2017; Pimm et al., 2014). Species with small ranges tend to be more vulnerable to adverse natural events and anthropogenic activities (Gaston, 2003; Rodrigues et al., 2004). Accordingly, we also considered species with restricted ranges within Mozambique to be priority species for conservation. The 122 species were grouped by quartiles over the size of their suitable range. Accordingly, four groups of species were formed: restricted-range group, with species with suitable ranges within the lowest quartile; restricted-to-moderate range group, with species within the second quartile; moderate-to-wide range group, with species within the third quartile; and wide-range species, for species within the fourth quartile. Potential richness maps were also created for the set of "under-protected species" and the set of "restricted-range species". For both sets of species, we calculated the average potential richness and standard deviation of the "protected cells" and the "non-protected cells". We tested for statistical differences between protected and non-protected cells with non-parametric Kruskal Wallis tests.

To examine the overall congruence of the number of species between the maps of total species richness, of "under-protected species" richness and of "restricted-range species" rich-

ness, we used a modified t-test that can be used for the correlation of spatial variables (SpatialPack package, R environment; Vallejos et al., 2018).

Species conservation under climate change and human pressure

Climate change can shift a species' suitable climatic conditions to places where the species would be less adequately protected or exposed to greater human pressure. For this reason, we determined species richness changes under future climatic conditions. A map of suitability changes was produced by comparing, for each species, their current and future suitable ranges and quantifying the potential number of species gained or lost in each of the country's grid cells, assuming no dispersal. In addition, based on the suitable future ranges, we measured the extent and representativeness of the existing CA network for protecting species and their suitable future ranges, as in the previous section.

"Human pressure" in Mozambique was quantified by averaging the values of HF and population densities across the entire country, inside the conservation areas, within the species' suitable ranges, and within the species' protected range, for current and future projections.

Priority zones for conservation

Priority zones to improve mammal conservation were projected from non-protected areas with high richness and high species rarity, as well as with low human pressure and climate change impact.

First, we determined "Centres of non-protected high richness" by selecting the 25% of non-protected cells with the highest number of "under-protected" species, and "Centers of rarity" by selecting the 25% of the non-protected cells with the highest number of restricted-range species. We then merged these Centres' cells and selected the 30 cells with both low human pressure and low change in climate suitability (i.e., lower potential loss of species). We only considered cells with HF values below 7 (Venter et al., 2016) and with values of HPD predictions for 2020 below the current country's average (37.73 hab./km2; The World Bank, 2017).

Thirdly, we created 0.3º width buffers around these top 30 cells using the "gBuffer" function available in the R package "rGeos" (Bivend et al., 2017). Intersecting buffers were merged, and the resulting spatial areas were considered to represent "priority conservation zones". Climate conditions and human pressure, under current and future projections, were measured (mean and standard deviation) in these priority zones for conservation.

To evaluate the effectiveness of the proposed priority zones, we estimated the gain from the hypothetical creation of one to all priority zones in the country. For each hypothetical scenario of creating an "X" number of new conservation areas, we randomly extracted "X" zones from the set of "priority conservation zones" and repeated this process 2000 times to obtain all possible combinations of "priority conservation zones". Next, for each combination of "priority conservation zones" selected, we calculated the potential gain in species protected range and the number of species that would be considered protected, given the protection targets established in "Data analysis" - Section 4.2.3. Finally, we ranked the "priority conservation zones" considering the total number of restricted-range species, under-protected species, and the overall number of species represented.

4.3 Results

4.3.1 Species richness and complementarity within the CAs network

We analysed 122 mammal species, which represent 82% of the terrestrial mammals under five kilograms reported for Mozambique (Chapter 2). Our models showed good power in predicting species' suitable ranges (see Supplementary information - Table 4.S2 for average TSS values of models selected to construct the final ensemble model for each species). The potential richness map, obtained from overlapping all species' suitable ranges, shows that approximately 35% of the country's territory could potentially harbour more than half of the small-sized species, and almost 8% of the territory could shelter more than 75%. The areas of highest richness were mainly concentrated in central Mozambique, and Manica and Sofala provinces (Figure 4.1B). The mean potential richness was significantly higher in non-protected cells (50.3 +- 18.6 SD) than in cells inside CAs (31.9 +- 20.9 SD; Kruskal-Wallis chi-squared: 68.76, df=1, p<2.2x10-16).

Our results for current climatic conditions indicate a mean number of 73 species per CAs (+- 18 SD), with the highest number of species obtained for Chimanimani NR, followed by Gorongosa NP (Table 4.1). Almost half of the species have suitable climatic conditions in more than six CAs (n=59) and 17 species in more than nine CAs, while 26 species may be protected in less than three CAs (Supplementary information, Figure 4.S1).

Most species (119; 97.5%) have suitable climatic conditions in current Mozambique´s CAs network. Thus, only three species were considered "gap species": *Gerbilliscus boehmi*, *Praomys*

delectorum, and *Dasymys incomtus*, all rodents. The three Near-threatened species and the Data-deficient species may be protected in at least five CAs.

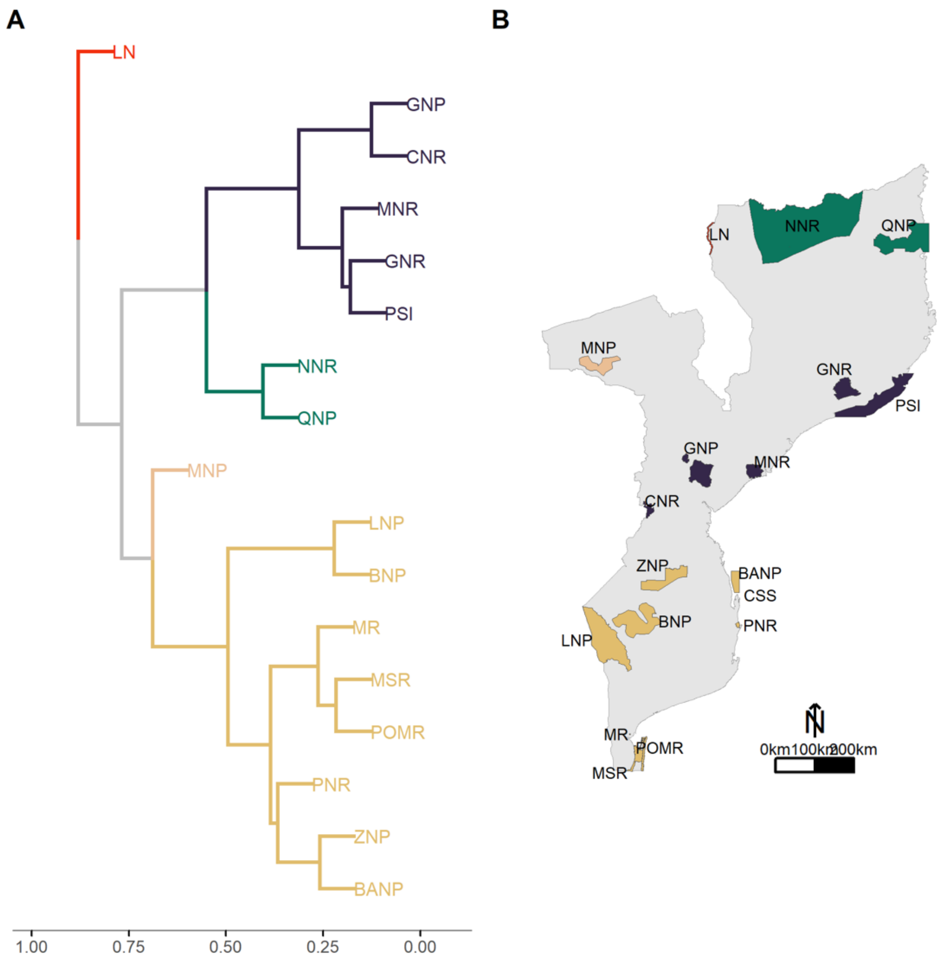

Figure 4.2: Complementarity of the current conservation area network in Mozambique based on predictions of the suitable ranges of 122 mammal species under five kilograms. (A) Cluster analysis of mammal diversity using Jaccard distance between conservation areas in Mozambique, using the Jaccard distance index; (B) Geographical location of the conservation areas across the country with visualisation of complementarity between them, given cluster defined in A). Conservation areas abbreviatures: NNR - Niassa national reserve, QNP - Quirimbas national park, LN - Lake Niassa partial reserve, GNR - Gilé national reserve, MNP - Mágoè national park, GNP. Gorongosa national park, MNR - Marromeu national reserve, CNR - Chimanimani national reserve, ZNP - Zinave national park, BANP - Bazaruto national park, LNP - Limpopo national park, BNP - Banhine national park, CSS - Cabo São Sebastião Total protection area, MSR - Maputo special reserve, PONR – Ponta do Ouro national reserve, MR - Malhazine national reserve , PSI - Primeiras e Segundas islands environmental protection area , PNR - Pomene national reserve.

Based on the suitable range maps, we found moderate similarity among CAs for representing the targeted species, as evidenced by a mean Jaccard similarity index of 51.5%. Diversity similarities indicated five main groups (at 60% dissimilarity; Figure 4.2).

Three groups of CAs emerged with less than 25% dissimilarity: (i) the southern CAs and

Table 4.2: List of mammal species (body mass <5kg) considered protected and under-protected (bottom-15) in the conservation areas of Mozambique, according to the protection targets established in the study. Range-size expressed the a group of species according to the quartiles on their suitable range size in Mozambique, for current projections. '1' represents the group of species with suitable ranges within the first quartile ("Restricted" ranges); '2' the group of species within the second quartile ("Restricted-to-moderate" ranges); '3' the group of species within the third quartile ("Moderate-to-wide" ranges); and '4' the group of species within the fourth quantile ("Wide-range" ranges).

	Species	Order	Range-size	Conservation areas (N)	Range protected (%)
PROTECTED	*Tadarida fulminans*	Chiroptera	2	2	16,39
	Hipposideros ruber	Chiroptera	3	5	13,6
	Mus triton	Rodentia	4	7	12,36
	Miniopterus inflatus	Chiroptera	3	7	12,21
	Micaelamys namaquensis	Rodentia	2	9	12,14
	Epomophorus labiatus	Chiroptera	3	5	12,05
	Rhinolophus fumigatus	Chiroptera	4	10	11,68
	Galerella sanguinea	Carnivora	2	8	11,54
	Neoromicia zuluensis	Chiroptera	4	11	11,49
	Acomys spinosissimus	Rodentia	4	11	11,01
	Rhinolophus hildebrandtii	Chiroptera	4	10	10,95
	Galago moholi	Primates	3	6	10,77
	Mastomys natalensis	Rodentia	4	11	10,33
	Myotis welwitschii	Chiroptera	3	6	10,28
	Graphiurus murinus	Rodentia	3	9	10,19
UNDERPROTECTED (Bottom-15)	*Glauconycteris variegata*	Chiroptera	2	3	3,24
	Heliophobius argenteocinereus	Rodentia	1	2	2,89
	Myotis tricolor	Chiroptera	2	6	2,6
	Taphozous mauritianus	Chiroptera	1	1	2,58
	Nycteris macrotis	Chiroptera	3	4	2,4
	Graphiurus platyops	Rodentia	1	1	2,08
	Scotophilus nigrita	Chiroptera	2	3	1,92
	Neoromicia capensis	Chiroptera	1	1	1,75
	Crocidura mariquensis	Eulipotyphla	1	2	1,74
	Rhinolophus clivosus	Chiroptera	1	2	1,42
	Dendromus mystacalis	Rodentia	1	2	1,35
	Rhinolophus simulator	Chiroptera	1	2	0,81
	Dasymys incomtus	Rodentia	1	0	0
	Gerbilliscus boehmi	Rodentia	1	0	0
	Praomys delectorum	Rodentia	1	0	0

Magoé NP, (ii) the central CAs as well as the northern Niassa NR and Quirimbas NP, and (iii) Lake Niassa Partial reserve. The CAs Magoé NP, Lake Niassa and the group Niassa NR and Quirimbas NP, are individually more dissimilar from the remaining areas and from each other (Figure 4.2). These CAs - present suitable climatic conditions for fewer overall species (Table 4.1). The two larger groups (i.e. more than five CAs, and with the highest number of predicted species) were: (i) the southern CAs located south of the Save river, (ii) and the central CAs located in Sofala, Manica and Zambézia provinces (Figure 4.2; Table 4.1).

4.3.2 Representativeness of the CA network and protection targets

Most species (107; 88%) did not achieve the protection targets needed to be considered adequately protected (Figure 4.3A). The representativeness (i.e., the amount of protected range)

for the species with suitable ranges within CAs did not exceed 17% and could be as low as 0.81% in the worst case, with average overall representativeness of 7.7%. Table 4.2 lists the 15 species considered protected across the country and the 15 species with the lowest proportion of their suitable range protected.

Geographical patterns of richness regarding the totality of under-protected species (Figure 4.3B) mostly coincide with overall small-sized mammal diversity patterns (Figure 4.1B). The under-protected species have average representativeness of 7.1%. For this group of species, a higher number of species was estimated for non-protected cells (42.2 +/- 18.3 SD) than for protected cells (27.8 +/- 19.3 SD) with statistical significance (Kruskal-Wallis chi-squared: 74.175, df=1, p<2.2x10-16).

The areas of potentially high diversity of the restricted-range species are dispersed across the country (Figure 4.3C). A higher number of restricted-range species (N=31) was also estimated for non-protected cells (5.73 +-2.55 SD) than for protected cells (3.50 +- 2.50 SD), with statistical significance (Kruskal-Wallis chi-squared: 60.661, df=1, p<2.2x10-16).

4.3.3 Species conservation under scenarios of climate change and human pressure

Climate change

The projections for 2050 showed that approximately 15% of the country may lose climatically suitable areas for more than ten species, with this loss being particularly severe in the provinces of Sofala, Zambézia and Inhambane (Figure 4.4A).

In a balance between species gains and losses, six protected areas were predicted to lose mammal diversity under future climatic conditions. These were: Zinave NP, with the potential loss of climatically suitable area for eight species, followed by Banhine NP, Gilé NR, Gorongosa NP, Marromeu NR and Primeiras e Segundas environmental protection area (Figure 4.4B). In contrast, Chimanimani NP, Niassa NR and Maputo NR showed an increase in the number of protected species under future climate conditions.

The climatic projections for 2050 indicate a substantial overall range loss, even if some species gain new climatically suitable areas. Suitable range losses were predicted for more than half of the small-sized mammal species in this study (N=66). The majority of these were projected to lose more than 40% of their suitable ranges (N=35). Our models predicted the most

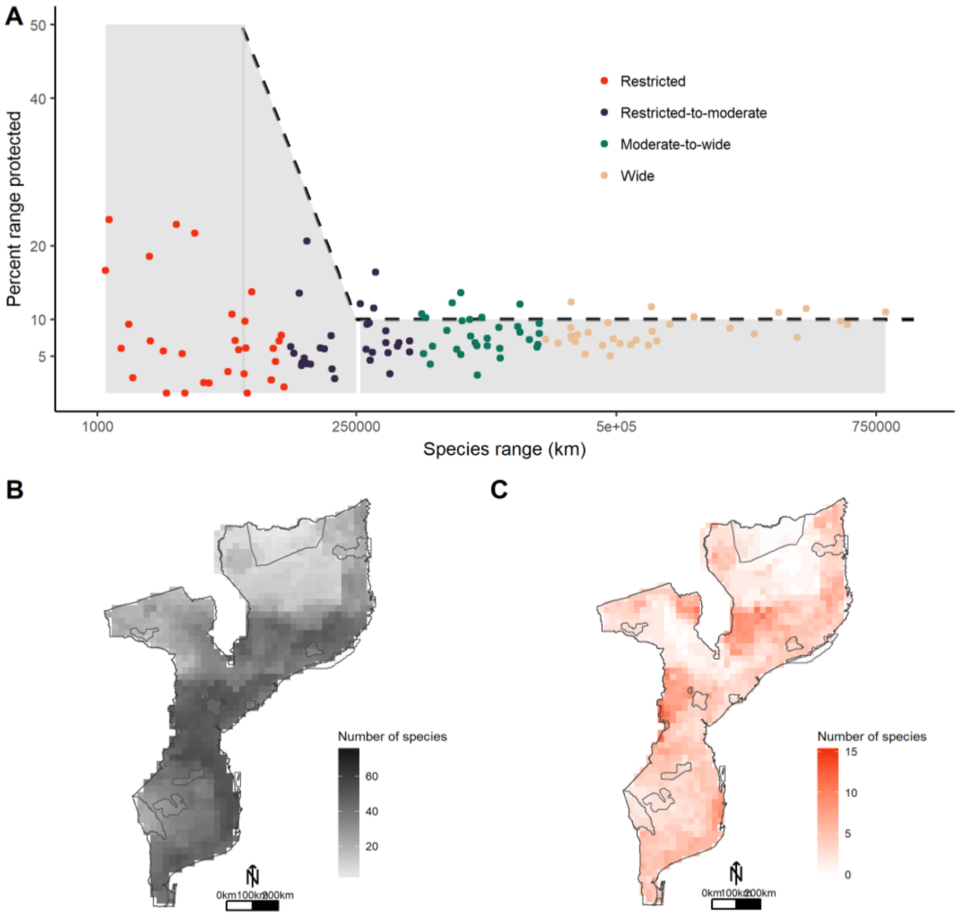

Figure 4.3: Representativeness of Mozambique's CAs network and protection targets regarding 122 mammal species (<5 kg). (A) Relationship between suitable range size and the proportion that is covered by the conservation area network. Each point represents a species. The dashed line indicates the protection targets - i.e. percentage of the range that must be overlapped by conservation areas for the species to be considered covered - as in Rodrigues et al. (2004). For species with a very restricted range (<1000 km2), the protection target is 100% of the range; for very widespread species (>250000 km2), the target is 10%. For species with an intermediate size range, the target was interpolated between these two extremes. Species that fall in the grey area, beneath the line, are classified as "under-protected species". (B) The richness of "under-protected" species (N=107 species) across Mozambique (0.25º resolution grid). (C) The richness of "Restricted-range" species (N=31 species) across Mozambique (0.25º resolution grid). Richness maps were obtained by summing species' suitable range maps predicted for current climate conditions. Conservation areas are shown by grey-line polygons. The 122 target species were divided into four groups by quartiles on their suitable range size in Mozambique, from "Restricted-range species", in the first quartile, to "wide-range species", in the fourth quartile.

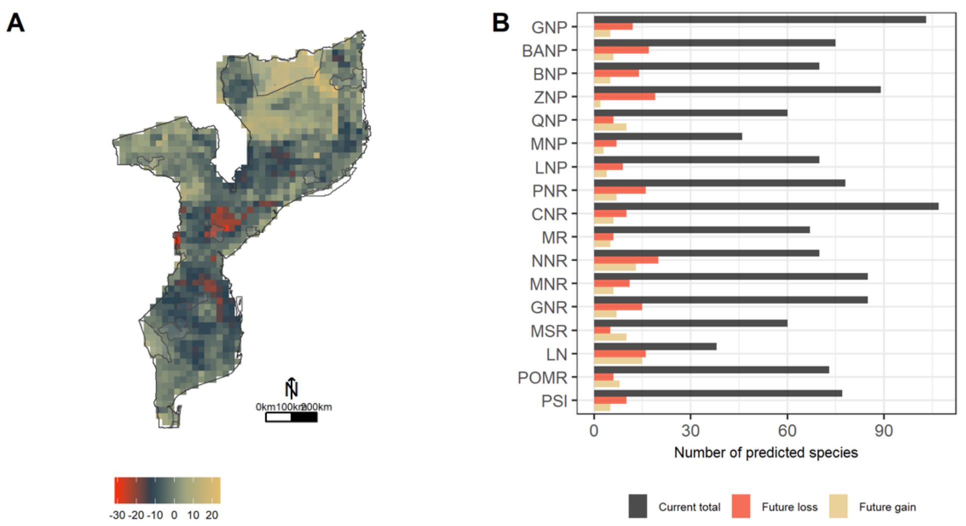

Figure 4.4: Climate suitability and CAs representation change for 122 mammal species (<5kg) across Mozambique's territory (A) Suitability change according to climate change predicted for 2050 (scenario RCP 8.5), in terms of the number of species potentially lost and gained within each 0.25º grid cell. (B) Predictions of current potential mammal diversity in each conservation area, and future changes in species richness (potential species gains or species losses). Predictions under future climatic conditions were based projection for the year 2050 under the scenario RCP 8.6. Conservation areas abbreviatures: NNR - Niassa national reserve, QNP - Quirimbas national park, LN - Lake Niassa partial reserve, GNR - Gilé national reserve, MNP - Mágoè national park, GNP. Gorongosa national park, MNR - Marromeu national reserve, CNR - Chimanimani national reserve, ZNP - Zinave national park, BANP - Bazaruto national park, LNP - Limpopo national park, BNP - Banhine national park, CSS - Cabo São Sebastião Total protection area, MSR - Maputo special reserve, PONR – Ponta do Ouro national reserve, MR - Malhazine national reserve , PSI - Primeiras e Segundas islands environmental protection area , PNR - Pomene national reserve.

considerable losses in climate suitability for the restricted-range group (Figure 4.5). For instance, a complete range loss was predicted for the mustelid *Poecilogale albinucha*, and severe range losses (i.e., more than 80%) were forecasted for two rodents (*Lophuromys flavopunctatus*, *Dendromus mystacalis*), three bats (*Roussetus aegyptiacus*, *Myotis tricolor*, *Rhinolophus simulator*), and two shrews (*Crocidura olivieri*, *Crocidura luna*), most of which are restricted-range. In contrast, our models showed an increase of more than 40% in the current suitable range for 16 species, which are distributed across the four range-size groups and belong to various taxonomic groups.

Under future climate conditions, the overall average representativeness was predicted to maintain equivalent levels to those of current conditions (Figure 4.5), with approximately 48% (N=59) of the species improving their protected range, 46% (N=57) losing their protected range and 5% (N=6) without alterations in their protected range. Species representativeness within the CAs network varied between no coverage, for the murid *L. flavopunctatus* and the golden mole *Calcochloris obtusirostris*, to more than 28% coverage, for the gerbil *G. boehmi*, a gap species under the current climate. Also, near-threatened and data-deficient species remained under-protected under future climate conditions.

When analysing the species with similar range sizes under current climatic conditions, the average representativeness is less than 10%, varying from 7.41% to 8.31%, with a higher overall percentage protected range for wide-range species than for restricted-range species. Besides, the proportion of the CAs network protected range was more variable for the restricted-range species and spanned from no coverage to more than 25% species covered (Figure 4.5).

The suitable range projections for 2050 indicate that the average representativeness of the restricted-range species in the CAs network may further decrease. Also, as observed for the current climatic conditions for this group of species, representation within the CAs network was highly variable and spanned from no coverage to an increase in coverage of up to 40% of their protected range (Figure 4.5).

Human pressure in current and future climatic conditions

In Mozambique, human pressure is higher in coastal areas, near major rivers and along main roads (Supplementary material – Figure 4.S2A). Inside the CAs network, overall HF values, although highly variable, are low with an average of 3.8. According to 2015 estimates, the average HPD inside the CAs is 8.12 people per square kilometres. A slight increase is predicted for

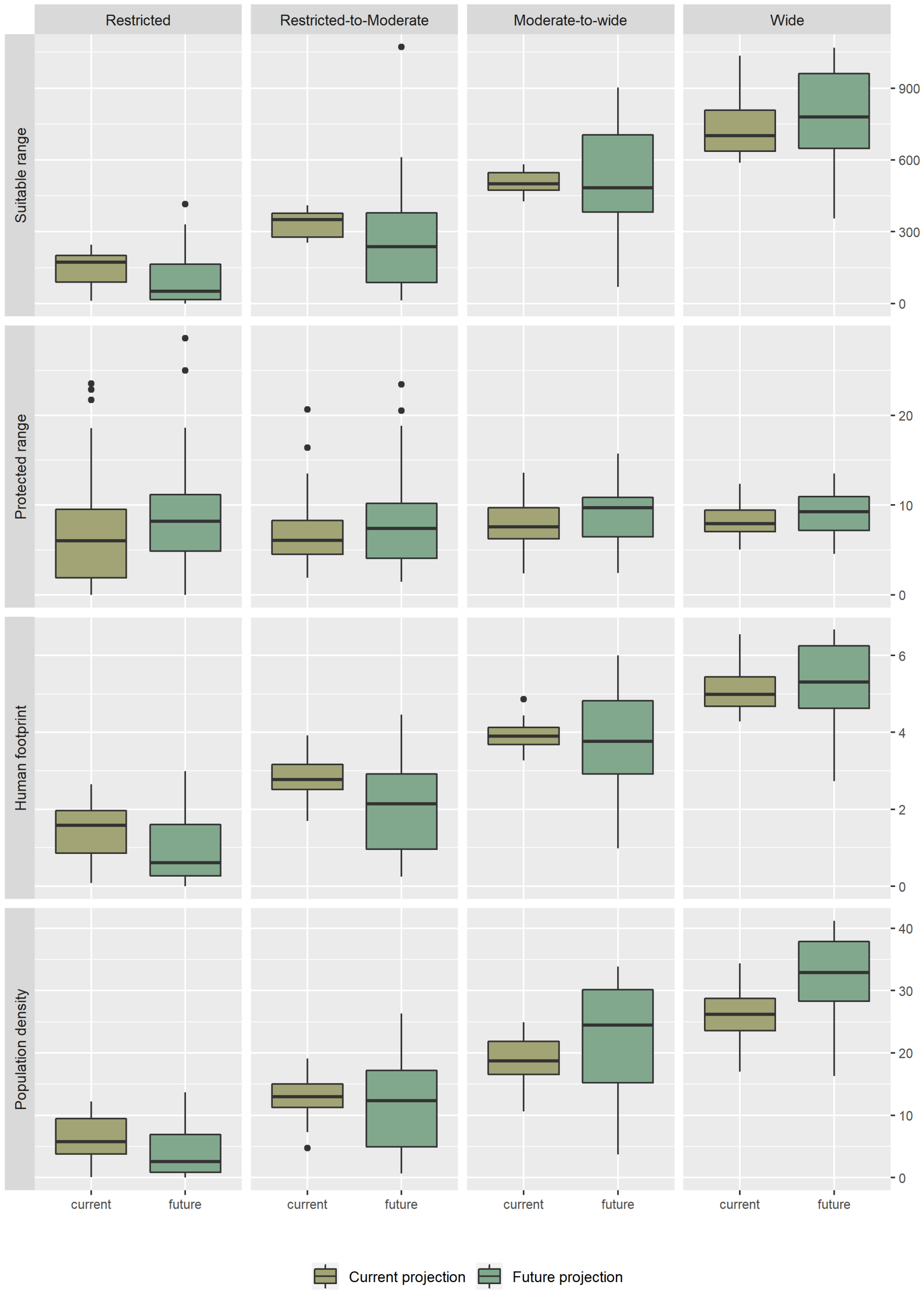

Figure 4.5: Predicted effect current climatic conditions, future climate conditions on species suitable and protected ranges, and effect of human pressure on species suitable range, for different range-size groups regarding 122 species of Mozambican mammals with a bodyweight less than 5Kg. Species were grouped by quartiles on their suitable range size in Mozambique, for current projections. "Restricted" represents the group of species with suitable ranges within the first quartile; "Restricted-to-moderate" the group of species within the second quartile; "Moderate-to-wide" the group of species within the third quartile; and "Wide-range" the group of species within the fourth quantile.

2020 (Supplementary material - Figure 4.S2B). Considering the projected range changes under future climatic conditions, species from the restricted and restricted-to-moderate range groups will experience, along with a reduction in their suitable areas, a decrease in the average HF and human population density inside their future climatically suitable areas. However, species with wide-range sizes will experience an increase in the average HF and human population density inside their future climatically suitable areas (Figure 4.5).

4.3.4 Priority zones for conservation

Thirteen priority zones for small-sized mammal conservation were selected (Figure 4.6). These are dispersed across Mozambique in nine provinces (Figure 4.6A). West Manica and Zambezia provinces contain the three zones predicted to enclose the highest number of species. They are located in the eastern escarpment of the continental plateau and include the moderate to higher elevation lands of the country (Figure 4.6A,B).

The effectiveness of the proposed priority zones to fill the gaps in range coverage will maximise the overall number of protected species if at least two to four of the priority zones are created (Figure 4.6C). However, even though the representativeness of the restricted-range species will increase with the creation of the proposed zones by up to 40%, all species will remain under-protected.

4.4 Discussion

Our study aimed to contribute to mammal conservation in Mozambique. It provides an evaluation of the representativeness and effectiveness of the country's CA network for protecting mammal species under 5 kg and proposes a baseline set of priority areas to complement the current conservation network.

4.4.1 Species richness patterns and future change

Based on our models, central and coastal Mozambique provinces were predicted to have elevated levels of species richness of small-sized mammal fauna. Northern Mozambique presented lower overall predicted richness. Climate change has the potential to impact the country's mammal fauna, with half of the small-sized mammals considered vulnerable, i.e. predicted to lose climatically suitable conditions, according to climate change projections for 2050. Furthermore,

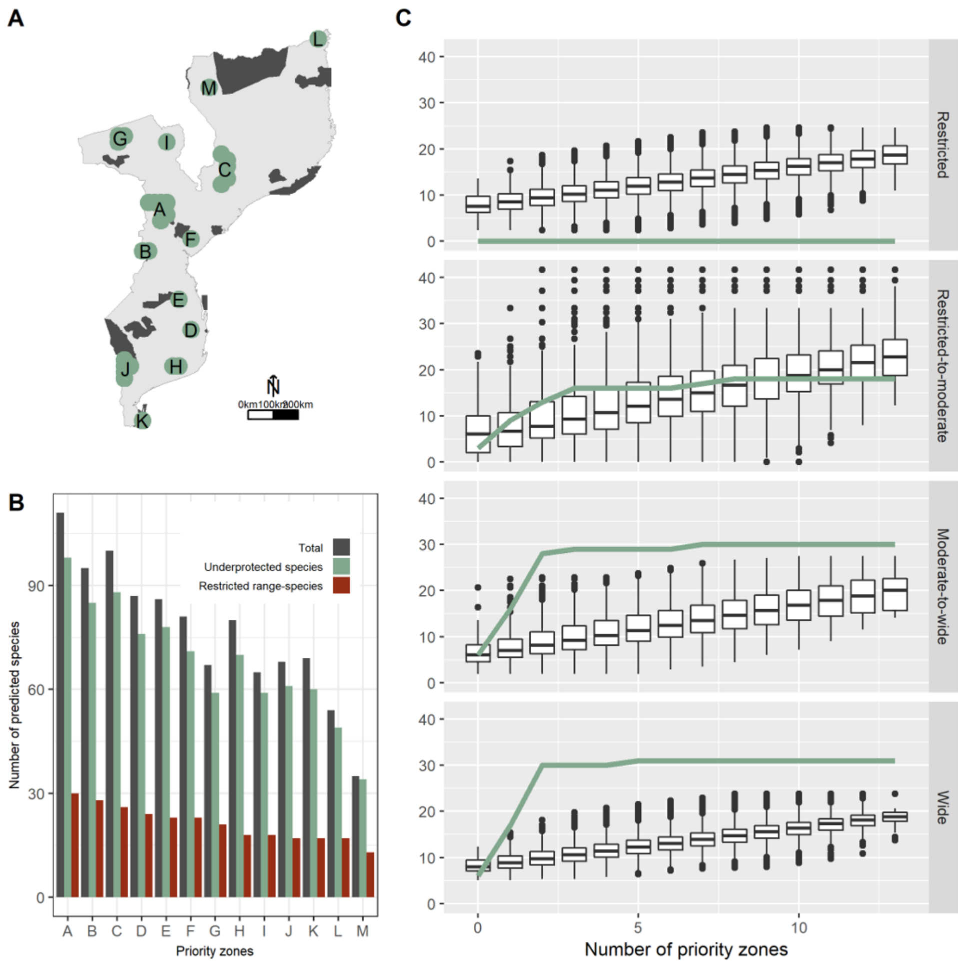

Figure 4.6: Priority zones proposed to improve mammal conservation in Mozambique. (A) Geographical indication of the new zones selected as a priority for conservation (green). Dark polygons represent current CAs. (B) The total number of species, under-protected species and restricted-range species in each priority zone as the potential to protect if realised. Numbers on the x-axis correspond to the letter of the priority zone in panel A. (C) Potential changes in representativeness (boxplots) and number of species effectively protected (green line) by the random creation of one or more priority zones, for each range-size groups regarding 122 species of Mozambican mammals with a bodyweight less than 5Kg. Notes : Priority zones names and provinces: A - north-western Manica dry Miombo scrublands (Manica), B - Manica plateau forest transitions and grasslands (Manica), C - Mt. Mabu and Mt. Chiperone forest and woodlands (Zambezia), D - Sitila-Massinga dry forest-thicket complex (Inhambane), E - Save Pan thicket (Inhambane), F - Cherigoma plateau next to Gorongosa NP (Sofala), G - Moravia plateau grasslands (Tete), H - Panda coastal dune (Inhambane), I - Furancungo woodlands (Tete), J - Massingir plateau grasslands (Gaza), K - Zitundo forest transitions and woodlands (Maputo), L - Mueda plateau coastal forests and woodlands (Cabo Delgado), M - Njesi plateau region (Niassa).

non-protected areas were predicted to currently have a higher richness of small-sized mammals when compared to protected areas, and future climate projections indicate a reduction in mammal fauna protection within some conservation areas.

The Zambezi valley between Sofala and Zambézia provinces, for which the model predictions indicate high species diversity, was projected to undergo a large reduction in climate suitability for mammal species in the future. This area with a high number of vulnerable species includes part of Gorongosa NP, the Marromeu complex area (Figure 4.4), and the hunting area "Coutada 12", which is planned to be added to Gorongosa NP soon (Pringle, 2017). These results are supported by a study of the country's vulnerability and exposure to natural disasters under climate change, in which central Mozambique is also predicted to be the region most affected with hotter drought spells and more extreme floods, particularly in areas at lower altitudes, such as the Zambezi valley (INGC, 2009). In fact, just recently, in March 2019, this area was severely affected by Tropical Cyclone Ida, one of the worst disasters ever in southern Africa, with calamitous flooding and landslides (Torpey et al., 2019)).

A substantial part of the northern provinces, north of the Zambezi River, have lower current species richness based on our projections. We would like to note that given the smaller effort devoted to sampling the northern provinces over the years Chapter 3 and because niche models are determined by the data (Cayuela et al., 2009), the lower richness predicted reflects the limited knowledge about not only of species distribution but also regarding species diversity across the region. Northern Mozambique had already been identified as the main gap in the knowledge of Mozambique biodiversity as of 1976 (Smithers and Tello, 1976). In recent years, however, more surveys and expedition events have been sampling the region and revealed many new species and records for the country, for various taxonomic groups (see Chapter 2). In addition, northern Mozambique's biodiversity can be expected to be biogeographically different because the Zambezi River may act as a barrier to gene flow for terrestrial taxa between the northern provinces and the rest of the country. Indeed, there is increasing evidence that this river can constrain or limit population expansions for terrestrial species with low dispersal and swimming ability, including rodents (Bryja et al., 2010); (Petružela et al., 2018), primates (Zinner et al., 2009), bovids (Cotterill, 2003) and terrestrial fishes (Bartáková et al., 2015).

