A Large Mammal Survey of Bicuar and Mupa National Parks, Angola

With Special Emphasis on the Presence and Status of Cheetah and African Wild Dogs

Survey and report commissioned by the National Institute of Biodiversity and Conservation Areas in partnership with the Range Wide Conservation Program for Cheetah and African Wild Dogs

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Cover photo A camera trap picture of an African wild dog (mabeco) taken near the artificial waterhole at Posto Vicussekue in Bicuar National Park. This wild dog is very unusual in having a black tip on its tail, whereas wild dogs almost always have a white tip on their tail.

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Introduction and background

The need for surveys across Angolan Protected Areas has been emphasised by the National Institute of Biodiversity and Conservation Areas (INBAC) in Angola. The current survey was done in partnership between the Ministerio de Ambiente (MINAMB), the Instituto Nacional de Biodiversidade e Áreas de Conservação (INBAC), The Range Wide Conservation Program for cheetah and African wild dogs (RWCP), Panthera, the Zambian Carnivore Programme (ZCP) and the Southern African Science Service Center for Climate Change and Adaptive Land Management (SASSCAL).

Throughout the report, we use the past tense to refer to our observations and inferences about species distributions during the survey period of August and September 2016. To distinguish these recent results from previous historical distributions (such as those reported in a series of reports by Huntley in the 1971 to 1974), we are explicit in referring to the older accounts as historical data.

Study area

The study area was Bicuar and Mupa National Parks in Angola, and the area between the parks.

Methods

We employed a joint survey methodology that combines the complementary strengths of four survey techniques: 1) interviews of officials and local communities, 2) camera trap surveys, 3) spoor surveys, and 4) reconnaissance (recon) and wildlife observations. Each technique provides a different perspective on the mammal community and other aspects of the park, and in combination they provide a more complete picture of the biota of the park and the challenges facing the park than any one alone would provide. Throughout the survey, we used remote imagery, spatial information on water sources and human distributions and interviews with managers and local inhabitants to guide our survey efforts.

Results and Discussion

Bicuar

The results of the investment into Bicuar restoration were evident in the infrastructure and staff at Bicuar. Bicuar had a good foundation of infrastructure including buildings, roads and artificial water and well-trained and dedicated staff. Together this indicates a well-capitalized and well-managed park, with a good plan for restoration. This provides an excellent foundation for rebuilding wildlife populations and attracting tourism, but is dependent upon ongoing investment and protection. Habitats were mainly intact, although fire had a strong presence.

The survey in Bicuar consisted of a combined effort of MINAMB, Bicuar, Panthera and SASSCAL staff, with 154 km of spoor transects and 1265 km of recon and wildlife observation surveys. During the survey we had 39 camera traps operating for about 27 days each in Bicuar. Survey effort was higher in the core area of Bicuar, where permanent water and good protection results in the highest animal densities

Leopards and spotted hyaena were the most common large carnivores at Bicuar, and both were at good densities in the core area of the park, and were widespread through the outer areas of the park. Cheetah were absent from the system and have been for over a decade, with no observations of the species and no records of their presence. Lion were also absent and reported only as rare visitors. Wild dog were present at low densities and widespread through the park. We estimated that the wild dog population was a resident population of 40 to 50 individuals that operated mostly in small packs. Key threats to the wild dog population included: prey depletion especially in preferred size and type, likely persecution in areas outside park, small size and likely isolation of population. Other potential threats (e.g. disease from domestic dogs) were not assessed by this survey.

Ten species of medium and small carnivores were detected in the park, including serval, caracal, black-backed jackal, wildcat, miombo genet, honey badger, bat-eared fox, Cape fox, aardwolf, Selous mongoose and swamp mongoose. Of these species, serval, caracal, black-backed jackal and wildcat were the most common. Civet and side-striped jackal were notably absent, although both were observed at Mupa and may also be present at Bicuar.

During the surveys we observed elephants and seven species of ungulates including; common duiker, steenbok, roan, bushpig, warthog, kudu, and eland. Of these duiker and roan were the most common. We estimated there may be 70 elephants in Bicuar, operating from two main areas of remote forest and thicket. The distance at which 50% of animals flee was estimated at 264 m for roan, 209 m for duiker and 226 m across all observed species.

We observed no evidence of ivory or bushmeat poaching in Bicuar during our visit. Pressures on the park include the continued potential threat of poaching, encroachment by settlement and livestock, fire, and low level extractive activities such as harvesting of thatching grass.

The park has excellent potential to become a major destination for wildlife tourism in southern Africa. This will require significant recovery of wildlife and viewing rates from current levels. In the meantime, there is good potential for tourism from 4WD and wilderness enthusiasts.

Mupa

Mupa National Park has had much human settlement inside the original 'colonial' boundaries. Only a few areas in the central western part were relatively free from human settlement. Currently there is no infrastructure and little or no protection of the park area.

We focused our attention on these areas, near water locations as reported by officials and locals. The Administrator Adjunto in Cuvelai organized a meeting with a range of officials and headmen in Cuvelai. This meeting and numerous discussions with local headmen and villagers, in conjunction with extensive use of remote imagery helped us to identify likely areas for wildlife.

The survey team consisted of five people, joined at times by local officials, headmen or villagers. We performed over 2000 km of recon and wildlife observation surveys and over 100 km of spoor transects. Access to the interior parts of the park was extremely limited, roads often heavily overgrown, and some surveys were done on foot. A total of 29 cameras were set for about three weeks in Mupa. We conducted 35 interviews of officials, headmen and villagers in and around the park.

Mammals were much lower in abundance and also lower in diversity in Mupa than in Bicuar and were generally restricted to areas near water with little or no human settlement. As in Bicuar, leopards and spotted hyaena were the most common large carnivores in Mupa, although at much lower densities than Bicuar. Cheetah were not present in Mupa and there was no evidence that they have been present since 1970s. Lions were mostly absent, but were reported to wander through every five years or so. Wild dog were present at low densities in areas of the park with little or no human settlement. We estimated that the wild dog population was about 20-30 dogs and that these dogs were not resident solely in Mupa but moved back and forth across the Cuvelai River on the eastern boundary of the park to wildlife areas further east. Key threats for this wild dog population included: heavy prey depletion especially in preferred size and type, extensive human habitation and livestock in the park, likely increase in human habitation to the east of the park which may stop movement to wildlife areas to the east which may be critical to sustaining this population, small population size, lack of permanent water that is not dominated by humans and reported direct persecution. Other possible threats (e.g. disease) were not assessed in this survey.

Nine species of medium and small carnivores were detected in the park, including serval, caracal, black-backed jackal, side-striped jackal, civet, honey badger, Selous mongoose, banded mongoose and an unidentified species of mongoose. During the surveys we observed six species of wild ungulates including; common duiker, steenbok, roan, bushpig, warthog, and kudu. Of these duiker, steenbok and bushpig were the most common, with kudu also reported to be widespread. Elephants and eland are absent from Mupa. Giraffe were widely reported to have been absent from Mupa since around 1975.

