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**Authors:**
**Alan T. K. Lee**
**University of Cape Town**

**Craig Turner**
**Biosphere Expeditions &**
**Wychwood Environmental Ltd**

**Matthias Hammer (editor)**
**Biosphere Expeditions**

# Abstract

The fynbos biome of South Africa is a biodiversity hotspot renowned for its very high plant species richness, endemic birds and the presence of the Cape mountain leopard (*Panthera pardus*). Biodiversity monitoring across a range of faunal taxa was conducted in mountain fynbos habitat in the context of determining prey availability for leopard, caracal (*Caracal caracal*) and African wildcat (*Felis silvestris lybica*). Studies were conducted, with the help of international volunteers recruited by Biosphere Expeditions, at Blue Hill Nature Reserve, a recently established protected area where land management changed from agriculture to biodiversity conservation in 2009.

We examined prey availability at a spatial and temporal scale, using transects, Sherman traps and camera trap monitoring. Mammal density across all three measures suggests low mammal abundance and thus food availability for the predators in the fynbos ecosystem, which is known to have low carrying capacity.

Camera trap photos from fixed monitoring points were used to examine the recovery of medium to large mammal species at the study site. Trends were positive for most common species (with the exception of African wildcat), with significant increases in standardised capture rate indices reported for caracal, greater kudu (*Tragelaphus strepsiceros*) and grey rhebok (*Pelea capreolus*).

Transects to monitor wildlife also fed into a biome-wide survey to assess the status of the endangered Hottentot buttonquail (*Turnix hottentottus*), a bird endemic to the fynbos.

We also conducted the first bat survey undertaken at Blue Hill Nature Reserve using Anabat Express recording devices and report the presence of five bat species.



# Opsomming

Die fynbos bioom van Suid Afrika is wel bekend vir sy uitstekende biodiversiteit, met n groot aantal plante sorte, inheemse voels, en ook die Kaapse Berg Luiperd (*Panthera pardus*). Ons het biodiversiteit monitering onderneem oor n groot verskeidenheid fauna vanaf klein tot groot om te bepaal die beskikbaarheid van prooi vir luiperd, rooikat (*Caracal caracal*) en wildekat (*Felis silvestris lybica*). Hierdie studier was deur Biosphere Expeditions onderneem, wie vrywillige werkers gevind het om die monitering op die Blue Hill Natuur Reservaat en omgewings te implementeer. Blue Hill Natuur Reservaat is n nuwe beskermde gebied geïmplementeer in 2009 wat tevore n landbou gebied was.

Ons het prooi beskikbaarheid ondersoek op n ruimtelik en temporale skaal met gebruik van transects, Sherman-traps en automatiese kameras. Die aantal soogdiere oor al drie van die statistieke was baie laag, wat beteken min beskikbaarheid van kos vir die roofdiere in die fynbos sisteem, al hoewel daar alreeds kennis daarvan is.

Automaties kameras op konstante moniteering plekke was gebruik om te sien of daar herstel was van die aantal gemiddelde tot groot soogdiere nommers op Blue Hill. Oor die algemeen (behalwe wildekat) was die aantal fotos meer oor tyd, wat aandei herstel van die wild. Daar was beduidende verhogings vir rooikat, kudu (*Tragelaphus strepsiceros*) en vaal rhebok (*Pelea capreolus*).

Transects om wild oor die hele bioom te moniteer om die populasie van die bedreigde, inheemse Kaapse kwarteltjie (*Turnix hottentotus*) te ondervind was ook deur die expedisie gehelp. Die expedisie het ook die eerste vlermuis opmeeting onderneem met gebruik van Anabat recording devices, wat vyf spesies gevind het.

# Contents

# 1. Expedition review

M. Hammer (editor)
Biosphere Expeditions

## 1.1. Background

Biosphere Expeditions runs wildlife conservation research expeditions to all corners of the Earth. Our projects are not tours, photographic safaris or excursions, but genuine research expeditions placing ordinary people with no research experience alongside scientists who are at the forefront of conservation work. Our expeditions are open to all and there are no special skills (biological or otherwise) required to join. Our expedition team members are people from all walks of life, of all ages, looking for an adventure with a conscience and a sense of purpose. More information about Biosphere Expeditions and its research expeditions can be found at www.biosphere-expeditions.org.

This report deals with an expedition to South Africa's Cape Floral Kingdom that ran from 4 to 16 October 2015 and focused on monitoring two of Africa's iconic cats: the threatened Cape mountain leopard (*Panthera pardus*) and the caracal (*Caracal caracal*), in an effort to mitigate conflict with farmers and thereby contribute significantly to cat survival and their conservation. Working in the unique biome of South Africa's Cape Floral Kingdom (fynbos) – a UNESCO World Heritage Site and the world's only biome contained within one country – the expedition also conducted a larger biodiversity survey, focusing on cat prey species such as antelopes, as well as small mammals. The ultimate goal is to develop a remote monitoring technique that will better inform landowners of the status of their prey wildlife and predatory cats, identify potential conflict areas, and use the knowledge gained to mitigate conflicts. To this end the project's overall aim is to develop camera trap and transect monitoring techniques that will enable landowners to determine predator and prey densities on their land. The project also wants to contribute to the biodiversity monitoring of the area through the contribution to citizen science projects. To achieve all this, the expedition monitored the density, abundance, spatial distribution, home range size and habitat preferences of a known population of wildlife on a nature reserve using transect and camera trap techniques. It also monitored small mammal and cat prey species, such as antelopes, by trapping, camera trapping and flush survey efforts.

Almost all of Africa is under some sort of human impact and the Cape Floral Kingdom (fynbos) is no exception. Much wildlife roams on understaffed, underfinanced, remote, mountainous nature reserves where monitoring is difficult; or on private farmland where landowners have mixed attitudes to perceived problem animals such as leopard, caracal, jackal, baboon and bushpig. The Cape mountain leopard is one of South Africa's TOPS (Threatened Or Protected Species), which restricts legal hunting, but the laws are near impossible to enforce. There is a strong farmer lobby pushing for greater control of 'pest' species and anecdotal evidence suggests control by legal and illegal methods is widespread across the country.

Wherever humans and wildlife come together, conflicts tend to appear, and human–wildlife conflict has been identified as one of the biggest threats to biodiversity worldwide. Sound scientific knowledge is key to mitigating this conflict and to making wise management decisions that balance the need of humans, wildlife and the environment. We believe that knowledge is the key to conservation and the most effective way to mitigate human–wildlife conflict.

The Cape Floral Kingdom is one of the world's biodiversity hotspots and as such is a UNESCO World Heritage Site. It is dominated by a fire-driven ecosystem – the fynbos biome with unsurpassed botanical richness: 7,000 of 9,000 plant species that are found here are endemic. It is in the flower-filled Cape Fold Mountains of South Africa that the Cape mountain leopard is found – a leopard half the size of the savannah leopards of Africa, but with home ranges twice the size. In 2008 the IUCN (International Union for Conservation of Nature) classified leopards as Near Threatened, stating that they may soon qualify for the Vulnerable status due to habitat loss and fragmentation. Indeed, they are becoming increasingly rare outside protected areas.

### 1.2. Research area

At 1.2 million km$^2$ South Africa is the world's 25$^{th}$ largest country. It is incredibly biodiverse, with habitats ranging from forest to savannah, grassland, thicket, karoo, desert and fynbos. South Africa is also very rich in wildlife, and is a favoured Big Five safari destination.

The core of the study site is the Blue Hill Nature Reserve, a 2,300 ha CapeNature stewardship nature reserve with mountains ranging from 1,000 to just under 2,000 m and under the care of the Lee Family Trust. CapeNature is the Western Cape provincial conservation department in charge of the network of nature reserves of the Western Cape. The property was purchased in 2009 by Chris Lee, a retired geologist who has been awarded the Draper Memorial Award for contributions to South African geology. The land was previously used for cattle ranching. It was incorporated into the local community conservancy in 2010 and officially declared a nature reserve in 2013. The trust has an obligation to manage the land for biodiversity under a management plan administered by Eastern Cape Parks and Tourism, the state organisation charged with managing the Baviaanskloof Mega Reserve.


**Figure 1.2a.** Flag and location of South Africa and study site.

An overview of Biosphere Expeditions' research sites, assembly points, base camp and office locations is at Google Maps.

Blue Hill lies on the western side of the massive Baviaanskloof Mega Reserve and wildlife is free to move between these protected areas. The Baviaanskloof area is one of outstanding natural beauty, owing to its spectacular landforms, a diverse array of plants and a wide variety of animals. The area is also part of the Cape Floristic Region World Heritage Site as of 2004.

### 1.3. Dates

The project ran for one two-week slot, composed of a team of international research assistants, scientists and an expedition leader. Slot dates were 4 – 16 October 2015.

Team members could join for multiple slots (within the periods specified). Dates were chosen to coincide with spring and the period associated with the mildest climate in terms of temperature extremes.

### 1.4. Local conditions & support

Expedition base

The expedition team was based at Blue Hill, a former farmstead in a remote part of the mountains. Team members shared, on a twin bed basis, comfortable rooms with beds, linen and all modern amenities such as mains power, hot showers and WCs. There is also a communal building with a dining room and a lounge with sofas and a fireplace. All meals were prepared for the team and special diets could be catered for by prior arrangement.

Weather

The weather during the expedition was mild to warm, with a cold front arriving on the last few days. The average daytime temperature was 19 ± 6ºC, while temperatures at night averaged 16 ± 5ºC. Rainfall recorded was 4.4 mm. Temperature data were taken from an on-site Davis Vantage-Vue weather station that recorded weather every 30 minutes during the month of October.

Field communications

There was a landline telephone for receiving calls and (slow) internet/email access at base. Mobile phones were used for communication between teams and around the study site. The expedition leader posted a diary with multimedia content on Wordpress and excerpts of this were mirrored on Biosphere Expeditions' social media sites such as Facebook and Google+.

Transport & vehicles

Team members made their own way to the assembly point in the city of George, Western Cape, in time. From there onwards and back to George, all transport (4WD vehicles and mountain bikes) was provided for the expedition team. Expedition participants were trained in the use of the 4WD vehicles and thereafter drove them around the study site.

Medical support and incidents

The expedition leader was a trained first aider, and the expedition carried a comprehensive medical kit. South Africa's healthcare system is of an excellent standard and the nearest doctor and public hospital are in Uniondale (45 km/45 minutes). The nearest private clinic is in George (200 km/2 hours). Safety and emergency procedures were in place, but did not have to be invoked as there were no serious medical or other incidents.

### 1.5. Local scientist

Dr Alan Lee, the expedition's field scientist, was born in Zimbabwe and educated in pre- and post-apartheid South Africa. He graduated from the University of Witwatersrand with an Honour's Bachelor's Degree in Botany and Zoology in 1996. While working and travelling from London he obtained a Diploma in Computing in 2001. He then commenced a period of seven years in Peru, first working for a volunteer project investigating impacts of tourism on Amazonian wildlife, and then from 2005 to 2010 undertaking a Ph.D. on the parrots of the Peruvian Amazon. Biosphere Expeditions part-financed and contributed data to the Ph.D. resulting in three peer-reviewed publications. In 2011 Alan set up the Blue Hill Escape guest establishment on the Blue Hill Nature Reserve with his wife, Anja, and parents Chris and Elaine Lee. In 2012 he was accepted as a postdoctoral research fellow at the Percy FitzPatrick Institute of African Ornithology at the University of Cape Town to undertake an assessment of the status of the endemic birds of the fynbos.