Given climate change, northern Mozambique, mainly Niassa and Cabo Delgado provinces, according to our results, would become suitable for several species, resulting in potential species gains under future climate conditions. These potential expansions of species' suitable ranges

into northern Mozambique show that this region's conservation areas may play an essential role in the preservation of species. However, considering that the Zambezi River can limit population dispersal, these projected range expansions are merely theoretical and potentially misleading. On the other hand, if species effectively respond to climate change with range expansion towards northern provinces, further challenges exist as northern provinces are increasingly explored for natural resources (wildlife, oil, coal, wood), which is reducing the availability of land in its natural state (Guedes et al., 2018).

4.4.2 Complementarity and representativeness of the current conservation network

Mozambique's conservation areas contain suitable conditions for most species; however, several presented high redundancies, contributing similarly to species richness coverage, as shown in our results (Figure 4.2). Species redundancy is predominantly high in the "first-born" conservation areas, most of them established in savannah woodlands. This pattern is probably a function of, not only the country's ecoregional characteristics but also, the country's and the region's history. The location of the conservation areas and wildlife reserves declared in the first half of the last century across Africa were usually determined by colonial authorities for sport hunting in areas with high megafauna abundances more attractive to professional hunters (Caro, 2003; Fjeldså et al., 2004; Huntley et al., 2019). Following this trend, governments in Mozambique have continuously given priority to the preservation of zones with elevated aesthetic and recreational value. Few studies have explicitly attempted to assess the effectiveness of the existing conservation areas across Africa to protect a more comprehensive range of mammal diversity. Caro (2003) studied the effectiveness of conservation areas by examining mammal populations in East Africa's reserves, which were established using large mammals as umbrella species. The authors observed that, overall, the conservation areas were effective in protecting mammal species, notwithstanding the fact that small mammal abundance was higher outside the reserves. In 2004, Fjeldså et al. evaluated Africa's CA networks globally based on the distribution of 197 threatened mammals. The authors demonstrated that the African network while providing good coverage of large mammal ranges, was less effective in protecting the majority of the threatened smaller-bodied species, which often represent restricted-range species. More recently, Smith et al. (2016) evaluating priority areas for Chiroptera conservation across Africa using niche modelling, found low bat representation within existing conservation areas, with

only 5% of suitable habitat in protected areas.

With our approach, we can state that the range of suitable conditions for Mozambique's terrestrial mammals is not well-covered by the current conservation network, with less than 30% of the country's small-sized mammals sufficiently protected. Moreover, we show that the restricted-range species were markedly less well-covered than wider-range species. Thus, although Mozambique's CA network has increased substantially in the last decade, the existing conservation area network remains inadequate for assuring the conservation of the country's biodiversity.

Additionally, mammal conservation is also affected by a lack of detailed knowledge regarding species occurrence, particularly regarding small-sized mammals. In Chapter 2, we have highlighted that small-sized mammal groups were poorly sampled over the years (e.g., Afrosoricidae, Hyracoidea, Lagomorpha, Macroscelidea, and Rodentia), with most of the species having less than ten records reported for Mozambique. Moreover, comprehensive mammal species lists are currently still lacking for CA, with very few small-sized mammals listed in CA management plans (Table 4.1). This lack of overall knowledge regarding mammal diversity across the country contributes to the lack of more accurate assessments of the current gaps in conservation areas, which in turn hinders effective systematic conservation planning.

4.4.3 Priority areas for conservation

The combined effects of human pressure and climate change on the remaining unprotected areas of Mozambique will have apparent effects on the species' distributions making the selection of additional areas for the protection of terrestrial mammals a complex task. As Mozambique's human population increases and the land is in ever-shorter supply, increasing the urgency to minimise pressure on biodiversity, it is more important than ever to analyse how conservation efforts can become more efficient. Accordingly, the priority zones suggested not only reflect the more significant gaps in the conservation network in Mozambique but also consider, to some extent, the real feasibility of their establishment by selecting areas with low human pressure and lower climate change impact (Figure 4.4, Figure 4.S2). Our approach enables us to suggest thirteen priority zones for conservation in Mozambique with the potential to improve the preservation of mammal diversity. We deliberately made the priority zones unstructured in shape and variable in size (Figure 4.5A). Our aim here is to draw attention to the country's regions where important zones for effective mammal conservation occur. The actual shape, size, and type of

conservation area will need to be determined with a case-by-case evaluation.

Several of the priority zones for conservation identified encompass areas that have already been considered necessary for biodiversity preservation regarding other taxonomic groups, as well as for the protection of essential ecosystems. Nevertheless, these zones still lack adequate protection. For instance, the priority zone we propose in the Furancungo woodlands (Tete), an area characterised by Brachystegia and mixed woodlands crossed by many streams, is listed as an Important Bird Area (IBA; Parker, 2001) and considered to have international significance for the conservation of birds on a global scale. Another example is the suggested priority zone that includes Mount Mabu, which is part of the East African mountain ranges and supports Afromontane forest. The importance for sustaining biodiversity in this zone was stated for several taxonomic groups, from plants to birds (Bayliss et al., 2014; Conradie et al., 2016; Parker, 2001; Spottiswoode et al., 2008; Timberlake et al., 2007), as well as for small-sized mammals (Chiroptera; Cooper-Bohannon et al., 2016, e.g). This priority zone forms part of the Afromontane archipelago-like regional centre of endemism. Besides, the Afromontane ecoregion is critically endangered due to the impacts of forestry and agriculture industries (WWF), and there is an urgent need for a clear understanding of the nature of the threats, and mitigation measures that will grant the protection of these habitats in Mozambique (Conradie et al., 2016). Finally, the third example is the coastal dune thicket habitat in southern Mozambique, Inhambane province, where three zones were proposed. The coastal dune thicket habitat area was recently described as essential for restricted-range plant species preservation and in need of an immediate conservation plan (McClelands and Massingue, 2018).

CBD's Aichi Target 11 states that conservation areas should consider not only places that are "ecologically representative" but also make conservation areas broader and well-connected. Some of the priority zones identified by our study provide an opportunity to improve the conservation network for biodiversity because of their proximity to the established conservation areas. For example, one of the priority zones proposed is situated between Lake Niassa partial reserve and Niassa NR; the others are located next to Gorongosa NP, Chimamanimani NR, Limpopo NP, Zinave NP, and Maputo Special Reserve (Figure 4.5A). As they are connected to already established conservation areas, these proposed priority zones enable the expansion of the current network of national parks and reserves by protecting more extensive and continuous areas of land allowing greater species dispersal across the region and, in addition, facilitating species range expansions given climate change.

The establishment of new CA in sites with human population settlements is a challenge and one that Mozambique's authorities have had to address previously (Boer and S. Baquete, 1998; Givá and Raitio, 2017; Milgroom and Spierenburg, 2008; Tornimbeni, 2007). People inhabit most of the national parks and reserves in Mozambique, even though the legal definition of national parks and reserves suggested for many years that there should not be people living within their boundaries (MITADER, 2015; Soto, 2012). Thus, for the successful establishment of new CA, the inclusion of local people in the implementation and management phases is essential to improve the relationship between the CA's authorities and the local population generally (Boer and S. Baquete, 1998; Hübschle, 2017; Tornimbeni, 2007).

4.4.4 Methodological approach and limitations

The paucity of species distribution data for Mozambique's mammal species was a challenge in the development of this study, as we aimed to evaluate how well conservation areas appear to cover the distribution of mammal species and identify accurate conservation priorities. The lack of species distribution data is a broadly recognised constraint to conservation planning in the tropics (Cayuela et al., 2009). Moreover, for Mozambique, the uneven availability or quality of environmental data also emerges as a limiting factor, not only for conservation planning but also for other purposes, such as climate forecasting or ecosystem service assessments (Niquisse et al., 2017; Sietz et al., 2011, e.g.). For instance, the national climate data network is weak partially due to war-related damage and inadequate spatial coverage, but also due to lack of clear hierarchies and decision-making centres for providing consolidated data and information (Sietz et al., 2011).

The method chosen to construct species ranges has a strong impact on the way the potential species distributions are interpreted (Bombi et al., 2011; Raedig and Kreft, 2011). In this study, we could have used species distribution data from the IUCN's global conservation assessment (IUCN 2018), which is a widely used resource for species distribution data in conservation studies (Ceballos et al., 2017, e.g.). However, even though mammals are relatively well studied, for the Africa continent the proportion of mammals that are Data Deficient is greater than for most other regions, and furthermore, the information needed for Red List assessments are often incomplete or absent for many other species (Stephenson et al., 2017). IUCN range maps of poorly known species and for data-deficiency regions overestimate species ranges and are not able to provide greater reliability than the more complex approaches, such as niche mod-

els (Brito et al., 2016; Rondinini et al., 2006). In fact, for Mozambique, and based on recent IUCN distributional range maps, a recent report evaluating the protection of threatened vertebrates raised awareness on the lack of information regarding the distribution of several native threatened species in the country (Pereira and Nazerali, 2016).

An additional constraint, in cases of a lack of data, is that conservation assessments may incorrectly categorise a species as non-threatened. This erroneous classification may occur because of underestimations of the total amount of area needed to be conserved for species protection by including areas without suitable conditions in the species range (Graham et al., 2007; Rondinini et al., 2006).

Niche models prove to be a powerful and cost-effective tool to assess species' suitable ranges (Cooper-Bohannon et al., 2016; Rubidge et al., 2011, e.g.), and in this study provided a robust starting point from which we could determine where and how species' suitable conditions are distributed across Mozambique, in a straight forward approach. For the majority of the country's mammals, niche models improve on IUCN range maps because they make the interpretation unambiguous and more uniform across species. Therefore, we considered the analysis of species' suitable ranges as the best possible proxy for the distributions of the targeted species. Nevertheless, it should be noted that surveys are still required to verify whether the species are present within the predicted suitable ranges since the predicted species ranges reflect the potential climatic niche instead of their true distributions.

Niche models are data-driven models. Consequently, the accuracy of model predictions depends critically on the quality and quantity of data (Cayuela et al., 2009; Hortal et al., 2015). Methodological decisions were made to obtain more accurate models while attempting to reduce data biases—from data and species selection, to model selection and validation (Section 4.2). Additionally, the inclusion of historical and recent records of occurrence not only allowed us to obtain a higher number of records for a large number of species but also contributed to circumventing the underestimation of current and future suitable ranges (Faurby and Araújo, 2018). Furthermore, niche models are evaluated quantitatively, and our study's models showed good power in predicting species' suitable ranges (Table 4.S2).

While we were able to adequately estimate the areas in which species could potentially find suitable conditions, we are aware that there is still room for improvement. A careful assessment of the modelling results should be made, particularly in the cases of restricted-range and threatened species. Model improvement could be achieved by, for example, removing areas

in the predicted range that are isolated from the occurrence records by a dispersal barrier, or incorporating areas with occurrence records not included in the predicted range.

The availability of quality species occurrence and environmental data (e.g. topographic, climatic and land-use data) with better spatial and temporal resolution and increased accuracy is of crucial importance for effective conservation planning. Given that land-use change in Africa is a significant driver of biodiversity loss (Biggs et al., 2008), one possible way to improve the forecast would be to include land-cover data for current and future scenarios to support more accurate predictions of species' real distribution trends. However, because transformations in land-cover are happening at a high rate (Niquisse et al., 2017), and accurate spatial descriptors should designate short time periods (less than 10 years), species data for modelling species distribution would have to be limited to that time-frame, further reducing the number of records per species that could be used in the analysis.

4.4.5 Final remarks

Biodiversity conservation and management in developing countries rich in natural resources is a challenge for governments that must effectively protect biodiversity while providing the means for human sustenance under a model of environmental sustainability. In Mozambique, although the legal instruments on biodiversity protection were recently improved, the regulatory role of the government over the conservation areas is still not well defined with overlapping competencies between different state ministries, which further delays sustainable management and maintenance of conservation areas (MITADER, 2015). Moreover, the country's circumstances and history lead to a lack of internal capacity, technical staff and equipment for applied conservation research and monitoring, and consequently, regular revisions of management plans, systematic monitoring activities and active poaching control are insufficient (Hatton et al., 2001). This background further hinders biodiversity preservation and management. A collaboration between governmental institutions and the national and international scientific communities could, in the short term, improve the knowledge baseline to effectively inform decisions that will be valuable for the sustainability and validity of future conservation planning and management actions. In this context, the assessment and proposal regarding the conservation network in Mozambique hereby presented are useful for informed conservation planning that aims to maintain species diversity in agreement with CBD's Aichi target 11. In addition, our work demonstrates how scientific communities, national and international, can contribute to a better

understanding of Mozambique's conservation value.

4.5 Supplementary material

4.5.1 Supplementary tables

Table 4.S1: Summary of the bioclimatic variables considered in the study. Also, it is presented the variable importance for the modelling of small-sized mammals, which is calculated as the number of species' ensemble models that were constructed using that variable. Bioclimatic variables were obtained from WorldClim (Fick & Hijmans, 2017). These variables are derived from the monthly temperature and rainfall values. A quarter is equivalent to three months (1/4 of the year). (see Material and Methods - Section 4.2)

Short name	Long name	Variable importance
BIO18	Precipitation of Warmest Quarter	115
BIO15	Precipitation Seasonality (Coefficient of Variation)	106
BIO2	Mean Diurnal Range (Mean of monthly (max temp - min temp))	80
BIO4	Temperature Seasonality (standard deviation *100)	79
BIO8	Mean Temperature of Wettest Quarter	71
BIO12	Annual Precipitation	65
BIO19	Precipitation of Coldest Quarter	62
BIO14	Precipitation of Driest Month	53
BIO16	Precipitation of Wettest Quarter	42
BIO10	Mean Temperature of Warmest Quarter	18
BIO11	Mean Temperature of Coldest Quarter	11
BIO7	Temperature Annual Range (BIO5-BIO6)	10
BIO17	Precipitation of Driest Quarter	5
BIO6	Minimum Temperature of Coldest Month	4

Table 4.S2: Average TSS values of models selected to construct the final ensemble model for each species.

Species	Average TSS
Acomys spinosissimus	0,714
Aethomys chrysophilus	0,640
Micaelamys namaquensis	0,690
Anomalurus derbianus	0,852
Bdeogale crassicauda	0,774
Calcochloris obtusirostris	0,903
Chaerephon ansorgei	0,859
Chaerephon nigeriae	0,812
Chaerephon pumilus	0,696
Cloeotis percivali	0,820
Cricetomys gambianus	0,752
Crocidura cyanea	0,746
Crocidura fuscomurina	0,812
Crocidura hirta	0,716
Crocidura luna	0,747
Crocidura mariquensis	0,796
Crocidura olivieri	0,791
Crocidura silacea	0,799
Cryptomys darlingi	0,838
Cryptomys hottentotus	0,714
Dasymys incomtus	0,700
Dendromus melanotis	0,763
Dendromus mystacalis	0,750
Dendromus nyikae	0,791
Eidolon helvum	0,778
Elephantulus brachyrhynchus	0,800
Elephantulus fuscus	0,869
Elephantulus myurus	0,721
Epomophorus crypturus	0,798
Epomophorus labiatus	0,763
Epomophorus wahlbergi	0,758

Table 4.S2 continued from previous page

Species	**Average TSS**
Neoromicia capensis	0,855
Neoromicia rendalli	0,835
Neoromicia zuluensis	0,825
Paragalago granti	0,836
Galago moholi	0,756
Galerella sanguinea	0,698
Genetta angolensis	0,864
Genetta genetta	0,758
Genetta tigrina	0,703
Gerbilliscus boehmi	0,816
Gerbilliscus inclusus	0,864
Gerbilliscus leucogaster	0,672
Gerbillurus paeba	0,827
Glauconycteris variegata	0,771
Grammomys cometes	0,866
Grammomys dolichurus	0,723
Graphiurus microtis	0,735
Graphiurus murinus	0,759
Graphiurus platyops	0,843
Heliophobius argenteocinereus	0,750
Heliosciurus mutabilis	0,759
Helogale parvula	0,707
Hipposideros caffer	0,762
Hipposideros ruber	0,756
Hipposideros vittatus	0,733
Ictonyx striatus	0,735
Kerivoula argentata	0,799
Laephotis botswanae	0,926
Lemniscomys rosalia	0,682
Lepus capensis	0,750
Lepus microtis	0,675
Lissonycteris angolensis	0,898

Table 4.S2 continued from previous page

Species	Average TSS
Lophuromys flavopunctatus	0,803
Mastomys natalensis	0,497
Miniopterus fraterculus	0,766
Miniopterus inflatus	0,778
Miniopterus natalensis	0,850
Mops condylurus	0,715
Mops niveiventer	0,854
Mungos mungo	0,678
Mus minutoides	0,704
Mus triton	0,736
Myotis bocagii	0,785
Myosorex meesteri	0,907
Myotis tricolor	0,772
Myotis welwitschii	0,749
Nandinia binotata	0,950
Nycteris grandis	0,811
Nycteris hispida	0,723
Nycteris macrotis	0,768
Nycticeinops schlieffenii	0,704
Nycteris thebaica	0,716
Otomys angoniensis	0,717
Otolemur crassicaudatus	0,702
Otolemur garnettii	0,891
Paraxerus cepapi	0,614
Paraxerus flavovittis	0,878
Paraxerus palliatus	0,772
Pelomys fallax	0,798
Petrodromus tetradactylus	0,697
Pipistrellus hesperidus	0,798
Neoromicia nana	0,723
Poecilogale albinucha	0,850
Praomys delectorum	0,877

Table 4.S2 continued from previous page

Species	Average TSS
Rhabdomys dilectus	0,747
Rhinolophus blasii	0,832
Rhinolophus clivosus	0,738
Rhinolophus darlingi	0,781
Rhinolophus deckenii	0,884
Rhinolophus denti	0,889
Rhinolophus fumigatus	0,767
Rhinolophus hildebrandti	0,717
Rhinolophus lobatus	0,817
Rhinolophus mossambicus	0,892
Rhinolophus simulator	0,785
Rhinolophus swinnyi	0,750
Rhynchocyon cirnei	0,743
Rousettus aegyptiacus	0,749
Saccostomus campestris	0,642
Scotophilus dinganii	0,748
Scotophilus leucogaster	0,867
Scotophilus nigrita	0,849
Scotophilus viridis	0,741
Steatomys pratensis	0,820
Suncus megalura	0,868
Tadarida aegyptiaca	0,777
Tadarida fulminans	0,867
Taphozous mauritianus	0,847
Thallomys paedulcus	0,761
Triaenops persicus	0,808
Uranomys ruddi	0,865

4.5.2 Supplementary figures

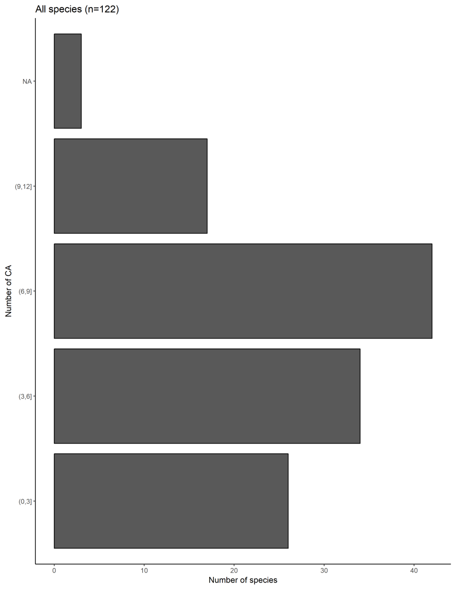

Figure 4.S1: Frequency distribution of mammal species (under 5kg) represented in Mozambique's conservation areas.

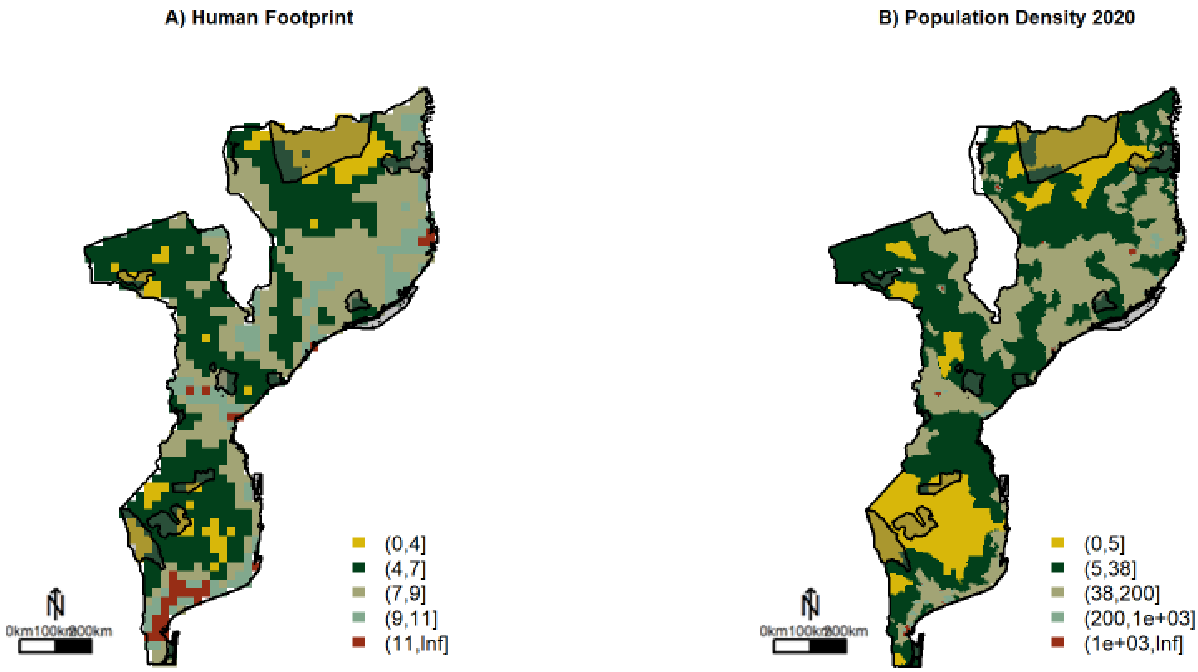

Figure 4.S2: Spatial representation A) human footprint and B) population density estimates for 2020 across Mozambique's territory at 0.25º resolution grid. (see Material and Methods - Section 4.2.3)

5

Synthesis and future research avenues

Contents

CHAPTER 5

Synthesis and future research avenues

This thesis assesses the current knowledge on the occurrence of mammal fauna in Mozambique in order to determine the future challenges lying ahead for conservation efforts. The knowledge generated through the analyses of primary biodiversity data using biodiversity informatics tools was used to pave the way towards a more informed conservation planning in Mozambique. In this section we synthesise the main findings of the thesis, explore potential research avenues for future work, and expound upon the challenges related to the use and mobilisation of biodiversity data.

5.1 Connecting dispersed knowledge

Prior to the present thesis, much of the knowledge on Mozambique's terrestrial mammals was dispersed across institutional databases, the GBIF portal, scientific publications and grey literature. The occurrence records aggregated in this work underwent cleaning efforts that improved data interoperability, and verified or identified uncertain data, increasing the quality of the data records. This process implied rigorous and time-consuming work. Even though some automatic procedures can be implemented to speed up the process and identify common errors, manual and individual curation of records was necessary to make the most out of the records.

When characterising data source by format and contents, we note that data obtained from the scientific literature generally came with a description of how the records were collected, providing detailed and reliable information, specifically regarding the species' taxonomic identification. However, underlying details, such as georeferenced records, were not always easily obtained directly from the literature. Recent scientific publications present geographic coordinates more frequently than older ones. In the case of data obtained from "grey" literature, these generally came with a description of how and where records were collected. However, species were generally identified with their common name rather than the scientific one, and the locations of records were presented via maps with occurrence points rather than the direct presentation of geographic coordinates.

The digitisation and cleaning procedures performed in our study improved the quality of the occurrence data gathered, but also the geographic and taxonomic comprehensiveness of the final and shared dataset. We did not remove from this dataset records that were not 100% complete or accurate, because these data can still prove useful for different purposes as quality issues affecting some users may be of secondary or no importance to other users (Belbin et al., 2013, e.g.). We, however, included the uncer-

tainty levels regarding the geographic coordinates provided and maintained original information in the data sources when records had to be updated.

The current access to increasing amounts of digital biodiversity data opens up new prospects for research. Given global changes, and from the perspective of biodiversity conservation, it is increasingly essential to obtain and compile information on the occurrence and distribution of a species in a region. The aggregation of data from dispersed sources is crucial for biodiversity assessments, as required by the Convention on Biological Diversity, and highlights the potential mammal diversity as yet uncovered in the Republic of Mozambique. The integrated dataset of occurrence of the mammals of Mozambique is now available for local and regional agencies to meet additional objectives.

5.2 Current knowledge status

As pointed out throughout the thesis, there is an unequal distribution of biodiversity data across the globe, with a lack of information for the species-rich regions and countries, such as southern Africa and Mozambique. In addition, most of the records shared in e-platforms, such as GBIF, are provided by institutions from developed countries in the Northern Hemisphere. Understudied countries, which are often developing countries, present reduced access to information and reduced dissemination of internal research. A significant portion of the biodiversity information of this country, as revealed in this thesis, is hidden in technical reports and grey literature, which are digitally inaccessible.

Aiming to narrow the gap of biodiversity knowledge in Mozambique, this work contributed to:

1. the update of the checklist of terrestrial mammals of Mozambique, pinpointing species and specimens in need of occurrence and taxonomic re-evaluation,
2. the clarification of the areas of less knowledge on terrestrial mammal occurrence, and
3. the evaluation of the effectiveness of Mozambique's conservation network to protect small-sized mammals given human-induced changes.

Despite the contribution of the present work, by providing data-based information as a reference that can be used to support species conservation and management, we strongly encourage actions from the scientific community and the government authorities to improve the Mozambique's biodiversity knowledge.

5.2.1 Species diversity

Using digital and non-digital sources, we compiled more than 17 000 records from mammals occurring in Mozambique (Chapter 2). The data integrated resulted in a total of 217 mammal species (representing

14 orders, 39 families and 133 genera). This total represents an increase of 37 species in comparison to the previous synopsis of Mozambique's mammal fauna by Smithers and Tello (1976). Further, we produced a list of species with dubious reports in the country, which included a total of 23 species. The list of species with doubtful occurrence is a powerful tool to identify species or groups that lack evidence of occurrence in the country, and precious for framing further investigation and surveys.

In the last decade, we observed a significant improvement on the knowledge of mammals species in Mozambique, generated by both national and international researchers (Gomes, 2013; Van Berkel et al., 2019, e.g.), and several new mammal species have been reported since 2010 (Monadjem et al., 2010; Taylor et al., 2013, 2018, 2012, e.g.).

However, we found that approximately a quarter of the species lacks recent records. Furthermore, nearly one-third of the species reported had fewer than ten records of occurrence in the country. Our study shows that Afrosoricidae, Hyracoidea, Lagomorpha, Macroscelidea and Rodentia were less sampled over the years and only half of these smaller-sized mammals were recently reported, most of which with fewer than ten records across the country.

We consider that the current number of mammal species in Mozambique is still underestimated, especially when compared with the number of species listed for adjacent countries, such as South Africa or Zimbabwe. Thus, an increasing effort should be made towards a complete inventory of the country's diversity, not only by intensifying surveys but also through an increase of biodiversity data digitisation and mobilisation actions.

5.2.2 Knowledge gaps

Accurate decisions that efficiently safeguard biodiversity can only be made when we know where we should trust our knowledge about species occurrence. The assessment of inventory completeness to map gaps of knowledge is a straightforward approach to support conservation planning based on primary species-occurrence data.

In Chapter 2, we assessed the knowledge gaps regarding the available information of terrestrial mammal occurrence in Mozambique by identified areas that are geographically distant and environmentally distinct from well-inventoried sites. Our study clearly shows that spatial knowledge of terrestrial mammals of Mozambique is not equally distributed: with continuously well-inventoried areas concentrated in central and south provinces, whereas north Mozambique remains poorly documented. The findings highlight how understudied the country is still, and pinpoint areas lacking knowledge regarding differently-sized mammals.

Worth noting is that data on small mammals (under 5 kg) are distributed across less than 40% of the country, indicating that in a significant part of the territory there is very little information on the di-

versity of these species. Particularly regarding the small-sized mammals, we must stress the importance of further surveying the Eastern miombo woodlands and the Afromontane forest ecoregions in Northern Mozambique. These ecoregions hold essential habitats for speciation and conservation of small mammals and are particularly vulnerable to climate change (Taylor et al., 2019, 2012).

5.2.3 Effectiveness of conservation areas

In Mozambique, many of the current conservation areas were initially gazetted for the protection of emblematic and large wildlife species. Thus, using Mozambique's conservation areas network, as a case study, we intended to determine the extent to which the conservation network safeguards overall mammal richness, particularly the smaller sized species. Our results indicate that, taxonomically and spatially, the small-sized mammals were the least known group among Mozambique's mammal fauna.

Thus, we evaluated the effectiveness of the country's conservation network for protecting that group. The assessment was based on predictions of potential species richness and distributions for 122 mammals, all under 5kg and across eight taxonomic orders, using niche modelling techniques. We detected a lack of protection of suitable ranges for small-sized mammals throughout the country.

This evaluation contributes to the understanding that large species may not act as successful umbrella species for delineating protection areas with suitable conditions for smaller mammals. Moreover, given that we predict that lack of protection for small-sized mammals is to become more acute, in the near future, we propose priority areas for conservation that account for climate change and increasing human pressure.

5.3 Future research avenues

The work developed in this thesis is an important "stepping stone" towards a comprehensive and up-to-date knowledge of the occurrence and distribution of the terrestrial mammals in Mozambique. Nevertheless, we highly recommend further sampling and digitisation efforts to address the spatial and taxonomic biases and the knowledge gaps identified for Mozambique. Building on the results obtained and the data compiled, there is a significant potential for new and broad insights for biodiversity research and effective species preservation in Mozambique, demanding further investigation.

Based on the findings described in Chapter 2, it would be desirable to investigate the species that were identified as being of dubious occurrence in the country. A re-appraisal of the specimens linked with these species would not only allow a clarification of the associated meta-data, but also a taxonomic verification of previous identifications. In this way, errors would be identified, raising the accuracy of Mozambique's checklist of terrestrial mammal. The results described in Chapter 2 show that actions need

to be taken if the taxonomic and spatial gaps in knowledge are to be addressed; in particular, surveys that explore and target the poorly known areas within north Mozambique, as well as the lesser-known taxa identified in Chapter 1.

Following a global tendency of declining specimen collection efforts since the mid-20th century (Troudet et al., 2017), analysis of distribution records across time uncovers an expected pattern regarding knowledge on mammals from Mozambique: higher availability of recent observation-based records than recent specimen-based records. Without the collection of specimens, follow-up studies are hindered. Moreover, observation-based records mostly focus on the well-known and easy to identify species increasing the knowledge gap among the rare and lesser-known species. Given that specimen collections and data allow re-interpretations and can easily be updated in the future (Ceríaco et al., 2016, e.g.), we recommend that biodiversity monitoring plans include not only the regular aerial census within the protected areas, but also carefully planned collections of specimens which should comply with permitting regulations and ethics guidelines.

Considering the results in Chapter 3, a worthwhile research avenue would be taking further step and test the cost-effectiveness of the suggested priority areas for conservation, by the prioritisation of their importance and their irreplaceability. This further step would warrant the protection of a higher number of species from a full taxonomic range and provided crucial information to decision-makers working to increase the representativeness of biodiversity in conservation areas. Equally, and because we now understand the patterns of knowledge and data uncertainty, it would be worthwhile to:

1. perform a biogeographic regionalization of distribution of mammals in Mozambique and verify if, for this taxonomic group, the country's division in North Mozambique (above the Zambezi River), Central Mozambique and South Mozambique (below the Save River) renders meaningful biogeographical units, and
2. identify the environmental predictors and the mammal traits associated with them. The assessment of these patterns can be of great value to researchers, land planners and decision-makers.

5.4 Future challenges for conservation – contributions from species primary data

5.4.1 Data limitations

Primary species-occurrence data have been described as biased, haphazard, unstandardised, incomplete, and unique because of collecting bias and/or digitisation gaps (Gueta and Carmel, 2016; Hortal et al., 2007; Meyer et al., 2015; Soberón et al., 2000; Willis et al., 2007). This type of data has numerous

shortfalls, from incomplete or partially erroneous documentation to spatial and temporal biases, improper or outdated taxonomic identification, incorrect or a lack of georeferencing, and incomplete labelling (Aubry et al., 2017; Hortal et al., 2015; Stropp et al., 2016; Troudet et al., 2017). Consequently, the usefulness of primary data for the study of biodiversity depends not only on data availability but also on data quality. The data included in this thesis were no different, and we acknowledge the challenging sources of error inherent to primary biodiversity datasets.

Despite all the constraints related to primary data proprieties, we provide new and valuable research insights regarding historical and current biodiversity knowledge and practices in Mozambique. Our confidence in the results comes from the efforts taken into

1. the improvement of data quality (e.g. georeferencing, manual curation, taxonomic updates);

2. understanding the primary biases and problems in the data; and

3. selection of methodologies and strategies in the different studies which were particularly suited to fill data gaps.

Nevertheless, the results generated in this work were interpreted with appropriate caution and data uncertainty was highlighted. For instance, in Chapter 1, to compile a checklist of species occurring in the country, a "Species selection process" was implemented to distinguish between confirmed and dubious species occurrence.

However, a significant challenge will be to continue to work on the usefulness of primary biodiversity data in a way that can enhance trust in conservation assessments made from such datasets. Partly, this challenge is being addressed by the biodiversity data platform (GBIF, Manis, e.g.), which, besides finding ways to flag issues in data such as errors in geographic coordinates, problems in taxonomic identification, or lack of information regarding the collection event, has established strict data standards to control data quality. Also scientific journals are increasingly establishing data archiving standards and ensuring that authors share their datasets. Concerns do still remain regarding the use and benefits of primary biodiversity data within the governments and the research community. This lack of trust calls for an integrated approach of dissemination and communication, namely to:

1. raise interest and awareness about the benefits of accessible digital information,

2. disseminate the methodologies that make the most out of the data and their results,

3. identify the expectations among researchers and decision-makers, and

4. a community around the biodiversity data sharing including all relevant stakeholders.

5.4.2 Filling knowledge gaps

We show that primary biodiversity data can contribute significantly to conservation assessment and planning in the prioritisation of areas for future surveys (Chapter 3) and areas for conservation (Chapter 4). The spatial knowledge of terrestrial mammals of Mozambique, however, is not equally distributed and accessible biodiversity data is sparse.