Numerous evidence of poaching for bushmeat was found in our survey of Mupa, including: bushmeat for sale on the roadside; hunter's camps and animal skins; sticks to hold a set gun over a waterhole; a well-used motorcycle trail accessing game areas and camera trap images and direct observation of a man on a motorcycle with gun in a remote wildlife area; a camera trap image of a hyaena with a snare wound.

Area between the parks

At their closest, the parks are separated by only 25 km. However in this area are two rivers that were both heavily settled, creating a significant barrier to movement. Although elephants, wild dogs and other species accessed the Cunene River from the Bicuar side, residents on the eastern side of the Cunene reported that the animals never cross onto their side, and that any elephant that did would be shot by poachers. In the area that we surveyed, locals and headmen reported that elephants had not crossed over to the east side of the Cunene since 2005. Animals that were reported between the parks include duiker, hyaena, leopard and kudu. Our only mammal observations in the area between the parks were hyaena tracks and a direct observation of a duiker. Together, this evidence suggests that there was little or no remaining movement of animals such as elephant and wild dog between Bicuar and Mupa, although species more tolerant of humans may still have moved between the parks.

Management recommendations

Bicuar

We make the following recommendations to management for Bicuar

- Bicuar has an excellent foundation for recovery of infrastructure and staff, and the beginnings of a recovery. However, this is entirely dependent on continued protection. The highest priority for Bicuar is to maintain current staffing levels and

continuity of staff salaries. This is extremely urgent and important. Maintained vigilance against poaching and encroachment is vital for the park.

- Tourism to the park could be dramatically increased in the near term by making existing facilities available for camping and promotion of the park's receptivity to tourism.
- The management should pursue the idea of reintroduction of buffalo and should solicit a report on feasibility and a reintroduction plan with costings. Other species could also be considered for reintroduction, but only if that species was known previously to be in Bicuar.
- A remote waterhole should be surveyed and given better road access and protection.
- Management could consider inviting The Nature Conservancy to provide advice on fire management.
- Management could also periodically re-evaluate the degree to which extractive activities in the park contribute to (and detract from) management objectives, particularly if wildlife populations make a significant recovery.
- Bicuar would make an excellent candidate for a co-management relationship to help provide funds and other support to manage and protect the park.

Mupa

We make the following recommendations for Mupa:

- Mupa is highly depleted and encroached, however it retains most of the species found in Bicuar. This together with significant areas with little or no human settlement suggests that recovery is possible.
- Recovery of Mupa could consist of a formal or de facto re-gazettal of the park to contain the remaining core areas without significant settlement and with remaining wildlife populations, as well as perhaps an expansion to include the wildlife areas to the east of the current park. This should be accompanied by paying the people inside the new park boundaries to relocate into de-gazetted areas.
- Several key issues would need to be addressed in the recovery of this redefined park, including poaching, infrastructure, careful provision of artificial water, protection from settlement and livestock, and creation and maintenance of wildlife corridors across the Cuvelai river area to the east.
- Re-establishment of connection to Bicuar would help both parks, but it is likely to be difficult.
- The small roan herd of 17 or 18 individuals may be the last roan in Mupa and is highly vulnerable and in urgent need of protection.
- Mupa also has significant potential for adventure tourism by 4WD and wilderness enthusiasts.

Further research

Priorities for further research include:

- Improved understanding of wild dog population status, movements and threats
- A repeat camera trap survey in Bicuar of similar design using paired cameras in three to five years' time.
- A feasibility analysis and costed reintroduction plan for reintroduction of species such as buffalo into Bicuar.
- Further surveys of the area would be advised if a re-gazettal of Mupa is planned.

1.2. Português

Introdução e contextualização

O Instituto Nacional de Biodiversidade e Áreas de Conservação (INBAC) tem dado especial enfase à necessidade de serem feitos levantamentos nas áreas protegidas em Angola. O presente levantamento é o resultado de uma parceria entre Ministério do Ambiente (MINAMB), Instituto Nacional de Biodiversidade e Áreas de Conservação (INBAC), Range Wide Conservation Program for cheetah and African wild dogs (RWCP), Panthera, Zambian Carnivore Programme (ZCP) e Southern African Science Service Center for Climate Change and Adaptive Land Management (SASSCAL).

Ao longo do relatório, recorreu-se ao tempo verbal pretérito perfeito para mencionar as observações e inferências sobre distribuição de espécies obtidas durante o levantamento de Agosto e Setembro de 2016. De forma a distinguir os resultados alcançados de distribuições históricas (como as reportadas por Huntley nos relatórios criados entre 1971 e 1974), fazemos explicita referência quando nos referimos a dados históricos.

Área de Estudo

As áreas analisadas foram os Parques Nacionais do Bicuar e da Mupa, bem como a área que separa os parques.

Metodologia

Para este relatório, utilizou-se um conjunto de métodos que combinam as virtudes de quatro técnicas de levantamento: 1) inquéritos a autoridades e comunidades locais, 2) levantamentos com camaras armadilha, 3) pesquisa de vestígios; e 4) reconhecimento e observações de vida selvagem. Cada técnica acrescenta uma perspectiva distinta sobre a comunidade de mamíferos e outros aspectos do parque, e, quando combinadas, permitem obter uma visão mais completa sobre a biota do Parque e dos desafios enfrentados, muito mais do que se utilizadas isoladamente. Ao longo do levantamento, recorreu-se a imagens de satélite e informação espacial sobre recursos de água e distribuição antrópica, bem como entrevistas a administradores e habitantes locais, de forma a melhor orientar o esforço aplicado no levantamento.

Resultados e Discussão

Bicuar

O resultado do investimento feito na restauração do Bicuar é notório, não só na infraestrutura, mas também no que diz respeito aos funcionários. O parque do Bicuar demonstrou ter boa infraestrutura de base, incluindo edifícios, estradas, pontos de água artificiais e funcionários dedicados e bem treinados. Em conjunto, estes são indicativos de um parque bem capitalizado, com boa gestão, e com um plano de recuperação adequado. Esta é a base fundamental para a recuperação de populações de vida selvagem, sendo, no entanto, dependente de investimento e proteção contínuos. Os *habitats* pareceram na sua maioria intactos, embora o fogo tivesse presença marcadamente forte.

O levantamento no Bicuar foi o resultado do esforço conjunto de funcionários do MINAMB, Bicuar, Panthera e SASSCAL, tendo sido percorridos 154 km de transectos em que se registaram vestígios (rasto e fezes) e 1265 km de transectos para reconhecimento e observações directas de vida selvagem. Ao longo do levantamento, foram dispostas 39 camaras armadilha que operaram durante 27 dias consecutivos. O esforço de levantamento

foi superior no núcleo do Bicuar, onde as densidades populacionais de animais são mais elevadas, resultado da proteção e acesso a água permanente.

