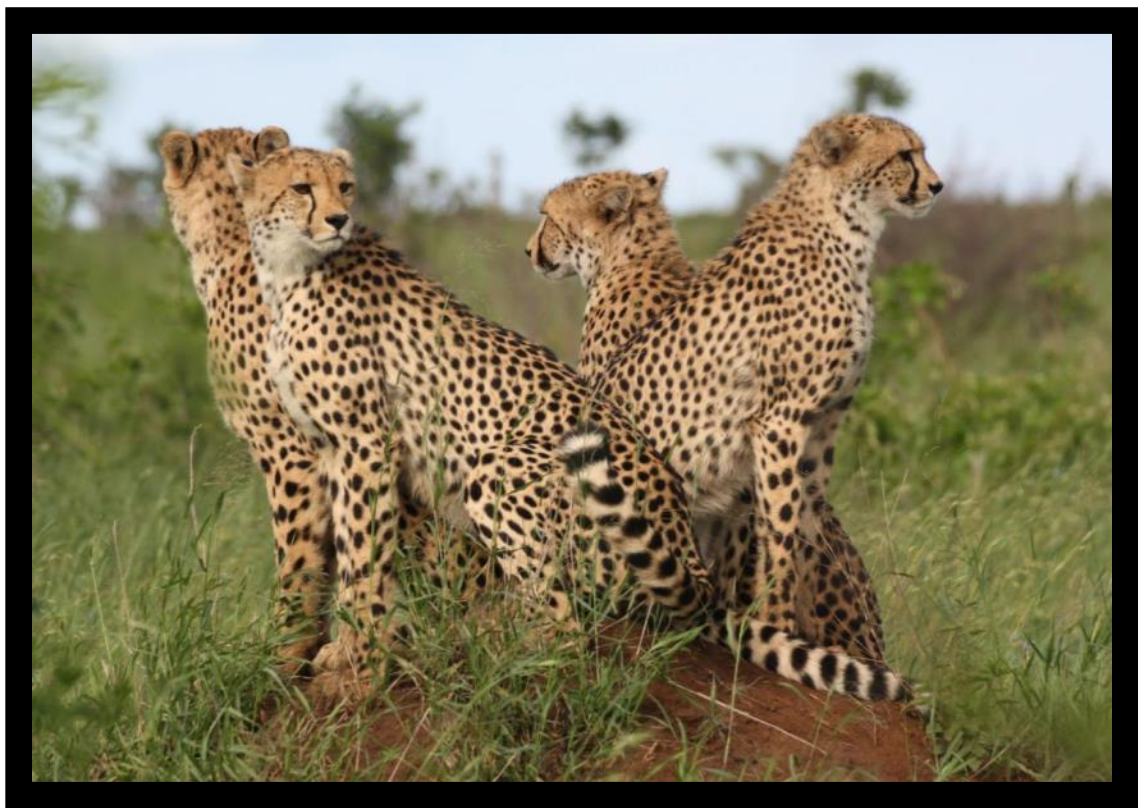


# **Cheetah distribution, threats and landscape connectivity in south-western Mozambique.**

**Annual Progress Report, March 2015**

By Leah Andresen



## **Project summary:**

This is a research project aimed at providing the necessary information to ensure the growth and persistence of a cheetah meta-population in the Greater Limpopo Transfrontier Conservation Area of South Africa, Mozambique and Zimbabwe. Our primary focus is on improving knowledge of cheetah conservation biology in the Mozambican components and our goal is to make a meaningful contribution towards achieving the objectives of the regional conservation strategy for cheetah in Mozambique.

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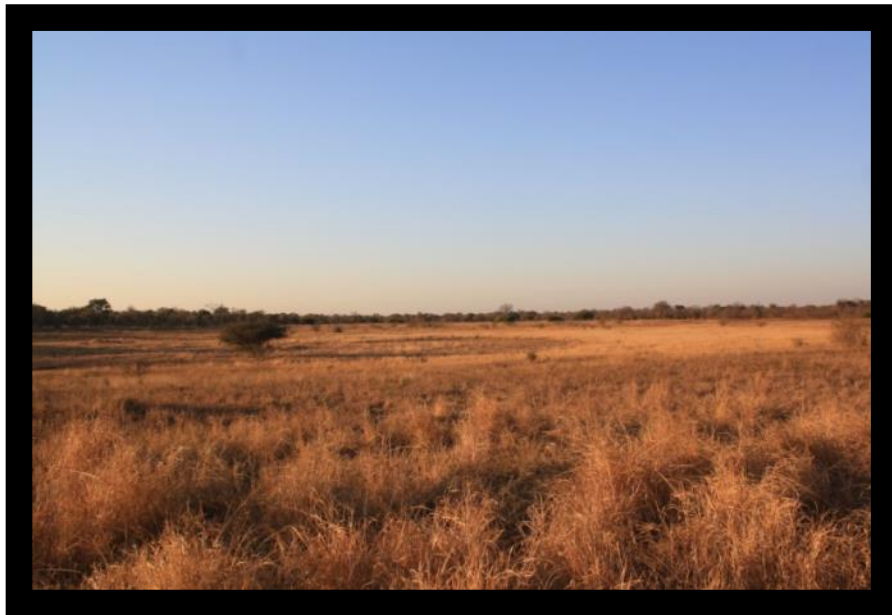
## **Acknowledgements**

We thank the National Administration of Conservation Areas and the management of Banhine National Park and Limpopo National Park for facilitating and encouraging the project and the Rangewide Programme for Cheetah and Wild dog for their support. We kindly thank Conservation Canines for expert detection dog and handling services and all our volunteer research assistants for their hard work in the field. We are grateful for the support of the National Geographic Society Big Cats Initiative, Panthera, the Columbus Zoo and the Nelson Mandela Metropolitan University and for additional sponsorship provided by Bidvest Car Rental, General Tyre, Ironman Suspension, Twin Cities Eco-Turismo and Acana.