Furthermore, many areas lacking data on species occurrence coincide with areas that are highly exploited for their natural resources, have high population growth and are prone to habitat degradation. Thus, effort must be devoted to fill knowledge gaps on species occurrence and distribution and to expand the taxonomic extent of conservation planning, as increased geographical coverage of the country's species diversity will promote more reliable decision-making. Addressing the knowledge gaps would prevent the duplication of research efforts and prioritise, terms of financial support, the areas that need urgent attention.

Knowledge gaps should be addressed not only by the enhancement of sampling effort but also by improved access to further biodiversity data and better overall dissemination of recent internal research. In under-documented countries, as we have shown for Mozambique, valuable and hard-earned information on biodiversity is often locked in survey reports, thesis, research reports or publications in low circulation local journals, making their access difficult. To efficiently indorse the discovery of these data and make them computer-readable, national and international initiatives with a strong emphasis on capacity-building of national and local institutions need to be expanded and funded.

5.4.3 Sharing and aggregation of data on biodiversity

Wherever relevant data on biodiversity is sparse, scattered or uncurated, conservation research tends to be significantly restricted (Gaikwad and Chavan, 2006; Geijzendorffer et al., 2016). The global GBIF database is one of the most important platforms engaged in making biodiversity data openly available to all countries and individuals. The GBIF, however, only represents a proportion of the available species-occurrence data and, particularly regarding data on African mammals, as of November 2019, the vast majority of accessible records (90%; ref: GBIF.org (29 November 2019) GBIF Occurrence Download `https://doi.org/10.15468/dl.lsnqjm`) were published by European or North American institutions. Probably, a reflection of the number of African countries (21 out of 57) that are participating in GBIF. Globally widespread reluctance in sharing biodiversity data in the open domain still presents a significant challenge. Such reluctance is often related to professional recognition issues and data quality control (Enke et al., 2012; Franz and Sterner, 2018; Grattarola and Pincheira-donoso, 2019; Stephenson et al., 2017).

The establishment of a regional or national infrastructure that promotes the interconnection and

cross-sectoral collaboration of scientific communities, research centers and stakeholders can be an efficient way to ensure data-sharing and aggregation. Also, this kind of network allows for the definition of data-publishing policies at a regional or national level and should establish standards of data sharing. The establishment of such policies would allow data to be integrated into a structured format that can be used by geographic information systems and other computer programs for evaluation and assessment as required by CBD (Article 17, Convention on Biological Diversity).

The "Atlas of Living Australia" (ALA; Belbin and Williams, 2016) and "Biodiversidata" from Uruguay (Grattarola et al., 2019), are two good examples regarding the implementation of national portals dedicated to biodiversity data. These two countries have very different realities concerning the open-access and accessibility of their data. "Atlas of Living Australia" was the first web portal to show that such a digital platform for knowledge-sharing could be created on a national scale.

At a very different scale, "Biodiversidata" is the first effort from the Uruguayan Consortium of Biodiversity Data to create an open-access platform to host and distribute a database on the biodiversity of Uruguay, a poorly understudied country regarding its biodiversity. As a strategy to promote the participation of researchers on sharing their data, the authors of the portal published a data-paper introducing the platform and listed as co-authors all researchers that agreed to share data through the open-access platform (Grattarola et al., 2019; Grattarola and Pincheira-donoso, 2019).

Although Mozambique is not yet a participant in GBIF, the country's authorities have already recognised the importance of platforms to biodiversity information sharing and decision-making. The process started with a workshop to discuss the participation of the country in GBIF, mentored by the Portuguese GBIF Node in 2016 (`http://www.gbif.pt/node/338?language=en`). In addition, Mozambique participated in the programme Biodiversity Information for Development (BID), which is a multiyear programme funded by the European Union and led by GBIF to increase the amount of biodiversity information available in the nations of sub-Saharan Africa, the Caribbean and the Pacific (`https://bid.gbif.org`). From this participation, eight datasets on Mozambique's biodiversity were compiled and made accessible on the GBIF platform, although none of which on mammal species (`https://www.gbif.org/project/6QF1fqTDq0GkkkSuwKq024/`).

Furthermore, several institutions in the country (Eduardo Mondlane University, Natural History Museum of Maputo, Centre of Biotechnology, e.g.) are involved in an international project to develop a database system, named "Biodiversity Network of Mozambique – BioNoMo", aiming to aggregate the dispersed biodiversity data already existing in scientific literature or past projects. The creation of such a platform could be an opportunity to recognise the efforts and knowledge of national researchers and organisations, and a solution to obtain a much more comprehensive spatio-temporal dataset to understand the patterns of biodiversity.

5.4.4 Concluding remarks

Nations must know what and where to conserve. It is a prior condition to be able to make accurate decisions and to efficiently allocate the limited resources for improving quality and coverage of species distributions, and successfully safeguard biodiversity. The deadline to comply with the Convention on Biological Diversity's targets is impossibly close, and the decisions made in the next few years will dictate what countries can hope to achieve these goals.

By mobilising and connecting existing data and observations, we increased the amount of accessible information related to an understudied country. Moreover, we made available a vital resource with better quality baseline information on the mammal fauna of Mozambique, which is now discoverable for researchers and decision-makers. The dataset produced should be viewed as a work in progress, which can be updated as new information becomes available and accessible. While it has some limitations, intrinsic to primary biodiversity data, it is for the most detailed and complete compilation of primary occurrence data on terrestrial mammals from Mozambique.

We call for the scientific community to share information and concentrate their efforts to prioritise taxa and countries that are still poorly known. By doing so, we will gradually decrease the gap in data quantity and quality between developed and developing countries soon. We expect that our approach will interest researchers, conservation biologists, policy-makers and students of biodiversity conservation, and in biodiversity informatics. If Mozambique's scientific community is able to mobilize and create an open-access platform it will foster national and international coordination, along with cross-sectoral collaboration for biodiversity data management, that can promote and encourage the use of primary biodiversity data. In this era of global change, we firmly believe that data-intensive science around biodiversity and innovation in biodiversity informatics will guarantee more effective decisions for a sustainable future.

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A

Sources of data

Contents

Appendix A

Sources of data

List of the data sources of primary species-occurrence data of terrestrial mammal species reported from Mozambique.

A.1 Scientific literature (in chronological order)

Smithers, R.H.N. and Tello, J.L.P., 1976, Checklist and Atlas of the Mammals of Moçambique, Museum Memoir No. 8, The Trustees of the National Museums and Monuments of Rhodesia, Salisbury.

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A.2 Natural history collections

Table 1.1: List of institutions with natural history collections integrated into this study on terrestrial mammal species reported from Mozambique.

Accronym	Institution	Locality
AMNH	American Museum of Natural History [1]	New York, USA
BRTC	Texas Cooperative Wildlife Collection [1]	College Station, USA
CAS	California Academy of Sciences [1]	San Francisco, USA
EMBL	European Molecular Biology Laboratory [1]	Heidelberg, Germany
FMNH	Field Museum of Natural History [1]	Chicago, USA
HSUWM	Humboldt State University Wildlife Museum [1]	Arcata, USA
IICT	Instituto de Investigação Científica Tropical	Lisbon, Portugal
ISM	Illinois State Museum [1]	Illinois, USA
KU	University of Kansas Biodiversity Research Center [1]	Lawrence, USA
LACM	Los Angeles County Museum of Natural History [1]	Los Angeles, USA
MACN	Museo Argentino de Ciencias Naturales [1]	Buenos Ai res, Argentina
MCZ	Museum of Comparative Zoology, Harvard University [1]	Harvard, USA
MHNG	Muséum d'histoire naturelle de la Ville de Genève [1]	Geneva, Switzerland
MNCN	Museo Nacional de Ciencias Naturales	Madrid, Spain
MNHN	Museum National d'Histoire Naturelle	Paris, France
MSU	Michigan State University Museum [1]	Michigan, USA
MUP	Museu de Historia Natural da Universidade do Porto	Oporto, Portugal
MVZ	Museum of Vertebrate Zoology, University of California [1]	Berkeley, USA
MZNA	Museum of Zoology, University of Navarra [1]	Navarra, Spain
NHMUK	The Natural History Museum	London, England
NHMW	Naturhistorisches Museum Wien [1]	Vienna, Austria
NMR	Natural History Museum Rotterdam [1]	Rotterdam, Netherlands
NMZB	Natural History Museum of Zimbabwe [1]	Bulawayo, Zimbabwe
NRM	Naturhistoriska Riksmuseet [1]	Stockholm, Sweden
OSU	Museum of Biological Diversity, Ohio State University [1]	Columbus, USA
RBINS	Royal Belgian Institute of Natural Sciences [1]	Brussels, Belgium
RMCA	Royal Museum for Central Africa [1]	Tervuren, Belgium
RMNH	Rijksmuseum voor Natuurlijke Historie [1]	Leiden, The Netherlands
ROM	Royal Ontario Museum [1]	Toronto, Canada
SAMA	South Australian Museum [1]	Adelaide, Australia
SMF	Senckenberg Naturmuseum Frankfurt [1]	Frankfurt, Germany
SNOMNH	Sam Noble Oklahoma Museum of Natural History [1]	Norman, USA
TTU	Museum of Texas Tech University [1]	Lubbock, USA
UNSM	University of Nebraska State Museum [1]	Lincoln, USA
USNM	National Museum of Natural History [1]	Washington D.C., USA
UWBM	University of Washington Burke Museum [1]	Seattle, USA
WAM	Western Australian Museum [1]	Perth, Australia
ZMB	Museum for Naturkunde	Berlin, Germany

[1] Data downloaded from Global Biodiversity Information Facility (GBIF) – www.gbif.org

A.3 Unpublished survey reports (in chronological order)

Table 1.2: List of reports with survey data on terrestrial mammal species reported from Mozambique integrated into this study

Survey area	References
Mozambique (country-wide survey)	Agreco G.E.I.E., 2008, National Census of Wildlife in Mozambique – Final Report, Author and Ministério da Agricultura da República de Moçambique, Maputo
Gorongosa National Park	Dunham, K.M., 2004, Aerial Survey of Large Herbivores in Gorongosa National Park, The Gregory C. Carr Foundation, Cambridge MA
Mareja Community Reserve	Schneider, M.F., 2004, Checklist of Vertebrates and Invertebrates of Mareja Reserve, Universidade Eduardo Mondlane and International Union for the Conservation of Nature, Mozambique, Maputo
Maputo Special Reserve	Matthews, W.S. and Nemane, M., 2006, Aerial survey report for Maputo Special Reserve, Ezemvelo Kwazulu-Natal Wildlife, Ministério do Turismo, Reserva Especial de Maputo, Maputo
Limpopo National Park	Whyte, I. and Swanepoel, B., 2006, An Aerial Census of the Shingwedzi Basin Area of the Limpopo National Park, Ministério do Turismo, Maputo
Zinave National Park	Stalmans, M., 2007, Parque Nacional de Zinave, Moçambique - Wildlife survey. Projecto Áreas de Conservação Transfronteira e Desenvolvimento do Turismo, Ministério do Turismo, Maputo.
Mount Chiperone	Timberlake, J., Bayliss, J., Alves, T., Baena, S., Harris, T. and Sousa, C., 2007, The Biodiversity and Conservation of Mount Chiperone, Mozambique, Darwin Initiative Award15/036, Royal Botanic Gardens, Kew, London
Gilé National Reserve	Mesochina, P., Langa, F. and Chardonnet, P., 2008, Preliminary Survey of Large Herbivores in Gilé National Reserve, Zambezia Province, Mozambique, Direcção Provincial do Turismo da Zambézia and IGF Foundation, Paris
Banhine National Park	Stalmans, M. and Peel, M., 2009, Parque Nacional de Banhine, Moçambique - Wildlife survey. Projecto Áreas de Conservação Transfronteira e Desenvolvimento do Turismo, Ministério do Turismo, Maputo
Mount Namuli	Timberlake, J., Dowsett-lemaire, F., Bayliss, J., Alves, T., Baena, S., Bento, C., Cook, K., Francisco, J., Harris, T., Smith, P. and Sousa, C., 2009, Mt. Namuli, Mozambique: biodiversity conservation, Darwin Initiative Award 15/036, Royal Botanic Gardens, Kew, London
Mount Mabu	Dowsett-Lemaire, F. and Dowsett, R., 2009, The avifauna and forest vegetation of Mt. Mabu, northern Mozambique, with notes on mammals. Final report (October 2008), Dowsett-Lemaire miscellaneous Report 66
Mount Inago	Bayliss, J., Monteiro, J., Fishpool, L., Congdon, C., Bampton, I., Bruessow, C., Matimele, H., Banze, A., Timberlake, J., 2010, Biodiversity and Conservation of Mount Inago, Mozambique. Report produced under Darwin Initiative Project: Monitoring and Managing Biodiversity Loss in South-east Africa's Montane Ecosystems D.I.No.15/036, Malawi.
Mágoè National Park	Dunham, K.M., 2010, Part 4 - Aerial Survey of Wildlife south of Lake Cabora Bassa Wildlife Survey Phase 2 and Management of Human-Wildlife Conflicts in Mozambique.
Zinave National Park and surrounding area	Dunham, K.M., Westhuizen, E. Van Der, Westhuizen, H. F. Van Der and Gandiwa, E., 2010, Aerial Survey of Elephants and other Large Herbivores in Gonarezhou National Park (Zimbabwe), Zinave National Park (Mozambique) and surrounds: 2009', Parks and Wildlife Management Authority, The Transfrontier Conservation Areas Coordination Unit, Frankfurt Zoological Society
Quirimbas National Park	Grupo de Gestão de Recursos Naturais e Biodiversidade (GRNB), 2010, Biodiversity Baseline of the Quirimbas National Park, Mozambique - Final Report, Author, Universidade Eduardo Mondlane, Maputo

B

Species accounts

Appendix B

Species accounts

B.1 Species checklist

B.1.1 Afrosoricida

Chrysochloridae

***Calcochloris obtusirostris* (Peters, 1851)**

Yellow golden mole

Other recorded names: *Calcochloris obtusirostris chrysillus; Calcochloris obtusirostris limpopoensis; Calcochloris obtusirostris obtusirostris;*

Museum records: AMNH: M-54362; RMNH: RMNH-MAM-39015.a, RMNH-MAM-39015.b; NHMUK: 1884.8.30.1, 1906.11.8.25, 1906.11.8.26, 1906.11.8.27, 1906.11.8.28; ZMB: 712, 720, 12945, 31020, 85341, 137660, 137661, 137662, 137663, 137713; USNM: 351955, 351956, 351957, 351958;

Bibliographic records: Smithers and Tello (1976); Downs and Wirminghaus (1997);

Reported distribution in Mozambique: Gaza; Inhambane; Maputo; Maputo City; Sofala;

Known distribution (Wilson and Reeder 2005): Maputaland (KwaZulu-Natal) and Kruger Nat. Park (Limpopo Prov., South Africa); S. Zimbabwe and S. Mozambique.

***Carpitalpa arendsi* Lundholm, 1955**

Arend's golden mole

Other recorded names: Chlorotalpa arendsi;

Museum records: USNM: 365001;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Manica;

Known distribution (Wilson and Reeder 2005): E. Zimbabwe and adjacent Mozambique.

B.1.2 Artiodactyla

Bovidae

***Aepyceros melampus* (Lichtenstein, 1812)**

Impala

Other recorded names: Aepyceros melampus johnstoni; Aepyceros melampus melampus;

Museum records: AMNH: M-216391, M-216392, M-216393, M-216394; MUP: 27421, 38104; ZMB: 8731, 58743; TTU: 40501; IICT: CZ000000359, CZ000000361, CZ000000405, CZ000000407, CZ000000408, CZ000000412, CZ000001202, CZ000001221, CZ000001222; USNM: 352946; MACN: 15744;

Bibliographic records: Smithers and Tello (1976); Dunham (2004); Whyte and Swanepoel (2006); Stalmans (2007); AGRECO (2008); Stalmans and Peel (2009); Dunham (2010); Dunham et al. (2010); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Maputo City; Nampula; Niassa; Sofala; Tete;

Known distribution (Wilson and Reeder 2005): S. Angola, N. and E. Botswana, Burundi (extinct?), Dem. Rep. Congo, Kenya, Malawi, Mozambique, N. Namibia, Rwanda, South Africa, Swaziland, Tanzania, Uganda, Zambia, Zimbabwe.

***Alcelaphus lichtensteinii* (Peters, 1849)**

Lichtenstein's hartebeest

Other recorded names: Alcelaphus buselaphus; Alcelaphus buselaphus lichtersteini; Alcelaphus lichtensteini; Alcelaphus sp.; Sigmoceros lichtensteini;

Museum records: AMNH: M-216382, M-216383; ZMB: 8671; MSU: MR.11622, MR.11623; IICT: CZ000000410, CZ000000413, CZ000001123, CZ000001130, CZ000001143, CZ000001175, CZ000001177, CZ000001184, CZ000001203, CZ000001410; NHMUK: 1919.7.15.89, 1919.7.15.91, 1941.40, 1944.87, 1944.88, 1944.89, 1944.90, 1944.91, 1944.92, 1944.93, 1944.94, 1944.95, 1991.0575; MCZ: BOM-8291; USNM: 20868;

Bibliographic records: Smithers and Tello (1976); Dunham (2004); AGRECO (2008);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Nampula; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): E. Angola, S.E. Dem. Rep. Congo, Malawi, Mozambique, South Africa, Swaziland (extinct), Tanzania, Zambia, S.E. Zimbabwe.

***Cephalophus natalensis* A. Smith, 1834** Red duiker

Other recorded names: Cephalophus natalensis natalensis; Cephalophus natalensis robertsi;

Museum records: AMNH: M-216375; HSUWM: 2661, 2719; NHMUK: 1939.4716, 1991.0573; IICT: CZ000000732, CZ000000733, CZ000000734, CZ000001086, CZ000001103;

Bibliographic records: Smithers and Tello (1976); Downs and Wirminghaus (1997); Matthews and Nemane (2006); Mesochina, Langa and Chardonnet (2008); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Maputo City; Nampula; Sofala; Zambezia; **Known distribution (Wilson and Reeder 2005):** E. Kenya, Malawi, Mozambique, S. Somalia, South Africa, Swaziland, E. and S. Tanzania, and E. Zambia; sight records from E. Ethiopia.

***Connochaetes taurinus* (Burchell, 1823)**

Blue wildebeest

Other recorded names: Connochaetes taurinus johnstoni; Connochaetes taurinus taurinus;

Museum records: AMNH: M-216384, M-216385, M-216386; MUP: 27419; UWBM: UWBM:41058; MSU: MR.11626; IICT: CZ000000414, CZ000000420, CZ000001019, CZ000001172, CZ000001174, CZ000001196; RMNH: RMNH-MAM-45639; NHMUK: 1899.6.9.1, 1924.7.22.29, 1927.2.11.27, 1927.2.11.28, 1941.17; MCZ: 47108; ISM: 693122;

Bibliographic records: Smithers and Tello (1976); Whyte and Swanepoel (2006); AGRECO (2008); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Niassa; Sofala; Zambezia;

Known distribution (Wilson and Reeder 2005): Angola, Botswana, S. Kenya, Malawi (extinct), Mozambique, Namibia, N.E. South Africa, Tanzania, Zambia, Zimbabwe.

***Hippotragus equinus* (E. Geoffroy Saint-Hilaire, 1803)**

Roan antelope

Other recorded names: Hippotragus equinus equinus; Hippotragus vittatus;

Museum records: FMNH: 7228, 7229, 7230, Taxidermy Catalogue:7228, Taxidermy Catalogue:7229, Taxidermy Catalogue:7230;

Bibliographic records: Smithers and Tello (1976); AGRECO (2008); Dunham (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Savanna woodland in Angola, Benin, Botswana, Burkina Faso, Burundi (extinct), N. Cameroon, Central African Republic, S. Chad, Côte d'Ivoire, N. and S. Dem. Rep. Congo, N. Eritrea (extinct?), W. Ethiopia, Gambia (extinct), Ghana, Guinea, Guinea-Bissau, Kenya, Malawi, S. Mali, S. Mauritania, Mozambique, Namibia, S. Niger, Nigeria, Rwanda, Senegal, E. South Africa, Swaziland (extinct, reintroduced), Sudan, Tanzania, Togo, Uganda, Zambia and Zimbabwe.

***Hippotragus niger* (Harris, 1838)**

Sable antelope

Other recorded names: Hippotragus niger niger; Hippotragus vittatus;

Museum records: AMNH: M-216381; MUP: 27403; ZMB: 8853; MVZ: 137056; IICT: CZ000000347, CZ000000416, CZ000000418, CZ000000422, CZ000001140, CZ000001141, CZ000001142, CZ000001171, CZ000001178, CZ000001179, CZ000001182, CZ000001191, CZ000001579; NHMUK: 1941.38; USNM: 61736, 61737, 61738, 61739, 61740, 61741; SMF: 42435;

Bibliographic records: Smithers and Tello (1976); Dunham (2004); Whyte and Swanepoel (2006); AGRECO (2008); Mesochina, Langa and Chardonnet (2008); Dunham (2010); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Maputo City; Nampula; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Savanna woodland in Africa; giant sable (variani) in C. Angola; other subspecies in E. Angola, N. Botswana, S. Dem. Rep. Congo, S.E. Kenya, Malawi, Mozambique, N.E. Namibia, N.E. South Africa, Tanzania, Zambia and Zimbabwe.

***Kobus ellipsiprymnus* (Ogilbyi, 1833)**

Waterbuck

Other recorded names: Kobus ellipsiprymmus ellipisipyrmmus; Kobus ellipsiprymnus defassa; Kobus ellipsiprymnus ellipsiprymnus; Kobus ellipsiprymunus; Kobus leche; **Museum records:** AMNH: M-206987, M-216377, M-216378; MUP: 27405; ZMB: 8817; UNSM: 5147;

IICT: CZ000001124, CZ000001126, CZ000001128, CZ000001176, CZ000001192, CZ000001214; NHMUK: 1924.7.22.34, 1941.31, 1963.1477, 1963.1478, 1982.2529, 1983.2533; MCZ: 57387; USNM: 20851, 20852, 20853, 20854, 61731, 367427, 589199; SMF: 42442; FMNH: 7225, Taxidermy Catalogue:7225;

Bibliographic records: Smithers and Tello (1976); Dunham (2004); Matthews and Nemane (2006); Whyte and Swanepoel (2006); AGRECO (2008); Mesochina, Langa and Chardonnet (2008); Dunham (2010); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Maputo City; Nampula; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Mesic non-forested habitats in Angola, Benin, N. and EC Botswana, Burkina Faso, Burundi, N. Cameroon, Central African Republic, S. Chad, Côte d'Ivoire, N. and S. Dem. Rep. Congo, N. Eritrea, Ethiopia, S. Gabon, Gambia (extinct), Ghana, Guinea, Guinea-Bissau, Kenya, Malawi, S. Mali, S. Mauritania, Mozambique, N.E. Namibia, S. Niger, Nigeria, S. Republic of Congo, Rwanda, Senegal, E. South Africa, Swaziland, Sudan, Tanzania, Togo, Uganda, Zambia and Zimbabwe.

***Neotragus moschatus* (Von Dueben, 1846)**

Suni

Other recorded names: Neotragus moschatus livingstonianus; Neotragus moschatus zuluensis; Nesotragus moschatus levingstonianus; Nesotragus moschatus livingstonianus;

Museum records: AMNH: M-216390; RBINS: 3788, 359890; ZMB: 2138, 57142, 57152; HSUWM: 2658, 2659, 2721; SNOMNH: 19833; IICT: CZ000000686, CZ000000690, CZ000000692, CZ000000988, CZ000000990, CZ000001013; RMNH: RMNH-MAM-51539.A, RMNH-MAM-51539.B; USNM: 352941, 367447, 367448, 367449;

Bibliographic records: Smithers and Tello (1976); Downs and Wirminghaus (1997); Schneider (2004); Matthews and Nemane (2006); Mesochina, Langa and Chardonnet (2008); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Nampula; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): S.E. Kenya, Malawi, Mozambique, South Africa, E. Tanzania, N.E. Zimbabwe.

***Oreotragus oreotragus* (Zimmerman, 1783)**

Klipspringer

Other recorded names: Oreotragus oreotragus aceratos; Oreotragus oreotragus centralis;

Museum records: ZMB: 2241, 56918; USNM: 61727, 61728, 61729, 61730; IICT: CZ000000702;

Bibliographic records: Smithers and Tello (1976); Mesochina, Langa and Chardonnet (2008); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Manica; Maputo; Nampula; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): S.W. Angola, E. Botswana, Burundi (extinct?), Djibouti, Eritrea, Ethiopia, C. Nigeria, Central African Republic, Dem. Rep. Congo, Kenya, Malawi, Mozambique, Namibia, Rwanda, N. Somalia, South Africa, Swaziland, N.E. and S.E. Sudan, Tanzania, N.E. and S.W. Uganda, Zambia, Zimbabwe.

***Ourebia ourebi* (Zimmerman 1783)**

Oribi

Other recorded names: Ourebia ourebi hastata; Ourebia ourebi ourebi;

Museum records: AMNH: M-216387, M-216388; ZMB: 88794, 000 ?; HSUWM: 2720; MSU: MR.11629; LACM: 70102; IICT: CZ000000687, CZ000000688, CZ000000689, CZ000000691, CZ000000695, CZ000000701, CZ000000967, CZ000000978, CZ000000986, CZ000001069, CZ000001088; MCZ: BOM-8117; USNM: 367430, 367431,;

Bibliographic records: Smithers and Tello (1976); Dunham (2004); Stalmans (2007); Stalmans and Peel (2009); Dunham et al. (2010); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Angola, Benin, N. Botswana, Burkina Faso, Burundi (extinct?), Cameroon, Central African Republic, S. Chad, N. Côte d'Ivoire, N. and S.E. Dem. Rep. Congo, N. Eritrea, W. Ethiopia, Gambia, Ghana, Guinea, Guinea Bissau, Kenya, Lesotho, Malawi, S. Mali, Mozambique, S.W. Niger, Nigeria, Rwanda, S. Senegal, N. Sierra Leone, S. Somalia, E. South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda, Zambia, Zimbabwe.

***Philantomba monticola* (Thunberg, 1789)**

Blue duiker

Other recorded names: Cephalophus monticola; Cephalophus monticola u. maxwelli; Cephalophus niger?; Philantomba monticola hecki;

Museum records: ZMB: 16125, 57448, 57732; FMNH: 177241, 177242, 177243, 177244, 177245;

Bibliographic records: Smithers and Tello (1976); Dowsett-Lemaire and Dowsett (2009); Timberlake et al. (2009); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Manica; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Forested habitats in N. Angola, Cameroon, Central African Republic, Dem. Rep. Congo, Equatorial Guinea, Gabon, W. and E. Kenya, Malawi, Mozambique, Nigeria east of Cross River, Republic of Congo, South Africa, S. Sudan, Tanzania including Pemba and Zanzibar Islands, Uganda, Zambia, E. Zimbabwe.

***Raphicerus campestris* (Thunberg, 1811)**

Steenbok

Other recorded names: Raphiceros campestris; Raphicerus campestris capricornis; Raphicerus sharpei;

Museum records: AMNH: M-206997, M-215159, M-216389; UNSM: 5141; USNM: 61726, 352943, 352944, 352945, 399398; MCZ: 34110; IICT: CZ000000693, CZ000000694, CZ000000696, CZ000000697, CZ000000992, CZ000001073, CZ000001077, CZ000001099, CZ000001101;

Bibliographic records: Smithers and Tello (1976); Matthews and Nemane (2006); Stalmans (2007); Stalmans and Peel (2009); Dunham et al. (2010); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Maputo City; Sofala;

Known distribution (Wilson and Reeder 2005): E. Africa in S. Kenya and N. and C. Tanzania; S. Africa in S. Angola, Botswana, S. Mozambique, Namibia, South Africa, Swaziland, W. Zambia and Zimbabwe.

***Raphicerus sharpei* Thomas, 1897**

Sharpe's grysbok

Other recorded names: Raphicerus sharpei colonicus; Raphicerus sharpei sharpei;

Museum records: NHMUK: 1905.11.14.1; USNM: 367432, 367433, 367434, 367435, 367436, 367437, 367438, 367439, 367440, 367441, 367442, 367443, 367444, 367445, 367446; MCZ: 43888; IICT: CZ000000698, CZ000000700, CZ000001038, CZ000001095;

Bibliographic records: Smithers and Tello (1976); Stalmans (2007); Dunham (2010); Dunham et al. (2010);

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Maputo; Sofala; Tete;

Known distribution (Wilson and Reeder 2005): N. Botswana, S.E. Dem. Rep. Congo, Malawi, Mozambique, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe.

***Redunca arundinum* (Boddaert, 1785)**

Southern reedbuck

Other recorded names: Redunca arundinum arundinum; Redunca fulvorufula;

Museum records: AMNH: M-206988, M-206994, M-216379, M-216380; MUP: 27406; ZMB: 8826; HSUWM: 2722; IICT: CZ000000677, CZ000000678, CZ000000679, CZ000000681, CZ000000682, CZ000000683, CZ000000684, CZ000000685, CZ000001085, CZ000001115, CZ000001116, CZ000001117, CZ000001118, CZ000001213, CZ000001220, CZ000001225, CZ000001398; NHMUK: 1944.97, 1944109; MCZ: 34120, 34121, 34122, 34123, 34260, BOM-8264; ISM: 693123; USNM: 61732, 61733, 61734, 352942, 367428, 367429, 367452; SMF: 42431; FMNH: 7233, Taxidermy Catalogue:7233;

Bibliographic records: Smithers and Tello (1976); Dunham (2004); Matthews and Nemane (2006); Stalmans (2007); AGRECO (2008); Mesochina, Langa and Chardonnet (2008); Stalmans and Peel (2009);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Maputo City; Nampula; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Angola, N. and E. Botswana, S. Gabon, S. Dem. Rep. Congo, Lesotho (vagrant), Malawi, Mozambique, N. Namibia, S. Republic of Congo, E. South Africa, Swaziland, Tanzania, Zambia and Zimbabwe.

***Redunca fulvorufula* (Afzelius, 1815)**

Mountain reedbuck

Other recorded names: Redunca fulvorufula fulvorufula;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Maputo;

Known distribution (Wilson and Reeder 2005): W. Africa in E. Nigeria and W. Cameroon; E. Africa in C. Ethiopia, Kenya, S.E. Sudan, N. Tanzania, and N.E. Uganda; S. Africa in S.E. Botswana, Lesotho, S. Mozambique, E. South Africa and Swaziland.

***Sylvicapra grimmia* (Linnaeus, 1758)**

Common duiker

Other recorded names: Capra sp.; Sylvicapra; Sylvicapra grimmia albifrons; Sylvicapra grimmia caffra; Sylvicapra grimmia orbicularis;

Museum records: AMNH: M-216376; ZMB: 57235, 57247, 57279; HSUWM: 2660; MSU: MR.11630; LACM: 70101; IICT: CZ000000703, CZ000000704, CZ000000705, CZ000000706, CZ000000707, CZ000000708, CZ000000709, CZ000000710, CZ000000711, CZ000000712, CZ000000713, CZ000000714, CZ000000715, CZ000000716, CZ000000717, CZ000000718, CZ000000719, CZ000000720, CZ000000721, CZ000000722, CZ000000723, CZ000000724, CZ000000725, CZ000000726, CZ000000727, CZ000000728, CZ000000731, CZ000000965, CZ000000966, CZ000000968, CZ000000969, CZ000000970, CZ000000972, CZ000000975, CZ000000976, CZ000000977, CZ000000980, CZ000000982, CZ000000991, CZ000000993, CZ000000994, CZ000000997, CZ000000999, CZ000001003, CZ000001006, CZ000001007, CZ000001009, CZ000001034, CZ000001037, CZ000001041, CZ000001072, CZ000001076, CZ000001084, CZ000001107, CZ000001110, CZ000001112; RMNH: RMNH-MAM-39290.a, RMNH-MAM-39290.b, RMNH-MAM-50793.A, RMNH-MAM-50793.B; NHMUK: 1919.7.15.133, 1939.4729, 1874.4.28.7; MCZ: 43885, 43886, 43887; USNM: 61721, 61722, 61723, 61724, 61725, 352934, 352935, 352936, 352937, 352938, 352939, 352940, 367408, 367409, 367410, 367411, 367412, 367413, 367414, 367415, 367416, 367417, 367418, 367419, 367420, 367421, 367422, 367423, 367424, 367425, 367426;

Bibliographic records: Smithers and Tello (1976); Dunham (2004); Matthews and Nemane (2006); Whyte and Swanepoel (2006); Stalmans (2007); AGRECO (2008); Mesochina, Langa and Chardonnet (2008); Stalmans and Peel (2009); Dunham (2010); Dunham et al. (2010); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Maputo City; Nampula; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Non-forested habitats in Angola, Benin,

Botswana, Burkina Faso, Burundi, N. Cameroon, Central African Republic, S. Chad, Côte d'Ivoire, S, E, and N. Dem. Rep. Congo, Eritrea, Ethiopia, S. Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Malawi, S. Mali, Mozambique, Namibia, S. Niger, Nigeria, Rwanda, Republic of Congo, Senegal, N. Sierra Leone, S. Somalia, South Africa, Swaziland, Sudan, Tanzania, Togo, Uganda, Zambia and Zimbabwe.

***Syncerus caffer* (Sparrman 1779)**

African buffalo

Other recorded names: Synceros caffer; Syncerus caffer caffer;

Museum records: AMNH: M-216373, M-216374; MUP: 27417; ZMB: 103474; UNSM: 5145; MSU: MR.11627; SNOMNH: 19839; IICT: CZ000000350, CZ000001139, CZ000001187, CZ000001188, CZ000001585; NHMUK: 1941.19, 1941.22, 1944.82; ISM: 688552, 688553, 688554, 688555; USNM: 20864, 20865, 20866, 579268; SMF: 42448;

Bibliographic records: Smithers and Tello (1976); Dunham (2004); Whyte and Swanepoel (2006); AGRECO (2008); Mesochina, Langa and Chardonnet (2008); Stalmans and Peel (2009); Dunham (2010); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Maputo City; Nampula; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Rain forest and savanna of Angola, Benin, N. and E. Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, S. Chad, Côte d'Ivoire, Dem. Rep. Congo, Equatorial Guinea, N. Eritrea, Ethiopia, Gabon, Gambia (extinct), Ghana, Guinea, Guinea-Bissau, Kenya, Liberia, Malawi, S. Mali, Mozambique, N.E. Namibia, S.W. Niger, Nigeria, Republic of Congo, Rwanda, Senegal, Sierra Leone, S. Somalia, South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda, Zambia and Zimbabwe.

