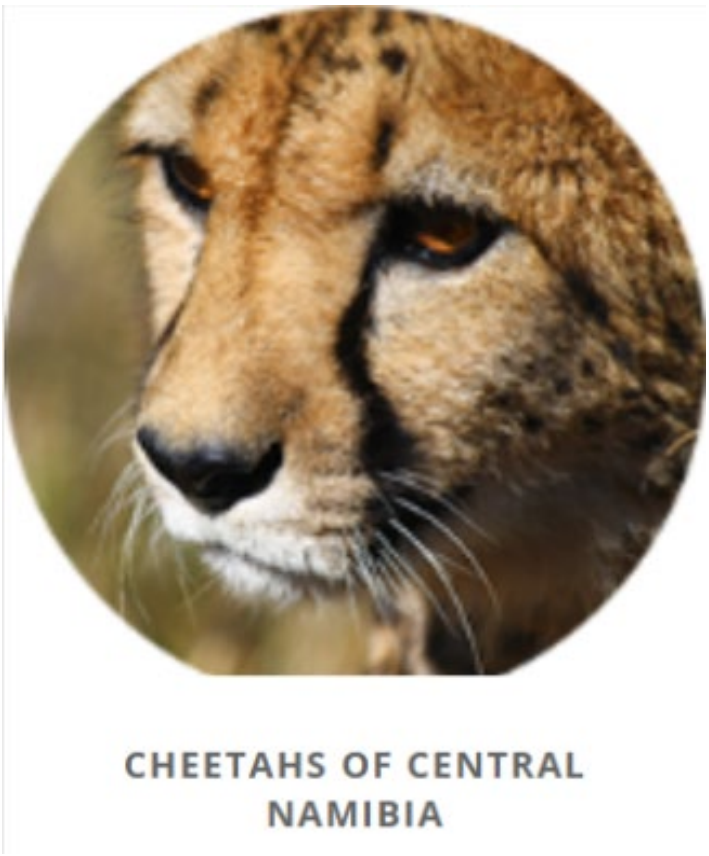
Project: Cheetahs of Central Namibia



Authors:
Willem Daniel Briers-Louw
Matti-Tweshingilwa Nghikembua

Organisations:
Cheetah Conservation Fund
Zooniverse

Background

Cheetah Conservation Fund (CCF) is situated approximately 44km (27miles) east of Otjiwarongo in north-central Namibia. CCF forms part of the Greater Waterberg Landscape (GWL), which consists of five conservancies: Waterberg Conservancy (this is where CCF is located), Ozonahi Conservancy, Okamatapati Conservancy, Otjituuo Conservancy, and the African Wild Dog Conservancy (Figure 1). In total, the GWL covers over 19,000 km^2. This is... well, enormous! If the GWL was a country it would be larger than 100 other countries. To read more about the GWL visit http://www.landscapesnamibia.org/waterberg/.