### 1.6. Expedition leader

Craig Turner was born in Oxford, England. He studied biology, ecology and environmental management at Southampton, Aberdeen and London universities. Soon after graduating from his first degree, he left the UK for expedition life in Tanzania. Since then, he has continued to combine his interest in travel and passion for conservation, working with a wide range of organisations on projects and expedition sites in the Americas, Africa, Asia and the Pacific. He has managed expedition grant programmes for the Zoological Society of London, been a frequent contributor to the 'Explore' conference held by the Royal Geographical Society, and is an active member of the British Ecological Society Review College. Having visited and/or worked in more countries than years have passed, he is ever keen to share his exploits, writing for several magazines, and is a published photographer.

### 1.7. Expedition team

The expedition team was recruited by Biosphere Expeditions and consisted of a mixture of all ages, nationalities and backgrounds. They were (in alphabetical order and with country of residence): Martha Anderson (USA), Bill Caudwell (UK), David Glossop (UK), Georg Keller (Switzerland), Christine Marklow (UK), Andrew (Prasadu) Porritt (UK), Khomotso Rammala* (South Africa).

*Placement kindly supported by the Friends of Biosphere Expeditions. The Biosphere Expeditions placement programme seeks to identify, train and encourage the next generation of local conservationists.

### 1.8. Expedition budget

Each team member paid towards expedition costs a contribution of £1,790 per person per two-week slot. The contribution covered accommodation and meals, supervision and induction, special research equipment and all transport from and to the team assembly point. It did not cover excess luggage charges, travel insurance, personal expenses such as telephone bills, souvenirs etc., or visa and other travel expenses to and from the assembly point (e.g. international flights). Details on how this contribution was spent are given below.

| **Income** | £ |
|---|---|
| Expedition contributions | 11,825 |
| | |
| **Expenditure** | |
| Expedition base<br>includes all board & lodging | 1,412 |
| Transport<br>includes transfers, car hire, fuel | 1,870 |
| Equipment and hardware<br>includes research materials & gear etc. purchased in South Africa & elsewhere | 3,876 |
| Staff<br>includes local and Biosphere Expeditions staff salaries and travel expenses | 4,992 |
| Administration<br>includes miscellaneous fees & sundries | 540 |
| Team recruitment South Africa<br>as estimated % of annual PR costs for Biosphere Expeditions | 4,186 |
| | |
| **Income – Expenditure** | **-5,051** |
| | |
| **Total percentage spent directly on project** | **143%*** |

*This means that in 2015, the expedition ran at a loss and was supported over and above the income from the expedition contributions by Biosphere Expeditions.

## 1.9. Acknowledgements

We are grateful to the volunteers, who not only dedicated their spare time to helping but also, through their expedition contributions, funded the research. Thank you also to Bool Smuts and the staff of the Landmark Foundation, and to all those who provided assistance and information. Biosphere Expeditions would also like to thank members of the Friends of Biosphere Expeditions and donors for their sponsorship. Finally, thank you to Chris, Elaine and Anja Lee for being such excellent hosts and making us feel at home at the expedition base.

## 1.10. Further information & enquiries

More background information on Biosphere Expeditions in general and on this expedition in particular including pictures, diary excerpts and a copy of this report can be found on the Biosphere Expeditions website www.biosphere-expeditions.org.

Enquires should be addressed to Biosphere Expeditions at the address given on the website.

# 2. Prey availability for leopards and other carnivores in mountain fynbos

Alan Tristram Kenneth Lee
University of Cape Town

## 2.1. Introduction

The African leopard (*Panthera pardus pardus*) is a leopard subspecies occurring across most of sub-Saharan Africa. In 2008, the IUCN classified leopards as Near Threatened, stating that they may soon qualify for the Vulnerable status due to habitat loss and fragmentation. They are becoming increasingly rare outside protected areas and leopards in southernmost populations exist in the Eastern and Western Cape, South Africa, in a fragmented population structure with lower than expected genetic diversity (McManus et al. 2015). The author believes leopard population may become isolated within a few generations and management actions that increase habitat connectivity and reduce human–carnivore conflict are needed.

The ecology and activity patterns of leopards have been studied intensively in savannah and forest habitats (e.g. Braczkowski et al., 2012, Balme et al., 2007, Balme et al., 2012), but little information is available from the rugged mountain areas of the Cape Fold Mountains. These mountains are dominated by the fynbos habitat type of the Cape Floristic Region, a nutrient-poor and fire-driven ecosystem. Historical accounts indicate that a high and diverse number of large (>20 kg) indigenous herbivores occurred here, especially in lowland areas (Boshoff and Kerley, 2001), but avoided nutrient-poor sandstone fynbos in favour of more nutrient-rich renosterveld (a term used for one of the major plant communities and vegetation types of the Cape Floristic Region) (Radloff, 2008). In association with these large herbivores, all the members of the large carnivore guild including lion were found (Skead et al., 2011).

Now leopards are the only remaining top predator in the Western Cape and Eastern Cape (Martins and Martins, 2006). They play a critical role in ecosystem structure; for instance, control of other species such as the black-backed jackal (*Canis mesomelas*). Male Cape mountain leopards average 35 kg (in stark contrast to savannah leopards, where males of up to 90 kg have been recorded) and females average 21 kg, which is slightly more than the smallest leopard subspecies, the Arabian leopard (*Panthera pardus nimr*) at 17 kg. Male leopard home ranges from the Baviaanskloof, South Africa, have been recorded in excess of 600 sq km and are amongst the largest known territories ever recorded (McManus, unpublished data). An estimate is that there are fewer than 1,000 Cape mountain leopards in total (Martins and Martins, 2006).

Dietary studies suggest different dietary preferences depending on area, but favoured prey include klipspringer (*Oreotragus oreotragus*), dassie (rock hyrax, *Procavia capensis*), porcupine (*Hystrix africaeaustralis*) and mice for mountain leopards (Martins et al., 2011). By contrast, leopards from forested areas in this region eat more locally abundant prey such as bushbuck (*Tragelaphus scriptus*), while very few baboons (*Papio ursinus*) are eaten as these group living animals can be very dangerous (Braczkowski et al., 2012b). Leopards do predate livestock, which can constitute a significant part of their diet for individuals whose territory overlaps with agricultural areas, and this leads to conflict with livestock farmers (Inskip and Zimmermann, 2009).

Due to the small size of the Cape mountain leopard, it is likely that there is a degree of competition with the second largest feline in the area, the caracal (*Caracal caracal*). A male caracal at 20 kg weighs nearly as much as a female leopard. The caracal is considered a generalist and very adaptable predator, recorded taking a diverse array of prey items ranging from small birds and reptiles to antelope many times their own size (Avenant and Nel, 2002, Melville et al., 2004, Braczkowski et al., 2012a). They also appear to display a wider habitat tolerance than Cape mountain leopard, occurring from moist mountain fynbos to arid karoo habitats in the region. It is likely they are more tolerant of human landscape modification and therefore cause much damage to small livestock across South Africa (Thorn et al., 2012). They are therefore much despised amongst the local farming community and frequently the target of problem animal control measures.

In this first step of our broader study aim to describe predator diets in relation to available prey items in order to identify dietary partitioning in a predator community, we aim to document potential prey availability at a mountain fynbos site. We do this through camera trapping for medium to large mammals, Sherman trapping for small mammals, and flush transects for small to medium mammals, as well as game bird species.

## 2.2. Materials and methods

Study area

The fynbos biome (fynbos, also known as the Cape Floral Kingdom/Cape Floristic Region) comprises one of only six floral kingdoms in the world and is contained entirely within the political boundaries of South Africa, where it is mostly restricted to the Western and Eastern Cape provinces of the Cape Fold Belt. Owing to its exceptional plant species richness and high level of endemism, as well as high levels of animal diversity and endemism, it is recognised as one of the world's 25 biodiversity 'hotspots' (Myers et al., 2000). The biome takes its name from 'fynbos', the dominant vegetation type. The other two main vegetation types are 'renosterveld' and 'strandveld'. Vegetation is dominated by three characteristic families: Proteaceae, Ericaceae and Restionaceae. The region experiences significant winter rainfall, although summer rainfall can predominate in the eastern regions. The fynbos is a fire-driven ecosystem, with most plant species adapted to an intermittent fire regime (6–40 years). Conversion to agriculture, urbanisation and the invasion of a variety of alien plant types pose major conservation threats to the area.

Transects were conducted across the biome, although we report on camera trapping and small mammal trapping from the Blue Hill Nature Reserve only here (BHNR; -33.56 to -33.62; 23.40 to 23.43E; Figure 2.1a). BHNR is situated on the western border of the Baviaanskloof Nature Reserve, Western Cape, South Africa. The greater Baviaanskloof Nature Reserve encompasses a range of biomes including savannah, afromontane forest, thicket, fynbos, nama and succulent karoo. The 2,230 ha BHNR lies between 1,000 and 1,530 m above sea level (m asl) in fynbos. The reserve falls into an aseasonal rainfall region, with annual informal records from the closest town, Uniondale (40 km distant, 730 m asl), for the 1965–1997 period 344 ± 102mm (Lee and Barnard, 2013). The property that forms the reserve was acquired by the Lee Family Trust in 2009 who initiated a partnership with CapeNature, the Western Cape provincial agency in charge of protected areas, to convert the land to a stewardship nature reserve. This process was completed in 2013 with the land now managed for biodiversity.

Prior to this, recent use of the land had been for agricultural purposes, mostly stock farming of cattle and sheep. Rifle cartridges are frequently found even in remote areas, indicating widespread hunting activities. The area has been influenced by European heritage settlers for approximately two to three hundred years, and native inhabitant rock art in cave shelters indicates Khoi-San presence prior to this, although the scope and scale of any settlement is unknown.