## Project Rational

The Greater Limpopo Transfrontier Conservation Area (GLTFCA) is important for the regional and global viability of cheetah because it includes population strongholds in South Africa and Zimbabwe that are contiguous to large tracts of potential habitat in Mozambique. South-western Mozambique could provide additional key habitat, which would increase the regional viability for the species by increasing connectivity and providing space for range and population expansion.

Presently, however, little is known cheetah distribution, prey base or threats in south-western Mozambique. Addressing this need for reliable information is the focus of our project. While the Mozambican components of the GLTFCA were heavily impacted by years of armed conflict; subsequent decades of political stability and the proximity of protected populations in South Africa and Zimbabwe has provided the opportunity for cheetah recovery in Mozambique. Additionally, it is possible that relic populations of cheetah may persist at low density in and around the historic Mozambican protected areas, Banhine and Zinave National Parks. My initial investigations revealed a small but critically important population of cheetah in the Limpopo National Park (Andresen *et al.*, 2012; Andresen, Everatt & Somers, 2014). These results cast a very positive light on the opportunities for the species conservation across the broader area.



*Important cheetah habitat in Limpopo National Park*

However, despite the region's vastness, human densities and human impacts are increasing, with consequent declining opportunities for conservation (Newmark, 2008). The persistence of cheetah in the region is therefore dependent on both the protection of source populations in established reserves and maintaining a level of co-existence with humans across multi-use areas (e.g., Athreya *et al.*, 2013) that can increase connectivity and population and range expansion.



The current situation therefore represents a window of opportunity but the timing is critical: if potential range areas in south-western Mozambique support resident sub-populations that could contribute to the viability of a regional meta-population, then the conservation interventions required for their persistence must be determined and implemented. Furthermore, ensuring the viability of protected source populations in Kruger National Park, South Africa, and Gonarezhou National Park, Zimbabwe, requires knowledge of the effects of adjacent human-impacted lands in Mozambique (e.g., to mitigate edge effects (Woodroffe & Ginsberg, 1998) and detect potential ecological traps (Battin, 2004; van der Meer, Rasmussen & Fritz, 2014)). In order to achieve the expansion and persistence of a regional meta-population, reliable information on population distribution, demographics, prey availability, anthropogenic pressures, recoverable range, landscape connectivity, and source-sink dynamics are required (Linkie *et al.*, 2006; Armstrong & Seddon, 2007; IUCN, 2007; Breitenmoser *et al.*, 2012;). This ambitious project is taking a landscape-scale approach to provide the required information to ensure the expansion and persistence of a cheetah (meta-) population in the GLTFCA.