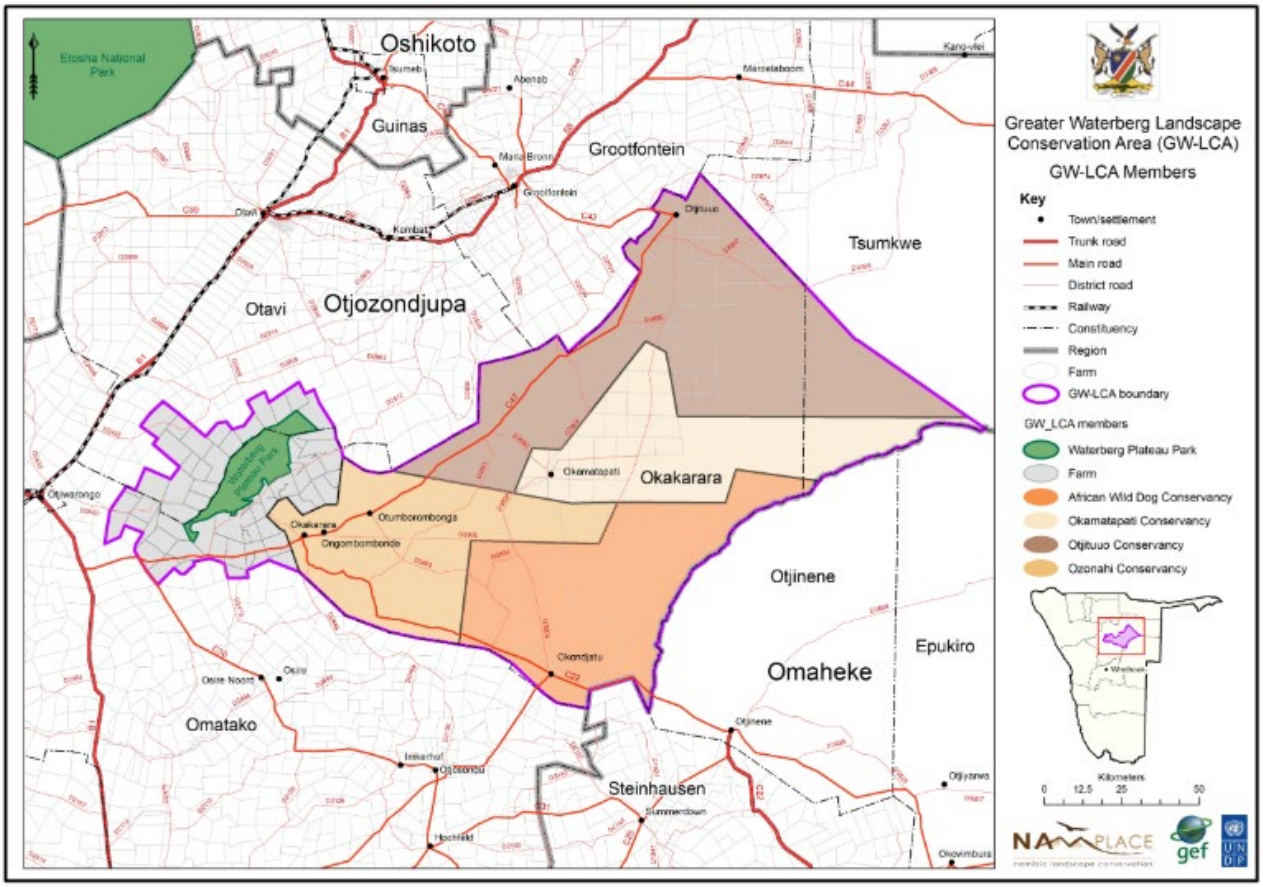


Figure 1: Map of the Greater Waterberg Landscape (GWL). The GWL includes four communal conservancies (African Wild Dog, Okamatapati, Otjituuo and Ozonahi) as well as the freehold farms and the Waterberg Plateau National Park.

Why is this project (*Cheetahs of Central Namibia*) important?

There are only approximately 7,100 cheetah left in the wild and a large proportion of them are found right here in Namibia. Cheetahs are Africa's most endangered big cat. In Namibia most of them live outside of national parks, in habitats like the Greater Waterberg Landscape where humans, livestock and wildlife are all mixed together. Much of CCF's work focuses on reducing human-wildlife conflict. For cheetahs to have a chance to survive in the wild, CCF must find a way for humans and carnivores to exist side-by-side. For decades now, CCF has worked with farmers and communities to reduce livestock losses and the retaliatory killing of carnivores. They help locals realize economic value from their wildlife by encouraging tourism and other non-destructive economic activities. And CCF constantly strives to better understand the biodiversity and dynamics of the complex ecosystem that is the Greater Waterberg Landscape.

Camera trapping

A key foundation to all of these programs is a solid understanding of the wildlife habitat. And that is where the camera trap program plays a vital role. Cheetah Conservation Fund relies on camera trapping to collect crucial information on wildlife within the GWL. By collecting this data, CCF is able to determine presence of species (both carnivores and their prey), species biodviersity within the open landscape, and estimate population trends over time. Camera trapping also allows CCF to determine activity patterns of different species, which helps to understand whether species show temporal niche partitioning (i.e. species partition their activity patterns so as not to compete with a more dominant species). Knowing the answer to these and other questions will help us understand the ecosystem more completely and design conservation programs to protect the cheetah, other carnivores, and indeed the entire habitat.

Citizen Science

Citizen science is a relatively new concept that has grown rapidly throughout the world. It allows non-professional scientists to assist in scientific research. Zooniverse provides such a platform to allow volunteers from around the world to assist with camera trap photo identification and sorting from various projects. The different stages in a camera trapping project include: (1) project design; (2) site selection and placement/retrieval of camera traps; (3) identification/sorting of camera trap photos; (4) analysing the data; and (5) writing up the results in report/publication format. Identification and sorting of camera photos is arguably the most time-consuming stage of any project and thus engaging with volunteers on such a large scale, helps research-based organisations process data more rapidly. This then provides crucial information to better conserve wildlife and improve our knowledge on the ecology and biology of wildlife.

Methods

Wildlife populations are monitored using remote camera traps throughout the year in CCF's reserve, an area designated for wildlife conservation. This is especially important to understand the biology and ecology of endangered species such as cheetah and to better conserve these species. For this project, nine Bushnell® Trophy Cam camera traps were placed in the reserve, as part of CCF's ongoing monitoring of wildlife. These camera traps were placed at natural and artifical waterpoints as well as cheetah playtrees (i.e. trees used regularly by cheetahs/leopards for the purpose of scent-marking). These camera traps are motion-sensored and were set on burst-fire (i.e. three photos per every trigger of the camera trap). This is important for the identification of different cheetah and leopard individuals, as each individual has a unique coat pattern, and multiple photos can help with comparing patterns from different parts of the body.