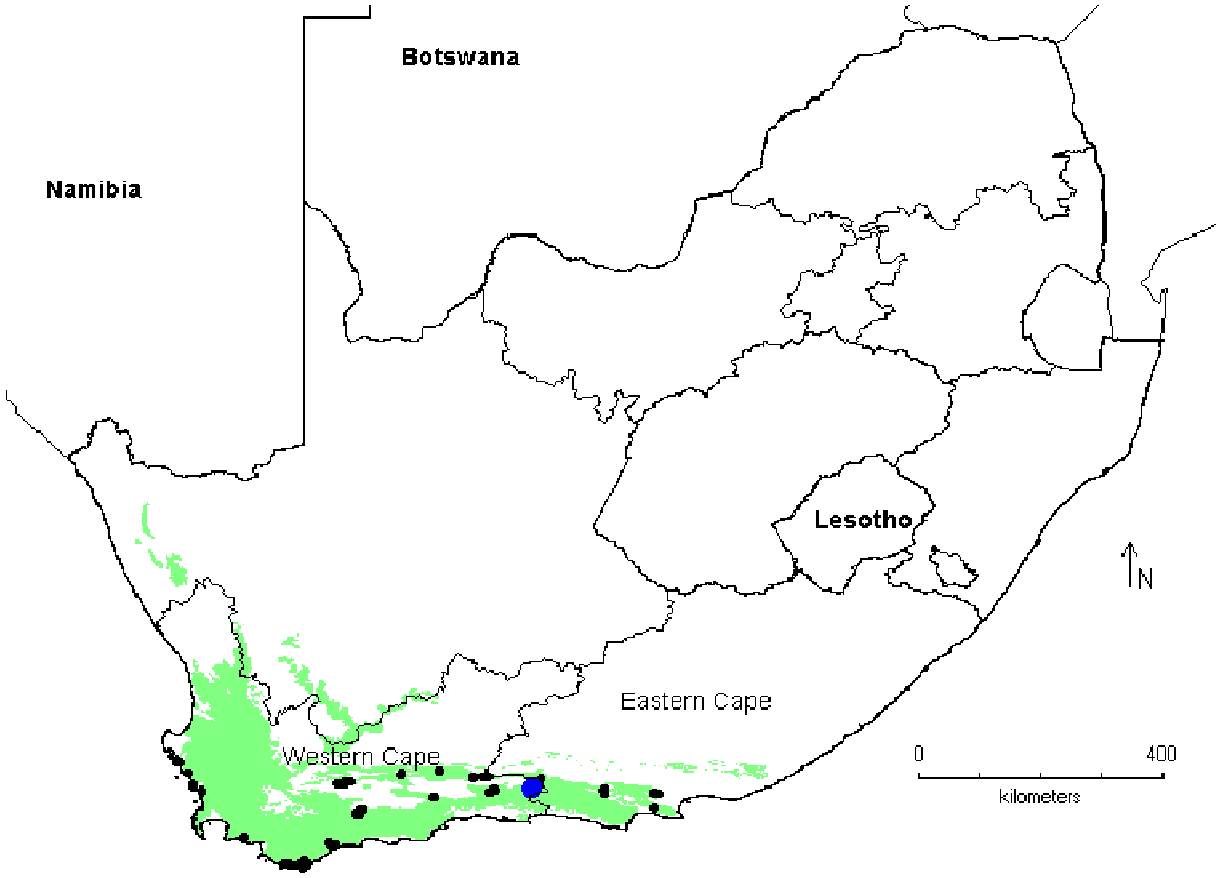


**Figure 2.1a.** Study area map, with fynbos biome (green), location of BHNR (blue circle) and sites where flush surveys were conducted (black circles).

Medium to large mammal relative abundance from camera traps

To quantify relative abundance of medium to large mammals at BHNR, we considered a database of photos from camera traps placed both randomly and at fixed point monitoring positions across the reserve. In most cases, camera placement was non-random, with fixed point monitoring conducted at old gate positions along vehicle tracks. This is likely to bias results for species, such as leopards, which make frequent use of man-made tracks. We also did not correct for size, although size is known to influence probability of capture by remote cameras. Camera placement was typically low – from ground level to 50 cm – due to the expected dominance of small to medium mammals. Number of active camera traps ranged from 4 to 10, depending on resources available. All cameras were set to take photographs, and in some cases additional video footage was also recorded after the initial photograph. All cameras were set with an inactive period of 30 seconds, i.e. minimum time between sequential photographs.

The first camera traps were placed on 11 May 2010, and we analysed data from 6,703 photos taken over 3,455 trap nights (sum of nights when camera traps were active) until 16 June 2016. Sampling was effectively conducted over 1,192 unique dates. Biosphere Expeditions team members in October 2016 entered much of the data (>3,000) after training on mammal identification.

We present two indices of abundance:

1. Relative Abundance Index (RAI): total number of individuals observed in all photographs/trap nights. This index will be ranked higher for species in larger groups (more individuals and photos per time interval, e.g. baboons).

2. Occupancy Rate Index (ORI): sum of unique capture dates/sampling period (1,192). This is a broader index that simply records the presence or absence of a species and is likely to be higher for more mobile or widespread species (leopard, aardvark) and less influenced by local group size.

We tested the correlation between these metrics at the species level using Spearman's ranked correlation coefficients in R (R Core Team, 2015).

Small mammal abundance from Sherman traps

In order to sample small mammal abundance, we created two Sherman trapping arrays at BHNR based on guidelines from Manley et al. (2006, Chapter 5: Small Mammal Monitoring). Fifty Sherman LFA folding traps (3 x 3.5 x 9" or 7.62 x 8.89 x 22.86 cm) were placed along four routes (two routes in each array with 25 traps each spaced at approx. 25 metre intervals), with sampling on the first array over three nights, and then moved to the second array for a further three nights. Arrays were positioned along an altitudinal gradient, on north- and south-facing slopes in fynbos approximately 16 years since the last fire. Traps were baited with peanut butter and a commercial mixed bird food. Traps were placed in sheltered locations near rocks or under bushes and checked twice a day. Trapped animals were photographed if necessary for identification, weighed and then released. Sampling was conducted from 8 October 2015 to 14 October 2015.

Due to low species diversity, we pooled all captures to examine the influence of aspect and altitude. We used binomial logistic modelling for capture vs non-capture from each trap check, keeping the individual trap location as a random effect. For modelling we used the lme4 package (Bates et al., 2013) and obtained p values using the lmerTest package (Kuznetsova et al., 2013) in R. We also used logistic regression to test for differences in capture rates between arrays and between morning and afternoon trap checks.

Terrestrial bird and mammal abundance from flush surveys

In order to determine encounter rates and densities of potential prey items, we conducted 'flush' surveys at BHNR and further sites across the fynbos biome. A flush survey is a multiple observer survey with observers spaced ideally at 5-metre intervals. The length of the survey line is noted, and area calculated as the number of observers x 5 (for sphere of influence) x length. We recorded all encounters with a target set of terrestrial birds and mammals of adult size >2 kg.

We present an index of relative abundance as total number of individuals observed per kilometre with mean and standard deviation presented as the sum of all individuals observed per kilometre of transect walked, using each transect as the sampling unit. We also calculate density (individuals/ha) as the subset of all individuals observed within the transect line. Angle and distance were also recorded to groups outside the line of the transect for considered use of distance-sampling techniques (Buckland et al., 2005). However, we did not receive the minimum number of group encounters with this information (20) for any of our target species to use this technique for the sample period presented here (October 2015 – February 2016).

It is important to note that our surveys were centred around attempts to document the presence and local density of the endangered and endemic Hottentot buttonquail (*Turnix hottentottus*). Survey routes were placed to optimise encounter rates with this species and hence transect placement does not follow a truly randomised design to allow unbiased estimates for all the species recorded. Transects were preferentially aligned through habitat with gentle slopes and in younger fynbos (time since last fire). The estimates thus only describe encounter rates and density estimates for fynbos fitting the following slope and fire descriptions (Fig. 2.2).

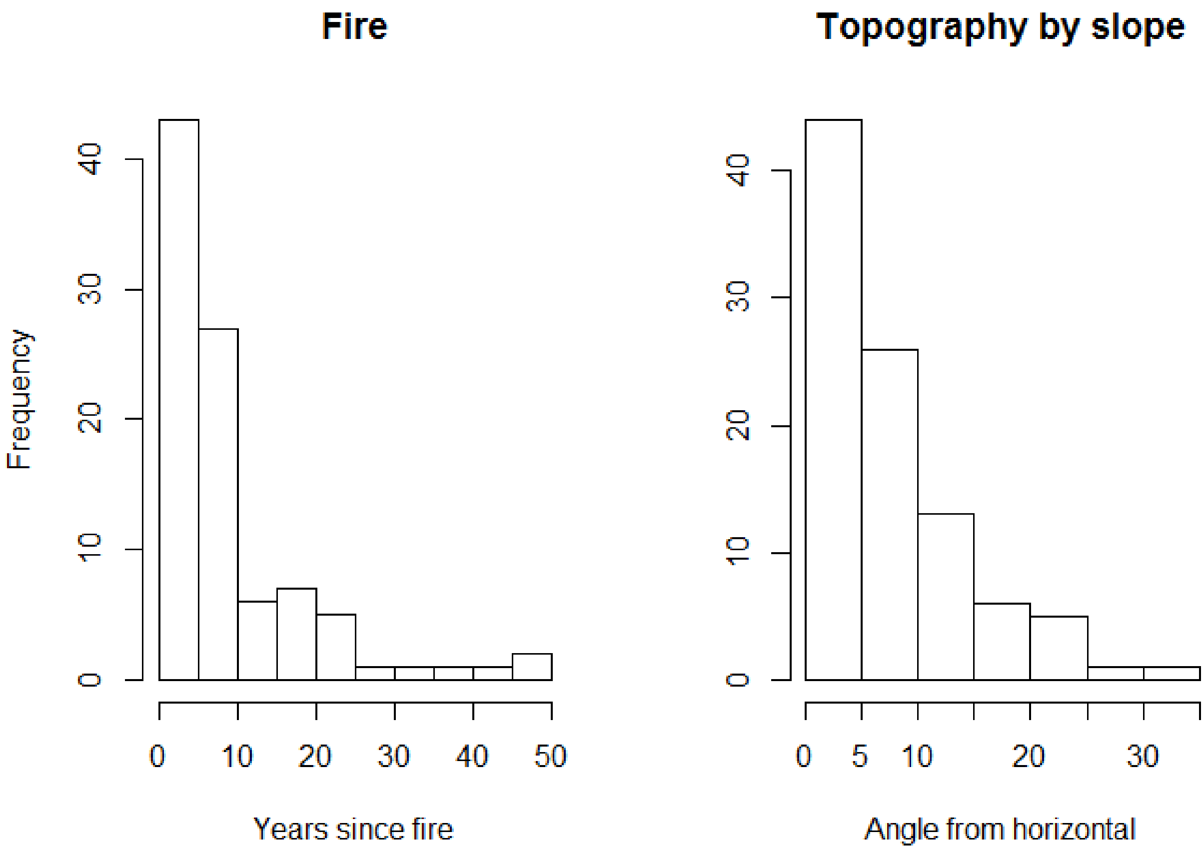


**Figure 2.2.** Histograms of mean time since fire (left) and slope (right) for 96 transects conducted across the fynbos biome indicating sampling bias towards young veld (<10 years since fire) and gentle terrain (<10 degree slope).

## 2.3. Results

Medium to large mammal relative abundance from camera traps

We recorded at least 27 different species of mammal from camera trap photos at BHNR (Table 2.3a), ranging in size from the greater kudu to an unidentified rodent species. Baboons were the most numerous (RAI = 61%), while a variety of species were recorded only once, including Cape genet, vervet monkey and black-backed jackal. Baboons were only third on the Occupancy Rate Index (ORI = 21%), with common duiker the highest (49%), followed by Cape grysbok (ORI = 39%). Humans were frequently recorded on camera (ORI = 19%), as were vehicles (ORI = 21%). By contrast, leopard and caracal both had ORI = 4%, twice that of African wildcat at 2%. In other words, on any given night there was a 4% chance that a leopard or caracal would be recorded by the camera traps deployed at BHNR.