***Taurotragus oryx* (Pallas, 1766)**

Common eland

Other recorded names: Taurotragus; Tragelaphus oryx;

Museum records: AMNH: M-216372; MUP: 27407; ZMB: 41731, 78890, 78892, 78894, 78895, 78897, 78898, 78899, 78900, 78923, 78925, 78926, 78948, 78949, 78950, 78953, 78958, 78960, 78961, 78962, 78964; UNSM: 5144; SNOMNH: 19848; NHMUK: 1941.51, 1944101; USNM: 61742;

Bibliographic records: Smithers and Tello (1976); AGRECO (2008); Mesochina, Langa and Chardonnet (2008); Dunham et al. (2010); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Nampula; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Angola, Botswana, Burundi (extinct), S. Dem. Rep. Congo, Ethiopia, Kenya, Lesotho (seasonal), Malawi, Mozambique, Namibia, Rwanda, South Africa, S.E. Sudan, Swaziland (extinct, reintroduced), Tanzania, Uganda, S. Zaire, Malawi, Zambia and Zimbabwe.

***Tragelaphus angasii* Gray 1849**

Nyala

Other recorded names: Tragelaphus angasi; Tragelaphus angasii angasii; Tragelaphus strepsiceros;

Museum records: AMNH: M-54001, M-54078, M-54079, M-54080, M-54081, M-54357, M-146628, M-146629, M-185466, M-206986; HSUWM: 2718; SAMA: M5853; LACM: 52492, 52493; IICT: CZ000000367, CZ000000951, CZ000001138, CZ000001204, CZ000001219, CZ000001223, CZ000001224; NHMUK: 1991.0574; MCZ: 34112, 34113, 34114, 34115, 34125, 34126, 34127, 34128, 34129, 34130, 34131, 34258, 34259, 37529, 37530, 37531, 37532, 37533, 37560, 37561, 37562, 37563, 37564, 37572, 37573, 37574, 37575, 37577, 37601, 37602; UNSM: 15186; SMF: 42434; FMNH: 30238;

Bibliographic records: Smithers and Tello (1976); Dunham (2004); Matthews and Nemane (2006); Whyte and Swanepoel (2006); Stalmans (2007); AGRECO (2008); Stalmans and Peel (2009); Dunham et al. (2010);

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Maputo; Maputo City; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): S. Malawi, Mozambique, South Africa, Swaziland (extinct, reintroduced), and N. and S. Zimbabwe. Reintroduced or newly introduced to private land in South Africa and Namibia.

***Tragelaphus scriptus* (Pallas, 1766)**

Bushbuck

Other recorded names: Tragelaphus scriptus ornatus; Tragelaphus scriptus silvaticus;

Tragelaphus strepsiceros;

Museum records: AMNH: M-185467, M-216370, M-216371, M-216398; MUP: 27411; UNSM: 5146, 15189; MSU: MR.11632; IICT: CZ000000356, CZ000000357, CZ000000358, CZ000000360, CZ000000362, CZ000000404, CZ000000995, CZ000001005, CZ000001087, CZ000001097, CZ000001111, CZ000001226; NHMUK: 1927.2.11.101, 1941.99; USNM: 367402, 367403, 367404, 367405, 367406, 367407;

Bibliographic records: Smithers and Tello (1976); Downs and Wirminghaus (1997); Dunham (2004); Matthews and Nemane (2006); Stalmans (2007); Mesochina, Langa and Chardonnet (2008); Dunham (2010); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Nampula; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Savanna and secondary forest in Angola, Benin, N. and E. Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, S. Chad, Côte d'Ivoire, Dem. Rep. Congo, Equatorial Guinea, N. Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Liberia, Malawi, S. Mali, S. Mauritania, Mozambique, N.E. Namibia, S.W. Niger, Nigeria, Republic of Congo, Rwanda, Senegal, Sierra Leone, S. Somalia, E. and S. South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda, Zambia and Zimbabwe.

***Tragelaphus strepsiceros* (Pallas, 1766)**

Greater kudu

Other recorded names: Tragelaphus strepsiceros strepsiceros;

Museum records: MUP: 27412, 38102; ZMB: 78971, 78973; HSUWM: 2717; IICT: CZ000000415, CZ000000419; USNM: 61735, 367400, 367401; MACN: 15743; SMF: 42444;

Bibliographic records: Smithers and Tello (1976); Dunham (2004); Matthews and Nemane (2006); Whyte and Swanepoel (2006); Stalmans (2007); AGRECO (2008); Mesochina, Langa and Chardonnet (2008); Stalmans and Peel (2009); Dunham (2010); Dunham et al. (2010); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Nampula; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Angola, Botswana, N. Central African Republic, S. Chad, S.E. Dem. Rep. Congo, Djibouti, N. Eritrea, Ethiopia, Kenya, Malawi,

Mozambique, Namibia, Somalia (extinct?), South Africa, W. and E. Sudan, N.E. Uganda, Zambia and Zimbabwe.

Giraffidae

***Giraffa camelopardalis* (Linnaeus, 1758)**

Giraffe

Other recorded names: Giraffa camelopardalis camelopardalis;

Bibliographic records: Smithers and Tello (1976); Whyte and Swanepoel (2006); AGRECO (2008); Dunham et al. (2010);

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Maputo;

Known distribution (Wilson and Reeder 2005): Disjunct; W. and C. Africa in Burkina Faso (vagrant), N. Cameroon, Central African Republic, S. Chad, N.E. Dem. Rep. Congo, Eritrea (extinct), W. and S. Ethiopia, Gambia (extinct), Kenya, Mali (extinct), S.E. Mauritania (extinct), Niger, Nigeria (extinct, now a vagrant), Senegal (extinct), S. Somalia, Sudan, Tanzania and Uganda; may have occurred in Benin; introduced into Rwanda; S. Africa in S. Angola (extinct?), Botswana, Mozambique (extinct), Namibia, South Africa, Swaziland (extinct, reintroduced), Zambia, and Zimbabwe. Introduced beyond its former range in South Africa, including KwaZulu-Natal.

Hippopotamidae

***Hippopotamus amphibius* Linnaeus, 1758**

Common hippopotamus

Museum records: NMR: 999000003071; MUP: 23351; MHNG: MAM-843.076, MAM-843.077; NHMW: 643; RMNH: RMNH-MAM-45292, RMNH-MAM-52666; NHMUK: 1907.10.25.2, 1912.12.8.1, 1912.12.8.2, 1916.8.8.1, 1939.4460; FMNH: 105018; ISM: 688551;

Bibliographic records: Smithers and Tello (1976); Dunham (2004); Matthews and Nemane (2006); Stalmans (2007); AGRECO (2008); Dunham (2010); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Maputo City; Nampula; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Rivers of savanna zone of Africa, and main rivers of forest zone in C. Africa, in Angola, Benin, N. Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, S. Chad, Côte d'Ivoire, Dem. Rep. Congo, N. Eritrea,

Ethiopia, Equatorial Guinea, Gabon, Gambia, Ghana, Guinea, Guinea Bissau, Kenya, Liberia, Rwanda, Senegal, Sierra Leone, Somalia, Sudan, Swaziland, Malawi, Mozambique, Namibia, Niger, Nigeria, Republic of Congo, Sierra Leone, South Africa, Tanzania, Togo, Uganda, Zambia and Zimbabwe.

Suidae

***Phacochoerus africanus* (Gmelin, 1788)**

Common warthog

Other recorded names: Phacochoerus aethiopicus; Phacochoerus aethiopicus sundervalli; Phacochoerus aethiopicus sundevalli;

Museum records: AMNH: M-206985, M-216360, M-216361, M-216363, M-216364, M-216365, M-216366; ZMB: 30189, 64607, 64642, 70065, 70075; HSUWM: 2723; MSU: MR.11628; SNOMNH: 19830; USNM: 61720, 367451;

Bibliographic records: Smithers and Tello (1976); Dunham (2004); Stalmans (2007); AGRECO (2008); Mesochina, Langa and Chardonnet (2008); Stalmans and Peel (2009); Dunham (2010); Dunham et al. (2010); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Nampula; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Outside rainforest zone of Africa in Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Côte d'Ivoire, Dem. Rep. Congo, Eritrea, Ethiopia, Gambia, Ghana, Guinea, Guinea Bissau, Kenya, Malawi, Mali, Mauritania, Mozambique, Namibia, Niger, Nigeria, Republic of Congo, Rwanda, Senegal, Sierra Leone, N. Somalia, South Africa, Sudan, Tanzania, Togo, Uganda, Zambia and Zimbabwe.

***Potamochoerus larvatus* (F.Cuvier, 1822)**

Bushpig

Other recorded names: Potamochoerus porcus; Potamochoerus porcus maschona; Potamochoerus porcus myasae; Potamochoerus porcus nyasae;

Museum records: AMNH: M-214765, M-216359, M-216362; UNSM: 15172; IICT: CZ000000349, CZ000000729, CZ000000730, CZ000001135, CZ000001459, CZ000001460; NHMUK: 1939.4421; MCZ: 37584, 43889, 43890, 45427; USNM: 589184;

Bibliographic records: Smithers and Tello (1976); Dunham (2004); Matthews and Nemane (2006); Stalmans (2007); Mesochina, Langa and Chardonnet (2008); Dowsett-Lemaire and Dowsett (2009); Stalmans and Peel (2009); Dunham (2010); Dunham et al. (2010); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Maputo City; Nampula; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Angola, N. Botswana, Burundi, N. Eritrea, Ethiopia, E. and S. Dem. Rep. Congo, Kenya, Malawi, Mozambique, Rwanda, S. Somalia, N.E. and S. South Africa, S. Sudan, Swaziland, Tanzania, Uganda, Zambia and Zimbabwe; Madagascar and Comoro Islands (introduced?).

B.1.3 Carnivora

Canidae

***Canis adustus* Sundevall, 1847**

Side-striped jackal

Other recorded names: Canis adustus adustus;

Museum records: AMNH: M-216344; USNM: 61759; NMZB: NMZB-MAM-0067979 ?; IICT: CZ000000741;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Maputo; Maputo City; Nampula; Sofala; Tete; Zambezia.

Known distribution (Wilson and Reeder 2005): Angola, Botswana, Cameroon, Central African Republic, Dem. Rep. Congo, Ethiopia, Gabon, Kenya, Malawi, Mozambique, Namibia, Niger, Nigeria, Republic of Congo, Senegal, South Africa, Sudan, Tanzania, Uganda, Zambia, Zimbabwe.

***Canis mesomelas* Schreber, 1775**

Black-backed jackal

Other recorded names: Canis mesomelas mesomelas;

Museum records: MNCN: 4182; NMZB: NMZB-MAM-0068032; USNM: 589192;

Bibliographic records: Smithers and Tello (1976); Dunham (2004); Matthews and Nemane (2006); Mesochina, Langa and Chardonnet (2008); Stalmans and Peel (2009); GRNB

(2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Manica; Maputo; Maputo City; Sofala; Zambezia;

Known distribution (Wilson and Reeder 2005): Allopatric south and east African populations: Angola, Botswana, Ethiopia, Kenya, Mozambique, Namibia, South Africa, Somalia, Sudan, Tanzania, Uganda, Zimbabwe.

***Lycaon pictus* (Temminck, 1820)**

African wild dog

Other recorded names: Lycaon pictus pictus;

Museum records: IICT: CZ000000738, CZ000000740, CZ000001218;

Bibliographic records: Smithers and Tello (1976); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Nampula; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Angola, Botswana, Cameroun, Central African Republic, Chad, Côte d'Ivoire (?), Ethiopia, Gambia (?), Guinea, Kenya, Malawi, Mali, Mozambique, Namibia, Senegal, Somalia, South Africa, Sudan, Tanzania, Uganda, Zambia, Zimbabwe.

***Otocyon megalotis* (Desmarest, 1822)**

Bat-eared fox

Other recorded names: Otocyon megalotis megalotis;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Gaza; Inhambane;

Known distribution (Wilson and Reeder 2005): Allopatric south and east African populations: Angola, Botswana, Ethiopia, Mozambique, Namibia, Somalia, South Africa, Sudan, Tanzania, Uganda, Zambia, Zimbabwe.

Felidae

***Acinonyx jubatus* (Schreber, 1775)**

Cheetah

Other recorded names: Acinonyx jubatus jubatus;

Museum records: AMNH: M-119654, M-119655, M-119656, M-119657;

Bibliographic records: Smithers and Tello (1976); GRNB (2010); Andresen et al. (2012);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Nampula; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Algeria, Angola, Benin, Botswana, Burkina Faso, Cameroon, Central African Republic, Chad, Dem. Rep. Congo, Egypt, Eritrea, Ethiopia, Malawi, Mali, Mauritania, Mozambique, Namibia, Niger, Nigeria, Somalia, South Africa, Sudan, Swaziland, Tanzania, Togo, Zambia, Zimbabwe. Recently extinct: Afghanistan, Burundi, India, Iran, Iraq, Israel, Jordan, Kazakhstan, Kenya, Kuwait, Lebanon, Libya, Morocco, Pakistan, Saudi Arabia, Senegal, Syrian Arab Republic, Tunisia, Turkmenistan, Uganda, Uzbekistan, Western Sahara, Yemen.

***Caracal caracal* (Schreber, 1776)**

Caracal

Other recorded names: Felis caracal limpopoensis;

Museum records: ZMB: 57825; NMZB: NMZB-MAM-0067921, NMZB-MAM-0067922; IICT: CZ000000672;

Bibliographic records: Smithers and Tello (1976); Stalmans and Peel (2009);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Nampula; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Afghanistan, Algeria, Angola, Benin, Botswana, Burkina Faso (?), Cameroon, Central African Republic, Chad, Côte d'Ivoire, Dem. Rep. Congo, Djibouti, Egypt, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, India, Iran, Iraq, Israel, Jordan, Kazakhstan, Kenya, Kuwait, Lebanon, Lesotho, Libya, Malawi, Mali (?), Mauritania, Morocco, Mozambique, Namibia, Niger, Nigeria, Oman, Pakistan, Saudi Arabia, Senegal, Somalia, South Africa, Sudan, Syrian Arab Republic, Tajikistan, Tanzania, Togo, Tunisia, Turkey, Turkmenistan, Uganda, United Arab Emirates, Uzbekistan, Yemen, Zambia, Zimbabwe.

***Felis silvestris* Schreber, 1775**

African wildcat

Other recorded names: Felis sylvestris cafra, Felis libyca; Felis lybica; Felis lybica cafra;

Felis silvestris lybica; **Museum records:** NMZB: NMZB-MAM-0004416, NMZB-MAM-0004417, NMZB-MAM-0008360, NMZB-MAM-0065273; MNHN: 1911-2300; USNM: 367386, 367387, 367388, 367389, 367390, 367391, 367392, 367393; ISM: 693102; IICT: CZ000000294, CZ000000302, CZ000000664, CZ000000674, CZ000000676;

Bibliographic records: Smithers and Tello (1976); Mesochina, Langa and Chardonnet (2008); Stalmans and Peel (2009); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Nampula; Sofala; Tete; Zambezia.

***Leptailurus serval* (Schreber, 1776)**

Serval

Other recorded names: Felis capensis beirae; Felis serval; Felis serval beirae; Felis serval serval; Leptailurus serval beirae; Leptailurus serval serval;

Museum records: NHMUK: 1907.6.2.29; NMZB: NMZB-MAM-0055021, NMZB-MAM-0067948, NMZB-MAM-0067949; USNM: 61754, 61755, 367394; MCZ: 34106, 44284; IICT: CZ000000295, CZ000000296, CZ000000300, CZ000000303, CZ000000651, CZ000000660, CZ000000661, CZ000000669, CZ000000670;

Bibliographic records: Smithers and Tello (1976); Mesochina, Langa and Chardonnet (2008);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Nampula; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Côte d'Ivoire, Dem. Rep. Congo, Djibouti, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho (?), Liberia, Malawi, Mali, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda, Zambia, Zimbabwe.

***Panthera leo* (Linnaeus, 1758)**

Lion

Other recorded names: Panthera leo krugeri;

Museum records: WAM: M49269; ZMB: 55355; IICT: CZ000000343, CZ000000961, CZ000000962, CZ000001198, CZ000001199, CZ000001200, CZ000001201; MCZ: 56777;

ISM: 693105; USNM: 61753, 367397,; FMNH: 7226;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Maputo City; Nampula; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Côte d'Ivoire, Eritrea, Ethiopia, Gabon, Ghana, Guinea, Guinea-Bissau (?), India, Lesotho, Malawi, Mali, Mozambique, Namibia, Niger, Nigeria, Senegal, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda, Zambia, Zimbabwe. Recently extinct: Afghanistan, Algeria, Egypt, Gambia, Iraq, Israel, Jordan, Kenya, Lebanon, Libya, Kuwait, Mauritania, Morocco, Pakistan, Republic of Congo, Rwanda, Saudi Arabia, Syrian Arab Republic, Turkey, Tunisia, Western Sahara.

***Panthera pardus* (Linnaeus, 1758)**

Leopard

Other recorded names: Panthera pardus pardus;

Museum records: AMNH: M-186944; UWBM: 82206; CAS: 31788; HSUWM: 2657; IICT: CZ000001020, CZ000001211, CZ000001215; USNM:;

Bibliographic records: Smithers and Tello (1976); Dunham (2004); Mesochina, Langa and Chardonnet (2008); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Nampula; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Afghanistan, Algeria, Angola, Arabia, Armenia, Botswana, Burma, Cameroon, Central African Republic, Chad, China, Dem. Rep. Congo, Egypt, Ethiopia, Gabon, Guinea-Bissau, India, Indonesia (Java), Iran, Iraq, Kenya, Liberia, Laos, Malawi, Malaysia, Mauritania, Morocco, Mozambique, Namibia, Nepal, Niger, Nigeria, North and South Korea, Pakistan, Republic of Congo, Russia, Saudia Arabia, Senegal, Sierra Leone, Somalia, South Africa, Sri Lanka, Sudan, Tanzania, Thailand, Tunisia, Turkey, Turkmenistan, Uganda, Vietnam, Zambia, Zimbabwe.

Herpestidae

***Atilax paludinosus* (G.[Baron] Cuvier, 1829)**

Marsh mongoose

Other recorded names: Atilax paludinosus rubellus;

Museum records: USNM: 367380, 367381; NMZB: NMZB-MAM-0068316; IICT: CZ000000629;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Maputo; Nampula; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Algeria, Angola, Botswana, Cameroon, Central African Republic, Côte d'Ivoire, Dem. Rep. Congo, Equatorial Guinea, Ethiopia, Gabon, Liberia, Malawi, Mozambique, Niger, Rwanda, Senegal, Sierra Leone, Somalia, South Africa, Sudan, Tanzania, Uganda and Zambia.

***Bdeogale crassicauda* Peters, 1852**

Bushy-tailed mongoose

Museum records: IICT: CZ000000265, CZ000000607;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Cabo Delgado; Manica; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Kenya, Malawi, C. Mozambique, Tanzania, S. and E. Zambia, N.E. Zimbabwe.

***Galerella sanguinea* Ruppell, 1836**

Slender mongoose

Other recorded names: Galerella sanguinea ignitus; Galerella sanguineus; Herpestes sanguinea; Herpestes sanguineos ignitoides; Herpestes sanguineus; Herpestes sanguineus auratus; Herpestes sanguineus ignitoides; Herpestes sanguineus mossambicus; Herpestes sanguineus ornatus; Myonax canni ornatus;

Museum records: NMZB: NMZB-MAM-0062396, NMZB-MAM-0062397, NMZB-MAM-0062398, NMZB-MAM-0062399, NMZB-MAM-0062400, NMZB-MAM-0062401, NMZB-MAM-0062402, NMZB-MAM-0062403, NMZB-MAM-0068252; FMNH: 177226, 177227, 177228; IICT: CZ000000605, CZ000001206, CZ000001400;

Bibliographic records: Smithers and Tello (1976); Timberlake et al. (2009);

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Maputo; Nampula; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Angola, Benin, Botswana, Burkina Faso,

Cameroon, Cape Verde Islands, Central African Republic, Côte d'Ivoire, Dem. Rep. Congo, Equatorial Guinea, Ethiopia, Ghana, Kenya, Liberia, Malawi, Mauritana, Mozambique, Namibia, Niger, Republic of Congo, Rwanda, Senegal, Sierra Leone, Somalia, South Africa, Sudan, Tanzania, Togo, Uganda, Zambia, Zimbabwe.

***Helogale parvula* (Sundevall, 1847)**

Common dwarf mongoose

Other recorded names: Helogale ivori; Helogale parvula parvula; Helogale parvula undulata;

Museum records: NHMUK: 1974888; USNM; FMNH: 35323, 35324; MCZ: 23005, 23006;

Bibliographic records: Smithers and Tello (1976); Mesochina, Langa and Chardonnet (2008);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Nampula; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Angola, Botswana, Dem. Rep. Congo, Ethiopia, Gambia, Kenya, Malawi, Mozambique, Namibia, Somalia, South Africa, Sudan, Tanzania, Uganda, Zambia.

***Herpestes ichneumon* (Linnaeus, 1758)**

Egyptian mongoose

Other recorded names: Herpestes ichneumon mababiensis;

Museum records: USNM: 61758, 352933; NMZB: NMZB-MAM-0068534; IICT: CZ000000241;

Bibliographic records: Smithers and Tello (1976); Stalmans and Peel (2009);

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Maputo; Sofala; Zambezia;

Known distribution (Wilson and Reeder 2005): Algeria, Angola, Botswana, Cameroon, Chad, Côte d'Ivoire, Dem. Rep. Congo, Egypt, Ethiopia, Gambia, Ghana, Gibraltar, Guinea, Israel, Jordan, Kenya, Lebanon, Liberia, Lybia, Malawi, Morocco, Mozambique, Niger, Portugal, Rwanda, Senegal, Sierra Leone, South Africa, Spain, Sudan, Syria, Tanzania, Togo, Tunisia, Turkey, Uganda, Zambia.

Ichneumia albicauda **(G.Cuvier, 1829)**

White-tailed mongoose

Other recorded names: Ichneumia albicauda grandis;

Museum records: AMNH: M-216352, M-216353, M-216354; NMZB: NMZB-MAM-0068296, NMZB-MAM-0068297, NMZB-MAM-0068298, NMZB-MAM-0068300, NMZB-MAM-0068301;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Maputo; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Angola, Botswana, Burkina Faso, Central African Republic, Côte d'Ivoire, Dem. Rep. Congo, Ghana, Kenya, Kenya, Mozambique, Namibia, Niger, Nigeria, Oman, Senegal, Sierra Leone, Somalia, South Africa, Sudan, Yemen, Zambia, Zimbabwe.

Mungos mungo **(Gmelin, 1788)**

Banded mongoose

Other recorded names: Mungos mungo bororensis; Mungos mungos; Mungos mungos boroensis; Mungos mungo senescens; Mungos mungos rossi;

Museum records: AMNH: M-216350, M-216351; USNM: 367382, 367396; FMNH: 177229, 177230; IICT: CZ000000235, CZ000000239, CZ000000262, CZ000000609, CZ000000613, CZ000000615, CZ000001716;

Bibliographic records: Smithers and Tello (1976); Mesochina, Langa and Chardonnet (2008); Timberlake et al. (2009);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Nampula; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Angola, Botswana, Burundi, Cameroon, Central African Republic, Chad, Dem. Rep. Congo, Ethiopia, Guinea-Bissau, Kenya, Malawi, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Somalia, South Africa, Sudan, Tanzania, Uganda, Zambia, Zimbabwe.

Paracynictis selousi **(de Winton, 1896)**

Selous' mongoose

Other recorded names: Paracynictis selousi selousi;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Manica;

Known distribution (Wilson and Reeder 2005): Angola, Botswana, Malawi, Mozambique, Namibia, South Africa, Zambia, Zimbabwe.

***Rhynchogale melleri* (Gray, 1865)**

Meller's mongoose

Other recorded names: Rhynchogale melleri melleri;

Museum records: USNM: 367378, 367379; NMZB: NMZB-MAM-0068382, NMZB-MAM-0068383, NMZB-MAM-0068384, NMZB-MAM-0068385; IICT: CZ000000259, CZ000000263, CZ000000610, CZ000000611, CZ000000612; **Bibliographic records:** Smithers and Tello (1976);

Reported distribution in Mozambique: Manica; Maputo; Sofala; Tete;

Known distribution (Wilson and Reeder 2005): Dem. Rep. Congo, Malawi, Mozambique, South Africa, Tanzania, Zambia, Zimbabwe.

Hyaenidae

***Crocuta crocuta* (Erxleben, 1777)**

Spotted hyaena

Museum records: AMNH: M-216355; USNM;

Bibliographic records: Smithers and Tello (1976); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Nampula; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Angola, Botswana, Cameroon, Dem. Rep. Congo, Ethiopia, Gabon, Gambia, Guinea, Kenya, Malawi, Mauritania, Mozambique, Namibia, Nigeria, Senegal, Sierra Leone, Somalia, South Africa, Sudan, Tanzania, Togo, Uganda, Zambia, Zimbabwe..

***Hyaena brunnea* (Thunberg, 1820)**

Brown hyena

Other recorded names: Hyanea brunnea;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Gaza; Maputo; Sofala;

Known distribution (Wilson and Reeder 2005): Botswana, Mozambique, Namibia, South Africa, Zimbabwe.

***Proteles cristata* (Sparrman, 1783)**

Aardwolf

Other recorded names: Proteles cristatus;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Gaza; Manica; Maputo; Maputo City;

Known distribution (Wilson and Reeder 2005): Angola, Botswana, Central African Republic, Egypt, Ethiopia, Kenya, Mozambique, Namibia, Somalia, South Africa, Sudan, Tanzania, Uganda, Zambia, Zimbabwe.

Mustelidae

***Aonyx capensis* (Schinz, 1821)**

African clawless otter

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Gaza; Manica; Maputo; Sofala; Zambezia;

Known distribution (Wilson and Reeder 2005): Angola, Benin, Botswana, Burkina Faso, Burundi (?), Cameroon, Central African Republic, Chad, Côte d'Ivoire, Dem. Rep. Congo, Ethiopia, Gabon, Ghana, Guinea-Bissau, Kenya, Liberia, Malawi, Mozambique, Namibia, Niger, Nigeria, Republic of Congo, Rwanda, Senegal, Sierra Leone, South Africa, Sudan, Tanzania, Togo, Uganda, Zambia, Zimbabwe.

***Ictonyx striatus* (Perry 1810)**

Striped polecat

Other recorded names: Ictonyx striatus oder; Ictonyx striatus striatus;

Museum records: ZMB: 954; NMZB: NMZB-MAM-0068679; MCZ: 4045, 4047, 4048, 5958; FMNH: 177231, 177232, 177233; IICT: CZ000000266, CZ000000353;

Bibliographic records: Smithers and Tello (1976); Mesochina, Langa and Chardonnet (2008);

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Maputo; Nampula; Sofala; Zambezia;

Known distribution (Wilson and Reeder 2005): Angola, Benin, Botswana, Burkina Faso, Cameroon, Central African Republic, Chad, Côte d'Ivoire, Ethiopia, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Malawi, Mali, Mauritania, Mozambique, Namibia, Niger, Nigeria, Republic of Congo, Senegal, Somalia, South Africa, Sudan, Tanzania, Togo, Uganda, Zambia, Zimbabwe.

***Hydrictis maculicollis* (Lichtenstein, 1835)**

Speckle-throated otter

Other recorded names: Lutra maculicollis;

Museum records: NMZB: NMZB-MAM-0068614;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Maputo; Sofala;

Known distribution (Wilson and Reeder 2005): Angola, Benin, Botwana, Burkina Faso, Cameroon, Central African Republic, Chad, Côte d'Ivoire, Dem. Rep. Congo, Ethiopia, Gabon, Kenya, Liberia, Malawi, Mozambique, Namibia, Nigeria, Rwanda, Sierra Leone, South Africa, Sudan, Tanzania, Togo, Uganda, Zambia.

***Mellivora capensis* (Schreber, 1776)**

Honey badger

Other recorded names: Mellivora capensis capensis;

Museum records: CAS: 14839; NMZB: NMZB-MAM-0068619;

Bibliographic records: Smithers and Tello (1976); Mesochina, Langa and Chardonnet (2008); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Sofala; Tete; Zambezia; **Known distribution (Wilson and Reeder 2005):** Nepal (Savanna and steppe), India, Turkmenistan, Lebanon, South Africa.

***Poecilogale albinucha* (Gray, 1864)**

African striped weasel

Museum records: NMZB: NMZB-MAM-0017667; FMNH: 177234, 177235, 177236,

214727;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Manica; Maputo; Sofala; Zambezia;

Known distribution (Wilson and Reeder 2005): Angola, Botswana, Burundi, Dem. Rep. Congo, Kenya, Malawi, Mozambique, Namibia, Republic of Congo, Rwanda, South Africa, Tanzania, Uganda, Zambia, Zimbabwe.

Nandiniidae

***Nandinia binotata* Gray, 1830**

African palm civet

Museum records: NMZB: NMZB-MAM-0004363, NMZB-MAM-0054897, NMZB-MAM-0054898, NMZB-MAM-0054899, NMZB-MAM-0054900, NMZB-MAM-0054901, NMZB-MAM-0064333, NMZB-MAM-0064334, NMZB-MAM-0068523, NMZB-MAM-0068563, NMZB-MAM-0068566, NMZB-MAM-0068579, NMZB-MAM-0068582, NMZB-MAM-0068602; FMNH: 177254;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Manica; Sofala; Zambezia;

Known distribution (Wilson and Reeder 2005): Angola, Benin, Burundi, Cameroon, Central African Republic, Côte d'Ivoire, Dem. Rep. Congo, Equatorial Guinea, Gabon, Ghana, Guinea, Guinea-Bissau, Kenya, Liberia, Malawi, Mozambique, Nigeria, Republic of Congo, Rwanda, Senegal, Sierra Leone, Sudan, Tanzania, Togo, Uganda, Zambia, Zimbabwe.

Viverridae

***Civettictis civetta* (Schreber, 1776)**

African civet

Other recorded names: Civettictis civetta australis; Civettictis civetta civetta; Civettictis civetta schwarzi; Viverra civetta; Viverra civetta civetta;

Museum records: AMNH: M-216348; USNM: 61756, 367377, 367450, 589101; MCZ: 44287; IICT: CZ000000193, CZ000000195, CZ000000196, CZ000000199, CZ000000200, CZ000000201, CZ000000589, CZ000000590, CZ000000591, CZ000000592, CZ000000594, CZ000000595, CZ000000596, CZ000000597, CZ000000604;

Bibliographic records: Smithers and Tello (1976); Mesochina, Langa and Chardonnet (2008); Stalmans and Peel (2009); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Maputo City; Nampula; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Angola, Benin, Botswana, Cameroon, Central African Republic, Côte d'Ivoire, Dem. Rep. Congo, Equatorial Guinea, Ethiopia, Gabon, Gambia, Guinea, Kenya, Liberia, Malawi, Mozambique, Namibia, Niger, Nigeria, Republic of Congo, Rwanda, Senegal, Sierra Leone, South Africa, Sudan, Tanzania, Uganda, Zambia, Zimbabwe.

***Genetta angolensis* Bocage, 1882**

Angolan genet

Other recorded names: Genetta mossambica;

Museum records: ZMB: 19659; MCZ: 44282;

Reported distribution in Mozambique: Cabo Delgado; Tete;

Known distribution (Wilson and Reeder 2005): Angola, Dem. Rep. Congo, Malawi, Mozambique, Tanzania, Zambia, Zimbabwe.

***Genetta genetta* (Linnaeus, 1758)**

Common genet

Other recorded names: Genetta genetta felina; Genetta genetta pulchra;

Museum records: MCZ: 34136; USNM: 61757;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Gaza; Maputo; Sofala;

Known distribution (Wilson and Reeder 2005): Algeria, Angola, Arabia, Belgium, Benin, Botswana, Burkina Faso, Cameroon, Central African Republic, Chad, Egypt, Ethiopia, France, Ghana, Kenya, Liberia, Libya, Mali, Mauritania, Morocco, Mozambique, Namibia, Niger, Nigeria, Oman, Portugal, Senegal, Spain, Somalia, South Africa, Sudan, Tanzania, Togo, Tunisia, Uganda, Yemen, Zambia, Zimbabwe.

***Genetta maculata* Pucheran 1855**

Rusty-spotted genet

Other recorded names: Genetta pardina; Genetta pardina rubiginosa; Genetta pardina zuluensis; Genetta rubiginosa;

Museum records: AMNH: M-216345, M-216346, M-216347; USNM: 352932, 367360, 367361, 367362, 367363, 367364, 367365, 367366, 367367, 367368, 367369, 367370, 367371, 367372, 367373, 367374, 367375, 367376, 367395; IICT: CZ000000129, CZ000000154, CZ000000157, CZ000000160, CZ000000165, CZ000000166, CZ000000168, CZ000000174, CZ000000176, CZ000000177, CZ000000180, CZ000000566, CZ000000568, CZ000000569, CZ000000570, CZ000000571, CZ000000572, CZ000000573, CZ000000574, CZ000000575, CZ000000576, CZ000000577, CZ000000578, CZ000000579, CZ000000580, CZ000000581, CZ000000582, CZ000000584, CZ000000585, CZ000000586, CZ000000587;

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Maputo; Sofala; Tete;

Known distribution (Wilson and Reeder 2005): Angola, Botswana, Cameroon, Central African Republic, Chad, Dem. Rep. Congo, Eritrea, Equatorial Guinea, Ethiopia, Gabon, Ghana, Kenya, Malawi, Mozambique, Namibia, Nigeria, Republic of Congo, Rwanda, Somalia, South Africa, Sudan, Tanzania, Togo, Uganda, Zambia, Zimbabwe.

***Genetta tigrina* (Von Schreber, 1776)**

Cape genet

Other recorded names: Genetta tigrina rubiginosa;

Museum records: NMZB: NMZB-MAM-0004378, NMZB-MAM-0004379, NMZB-MAM-0064326, NMZB-MAM-0068129, NMZB-MAM-0068130, NMZB-MAM-0068131, NMZB-MAM-0068132, NMZB-MAM-0068133, NMZB-MAM-0068134, NMZB-MAM-0068135, NMZB-MAM-0068136, NMZB-MAM-0068137, NMZB-MAM-0068138, NMZB-MAM-0068139, NMZB-MAM-0068140, NMZB-MAM-0068141, NMZB-MAM-0068142, NMZB-MAM-0068143, NMZB-MAM-0068144, NMZB-MAM-0068145, NMZB-MAM-0068146, NMZB-MAM-0068147, NMZB-MAM-0068148, NMZB-MAM-0068149, NMZB-MAM-0068150, NMZB-MAM-0068151, NMZB-MAM-0068153, NMZB-MAM-0068154, NMZB-MAM-0068244, NMZB-MAM-0068245, NMZB-MAM-0068246, NMZB-MAM-0068247, NMZB-MAM-0068248, NMZB-MAM-0068249, NMZB-MAM-0068250, NMZB-MAM-0068251; FMNH: 177237, 177238, 177239;

Bibliographic records: Smithers and Tello (1976); Mesochina, Langa and Chardonnet (2008); Timberlake et al. (2009);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Ma-

puto; Nampula; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): South Africa.