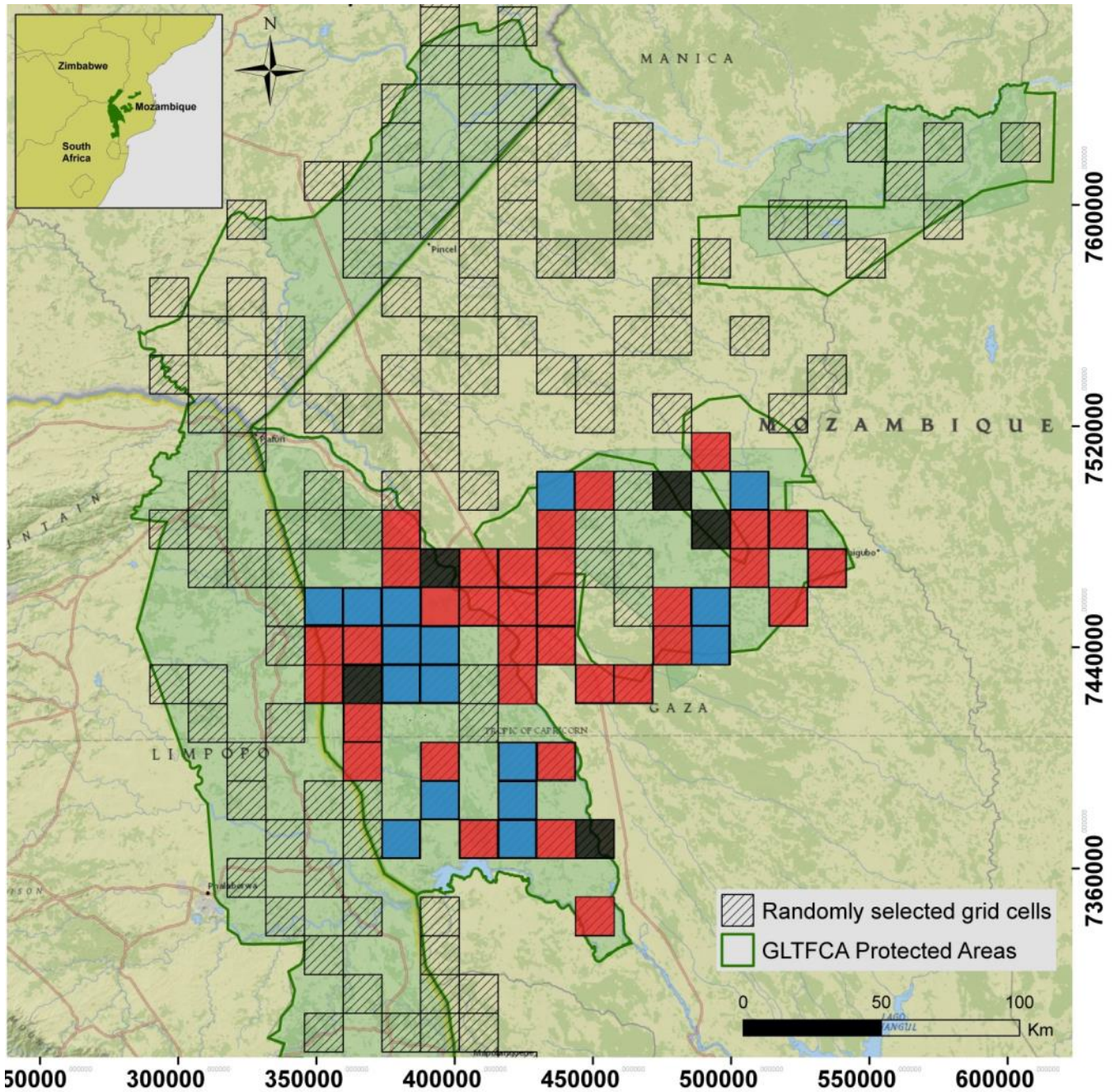
## Objectives

- 1) Quantify cheetah distribution, prey and habitat availability and threats in the Mozambican GLTFCA.
- 2) Quantify source-sink dynamics (and identify potential ecological traps) between established protected areas in South Africa and Zimbabwe and human-impacted areas in Mozambique.
- 3) Evaluate dispersal barriers and potential corridors between all National Parks in the GLTFCA and evaluate and identify areas (i.e., Banhine and Zinave National Parks) that may be naturally recoverable and/or suitable for re-introductions.
- 4) Evaluate the specific management actions and land use planning required to ensure cheetah (meta-) population viability in the GLTFCA.

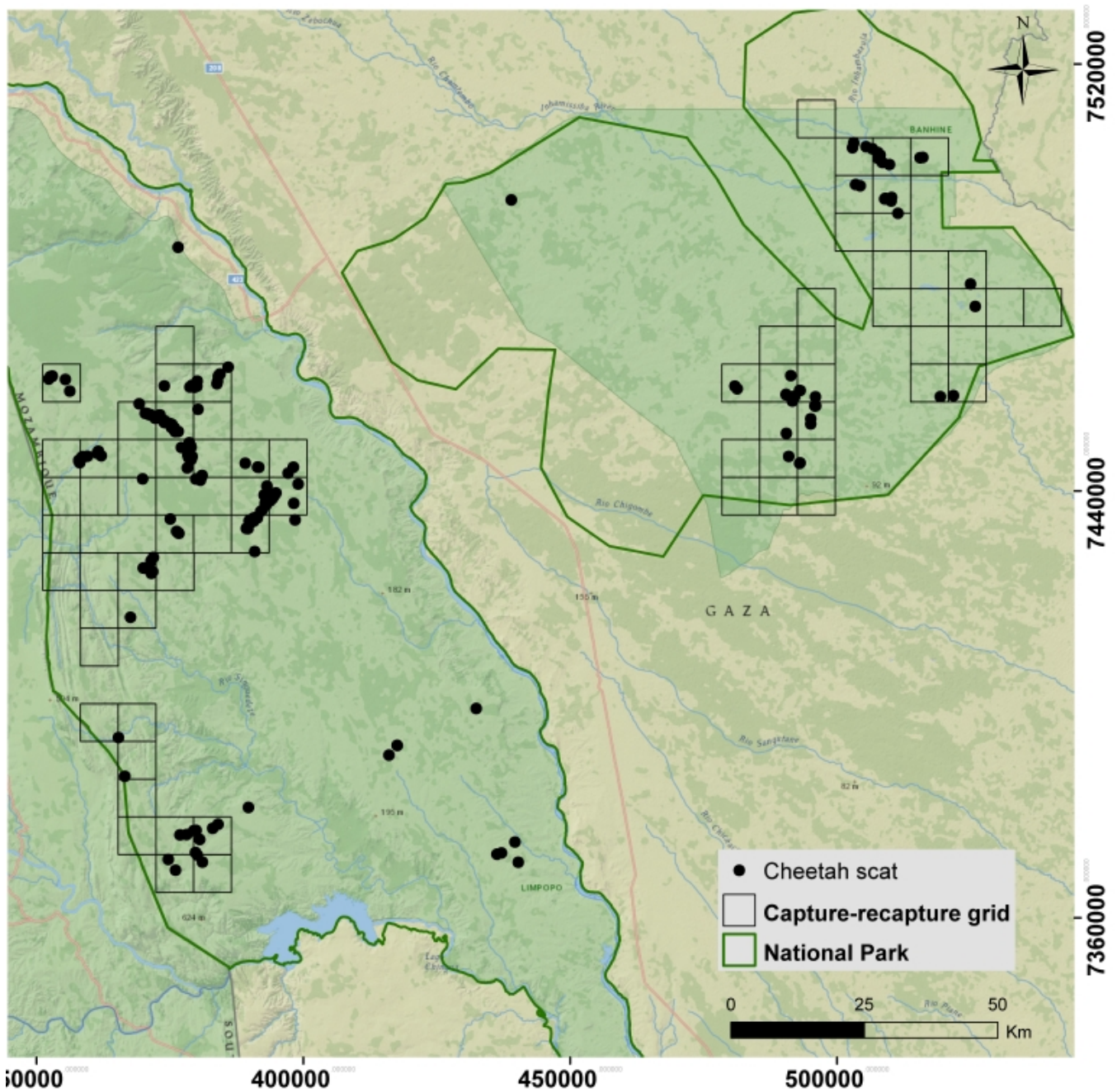
## Narrative Report

### Activities conducted to date (July 2014-February 2015)

- 1) Occupancy sign surveys were conducted to quantify cheetahs' occurrence distribution, prey and habitat availability and threats (Fig.1).
  - 2 052 km of transects walked.
  - 50 x 200 km<sup>2</sup> grid cells surveyed (22 in Limpopo, 15 in Banhine and 13 in Limpopo-Banhine corridor).
- 2) Detection dog surveys were conducted to collect genetic material (scats) to estimate cheetah's population density; quantify connectivity and source-sink dynamics (Fig. 2).
  - 686 km of surveys walked with detection dog (304 km in Limpopo and 382 km in Banhine).
  - 47 x 50 km<sup>2</sup> grid cells surveyed (25 in Limpopo and 22 in Banhine).
- 3) Distance sampling of ungulates was conducted to quantify prey availability for cheetahs and estimate cheetah carrying capacity (e.g., Banhine survey area, Fig. 3).
  - 1 774 km of prey density transects conducted (1 164 km in Limpopo and 610 km in Banhine).