**Table 2.3a.** Medium to large mammals recorded by camera traps at BHNR for the 2010–2015 period. n = total number of individuals in photos; RAI = Relative Abundance Index (n/3517); Freq = number of days a species was recorded; ORI = Occupancy Rate Index (Freq/1192); mean and SD are mean and standard deviation of the number of individuals recorded in each photo (group size).

| Species | n | RAI | Freq | ORI | Mean | SD |
|---|---|---|---|---|---|---|
| Chacma baboon *Papio ursinus* | 2142 | 0.61 | 250 | 0.21 | 1.56 | 1.09 |
| Common duiker *Sylvicapra grimmia* | 1118 | 0.32 | 582 | 0.49 | 1.01 | 0.12 |
| Cape grysbok *Raphicerus melanotis* | 894 | 0.25 | 460 | 0.39 | 1.03 | 0.16 |
| Grey rhebok *Pelea capreolus* | 319 | 0.09 | 160 | 0.13 | 1.12 | 0.41 |
| Greater kudu *Tragelaphus strepsiceros* | 225 | 0.06 | 101 | 0.08 | 1.07 | 0.38 |
| Aardvark *Orycteropus afer* | 133 | 0.04 | 116 | 0.1 | 1.01 | 0.09 |
| Rock hyrax *Procavia capensis* | 101 | 0.03 | 19 | 0.02 | 1.06 | 0.24 |
| Honey badger *Mellivora capensis* | 73 | 0.02 | 47 | 0.04 | 1.11 | 0.31 |
| Cape porcupine *Hystrix africaeaustralis* | 72 | 0.02 | 48 | 0.04 | 1.11 | 0.31 |
| Leopard *Panthera pardus* | 66 | 0.02 | 53 | 0.04 | 1.03 | 0.18 |
| Caracal *Caracal caracal* | 64 | 0.02 | 47 | 0.04 | 1.02 | 0.13 |
| Bushpig *Potamochoerus larvatus* | 61 | 0.02 | 34 | 0.03 | 1.05 | 0.29 |
| Klipspringer *Oreotragus oreotragus* | 54 | 0.02 | 30 | 0.03 | 1 | 0 |
| Hare *Lepus* sp. | 42 | 0.01 | 31 | 0.03 | 1 | 0 |
| Gemsbok *Oryx gazella* | 33 | 0.01 | 28 | 0.02 | 1 | 0 |
| Grey mongoose *Galerella pulverulenta* | 29 | 0.01 | 18 | 0.02 | 1 | 0 |
| African wildcat *Felis silvestris lybica* | 26 | 0.01 | 24 | 0.02 | 1 | 0 |
| Water mongoose *Atilax paludinosus* | 11 | 0 | 8 | 0.01 | 1 | 0 |
| Meerkat *Suricata suricatta* | 7 | 0 | 6 | 0.01 | 1 | 0 |
| Mountain reedbuck *Redunca fulvorufula* | 4 | 0 | 4 | 0 | 1 | 0 |
| Aardwolf *Proteles cristata* | 3 | 0 | 3 | 0 | 1 | 0 |
| Cape clawless otter *Aonyx capensis* | 2 | 0 | 2 | 0 | 1 | 0 |
| Cape genet *Genetta tigrina* | 1 | 0 | 1 | 0 | 1 | NA |
| Jackal *Canis mesomelas* | 1 | 0 | 1 | 0 | 1 | NA |
| Mouse (unidentified) | 1 | 0 | 1 | 0 | 1 | NA |
| Red-tailed rock rabbit *Pronolagus* sp. | 1 | 0 | 1 | 0 | 1 | NA |
| Vervet monkey *Chlorocebus pygerythrus* | 1 | 0 | 1 | 0 | 1 | NA |

In addition, a variety of other species or taxa were included, including domestic cat, dog, sheep and cow from neighbouring properties, as well as leopard tortoise (*Stigmochelys pardalis*), the only reptile. Twenty species of bird were identified ranging in size from the large black-headed heron (*Ardea melanocephala*) to the much smaller Cape weaver (*Ploceus capensis*). Medium-sized game birds including Cape spurfowl (*Pternistis capensis*), red-necked spurfowl (*Francolinus afer*) and grey-winged francolin (*Francolinus africanus*) were most common. Elevent percent of photographs were classified as blank, with no animals present, while 3% could not be identified to a useful taxonomic group.

As expected, baboons appeared to have the largest group sizes in terms of numbers of individuals per photo frame, although the mean of 1.5 ± 1 is by no means a realistic metric of actual group size since it would be practically impossible to capture an entire group in one photo frame.

Small mammal abundance from Sherman traps

Capture success along the Sherman trap arrays was low: 4% (21 captures of 500 checks), with at least one confirmed recapture and one suspected recapture. Identifiable species were: striped field mouse *Rhabdomys pumilio* (n = 3); Cape elephant shrew *Elephantulus edwardii* (2); Namaqua rock mouse *Aethomys namaquensis* (6); and African pygmy mouse *Mus minutoides* (1). There was uncertainty regarding the identification for nine individuals, which most closely resembled Namaqua rock mouse, but differed in weight perhaps due to age (Table 2.3b).

**Table 2.3b.** Rodent species capture totals from Sherman traps, together with mean and standard deviation (SD) of mass.

| Species | n | Mean mass (g) | SD |
|---|---|---|---|
| Striped field mouse *Rhabdomys pumilio* | 3 | 32.7 | 20.4 |
| Cape elephant shrew *Elephantulus edwardii* | 2 | 61.4 | 1.5 |
| Namaqua rock mouse *Aethomys namaquensis* | 6 | 55.8 | 5.0 |
| African pygmy mouse *Mus minutoides* | 1 | 21.1 | NA |
| Unidentified | 9 | 41.3 | 15.9 |

Capture rates were significantly higher during morning trap checks ($z = -3.4$, $p < 0.01$), suggesting strong nocturnal behaviour among this community of small mammals. Neither altitude nor aspect were significant predictors in a model of capture probability (Table 2.3c). No other small mammals or other taxa were captured. There was no difference between the two array locations ($z = -0.87$, $p = 0.38$).

**Table 2.3c.** Model results of probability of capture in Sherman traps as a function of altitude and aspect (N or S).

| | Estimate | SE | z value | Pr(>\|z\|) |
|---|---|---|---|---|
| (Intercept) | 3.364 | 4.516 | 0.745 | 0.456 |
| Altitude | -0.006 | 0.004 | -1.399 | 0.162 |
| Aspect S | -0.258 | 0.452 | -0.570 | 0.569 |

Terrestrial bird and mammal abundance from flush surveys

The 96 flush surveys conducted to date were conducted over 214 km covering a combined sample area of 565 ha. While nominally an impressive effort, only nine species of mammal were recorded (Table 2.3d), compared to the 28 for camera trap surveys (see above). We also recorded information for nine target bird species. While clapper lark was most frequently encountered, biomass per hectare was highest for the mammal species baboon (1 kg/ha), grey rhebok (0.33 kg/ha) and duiker (0.29 kg/ha).

**Table 2.3d.** Encounter rates (ind/km), densities (ind/ha) and resulting biomass/ha (mean of density x mass) for terrestrial birds and mammals in young fynbos of gentle terrain. Results are from 96 surveys from across the fynbos biome. Mass is the average of mass ranges identified from a variety of internet resources.

| Species | Mass (kg) | Individuals | Groups | Ind/km Mean | SD | Ind/ha Mean | SD | Biomass/ ha |
|---|---|---|---|---|---|---|---|---|
| Clapper lark *Mirafra apiata* | 0.04 | 60 | 49 | 0.344 | 0.832 | 0.074 | 0.232 | 0.0030 |
| Grey-winged francolin *Francolinus africanus* | 1.5 | 36 | 10 | 0.144 | 0.575 | 0.037 | 0.211 | 0.0555 |
| Hottentot buttonquail *Turnix hottentottus* | 0.03 | 34 | 28 | 0.159 | 0.634 | 0.034 | 0.137 | 0.0010 |
| Baboon *Papio ursinus* | 30 | 49 | 5 | 0.265 | 1.488 | 0.033 | 0.327 | 0.9900 |
| Cape spurfowl *Pternistis capensis* | 1.35 | 35 | 10 | 0.125 | 0.726 | 0.03 | 0.257 | 0.0405 |
| Long-billed pipit *Anthus similis* | 0.03 | 17 | 16 | 0.078 | 0.309 | 0.024 | 0.092 | 0.0007 |
| Common quail *Coturnix coturnix* | 0.5 | 25 | 21 | 0.084 | 0.275 | 0.021 | 0.077 | 0.0105 |
| Common duiker *Sylvicapra grimmia* | 18 | 9 | 9 | 0.064 | 0.303 | 0.016 | 0.128 | 0.2880 |
| Grey rhebok *Pelea capreolus* | 25 | 14 | 5 | 0.052 | 0.393 | 0.013 | 0.11 | 0.3250 |
| Cape rockjumper *Chaetops frenatus* | 0.05 | 31 | 26 | 0.123 | 0.435 | 0.011 | 0.068 | 0.0006 |
| Red-tailed rock rabbit *Pronolagus* sp. | 2 | 8 | 8 | 0.019 | 0.111 | 0.007 | 0.041 | 0.0140 |
| Cape Grysbok *Raphicerus melanotis* | 10 | 4 | 4 | 0.016 | 0.081 | 0.003 | 0.017 | 0.0300 |
| Steenbok *Raphicerus campestris* | 11 | 5 | 4 | 0.025 | 0.125 | 0.002 | 0.018 | 0.0220 |
| Unknown francolin | 0.6 | 3 | 3 | 0.016 | 0.117 | 0.002 | 0.014 | 0.0012 |
| Red-necked spurfowl *Francolinus afer* | 0.6 | 1 | 1 | 0.002 | 0.015 | 0.001 | 0.005 | 0.0006 |
| Dassie rock hyrax, *Procavia capensis* | 4 | 4 | 2 | 0.024 | 0.164 | 0 | 0 | 0.0000 |
| Klipspringer *Oreotragus oreotragus* | 12 | 7 | 5 | 0.028 | 0.135 | 0 | 0 | 0.0000 |
| Mountain reedbuck *Redunca fulvorufula* | 30 | 1 | 1 | 0.01 | 0.102 | 0 | 0 | 0.0000 |

## 2.4. Discussion & conclusions

Medium to large mammal relative abundance from camera traps

Overall, the presence of potential medium to large prey species for caracal and leopard at BHNR appears healthy, with a variety of small to medium antelope and game bird species that are more common than the predators. Baboon and duiker were noted as being especially common, with support for this coming from the flush survey conducted on a wider scale. It is interesting to note the very low encounter rate with black-backed jackal, a species confirmed to cause stock losses on neighbouring farms. Whether this is due to the presence of leopard can only be speculated upon.

Small mammal abundance from Sherman traps

The results presented in this report represent the first formal small mammal survey at BHNR. While three of the species recorded were known to be present, the capture of several Namaqua rock mice presented a novel species for the BHNR list.

Capture rates were low given that the veld condition was perceived to be good after above average winter rainfall. However, the previous summer had been unseasonably hot and dry, with very low capture rates of birds at the study site. Capture rates of birds have been shown to be correlated with actual density (Lee et al., 2015). In addition, local crop failures at BHNR were noted during that season, partly attributed to a late spring frost. It is possible that the capture rates were low as a consequence of unfavourable conditions in the previous breeding season and it is likely that capture rates in forthcoming years will be different, especially since rodents are known to react and breed quickly in response to favourable environmental conditions.

It is also likely that this set of mammals is a food source for caracal and certainly for African wildcat. Low African wildcat ORI may be linked to low food resources as well as the presence of the larger, competitor felids. It will certainly be of interest to conduct follow-up surveys at these sites in coming years and relate small mammal capture rates to wildcat and other predator species presence.

Terrestrial bird and mammal abundance from flush surveys

Given the fairly substantial survey effort involving many people, all of which was conducted on foot, the species richness and density estimates from the biome-wide survey of terrestrial birds and mammals were surprisingly low. Some species were likely not detected due to their nocturnal habits when shelter is sought in burrows: aardvark, bushpig, porcupine and to a lesser degree honey badger, otter and water mongoose. No felids were encountered, although this may well be due to flight before detection. Certainly, it may be additional evidence for the rarity of these species.