Data analysis

Data were collected during the dry season data were sorted, which resulted in over 208 000 camera trap photos (Table 1). Data were sorted through the Zooniverse website on the project *Cheetahs of Central Namibia* by willing volunteers (*n* = 7 840). The data was then compiled and entered in an Excel spreadsheet. Species richness and species diversity indices were created in the package *vegan* version 2.5-3 (Oksanen *et al*., 2018) in R version 3.5.2 (R Core Team, 2018). The package *camtrapR* (Niedballa, Sollmann, Courtiol & Wilting, 2016) in R was used to filter data and sort into target species. Activity patterns and overlap as well as detection maps were made for the different species.

Table 1: *Cheetahs of Central Namibia* project details.

Details	Number
Total users	7 840
Average number of classifications per user	267
Average number of classifications per photo	10.04
Total photos sorted	208 077
Total number of target species (mammals & ostrich)	37
Total number of camera trap locations	9

Figure 2: Camera trap sites on CCF farms within the Greater Waterberg Landscape.

Results

Species richness and diversity indices

Overall, all camera trap sites displayed fairly similar levels of species richness and diversity (Figure 3 and 4). Interestingly, Field5PlayTree had both the highest species richness and species diversity for all camera trap sites. This could be explained by the fact that this playtree was on the edge between a closed woodland and open grassland. Given that certain species prefer different habitats (e.g. springbok prefer open grassland and duiker prefer woodland), this site would capture a wider variety of species as it acts as a transitional zone between the two habitat types. Main Road Dam showed the lowest species richness and diversity of all sites. This could be explained by the fact that water in the dam tends to dry up earlier than over natural dams during the peak of the dry season.

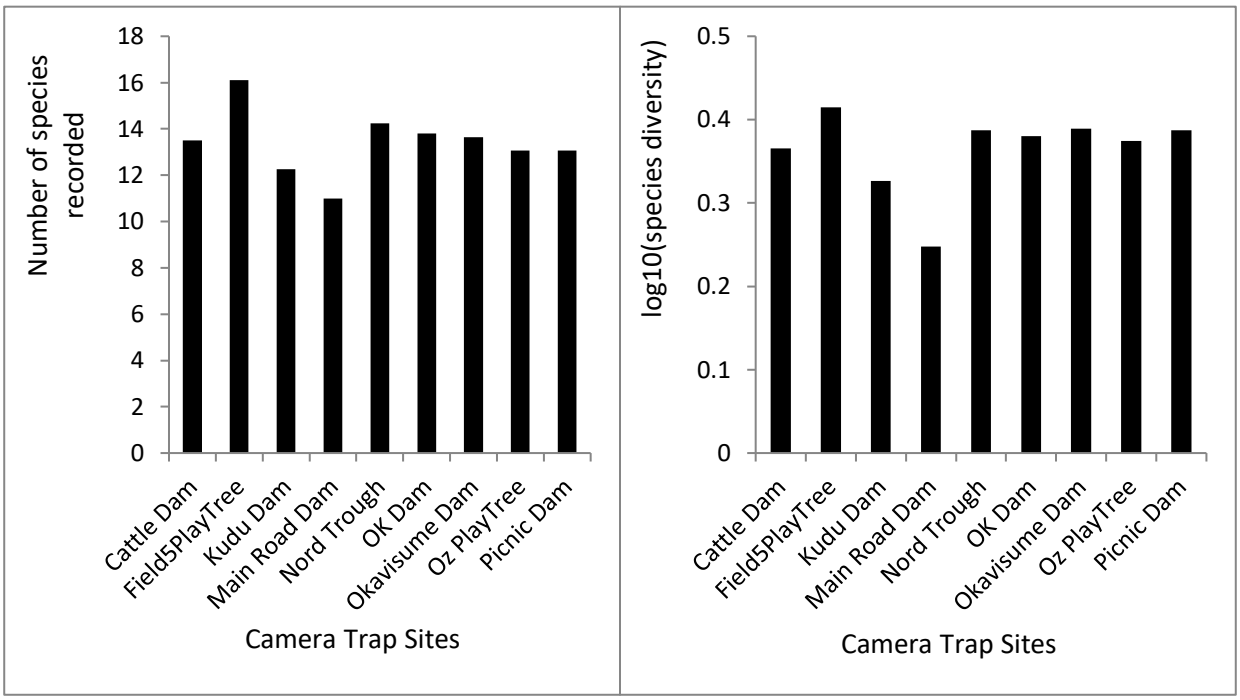


Figure 3: Species richness index calculated per camera trap site.

Figure 4: Species diversity indicex per camera trap site.

Activity patterns and activity overlap

Interestingly, leopard and cheetah had the highest temporal overlap between all carnivores (Figure 5). This means that both leopard and cheetah are active at similar times, despite competing for similar prey species such as steenbok, duiker, springbok and kudu. Both carnivores are having similar hunting strategies i.e. they opportunistic hunters, although leopards are competitively dominant over cheetahs. It appears as though the density of leopard in the GWL is increasing, while the density of cheetah is decreasing.