**Figure 1:** The Greater Limpopo Transfrontier Conservation Area, showing 150 randomly selected 200 km<sup>2</sup> grid cells (shaded and coloured); cells sampled during July 2014-February 2015 where cheetah detections were confirmed (blue) and not detected/confirmed (red); and cells removed from sampling because they contained >80% human settlements (black).



**Figure 2:** Capture-recapture grids in Limpopo and Banhine National Parks surveyed by detection dog and/or human-only teams and location of 333 and 71 cheetah scats collected in Limpopo and Banhine National Parks, respectively. Scats located within the grid cells were collected during August-October 2014 on 304 km and 382 km detection dog surveys and 382 and 379 km human-only surveys in Limpopo and Banhine National Parks, respectively. Note the revised Banhine National Park boundaries (2014) are overlaid on the original park boundaries.

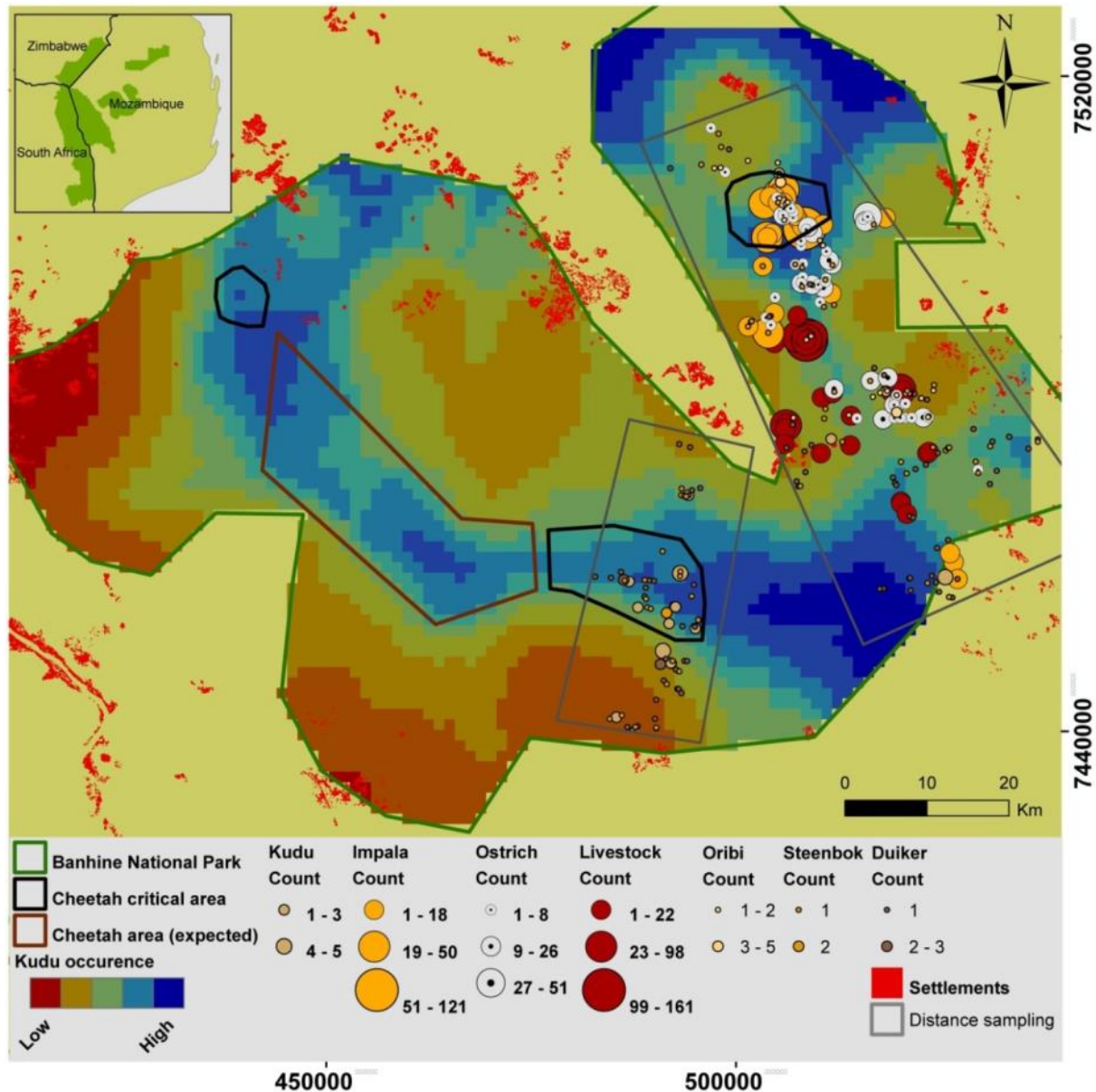
## Preliminary Findings

The most exciting preliminary result was the discovery of a population of cheetahs in the Banhine National Park. We documented sign of cheetahs across a broad survey area and found evidence of male territorial marking behaviour. Importantly, we found that there are fairly large tracts of habitat with little human impact and no livestock that are currently supporting cheetah and other wildlife (including African wild dog, lion and elephant). These results are hugely positive because they show that Banhine has the potential to greatly contribute to cheetah conservation and that it is not too late for the park to be restored.