No que diz respeito aos grandes carnívoros, os mais comuns no parque do Bicuar foram leopardo e hiena malhada, sendo que ambos apresentavam boa densidade no núcleo do parque, estando também dispersos pelas áreas mais externas. A chita demonstrou estar ausente deste sistema há mais de uma década, pelo que não houve observações directas nem registos da sua presença. O leão também se mostrou ausente, havendo apenas registos de raras visitas. Os mabecos demonstraram estar presentes, em baixa densidade populacional, e dispersando-se por todo o parque. Estimou-se que a população de mabecos seja residente, com 40 a 50 indivíduos, organizados em pequenas matilhas. As principais ameaças à população de mabecos incluíam: diminuição de presas, especialmente no tipo e tamanho preferidos; elevada probabilidade de perseguição em áreas externas ao parque; tamanho reduzido das matilhas e presumível isolamento. Outras potenciais ameaças (p. ex. patologias transmitidas por cães domésticos) não foram avaliadas neste levantamento.

Foram detectadas no parque dez espécies de mamíferos de pequeno e médio porte, incluindo serval, lince, chacal de dorso preto, gato bravo, geneta de Angola, texugo-do-mel, raposa orelhas-de-morcego, raposa prateada, protelo, mangusto selous e mangusto dos pântanos. Das espécies referidas, serval, lince, chacal de dorso preto e gato bravo foram as mais comuns. Civeta e chacal de flancos raiados estiveram notoriamente ausentes, embora, ambos tivessem sido observados na Mupa e muito provavelmente estivessem presentes no Bicuar.

Durante os levantamentos, foram observados elefantes e sete espécies de ungulados incluindo: bambi, punja, palanca vermelha, porco bravo, facochero, olongo e gunga. Destes, o bambi e a palanca vermelha foram os mais comuns. Estimou-se que existam 70 elefantes no Bicuar, instalados em duas áreas remotas de floresta e mata cerrada. Estimou-se ainda a distância em que 50% dos animais foge, sendo de 264 m para palanca vermelha, 209 m para bambi, e 226 m para todas as espécies observadas.

Durante a nossa visita, não foram observadas no Bicuar quaisquer evidências de caça furtiva, seja para carne de consumo ou tráfico de marfim. As pressões sofridas pelo parque compreendiam a ameaça constante de caça furtiva, invasão por população e gado, fogo, e actividades de exploração menores como a colheita de capim para produção de telhados de palha.

O parque tem excelente potencial para vir a ser um grande destino de turismo de vida selvagem, na África austral. Para tal, é indispensável haver significativa recuperação, relativamente aos valores actuais, das populações de vida selvagem e, consequentemente, de avistamento de animais. Entretanto, já existe elevado potencial para turismo de aventura em 4x4 e amantes de natureza e vida selvagem.

Mupa

O Parque Nacional da Mupa há muito que apresenta elevado número de assentamentos humanos dentro dos limites originalmente estabelecidos na época colonial. Apenas na região centro-oeste se encontraram pequenas áreas relativamente livres de populações humanas. Actualmente, não existe qualquer tipo de infraestrutura e a proteção é bastante reduzida ou inexistente.

Focamos a atenção em áreas, próximas de pontos de água, conforme nos foi indicado por autoridades e habitantes locais. O Administrador Adjunto do Cuvelai organizou um encontro com um conjunto de autoridades locais e sobas do Cuvelai. Este encontro e as numerosas

trocas de ideias com sobas e habitantes locais, em conjunto com amplo recurso a imagens de satélite, ajudaram-nos a identificar possíveis áreas para a existência de vida selvagem.

A equipa que levou a cabo estes levantamentos era composta por cinco elementos, aos quais se juntavam por vezes autoridades, sobas e habitantes locais. Foram percorridos mais de 2000 km para reconhecimento e observações diretas de vida selvagem e mais de 100 km de transectos para registo de vestígios. O acesso ao interior do parque mostrou-se extremamente limitado, com estradas frequentemente cobertas com vegetação, pelo que alguns levantamentos foram feitos a caminhar. Um total de 29 camaras armadilha foram colocadas que operaram durante cerca de três semanas na Mupa. Foram feitas 35 entrevistas a autoridades, sobas e habitantes locais, no interior e arredores do parque.

Na Mupa, os mamíferos encontravam-se em menor abundância e diversidade, relativamente ao Bicuar, e estavam, por norma, restritos às áreas próximas de água em que os assentamentos humanos eram reduzidos ou inexistentes. Assim como no Bicuar, leopardo e hiena malhada foram os grandes carnívoros mais comuns na Mupa, embora com menores densidades comparativamente ao Bicuar. A chita demonstrou estar ausente na Mupa, não havendo evidências da sua presença desde os anos 70. O leão também se mostrou ausente, havendo relatos de circularem pela área a cada cinco anos. Os mabecos demonstraram estar presentes em reduzida densidade, em áreas do parque em que a população humana é diminuída ou ausente. Estimou-se que a população de mabecos seja de 20-30 animais e que estes não sejam apenas residentes na Mupa, mas se movimentem, através do Rio Cuvelai, situado na fronteira este do parque, para áreas com vida selvagem a este do mesmo. As principais ameaças a estas populações de mabecos incluíam: diminuição de presas, especialmente no tipo e tamanho preferidos; população humana e gado dentro do parque em número consideravelmente elevado; provável aumento da população humana na região este do parque impedindo a movimentação para as áreas de vida selvagem a este do mesmo, que podem ser críticas para a sustentabilidade desta população; tamanho reduzido da população; ausência de acesso a pontos de água permanente que não sejam dominados por humanos; e perseguição directa reportada. Outras potenciais ameaças (p. ex. patologias) não foram avaliadas neste levantamento.

Foram detectadas no parque nove espécies de mamíferos de pequeno e médio porte, incluindo serval, lince, chacal de dorso preto, chacal de flancos raiados, civeta, texugo-do-mel, mangusto selous, mangusto listrado e uma terceira espécie de mangusto não identificada. Durante os levantamentos foram observadas seis espécies de ungulados selvagens incluindo: bambi, punja, palanca vermelha, porco bravo, facochero e olongo. Destas, o bambi, a punja e o porco bravo foram os mais abundantes, tendo o olongo também sido reportado como bastante disperso. Elefantes e gunga revelaram-se ausentes na Mupa. A girafa foi reportada como estando ausente da Mupa desde 1975.

No levantamento efectuado na Mupa, foram encontradas numerosas evidências de caça furtiva para carne para consumo, incluindo: venda de carne de caça ao longo da estrada; acampamentos de caçadores e peles de animais; estrutura em paus para armadilha com arma de fogo apontando a ponto de água; trilho de motorizada bem marcado que dá acesso a áreas remotas onde a caça se concentra e imagens de camara armadilha de um homem armado a circular em motorizada nestas áreas; uma imagem de camara armadilha de uma hiena com ferida provocada por armadilha; e observação directa de um caçador em motorizada.