In the GWL, leopards are able to occupy relatively small home range compared to cheetahs (Marker & Dickman, 2005). In contrast, cheetah home ranges can be as large as 1 651 km^2, and may include several leopards within such a large home range (Marker, Dickman, Mills, Jeo & Macdonald, 2008). If both carnivores have dietary, temporal and spatial overlap, it might explain why we are seeing a decline in cheetahs in the GWL. Previous research indicates that cheetahs are able to coexist with more dominant competitors by displaying local avoidance behaviour both spatially and temporally to reduce chance encounters with these more dominant species (Durant, 1998). Cheetahs may also delay hunting when more dominant carnivores in the area due to the risk of interspecific killing and/or kleptoparasitism i.e. having their kill stolen by other carnivores (Durant, 2000). Despite this research, we still need a thorough investigation as to whether leopards are outcompeting cheetahs and to what extent illegal hunting of cheetahs has had on the population size.

The brown hyena is mainly a scavenger and will often follow leopards to a kill. Brown hyena also had high activity overlaps with other carnivores in the GWL, although they often appear to pass by the camera trap approximately 30minutes to one hour after a cheetah or leopard. In body size, the black-backed jackal is relatively small (weighing 5.4–10kg) compared to the other carnivores mentioned above and feeds on a wide variety of prey items including vegetation, fruit, insects, arthropods, birds and small to medium-sized mammals. This allows jackals to thrive in many environments. Jackals are found through CCF land and also displayed a high overlap with other larger carnivores (Figure 1), but their diet probably allows them to coexist with the larger carnivores.

The activity patterns of the six main herbivore species in the GWL are displayed in Figure 6. Eland, red hartebeest and steenbok were mostly active during the early morning and/or late aternoon. Activity for oryx peaked at 09:00 while for kudu activity peaked at 10:00. In general, the main herbivore species showed a dip in activity during the middle of the day due to the heat. However, warthog showed peak daily activity during the middle of the day (i.e. 10:00-13:00) which is often the hottest time during the day. The 93% acitivity overlap between steenbok and eland was the highest recorded for any two species (Figure 7). Steenbok and duiker also showed a high activity overlap of 91%, with activity peaks at 07:00 and 18:30. Such activity patterns are described as crepuscular.