Occupancy surveys showed that there are two important wildlife areas in Banhine; 1) a proportion of the grasslands and wetlands in the north-east (above) and, 2) the southern sandveld (Fig. 3, but see Appendix 1 for landscapes). Impala (434 recorded) and ostrich (428) were the most numerous herbivores counted in the northern core wildlife area (Fig. 3). Other grassland herbivores include reedbuck, steenbok and oribi. The sandveld landscape (Appendix 1) lacks permanent surface water, resulting in few settlements and livestock (Fig. 3). Kudu, duiker, nyala and steenbok occur widely in the sandveld (e.g., Kudu, Fig. 3) and impala are patchily distributed near 'pans' (depressions where water accumulates). Our results indicate that the majority of the Banhine cheetah population occurs in the sandveld region of the park (Figs. 2 & 3).





**Figure 3: Critical cheetah areas and prey base in Banhine National Park.** Critical cheetah areas are locations where cheetah presence was confirmed; the expected cheetah area has not yet been surveyed but shares important characteristics with critical cheetah areas; kudu occurrence is from logistic regression model of detections from occupancy surveys; locations where distance sampling was conducted and counts of cheetah prey.

Human impact, including livestock grazing and bushmeat poaching, is greatest in the grasslands and wetlands surrounding the northern core wildlife area and lowest in the southern sandveld (from detections of livestock, domestic dogs and bushmeat hunting on occupancy surveys and livestock counts on distance sampling surveys; e.g., livestock counts, Fig. 3). Prey abundance is generally lower in Banhine than in Limpopo, and many larger bodied species are absent (e.g.,

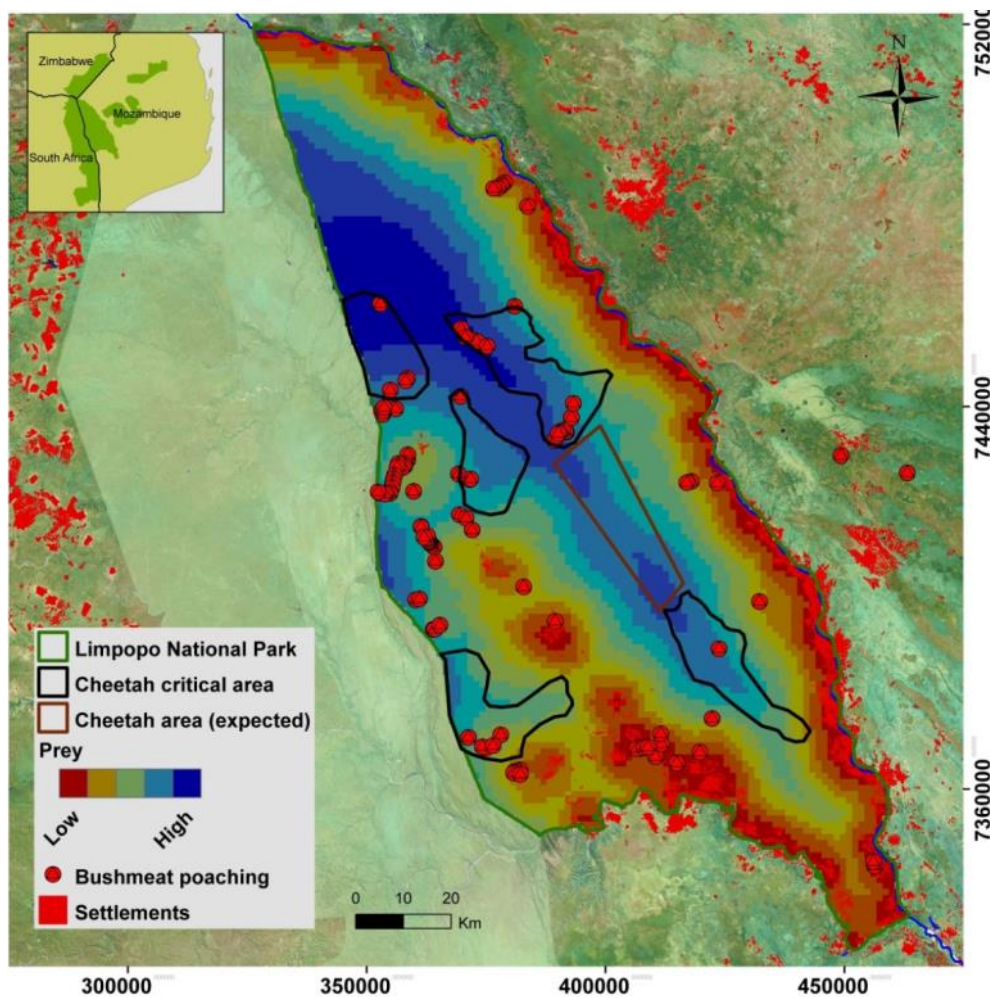
zebra and wildebeest). The extent of bushmeat poaching was, however, was comparable in the two parks (detected on 15% and 19% of 1 km surveys, respectively). In both Limpopo and Banhine, people hunt with large packs of domestic dogs (e.g., 5-20 animals), and we expect that cheetah are displaced by these activities, particularly in the open grasslands of Banhine. There are also large flocks of goats and sheep (e.g., 30-50 animals) in the southern grasslands (Fig. 3), and persecution due to real or perceived livestock depredation may be a factor. However, livestock herders are usually accompanied by packs of domestic dogs, which we expect is deterring cheetah from these areas. Threats to sandveld habitats occur mainly along park edges and include land clearing for crops, livestock grazing and bushmeat hunting associated with small (1-2 family) settlements (situated on pans) (Fig. 3). Other threats include illegal commercial logging of mahogany and clearing of mopane forest for charcoal, which we found to be associated with comparatively higher levels of bushmeat hunting.