In terms of potential prey items, biomass of mammals per hectare is much higher than that of game birds. This would indicate that energy expended in hunting efforts would be far more valuably spent on hunts of available mammals, likely accounting for the relatively low abundance of birds in previous dietary studies of leopard and caracal (Melville et al., 2004, Braczkowski et al., 2012b).

Conclusions and future research

The information collected by the participants of one South African expedition is very impressive, and we have a far better understanding of the species richness and relative abundance of mammals both at BHNR and for the wider fynbos biome. Generally, this study confirms that encounter rates at all levels of potential prey for the carnivores that live in mountain fynbos are low. It has been postulated that the low density and large ranges of mountain leopard are to a degree a function of low prey availability (Martins et al., 2011). This study corroborates these findings. In addition, most potential prey items are small and thus there would be selective pressure against large individuals forced to hunt more frequently or to hunt the more scarce large prey items. We postulate that this, rather than any physiological adaptation to the harsh fynbos climate, is the mechanism resulting in the much smaller body size of the Cape mountain leopard.

There is much that can be considered for future avenues of research that need to be realised. For example, comparative measures of prey abundance on stock land could inform land management decisions that result in decreased conflict. Dietary analysis of scat would provide information on prey preference given abundance in the landscape, where sampling is also ideally undertaken across the biome with analysis conducted through modern genomic sampling techniques. The failure of research to address the range-wide conservation needs of leopards in South Africa has been noted as a case study (Balme et al., 2014) and we feel that our research here has contributed to understanding a little bit more about why the Cape mountain leopards are the way they are and why they do what they do.

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# 3. Annual patterns of mammal abundance at a mountain fynbos site

Alan Tristram Kenneth Lee
University of Cape Town

## 3.1. Introduction

Changing land use may result in profound changes in biodiversity (DeFries et al., 2004). These changes are normally described in terms of environmental degradation as a result of greater human influence (Kerr and Currie, 1995). Fewer studies examine the result of biodiversity change in the face of land management change designed for biodiversity with reduced human impact. Here we report on the changes observed in species encounter rates from camera traps placed at Blue Hill Nature Reserve (BHNR), Western Cape, South Africa. With the cessation of hunting plus reduced competition for browse and graze resources, we expect increases in the frequency of capture of medium to large mammal species as recorded by camera traps.

## 3.2. Methods

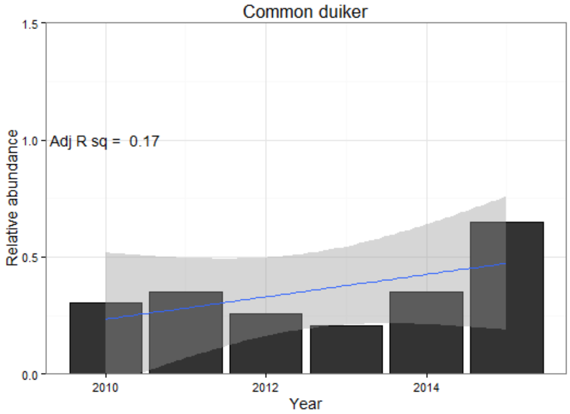
We examined the camera trap database described in Chapter 2 of this report, which contains data for the period 11 May 2010 to 14 July 2015. For each of the most common species we created a relative reporting rate index based on the total number of individuals observed in all camera trap photos divided by the number of active camera trapping nights for each year (Table 3.2a). We explored the resulting relative abundance index per year as a function of year (time since land use change to conservation) using standard linear modelling functions in R.

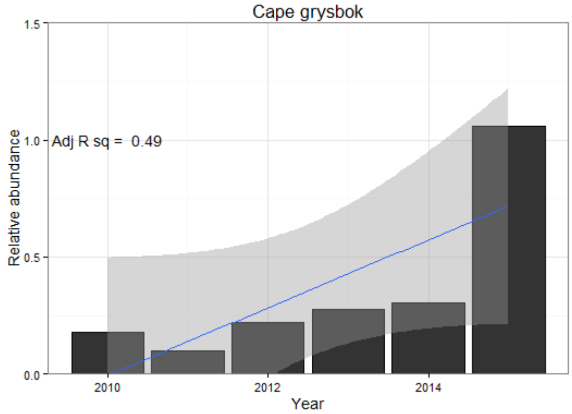
**Table 3.2a.** Effort table of trap nights per year.

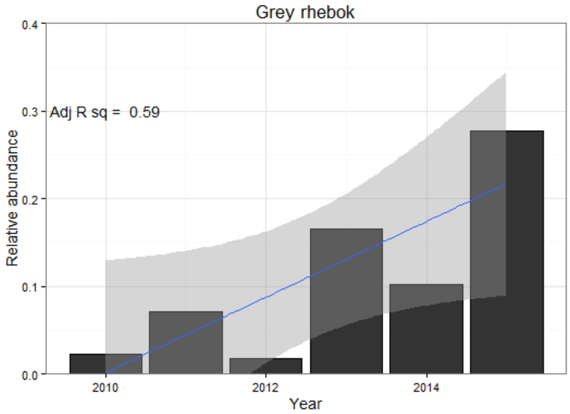
| Year | Trap nights |
|---|---|
| 2010 | 526 |
| 2011 | 713 |
| 2012 | 344 |
| 2013 | 563 |
| 2014 | 1172 |
| 2015 | 137 |

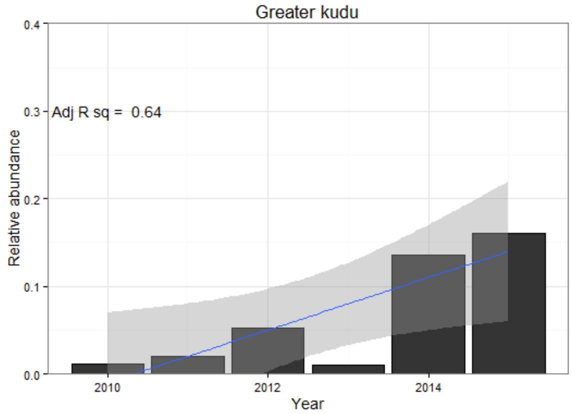
## 3.3. Results

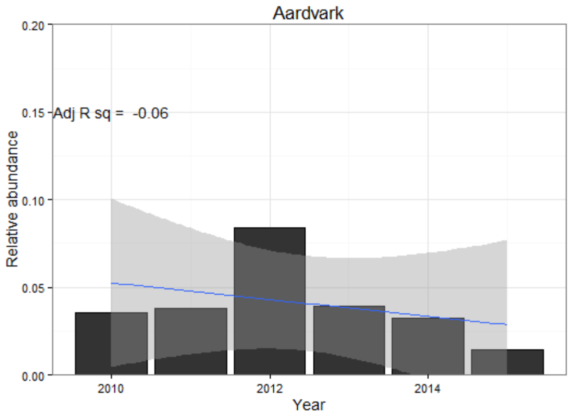
The four most common antelope groups all displayed a positive slope with time, and this was significant for grey rhebok and kudu (Figure 3.3a, Table 3.3a). Grysbok also showed a near significant increase ($p = 0.07$). Caracal was the only one of the three feline predators to show a significant positive increase with time across the six year intervals considered here ($p = 0.04$). There were no significant increases for any of the other major taxa groups, which generally showed no change. Encouragingly, no species showed significant declines in encounter rates.

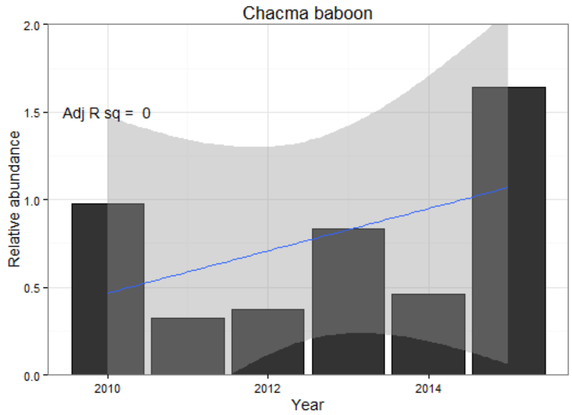

Common duiker
Adj R sq = 0.17
Relative abundance
Year
0.0
0.5
1.0
1.5
2010
2012
2014

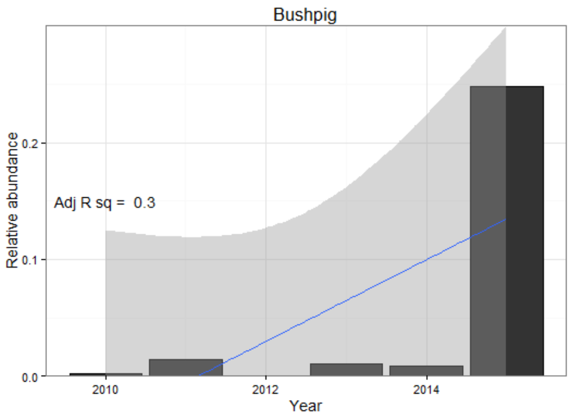

Cape grysbok
Adj R sq = 0.49
Relative abundance
Year
0.0
0.5
1.0
1.5
2010
2012
2014

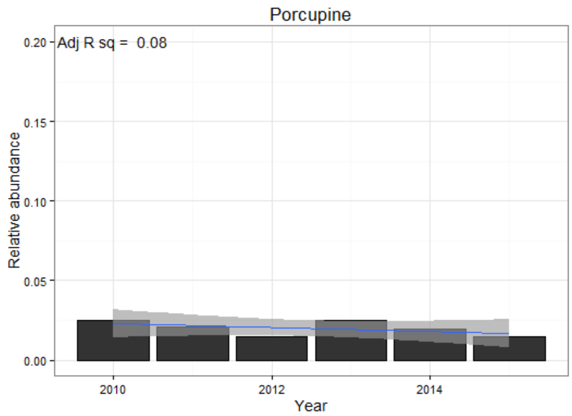

Grey rhebok
Adj R sq = 0.59
Relative abundance
Year
0.0
0.1
0.2
0.3
0.4
2010
2012
2014


Greater kudu
Adj R sq = 0.64
Relative abundance
Year
0.0
0.1
0.2
0.3
0.4
2010
2012
2014


Aardvark
Adj R sq = -0.06
Relative abundance
Year
0.00
0.05
0.10
0.15
0.20
2010
2012
2014


Chacma baboon
Adj R sq = 0
Relative abundance
Year
0.0
0.5
1.0
1.5
2.0
2010
2012
2014


Bushpig
Adj R sq = 0.3
Relative abundance
Year
0.0
0.1
0.2
2010
2012
2014


Porcupine
Adj R sq = 0.08
Relative abundance
Year
0.00
0.05
0.10
0.15
0.20
2010
2012
2014