Área entre os parques

No ponto em que se encontram mais próximos, os parques distam apenas 25 km. No entanto, esta área é banhada por dois rios, ambos com as margens vastamente cobertas por assentamentos humanos, o que cria uma barreira significativa ao movimento de espécies. Embora elefantes, mabecos e outras espécies acedam ao Rio Cunene a partir do Bicuar, residentes do lado este do Cunene reportaram que os animais não cruzam o rio, e que qualquer elefante que o fizesse seria baleado por caçadores. Na área em que fizemos o levantamento, habitantes locais e sobas afirmaram que desde 2005 nenhum elefante cruzou o rio para o lado este. Animais reportados na área entre os parques incluíam bambi, hiena, leopardo e olongo. As únicas observações de mamíferos nesta área foram o rasto de hiena e uma observação directa de bambi. Em conjunto, as evidências sugerem que o movimento de animais, tais como elefantes e mabecos, entre os parques do Bicuar e Mupa é reduzido ou inexistente, embora espécies antropicamente mais tolerantes ainda se possam movimentar entre os parques.

Recomendações de gestão

Bicuar

Deixam-se as seguintes recomendações de gestão para o Bicuar

- O Bicuar apresenta excelente base para a recuperação de infraestrutura e funcionários, bem como para o início de uma recuperação total. No entanto, este facto é totalmente dependente de constante proteção. A principal prioridade para o Bicuar será manter o número de funcionários e garantir o pagamento contínuo de salários. Este é um factor vital e prioritário. Manter a vigilância contra a caça furtiva e invasão pela população é essencial para o parque.
- O turismo poderia ser aumentado dramaticamente e a curto prazo por utilizar a infraestrutura existente e disponibilizá-la para campismo, bem como por promover a receptividade do parque ao turismo.
- A administração do parque deveria levar avante a ideia de reintrodução de búfalo e solicitar um relatório sobre esta possibilidade, assim como um plano de reintrodução com orçamento. Poderiam ainda ser consideradas outras espécies para reintrodução, mas única e exclusivamente se originalmente estiveram presentes no parque.
- Existe um ponto de água que se encontra em área remota ao qual deveria ser melhorado o acesso e proteção.
- A administração do parque poderia considerar fazer um convite à organização *The Nature Conservancy* para obter conselhos sobre gestão de fogos.
- A administração deveria periodicamente reavaliar se as actividades de extração menores que decorrem no parque estarão a contribuir para (ou a comprometer) os objectivos de gestão, particularmente se as populações de vida selvagem recuperarem significativamente.
- O Bicuar seria um excelente candidato a parceria de co-administração que ajudasse a providenciar financiamento e outros tipos de suporte na gestão e proteção do parque.

Mupa

Deixam-se as seguintes recomendações de gestão para a Mupa:

- O parque da Mupa encontra-se profundamente empobrecido e invadido, ainda assim, conserva a grande maioria das espécies que se encontram no Bicuar. Este aspecto e o facto de que existem áreas com reduzida (ou até inexistente) população humana, sugerem que a recuperação é possível.
- A recuperação da Mupa pode exigir uma redefinição dos limites do parque de forma a conter as principais áreas onde ainda se encontram populações de vida selvagem e o

número de assentamentos humanos é reduzido, bem como, uma possível expansão de forma a incluir as áreas de vida selvagem a este do parque. Esta operação deveria ser acompanhada de pagamento a ser feito aos habitantes desta área para se deslocarem para áreas externas aos novos limites do parque.

- Várias questões fundamentais deveriam ser consideradas na recuperação do parque redefinido, incluindo a caça furtiva, infraestrutura, criação cautelosa de pontos de água artificiais, proteção contra os assentamentos humanos e gado, criação e manutenção de corredores de vida selvagem que se estendam à área a este do Rio Cuvelai.
- Restabelecer a ligação ao Bicuar seria benéficioso para ambos os parques, no entanto, presume-se que seja difícil de implementar.
- É provável que a pequena população de palancas vermelha, com 17 ou 18 indivíduos, seja a última da Mupa e esteja altamente vulnerável, assim e por esse motivo, a sua proteção deveria ser uma prioridade.
- O parque da Mupa também apresenta elevado potencial para turismo de aventura em 4x4 e amantes da natureza e vida selvagem.

Investigação adicional

Prioridades para futura investigação incluem:

- Aumento do conhecimento sobre a população de mabecos no que diz respeito ao seu estado, movimentos e ameaças.
- Repetir um levantamento no Bicuar com recurso a camaras armadilha, empregando o mesmo protocolo, mas utilizando pares de camaras, dentro de um período de 3 a 5 anos.
- Solicitar análise à viabilidade e custo de um plano de reintrodução de espécies, como o búfalo, no Bicuar.
- Se se proceder à redefinição dos limites da Mupa, sugere-se que seja feito um novo levantamento na área redefinida.

2. INTRODUCTION AND BACKGROUND

The need for surveys across Angolan Protected Areas has been emphasised by the National Institute of Biodiversity and Conservation Areas (INBAC) in Angola. In September 2015, the Range Wide Conservation Program for Cheetah and African Wild Dogs (RWCP) held meetings in Luanda with the Angolan Ministry of Environment (Ministério do Ambiente: MINAMB), INBAC and the Directorate of National Biodiversity (DNB). The authorities expressed a priority interest in Iona, Bicuar and Mupa National Parks and the RWCP committed to help. A full large carnivore survey was carried out in Iona National Park in December 2015, and in March 2016 the RWCP signed an MoU with MINAMB pertaining to the conservation of cheetah and African wild dogs in Angola. The large mammal surveys in Bicuar and Mupa National Parks, reported on here, were carried out in August and September 2016, under the auspices of this MoU.

Funding for these surveys was secured by the RWCP from a private donor. Dr Jake Overton, from Panthera, was contracted to carry out the survey, in partnership with INBAC and MINAMB. The Park Administrator and local staff were closely involved with the work, and the Angolan Carnivore Project also partnered with the team for genetic analysis of carnivore scats collected.

Bicuar and Mupa were prioritised as areas of particular interest by MINAMB because of the potential for tourism in the region and in order that they could use the results of the survey to leverage more funding for management and conservation. The parks were also of particular interest to the RWCP because of their potential to support cheetah and wild dog populations. Before the surveys, African wild dogs had been seen in Bicuar (but not Mupa) but it was unclear whether they were resident or transitory. Both parks were designated as 'unknown range' for cheetah.

Prior to this survey, there was little published information on these parks. Previous information on the parks is summarized in the study area description below.

Throughout the report, we use the past tense to refer to our observations and inferences about species distributions during the survey period of August and September 2016. To distinguish these recent results from previous historical distributions (such as those reported in a series of reports by Huntley in the 1971 to 1974), we are explicit in referring to the older accounts as historical data.