Using the biomass of prey counts (duiker and impala) and approximate prey densities following Caro, (1999) and trophic scaling from Hayward *et al.*, (2006; 2007), we estimate a potential carrying capacity of 10 cheetahs in the distance sampling areas (Fig. 3). Please note this calculation does not consider anthropogenic factors or actual prey densities and has not been extrapolated across the park. We placed a camera-trap at a marking site and obtained the first known images of cheetah in Banhine (right).



We sampled across a much larger area in Limpopo than had been previously surveyed (Andresen *et al.*, 2014). Our results show that the cheetah population in Limpopo is broadly distributed but restricted by intensive agricultural settlements (Fig. 4). Limpopo is undergoing voluntary resettlement of communities from the core area. We documented the local expansion of cheetah and their prey into a region surrounding and within a village abandoned by approximately 300 people and their livestock in 2013. By contrast, a second recently abandoned village site contained no cheetah and fewer prey and high levels of livestock and bushmeat poaching. The

villages differed in their vicinity to existing villages and landscape type. Information on cheetah and prey response to resettlement will be important for population viability analysis. Cheetahs are highly associated with sandveld habitats that encompass the core length of the park. Kudu, nyala, impala and duiker are widespread in this region and there are few agricultural or livestock impacts. However, bushmeat hunting is widespread including in important cheetah habitats (Fig. 4). The park is large and strategically located and therefore increasing this population will make a demonstrable contribution to cheetah conservation.



**Figure 4: Critical cheetah areas, bushmeat poaching and prey base in Limpopo National Park.** Critical cheetah areas are locations we found cheetah sign; the expected cheetah area has not yet been surveyed but shares important characteristics with critical cheetah areas; kudu occurrence is from logistic regression model of detections from occupancy surveys; locations of bushmeat poaching events including snares, carcasses, hunting camps and encounters. We are using this information to improve habitat quality for cheetah by assisting park management to direct their anti-poaching efforts to critical cheetah areas.

There are considerable human-impacts in the potential corridor areas between Limpopo and Banhine National Parks; the greatest barrier to wildlife movement appears to be a near-continuous band of agricultural settlements along both sides of the Limpopo River. However, we did document wild ungulates in some areas; including duiker on 42 %, kudu on 25 %, steenbok on 11 %, bushpig on 8 %, nyala on 7 %, and warthog on 4 % of 1 km trail segments surveyed, respectively.

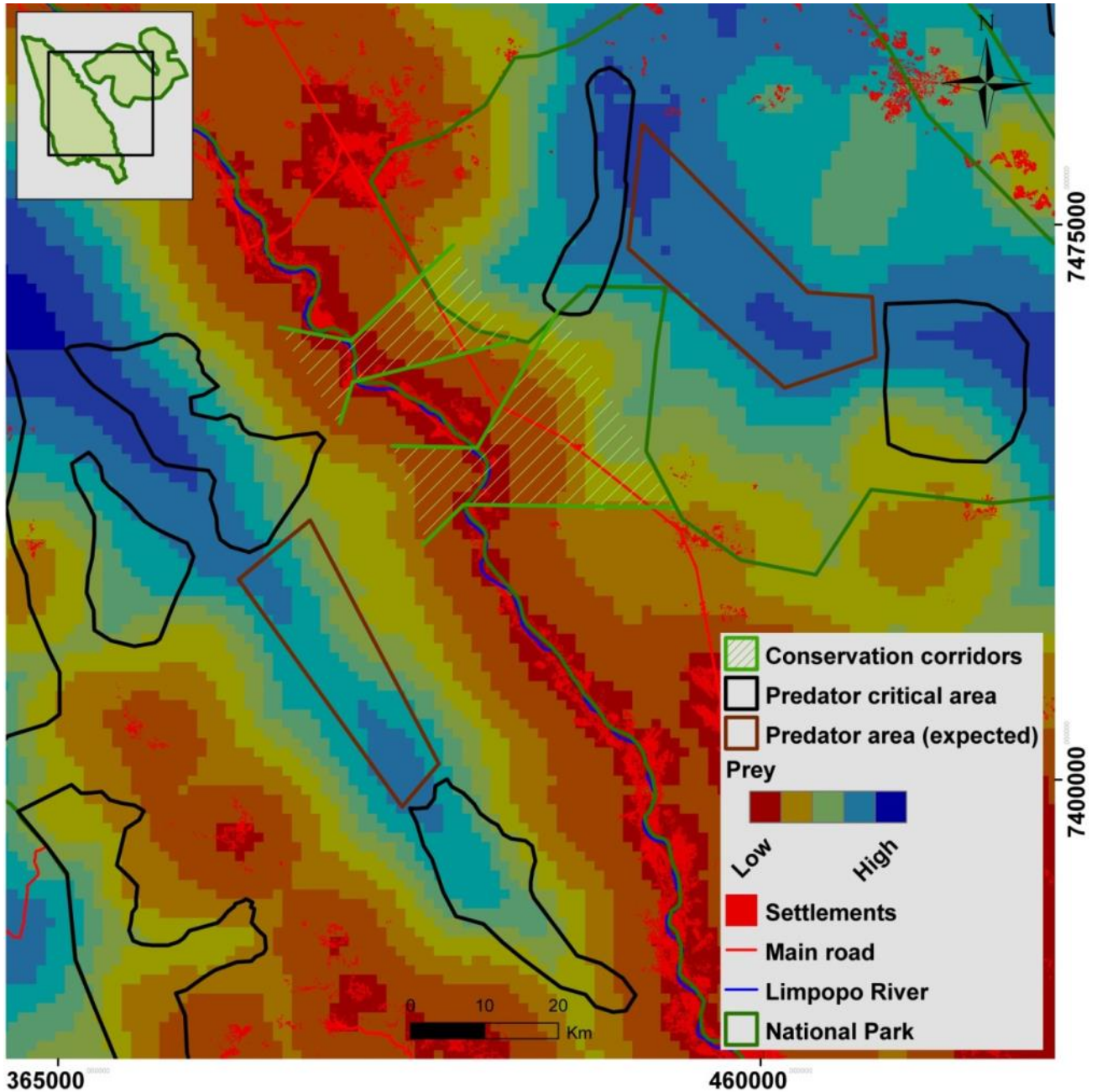
That some potential corridor areas support low densities of wild ungulates is extremely promising because these areas may permit cheetah dispersal; however, wild ungulate populations are likely rapidly diminishing with rising human impacts.