B.1.4 Chiroptera

Emballonuridae

***Coleura afra* (Peters, 1852)**

African sheath-tailed bat

Other recorded names: Coleurus afra;

Museum records: ZMB: 135818, 135819, 135823, 135826, 135827, 135830, 135831, 135837, 135839, 135840; RMNH: RMNH-MAM-27333; NHMUK: 1858.6.18.12, 1907.1.1.703;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Tete;

Known distribution (Wilson and Reeder 2005): Guinea-Bissau to Somalia and Djibouti, south to Angola, Dem. Rep. Congo, and Mozambique; Yemen.

***Taphozous mauritianus* E.Geoffroy, 1818**

Mauritian tomb bat

Museum records: NMZB: NMZB-MAM-0063743; MCZ: 43769; USNM: 365457, 365458, 365459;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Gaza; Sofala; Tete;

Known distribution (Wilson and Reeder 2005): South Africa to Sudan and Somalia to Senegal; Mauritius and Reunion Islands (Mascarene Islands); São Tomé and Príncepe; Madagascar; Assumption Island and Aldabra Island.

Hipposideridae

***Cloeotis percivali* Thomas, 1901**

Percival's short-eared trident bat

Other recorded names: Cleotis percivali australis;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Manica; Tete;

Known distribution (Wilson and Reeder 2005): Kenya, Tanzania, S. Dem. Rep. Congo, Mozambique, Zambia, Zimbabwe, S.E. Botswana, Swaziland, N.E. South Africa.

***Hipposideros caffer* (Sundevall, 1846)**

Sundevall's leaf-nosed bat

Other recorded names: Hipposideros caffer caffer;

Museum records: AMNH: M-216214, M-216215, M-216216, M-216217, M-216218, M-216219, M-216220, M-216221, M-216237, M-216238, M-245160, M-245161, M-245162, M-245163, M-245164, M-245165; ZMB: 135746; LACM: 19674, 19675, 19676, 19677; TTU: 8307; IICT: CZ000000046; NHMUK: 1968.1003; FMNH: 177114, 177115, 177116, 177117, 177118, 177119, 177120, 177121, 177122, 177123, 177124, 177125, 177126, 177127, 177128, 177129, 177215; USNM: 352042, 352043, 352044, 352045, 352046, 352047, 365228, 365229, 365230, 365231, 365232, 365233, 365234, 365235, 365236, 365237, 365238, 365239, 365240, 365242, 365243, 365248, 365249, 365251, 365252, 365253, 365265, 365266, 365270, 365271, 365272, 365274, 367535, 479262, 479263, 479264, 479265, 479266, 479267; SMF: 87654, 89149; BRTC: TCWC:20886; MCZ: 43774;

Bibliographic records: Smithers and Tello (1976); Monadjem et al. (2010);

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Maputo; Maputo City; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): S.W. Arabian Peninsula including Yemen; most of sub-saharan Africa except the central forested region; Morocco; Zanzibar and Pemba.

***Hipposideros ruber* (Noack, 1893)**

Noack's leaf-nosed bat

Other recorded names: Hipposideros ruber centralis;

Museum records: FMNH: 177130, 177131, 177132, 177133, 177134, 177135, 177136, 177137, 177138; USNM: 365244, 365245, 365246, 365247, 365250, 365254, 365255, 365256, 365257, 365258, 365259, 365260, 365261, 365262, 365263, 365264, 365267, 365268, 365269, 365273, 367496, 367497, 367498, 367499, 367500, 367501, 367502, 367503, 367504, 367505, 367506, 367507, 367508, 367509, 367510, 367511, 367512, 367513, 367514, 367515, 367516, 367517, 367518, 367519, 367520, 367521, 367522, 367523, 367524, 367525, 367526, 367527, 367528, 367529, 367530, 367531, 367532, 367533, 367534;

Bibliographic records: Timberlake et al. (2009); Monadjem et al. (2010); Bayliss et al. (2014);

Reported distribution in Mozambique: Niassa; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Senegal and Gambia to Ethiopia, south to Angola, Zambia, Malawi, and Mozambique; Bioko; São Tomé and Príncipe.

Hipposideros vittatus **Peters, 1852**

Striped leaf-nosed bat

Other recorded names: Hipposideros commersonii; Hipposideros commersoni marungensis; Hipposideros commersoni vittatus; Hipposideros marungensis; Hipposideros vittata;

Museum records: AMNH: M-216213, M-216235; SMF: 87655, 87656, 87657, 87658, 87659, 87660, 89148; NMZB: NMZB-MAM-0064270, NMZB-MAM-0064271, NMZB-MAM-0064272; TTU: 8308; ZMB: 135762, 135763;

Bibliographic records: Smithers and Tello (1976); Monadjem et al. (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Sofala; Tete;

Known distribution (Wilson and Reeder 2005): Ethiopia, Somalia, Kenya, Tanzania (incl. Pemba, Chumbwe and Zanzibar Isl), Malawi, Mozambique (incl. Ibo Isl), Zambia, Zimbabwe, Botswana, Dem. Rep. Congo, Angola, Namibia, South Africa, Guinea-Bissau.

Triaenops persicus **Dobson, 1871**

Persian trident bat

Other recorded names: Triaenops afer; Triaenops persicus afer; Trianops persicus afer;

Museum records: AMNH: M-216236, M-245393, M-245394, M-245395, M-245396, M-245397, M-245398, M-245399, M-245400, M-245401, M-245402, M-245403; SMF: 89145, 89146, 89147; ROM: 67542, 67543, 67544, 67545, 67546, 67547, 67548, 67549; TTU: 8305; USNM: 365188, 365276, 365277, 365278, 365279, 365280, 365281, 365282, 365283, 365284, 365285, 365286, 365287, 365288, 365289, 365290, 365291, 365292, 365293, 365294, 365295, 365296, 365297, 365298, 365299, 365300, 365301, 365302, 365303, 365304, 365305, 365306, 365307, 365308, 365309, 365310, 365311, 365312, 365313, 365314, 365315, 365316, 365317, 365318, 365319, 365320, 367536, 367537, 367538, 367539, 367540, 367541, 367542, 367543, 367544, 367545;

Bibliographic records: Smithers and Tello (1976); Monadjem et al. (2010);

Reported distribution in Mozambique: Cabo Delgado; Inhambane; Niassa; Sofala; Tete;

Known distribution (Wilson and Reeder 2005): Somalia, Djibouti, Ethiopia, Kenya, Tanzania, Uganda, Angola, Zanzibar, Malawi, Mozambique, Zimbabwe, Yemen, Oman, Republic of Congo, Iran, Pakistan.

Molossidae

***Chaerephon ansorgei* (Thomas, 1913)**

Ansorge's free-tailed bat

Other recorded names: Tadarida ansorgei;

Museum records: USNM: 365471;

Bibliographic records: Smithers and Tello (1976); Monadjem et al. (2010);

Reported distribution in Mozambique: Gaza; Nampula; Tete; **Known distribution (Wilson and Reeder 2005):** Nigeria and Cameroon to Ethiopia, south to Angola and KwaZulu-Natal (South Africa).

***Chaerephon bivittatus* (Heuglin, 1861)**

Spotted free-tailed bat

Other recorded names: Tadarida bivitatta; Tadarida bivittata;

Museum records: IICT: CZ000000039, CZ000000051;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Manica; Maputo;

Known distribution (Wilson and Reeder 2005): Sudan, Ethiopia, Eritrea, Uganda, Kenya, Tanzania, Zambia, Zimbabwe, Mozambique.

***Chaerephon nigeriae* Thomas, 1913**

Hoary wattled bat

Museum records: NMZB: NMZB-MAM-0063862, NMZB-MAM-0063863, NMZB-MAM-0063864, NMZB-MAM-0063865, NMZB-MAM-0063866, NMZB-MAM-0063867, NMZB-MAM-0063868, NMZB-MAM-0063869, NMZB-MAM-0063870, NMZB-MAM-0063871;

Known distribution (Wilson and Reeder 2005): Guinea, Sierra Leone, Mali, Ghana, Togo, and Nigeria to Saudi Arabia and Yemen, Ethiopia south to Namibia, Botswana, Uganda,

Malawi and Zimbabwe.

Chaerephon pumilus **(Cretzschmar, 1826)**

Little free-tailed bat

Other recorded names: Chaerephon limbatus; Chaerephon pumila; Chaerephon pumila limbatus; limbatus; Tadarida limbatus; Tadarida pumila; Tadarida pumila elphicki; Tadarida pumila limbata;

Museum records: AMNH: M-216231, M-216232, M-216234, M-232700, M-245174, M-245175, M-245176, M-245177, M-245178, M-245179, M-245180, M-245181, M-245182, M-245183, M-245184, M-245185, M-245186, M-245187; ROM: 67530, 67531, 67532, 67533; ZMB: 539, 135811, 135812, 135815, 537/ 85520, 538/ 85519; MHNG: MAM-816.092, MAM-816.093, MAM-816.094; NMZB: NMZB-MAM-0063961, NMZB-MAM-0063962; IICT: CZ000000041, CZ000000095, CZ000000096, CZ000000119, CZ000000122; NHMUK: 7.1.1.704, 58.6.18.14, 1907.1.1.704; MCZ: 43770, 43771, 43772, 43773, 57215; USNM: 352117, 352118, 352119, 352120, 352121, 352122, 352123, 352124, 352125, 352126, 352127, 352128, 352129, 352130, 352131, 352132, 352133, 352199, 352200, 352201, 352202, 352203, 352204, 352205, 352206, 352207, 352208, 352209, 352210, 352211, 352212, 352213, 352214, 352215, 352216, 352217, 352218, 352219, 352220, 352221, 352222, 352223, 352224, 352225, 352226, 352227, 352228, 352229, 352230, 352231, 352232, 352233, 352234, 352235, 352236, 352237, 352238, 352239, 352240, 352241, 352242, 352243, 352244, 352245, 352246, 352247, 352248, 352249, 352250, 352251, 352252, 365460, 365461, 365462, 365463, 365464, 365465, 365466, 365479, 367605; FMNH: 65847, 65848, 65849, 65850, 65851, 65852, 65853, 65854, 65855, 65856, 65857, 65858, 65859, 65860, 65861, 65862, 65863, 65864, 65865, 105701;

Bibliographic records: Smithers and Tello (1976); Downs and Wirminghaus (1997); Schneider (2004); GRNB (2010); Monadjem et al. (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Maputo City; Nampula; Niassa; Sofala; Tete;

Known distribution (Wilson and Reeder 2005): Senegal to Yemen, south to South Africa; Bioko; São Tomé; Pemba and Zanzibar; Comoro Islands; Seychelles; Madagascar.

Mops condylurus **(A.Smith, 1833)**

Congo free-tailed bat

Other recorded names: Tadarida condylura; Tadarida condylura condylura;

Museum records: AMNH: M-216233, M-244311, M-244312, M-244313, M-244314, M-244315, M-244316, M-244317, M-244318, M-244319, M-244320; ROM: 51090, 67534, 67535, 67536, 67537, 67538, 67539, 67540, 67541; USNM: 352134, 352135, 352136, 352137, 352138, 352139, 352140, 352141, 352142, 352143, 352144, 352145, 352146, 352147, 352148, 352149, 352150, 352151, 352152, 352153, 352154, 352155, 352156, 352157, 352158, 352159, 352160, 352161, 352162, 352163, 352164, 352165, 352166, 352167, 352168, 352169, 352170, 352171, 352172, 352173, 352174, 352175, 352176, 352177, 352178, 352179, 352180, 352181, 352182, 352183, 352184, 352185, 352186, 352187, 352188, 352189, 352190, 352191, 352192, 352193, 352194, 352195, 352196, 352197, 352198, 365467, 365470, 365492, 365493, 365494, 365495, 365496, 365497, 365498, 365499, 365500, 365501, 365502, 365504, 365505, 365506, 365507, 365508, 365509, 365510, 365511, 365512, 365513, 365514, 365515, 365516, 365517, 365518, 365519, 365520, 365521, 365522, 365523, 365524, 365525, 365526, 365527, 365528, 365529, 365530, 365531, 365532, 365533, 365534, 365535, 365536, 365537, 365538, 365539, 365540, 365541, 365542, 365543, 365544, 365545, 365546, 365547, 365548, 365549, 365550, 365551, 365552, 365553, 365554, 365555, 365556, 365557, 365558, 365559, 365560, 365561, 365562, 365563, 365564, 365565, 365566, 365567, 365568, 365569, 365570, 365571, 365572, 365573, 365574, 365575, 365576, 365577, 365578, 365579, 365580, 365581, 365582, 365583, 365584, 365585, 365586, 365587, 365588, 365589, 365590, 365591, 365592, 365593, 365594, 365595, 365596, 365597, 365598, 365599, 365600, 365601, 365602, 365603, 365604, 365605, 365606, 365607, 365608, 365609, 365610, 365611, 365612, 365613, 365614, 365615, 365616, 365617, 365618, 365619, 365620, 365621, 365622, 365623, 365624, 365625, 365626, 365627, 365628, 365629, 365630, 365631, 365632, 365633, 365634, 365635, 365636, 365637, 365638, 365639, 365640, 365641, 365642, 365643, 365644, 365645, 365646, 365647, 365648, 365649, 365650, 365651, 365652, 365653, 365654, 365655, 365656, 365657, 365658, 365682, 365683, 365684, 365685, 365686, 365687, 365688, 365689, 365690, 365691, 365692, 365693, 365694, 365695, 365696, 365697, 365698, 365699, 365700, 365701, 365702, 365703, 367572, 367573, 367574, 367575, 367576, 367577, 367578, 367579, 367580, 367581, 367582, 367583, 367584, 367585, 367586, 367587, 367588, 367589, 367590, 367591, 367592, 367593, 367594, 367595, 367596, 367597, 367598, 367599, 367600, 367601, 367602, 367603, 367604, 367606, 367607, 367608, 367609, 367610, 367611, 367612, 367613, 367614, 367615, 367616, 367617, 367618, 367619, 367620, 367621, 367622, 367623, 367624, 367625, 367626, 367627, 367628, 367629, 367630,

367631, 367632, 367633, 367634, 367635, 367636, 367637, 367638, 367639, 367640, 367641, 367642, 367643, 367644, 367645; FMNH: 177175, 177176, 177177, 177178, 177179, 177180, 177181, 177182, 177183, 177184, 177185, 177186, 177187, 177188, 177189, 177190, 177191; IICT: CZ000000045, CZ000000117;

Bibliographic records: Smithers and Tello (1976); Monadjem et al. (2010);

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Maputo; Sofala; Tete;

Known distribution (Wilson and Reeder 2005): Cameroon, Dem. Rep. Congo, Uganda.

***Mops niveiventer* Cabrera and Ruxton, 1926**

White-bellied free-tailed bat

Other recorded names: Tadarida niveiventer;

Museum records: USNM: 365468, 365469;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Tete;

Known distribution (Wilson and Reeder 2005): Dem. Rep. Congo, Rwanda, Burundi, Tanzania, Angola, Zambia, Mozambique.

***Sauromys petrophilus* (Roberts, 1917)**

Roberts's flat-headed bat

Other recorded names: Sauromys petrophilus petrophilus;

Museum records: USNM: 365659, 365660, 365661, 365662, 365663, 365664, 365665, 365666, 365667, 365668, 365669, 365670, 365671, 365672;

Bibliographic records: Smithers and Tello (1976); Monadjem et al. (2010);

Reported distribution in Mozambique: Niassa; Tete;

Known distribution (Wilson and Reeder 2005): South Africa, Namibia, Botswana, Zimbabwe, Mozambique, perhaps Ghana.

***Tadarida aegyptiaca* (E, Geoffroy, 1818)**

Egyptian free-tailed bat

Other recorded names: Tadarida aegyptiaca aegyptiaca; Tadarida aegyptiaca bocagei;

Museum records: NMZB: NMZB-MAM-0019874, NMZB-MAM-0063966, NMZB-MAM-0063967, NMZB-MAM-0063968, NMZB-MAM-0063969, NMZB-MAM-0063970, NMZB-

MAM-0063971, NMZB-MAM-0063972, NMZB-MAM-0063973, NMZB-MAM-0063974, NMZB-MAM-0063975, NMZB-MAM-0063976, NMZB-MAM-0063977, NMZB-MAM-0063978, NMZB-MAM-0063979, NMZB-MAM-0063980, NMZB-MAM-0063981, NMZB-MAM-0063982, NMZB-MAM-0063983, NMZB-MAM-0063984, NMZB-MAM-0063985, NMZB-MAM-0063986, NMZB-MAM-0063987, NMZB-MAM-0063988, NMZB-MAM-0063989; USNM: 365480, 365481, 365482, 365483, 365484, 365485, 365486, 365487, 365488, 365489, 365490, 365491, 365503, 479953;

Bibliographic records: Smithers and Tello (1976); Monadjem et al. (2010);

Reported distribution in Mozambique: Manica; Nampula; Tete;

Known distribution (Wilson and Reeder 2005): South Africa to Nigeria, Algeria, and Egypt to Saudi Arabia, Yemen and Oman, east to India and Sri Lanka, N. to Afganistan.

***Tadarida fulminans* (Thomas, 1903)**

Malagasy free-tailed bat

Other recorded names: Tadarida fulminans mastersoni;

Museum records: USNM: 365472, 365473, 365474, 365475, 365476, 365477, 365478;

Bibliographic records: Monadjem et al. (2010);

Reported distribution in Mozambique: Manica; Nampula; Tete;

Known distribution (Wilson and Reeder 2005): E. Dem. Rep. Congo, Rwanda, Kenya, Tanzania, Zambia, Malawi, Zimbabwe, N.E. South Africa, Madagascar.

***Tadarida ventralis* (Heuglin, 1861)**

Giant free-tailed bat

Other recorded names: Tadarida africana;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Manica; Tete;

Known distribution (Wilson and Reeder 2005): Eritrea to South Africa.

Nycteridae

***Nycteris grandis* Peters, 1865**

Large slit-faced bat

Bibliographic records: Smithers and Tello (1976); Monadjem et al. (2010);

Reported distribution in Mozambique: Cabo Delgado; Manica;

Known distribution (Wilson and Reeder 2005): Senegal to Dem. Rep. Congo, Kenya, Zimbabwe, Malawi, and Mozambique; Zanzibar and Pemba.

Nycteris hispida **(Schreber, 1775)**

Hairy slit-faced bat

Other recorded names: Nycteris hispida villosa;

Museum records: MNHN: MO-1881-303, MO-1881-304;

Bibliographic records: Smithers and Tello (1976); Monadjem et al. (2010);

Reported distribution in Mozambique: Inhambane; Manica; Niassa; Tete;

Known distribution (Wilson and Reeder 2005): Senegal, Gambia, and extreme S. Mauritania to Somalia and south to Angola, C. Mozambique, Botswana, and Malawi; Zanzibar; Bioko.

Nycteris macrotis **Dobson, 1876**

Big free-tailed bat

Museum records: IICT: CZ000000062;

Bibliographic records: Monadjem et al. (2010);

Reported distribution in Mozambique: Gaza; Maputo; Niassa; Sofala;

Known distribution (Wilson and Reeder 2005): Senegal and Gambia to Ethiopia, south to Zimbabwe, Malawi and Mozambique; Zanzibar.

Nycteris thebaica **E.Geoffroy, 1818**

Egyptian slit-faced bat

Other recorded names: Nycteris thebaica capensis;

Museum records: AMNH: M-245150, M-245151, M-245152, M-245153, M-245154, M-245155; ROM: 51069, 51070, 51071; MHNG: MAM-816.091; NMZB: NMZB-MAM-0064244, NMZB-MAM-0064245, NMZB-MAM-0064246, NMZB-MAM-0064247; LACM: 19678, 19679, 19680, 19681, 19682, 19683; TTU: 8299; IICT: CZ000000056; RMNH: RMNH-MAM-35901.a, RMNH-MAM-35901.b; NHMUK: 1858.6.18.15, 1907.1.1.337; FMNH: 177098, 177099, 177100, 177101, 177102, 177213, 214721; USNM: 352011, 352012, 352013, 352014, 352015, 352016, 352017, 352018, 352019, 352020, 352021, 352022, 352023, 352024, 352025, 352026, 352027,

352028, 352029, 352030, 352031, 352032, 352033, 365136, 365137, 365138, 365139, 365140, 365141, 365142, 365143, 365144, 365145, 365146, 365147, 365148, 365149, 365150, 365151, 365152, 365153, 365154, 365155, 365156, 365157, 365158, 365159, 365160, 365161, 365162, 365163, 365164, 365165, 365166, 365167, 365168, 365169, 365170, 365171, 365172, 365173, 365174, 365175, 365177, 367456, 367457, 367458, 367459, 367460, 367461, 367462, 367463, 367464, 367465, 367466, 367467, 367468, 367469, 367470, 367471, 367472, 367473, 367474, 367475, 367476, 367477, 367478, 367479, 367480, 367481, 367482, 367483, 367484, 367485, 367486, 367487, 367488, 367489, 367490, 367491, 367492, 367493, 367494, 367495,;

Bibliographic records: Smithers and Tello (1976); Monadjem et al. (2010);

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Maputo; Maputo City; Nampula; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Central Arabia, Israel, Sinai, Egypt, Morocco, Senegal, Guinea, Mali, Burkina Faso, Ghana, Benin, Niger, Nigeria, Somalia, Djibouti, and Kenya, south to South Africa in open country; Zanzibar and Pemba.

***Nycteris vinsoni* Dalquest, 1965**

Vinson's slit-faced bat

Other recorded names: Nycteris aethiopica luteola; Nycteris macrotis vinsoni;

Museum records: KU: 105221;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Inhambane;

Known distribution (Wilson and Reeder 2005): Mozambique; known only from the type locality.

Pteropodidae

***Eidolon helvum* (Kerr, 1792)**

African straw-colored fruit bat

Other recorded names: Eidolon helvum helvum;

Museum records: NMZB: NMZB-MAM-0063733, NMZB-MAM-0063734; **Bibliographic records:** Smithers and Tello (1976); Timberlake et al. (2009);

Reported distribution in Mozambique: Manica; Maputo; Maputo City; Sofala; Zambezia;

Known distribution (Wilson and Reeder 2005): Mauritania, Senegal, and Gambia to Ethiopia to South Africa; S.W. Arabia and Oman; islands in the Gulf of Guinea and off E. Africa.

***Epomophorus crypturus* Peters, 1852**

Peters's epauletted fruit bat

Other recorded names: Epomophorus cf. crypturus;

Museum records: AMNH: M-216400; RMNH: RMNH-MAM-2545, RMNH-MAM-2545.A, RMNH-MAM-2545.B; ZMB: 135663; USNM: 365123, 365124, 365125, 365126, 365127, 365128, 365129, 365130, 365131, 365132, 365133, 365134;

Bibliographic records: Smithers and Tello (1976); Timberlake et al. (2009); Monadjem et al. (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Nampula; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Zambia, Tanzania, S.E. Dem. Rep. Congo, Mozambique, Malawi, Zimbabwe, Botswana, Namibia, South Africa.

***Epomophorus labiatus* (Temminck, 1837)**

Little epauletted fruit bat

Bibliographic records: Monadjem et al. (2010);

Reported distribution in Mozambique: Niassa;

Known distribution (Wilson and Reeder 2005): Saudi Arabia; Nigeria to Ethiopia and Djibouti, south to Republic of Congo and Malawi.

***Epomophorus wahlbergi* (Sundevall, 1846)**

Wahlberg's epauletted fruit bat

Other recorded names: Epomophorus wahlbergi wahlbergi;

Museum records: AMNH: M-245137, M-245138, M-245139; ROM: 41709, 51072, 51076, 51077, 51081, 51082, 51083, 51084, 51085, 51086, 51096, 51097, 51098, 51099, 51101, 51102; MHNG: MAM-816.089, MAM-816.090; NMZB: NMZB-MAM-0063691; NHMUK: 1864.1.9.4; FMNH: 177089, 177209, 177210, 214692, 214693, 214694; USNM: 351977, 351978, 351979, 351980, 351981, 351982, 351983, 351984, 351985, 351986, 351987, 351988,

351989, 351990, 351991, 351992, 351993, 351994, 351995, 351996, 351997, 351998, 351999, 352000, 352001, 352002, 352003, 352004, 352005, 352006, 352007, 352008, 352009, 352010, 365135, 367453, 367454, 367455; MVZ: 117088, 117089, 117090, 117091, 117092, 117093, 117094, 117973, 117974; MCZ: 22774;

Bibliographic records: Smithers and Tello (1976); Timberlake et al. (2009); Bayliss et al. (2010); Monadjem et al. (2010); Bayliss et al. (2014);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Maputo City; Nampula; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Cameroon to Sudan and Somalia, south to Malawi, Angola, and South Africa; Pemba and Zanzibar Islands.

***Lissonycteris angolensis* Bocage, 1898**

Angolan soft-furred fruit bat

Other recorded names: Lissonycteris goliath; Lyssonycteris goliath; Rousettus angolensis angolensis;

Bibliographic records: Smithers and Tello (1976); Timberlake et al. (2009); Monadjem et al. (2010);

Reported distribution in Mozambique: Manica; Nampula; Zambezia;

Known distribution (Wilson and Reeder 2005): Gambia, Senegal, Guinea Bissau, Guinea, Sierra Leone, Liberia, Côte d'Ivoire, Burkina Faso, Ghana, Togo, Nigeria, Cameroon, Central African Republic, Sudan, Ethiopia, Equatorial Guinea (Bioko only), Republic of Congo, Dem. Rep. Congo, Uganda, Rwanda, Kenya, Tanzania, Angola, Zambia, Zimbabwe, Mozambique.

***Myonycteris relicta* Bergmans, 1980**

Bergmans's collared fruit bat

Bibliographic records: Monadjem et al. (2010);

Reported distribution in Mozambique: Sofala;

Known distribution (Wilson and Reeder 2005): Kenya, Tanzania, Zimbabwe along border with Mozambique.

***Rousettus aegyptiacus* (E.Geoffroy, 1810)**

Egyptian rousette

Other recorded names: Rousettus aegyptiacus leachi; Rousettus aegyptiacus leachii; Rousettus aegypticus leachi; Rousettus leachi;

Museum records: SMF: 89144; NMZB: NMZB-MAM-0019818, NMZB-MAM-0019850, NMZB-MAM-0019851, NMZB-MAM-0019852, NMZB-MAM-0019853, NMZB-MAM-0019854, NMZB-MAM-0019855, NMZB-MAM-0019856, NMZB-MAM-0019857, NMZB-MAM-0019858, NMZB-MAM-0019859, NMZB-MAM-0019860, NMZB-MAM-0019861, NMZB-MAM-0019862, NMZB-MAM-0019863, NMZB-MAM-0019864, NMZB-MAM-0019865, NMZB-MAM-0019866, NMZB-MAM-0019867, NMZB-MAM-0019868, NMZB-MAM-0019869, NMZB-MAM-0019870, NMZB-MAM-0019871, NMZB-MAM-0019872, NMZB-MAM-0019873, NMZB-MAM-0019875, NMZB-MAM-0019876, NMZB-MAM-0019877, NMZB-MAM-0027455, NMZB-MAM-0027457, NMZB-MAM-0027459, NMZB-MAM-0027462, NMZB-MAM-0027463, NMZB-MAM-0027469, NMZB-MAM-0027472; FMNH: 177090, 177091, 177092, 177093, 177094, 177095, 177096, 177097, 177211, 177212; MCZ: 33168, 33169, 33170, 33171, 33172, 33173, 33174, 33175;

Bibliographic records: Smithers and Tello (1976); Timberlake et al. (2009); Monadjem et al. (2010); Bayliss et al. (2014);

Reported distribution in Mozambique: Cabo Delgado; Inhambane; Manica; Nampula; Sofala; Zambezia;

Known distribution (Wilson and Reeder 2005): Senegal and Egypt south to South Africa; Cyprus, Turkey, Jordan, Lebanon, Israel, S. Syria, Yemen, Saudi Arabia, S. Iraq, S. Iran, Pakistan, NW India; islands in the Gulf of Guinea (São Tomé and Príncipe); adjacent small islands.

Rhinolophidae

Rhinolophus blasii Peters, 1866

Blasius's horseshoe bat

Other recorded names: Rhinolophus blasii empusa; Rhinolophus cf blasii;

Museum records: MHNG: MAM-1971.049;

Bibliographic records: Smithers and Tello (1976); Timberlake et al. (2009); Monadjem et al. (2010); Bayliss et al. (2014);

Reported distribution in Mozambique: Manica; Zambezia;

Known distribution (Wilson and Reeder 2005): N.E. South Africa to S. Dem. Rep. Congo; Ethiopia; Somalia; Morocco; Algeria; Tunisia; Turkey; Yemen; Israel; Jordan; Syria; Iran; Serbia and Montenegro; Albania; Bulgaria; Romania; Transcaucasia and Turkmenistan;

Afghanistan; Pakistan; Italy; Greece; Cyprus.

Rhinolophus capensis **Lichtenstein, 1823**

Cape horseshoe bat

Museum records: FMNH: 177108, 177109, 177214;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Sofala; Zambezia;

Known distribution (Wilson and Reeder 2005): South Africa, Zimbabwe, Mozambique; occurence outside South Africa is doubtful.

Rhinolophus clivosus **Cretzschmar, 1828**

Geoffroy's horseshoe bat

Other recorded names: Rhinolophus clivosus keniensis; Rhinolophus clivosus zuluensis;

Museum records: MHNG: MAM-1971.054, MAM-1971.055, MAM-1971.059; NMZB: NMZB-MAM-0064263; FMNH: 177110, 177111, 177112, 177113;

Bibliographic records: Smithers and Tello (1976); Timberlake et al. (2009); Monadjem et al. (2010); Bayliss et al. (2014);

Reported distribution in Mozambique: Manica; Zambezia;

Known distribution (Wilson and Reeder 2005): Israel, Jordan, Saudi Arabia, Oman, Yemen, Egypt, Libya, Algeria, Sudan, Ethiopia, Eritrea, Djibouti, Somalia, Kenya, Uganda, Dem. Rep. Congo, Rwanda, Burundi, Tanzania, Malawi, Angola, Zambia, Mozambique, Zimbabwe, South Africa, Swaziland, Namibia.

Rhinolophus darlingi **K.Andersen, 1905**

Darling's horseshoe bat

Museum records: NMZB: NMZB-MAM-0064264, NMZB-MAM-0064265; USNM: 365203;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Manica; Sofala; Tete;

Known distribution (Wilson and Reeder 2005): N.E. South Africa, Namibia, S. Angola, N. and W. Botswana, Zimbabwe, Malawi, Mozambique, Tanzania, Nigeria.

Rhinolophus deckenii **Peters, 1837**

Decken's horseshoe bat

Bibliographic records: Monadjem et al. (2010);

Reported distribution in Mozambique: Sofala;

Known distribution (Wilson and Reeder 2005): Uganda, Kenya, Tanzania, Zanzibar and Pemba.

Rhinolophus denti **Thomas, 1904**

Dent's horseshoe bat

Other recorded names: Rhinolophus denti denti;

Museum records: USNM: 365179, 365196;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Manica; Tete;

Known distribution (Wilson and Reeder 2005): Northern Cape Prov. (South Africa), Namibia, Angola, Botswana, Zimbabwe, Mozambique, Guinea-Bissau, Guinea, Ghana.

Rhinolophus fumigatus **Ruppell, 1842**

Ruppell's horseshoe bat

Museum records: USNM: 365204, 365205, 365206,;

Bibliographic records: Smithers and Tello (1976); Monadjem et al. (2010);

Reported distribution in Mozambique: Manica; Niassa; Sofala; Tete;

Known distribution (Wilson and Reeder 2005): Somalia, Ethiopia, Eritrea, Sudan, Kenya, Uganda, Tanzania, Rwanda, Burundi, Dem. Rep. Congo, Nigeria, Niger, Sierra Leone, Côte d'Ivoire, Togo, Benin, Senegal, Gambia, Guinea, Mali, Burkina Faso, Ghana, Cameroon, Gabon, Republic of Congo, Central African Republic, Zambia, Malawi, Zimbabwe, Mozambique, Angola, Namibia, South Africa.

Rhinolophus gorongosae **Taylor et al., 2018**

Gorongosa horseshoe bat

Bibliographic records: Taylor et al. (2018);

Reported distribution in Mozambique: Sofala.

Rhinolophus hildebrandti **Peters, 1878** Upland horseshoe bat

Other recorded names: Rhinolophus hildebrandtii;

Museum records: AMNH: M-216206, M-216207, M-216208, M-216209, M-216210, M-216211, M-216212, M-245156, M-245157, M-245158, M-245159; MHNG: MAM-1971.061; NMZB: NMZB-MAM-0063469, NMZB-MAM-0063470; NHMUK: 1908.4.3.15; FMNH: 177103, 177104, 177105, 177106, 177107, 214706, 214707, 214708, 214709, 214710, 214711, 214712, 214713, 214714, 214715, 214716, 214717, 214718, 214719; USNM: 365207, 365208, 365209, 365210, 365211, 365212, 365213, 365214, 365215, 365216, 365217, 365218, 365219, 365220, 365221, 365222, 365223, 365224, 365225, 365226, 365227; SMF: 11639;

Bibliographic records: Smithers and Tello (1976); Bayliss et al. (2010); Monadjem et al. (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Nampula; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): NE South Africa and Mozambique to Ethiopia, S Sudan, and NE Dem. Rep. Congo; Nigeria.

***Rhinolophus lobatus* Peters, 1852**

Lander's horseshoe bat

Other recorded names: Rhinolophus landeri; Rhinolophus landeri lobatus;

Museum records: ROM: 51066, 51067, 51068; ZMB: 135862, 135863, 135865, 135866; MHNG: MAM-1971.062; NMZB: NMZB-MAM-0062052, NMZB-MAM-0062097, NMZB-MAM-0062098, NMZB-MAM-0062104; TTU: 8306; IICT: CZ000000060; NHMUK: 1908.4.3.9, 1908.4.3.11, 1908.4.3.12, 1908.4.3.14; USNM: 352034, 352035, 352036, 352037, 352038, 352039, 352040, 352041, 365178, 365180, 365181, 365182, 365183, 365184, 365185, 365186, 365187, 365189, 365190, 365191, 365192, 365194, 365195, 365197, 365241; SMF: 11640;

Bibliographic records: Smithers and Tello (1976); Monadjem et al. (2010); Bayliss et al. (2014); Taylor et al. (2018);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Senegal and Gambia to Ethiopia and Somalia, south to South Africa and Namibia; Bioko; Zanzibar.

***Rhinolophus mabuensis* Taylor et al., 2012**

Mount Mabu horseshoe bat

Bibliographic records: Taylor et al. (2012); Bayliss et al. (2014);

Reported distribution in Mozambique: Nampula; Zambezia.

Rhinolophus maendeleo **Kock, Csorba, Howell, 1999**

Maendeleo horseshoe bat

Other recorded names: Rhinolophus cf. maendeleo;

Bibliographic records: Monadjem et al. (2010);

Reported distribution in Mozambique: Zambezia;

Known distribution (Wilson and Reeder 2005): N.E. Tanzania.