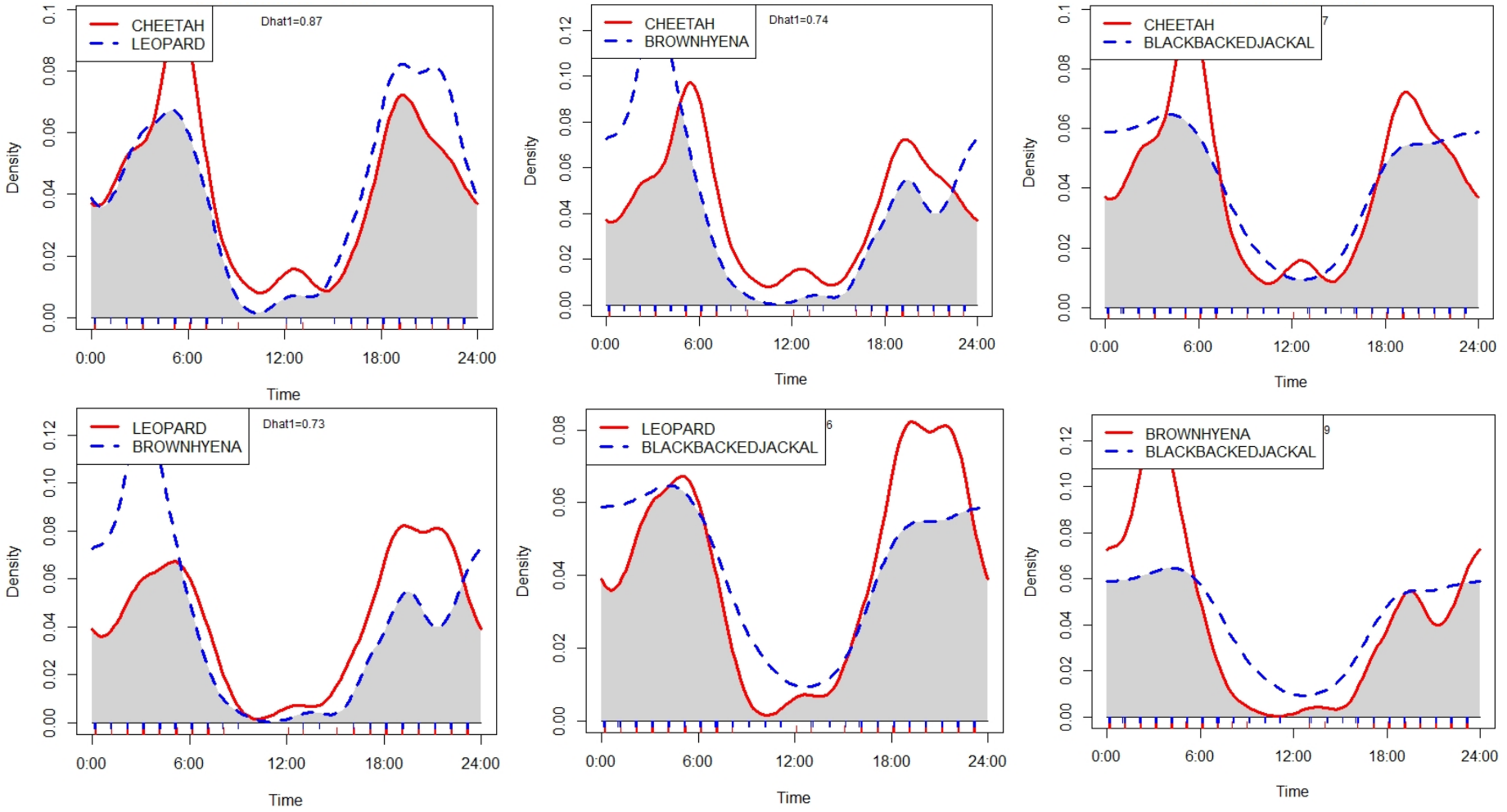


Figure 5: Activity overlap of the main carnivore species at all camera trap sites on CCF land in the GWL.

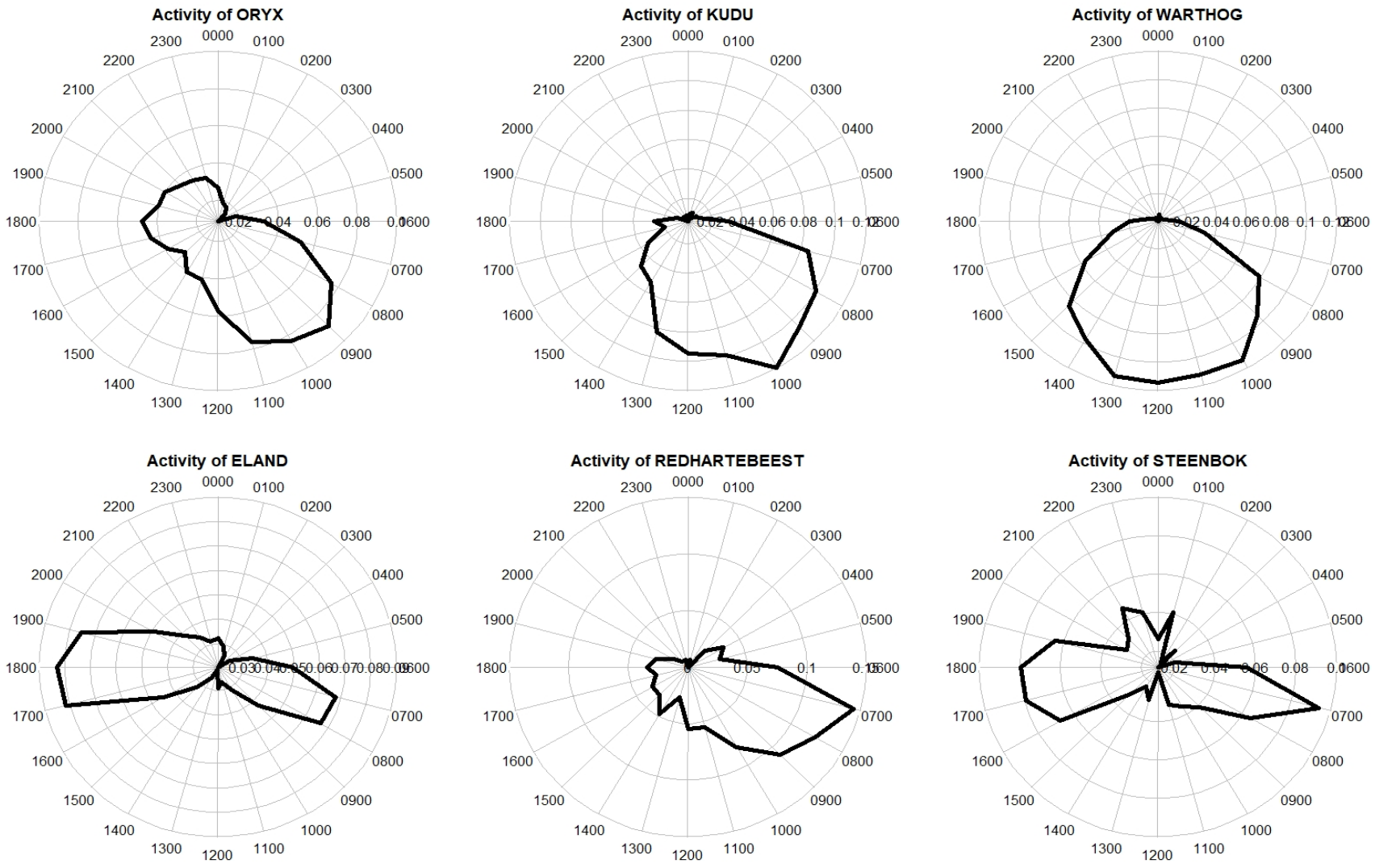


Figure 6: Activity patterns of the main herbivore species recorded on camera traps on CCF land in the GWL.