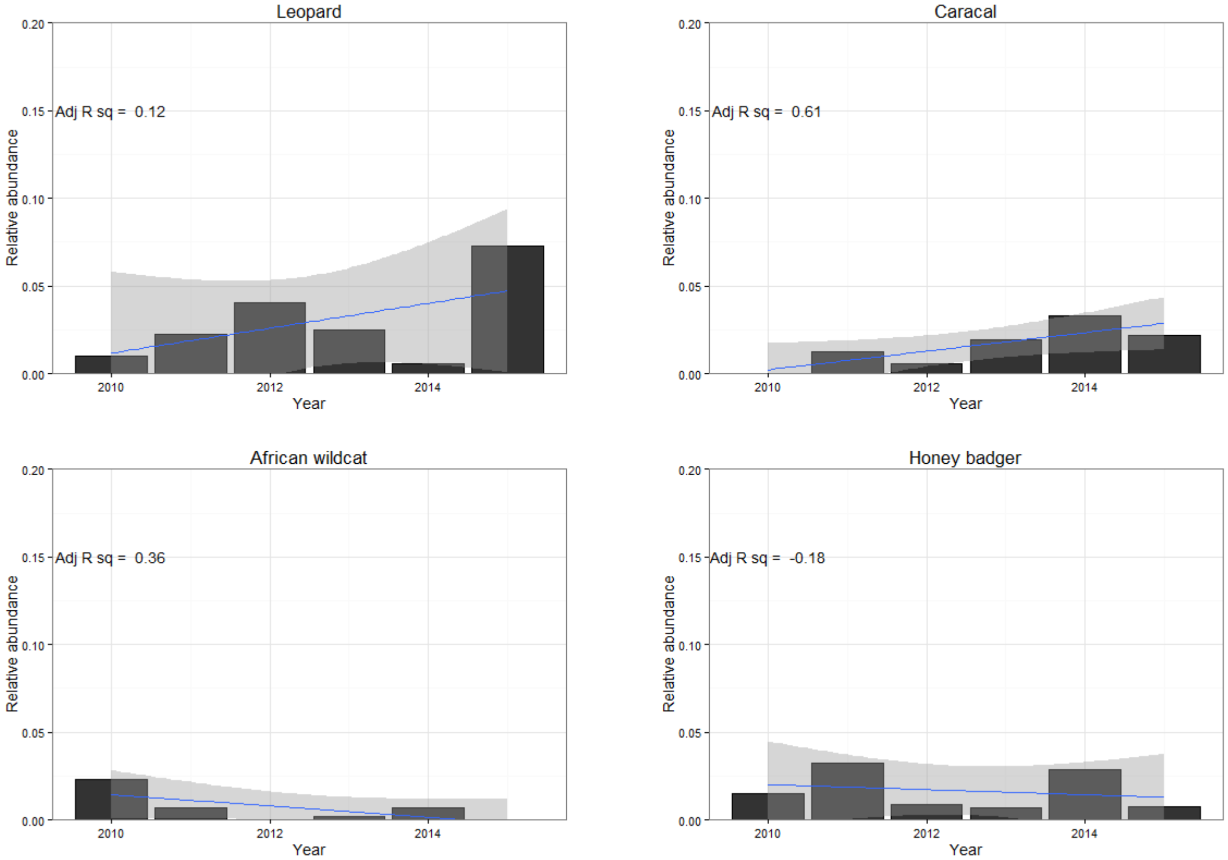



**Figure 3.3a.** Charts of relative abundance from camera trap photos plotted against year for a variety of mammals at BHNR. The thin blue line indicates the slope of the regression of relative abundance as a function of year, with the grey error shading indicating standard error. The adjusted R squared score for each model is indicated in each panel.

**Table 3.3a.** Summary output table of regression analysis of relative encounter rates per year as a function of year (time since recovery). Estimate is the slope of the regression line with its standard error (SE), and Statistic is the t value upon which the P value is calculated. P values < 0.05 are indicated in bold font.

| Species | Estimate | SE | Statistic | P value |
|---|---|---|---|---|
| Caracal *Caracal caracal* | 0.005 | 0.002 | 2.946 | **0.042** |
| Leopard *Panthera pardus* | 0.007 | 0.006 | 1.288 | 0.267 |
| Wildcat *Felis silvestris* | -0.003 | 0.002 | -1.95 | 0.123 |
| Common Duiker *Sylvicapra grimmia* | 0.048 | 0.034 | 1.41 | 0.231 |
| Cape Grysbok *Raphicerus melanotis* | 0.145 | 0.06 | 2.417 | 0.073 |
| Klipspringer *Oreotragus oreotragus* | -0.006 | 0.004 | -1.467 | 0.216 |
| Greater Kudu *Tragelaphus strepsiceros* | 0.03 | 0.01 | 3.143 | **0.035** |
| Grey Rhebok *Pelea capreolus* | 0.043 | 0.015 | 2.839 | **0.047** |
| Aardvark *Orycteropus afer* | -0.005 | 0.006 | -0.835 | 0.45 |
| Bushpig *Potamochoerus larvatus* | 0.035 | 0.02 | 1.778 | 0.15 |
| Honey badger *Mellivora capensis* | -0.001 | 0.003 | -0.496 | 0.646 |
| Cape porcupine *Hystrix africaeaustralis* | -0.001 | 0.001 | -1.205 | 0.294 |

### 3.4. Discussion

Year on year, there are encouraging signs of increased activity recorded through camera traps for a variety of taxa at BHNR, which we interpret as a recovery in local populations. There are certainly complicating effects, for example the widespread fire that occurred in 2012. In addition, rainfall is unpredictable both in terms of seasonality and quantity, and the influence on rapidly breeding species such as rock hyrax or even grysbok are unknown.

For leopards, relative abundance between years is very erratic. This is certainly to a degree a result of the loss of leopards due to persecution. Even if leopards are not specifically targeted by predator control measures, they are likely to fall victim to any trap deployed for species such as caracal. The use of gin traps, baited cage traps and hunting with dogs all takes place on the farms surrounding BHNR. A male leopard, known to be resident during 2011 and 2012, was found dead at the beginning of 2014 on a farm only a few kilometres south of BHNR. He was possibly killed in 2013. Death was known to be human-related, because the GPS collar the animal carried was vandalised. It is likely that a second resident female suffered the same fate, and the fate of two more leopards caught on camera frequently during 2012/2013 can only be speculated upon. The dearth of leopard activity on cameras during 2014 is cause for concern. Two males were recorded on camera during 2015, including one male collared by the Landmark Foundation deep in the Baviaanskloof (>50 km linear distance, Figure 3.4a). The second individual appears to be a young male, who has frequented BHNR for much of 2015 and has so far eluded extensive capture efforts (Figure 3.4b). No females were confirmed during 2015.


**Figure 3.4a.** The male leopard known as Scarface was collared by the Landmark Foundation in the Baviaanskloof.


**Figure 3.4b.** An uncollared male includes Blue Hill Nature Reserve as part of his regular territory patrols.


**Figure 3.4c.** Caracal are more frequently recorded on camera than leopards at BHNR, but the number of individuals has been impossible to determine.

By contrast, caracal showed a significant increase in relative abundance over the sampling period. It is impossible to tell whether caracal were responding to changes in persecution levels or to increased prey availability. However, we suspect the former as alternative prey in the form of goats, sheep and calves were previously available. Caracal have smaller territories than leopard, and the resident individuals are perhaps less likely to encounter predator control measures compared to the more wide-ranging leopards. We have no information on individual survival for the caracal as no individuals had distinctive markings (Figure 3.4c). By contrast, we were able to identify most leopards due to their unique coat markings.

This section of the report is simply an overview of current trends. At this stage there are still many more photographs to be analysed and more data entry to do before concrete patterns in recovery or decline can be confirmed.

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# 4. Blue Hill bat survey

Craig Turner
Biosphere Expeditions &
Wychwood Environmental Ltd

## 4.1 Introduction

Bats are a vital component of any ecological community providing vital ecosystem services including insect control, seed dispersal and pollination. Bats are often overlooked during simple biodiversity surveys due to their nocturnal habits and the specialised equipment needed to record or identify them.

During the Biosphere Expeditions South Africa expedition in 2015 a pilot bat survey using ultrasonic acoustic detectors was undertaken to assess what species were present in a small area of the Blue Hill Nature Reserve area (BHNR).

The principle aim of the bat study was to provide baseline information with respect to bat species and activity within the site, with the following specific objectives: (1) confirm the likely presence or absence of any bat roosts and assess their likely usage and (2) identify which bat species are present within or adjacent to the site, and levels of activity.

## 4.2 Methods

Bat detector activity surveys were conducted in October 2015. These were either run as 'dusk' surveys or 'overnight' surveys. Dusk surveys commenced 30 minutes before sunset and finished two hours after sunset. Dawn surveys commenced 30 mins before dawn until 1 hr after sunrise. Surveys were completed using a single Anabat Express detector to record bat echolocations as 'bat passes' (where a bat pass is defined as a sequence of greater than two echolocation calls made as a single bat flies past the microphone[1]).

The surveys were carried out in accordance with the standard methodology (BCT, 2012), and bat calls were analysed according to standard parameters (Parsons and Jones, 2000, Monadjem et al., 2010, Russ 2012). The surveys and analyses were conducted by the author[2]. Details of survey locations are given below (Table 4.2a, Figures 4.2a & 4.2b).

**Table 4.2a.** Survey types and locations.

| Site | Description | Survey type | Figure |
|---|---|---|---|
| 1 | Front garden between houses | Dusk | 4.2a & b |
| 2 | North of vehicle shed | Dusk | 4.2a & b |
| 3 | Leopard cage trap | Overnight | 4.2a |
| 4 | Entrance gate to BHNR | Overnight | 4.2a |

Data analysis

The data collected from Anabat bat detectors were analysed and interpreted using AnalookW software. Calls were also compared to a known library of calls[2], to facilitate accurate identification.

[1] http://www.bats.org.uk/nbmp_tutorials/tutorial26.html
[2] The author is grateful for the assistance of Dr Sandie Sowler, who amongst other things provided a call library.

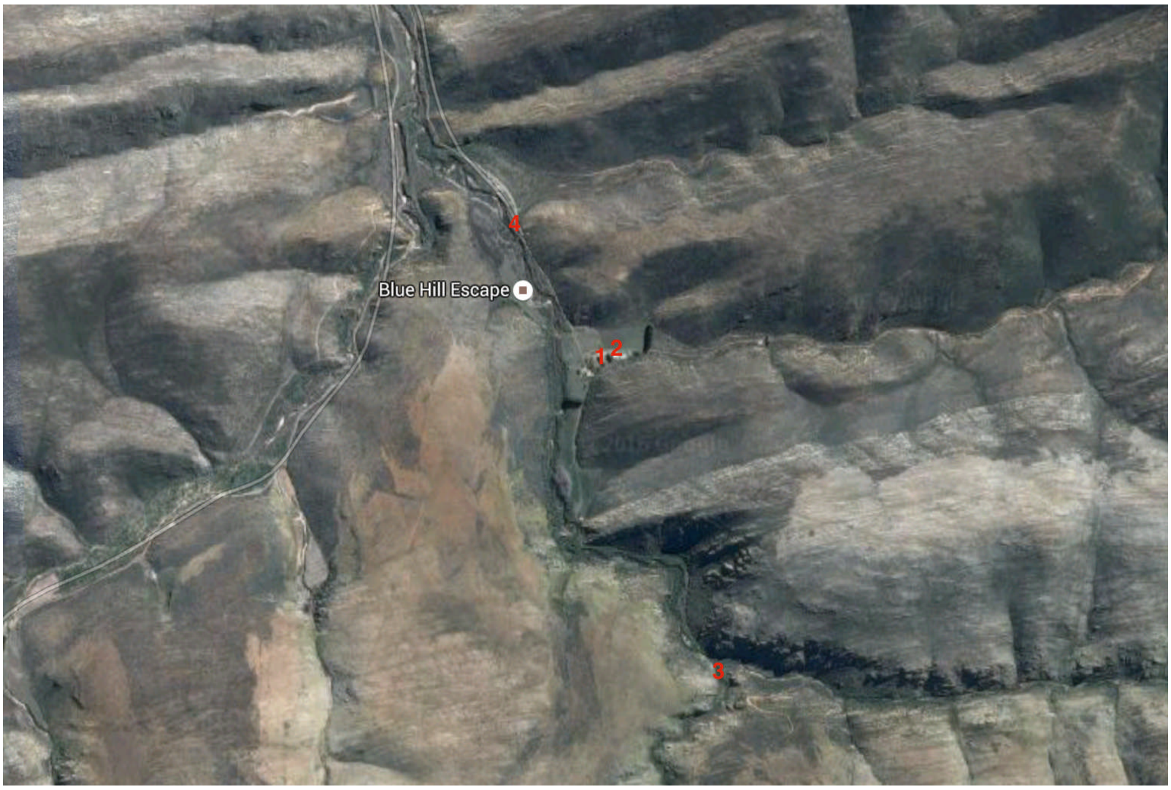


**Figure 4.2a.** Location of bat surveys (1–4) around BHNR.


**Figure 4.2b.** Location of the two survey points nearest the properties at BHNR.

Constraints and limitations

It should be noted that lack of evidence of a particular bat does not necessarily preclude it from being present at a later date. In relation to use of habitats or roost sites by bat species, use of a particular area of land can vary not only on a seasonal basis, but also from day to day. Whilst activity surveys are used to provide an estimate of the likely importance of a given area of land for bats, due to the highly mobile nature of bats it is not possible to determine accurately the exact numbers of bats using standard non-intrusive survey methods.