Rhinolophus mossambicus **Taylor et al., 2012**

Rift valley horseshoe bat

Bibliographic records: Taylor et al. (2012);

Reported distribution in Mozambique: Cabo Delgado; Inhambane; Niassa; Sofala. Known distribution (IUCN 2018): Mozambique; Zimbabwe.

Rhinolophus rhodesiae **Roberts, 1946**

Roberts' horseshoe bat

Bibliographic records: Taylor et al. (2018).

Rhinolophus simulator **K.Andersen, 1904**

Bushveld horseshoe bat

Museum records: NMZB: NMZB-MAM-0064257, NMZB-MAM-0064258; USNM: 365193, 365198, 365199, 365200, 365201;

Bibliographic records: Smithers and Tello (1976); Monadjem et al. (2010);

Reported distribution in Mozambique: Manica; Niassa; Sofala; Tete;

Known distribution (Wilson and Reeder 2005): South Africa to S. Sudan and Ethiopia; Cameroon; Liberia; Nigeria; Guinea.

Rhinolophus swinnyi **Gough, 1908**

Swinny's horseshoe bat

Other recorded names: Rhinolophus cf. swinnyi;

Museum records: NMZB: NMZB-MAM-0020079, NMZB-MAM-0020102, NMZB-MAM-0020105, NMZB-MAM-0020108, NMZB-MAM-0020109, NMZB-MAM-0020181, NMZB-MAM-0020182; USNM: 365202;

Bibliographic records: Smithers and Tello (1976); Bayliss et al. (2010); Monadjem et al. (2010);

Reported distribution in Mozambique: Inhambane; Manica; Nampula; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): South Africa, Zimbabwe, Mozambique, Malawi, Zambia, S. Dem. Rep. Congo, Tanzania, Zanzibar.

Vespertilionidae

***Neoromicia capensis* A.Smith, 1829**

Cape serotine

Other recorded names: Eptesicus capensis;

Museum records: USNM: 365410;

Bibliographic records: Smithers and Tello (1976); Monadjem et al. (2010);

Reported distribution in Mozambique: Gaza; Manica; Maputo; Sofala;

Known distribution (Wilson and Reeder 2005): Guinea-Bissau to Ethiopia, south to South Africa.

***Eptesicus hottentotus* (A.Smith, 1833)**

Long-tailed serotine

Other recorded names: Eptesicus hottentotus bensoni;

Museum records: USNM: 365430, 365431, 365432, 365433, 365434;

Bibliographic records: Smithers and Tello (1976); Timberlake et al. (2009); Monadjem et al. (2010);

Reported distribution in Mozambique: Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): South Africa to Angola and Kenya.

***Neoromicia melckorum* Roberts, 1919**

Melck's house bat

Other recorded names: Eptesicus melckorum;

Museum records: USNM: 365408, 365409;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Manica;

Known distribution (Wilson and Reeder 2005): SW South Africa, Zimbabwe, Zambia, Mozambique, Kenya, Tanzania.

***Neoromicia rendalli* Thomas, 1889**

Rendall's serotine

Other recorded names: Eptesicus rendalli;

Bibliographic records: Smithers and Tello (1976); Monadjem et al. (2010);

Reported distribution in Mozambique: Maputo; Nampula; Tete;

Known distribution (Wilson and Reeder 2005): Senegal, Mali, and Gambia to Somalia, south to Botswana, Malawi, Mozambique South Africa,

***Neoromicia zuluensis* Roberts, 1924**

Zulu serotine

Bibliographic records: Monadjem et al. (2010);

Reported distribution in Mozambique: Niassa; Sofala;

Known distribution (Wilson and Reeder 2005): Namibia, Botswana, Zambia, Natal, Malawi, N South Africa; also known from Kenya, Ethiopia, and Sudan.

***Glauconycteris variegata* (Tomes, 1861)**

Variegated butterfly bat

Other recorded names: Glauconycteris variegata variegata; **Museum records:** USNM;

Bibliographic records: Smithers and Tello (1976); Monadjem et al. (2010);

Reported distribution in Mozambique: Gaza; Inhambane; Maputo; Sofala;

Known distribution (Wilson and Reeder 2005): Senegal to Somalia, south to South Africa.

***Kerivoula argentata* Tomes, 1861**

Damara woolly bat

Other recorded names: Kerivoula argentata nidicula;

Bibliographic records: Smithers and Tello (1976); Monadjem et al. (2010);

Reported distribution in Mozambique: Inhambane; Manica; Maputo; Zambezia;

Known distribution (Wilson and Reeder 2005): Uganda and S. Kenya to Malawi, Angola, Namibia and KwaZulu-Natal (South Africa).

***Kerivoula lanosa* (A.Smith, 1847)**

Lesser woolly bat

Other recorded names: Kerivoula harrisoni lucia;

Bibliographic records: Smithers and Tello (1976); Monadjem et al. (2010);

Reported distribution in Mozambique: Inhambane; Manica;

Known distribution (Wilson and Reeder 2005): Guinea and Liberia to Ethiopia, south to South Africa.

***Kerivoula phalaena* Thomas, 1912**

Spurrell's woolly bat

Other recorded names: Kerivoula cf. phalaena; Kerivoula Phalaena;

Bibliographic records: Monadjem et al. (2010); Bayliss et al. (2014);

Reported distribution in Mozambique: Zambezia;

Known distribution (Wilson and Reeder 2005): Liberia, Ghana, Cameroon, Republic of Congo, Dem. Rep. Congo.

***Laephotis botswanae* Setzer, 1971**

Botswanan long-eared bat

Museum records: MHNG: MAM-1971.009;

Bibliographic records: Monadjem et al. (2010); Bayliss et al. (2014);

Reported distribution in Mozambique: Zambezia;

Known distribution (Wilson and Reeder 2005): Dem. Rep. Congo, Zambia, Malawi, Botswana, Zimbabwe, N.E. South Africa.

***Miniopterus fraterculus* Thomas and Schwann, 1906**

Lesser long-fingered bat

Other recorded names: Miniopterus cf. fraterculus; Miniopterus Fraterculus;

Museum records: AMNH: M-216222, M-216223, M-216224, M-216225, M-216226, M-216227, M-216228, M-216229, M-216230; MHNG: MAM-1971.014, MAM-1971.015, MAM-1971.018; TTU: 8296, 8297; USNM: 365456;

Bibliographic records: Smithers and Tello (1976); Timberlake et al. (2009); Monadjem et al. (2010); Bayliss et al. (2014);

Reported distribution in Mozambique: Inhambane; Sofala; Zambezia;

Known distribution (Wilson and Reeder 2005): South Africa, Malawi, Zambia, Angola, Mozambique, Madagascar.

***Miniopterus inflatus* Thomas, 1903**

Greater long-fingered bat

Other recorded names: Miniopterus africanus; Miniopterus inflatus rufus;

Museum records: MHNG: MAM-1971.019, MAM-1971.020, MAM-1971.021; FMNH: 177152, 177153, 177154, 177155, 177156, 177157, 177158, 177159, 177160, 177161, 177162, 177163, 177164, 177165, 177166, 177167, 177168, 177169, 177170, 177171, 177172, 177173, 177174, 177219;

Bibliographic records: Smithers and Tello (1976); Timberlake et al. (2007); Timberlake et al. (2009); Monadjem et al. (2010);

Reported distribution in Mozambique: Manica; Sofala; Zambezia;

Known distribution (Wilson and Reeder 2005): Kenya, Uganda, Burundi, E. and S. Dem. Rep. Congo, Cameroon, Gabon, Mozambique, Liberia, perhaps Nigeria.

***Miniopterus mossambicus* Monadjem, Goodman, Stanley and Appleton, 2013**

Mozambique long-fingered bat

Other recorded names: Miniopterus mossambicus;

Bibliographic records: Monadjem et al. (2013);

Reported distribution in Mozambique: Nampula; Zambezia.

***Miniopterus natalensis* (A.Smith, 1833)**

Natal long-fingered bat

Other recorded names: Miniopterus inflatus/natalensis; Miniopterus natalensis natalensis;

Miniopterus schreibersi; Miniopterus schreibersii; Miniopterus schreibersi natalensis;

Museum records: MHNG: MAM-1971.024; NHMUK: 1968.1014, 1968.1015, 1968.1016, 1968.1017, 1968.1018, 1968.1019, 1968.1020, 1968.1021, 1968.1022, 1968.1023, 1968.1033, 1968.1034, 1968.1035, 1968.1036, 1968.1037, 1968.1038, 1968.1039, 1968.1040, 1968.1041; USNM: 352116, 365439, 365440, 365441, 365442, 365443, 365444, 365445, 365446, 365447, 365448, 365449, 365450, 365451, 365452, 365453, 365454, 365455, 365673, 365674, 365675, 365676, 365677, 365678, 365679, 365680, 365681, 367555, 367556, 367557, 367558, 367559, 367560, 367561, 367562, 367563, 367564, 367565, 367566, 367567, 367568, 367569, 367570, 367571;

Bibliographic records: Smithers and Tello (1976); Monadjem et al. (2010); Bayliss et al. (2014);

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Maputo; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Sudan and S.W. Arabia to South Africa.

***Myotis bocagii* (Peters, 1870)**

Rufous myotis

Other recorded names: Myotis bocagei bocagei;

Museum records: MHNG: MAM-1971.027, MAM-1971.028; USNM:;

Bibliographic records: Smithers and Tello (1976); Timberlake et al. (2009); Monadjem et al. (2010);

Reported distribution in Mozambique: Manica; Niassa; Sofala; Zambezia;

Known distribution (Wilson and Reeder 2005): Senegal and Liberia to S. Yemen, south to Angola, Zambia, Malawi, and N.E. South Africa.

***Myotis tricolor* (Temminck, 1832)**

Temminck's myotis

Other recorded names: Myotis ricolor;

Museum records: MHNG: MAM-1971.030;

Bibliographic records: Smithers and Tello (1976); Timberlake et al. (2007); Timberlake et al. (2009); Monadjem et al. (2010); Bayliss et al. (2014);

Reported distribution in Mozambique: Manica; Zambezia;

Known distribution (Wilson and Reeder 2005): Liberia, Ethiopia and Dem. Rep. Congo, south to South Africa.

***Myotis welwitschii* (Gray, 1866)**

Welwitsch's myotis

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Gaza; Manica;

Known distribution (Wilson and Reeder 2005): South Africa, Mozambique, Zimbabwe, Angola, Zambia, Dem. Rep. Congo, Tanzania, Kenya, Uganda, Ethiopia.

***Nycticeinops schlieffenii* (Peters, 1859)**

Schlieffen's twilight bat

Other recorded names: Nycticeinops schlieffeni; Nycticeius schlieffeni australis;

Museum records: USNM: 365402, 365403, 365404, 365405, 365406, 365407,;

Bibliographic records: Smithers and Tello (1976); Monadjem et al. (2010);

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Maputo; Maputo City; Niassa; Sofala; Tete;

Known distribution (Wilson and Reeder 2005): Saudi Arabia, Yemen, and Egypt to Djibouti, Somalia, Mozambique, Mali, Botswana, South Africa, and Namibia; Mauritania and Ghana to Sudan and Tanzania.

***Pipistrellus hesperidus* Temmink, 1840**

Dusky pipistrelle

Other recorded names: Pipistrellus kuhli subtilis;

Museum records: MHNG: MAM-1971.048;

Bibliographic records: Smithers and Tello (1976); Timberlake et al. (2009); Monadjem et al. (2010);

Reported distribution in Mozambique: Gaza; Manica; Maputo; Zambezia;

Known distribution (Wilson and Reeder 2005): Cape Verde islands, Canary islands, Liberia, Chad, Bioko (Equatorial Guinea), Nigeria, Cameroon, Dem. Rep. Congo, Ethiopia, Eritrea, Kenya, Uganda, Rwanda, Burundi, Tanzania, Malawi, Zambia, Mozambique, Zimbabwe, Botswana, South Africa, Madagascar.

Neoromicia nana **(Peters, 1852)**

Tiny pipistrelle

Other recorded names: Neoromicia africanus; Neoromicia nanus; Pipistrellus africanus; Pipistrellus nanus;

Museum records: ROM: 51073, 51074, 51075, 51078, 51079, 51080, 51100, 68785, 68786, 68787, 68788, 68789; MHNG: MAM-1971.038; NMZB: NMZB-MAM-0064000, NMZB-MAM-0064004, NMZB-MAM-0064005, NMZB-MAM-0064006, NMZB-MAM-0064007, NMZB-MAM-0064008, NMZB-MAM-0064009, NMZB-MAM-0064010, NMZB-MAM-0064011, NMZB-MAM-0064012, NMZB-MAM-0064013, NMZB-MAM-0064014, NMZB-MAM-0064015, NMZB-MAM-0064016, NMZB-MAM-0064017, NMZB-MAM-0064018, NMZB-MAM-0064019; NHMW: 19644; IICT: CZ000000042, CZ000000048, CZ000000053, CZ000000068, CZ000000069, CZ000000070, CZ000000081, CZ000000086, CZ000000118; NHMUK: 1907.1.1.421, 1907.1.1.422, 1928.1.24.1, 1929.1.24.2, 1973493; MNHN: 1911-2293, 1911-2293 A, 1911-2293 B, 1911-2293 C; FMNH: 177139, 177140, 177141, 177142, 177143, 177144, 177145, 177146, 177147, 177148, 177149, 177150, 177151, 177216, 177217, 177218, 214723, 214724, 214725, 214877; USNM: 352049, 352050, 352051, 352052, 352053, 352054, 352055, 352056, 352057, 352058, 352059, 352060, 352061, 352062, 352063, 352064, 352065, 352066, 352067, 352068, 352069, 352070, 352071, 352072, 352073, 352074, 352075, 352076, 352077, 352078, 352079, 352080, 352081, 352082, 352083, 352084, 352085, 352086, 352087, 352088, 352089, 352090, 352091, 352092, 352093, 352094, 352095, 352096, 352097, 352098, 352099, 352100, 352101, 352102, 352103, 352104, 352105, 352106, 352107, 352108, 352109, 352110, 352111, 352112, 352113, 352114, 352115, 365321, 365322, 365323, 365324, 365325, 365326, 365327, 365328, 365329, 365330, 365331, 365332, 365333, 365334, 365335, 365336, 365337, 365338, 365339, 365340, 365341, 365342, 365343, 365344, 365345, 365346, 365347, 365348, 365349, 365350, 365351, 365352, 365353, 365354, 365355, 365356, 365357, 365358, 365359, 365360, 365361, 365362, 365363, 365364, 365365, 365366, 365367, 365368, 365369, 365370, 365371, 365372, 365373, 365374, 365375, 365376, 365377, 365378, 365379, 365380, 365381, 365382, 365383, 365384, 365385, 365386, 365387, 365388, 365389, 365390, 365391, 365392, 365393, 365394, 365395, 365396, 365397, 365398, 365399, 365400, 365401;

Bibliographic records: Smithers and Tello (1976); Timberlake et al. (2009); Monadjem et al. (2010);

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Maputo; Maputo City; Nampula; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Sierra Leone and Côte d'Ivoire to Kenya; Bioko (Equatorial Guinea).

***Pipistrellus rusticus* (Tomes, 1861)**

Rusty pipistrelle

Bibliographic records: Timberlake et al. (2009);

Reported distribution in Mozambique: Zambezia;

Known distribution (Wilson and Reeder 2005): Senegal, Gambia, Burkina Faso, Ghana, Nigeria, Central African Republic, and Ethiopia, south to Kenya, Tanzania, Malawi, Zambia, South Africa.

***Scotoecus albigula* Thomas, 1909**

Light-winged lesser house bat

Other recorded names: Scotoecus hindei/albigula;

Bibliographic records: Monadjem et al. (2010);

Reported distribution in Mozambique: Manica; Maputo; Nampula; Sofala;

Known distribution (Wilson and Reeder 2005): Senegal and Gambia to Kenya, Tanzania, Mozambique, Malawi, KwaZulu-Natal, South Africa.

***Scotophilus dinganii* (A.Smith, 1833)**

Yellow-bellied house bat

Other recorded names: Scotophilus dingaanii; Scotophilus nigrita dingani;

Museum records: NHMUK: 1906.11.8.14, 1906.11.8.16, 1906.11.8.17, 1907.6.2.15, 1908.1.1.28, 1908.1.1.29, 1908.1.1.30, 1908.1.1.31, 1908.1.1.32, 1908.4.3.25, 1908.1.1.27; NMZB: NMZB-MAM-0006959, NMZB-MAM-0064171; USNM: 352048, 365435;

Bibliographic records: Smithers and Tello (1976); Timberlake et al. (2009); Monadjem et al. (2010);

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Maputo; Maputo City; Nampula; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Senegal, Guinea-Bissau, and Sierra Leone

east to Somalia, Djibouti, and S. Yemen, and south to South Africa and Namibia.

Scotophilus leucogaster **Cretzschmar, 1830**

White-bellied house bat

Bibliographic records: Monadjem et al. (2010);

Reported distribution in Mozambique: Gaza;

Known distribution (Wilson and Reeder 2005): Mauritania, Senegal, and Gambia to N. Kenya and Ethiopia.

Scotophilus nigrita **(Schreber, 1774)**

Giant house bat

Other recorded names: Scotophilus gigas; Scotophilus nigrita alvenslebeni;

Museum records: NHMUK: 1907.6.2.16, 1907.6.2.17; KU: 105222;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Manica;

Known distribution (Wilson and Reeder 2005): Senegal to Sudan, E. Dem. Rep. Congo, Kenya, Zimbabwe, Malawi and Mozambique.

Scotophilus viridis **(Peters, 1852)**

Green house bat

Other recorded names: Scotophilus borbonicus; Scotophilus cf. viridis;

Museum records: ROM: 51087, 51089; ZMB: 135887; MHNG: MAM-816.095; NMZB: NMZB-MAM-0063217; NHMUK: 1849.8.16.26, 1908.4.3.26, 1908.4.3.27, 1908.4.3.28, 1908.4.3.29; USNM: 365411, 365412, 365413, 365414, 365415, 365416, 365417, 365418, 365419, 365420, 365421, 365422, 365423, 365424, 365425, 365426, 365427, 365428, 365429, 365436, 365437, 365438;

Bibliographic records: Smithers and Tello (1976); Monadjem et al. (2010);

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Maputo; Maputo City; Nampula; Niassa; Sofala; Tete;

Known distribution (Wilson and Reeder 2005): Senegal to Ethiopia south to Namibia and South Africa.

B.1.5 Eulipotyphla

Soricidae

***Crocidura cyanea* (Duvernoy, 1838)**

Reddish-gray musk shrew

Other recorded names: Crocidura cyanea infumata;

Museum records: USNM: 365110;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Gaza; Manica; Maputo; Sofala; Tete;

Known distribution (Wilson and Reeder 2005): South Africa, Namibia, Angola, Botswana, Mozambique, Zimbabwe.

***Crocidura fuscomurina* (Heuglin, 1865)**

Bicolored musk shrew

Other recorded names: Crocidura bicolor bicolor;

Museum records: USNM: 365074, 367268;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Gaza; Inhambane; Maputo; Sofala; Tete;

Known distribution (Wilson and Reeder 2005): Sudan and Guinea savanna from Senegal to Ethiopia, and south to South Africa.

***Crocidura hirta* Peters, 1852** Lesser red musk shrew

Other recorded names: Crocidura hirta hirta; Crocidura sericea;

Museum records: AMNH: M-252533, M-252534, M-252535, M-252536, M-252537, M-252538, M-252539, M-252540, M-252541, M-252542; NRM: 581803; ZMB: 669, 670, 671, 672, 673, 674, 137654, 137655, 137656, 137657, 137658, 137664, 137665; NMZB: NMZB-MAM-0003598, NMZB-MAM-0003599, NMZB-MAM-0003601, NMZB-MAM-0003602, NMZB-MAM-0003603, NMZB-MAM-0018362, NMZB-MAM-0028287, NMZB-MAM-0028288, NMZB-MAM-0028289, NMZB-MAM-0028290, NMZB-MAM-0028291, NMZB-MAM-0028292, NMZB-MAM-0082824, NMZB-MAM-0082825, NMZB-MAM-0082826, NMZB-MAM-0082827, NMZB-MAM-0082828, NMZB-MAM-0082829, NMZB-MAM-0082830, NMZB-MAM-0082831, NMZB-MAM-0082832, NMZB-MAM-0082835; NHMUK: 1906.11.8.40, 1906.11.8.41, 1907.1.11.13, 1907.1.11.14, 1907.1.11.15, 1907.6.2.25, 1907.6.2.26, 1907.6.2.27, 1908.1.1.45, 1922.7.17.111;

MNHN: MO-1983-86; MCZ: 44088; USNM: 351963, 351964, 351965, 351966, 351967, 351968, 351969, 351970, 351971, 351972, 351973, 352948, 365076, 365079, 365081, 365082, 365083, 365084, 365085, 365086, 365087, 365088, 365089, 365090, 365091, 365092, 365093, 365094, 365095, 365096, 365097, 365098, 365099, 365100, 365101, 365102; BRTC: TCWC:20880;

Bibliographic records: Smithers and Tello (1976); Gliwicz (1985); Schneider (2004); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Maputo City; Nampula; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Angola, Dem. Rep. Congo, Uganda, Kenya, Somalia, Tanzania, Malawi, Zimbabwe, Zambia, Mozambique, Botswana, Namibia, South Africa.

***Crocidura luna* Dollman, 1910**

Moonshine shrew

Museum records: FMNH: 177083, 177084, 177085, 177086, 177087, 177197, 177198, 177199, 177200, 177201, 177202, 177203, 177204, 177205, 214579, 214580, 214581, 214582, 214583, 214584, 214585, 214586, 214587, 214588, 214589, 214590, 214591, 214592, 214593, 214594, 214595, 214596, 214597, 214598, 214599, 214600, 214601, 214831, 214832, 214833; USNM: 365103, 365104, 365105, 365106, 365107, 365108, 365109, 365111, 365112, 365114, 365115, 365116, 365117, 365118, 365119, 365120;

Bibliographic records: Smithers and Tello (1976); Timberlake et al. (2009); Bayliss et al. (2014);

Reported distribution in Mozambique: Manica; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Mozambique, Zambia, Zimbabwe, E. Angola, Dem. Rep. Congo, Malawi, Tanzania, Kenya, Uganda, Rwanda.

***Crocidura mariquensis* (A.Smith, 1844)**

Swamp musk shrew

Other recorded names: Crocidura mariquensis mariquensis;

Museum records: NHMUK: 1906.11.8.42; USNM: 351976,;

Bibliographic records: Smithers and Tello (1976); Timberlake et al. (2009);

Reported distribution in Mozambique: Inhambane; Maputo; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Swamps and forest from South Africa to Mozambique, W. Zimbabwe and Zambia; N.W. Botswana and N.E. Namibia to S.C. Angola; perhaps S.E. Dem. Rep. Congo.

***Crocidura olivieri* (Lesson, 1827)**

African giant shrew

Other recorded names: Crocidura flavescens;

Museum records: FMNH: 177206, 177207, 214602, 214603, 214604, 214605, 214606, 214607, 214608, 214609, 214610, 214834, 214835; USNM: 365071, 365072, 365073;

Bibliographic records: Smithers and Tello (1976); Bayliss et al. (2014);

Reported distribution in Mozambique: Manica; Sofala; Zambezia;

Known distribution (Wilson and Reeder 2005): Egypt; Mauritania to Ethiopia, and southwards to N. South Africa.

***Crocidura silacea* Thomas, 1895**

Lesser gray-brown musk shrew

Other recorded names: Crocidura sp. cf. silacea;

Museum records: MHNG: MAM-816.096; FMNH: 214611, 214612, 214613, 214614, 214615, 214616, 214617, 214618, 214619, 214620, 214621, 214622, 214836, 214837, 214838, 214839; USNM: 351974, 351975, 365075, 365078, 365080;

Bibliographic records: Downs and Wirminghaus (1997); Timberlake et al. (2009); Bayliss et al. (2014);

Reported distribution in Mozambique: Gaza; Inhambane; Maputo; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Occurs in most of South Africa, and parts of Botswana, Angola; Mozambique, Zambia and S. Malawi.

***Myosorex meesteri* Taylor et al. 2013**

Meester's forest shrew

Other recorded names: Myosorex cafer;

Bibliographic records: Smithers and Tello (1976); Taylor et al. (2013);

Reported distribution in Mozambique: Manica; Sofala; Tete.

Suncus megalura **Jentink, 1888**

Climbing shrew

Other recorded names: Suncus megalura sorella;

Museum records: FMNH: 214691;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Manica; Sofala; Tete;

Known distribution (Wilson and Reeder 2005): Tropical forest and Guinea savanna zone of Africa from Upper Guinea to Ethiopia and south to Mozambique and Zimbabwe.

B.1.6 Hyracoidea

Procaviidae

Dendrohyrax arboreus **(A.Smith, 1827)**

Southern tree hyrax.

Other recorded names: Dendrohyrax arboreus arboreus;

Museum records: ZMB: 1984; NMZB: NMZB-MAM-0068820; MNHN: 1897-654;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Inhambane; Manica; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Western Cape Prov., Eastern Cape Prov., and KwaZulu-Natal (South Africa); Mozambique; Zambia; Malawi; Dem. Rep. Congo; Tanzania to Kenya and Sudan.

Heterohyrax brucei **(Gray, 1868)**

Yellow-spotted rock hyrax.

Other recorded names: Heterohyrax brucei mossabicus; Heterohyrax brucei ruddi; Hyrax mossambicus;

Museum records: ZMB: 3613; MNHN: 1897-655, 1902-534, 1902-535, 1902-757, 1902-758, 1902-760 bis, MO-1902-760; FMNH: 177240; USNM: 367398;

Bibliographic records: Smithers and Tello (1976); Timberlake et al. (2009); Bayliss et al. (2010); Bayliss et al. (2014);

Reported distribution in Mozambique: Gaza; Manica; Nampula; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Egypt to Somalia to southern Africa to WC Angola, with pockets' in C. Sahara.

Procavia capensis **(Pallas, 1766)**

Rock hyrax

Other recorded names: Procavia capensis johnstoni; Procavia rupestris;

Museum records: NMZB: NMZB-MAM-0068684, NMZB-MAM-0068701, NMZB-MAM-0068702, NMZB-MAM-0068703, NMZB-MAM-0068704, NMZB-MAM-0068705, NMZB-MAM-0068736; ROM: 8608040006; USNM: 61745, 61746, 61747, 61748, 61750, 367399;

Bibliographic records: Smithers and Tello (1976); Spassov and Roche (1988); Schneider (2004); Mesochina, Langa and Chardonnet (2008); Dowsett-Lemaire and Dowsett (2009); GRNB (2010); Bayliss et al. (2014);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Manica; Maputo City; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Sub-Saharan and N.E. Africa (a line from Senegal through S. Algeria and Libya, Egypt to southern most tip of Africa), portion of the Levant (Syria, Lebanon, Turkey, Israel), and the Arabian Peninsula (Saudi Arabia, Yemen); isolated mountains in Algeria and Libya.

B.1.7 Lagomorpha

Leporidae

Lepus capensis **Linnaeus, 1758**

Cape hare

Other recorded names: Lepus capensis aquilo;

Museum records: NHMUK: 1906.11.8.132; IICT: CZ000000863, CZ000000864, CZ000000865, CZ000000877, CZ000000885, CZ000000886, CZ000000887, CZ000000889, CZ000000891, CZ000000893, CZ000000895, CZ000000901, CZ000000903, CZ000000905, CZ000000908, CZ000000918, CZ000000924, CZ000000925, CZ000001342, CZ000001344, CZ000001354, CZ000001355, CZ000001362, CZ000001388, CZ000001389, CZ000001390, CZ000001399, CZ000001409, CZ000001413;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Maputo; Maputo City; Niassa; Sofala; Zambezia;

Known distribution (Wilson and Reeder 2005): As construed in the past, a single species (capensis sensu lato) inhabits Africa and the Near East in two separate, non-forested areas: South Africa, Namibia, Botswana, Zimbabwe, S. Angola, S. Zambia (?), Mozambique; and to the north, Tanzania, Kenya, Somalia, Ethiopia, countries of the Sahel and Sahara, and N. Africa; thence eastward through the Sinai to the Arabian Peninsula, Jordan, S. Syria, S. Israel and W. and S. Iraq, west of the Euphrates River.

***Lepus victoriae* Thomas, 1893**

Savanna hare

Other recorded names: Lepus microtis; Lepus saxatilis; Lepus ?whytei; Lepus whytei;

Museum records: ZMB: 81541, 81542, 81543, 81559; USNM: 352272, 352273, 352274, 352275, 352276, 352277, 352278, 352279, 352280, 352281, 352282, 352283, 352284, 365745, 365746, 365747, 365748, 365749, 365750, 365751, 365752, 365753, 365754, 365755, 365756, 365757, 365758, 365759, 365760, 365761, 365762, 365763, 365764, 365765, 365766, 365767, 365768, 365769, 365770, 365771, 365772, 365773, 365774, 365775, 365776, 365777, 365778, 365779, 365780, 365781, 365782, 365783, 365784, 365785, 365786, 365787, 365788; NMZB: NMZB-MAM-0067468, NMZB-MAM-0067469, NMZB-MAM-0067470, NMZB-MAM-0067471, NMZB-MAM-0067473, NMZB-MAM-0067474, NMZB-MAM-0067475, NMZB-MAM-0067476, NMZB-MAM-0067477, NMZB-MAM-0067479, NMZB-MAM-0067480, NMZB-MAM-0067481, NMZB-MAM-0067482, NMZB-MAM-0067483, NMZB-MAM-0067484; MCZ: 22978, 22979, 22980, 44123, 44124, 44125, 44126; IICT: CZ000001236;

Bibliographic records: Smithers and Tello (1976); Mesochina, Langa and Chardonnet (2008); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Maputo City; Nampula; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): From Atlantic coast of NW Africa (Senegal, south to Guinea and Sierra Leone) eastward across Sahel to Sudan and extreme W. Ethiopia; southward through E. Africa (E. Republic of Congo, W. Kenya) to NE. Namibia, Botswana, and KwaZulu-Natal (South Africa). Small isolated population in W. Algeria.

***Pronolagus crassicaudatus* (I.Geoffroy, 1832)**

Natal red rock hare

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Manica; Maputo; Zambezia;

Known distribution (Wilson and Reeder 2005): S.E. South Africa; extreme S. Mozambique.

***Pronolagus rupestris* (A.Smith, 1834)**

Smith's red rock hare

Other recorded names: Pronolagus rupestris nyikae;

Museum records: FMNH: 177246;

Bibliographic records: Timberlake et al. (2009); Bayliss et al. (2010); Bayliss et al. (2014);

Reported distribution in Mozambique: Nampula; Zambezia;

Known distribution (Wilson and Reeder 2005): Two disjunct areas: S. and C. South Africa, S. Namibia; and E. Africa, from N. Malawi and E. Zambia north through C. Tanzania to S.W. Kenya.

B.1.8 Macroscelidea

Macroscelididae

***Elephantulus brachyrhynchus* (A.Smith, 1836)**

Short-snouted elephant shrew

Other recorded names: Elephantulus brachyrhynchus langi;

Museum records: ZMB: 642, 643, 2791, 80085, 80086, 84903, 84913; NHMUK: 1973.1795, 1975628; USNM: 351959, 351960, 351961, 365002, 365003, 365004, 365005, 365006, 365007, 365008, 365009, 365010, 365011, 365012, 365013, 365014, 365015, 365016, 365017, 365018, 365019, 365020, 365021, 365022, 365023, 365024, 365025, 365026, 365027; IICT: CZ000001707, CZ000001708, CZ000001709;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Maputo; Maputo City; Sofala; Tete;

Known distribution (Wilson and Reeder 2005): N. South Africa; N.E. Namibia; E. and N. Botswana; Angola; Zimbabwe; Malawi; Zambia; S. Dem. Rep. Congo; Mozambique; Tanzania; Kenya and Uganda.

***Elephantulus fuscus* (Peters, 1852)**

Dusky elephant shrew

Other recorded names: Macroscelides fusius;

Museum records: ZMB: 644; MCZ: 43753, 43754, 43755, 43756, 43757, 43758, 43759, 43760, 44086, 44254;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Mozambique; S. Malawi; S.E. Zambia.

***Elephantulus myurus* Thomas and Schwann, 1906**

Eastern rock elephant shrew

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Gaza; Manica; Maputo; Tete;

Known distribution (Wilson and Reeder 2005): Zimbabwe; E. Botswana; N., C. and E. South Africa; Lesotho; W. Mozambique.

***Petrodromus tetradactylus* Peters, 1846**

Four-toed elephant shrew

Other recorded names: Petrodomus tetradactylus; Petrodromus rovumae; Petrodromus schwanni; Petrodromus tetradactylus beirae; Petrodromus tetradactylus tetradactylus; Petrodromus tetradctylus;

Museum records: AMNH: M-208663, M-245104, M-245105, M-245106, M-245107; ROM: 8608240004; ZMB: 647, 648, 32044, 86193, 86194, 86195, 000 ?, 30358/ 646; CAS: 29341, 29342, 29343, 29346, 29347, 29350, 29354; RMNH: RMNH-MAM-39312.a, RMNH-MAM-39312.b; NHMUK: 1906.11.8.32, 1990.0594; FMNH: 177247, 177248, 177249, 177250; USNM: 351962, 365028, 365029, 365030, 365031, 365032, 365033, 365034, 365035, 365036, 365037, 365038, 365039, 365040, 365041, 365042, 365043, 365044, 365045, 365046, 365047, 365048, 365049, 365050, 365051, 365052, 365053, 365054, 365055, 365056, 365057, 365058,

365059, 365060, 365061, 365062, 365063, 365064, 365065, 365066, 365067, 365068, 365069, 365070,; SMF: 11647; MCZ: 46267;

Bibliographic records: Smithers and Tello (1976); Downs and Wirminghaus (1997); Mesochina, Langa and Chardonnet (2008); Dowsett-Lemaire and Dowsett (2009); Timberlake et al. (2009); Bayliss et al. (2014);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Nampula; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Mozambique; Tanzania; S.E. Kenya; S. Uganda; Zambia; Malawi; S.E. Zimbabwe; Dem. Rep. Congo; E. Republic of Congo; N.E. Angola; E. South Africa.

***Rhynchocyon cirnei* Peters, 1847**

Checkered elephant shrew

Other recorded names: Rhynchocyon cirnae; Rhynchocyon cirnei cirnei; Rhynchocyon cirnei macrurus; Rhynchocyon cornei;

Museum records: CAS: 29355; RMNH: RMNH-MAM-39313; NHMUK: 1863.10.12.1, 1934.1.11.6; FMNH: 177193, 177194, 177251, 177252, 177253; ZMB: 637, 86191, 000 ?;

Bibliographic records: Smithers and Tello (1976); Mesochina, Langa and Chardonnet (2008); Dowsett-Lemaire and Dowsett (2009); Timberlake et al. (2009); Coals and Rathbun (2012); Bayliss et al. (2014);

Reported distribution in Mozambique: Cabo Delgado; Nampula; Niassa; Zambezia;

Known distribution (Wilson and Reeder 2005): N. Mozambique; Malawi, S. and S.W. Tanzania, N.E. Zambia, N. and E. Dem. Rep. Congo, Uganda.