Considering this, we believe that it is important that areas that may serve to maintain or promote connectivity for cheetah between Limpopo and Banhine are demarcated quickly before they are further degraded and lost (i.e., Caro, Jones & Davenport, 2009).



We are therefore urging the governing authority for conservation areas in Mozambique to secure a Limpopo-Banhine conservation corridor. To assist with the corridor planning process, we are providing information on critical cheetah (and other large predator) areas in both National Parks, and on wild ungulate occurrence (Fig. 5). Based on our preliminary results, we have indicated the regions that have the highest likelihood of functioning as a corridor for cheetah (and other large predators) (Fig. 5) (Andresen, Everatt & Kerley, 2015).



**Figure 5:** Recommended Limpopo-Banhine conservation corridor, identified as area with the highest likelihood of facilitating apex predator connectivity. Assessment is based on critical areas for cheetah, lion and African wild dog, and occurrence of important prey from logistic regression model and human land-use. Expected predator areas have not yet been surveyed but share important characteristics with critical predator areas.

## Progress towards meeting the projects objectives

### **Objective 1: Quantify cheetah distribution, prey and habitat availability and threats in the Mozambican GLTFCA.**

We have acquired considerable material and data to provide reliable information on cheetah distribution, prey base, habitat availability and threats across a 10 000 km<sup>2</sup> survey area in Limpopo and Banhine National Parks and adjacent community grazing and forestry lands and private hunting reserves. These lands represent approximately 50% of the selected sample sites in Mozambique. They also encompass some of the most logistically challenging areas. Cheetahs were detected in 32 % of the surveyed grid cells (Fig. 1). The detection or non-detection of prey, livestock and anthropogenic information were also recorded, including, duiker on 51%, kudu on 44 %, impala on 20 %, nyala on 15 % , cattle on 32 %, goats/sheep on 5 % domestic dogs on 16 % and bushmeat hunting on 10 % of 1 km trail segments surveyed, respectively. To quantify prey densities, we conducted distance sampling in both Limpopo and Banhine parks (e.g., Banhine survey, Fig. 3). Our information will feed into population viability analysis and will be used to provide informed recommendations on the conservation management and land-use required to ensure the growth and persistence of cheetah populations in Limpopo and Banhine (e.g., control and alleviate need for bushmeat, implement livestock and domestic dog free zones). More broadly, our information will be used to quantify cheetah's tolerance threshold to various rural subsistence activities. Our results will therefore be very important for promoting human cheetah co-existence in south-western Mozambique and across other similar range areas.



**Objective 2: Quantify source-sink dynamics (and identify potential ecological traps) between established protected areas in South Africa and Zimbabwe and human-impacted areas in Mozambique.**

The sampling required to quantify source-sink dynamics has been completed in the human-impacted Limpopo National Park in Mozambique, which borders on an established protected area (Kruger National Park) in South Africa. We have collected a total of 333 scats across a broad area in Limpopo (Fig. 2), often with the assistance of a detection dog (below). These data will be used to distinguish whether Limpopo is 1) a beneficial extension of (low-quality sink) habitat or 2) an ecological trap that is detrimental to the Kruger population (using gene flow patterns (Andreasen *et al.*, 2012) and habitat selection data from occupancy models). Ecological traps can occur when humans increase attractiveness of low-quality habitat or decrease suitability of high-quality habitat. Early detection of ecological traps is important because they can result in population decline or extirpation of source populations, and population densities are not a reliable indicator (Battin, 2004). Ecological traps can occur when humans cause high mortality in high quality habitats. For sub-ordinate predators, low-quality habitats may become attractive when humans reduce competitor densities in areas adjacent to sources (van der Meer *et al.*, 2014). Our information will be used to direct efforts to improve the quality of available habitat in Limpopo, to identify and secure additional (low quality) habitat, to reduce the attractiveness of ecological traps (attractive-sink habitat) and to reduce the effects of edges on source populations.



**Objective 3: Evaluate dispersal barriers and potential corridors between all National Parks in the GLTFCA and evaluate and identify areas (i.e., Banhine and Zinave National Parks) that may be naturally recoverable and/or suitable for re-introductions.**

We have completed occupancy spoor surveys to meet the above objective across a 2600 km<sup>2</sup> area, which represents the entire potential Limpopo-Banhine corridor (i.e., all selected grid cells). The information that we have acquired will permit an evaluation of the resistance of the landscape to movement by cheetah, including prey base and human land-use. In addition, we have



completed extensive sampling for scats in Limpopo and Banhine and have collected a total of 333 and 71 cheetah scats, respectively (Fig. 2). Genetic analysis will determine whether the Banhine cheetah population is (pre-war) relict, or a result of recent recolonization from Limpopo and/or Gonarezhou. Together with information on landscape resistance from occupancy surveys, these genetic data will enable a critical evaluation of landscape connectivity and barriers for dispersal between Limpopo and Banhine. This information will feed into land-use planning initiatives to increase cheetah population viability.