Other constraints to be aware of are: (1) the echolocation used by some bats is very quiet and difficult to detect. Some species may have been present without registering on the bat detectors used during the activity survey due to the nature of their echolocation; (2) the recording system employed by Anabats can only respond to the signal with the highest intensity at any time. As the signal from some bat species (such as pipistrelles) will nearly always be more intense than that of other bat species (such as *Myotis* bats), it is possible that some bat signals were not recorded. As a result, some bat activity may have been under-recorded; (3) the height at which Anabats were positioned may have limited the recording of some bat activity across all stations; (4) the identification of bats in the genus *Myotis* to species level based on recorded echolocations is not always possible[3] with a high degree of confidence. This is due to the similarity and overlap in characteristics between myotid bats and the calls they make, together with the ability of these bats to emit different calls in different habitats and situations. Techniques are being developed to assist with the identification of these bats from recordings, such as the use of 'slope' in the AnalookW programme designed for use with Anabat CF detectors. Comparison of slope between myotids and a library of known calls was used to assist with identification; (5) due to variation in the time spans for which the detector was deployed at the different locations, and the limited survey effort, only species presence is presented in the results, rather than a comparison of relative abundance.

## 4.3. Results

At least five species of bat were identified during the surveys (Table 4.3a, Figures 4.3a–e). Two species, the Egyptian free-tailed bat and the African pipistrelle, were recorded at all of the sites, whereas the Hottentot serotine was recorded at just one location.

**Table 4.3a**. Species records by site.

| Site | Egyptian free-tailed *Tadarida aegyptiaca* | African pipistrelle *Pipistrellus hesperidus* | Cape serotine *Neoromicia capensis* | Cape horseshoe *Rhinolophus capensis* | Hottentot serotine *Eptesicus hottentotus* |
|---|---|---|---|---|---|
| 1 | Y | Y | Y | Y | N |
| 2 | Y | Y | Y | Y | Y |
| 3 | Y | Y | N | Y | N |
| 4 | Y | Y | Y | N | N |

[3] BCT guidelines recognise that *Myotis* bats can only be identified with a low degree of confidence to species level, as set out in section 6.4.3 of the guidelines.