B.1.9 Perissodactyla

Equidae

***Equus quagga burchellii* (Gray, 1824)**

Burchell's zebra

Other recorded names: Equus burchelli; Equus burchellii; Equus burchellii crawshayi; Equus burchellii crawshyi; Equus quagga crawshayi;

Museum records: AMNH: M-216357, M-216358; MSU: MR.11621; IICT: CZ000000348, CZ000000355, CZ000000372, CZ000001064; NHMW: ST 783; FMNH: 7227; USNM: 61743,

61744;

Bibliographic records: Smithers and Tello (1976); Whyte and Swanepoel (2006); AGRECO (2008); Dunham (2010); Dunham et al. (2010); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Maputo City; Nampula; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): S. and E. Angola, N. and E. Botswana, S.E. Dem. Rep. Congo, Kenya, N. Namibia, S.E. Sudan, S.W. Ethiopia, Malawi, Mozambique, S. Somalia, South Africa, Swaziland, Tanzania, Uganda, Zambia and Zimbabwe.

Rhinocerotidae

***Ceratotherium simum* (Burchell, 1817)**

White rhinoceros

Bibliographic records: Smithers and Tello (1976); AGRECO (2008);

Reported distribution in Mozambique: Gaza; Maputo; Maputo City; Sofala;

Known distribution (Wilson and Reeder 2005): Formerly north of Equator in S. Chad, Central African Republic, S. Sudan, N.E. Dem. Rep. Congo, and Uganda. Southern Africa in S.E. Angola, Botswana, N.E. Namibia, S. Mozambique, South Africa, Swaziland, Zimbabwe, and possibly also S.W. Zambia. Now much restricted in distribution; in south of range, E. KwaZulu-Natal (South Africa), and reintroduced into other parts of South Africa (KwaZulu-Natal, Limpopo Prov., Mpumalanga, Free State), Namibia, Swaziland, Mozambique, Zimbabwe, and Botswana; introduced into Zambia and Kenya. In north of range, now confined to N.E. Dem. Rep. Congo.

***Diceros bicornis* (Linnaeus, 1758)**

Black rhinoceros

Museum records: ZMB: 83229, 102766, 102771; MUP: 23356;

Bibliographic records: Smithers and Tello (1976); Whyte and Swanepoel (2006); AGRECO (2008);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Manica; Nampula; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Formerly in S. Angola, Botswana, Burundi, N. Cameroon, Central African Republic, S. Dem. Rep. Congo, S. Chad, N. Eritrea,

Ethiopia, Kenya, Malawi, Mozambique, Namibia, S.E. Niger, Nigeria, Rwanda, Somalia, South Africa, Sudan, Swaziland, Tanzania, Uganda, Zambia, and Zimbabwe; possibly more widespread in Niger, extending to Benin and Côte d'Ivoire, within historic times. Very much reduced in numbers, particularly in recent decades of 20th century, and probably now extinct in many countries which it formerly occupied. Survives in reserves in Kenya, Tanzania, Namibia, Zambia, Zimbabwe and KwaZulu-Natal (South Africa), and possibly still in Cameroon, Chad, Central African Republic, Sudan, Rwanda, Malawi, Mozambique, Angola and Botswana; widely reintroduced into parts of South Africa.

B.1.10 Pholidota

Manidae

***Manis temminckii* Smuts, 1832**

Ground pangolin

Other recorded names: Manis temmincki;

Museum records: AMNH: M-42349; IICT: CZ000001554;

Bibliographic records: Smithers and Tello (1976); Spassov (1990); Mesochina, Langa and Chardonnet (2008);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Maputo City; Sofala; Zambezia;

Known distribution (Wilson and Reeder 2005): N. South Africa; N. and E. Namibia; Zimbabwe; Mozambique; Botswana; S. Angola; S. Zambia; S.E. Dem. Rep. Congo; S. Rwanda; Malawi; Tanzania; E. Uganda; W. Kenya; S. Sudan; S. Chad.

B.1.11 Primates

Cercopithecidae

***Cercopithecus mitis* Wolf, 1822**

Sykes' monkey

Other recorded names: Cercopithecus albogularis; Cercopithecus albogularis erythrarchus; Cercopithecus albogularis nyasae; Cercopithecus mitis albogularis; Cercopithecus mitis boutourlinii; Cercopithecus mitis erytharchus; Cercopithecus mitis erythrarchus; Cercopithecus mitis nyasae; Cercopithecus nictitans mitis; Cercopithecus simum; Cercopithecus stairsi

mossambicus;

Museum records: AMNH: M-185468; NMZB: NMZB-MAM-0067979 ?, NMZB-MAM-0067713, NMZB-MAM-0067714, NMZB-MAM-0067880, NMZB-MAM-0067881, NMZB-MAM-0067882; RMNH: RMNH-MAM-39121.a, RMNH-MAM-39121.b; NHMUK: 1893.11.16.1, 1907.6.2.110, 1908.1.1.3, 1908.1.1.4, 1908.1.1.5, 1908.5.7.2, 1934.1.11.3, 1975.1804, 1939352, 1939582, 1939583, 1907.6.2.109 ?; MNHN: MO-1911-2289; FMNH: 177221, 177222, 177223, 177224, 177225; USNM: 365744;

Bibliographic records: Smithers and Tello (1976); Downs and Wirminghaus (1997); Dowsett-Lemaire and Dowsett (2009); Timberlake et al. (2009); Bayliss et al. (2010); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Nampula; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Ethiopia to South Africa, S. and E. Dem. Rep. Congo, NW Angola.

***Chlorocebus pygerythrus* Cuvier, 1821**

Vervet monkey

Other recorded names: Cercopithecus aethiops; Cercopithecus aethiops pygerythrus; Cercopithecus aethiops rufoviridis; Cercopithecus pygerythrus; Cercopithecus pygerythrus pygerythrus; Cercopithecus pygerythrus rufoviridis; Cercopithecus pygerythrus whytei; Chlorocebus aethiops; Chlorocebus pygerythrus rufoviridis;

Museum records: AMNH: M-216252, M-216253, M-216254, M-216255, M-216256, M-216258; ZMB: 60, 87561; NMZB: NMZB-MAM-0004401, NMZB-MAM-0004402, NMZB-MAM-0004405, NMZB-MAM-0004406, NMZB-MAM-0004407, NMZB-MAM-0028819, NMZB-MAM-0067861; IICT: CZ000000310, CZ000000314, CZ000000316, CZ000000321, CZ000000474, CZ000000475, CZ000000476, CZ000000477, CZ000000479; NHMUK: 1884.2.6.1, 1906.11.8.3, 1906.11.8.4, 1907.6.2.2, 1907.6.2.3, 1907.6.2.4, 1907.6.2.5, 1907.6.2.6, 1908.1.1.7, 1908.1.1.8, 1908.1.1.9, 1908.1.1.11, 1908.4.3.1, 1927.2.11.6, 1927.2.11.7, 1934.1.11.4, 1906.11.8.2, 1906.11.8.10 ?, 1907.6.2.109 ?, 1908.1.1.10 ?; USNM: 352265, 352266, 352267, 352268, 352269, 352270, 352271, 365738, 365739, 365740, 365741, 365742, 365743;

Bibliographic records: Smithers and Tello (1976); Schneider (2004); Stalmans (2007); Mesochina, Langa and Chardonnet (2008); Stalmans and Peel (2009); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Maputo City; Nampula; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Ethiopia (east of Rift Valley), Somalia, to Zambia east of the Luangwa, and South Africa.

***Papio cynocephalus* (Linnaeus, 1766)**

Yellow baboon

Other recorded names: Papio cyanocephalus; Papio cynocephalus cynocephalus; Papio ursinus;

Museum records: ZMB: 157, 11607; HSUWM: 2656; EMBL: AB495292; MZNA: 107795;

Bibliographic records: Smithers and Tello (1976); Schneider (2004); AGRECO (2008); Mesochina, Langa and Chardonnet (2008); Dowsett-Lemaire and Dowsett (2009); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Nampula; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Somalia, coastal Kenya, Tanzania to Zambezi River.

***Papio ursinus* (Kerr, 1792)**

Chacma baboon

Other recorded names: Papio ursinus griseipes;

Museum records: AMNH: M-216246, M-216247, M-216248, M-216249, M-216250, M-216251; MNCN: 2119; ZMB: 11608, 11609; IICT: CZ000000340, CZ000000341, CZ000000496, CZ000000498, CZ000000499; NHMUK: 1927.2.11.1, 1927.2.11.3, 1927.2.11.4, 1973.1809, 1908.1.1.10 ?, 1908.1.1.20 ?; USNM: 365736, 365737;

Bibliographic records: Smithers and Tello (1976); Stalmans (2007); AGRECO (2008); Stalmans and Peel (2009); Dunham et al. (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): South of Zambezi River, to S. Angola, S.W. Zambia.

Galagidae

***Paragalago granti* (Thomas and Wroughton, 1907)**

Mozambique dwarf galago

Other recorded names: Galago granti; Galagoides granti; Galagoides zanzibaricus granti; Galago senegalensis granti; Galago zanzibaricus;

Museum records: NHMUK: 1906.11.8.5, 1906.11.8.6, 1906.11.8.7, 1906.11.8.8, 1906.11.8.9, 1907.6.2.7, 1907.6.2.8, 1908.1.1.12, 1908.1.1.13, 1908.1.1.14, 1908.1.1.15, 1908.1.1.16, 1908.1.1.129, 1906.11.8.10 ?; NMZB: NMZB-MAM-0029529, NMZB-MAM-0055557, NMZB-MAM-0055558, NMZB-MAM-0067333, NMZB-MAM-0067340, NMZB-MAM-0067343, NMZB-MAM-0067344, NMZB-MAM-0067345, NMZB-MAM-0067346, NMZB-MAM-0067347, NMZB-MAM-0067348, NMZB-MAM-0067349, NMZB-MAM-0067350, NMZB-MAM-0067351, NMZB-MAM-0067352, NMZB-MAM-0067353, NMZB-MAM-0067354, NMZB-MAM-0067356, NMZB-MAM-0067357, NMZB-MAM-0067358, NMZB-MAM-0067359; USNM: 352253, 352254; FMNH: 177192, 177220; IICT: CZ000000133;

Bibliographic records: Smithers and Tello (1976); Dowsett-Lemaire and Dowsett (2009); Timberlake et al. (2009);

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Maputo City; Sofala; Zambezia;

Known distribution (Wilson and Reeder 2005): Mozambique north to Ulugurus in S. Tanzania.

Galago moholi A.Smith, 1836

Lesser galago

Other recorded names: Galago sanguinea; Galago senegalensis; Galago senegalensis moholi;

Museum records: MNCN: 2095; NMZB: NMZB-MAM-0003488, NMZB-MAM-0003490, NMZB-MAM-0003491, NMZB-MAM-0003492, NMZB-MAM-0003493, NMZB-MAM-0003494, NMZB-MAM-0003495, NMZB-MAM-0003496, NMZB-MAM-0003497, NMZB-MAM-0003498, NMZB-MAM-0003499, NMZB-MAM-0003500, NMZB-MAM-0003501, NMZB-MAM-0067360, NMZB-MAM-0067412, NMZB-MAM-0067428, NMZB-MAM-0084412; IICT: CZ000000144, CZ000000151, CZ000000504, CZ000000505, CZ000000506, CZ000000508; NHMUK: 1907.1.11.3, 1908.4.3.2, 1908.4.3.3, 1908.4.3.4, 1908.4.3.5, 1908.4.3.6, 1908.4.3.7; MCZ: 44131, 44132, 44133; USNM: 365704, 365705; SMF: 11646;

Bibliographic records: Smithers and Tello (1976); Downs and Wirminghaus (1997); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Ma-

puto; Maputo City; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): KwaZulu-Natal and N. Namibia north to Lake Victoria.

Otolemur crassicaudatus (E.Geoffroy, 1812)

Brown greater galago

Other recorded names: Galago crassicaudatus; Galago crassicaudatus crassicaudatus; Galago crassicaudatus llonnbergi; Galago crassicaudatus lonnbergi; Galago craussicaudatus craussicaudatus; Otolemur crassicaudatus crassicaudatus; Otolemur crassicaudatus kirkii;

Museum records: AMNH: M-216239, M-216240, M-216241, M-216242, M-216243, M-216244, M-216245; ZMB: 320, 64229, 64230, 103582; NMZB: NMZB-MAM-0004386, NMZB-MAM-0004387, NMZB-MAM-0004388, NMZB-MAM-0004389, NMZB-MAM-0033567, NMZB-MAM-0055433, NMZB-MAM-0055434, NMZB-MAM-0055435, NMZB-MAM-0055436, NMZB-MAM-0055512, NMZB-MAM-0067410, NMZB-MAM-0067411, NMZB-MAM-0067422, NMZB-MAM-0067423, NMZB-MAM-0067426, NMZB-MAM-0067429, NMZB-MAM-0084410, NMZB-MAM-0084411; IICT: CZ000000130, CZ000000131, CZ000000132, CZ000000134, CZ000000135, CZ000000136, CZ000000137, CZ000000142, CZ000000143, CZ000000145, CZ000000146, CZ000000147, CZ000000148, CZ000000149, CZ000000150, CZ000000152, CZ000000500, CZ000000501, CZ000000507, CZ000000514, CZ000000515, CZ000000516, CZ000000517, CZ000000518, CZ000000519, CZ000000520, CZ000000521, CZ000000522, CZ000000523, CZ000000524, CZ000000525, CZ000000527; NHMUK: 1864.6.4.1, 1903.3.11.1, 1908.1.1.17, 1908.1.1.18, 1908.1.1.19, 1908.1.1.22, 1908.1.1.23, 1908.1.1.24, 1908.1.1.25, 1908.1.1.26, 1908.1.1.132, 1908.3.10.1, 1920.9.1.1, 1920.9.1.2, 1934.1.11.5, 1908.1.1.20 ?; USNM: 352256, 352257, 352258, 352259, 352260, 352261, 352262, 352263, 352264, 365706, 365707, 365708, 365709, 365710, 365711, 365712, 365713, 365714, 365715, 365716, 365717, 365718, 365719, 365720, 365721, 365722, 365723, 365724, 365725, 365726, 365727, 365728, 365729, 365730, 365731, 365732, 365733, 365734, 365735;

Bibliographic records: Smithers and Tello (1976); Schneider (2004); Dowsett-Lemaire and Dowsett (2009);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Maputo City; Nampula; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Kenya, Tanzania and Rwanda to KwaZulu-Natal (South Africa) and Angola.

***Otolemur garnettii* (Ogilby, 1836)**

Northern greater galago

Other recorded names: Galago crassicaudatus garnettii; Otolemur garnettii garnettii;

Museum records: ZMB: 64281, 64282, 64283; USNM: 352255; IICT: CZ000000502;

Reported distribution in Mozambique: Maputo; Maputo City; **Known distribution (Wilson and Reeder 2005):** S. Somalia to S.E. Tanzania (including Zanzibar, Pemba and Mafia Islands) and perhaps N. Mozambique.

B.1.12 Proboscidea

Elephantidae

***Loxodonta africana* (Blumenbach, 1797)**

African bush elephant

Other recorded names: Loxodonta africana africana; Loxodonta cyclotis;

Museum records: AMNH: M-90304, M-216356, M-216397; MUP: 23352, 23354; MHNG: MAM-1923.037; IICT: CZ000001538, CZ000001555, CZ000001557, CZ000001560; NHMUK: 1875.3.22.1, 1983108; USNM: 397726;

Bibliographic records: Smithers and Tello (1976); Dunham (2004); Schneider (2004); Matthews and Nemane (2006); Whyte and Swanepoel (2006); AGRECO (2008); Mesochina, Langa and Chardonnet (2008); Stalmans and Peel (2009); Dunham (2010); Dunham et al. (2010); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Maputo City; Nampula; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Sub-Saharan, except C. and W. coast of Africa, including 30 countries from Senegal in the west to Somalia in the east.

B.1.13 Rodentia

Anomaluridae

***Anomalurus derbianus* (Gray, 1842)**

Lord Derby's scaly-tailed squirrel

Other recorded names: Anomalurus derbianus cinereus;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Zambezia;

Known distribution (Wilson and Reeder 2005): Sierra Leone, Cte d'Iroire, Ghana, Togo, Nigeria, Cameroon, Equatorial Guinea, Gabon, Angola, Dem. Rep. Congo, Uganda, Kenya, Tanzania, Zambia, N. Malawi, Mozambique.

Bathyergidae

***Cryptomys darlingi* Thomas, 1895**

Darling's mole-rat

Other recorded names: Cryptomys hottentotus; Cryptomys hottentotus darlingi;

Museum records: NHMUK: 1907.6.2.98; MNHN: 1926-181, 1926-182; USNM: 367229, 367230, 367231, 367232, 367233, 367234, 367235, 367236, 367237, 367238, 367239, 367240, 367241, 367242, 367243, 367244, 367245, 367246, 367247, 367248, 367249, 367250, 367251, 367252, 367253, 367254, 367255, 367256, 367257, 367258, 367259, 367260, 367261, 367262, 367263;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Sofala; **Known distribution (Wilson and Reeder 2005):** E. Zimbabwe and W. Mozambique.

***Cryptomys hottentotus* (Lesson, 1826)**

Southern African mole-rat

Other recorded names: Cryptomys hottentotus natalensis;

Museum records: SMF: 11641, 11642, 11643, 11644; FMNH: 214827, 214828, 214829, 214830, 214914, 214915, 214916;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Maputo; Sofala;

Known distribution (Wilson and Reeder 2005): South Africa to Tanzania, S. Dem. Rep. Congo and Namibia.

***Heliophobius argenteocinereus* Peters, 1846**

Silvery mole-rat

Other recorded names: Heliophobius argentocinereus argentocinereus; Heliophobus argenteocinereus;

Museum records: ZMB: 1859, 85454, 86308, 000 ?; RMNH: RMNH-MAM-26672.a, RMNH-MAM-26672.b; FMNH: 183861; USNM: 367264, 367265, 367266, 367267;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Nampula; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Zimbabwe, E. Zambia, and N. Mozambique to Dem. Rep. Congo, Kenya and N. Tanzania.

Gliridae

Graphiurus microtis (Noack, 1887)

Large small-eared dormouse

Other recorded names: Graphiurus murinus littoralis;

Museum records: ZMB: 14945, 71324; USNM: 352927, 352928, 352929, 352930; IICT: CZ000001706;

Reported distribution in Mozambique: Inhambane; Manica; Maputo City; Tete;

Known distribution (Wilson and Reeder 2005): Sub-Saharan Africa excluding West Africa: Chad, Sudan, Ethiopia, Uganda, Rwanda, Kenya, Tanzania, Mozambique, Malawi, S. Dem. Rep. Congo, Zambia, Botswana, Namibia, Zimbabwe and South Africa.

Graphiurus murinus (Desmarest, 1822)

Woodland dormouse

Museum records: ZMB: 1553; MHNG: MAM-1700.080; FMNH: 183735, 183862, 214728, 214729, 214730, 214731, 214732;

Bibliographic records: Smithers and Tello (1976); Gliwicz (1985);

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Maputo; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): C., E. and Southern Africa: E. Dem. Rep. Congo, Uganda, Rwanda, Burundi, Ethiopia, Kenya, Tanzania, Malawi, Mozambique, Zambia, Zimbabwe, South Africa.

Graphiurus platyops Thomas, 1897

Flat-headed African dormouse

Museum records: ZMB: 71379;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Inhambane; Manica;

Known distribution (Wilson and Reeder 2005): Southern Africa: Malawi, E. Zambia, Zimbabwe, Botswana, Mozambique and South Africa.

Hystricidae

***Hystrix africaeaustralis* Peters, 1852**

Cape porcupine

Other recorded names: Hystrix; Hystrix africae; Hystrix africaeaustralis africaeaustralis;

Museum records: AMNH: M-216336, M-216337; CAS: 14838; ZMB: 1284, 70878; FMNH: 89994; IICT: CZ000000421, CZ000001404;

Bibliographic records: Smithers and Tello (1976); Schneider (2004); Stalmans (2007); Mesochina, Langa and Chardonnet (2008); Stalmans and Peel (2009); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Nampula; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Mouth of the Congo River to Rwanda, Uganda, Kenya, W. and S. Tanzania, Mozambique and South Africa.

Muridae

***Acomys ngurui* Verheyen, Hulselmans, Wendelen, Leirs, Corti, Backeljau and Verheyen, 2011**

Nguru spiny mouse

Bibliographic records: Petruzela et al. (2018);

Reported distribution in Mozambique: Zambezia.

***Acomys selousi* de Winton, 1896**

Selous spiny mouse

Bibliographic records: Petruzela et al. (2018);

Reported distribution in Mozambique: Gaza.

***Acomys spinosissimus* Peters, 1852**

Southern African spiny mouse

Other recorded names: Acomys spinosissimus spinosissimus; **Museum records:** ZMB: 1711; RMCA: 67645 RMCA a6.016-M-1106, 67646 RMCA a6.016-M-1107; FMNH: 214744, 214745, 214746, 214747, 214884, 214885, 214886, 214887, 214888, 214889; USNM: 352811, 352812, 352813, 352814, 352815, 352816, 352817, 352818, 352819, 352820, 352821, 352822, 352823, 352824, 352825, 352826, 352827, 352828, 352829, 352830, 352831, 352832, 367023, 367024, 367025, 367026, 367027, 367028, 367029, 367030, 367031, 367032, 367033, 367034, 367035, 367036, 367037, 367038, 367039, 367040, 367041, 367042, 367043, 367044, 367045, 367046, 367047, 367048, 367049, 367050, 367051, 367052, 367053, 367054, 367055, 367056, 367057, 367058, 367059, 367060, 367061, 367062, 367063, 367064, 367065, 367066, 367067, 367068, 367069, 367070, 367071, 367072, 367073, 367074, 367075, 367076, 367077, 367078, 367079, 367080, 367081, 367082, 367083, 367084, 367085, 367086, 367087, 367088, 367089, 367090, 367091, 367092, 367093, 367094, 367095, 367096, 367097, 367098, 367099, 367100, 367101, 367102, 367103, 367104, 367105, 367106, 367107, 367108, 367109, 367110, 367111, 367112, 367113, 367114, 367115, 367116, 367117, 367118, 367119, 367120, 367121, 367122, 367123, 367124, 367125, 367126, 367127, 367128, 367129, 367130, 367131, 367132, 367133, 367134, 367135, 367136, 367137, 367138, 367139, 367140, 367141, 367142, 367143, 367144, 367145, 367146, 367147, 367148, 367149, 367150, 367151, 367152, 367153, 367154, 367155, 367156, 367157, 367158, 367159, 367160, 367345, 367346, 367347, 367348, 367349, 367350, 367351, 367352, 367353, 367354, 367355, 367356,;

Bibliographic records: Smithers and Tello (1976); Gliwicz (1985); Mesochina, Langa and Chardonnet (2008); Bayliss et al. (2010); Petruzela et al. (2018);

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Nampula; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): N.E. Tanzania and E.C. Tanzania, S.E. Dem. Rep. Congo, Zambia, Malawi, Zimbabwe, E. Botswana, C. Mozambique, and N. and N.W. South Africa.

***Aethomys chrysophilus* (de Winton, 1897)**

Red rock rat

Other recorded names: Aethomys chrysophilus acticola; Aethomys chrysophilus alticola; Aethomys silindensis;

Museum records: AMNH: M-252574, M-252575, M-252576, M-252577, M-252578, M-252579, M-252580, M-252581; NHMUK: 1907.6.2.59, 1908.4.3.73; MCZ: 46269; USNM: 352543, 352544, 352545, 352546, 352547, 352548, 352550, 352553, 352554, 352555, 352556, 352557, 352558, 352559, 352560, 352561, 352562, 352563, 352564, 352565, 352566, 352567, 352568, 352569, 352570, 352571, 352572, 352573, 352574, 352575, 352576, 352577, 352578, 352579, 352580, 352581, 366170, 366171, 366172, 366173, 366174, 366175, 366176, 366177, 366178, 366179, 366180, 366181, 366182, 366184, 366185, 366186, 366187, 366188, 366189, 366190, 366191, 366192, 366193, 366194, 366196, 366197, 366198, 366199, 366200, 366201, 366202, 366203, 366205, 366206, 366207, 366208, 366209, 366210, 366211, 366212, 366213, 366215, 366216, 366217, 366218, 366219, 366220, 366221, 366222, 366223, 366224, 366225, 366226, 366227, 366228, 366229, 366230, 366231, 366232, 366233, 366234, 366236, 366237, 366238, 366239, 366240, 366241, 366242, 366245, 366252, 366253, 366254, 366255, 366257, 366259, 366260, 366261, 366263, 366264, 366265, 366267, 366268, 366269, 366270, 366271, 366272, 366273, 366274, 366275, 366276, 366282, 366289, 366291, 366292, 366293, 366294, 366295, 366296, 366297, 366298, 366299, 366300, 366301, 366302, 366303, 366305, 366306, 367283, 367284, 367285, 428520, 428521, 428522, 428523, 428524, 428525, 428554, 428555, 428556, 428557, 480360;

Bibliographic records: Smithers and Tello (1976); Gliwicz (1985); Downs and Wirminghaus (1997); Schneider (2004); GRNB (2010); Mazoch et al. (2017);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Maputo City; Niassa; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): From S.E. Kenya south through Tanzania, Malawi, Zambia, S. Angola, N. Namibia, N. and E. Botswana, Zambia, Mozambique, and N.E. South Africa in a narrow band bordering Zimbabwe, Botswana, and Mozambique, generally the course of the Limpopo River.

***Aethomys ineptus* (Thomas and Wroughton, 1908)**

Tete veld rock rat

Bibliographic records: Chimimba et al. (2001); Mazoch et al. (2017);

Reported distribution in Mozambique: Maputo; Tete;

Known distribution (Wilson and Reeder 2005): Documented from N.E. South Africa (Mpumalanga, Gauteng, North West, Limpopo, Northern Cape, and KwaZulu-Natal Provs.; from about 25E30' S. in the north southward to the Durban region) and S. Mozambique.

Micaelamys namaquensis **A.Smith, 1834**

Namaqua rock rat

Other recorded names: Aethomys namaquensis; Aethomys namaquensis arborius;

Museum records: AMNH: M-252589, M-252590, M-252591, M-252592, M-252593; ZMB: 85443, 85444; NHMUK: 1908.4.3.79; FMNH: 183757;

Bibliographic records: Smithers and Tello (1976); Gliwicz (1985); Timberlake et al. (2009);

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Maputo; Maputo City; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): E. Angola, South Africa, Botswana, Zimbabwe, S. and C. Mozambique, S. Malawi, and S.E. Zambia,

Dasymys incomtus **(Sundevall, 1847)**

Common dasymys

Other recorded names: Dasymys incomtus incomtus; Dasymys sp.;

Museum records: NHMUK: 1977.31, 1977.32; FMNH: 183758, 183759, 183760, 183761; USNM: 366062, 366063, 366064, 366065, 366066, 366067, 366068, 366069, 366070, 366071, 366072, 366073, 366074, 366075, 366076, 366077, 366078, 366079, 366080, 366081, 366082, 366083, 366084, 366085, 366086, 366087, 366088, 366089;

Bibliographic records: Smithers and Tello (1976); Timberlake et al. (2009);

Reported distribution in Mozambique: Manica; Maputo; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): South Africa, Malawi, Zambia, Zimbabwe, C. and S. Mozambique, Angola, Dem. Rep. Congo, Uganda, Kenya, Tanzania, Ethiopia, S. Sudan.

Gerbilliscus boehmi **(Noack, 1887)**

Boehm's gerbil

Other recorded names: Tatera boehmi boehmi;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Tete;

Known distribution (Wilson and Reeder 2005): E. Angola, S. Dem. Rep. Congo, N. Zambia, Malawi, Tanzania, Kenya and Uganda.

***Gerbilliscus inclusus* (Thomas and Wroughton, 1908)**

Gorongoza gerbil

Other recorded names: Tatera inclusa; Tatera inclusa inclusa;

Museum records: NHMUK: 1908.1.1.79, 1908.1.1.80, 1923.3.4.28, 1934.1.11.38, 1934.1.11.39; FMNH: 214890;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Cabo Delgado; Manica; Nampula; Sofala; Zambezia;

Known distribution (Wilson and Reeder 2005): E. Zimbabwe, C. Mozambique to N.E. Tanzania.

***Gerbilliscus leucogaster* (Peters, 1852)**

Bushveld gerbil

Other recorded names: Meriones leucogaster; Tatera leucogaster; Tatera lobengulae panja;

Museum records: AMNH: M-208687, M-208688, M-252657, M-252658, M-252659, M-252660, M-252661, M-252662, M-252663, M-252664, M-252665, M-252666; CAS: 29348, 29349; ZMB: 1743; NHMUK: 1858.6.18.20, 1899.8.3.9, 1906.11.8.67, 1906.11.8.68, 1906.11.8.69, 1906.11.8.70, 1906.11.8.71, 1906.11.8.72, 1906.11.8.73, 1906.11.8.74, 1906.11.8.156, 1907.6.2.73, 1907.6.2.74, 1907.6.2.75, 1907.6.2.76, 1907.6.2.77, 1907.6.2.78, 1908.4.3.54, 1908.4.3.55, 1908.4.3.56, 1908.4.3.57, 1908.4.3.58, 1908.4.3.59, 1908.4.3.60, 1908.4.3.61; RMCA: 100279, 100280, 100281; MCZ: 43907, 43908, 43909, 43910, 43911, 43912, 43914;

Bibliographic records: Smithers and Tello (1976); Downs and Wirminghaus (1997);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Maputo City; Nampula; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): N. and W. South Africa, Mozambique, Zimbabwe, Botswana, Namibia, Malawi, Zambia, Angola, S.W. Tanzania and S. Dem. Rep. Congo.

***Gerbillurus paeba* (A.Smith, 1836)**

Paeba hairy-footed gerbil

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Gaza; Inhambane; Sofala;

Known distribution (Wilson and Reeder 2005): South Africa, W. Mozambique, W. Zimbabwe, Botswana, Namibia, and S.W. Angola.

***Grammomys cometes* (Thomas and Wroughton, 1908)**

Mozambique thicket rat

Other recorded names: Thallomys cometes; Thamnomys cometes;

Museum records: NHMUK: 1906.11.8.115; FMNH: 214748, 214749, 214750, 214751, 214752, 214753, 214754, 214755, 214756, 214757, 214758, 214759, 214893, 214894, 214895, 214896;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Maputo; Sofala; **Known distribution (Wilson and Reeder 2005):** From Pirie Forest (NW of King William's Town) in S.E. Eastern Cape Province of South Africa north through KwaZulu-Natal and Limpopo provinces of that country into E. Zimbabwe (Melsetter and Umtali districts) and Mozambique south of the Zambezi River.

***Grammomys dolichurus* (Smuts, 1832)**

Woodland thicket rat

Other recorded names: Grammomys ? dolichurus ?; Thamnomys dolichurus;

Museum records: ZMB: 1648; FMNH: 183660, 183661, 183762, 183763, 214760, 214761, 214762, 214763, 214764, 214765, 214766, 214767, 214768, 214769, 214770, 214771, 214772, 214773, 214774, 214775, 214776, 214777, 214778, 214779, 214780, 214781, 214782, 214783, 214784, 214785, 214786, 214787, 214788, 214789, 214790, 214791, 214897, 214898, 214899, 214900, 214901, 214902, 214903, 214904, 214905, 214906, 214907; USNM: 366044, 366045, 366046, 366047, 366048, 366049, 366050, 366051, 366052, 366053;

Bibliographic records: Smithers and Tello (1976); Bayliss et al. (2014);

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Sofala; Tete; Zam-

bezia;

Known distribution (Wilson and Reeder 2005): From Nigeria east to S. Ethiopia; then south through N. Dem. Rep. Congo, Uganda, Kenya, Tanzania, and C. and S. Malawi to N. and E. South Africa; E. Zimbabwe, and Mozambique; and west through Zambia (except in northeast on Nyika Plateau) to Angola.

***Grammomys macmillani* (Wroughton, 1907)**

Macmillan's thicket rat

Museum records: USNM: 366054, 366055, 366056, 366057, 366058, 366059, 366060, 366061;

Reported distribution in Mozambique: Sofala;

Known distribution (Wilson and Reeder 2005): Sierra Leone, Liberia, Central African Republic, S. Sudan, S. Ethiopia, N. Dem. Rep. Congo, Kenya, Uganda (including Bugala Island in Lake Victoria), Tanzania, Malawi, Mozambique, and E. Zimbabwe; limits unresolved.

***Lemniscomys rosalia* (Thomas, 1904)**

Single-striped grass mouse

Other recorded names: Lemniscomys griselda; Lemniscomys griselde caldior; Lemniscomys rosalia calidior;

Museum records: AMNH: M-252553, M-252554, M-252555, M-252556; CAS: 29360; NHMUK: 1908.1.1.72; MNHN: 1961-898; FMNH: 214908; USNM: 352524, 352525, 352526, 352527, 352528, 352529, 352530, 352531, 352532, 352533, 352534, 352535, 352536, 352537, 352538, 352539, 352540, 352541, 352542, 366105, 366106, 366107, 366108, 366109, 366110, 366111, 366112, 366113, 366114, 366115, 366116, 366117, 366118, 366119, 366120, 366121, 366122, 366123, 366124, 366125, 366126, 366127, 366128, 366129, 366130, 366131, 366132, 366133, 366134, 366135, 366136, 366137, 366138, 366139, 366140, 366141, 366142, 366143, 366144, 366145, 366146, 366147, 366148, 366149, 366150, 366151, 366152, 366153, 366154, 366155, 366156, 366157, 366158, 366159, 366160, 366161, 366162, 366163, 366164, 366165, 366166, 366167, 366168, 366169, 367275, 367276, 367277, 367278, 367279, 367280, 367281, 367282; MCZ: 44128, 44129, 44130, 44182;

Bibliographic records: Smithers and Tello (1976); Gliwicz (1985);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Ma-

puto; Maputo City; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): N. Namibia, South Africa, E. Swaziland, Zimbabwe, C. and N. Botswana, Mozambique, Zambia, Malawi, Tanzania, and S. Kenya; range inadequately resolved.