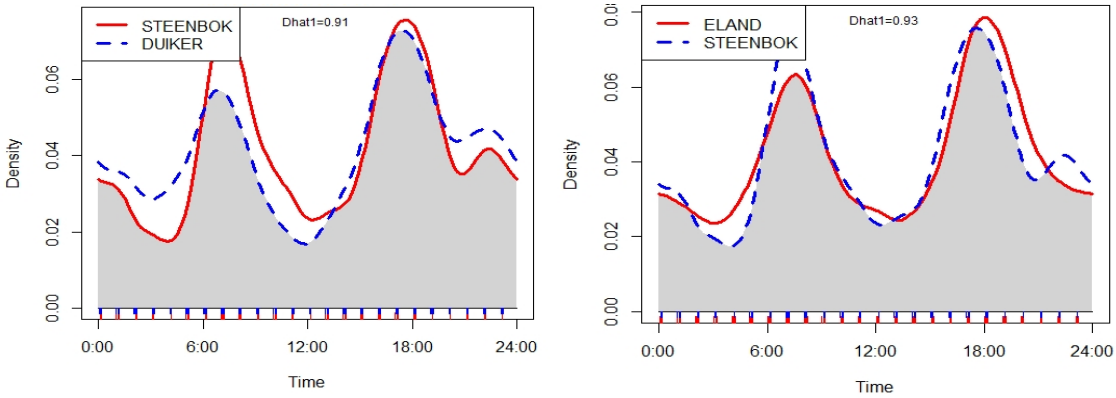


Figure 7: Activity overlap of steenbok and duiker (left) and steenbok and eland (right).

We also looked at the activity patterns of some other species which occur in the GWL. The aardvark is a nocturnal species and activity peaked at 23:00 (Figure 8). Porcupines were mostly active between 19:00 and 00:00, while scrub hares were active between 18:00 and 05:00. Ostrich, which is the largest non-flying bird in the world, is diurnal and activity peaked at 11:00.

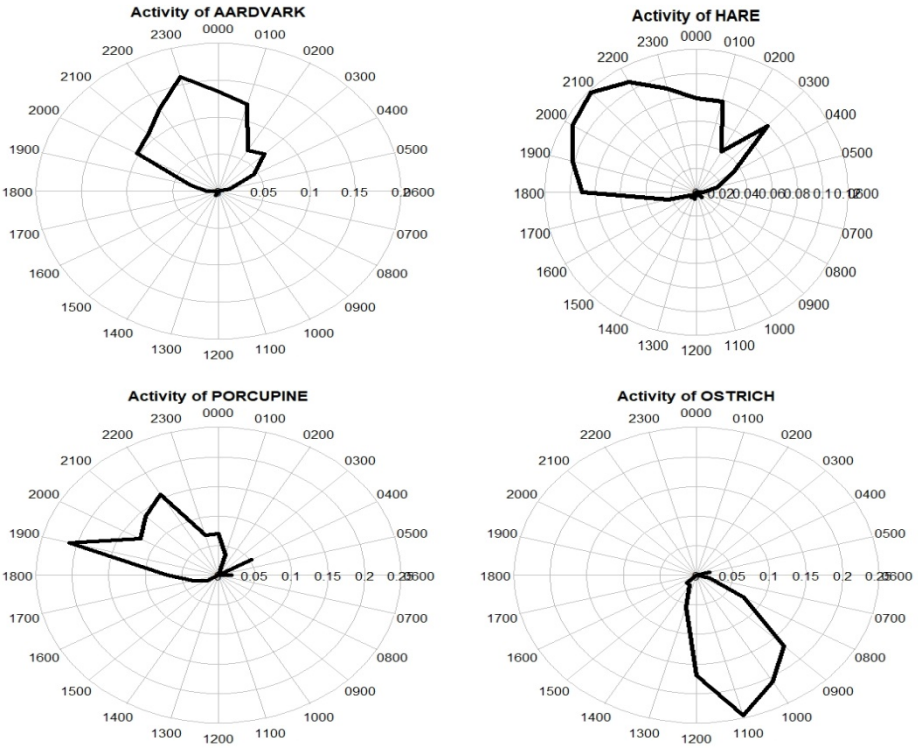


Figure 8: Activity patterns of less frequently sighted species in the GWL.

Animal detection maps

Carnivore species showed different detections on aross the camera trap locations on CCF land (Figure 9). Leopards were detected at all camera trap locations and showed the highest proportion of captures at Cattle Dam. Cheetahs were only captured at four camera trap sites and had the highest detection at Field5PlayTree. A playtree is typically a tree and/or a termite mound which cheetahs regularly visit to scent mark as a sign of territoriality. Caracal and African wild cat showed the highest proportion of photos at Picnic Dam, while brown hyena and black-backed jackal also displayed similar level of detection at Cattle and Picnic Dam.