Our results show that cheetah have either persisted in Banhine through years of war or have recently recolonized. In either case, it is likely that the population may be in need of rescue. We have acquired the majority of material and data to provide the information required 1) to determine if the cheetah population in Banhine requires augmentation and 2) to determine the required improvements to ensure that such a program is successful. Specifically, we have acquired sufficient material and data to evaluate the connectivity of the population to Limpopo, and the majority of the material and data to provide the information required on prey base, habitat availability and threats. Our information will be used to evaluate population size, carrying capacity and habitat suitability, which will inform conservation interventions to increase the cheetah population in Banhine.



**Objective 4: Evaluate the specific management actions and land use planning required to ensure cheetah (meta-) population viability in the GLTFCA.**

We have acquired the majority of the material and data to provide the information required to determine the best management actions and land-use planning to ensure the growth and persistence of cheetah populations in Limpopo and Banhine National Parks.

Specifically, we have acquired the material and data to provide the information required to evaluate best management strategies in (meta-) population viability analysis, including:

- 1) Population size and sex ratios.
- 2) Habitat suitability (space and prey availability and threats).
- 3) Connectivity.
- 4) Source-sink dynamics.

The information that we have gained will be important for promoting human cheetah co-existence in Limpopo and Banhine National Parks and will guide future education and outreach programs. Importantly, our information will be used to determine how land-use practices in south-western Mozambique influence cheetah population viability, and will inform efforts to improve habitat quality for cheetah and land-use strategies to maintain and/or promote connectivity.

**Other contributions to cheetah conservation**

In addition to the regional significance of our work, our information also provides a key contribution to the current understanding of cheetah conservation biology in large, unfenced, multi-user landscapes impacted by rural subsistence use including bushmeat hunting and subsistence farming. Since the majority of information on cheetah ecology in southern Africa is from fenced systems, our information provides a novel contribution that is highly applicable to resident and potential cheetah range areas in southern Africa. Our results can therefore be applied across other cheetah range areas to improve landscape-scale conservation planning and management.

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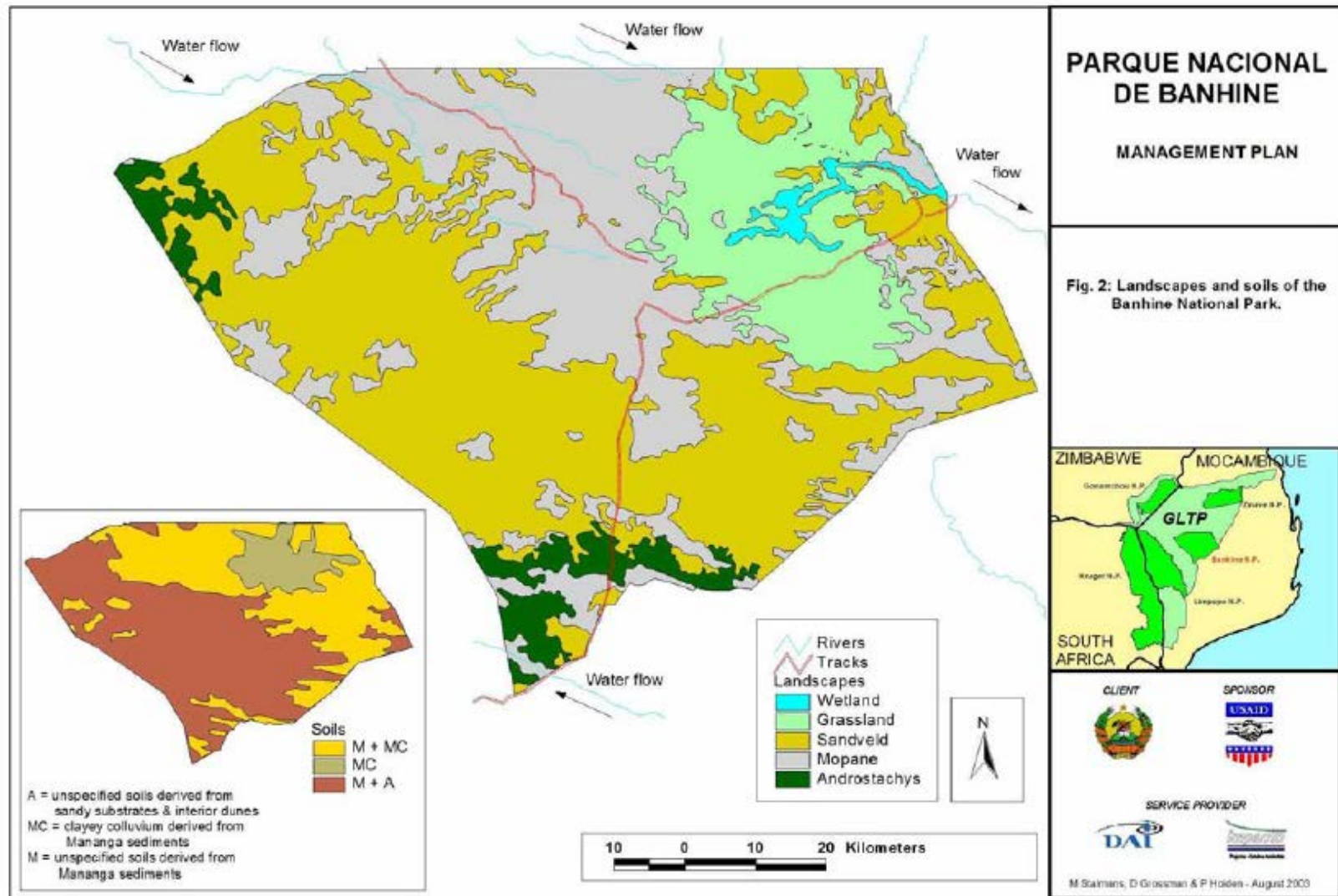
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## Appendix 1



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