# Abstract

Non-perennial rivers account for more than half of the total river-length in South Africa. Despite their abundance, they are rarely studied due to their highly variable nature. Few studies focus on the faunal components of the non-perennial river habitat, and those are predominantly focused on the aquatic invertebrate assemblages that inhabit these areas. Using camera traps, a survey was performed along the non-perennial Prins River in the Klein Karoo, Western Cape, South Africa, to investigate the use of pools in the riverbed by terrestrial mammals. Camera stations were active for 1280 camera trap days and spanned three different pools along the river. A total of 14 terrestrial mammal species were recorded, encompassing five orders (Primata, Carnivora, Rodentia, Ungulata and Lagomorpha). The most commonly photographed species were the Chacma baboon *(Papio ursinus*), steenbok (*Raphicerus campestris*) and cattle (*Bos taurus*). Detections were higher as a result of motion-triggered photography than hourly triggers by a factor of more than twelve. Detection rates increased in summer, but show specific variation between sites, suggesting that the microhabitats found within a non-perennial river are diverse. No relationship was found between water availability and detection rate, but species richness and total detections were highest following a flood that recharged the pools This study represented the first species inventory of the mammalian assemblage of the Prins River. Future investigations should be undertaken on other non-perennial rivers in South Africa with the goal of more sustainable management of these important environments.

**Keywords**: biodiversity, camera trap, terrestrial mammals, non-perennial, rivers, Klein Karoo

# Discussion

Non-perennial rivers are known for their dry appearance and despite the common assumption that these areas are barren (Steward *et al*., 2012), the results of this study have shown that there is a diverse assemblage of species found to occur within the vicinity of the Prins River. Camera trap photography revealed that the Prins River was home to an array of vertebrate species, including 14 terrestrial mammal taxa across five different orders which were cumulatively observed across three different sites along the river. The majority of those observations were of Chacma baboons (*Papio ursinus*), steenboks (*Raphicerus campestris*), black backed jackals (*Canis mesomelas*), and cattle (*Bos taurus*). Additionally, camera traps also photographed numerous unidentified birds across the Prins River. Detectability of species varied across sites and also varied across months of the year, with the majority of photographs being taken during summer. Moreover, it was found that time-triggered photographs captured drastically less detection than motion triggered photographs.

The effect of variances in water availability on species detections was not expected. While it would be assumed that species richness would be higher at sites with constant water availability, the reality was not so. NPR2, a site which only contained water during the flood in January 2018 (Figure 2), was found to have the highest number of detections as well as the highest species richness. It was found that visitation appeared to increase with water availability but that ultimately the patterns seen were idiosyncratic, suggesting that species visitation could not be explained simply by the presence or absence of water. As stated by Steward *et al*. (2012), the soil in dry riverbeds is highly retentive of organic matter and nutrients, thus enriching the surrounding vegetation. This makes it favourable to many species, including grazers such as cattle, which have been observed to feed in these habitats (Kassas and Imam, 1954). Furthermore, after a river dries up, species of terrestrial animals will consume any stranded matter such as dead fish or invertebrates (Williams, 2005). This further accounts for the highest visitation occurring in the month of February, immediately after the flood.

The sites show certain variation in species composition. There is a greater variation in detection rate. The larger members of order Ungulata are associated together. Ungulata also made up the highest proportion of species found. Mann *et al*. (2014) undertook a camera trap survey in the Klein Karoo as well and recorded a total of 23 mammal species. The study in question took place across the three distinct biomes within the Klein Karoo, and consequently, higher species diversity is expected in comparison to this present study which focused only on one habitat.

Periodic natural floods that occur are characteristic of this environment and visible effects are seen in the vegetation surrounding the river with flora becoming greener and more abundant. This was observed in the months following the flood of January 2018 (Figure 2). Considering that cattle often feed on the vegetation present, this is relevant for the agricultural practices of the area (Steward *et al*., 2012). Particularly in Klein Karoo, there is a reliance on farming (Maitre, Colvin and Maherry, 2009) and as explained by Kassas and Imam (1954), cattle typically graze in dry riverbeds. February has the highest monthly temperature of the year. This increased heat could be another factor to explain the increased visitation rates in summer. It was considered unlikely whether the increase in visitation rates in February was due to recruitment of juveniles to the population, as there was no noticeable increase in the amount of juveniles observed.

There are independent associations of predator and prey species occurring. The appearance of caracal (*Caracal caracal*) in only six intervals is expected due to their naturally low density (Melville and Bothma, 2006). They were seen at all three sites, as were some species of their natural prey, such as birds and steenbok (*Raphicerus campestris*) (Avenant and Nel, 2002). Variations in diurnal patterns of species were observed. Black-backed jackals are usually scarce when in an area with strong human presence, however having been known to appear more frequently where there is no such danger (Stuart and Stuart, 2015). As observed in this study, the remote nature of the location has led to an increased activity of jackals in daylight hours, frequently in pairs. The presence of certain ungulate species such as the eland (*Taurotragus oryx*) and South African oryx (*Oryx gazelle*) only at night is consistent with their behaviour, as typically these animals avoid the heat of the day, and forage at night when humidity is greater and vegetation is more hydrated (Grenot, 1992). Furthermore, the South African oryx (*Oryx gazelle*) in particular, does not require access to drinking water (Stuart and Stuart, 2015). This could account for why this species was not found in NPR1 which had perpetual water within the pool.