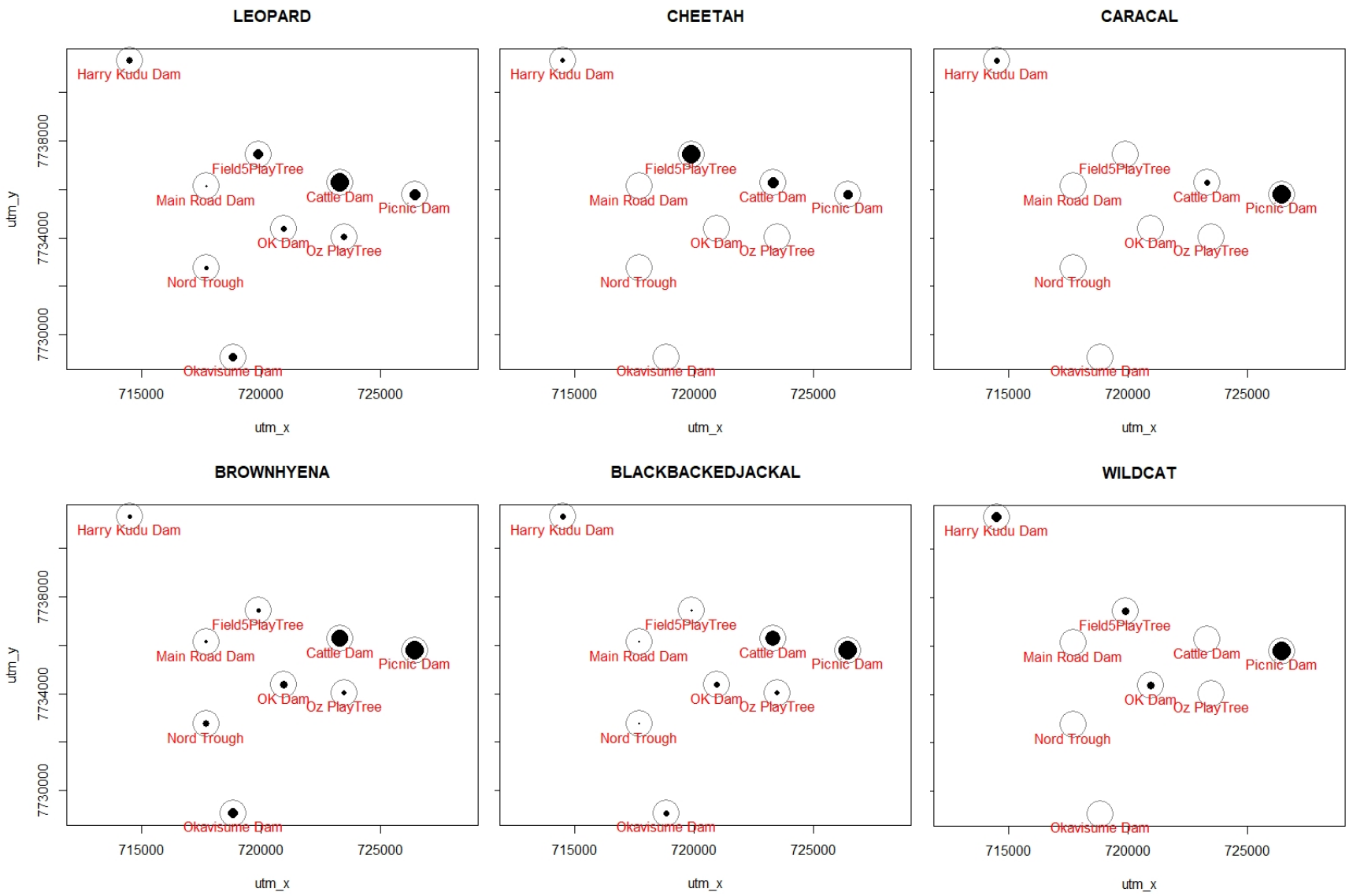


Figure 9: Map indicating the level of detection for carnivore species at each camera trap site. The size of the black circle indicates the proportion of camera trap pictures i.e. the larger the circle, the greater the proportion of photos.