## Example sonograms

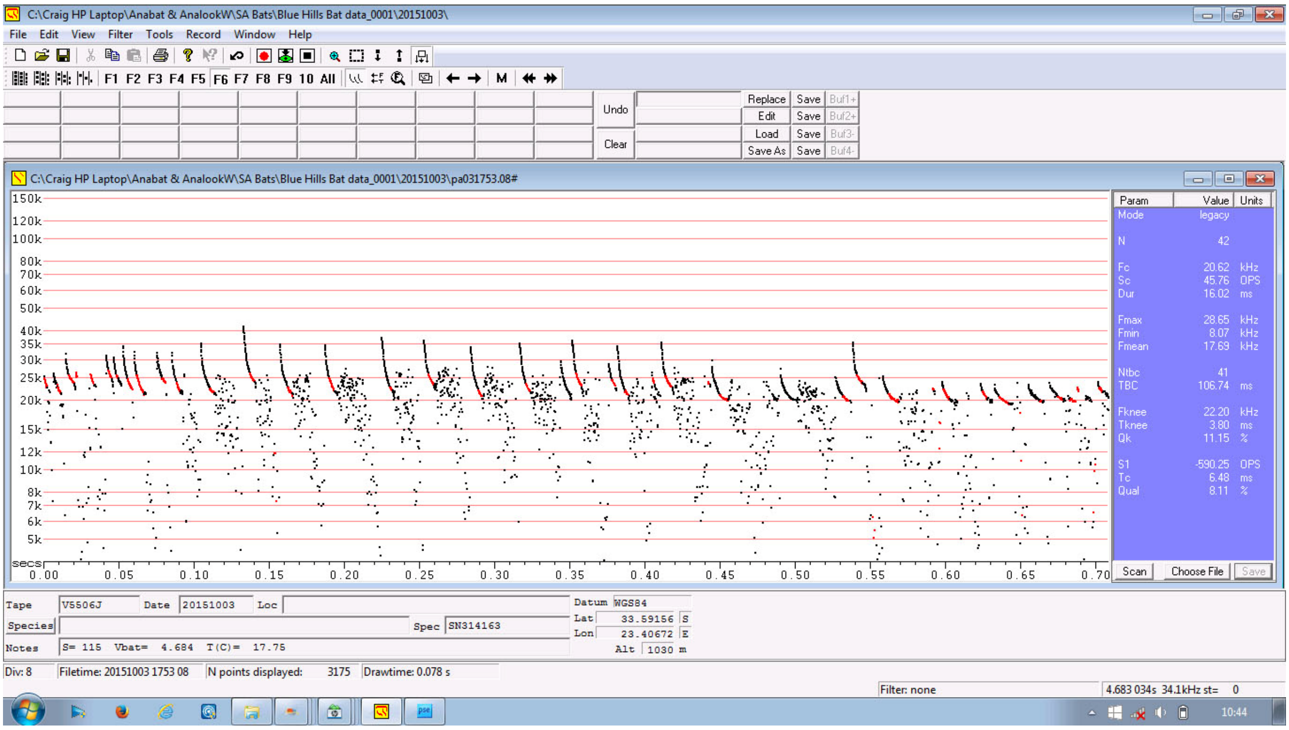


**Figure 4.3a.** Egyptian free-tailed bat (*Tadarida aegyptiaca*).

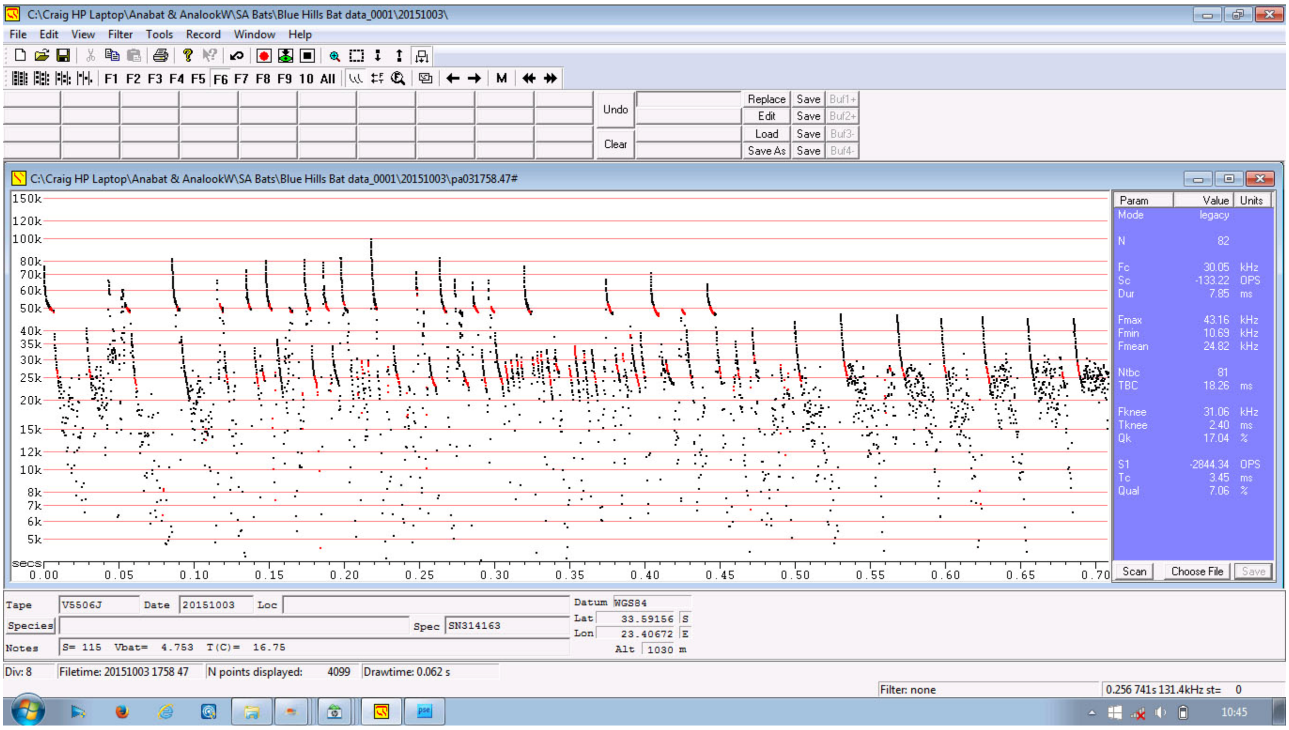


**Figure 4.3b.** African pipistrelle (*Pipistrellus hesperidus*), with Egyptian free-tailed below.

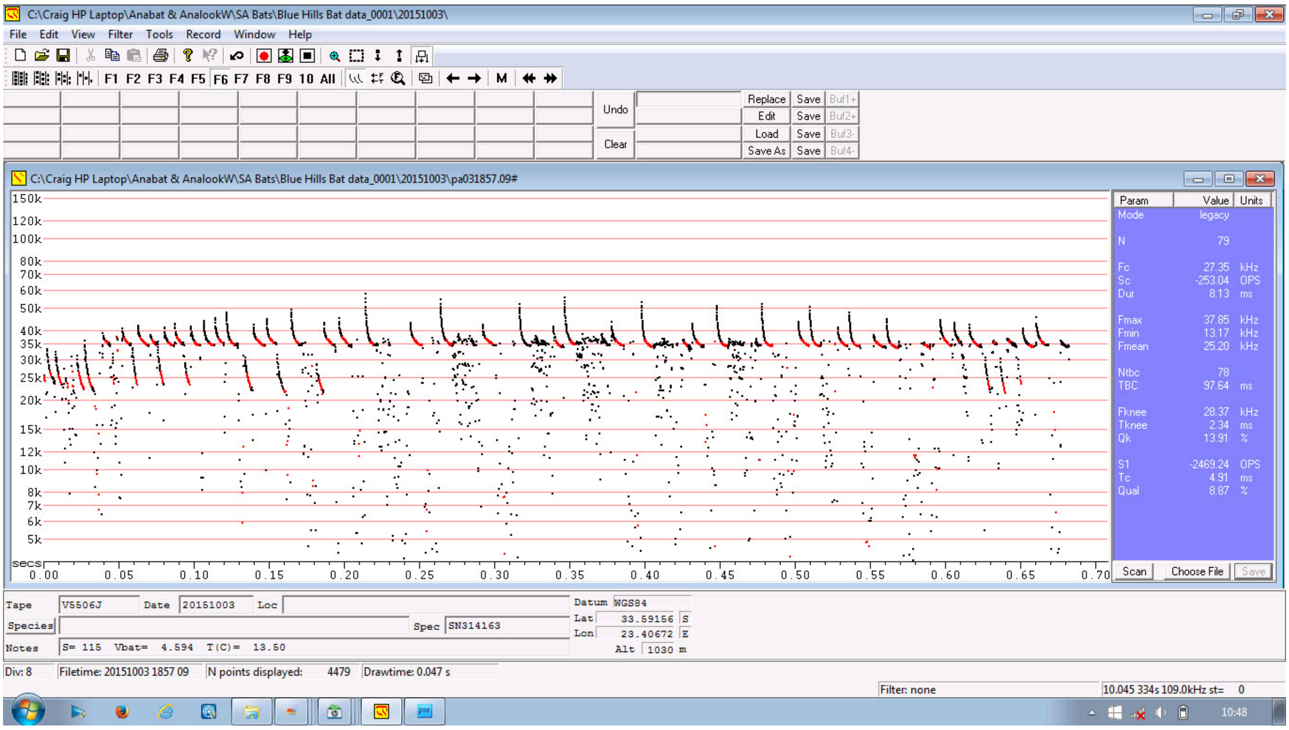


**Figure 4.3c.** Cape serotine (*Neoromicia capensis*).

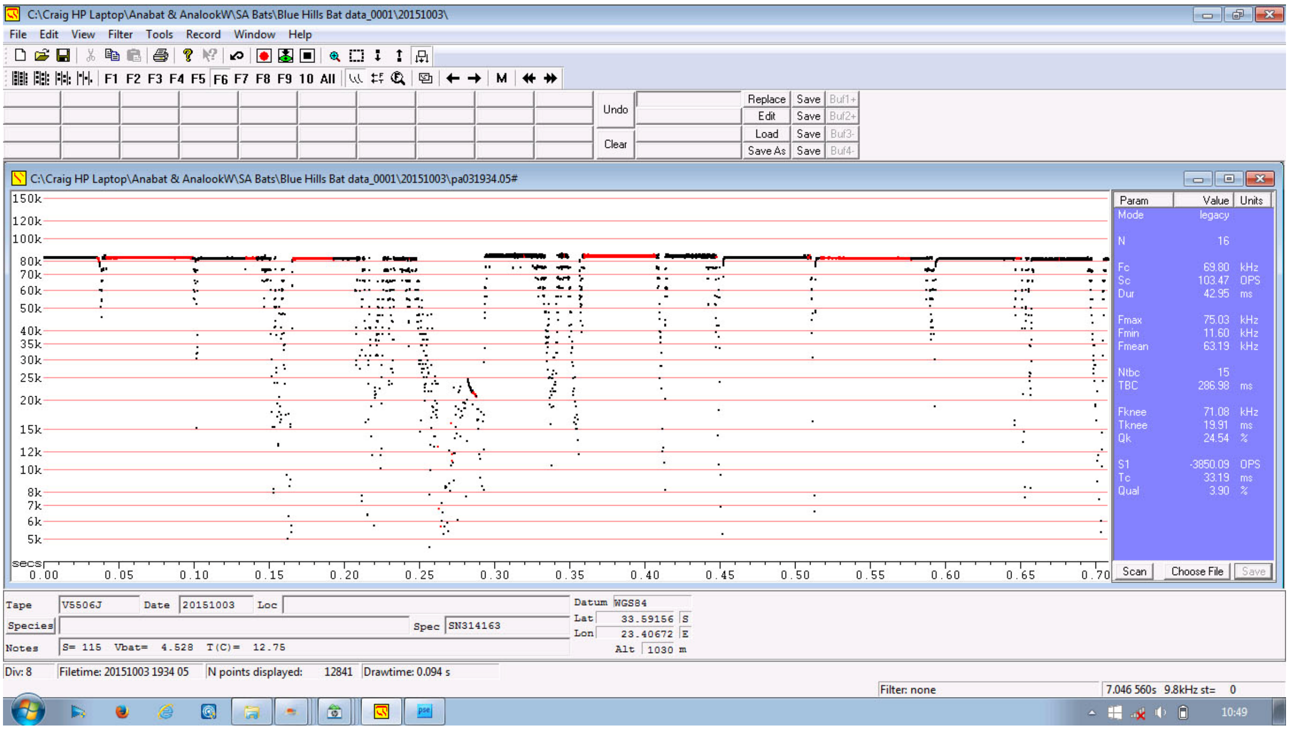


**Figure 4.3d.** Cape horsehoe bat (*Rhinolophus capensis*).

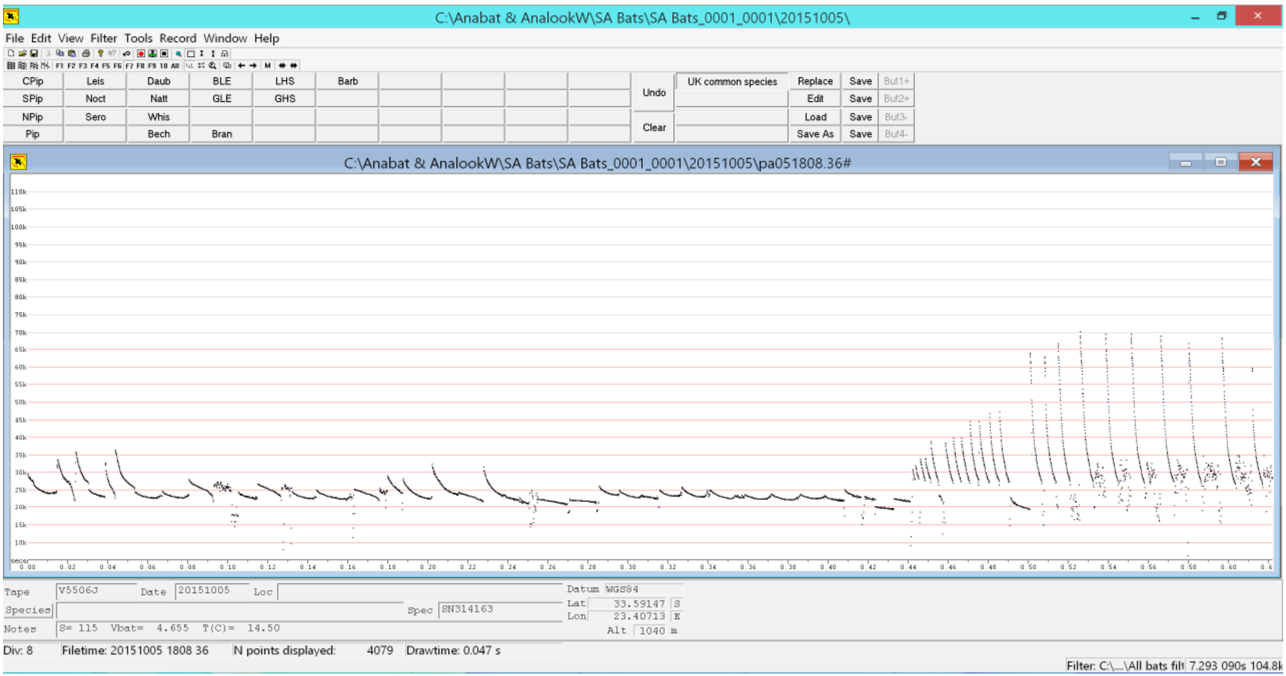


**Figure 4.3e.** Hottentot serotine (*Eptesicus hottentotus*), with Egyptian free-tailed bat.

The surveys also led to the exploration of one cave (-33.596S, 23.405E) known to support roosting bats. Upon visual inspection and documentation of further acoustic records, the species present are believed to be Cape horseshoe bats. The roost size at this stage is unknown.

## 4.4. Discussion

Literature indicates at least 30 species of bat in southern Africa and at least 12 species from the Western Cape. This short pilot study has confirmed the presence of at least five species within a small area of the BHNR.

A brief summary for each species recorded is given below.

Egyptian free-tailed bat (*Tadarida aegyptiaca*): A broadly distributed species, with a range that extends throughout Africa and the Arabian Peninsula, to India, Sri Lanka and Bangladesh. Classified as Least Concern (LC) on the IUCN Red List.

African pipistrelle (*Pipistrellus hesperidus*): This species has been recorded over much of sub-Saharan Africa. It ranges from the Cape Verde Islands, to Liberia and Côte d'Ivoire, Nigeria, Cameroon and Equatorial Guinea (Bioko), western Democratic Republic of the Congo, southern Sudan, Ethiopia, Eritrea and Somalia, into Kenya and Uganda, Rwanda, Burundi, Tanzania, Malawi, Mozambique, Zambia, Zimbabwe and Angola, and is found as far south as eastern and southern South Africa and possibly Swaziland. It is listed as Least Concern on the IUCN Red List in view of its wide distribution, presumed large population, and because it is unlikely to be declining fast enough to qualify for listing in a more threatened category.

Cape serotine (*Neoromicia capensis*): This species is widespread over much of sub-Saharan Africa. It has been recorded from Guinea Bissau in the west, to Somalia, southern Sudan and Eritrea in the east, ranging south to most of South Africa. It is listed as Least Concern on the IUCN Red List in view of its wide distribution, presumed large population, and because it is unlikely to be declining fast enough to qualify for listing in a more threatened category.

Cape horseshoe bat (*Rhinolophus capensis*): This species is restricted to the coastal belt of the Northern Cape, the Western Cape and the Eastern Cape of South Africa, as far east along the coast as the vicinity of East London. Listed as Least Concern on the IUCN Red List.

Hottentot serotine (*Eptesicus hottentotus*): This largely Southern African species ranges from southern Angola in the west, through parts of Namibia, South Africa, southern Lesotho, Botswana, Zimbabwe, Mozambique, Malawi and Zambia, with a single record as far north as southwestern Kenya. Although the species is considered to be sparsely distributed, it is locally common in parts of the range, such as Zimbabwe, but is though to be rarer elsewhere (e.g. South Africa). Listed as Least Concern on the IUCN Red List.

Clearly additional surveys in multiple locations, following standardised protocols, are likely to reveal yet more species, and begin to better illustrate bat usage of the wider landscape and habitat features.

Anabat Express detectors can be deployed in a similar way to camera traps, whereby they can be stationed in one location for several days and programmed to record data over set days or hours. If these are then moved around several locations, a data-driven 'picture' of bat activity in time and space emerges. Detectors could also be deployed to known caves to better assess probable or actual roosts. Finally, the detectors have inbuilt GPS, and thus can also be used for walked or driven transect surveys, either post-dusk or pre-dawn.

Future surveys are proposed:

- Multi-day static surveys at multiple locations, covering a range of habitats, altitudes and times of year.
- Cave entrance surveys, using static (daytime) deployment to assess roost locations and level of activity.
- Transect surveys along existing tracts.

### 4.5. Literature cited


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**Appendix I:** Expedition diary and reports

A multimedia expedition diary is available at https://biosphereexpeditions.wordpress.com/category/expedition-blogs/south-africa-2015/.

All expedition reports, including this and previous expedition reports, are available at www.biosphere-expeditions.org/reports.