The year of our survey had higher rainfall than normal years, so large dams and other significant but ephemeral water sources had water in them later in the year of the survey than in the average year.

3. STUDY AREA

The study area encompasses Bicuar and Mupa National Parks in Angola (Figure 1), and the area between the parks.

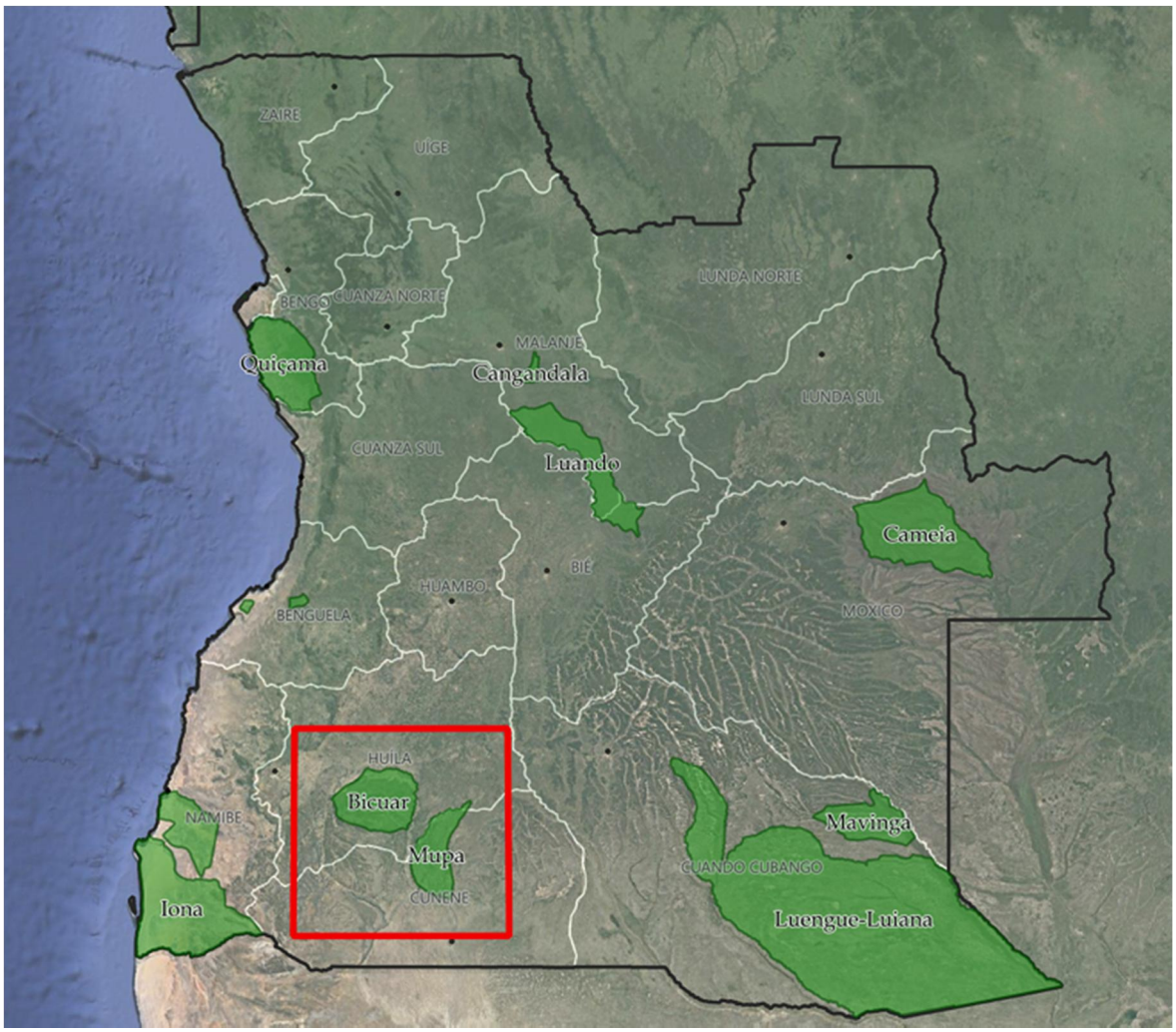

Figure 1. Location of Bicuar and Mupa National Parks in Angola. Provincial boundaries are shown in white with provincial names in grey.

3.1. Bicuar National Park

Bicuar National Park, declared in 1964, lies about 175 kms east of Lubango. The park is approximately 7,900 km^2 in area, roughly oval in shape, occupying gently undulating sandy soils with numerous low depressions draining eastwards. The Cunene river forms its eastern boundary from Capelongo to Mulondo (Huntley, 1971a).

Altitude ranges from 1150 to 1500 m above sea level; annual precipitation from 1200 mm in the northeast to 800 mm in the south and mean average temperature ranges from 20-22 C. (Huntley, 1971b).

Bicuar, inserted in the Zambezian phytogeography region, has a regular pattern of open grass plains on the seasonally waterlogged depressions of Uieba pan and a variety of savannah, woodland and ticket communities (Huntley, 1971a). The habitat types enclosed in Bicuar, represent a transition between Angola miombo woodlands and the drier Baikiaea woodlands of south central Africa (Ron, 2015).

Historically, Huntley (1973, 1974) reported that large and medium-sized mammals included: side-striped jackal, African wild dog, spotted hyaena, lion, leopard, cheetah, elephant, Burchell's zebra, warthog, bushpig, eland, vervet monkeys, greater kudu, bushbuck, roan antelope, reedbuck, blue wildebeest, impala, common duiker, oribi, steenbok, Cape buffalo,

giraffe, black-faced Impala, aardwolf, bat-eared fox, Defassa waterbuck, Damara dik-dik, thick-tailed galago and Cape pangolin. Huntley (1971) reported that the most abundant fauna species were elephant (500), Burchell's zebra (100), warthog (150), eland (300), roan antelope (300) and wildebeest (500).

A contemporary report (Ron, 2015) mentioned that most parts of the park had habitats in rather good conditions with nucleus populations of previously reported species, even though cheetah was not verified and only a small number of wild dogs, in one or two packs, had been reported.

Logging and fire, associated with agriculture practices in the park perimeter, have been identified as threats. Poaching for bush-meat, both for subsistence and commercial use, has also been identified as a threat, with the impact evident from the very vigilant behaviour and long flight distance of observed wildlife (Ron, 2015).

Even though there are no resident communities inside the park area, they have a significant impact on its margins through encroachment and unsustainable cultivation practices, limiting wildlife access to water in the dry season. Communities to the south and east of the park reported human-elephant-conflict incidents, related to damage to crops. As for the communities to the north and east of the park, conflict is related to access of cattle to grazing inside the park area (Ron, 2015).

Bicuar N.P. was rehabilitated in 2008, with the installation of infrastructure, including a radio communication system, accommodation facilities for tourists, and establishment of saltlicks and waterholes. In 2015, Ron (2015) reported there were 55 permanent park staff, including the park administrator.