Unidentified images occurred mostly during the night. Causes for an image being unidentified is typically cases where the animal moves too fast through the censor, or is too far away. This is a factor worth noting as flash photography may result in clearer images at night, but at the disadvantage of affecting animal behaviour, scaring certain species away from the area (Wegge, Pokheral and Jnawali, 2004). While none of the mammal inventory detected are endangered, certain species, such as the scrub hare (*Lepus saxatilis*), have decreasing populations (Robinson et al., 2019). This suggests that their presence in non-perennial rivers may grow in importance.

The inherent constraint of this study was the limited number of cameras which consequently affected sampling activity and restricted the scope of the study. Ideally, cameras should be implemented at comparable non-perennial rivers in the area to investigate similarities and differences in faunal assemblages. While sampling time was longer than other studies (Gonthier and Castañeda, 2013; Mann *et al*., 2014; Edwards, Gange and Wiesel, 2016), in order to accurately represent the surrounding environment, more sampling time would be needed. This is in line with Cusack *et al*. (2015) who found that after 1400 camera trap days, placement choices will not likely affect inferences made at the level of species communities. Most likely any mammals still undetected would be small, as identification is easier with bigger animals, and typically requires less refined studying. It is worth noting that the species accumulation curve showed relatively complete sampling of the mammal community. The high amount of unidentified photographs (N = 85) bring forth the possibility that any species remaining may have already been detected but were unable to be recognized. It is likely that any species in the area undetected include those found in similar studies and are difficult to detect, such as carnivores with low population density like the aardwolf (*Proteles cristatus*), small-spotted genet (*Genetta genetta*) and striped polecat (*Ictonyx striatus*) (Mann *et al*., 2015). Alternatively, smaller, typically-nocturnal mammals also prove difficult to detect, and species known to live around the study area include more individuals from the order Rodentia, Lagomorpha and certain members of Carnivora (such as the Cape fox, *Vulpes chama)* (Mann *et al*., 2015). Furthermore, it is possible any species that remain undetected may have a large home range, or are seasonal, and consequently have an extremely low detection probability. Further research should focus on usage through motion-triggered photographs, as time-lapse photography typically generates lower detection rates coupled with a high output. This makes data analysis inefficient, as most photographs are discarded. This does come with its own drawbacks, as animals that would not trigger by motion (such as by being too far away from the camera, or being too small) would not be detected at all. Overall, the camera traps were successful in their purpose for this study, and was able to capture the assemblage of mammal species of the area and was a valuable tool in this context. It fit this study’s purpose but may not be suitable for surveys that are concentrating on other types of animals, such as small mammals or birds.

A species list of the mammals occurring along the non-perennial Prins River has been generated, representing the known first of its kind for South Africa. None of the species are of current conservation priority, but may become so in future due to dwindling populations. Recharge events, as a result of heavy rainfall, are an important and natural part of the ecosystem. Visitation is higher immediately after such a recharge event, but the extent of this variation is site-specific, suggesting that the microhabitats that occur within a non-perennial river are diverse. Furthermore, non-perennial rivers have direct value in providing drinking water to animals as well as indirect benefits, such an enriching the surrounding vegetation. Non-perennial rivers are highly variable, and for this reason it is often recommended that these systems are studied on a case by case basis (Day et al., 2019). Future experiment designs are objective dependent, but replicates are needed to be able to have a robust comparison of community composition.

The limited quantity of water that may persist within non-perennial rivers is often thought of as insignificant and not capable for attracting a diverse array of species (Gómez et al., 2005). As such, non-perennial rivers tend to be improperly managed and are often abused and exploited (Steward *et al*., 2012). Moreover, current policies do not place any importance or value onto these systems in many parts of the world (Datry, Larned and Tockner, 2014), such as their lack of representation in European water policy (European Union Water Framework Directive, 2000). This way of thinking is inaccurate and the lack of protection given to these ecosystems will result in a continued degradation. Non-perennial rivers represent an important resource for local animal communities. Sustainable conservation policy making and management should highlight non-perennial rivers as biologically relevant elements of the environment (Sánchez-Montoya *et al*., 2016). The objective of this study was to demonstrate that even in areas as seemingly ‘lifeless’ as the beds of a dry river, there are direct and indirect benefits for its perpetuated existence and is associated with a variety of species. While it may be assumed that non-perennial rivers are devoid of biodiversity, the reality is more complex.