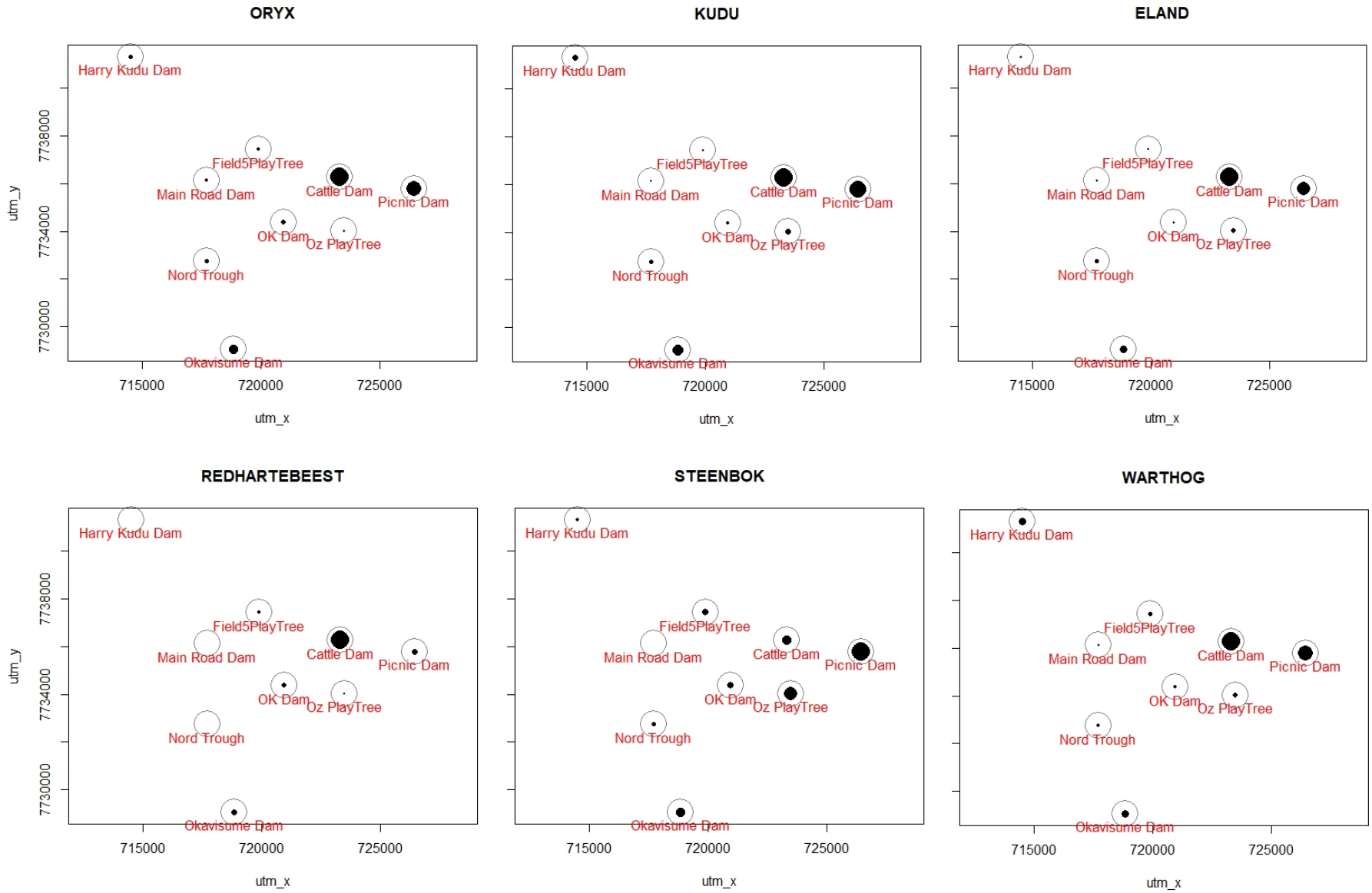


Figure 10: Map indicating the level of detection for herbivore species at each camera trap site. The size of the black circle indicates the proportion of camera trap pictures i.e. the larger the circle, the greater the proportion of photos.

At CCF, all the waterpoints in the dataset were natural dams except for Nord Trough (which is an artifical waterpoint). Most herbivore species had the highest proportion of photos at Cattle and Picnic Dam (Figure 10). Steenbok also showed a high detection at Oz PlayTree. As seen in Figure 6, steenbok tend to have the highest activity (which will include foraging) early morning and late afternoon as it is generally cooler during these times. However, during midday temperature reaches a maximum and steenbok will lie next to a tree in the shade. This may present an over-representation of numbers of individuals; however, data were thinned out by 30-min to account for temporal independence.

Summary

In total, over 208 000 camera trap photos were sorted by Zooniverse/*Cheetahs of Central Namibia* volunteers. *camtrapR* proved extremely useful in sorting and analysing data in R within a short run-time and CCF will certainly make use of this package for future research projects. Species richness and diversity indices were fairly even across all camera trap sites, meaning that the biodiversity is well spread out across the landscape. Two top predators, leopard and cheetah, had a high activity overlap; however, leopards and cheetahs displayed different detections per site. Cheetahs were only captured at four sites, mostly at playtrees, whereas leopards were captured on all nine camera traps, mostly at waterpoints. Herbivore species displayed mostly diurnal activity at waterholes, although some species such as steenbok and eland were mostly active during the early morning and late afternoon. Overall, the waterholes showed the highest detection of wildlife at CCF, which may be explained by the season in which cameras were active.

Acknowledgements

CCF would like to thank each and every Zooniverse/*Cheetahs of Central Namibia* volunteers that assisted with viewing and identifying animals in its camera trap project. Every photograph sorted went a long way in helping CCF to get through photos that have been piling up over time and finally they they sorted thanks to you! CCF would also like to thank the NNF Go Green Fund and Aktionsgemeinschaft Artenschutz (AGA) for providing funding and equipment for our camera trap project.

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