3.2. Mupa National Park

Mupa National Park, declared in 1964, is approximately 6,600 km^2 in area and lies about 68 km from Ondjiva (Huntley, 1971b). The Calonga River forms its northern boundary to Cassinga, as well as the western boundary, together with the Cunene River. The eastern boundary is the road from Evale to Cassinga and southern boundary the road from Cafu Experimental station to Evale (MINAMB). Altitude ranges from 1130 to 1340 m above sea level; annual precipitation is 620 mm; mean average temperature 22.8 ^{o}C (Huntley, 1971b).

Mupa is situated in the transition between Zambezian and Karoo-Namibe biomes. Habitat types include semi-arid woodland, thickets, seasonally inundated wetlands, open savannahs and grasslands (Ron, 2015). About 40% of its area is characterized by dense miombo woodland or thickets with strips of grass plains on the draining depressions. The southern region of the Park occupies poor drainage soils with well-developed mopane woodland (MINAMB).

Mupa National Park used to be famous for the presence of *Giraffa camelopardalis angolensis*, an Angolan giraffe subspecies (MINAMB), but also held large and medium sized mammals as: elephant, lion, leopard, hippopotamus, African wild dog, spotted hyaena, Burchell's zebra, bushpig, eland, black faced impala, roan antelope, red hartebeest, kudu, steenbok, reedbuck, common duiker, warthog, aardvark, vervet monkey, springhare and pangolin (Huntley, 1971b, 1974; Ron, 2015). Notably, cheetah is not included in these accounts. Wild dogs and lions were reported mostly east of the park. Avifauna was reported as rich, including various raptors, and ostrich east of the park (Ron, 2015).

Most of the Mupa NP area has been reported to be irreversibly degraded, occupied and converted to incompatible land uses. It was invaded by human population mostly during the war and holds inside its boundaries 134 villages with nearly 20,000 habitants, plus farms (MINAMB; Ron, 2015). A few restricted areas of the park still harboured habitat in reasonable conditions with reported wildlife sightings.

Logging and burning are frequently performed in all park areas as well as in its vicinity. Poaching, both subsistence and commercial, is reported. Armed poachers, bush meat selling along the road, and illegal sport hunting are common practices inside the park and surrounding areas (Ron, 2015).

The main human-wildlife-conflict in Mupa is related to livestock-wildlife conflict, limiting wildlife access to water and pasture resources. Human-elephant conflict was mainly reported in the dry season, when elephants migrate to the Cunene River. Cases of livestock predation by wild predators have been reported, as well as attacks on people. The existence of domestic dogs for livestock and corral protection constitutes a threat in terms of both disease transmission to wildlife and from competition to wild predators for small wild prey species (Ron, 2015).

Mupa National Park doesn't hold any infrastructure for management or surveillance (MINAMB). The municipal environment department had three staff members, engaged mainly in environmental education in cooperation with NGO's. Anti-poaching activities were implemented by the Forestry Institute (IDF), from the Agriculture Ministry, in cooperation with local police (Ron, 2015).

At their closest point, the Parks are 25 km apart and separated by the Cunene and Calonga Rivers.

4. METHODS

We employed a joint survey methodology that combines the complementary strengths of three survey techniques: 1) interviews of officials and local communities, 2) spoor surveys, 3) camera trap surveys, and 4) recon and wildlife observations. Each technique provides a different perspective on the mammal community and other aspects of the park, and in combination they provide a more complete picture of the biota of the park and the challenges facing the park than any one alone would provide. These techniques are detailed below.

Throughout the survey, we used remote imagery, spatial information on water sources and human distributions and interviews with managers and local inhabitants to guide our survey efforts.

A representative from MINAMB, Gercelina Alexandra, assisted with much of the surveys and placement of camera traps in Bicuar, and assisted in the review of GIS information and entry and download of field data into SMART. Three Bicuar scouts (fiscais), Fernando, Andonio, and Joaquim, were seconded to the project. These scouts were already experienced in distinguishing the spoor of different species in Bicuar and were trained in the spoor survey and camera trap survey techniques. These scouts were part of the survey team throughout the survey. An additional senior scout, Fernando Naufila, joined the survey for the Mupa surveys and assisted with the collection of camera traps in Bicuar and Mupa.

4.1. Interviews

Interviews provided a wide range of important information on current and historical species distributions, road locations and accessibility, locations of water sources, and information on pressures such as poaching. Interviews were conducted as structured conversations to provide information on species distributions of large carnivores including both current distributions and historical distributions. We also asked about poaching and other pressures.

While the course of the discussion depended on the person being interviewed and their likely knowledge about the area, we used the following list of topics in the interviews:

- Road conditions and access to particular areas of interest
- Water availability and water sources and the times when they kept water
- Large carnivore distributions and movements, especially wild dog and cheetah, but also lion, leopard and hyaena. We asked whether the species was present, and if so where. If the species was not present we asked the last time it had been present and the nearest location that they knew of to the location of the interview.
- Game distributions, including elephant distributions and movement, giraffe, and other game species. As above, we also asked whether the species was present and the last time it had been present.
- Pressures on the parks, including poaching, settlement and livestock.

While we did not ask questions about human wildlife conflict, this information was often provided voluntarily by the respondents.

In Bicuar, we interviewed only the park staff, including the park manager (Jose-Maria Kandungo) and scouts. In addition, we had discussions with the owner of a game ranch on the southern boundary of the park. Because of time constraints and the relative intactness of much of Bicuar other residents of areas around Bicuar were not interviewed.

In Mupa, at the beginning of our visit we had a meeting with a range of officials from the area, arranged by the Administrador Adjunto based in Cuvelai township. In addition because of the extensive human settlement inside and around Mupa -- and the much lower and patchy animal distributions -- we also extensively interviewed local headmen and villagers as well as persons we encountered on the roads. When we entered a new area we would seek the headman, and then introduce ourselves and pay our respects. We then asked for blessings to operate in the area. During the visit we followed the structured conservation topics listed above.

While interviews are immensely useful sources of information, they are subject to many vagaries and the results must be interpreted with caution. Persons vary greatly in their knowledge, and not all persons are willing to say they do not know something. Identification of animals can also be problematic, especially for rarer species such as cheetah. Respondents are also not always entirely honest or forthcoming, for a range of reasons.

Figure 2. Interviews of headmen and locals formed an important part of the information gathered during the survey. Here locals have gathered while we are doing spoor survey transects in interior Mupa.

4.2. Spoor Surveys

Spoor surveys were conducted on accessible roads and in some places in Mupa along grassy, seasonally flooded drainage systems that provided vehicle access into areas of Mupa without road access. Methods follow that of Funston et al. (2010), with minor modifications to adapt the techniques to conditions. Road or trails were driven at less than 10 km per hour, with two qualified trackers seated on the front on a custom-made tracker seat. All tracks of carnivores and game species were recorded. Road substrate quality was recorded every 500 m. All direct observations of mammals was also recorded, and the distance and direction to the animal, and direction of the vehicle. Animal behaviour was recorded, such as whether it was running away or relaxed.