***Lophuromys flavopunctatus* Thomas, 1888**

Yellow-spotted brush-furred rat

Other recorded names: Lophuromys aquilus;

Museum records: FMNH: 183662, 183663, 183664, 183665, 183666, 183667, 183668, 183669, 183670, 183671, 183672, 183673, 183674, 183675, 183676, 183764, 183765, 183766, 183767, 183768, 183769, 183770, 183771, 183772, 183773, 183774, 183775, 183776, 183777, 183778, 183779, 183780, 183781;

Bibliographic records: Smithers and Tello (1976); Bayliss et al. (2014);

Reported distribution in Mozambique: Zambezia; Known distribution (IUCN 2018): Angola; Burundi; Dem. Rep. Congo; Ethiopia; Kenya, Malawi; Mozambique; Rwanda; Sudan; Tanzania, Zambia.

***Mastomys natalensis* (Smith, 1834)**

Natal mastomys

Other recorded names: Mus microdon; Praomys natalensis;

Museum records: AMNH: M-252607, M-252608, M-252609, M-252610, M-252611, M-252612, M-252613, M-252614, M-252615, M-252616; SMF: 11645; RMCA: 100292, 100293, 100294, 100295, 100296, 100297, 100298, 100299, 100300, 100307, 100313, 100314, 100317, 100323, 100324, 100326, 100327, 100328, 100329, 100330, 100331, 100332, 100333, 100334, 100335, 100336, 100337, 100339, 100341, 100342, 100343, 67419 RMCA a6.016-M-0880, 67421 RMCA a6.016-M-0882, 67422 RMCA a6.016-M-0883, 67423 RMCA a6.016-M-0884, 67424 RMCA a6.016-M-0885, 67425 RMCA a6.016-M-0886, 67426 RMCA a6.016-M-0887, 67427 RMCA a6.016-M-0888, 67428 RMCA a6.016-M-0889, 67429 RMCA a6.016-M-0890, 67430 RMCA a6.016-M-0891; FMNH: 183677, 183678, 183679, 183680, 183681, 183682, 183683, 183684, 183685, 183782, 183783, 183784, 183785, 183786, 183787, 183788, 183789, 183790, 183791, 183792, 214792, 214793, 214794, 214795, 214796, 214797, 214798, 214799, 214800, 214801, 214802, 214803, 214804, 214909, 214910; ZMB: 1527, 1646, 1647, 85445;

Bibliographic records: Smithers and Tello (1976); Gliwicz (1985); Downs and Wirminghaus (1997); Colangelo et al. (2013);

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Maputo; Maputo City; Nampula; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Widespread in subsaharan Africa except for S.W. portion of continent.

***Mus minutoides* Smith, 1834**

Southern African pygmy mouse

Other recorded names: Leggada minutoides; Leggada minutoides marica; Mus minutoides minutoides; Mus musculoides;

Museum records: ZMB: 1657, 1658, 2817, 85451, 85452; MHNG: MAM-1700.085; NHMUK: 1907.1.1.180, 1907.6.2.93; RMCA: 66894 RMCA a6.016-M-0016, 66895 RMCA a6.016-M-0017, 66896 RMCA a6.016-M-0018; FMNH: 214805, 214806, 214807; USNM: 352793, 352794, 352795, 352796, 352797, 352799, 352800, 352801, 352802, 352803, 352804, 352805, 352806, 352807, 352808, 352809, 352810, 366990, 366994, 366995, 366996, 366997, 366999, 367000, 367001, 367002, 367003, 367004, 367005, 367006, 367007, 367008, 367009, 367010, 367011, 367012, 367013, 367014, 367015, 367016, 367017, 367340, 367341, 367342, 367343;

Bibliographic records: Smithers and Tello (1976); Gliwicz (1985); Downs and Wirminghaus (1997); Timberlake et al. (2009);

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Maputo; Maputo City; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Southern African Subregion: Zimbabwe, Mozambique (south of the Zambezi River), southern and eastern regions of South Africa (S Northern Cape, Western Cape, and Eastern Cape provinces; KwaZulu-Natal, Lesotho, Free State, C. and E. Limpopo provinces) and Swaziland.

***Mus neavei* (Thomas, 1910)**

Neave's mouse

Museum records: USNM: 366991, 366992, 366993, 366998;

Reported distribution in Mozambique: Tete;

Known distribution (Wilson and Reeder 2005): E. Dem. Rep. Congo, S.E. Zambia, S. Zimbabwe, Limpopo Province of South Africa, W. Mozambique and S. Tanzania. Distributional limits undocumented.

***Mus triton* (Thomas, 1909)**

Gray-bellied mouse

Museum records: FMNH: 183686, 183687, 183688, 183689, 183690, 183691, 183692, 183693, 183694, 183695, 183696, 183697, 183698, 183699, 183700, 183701, 183702, 183793, 183794, 183795, 183796, 183797, 183798, 183799, 183800, 183801, 183802, 183803, 183804, 183805; USNM: 366936, 366937, 366938, 366939, 366940, 366941, 366942, 366943, 366944, 366945, 366946, 366947, 366948, 366949, 366950, 366951, 366952, 366953, 366954, 366955, 366956, 366957, 366958, 366959, 366960, 366961, 366962, 366963, 366964, 366965, 366966, 366967, 366968, 366969, 366970, 366971, 366972, 366973, 366974, 366975, 366976, 366977, 366978, 366979, 366980, 366981, 366982, 366983, 366984, 366985, 366986, 366987, 366988, 366989, 367335, 367337, 367338, 367339;

Bibliographic records: Smithers and Tello (1976); Dowsett-Lemaire and Dowsett (2009); Timberlake et al. (2009); Bayliss et al. (2014);

Reported distribution in Mozambique: Manica; Maputo; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): N. and E. Dem. Rep. Congo, Uganda, Kenya, S. Ethiopia, Tanzania, Malawi, Tete Dist. of Mozambique, Zambia, and C. and N.E. Angola.

***Otomys angoniensis* Wroughton, 1906**

Angoni vlei rat

Other recorded names: Otomys angoniensis rowleyi;

Museum records: NHMUK: 1906.11.8.77; FMNH: 183654, 183742, 183743, 183744, 183745, 183746, 183747; USNM: 366102, 366103, 366104;

Bibliographic records: Smithers and Tello (1976); Timberlake et al. (2009);

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Maputo City; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): S.E. savannah and grasslands, from S. Kenya to S.E. Botswana and N.E. South Africa.

***Otomys auratus* Wroughton, 1906**

Southern African vlei rat

Other recorded names: Otomys irroratus;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Manica;

Known distribution (Wilson and Reeder 2005): Mesic savannah and grasslands of southern Africa Western Cape Province to Limpopo Province, South Africa; disjunct populations in W. South Africa and in E. Zimbabwe and contiguous Mozambique.

***Pelomys fallax* (Peters, 1852)**

East African pelomys

Museum records: AMNH: M-252558, M-252559, M-252560; ZMB: 1675, 85465; FMNH: 183703, 183704, 183806, 183807, 183808, 183809, 183810; USNM: 352931, 366091, 366092, 366093, 366094, 366095, 366096, 366097, 366098, 366099, 366100, 366101;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Nampula; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Savanna habitats from S. Kenya and S.W. Uganda through Tanzania, E. and S. Dem. Rep. Congo, Angola, Zambia, Malawi, and Mozambique, to E. and NW Zimbabwe and N. Botswana.

***Praomys delectorum* (Thomas, 1910)**

East African praomys

Museum records: FMNH: 183705, 183706, 183707, 183708, 183709, 183710, 183711, 183712, 183713, 183714, 183715, 183716, 183717, 183718, 183719, 183720, 183721, 183722, 183723, 183724, 183725, 183726, 183727, 183728, 183729, 183730, 183731, 183732, 183733, 183734, 183811, 183812, 183813, 183814, 183815, 183816, 183817, 183818, 183819, 183820, 183821, 183822, 183823, 183824, 183825, 183826, 183827, 183828, 183829, 183830, 183831, 183832, 183833, 183834, 183835, 183836, 183837, 183838, 183839, 183840, 183841, 183842, 183843, 183844, 183845, 183846, 183847, 183848, 183849, 183850, 183851, 183852, 183853, 183854, 183855;

Bibliographic records: Timberlake et al. (2007); Timberlake et al. (2009); Bayliss et al. (2014); Bryja et al. (2014);

Reported distribution in Mozambique: Zambezia;

Known distribution (Wilson and Reeder 2005): High plateaus and isolated mountains from N.E. Zambia (Nyika Plateau, Makutus, and Mafingas) and Malawi (Nyika Plateau), through Tanzania to S.E. Kenya.

***Rhabdomys dilectus* (de Winton, 1897)**

Mesic four-striped grass rat

Other recorded names: Arvicanthis sp.; Rhabdomys pumilio; Rhabdomys pumilio dilectus;

Museum records: AMNH: M-216333; FMNH: 214808, 214809, 214810, 214811, 214812, 214813, 214814, 214815, 214816, 214817, 214818, 214819, 214820, 214821, 214822, 214823, 214824, 214825, 214826, 214911, 214912, 214913;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Inhambane; Manica; Sofala;

Known distribution (Wilson and Reeder 2005): E. South Africa, E. Zimbabwe, W.C. Mozambique, Malawi (Nyika Plateau and Mulanje Massif), N.E. Zambia (Nyika Plateau), S.E. Dem. Rep. Congo, highlands in Tanzania, Kenya, E. Uganda, and S. and C. Angola.

***Thallomys paedulcus* (Sundevall, 1846)** Acacia thallomys

Other recorded names: Thallomys paedulcus ruddi; Thallomys ruddi;

Museum records: NHMUK: 1908.4.3.81; MCZ: 43906; USNM: 352582, 366183;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Maputo; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): From N.E. South Africa (N KwaZulu-Natal, W. Mpumalanga, Limpopo, Gauteng, and North West), Swaziland, and Botswana north through Zimbabwe, S. Zambia, Mozambique, Malawi, Tanzania, Kenya to S. Ethiopia and S. Somalia; limits unknown.

***Uranomys ruddi* Dollman, 1909**

Rudd's bristle-furred rat

Other recorded names: Uranomys ruddi woodi;

Museum records: USNM: 367018, 367019, 367020, 367021, 367022;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Manica; Sofala;

Known distribution (Wilson and Reeder 2005): Savannas in Senegal, Guinea, Côte d'Ivoire, Sierra Leone, Ghana, Togo, N. Nigeria, N. Cameroon, N.E. Dem. Rep. Congo, S.W. Ethiopia, Uganda, Kenya, Tanzania, C. Mozambique, Malawi, and S.E. Zimbabwe; limits unknown.

Nesomyidae

***Beamys major* Dollman, 1914**

Hinde's pouched rat

Other recorded names: Beamys hindei;

Museum records: FMNH: 183657, 183658, 183659, 183751, 183752, 183753;

Bibliographic records: Bayliss et al. (2014);

Reported distribution in Mozambique: Zambezia;

Known distribution (Wilson and Reeder 2005): S.E. Kenya and E. Tanzania.

***Cricetomys gambianus* Waterhouse, 1840**

Northern giant pouched rat

Other recorded names: Cricetomys ansorgei; Cricetomys gambianus?; Cricetomys gambianus ansorgei; Cricetomys gambianus viator;

Museum records: ZMB: 1720, 1721, 72269, 72275; NHMUK: 1906.11.8.125, 1908.1.1.130; FMNH: 183754, 183755, 183756, 214880; USNM: 352925;

Bibliographic records: Smithers and Tello (1976); Mesochina, Langa and Chardonnet (2008);

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Subsaharan savanna belt (Sudan and Guinea) and forest edges, from Gambia and Senegal eastwards to N.E. Dem. Rep. Congo, S. Sudan, and N. Uganda.

***Dendromus melanotis* Smith, 1834**

Gray African climbing mouse

Other recorded names: Dendromus melanotis vulturnus;

Museum records: MHNG: MAM-1706.055; FMNH: 214734, 214735, 214736, 214737, 214738, 214739, 214740, 214741, 214742, 214743, 214882, 214883; USNM: 367217; **Bibliographic records:** Smithers and Tello (1976); Timberlake et al. (2009); **Reported distribution in Mozambique:** Gaza; Manica; Maputo; Sofala; Zambezia; **Known distribution (Wilson and Reeder 2005):** From South Africa northward in the west through Botswana to C. Angola; northward in the east through Zimbabwe, Mozambique, Zambia, Malawi, and Tanzania to Uganda; westward through Nigeria and Ghana to S. Guinea; also from Ethiopia. Range limits unresolved.

***Dendromus mystacalis* Heuglin, 1863**

Chestnut climbing mouse

Museum records: USNM: 367213, 367215;

Bibliographic records: Smithers and Tello (1976); Timberlake et al. (2009);

Reported distribution in Mozambique: Gaza; Manica; Maputo; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Much of C. and E. Africa, including S. Sudan and Ethiopia, as far south as Angola and E. South Africa.

***Dendromus nyikae* Wroughton, 1909**

Nyika climbing mouse

Museum records: USNM: 367214, 367216, 367218;

Reported distribution in Mozambique: Manica; Tete;

Known distribution (Wilson and Reeder 2005): Patchy range in S. Sub-saharan Africa; S.C. Dem. Rep. Congo, N. and C. Angola, N. South Africa, E. Zimbabwe, Zambia, Malawi, and Eastern Arc Mtns, N.E. Tanzania.

***Saccostomus campestris* Peters, 1846**

Southern African pouched mouse

Other recorded names: Saccostomus campestris campestris; Saccostomus sp.;

Museum records: AMNH: M-216334, M-216335, M-252631, M-252632, M-252633, M-252634, M-252635, M-252636, M-252637, M-252638; ZMB: 1712, 2789, 85435, 85436, 85437, 85450, 85455, 85457, 85458, 85459, 85460, 85461; MVZ: 118602, 118603; RMNH: RMNH-MAM-26574.a, RMNH-MAM-26574.b; NHMUK: 1907.1.1.181; FMNH: 214733, 214881; USNM: 352833, 352834, 352835, 352836, 352837, 352838, 352839, 352840, 352841, 352842, 352843, 352844, 352845, 352846, 352847, 352848, 352849, 352850, 352851, 352852, 352853, 352854, 352855, 352856, 352857, 352858, 352859, 352860, 352861, 352862, 352863, 352864, 352865, 352866, 352867, 352868, 352869, 352870, 352871, 352872, 352873, 352874, 352875, 352876, 352877, 352878, 352879, 352880, 352881, 352882, 352883, 352884, 352885, 352886, 352887, 352888, 352889, 352890, 352891, 352892, 352893, 352894, 352895, 352896, 352897, 352898, 352899, 352900, 352901, 352902, 352903, 352904, 352905, 352906, 352907, 352908, 352909, 352910, 352911, 352912, 352913, 352914, 352915, 352916, 352917, 352918, 352919, 352920, 352921, 352922, 352923, 352924, 367161, 367162, 367163, 367164, 367165, 367166, 367167, 367168, 367169, 367170, 367171, 367172, 367173, 367174, 367175, 367176, 367177, 367178, 367179, 367180, 367181, 367182, 367183, 367184, 367185, 367186, 367187, 367188, 367189, 367190, 367191, 367192, 367193, 367194, 367195, 367196, 367197, 367198, 367199, 367200, 367201, 367202, 367203, 367204, 367205, 367206, 367207, 367208, 367209, 367210, 367211, 367212, 367357, 367358,; MCZ: 44212;

Bibliographic records: Smithers and Tello (1976); Gliwicz (1985);

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Maputo; Maputo City; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Arid to mesic southern savannahs and grasslands: from S.W. Tanzania across to W. Angola; south through most of Malawi, Zambia, Zimbabwe, Botswana, and Namibia; to S. Mozambique and S. South Africa (Western and Eastern Cape provinces).

***Steatomys parvus* Rhoads, 1896**

Tiny fat mouse

Other recorded names: Steatomys parvus loveridgei; Steatomys pratensis loveridgei;

Museum records: NHMUK: 1922.7.17.211;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Nampula;

Known distribution (Wilson and Reeder 2005): East and Southern Africa, and E.C. Sudan, S. Ethiopia, and Somalia; south through Kenya, Uganda, and Tanzania; to S.W. Angola, N.E. Namibia, N.W. Botswana, W. Zambia and W. Zimbabwe.

***Steatomys pratensis* Peters, 1846**

Fat mouse

Other recorded names: Steatomys pratensis pratensis;

Museum records: ZMB: 1678, 2788, 85438, 85439, 85440, 85462, 85464; MHNG: MAM-1700.086, MAM-1700.087, MAM-1700.088; RMNH: RMNH-MAM-26491; NHMUK: 1858.6.18.18, 1907.1.1.182; MCZ: 43930; USNM: 352926, 367219, 367220, 367221, 367222, 367223;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Maputo; Maputo City; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Southern and East Africa, S. Angola and N. Namibia; eastward through N. Botswana, Zimbabwe, N. South Africa, and Mozambique; north through Zambia, Malawi, and Tanzania to E.C. Ethiopia.

Pedetidae

***Pedetes capensis* (Forster, 1778)**

South African spring hare

Other recorded names: Pedetes cafer salinae; Pedetes capensis salinae;

Museum records: AMNH: M-214795, M-216269, M-216270, M-216271, M-216272; ZMB: 69132; USNM: 352294, 352295, 352296, 352297, 352298, 352299; NMZB: NMZB-MAM-0067267, NMZB-MAM-0067268, NMZB-MAM-0067269, NMZB-MAM-0067270, NMZB-MAM-0067271, NMZB-MAM-0067272, NMZB-MAM-0067273, NMZB-MAM-0067274, NMZB-MAM-0067278; IICT: CZ000000875, CZ000000876, CZ000001134, CZ000001345, CZ000001373, CZ000001392;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Gaza; Inhambane; Manica;

Known distribution (Wilson and Reeder 2005): South Africa, Namibia, Angola, Botswana, Mozambique, Zimbabwe, Zambia, S. Dem. Rep. Congo.

Sciuridae

Heliosciurus mutabilis **(Peters, 1852)**

Mutable sun squirrel

Other recorded names: Heliosciurus mutabulis; Heliosciurus mutabulis beirae; Heliosciurus rufobrachium; Heliosciurus rufobrachium chirindensis; Heliosciurus rufobrachium mutabilis; Heliosciurus rufobrachium smithersi; Heliosciurus rufobrachium vumbae;

Museum records: ZMB: 1396; USNM: 352292, 352293, 365797; NMZB: NMZB-MAM-0028526, NMZB-MAM-0064409, NMZB-MAM-0064410, NMZB-MAM-0064412, NMZB-MAM-0064413, NMZB-MAM-0064414, NMZB-MAM-0064415, NMZB-MAM-0069226, NMZB-MAM-0069230, NMZB-MAM-0069232, NMZB-MAM-0069233, NMZB-MAM-0069235, NMZB-MAM-0069240, NMZB-MAM-0069241; FMNH: 183738, 183739, 183740, 183741, 214879; MCZ: 46268;

Bibliographic records: Smithers and Tello (1976); Dowsett-Lemaire and Dowsett (2009); Timberlake et al. (2009); Bayliss et al. (2014);

Reported distribution in Mozambique: Gaza; Inhambane; Manica; Nampula; Sofala; Tete; Zambezia;

Known distribution (Wilson and Reeder 2005): Malawi; S. and S.W. highlands, Tanzania; N.W. of the Zambezi River near Beira (Mozambique); Chirinda Forest, Melsetter Dist., Sabi/Lundi River confluence, Vumba, Umtali (S.E. Zimbabwe).

Paraxerus cepapi **(A.Smith 1836)**

Smith's bush squirrel

Other recorded names: Paraxerus cepapi cepapoides; Paraxerus cepapi sindi; Paraxerus vincenti;

Museum records: NMZB: NMZB-MAM-0003472, NMZB-MAM-0003473, NMZB-MAM-0003478, NMZB-MAM-0003479, NMZB-MAM-0004640, NMZB-MAM-0004788, NMZB-MAM-0033880, NMZB-MAM-0069154, NMZB-MAM-0069155, NMZB-MAM-0069157, NMZB-MAM-0069158, NMZB-MAM-0069159, NMZB-MAM-0069160, NMZB-MAM-0069161, NMZB-MAM-0069163, NMZB-MAM-0069164, NMZB-MAM-0069165, NMZB-MAM-0069167, NMZB-MAM-0069168; IICT: CZ000000856, CZ000001234, CZ000001391; NHMUK: 1908.4.3.51; MCZ: 44116, 44117, 44118, 44119, 44120, 44121, 44122; USNM: 61751, 61752, 352285, 352286, 352287, 352288, 352289, 352291, 365789, 365790, 365791, 365792, 365793, 365794,

365795, 365796,; FMNH: 89995;

Bibliographic records: Smithers and Tello (1976); Mesochina, Langa and Chardonnet (2008); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Sofala; Tete; Zambezia; **Known distribution (Wilson and Reeder 2005):** S. Angola, Zambia, S.E. Dem. Rep. Congo, Malawi, S.W. Tanzania, Mozambique, N. Namibia, N. Botswana, Zimbabwe, N.E. South Africa.

***Paraxerus flavovittis* (Peters, 1852)**

Striped bush squirrel

Other recorded names: Paraxerus flavivittis mossambicus; Paraxerus flavovittis mossambicus;

Museum records: ZMB: 1402, 2248, 2267, 89487; NHMUK: 1922.7.17.155; FMNH: 34140; MCZ: 22869, 22870, 22871, 22872, 22873, 22874;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Cabo Delgado; Nampula; Zambezia;

Known distribution (Wilson and Reeder 2005): S. Kenya, Tanzania, N. Mozambique.

***Paraxerus palliatus* (Peters, 1852)**

Red bush squirrel

Other recorded names: Paraxerus palliatus; Paraxerus palliatus bridgemani; Paraxerus palliatus sponsus; Paraxerus swynnertoni; Paraxerus vincenti;

Museum records: AMNH: M-216264, M-216265, M-216266; ZMB: 1397, 89486; NMZB: NMZB-MAM-0004784, NMZB-MAM-0028520, NMZB-MAM-0033878, NMZB-MAM-0033879, NMZB-MAM-0069174, NMZB-MAM-0069175, NMZB-MAM-0069176, NMZB-MAM-0069186, NMZB-MAM-0069187, NMZB-MAM-0069189, NMZB-MAM-0069190, NMZB-MAM-0069191, NMZB-MAM-0069192; IICT: CZ000000623, CZ000000818, CZ000000831, CZ000000832, CZ000000850; NHMUK: 1906.11.8.63, 1914.7.18.1; USNM: 425526;

Bibliographic records: Smithers and Tello (1976); Downs and Wirminghaus (1997); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Nampula; Sofala; Tete;

Known distribution (Wilson and Reeder 2005): S. Somalia, E. Kenya, E. Tanzania, Malawi, Mozambique, Zimbabwe, KwaZulu-Natal (South Africa).

***Paraxerus vincenti* Hayman, 1950**

Vincent's bush squirrel

Museum records: NHMUK: 1934.1.11.14; FMNH: 183736, 183737;

Bibliographic records: Smithers and Tello (1976); Timberlake et al. (2009);

Reported distribution in Mozambique: Zambezia;

Known distribution (Wilson and Reeder 2005): N. Mozambique.

Thryonomyidae

***Thryonomys gregorianus* (Thomas, 1894)**

Lesser cane rat

Other recorded names: Thryonomys gregorianus sclateri;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Manica;

Known distribution (Wilson and Reeder 2005): Cameroon, Central African Republic, Dem. Rep. Congo, S. Sudan, Ethiopia, Kenya, Uganda, Tanzania, Malawi, Zambia, Zimbabwe, Mozambique.

***Thryonomys swinderianus* (Temminck, 1827)**

Greater cane rat

Museum records: AMNH: M-216338, M-216339, M-216340, M-216341, M-216342, M-216343; ZMB: 1179, 72336, 72352, 102364; USNM: 367226, 367227, 367228, 367359; IICT: CZ000000906, CZ000001358, CZ000001443;

Bibliographic records: Smithers and Tello (1976); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Maputo City; Nampula; Sofala; Tete;

Known distribution (Wilson and Reeder 2005): Africa, south of the Sahara.

B.1.14 Tubulidentata

Orycteropodidae

***Orycteropus afer* (Pallas, 1766)**

Aardvark

Other recorded names: Orycteropus afer afer;

Bibliographic records: Smithers and Tello (1976); Mesochina, Langa and Chardonnet (2008); GRNB (2010);

Reported distribution in Mozambique: Cabo Delgado; Gaza; Inhambane; Manica; Maputo; Nampula; Niassa; Sofala; Tete; Zamb

Known distribution (Wilson and Reeder 2005): Savannah zones of West Africa to E. Sudan, Ethiopia and Eritrea; Kenya; Somalia; N. and W. Uganda to Tanzania; Rwanda; N, E, and C. Dem. Rep. Congo; W. Angola; Namibia; Botswana; Zimbabwe; Zambia; Mozambique; South Africa.

B.2 Questionable occurrence species list

B.2.1 Artiodactyla

Bovidae

***Antidorcas marsupialis* (Zimmermann 1780)**

Springbok

Museum records: MNCN: 5124;

Reported distribution in Mozambique: Zambezia;

Known distribution (Wilson and Reeder 2005): S.W. Angola, Botswana, Namibia and South Africa.

***Litocranius walleri* (Brooke, 1879)**

Gerenuk

Museum records: SNOMNH: 19828;

Known distribution (Wilson and Reeder 2005): E. Ethiopia, Somalia, Kenya, N.E. Tanzania.

***Tragelaphus spekii* Sclater, 1863**

Sitatunga

Other recorded names: Tragelaphus spekei selousi;

Museum records: UNSM: 15192;

Reported distribution in Mozambique: Tete;

Known distribution (Wilson and Reeder 2005): Disjunct. Swamps in Gambia, W. Guinea, Guinea Bissau, and S. Senegal; not authentically recorded from Sierra Leone and doubtfully recorded from Côte d'Ivoire. Rainforest and swamps in C. and E. Angola, S. Benin, N. Botswana, Burundi, Cameroon, Central African Republic, Chad (Lake Chad only), Dem. Rep. Congo, Equatorial Guinea (Mbini), Gabon, Ghana, W. Kenya, Mozambique (W Tete Prov. only), N.E. Namibia (Caprivi Strip only), Niger (Lake Chad only; extinct), S. Nigeria (and Lake Chad), Republic of Congo, Rwanda, S. Sudan, W. and NW Tanzania, Togo (extinct?), Uganda, Zambia and Zimbabwe (extreme NW).

B.2.2 Chiroptera

Emballonuridae

***Taphozous perforatus* E.Geoffroy, 1818**

Egyptian tomb bat

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Manica;

Known distribution (Wilson and Reeder 2005): Mauritania and Senegal to Botswana, Mozambique, Somalia, Djibouti and Egypt; S. Arabia; Jordan; S. Iran; Pakistan; N.W. India.

Molossidae

***Mops thersites* Thomas, 1903**

Short-winged free-tailed bat

Other recorded names: Mops brachypterus; Tadarida thersites;

Museum records: ZMB: 135841;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Nampula;

Known distribution (Wilson and Reeder 2005): Gambia to Kenya; Tanzania (including Zanzibar and Mafia Island); Mozambique.

***Tadarida lobata* (Thomas, 1891)**

Big-eared free-tailed bat

Museum records: FMNH: 214722;

Reported distribution in Mozambique: Sofala;

Known distribution (Wilson and Reeder 2005): Kenya, Zimbabwe.

Nycteridae

***Nycteris woodi* K.Andersen, 1914**

Wood's slit-faced bat

Museum records: USNM: 365176;

Reported distribution in Mozambique: Tete;

Known distribution (Wilson and Reeder 2005): Zambia and South Africa to N.W. Mozambique and S.W. Tanzania.

*Pteropodidae

***Epomophorus gambianus* (Ogilby, 1835)**

Gambian epauletted fruit bat

Museum records: MHNG: MAM-1971.002;

Reported distribution in Mozambique: Zambezia;

Known distribution (Wilson and Reeder 2005): Senegal and Gambia to Central African Republic, east to Sudan, Ethiopia, S. to Malawi and Botswana.

Vespertilionidae

***Nyctalus noctula* (Schreber, 1774)**

Noctule

Other recorded names: Vespertilio macuanus;

Museum records: ZMB: 135715; MNHN: MO-1867-409;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Nampula;

Known distribution (Wilson and Reeder 2005): Europe and S. Scandinavia to Urals and Caucasus; Turkey to Israel and Oman; W. Turkmenistan, W. Kazakhstan, Uzbekistan, Kyrgyzstan, and Tajikistan to S.W. Siberia, Himalayas, south to Burma, Vietnam, and W. Malaysia; possibly Algeria. A record from Mozambique is dubious.

***Pipistrellus rueppellii* (J.Fischer, 1829)**

Ruppell's pipistrelle

Other recorded names: Pipistrellus rueppelli;

Museum records: ROM: 51088;

Reported distribution in Mozambique: Sofala;

Known distribution (Wilson and Reeder 2005): Mauritania, Senegal, Algeria, Israel, Egypt, and Iraq, south to Botswana and N.E. South Africa; Zanzibar.

***Scotoecus albofuscus* (Thomas, 1890)**

Light-winged lesser house bat

Other recorded names: Nycticeius albofuscus woodi;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Manica;

Known distribution (Wilson and Reeder 2005): Senegal and Gambia to Kenya, Tanzania, Mozambique, Malawi, KwaZulu-Natal (South Africa).

B.2.3 Eulipotyphla

Soricidae

***Crocidura flavescens* (I.Geoffroy, 1827)**

Greater red musk shrew

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Inhambane;

Known distribution (Wilson and Reeder 2005): South Africa.

***Crocidura nigrofusca* Matschie, 1895**

African black shrew

Museum records: USNM: 365077;

Reported distribution in Mozambique: Tete;

Known distribution (Wilson and Reeder 2005): S. Ethiopia and Sudan through E. Africa to Zambia and Angola, Dem. Rep. Congo, perhaps Cameroon.

***Suncus lixus* (Thomas, 1898)**

Greater dwarf shrew

Other recorded names: Suncus lixus gratulus;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Gaza;

Known distribution (Wilson and Reeder 2005): Savanna zones of Kenya, Tanzania, Malawi, Dem. Rep. Congo, Zambia, Angola, Botswana, and South Africa (KwaZulu-Natal, Northwest Prov., Mpumalanga and Limpopo).

***Suncus varilla* (Thomas, 1895)**

Lesser dwarf shrew

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Sofala;

Known distribution (Wilson and Reeder 2005): Savannahs from the Cape (South Africa) to Zimbabwe, Zambia, Tanzania, E. Dem. Rep. Congo, Malawi; an isolated record from Nigeria.

B.2.4 Macroscelidea

Macroscelididae

***Elephantulus intufi* (A.Smith, 1836)**

Bushveld elephant shrew

Museum records: ZMB: 84906; RMNH: RMNH-MAM-51943.a, RMNH-MAM-51943.b;

Reported distribution in Mozambique: Tete;

Known distribution (Wilson and Reeder 2005): S.W. Angola; Namibia; Botswana; N. South Africa.

B.2.5 Pholidota

Manidae

***Manis tricuspis* Rafinesque, 1821**

Tree pangolin

Museum records: MNHN: 1851-519, MO-1847-1839;

Known distribution (Wilson and Reeder 2005): Equatorial Africa from Senegal to W. Kenya, south to NW Zambia and S.W. Angola; N.E. Mozambique; Bioko (Equatorial Guinea).

B.2.6 Rodentia

Muridae

***Aethomys kaiseri* (Noack, 1887)**

Kaiser's aethomys

Museum records: USNM: 366090;

Reported distribution in Mozambique: Tete;

Known distribution (Wilson and Reeder 2005): S.W. Uganda, S. Kenya, Rwanda, S. and E. Dem. Rep. Congo, W. and S.W. Tanzania, Malawi, Zambia and N.C. Angola.

***Aethomys silindensis* Roberts, 1938**

Seilinda aethomys

Other recorded names: Aethomys selindensis;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Manica;

Known distribution (Wilson and Reeder 2005): E. Zimbabwe.

***Gerbilliscus validus* (Bocage 1890)**

Brush-tailed hairy-footed gerbil

Other recorded names: Tatera valida;

Museum records: IICT: CZ000000397;

Reported distribution in Mozambique: Sofala;

Known distribution (Wilson and Reeder 2005): From South Africa (Northern Cape Province) northwest through Namibia towards Brukaros-Karas Mtns and C. Namib Desert.

***Mastomys coucha* (Smith, 1834)**

Southern African mastomys

Museum records: MCZ: 46303;

Reported distribution in Mozambique: Sofala;

Known distribution (Wilson and Reeder 2005): Endemic to Southern African Subregion: South Africa (provinces of Eastern and Northern Cape, KwaZulu-Natal, Free State, Gauteng, Mpumalanga, and S. and W. Limpopo; also, in Lesotho), S. and W. Zimbabwe, C. Namibia.

Nesomyidae

***Dendromus mesomelas* (Brants, 1827)**

Brant's climbing mouse

Other recorded names: Dendromus mesomelas mesomelas;

Bibliographic records: Smithers and Tello (1976);

Reported distribution in Mozambique: Sofala;

Known distribution (Wilson and Reeder 2005): South Africa, N. Botswana, N.E. Namibia, N.W. Zambia, C. Mozambique. Steatomys krebsii Peters, 1852 Kreb's fat mouse

Museum records: USNM: 367224, 367225;

Reported distribution in Mozambique: Tete;

Known distribution (Wilson and Reeder 2005): Patchy distribution in Southern African Subregion; C and S.W. Angola, N.E. Namibia, N. Botswana, W. Zambia and South Africa.

B.3 List of Acronyms

AMNH American Museum of Natural History

BRTC Texas Cooperative Wildlife Collection

CAS California Academy of Sciences

EMBL European Molecular Biology Laboratory

FMNH Field Museum

HSUWM Humboldt State University

IICT Instituto de Investigacao Cientifica Tropical

ISM Illinois State Museum

KU University of Kansas Biodiversity Research Center

LACM Los Angeles County Museum of Natural History

MACN Museo Argentino de Ciencias Naturales

MCZ Museum of Comparative Zoology, Harvard University

MHNG Museum d Histoire Naturelle de la Ville de Geneve

MNCN Museo Nacional de Ciencias Naturales

MNHN Museum National d Histoire Naturelle

MSU Michigan State University Museum

MUP Museu de Historia Natural da Faculdade de Ciencias do Porto

MVZ Museum of Vertebrate Zoology, University of California

MZNA Museum of Zoology, University of Navarra

NHMUK Natural History Museum

NHMW Naturhistorisches Museum Wien

NMR Natural History Museum Rotterdam

NMZB Natural History Museum of Zimbabwe

NRM Naturhistoriska Riksmuseet

RBINS Royal Belgian Institute of Natural Sciences

RMCA Royal Museum for Central Africa

RMNH Rijksmuseum voor Natuurlijke Historie

ROM Royal Ontario Museum

SAMA South Australian Museum

SMF Senckenberg Naturmuseum Frankfurt

SNOMNH Sam Noble Oklahoma Museum of Natural History

TTU Museum of Texas Tech University

UNSM University of Nebraska State Museum

USNM National Museum of Natural History

UWBM University of Washington Burke Museum

WAM Western Australian Museum

ZMB Museum for Naturkunde

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