All data was entered into personal digital assistants (PDAs) using the software programs Spatial Monitoring and Reporting Tool (SMART) and Cybertracker.

The track index is calculated as the number of sets of tracks per 100 km of survey. A set of tracks are those from a given individual, and only fresh tracks less than 24 hours were included. For large carnivores, this track index was converted to estimated animal density of number of animals per 100 km^2 using the equation *density=0.3003*track index*. This is a slight modification of the calibration equation given in Winterbach et al. (2016) for large carnivores on sandy soils. Small carnivores are not reliably detected, especially on sandy soils, so track indices are not reported. While track indices are reported for ungulates as an index of abundance, calibration equations are not available to estimate densities for any species besides large carnivores.


Figure 3. Wild dog tracks from Bicuar.

4.3. Camera Traps

Camera traps were placed singly in stations at the beginning of the survey period and collected at the end of the survey period. Locations of traps were recorded in SMART. The primary criteria for trap placement (in decreasing order of importance) were:

- To establish presence of wild dogs
- To characterize large carnivore community and relative abundance
- To capture a wide range of species to provide information on overall mammal communities

Camera trap images were identified to species by the use of CATalogue (https://www.zooniverse.org/projects/panthera-research/camera-catalogue). This is a crowd-sourcing initiative that allows sorting the many camera trap images that come from camera trap surveys. This resulted in a species identification for each image. Often an individual animal will get multiple images in a single visit to the camera location, so further analyses were done to estimate the number of visits of individuals to each camera station. Any image taken at the same camera station of the same species within a 30 minute period was considered the same individual. In other words, a set of images of the same species within a 30 minute period from the same camera station is considered a single observation event. The number of individuals observed in that observation event was estimated as the maximum number in any of the single images in that set. Our measure of Total Count for each species at each camera station is the sum across all observation events at that station of the number of individuals in each observation event.

4.4. Recon and Wildlife Observations

Any time we were travelling in wildlife areas and not doing spoor transects, we recorded information using a PDA running the program SMART according to a protocol for recon and wildlife observation surveys. The information gathered was a subset of the information that was gathered on spoor transects, including all direct observations of animals and their distance and behaviour, and noteworthy observations including but not limited to: spoor of large carnivores or elephants, habitat or human features (such as waterholes), livestock, and villages. These observations provide more extensive and complete information on animals and features to supplement the information from more formal (but also more limited) survey techniques. Locations of all observations and the survey path were also recorded on the PDA in SMART.

4.5.Statistical Analyses

Statistical analyses were performed in R. For flight distance estimation, an index of flight distance was defined as the distance at which 50% of the animals were running away. This index was estimated from direct observations of animals during which the distance to the animals and observations of whether they were running or not were recorded. Running animals were given a score of one and animals not running a score of zero. The scores were regressed against distance to animal using a spline, providing an estimate of the proportion of animals running versus distance. The distance at which the regression predicted that 50% of the animals were running away was the estimate of the index. Confidence limits for the index were estimated by 1000 iterations of resampling from the data with replacement using the observed sample size and recalculating the index on the resampled data.

Figure 4. A camera trap on a trail near a seasonal waterhole in Mupa.

Figure 5. Placing camera traps at Tumbaeque in Bicuar. From left to right: Gercelina Alexandra, Fiscal Fernando, Sara Fernandes, Fiscal Andonio, David Elizalde, and Park Manager Jose-Maria Kandungo.

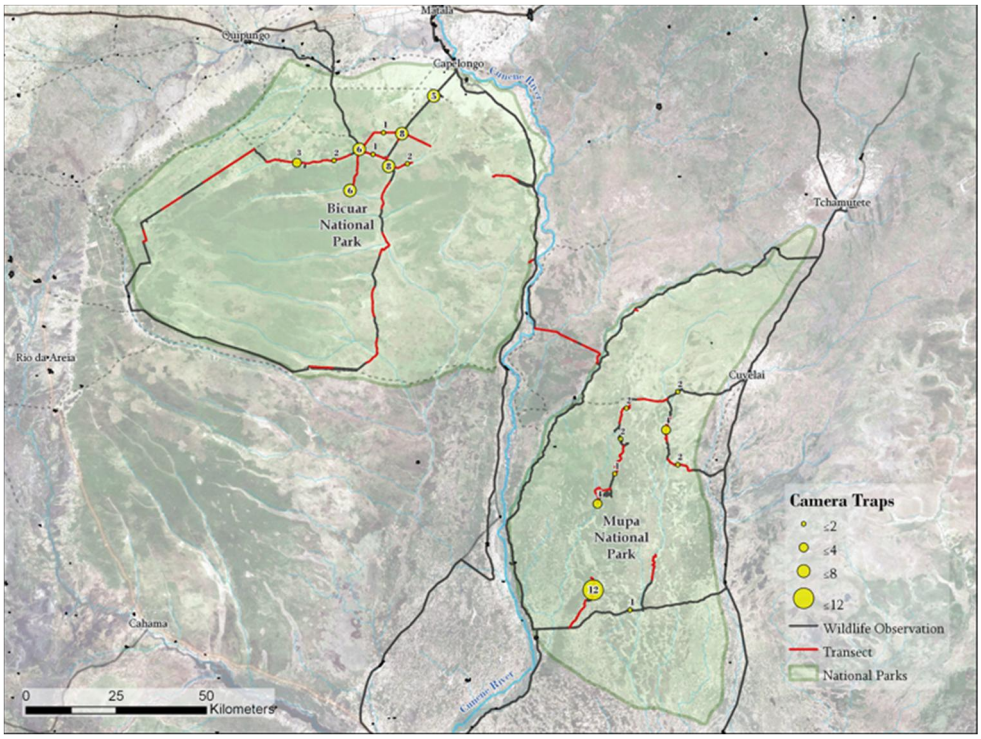

Figure 6. Map of Bicuar and Mupa National Parks, showing locations and number of camera traps, and the routes travelled and used for wildlife observations and spoor transects.

4.1. Remote Imagery and other GIS Information

We used a range of remote and spatial information to guide our survey. Satellite imagery was used to identify intact habitats and identify likely access roads, and aerial imagery from Google Earth was also used to guide the survey and identify likely animal trails and activities. Remote imagery was carried during the surveys on laptop computers and personal digital assistants to provide continued guidance. The ground-truthing provided by the field work allowed continual improvement in the use and interpretation of the remote imagery to identify access routes, human settlements, waterholes, and wildlife areas.

Information on household distributions was available for Cuvelai province, providing information on settlements in and around Mupa. This was used to guide survey efforts to areas without human settlement.

5. RESULTS AND DISCUSSION

5.1. Bicuar

5.1.1. Overview

The results of the investment into Bicuar restoration were evident in the infrastructure and staff at Bicuar. The main camp of Bicuar had well-built and well-maintained buildings and other infrastructure. The main access roads to and from the park were in good condition and accessible. Artificial water had been provided at a number of key waterpoints by the use of solar powered pumps. Scout outposts were also situated at key waterholes and around park boundaries and entry points. The staff, including the anti-poaching scouts (known as fiscal – plural fiscais), were well-trained and dedicated. Together this indicated a well-capitalized and well-managed park, with a good plan for restoration. This provides an excellent foundation for rebuilding wildlife populations and attracting tourism, but is dependent upon ongoing investment and protection. Habitats were mainly intact, although fire had a strong presence.

Figure 7. Main Camp of Bicuar National Park. A roan antelope passes in the foreground. In the background are visible the buildings of Main Camp and the solar panel and pump house for the permanent water hole.

Figure 8. Fiscal. Bicuar has well trained and dedicated rangers (fiscais), such as Fiscal Joaquim, pictured here.

Figure 9. Tumbaeque waterhole in Bicuar National park. The solar panels to run the pump are visible in the foreground, with the waterhole and game trails visible in the background. In the interior of Bicuar park, only those waterholes that have pumps retain water year round.

Figure 10. One of the easily travelled roads leading into Main Camp in Bicuar.

Figure 11. Miombo woodland in central Bicuar.

Figure 12. Vegetation of northern Bicuar. The image is taken from a lightly used road, with a gap visible ahead where the road passes through forest or thicket ahead near a large tree. Visible in the foreground and to the right is a grassy and shrubby vegetation common in some drainage areas.

5.1.2. Survey Effort

There were 42 camera traps operated in Bicuar, for about one month each. Four camera traps were stolen or lost to fire and several others were turned off or not properly turned on. The total camera trap days (including partial days) was 1,122, or an average of 26.7 days per trap. We conducted 154 km of spoor transects and 1,265 km of recon and wildlife observation surveys in Bicuar.

Survey effort was higher in the core area of Bicuar, where permanent water and good protection results in the highest animal densities. The core area encompassed six of the 15x15 km survey grids, with an area of 1,350 km^2.

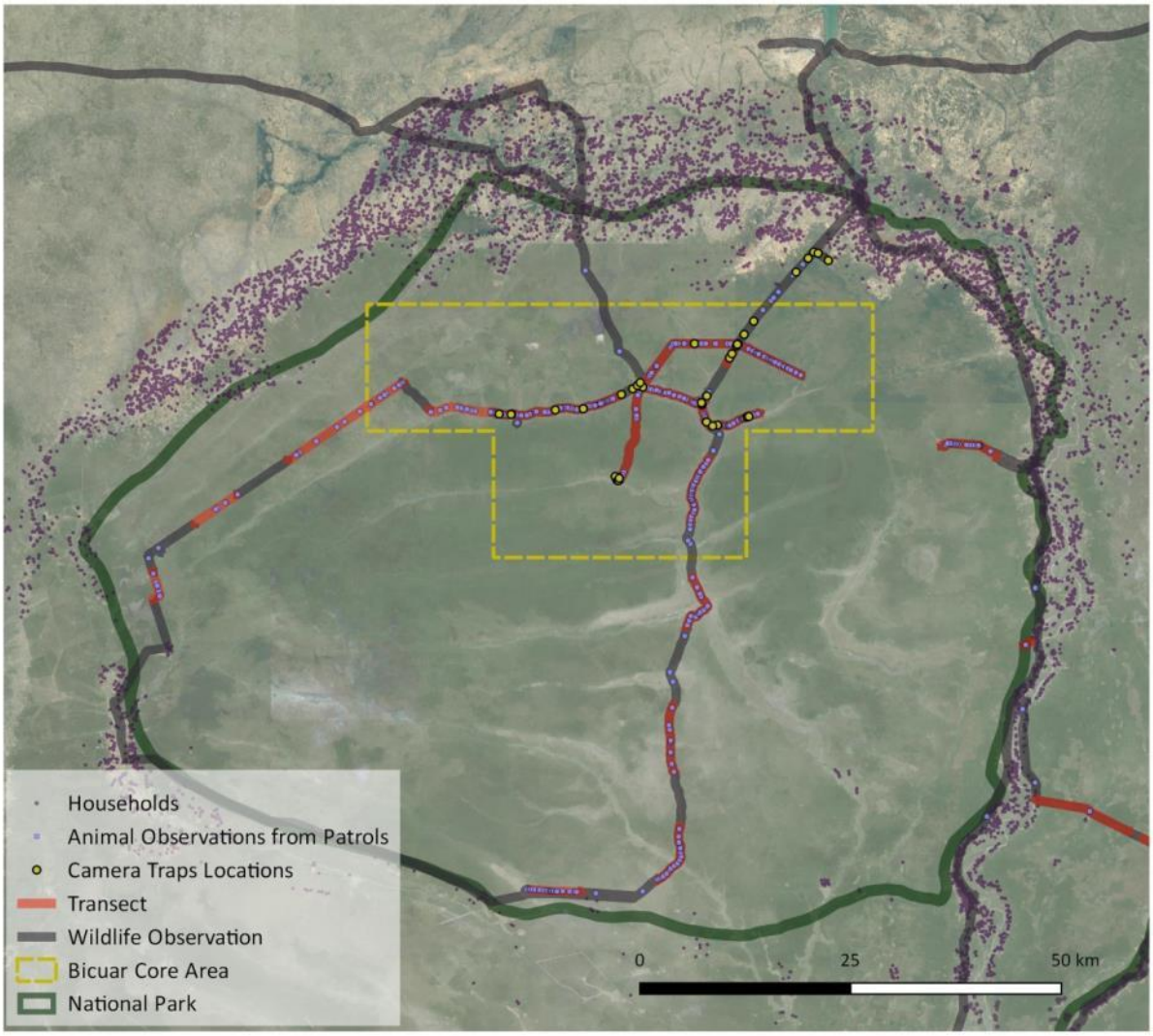

Figure 13. A map of Bicuar showing survey effort with tracks of spoor transects and recon and wildlife observation surveys with all locations of all observations of spoor and direct animal observations. Locations of camera traps are shown in yellow. Also shown is the core area of Bicuar with more intensive survey effort and camera traps. The purple dots around the edge of the park show the households mapped in and around the park in a 10 km buffer.

5.1.3. Mammal communities

The combination of spoor surveys, camera traps and direct observations provided a good characterization of the mammal communities of Bicuar. In the below discussion, a species was considered observed if it was detected by any of these methods. We consider separately those that were reported to us in interviews.

Leopards and spotted hyaena were the most common large carnivores at Bicuar, and both were at good densities in the core area of the park, and were widespread through the outer areas of the park (Tables 1 and 4). Wild dog were also present at lower densities and widespread through the park. Ten species of medium and small carnivores were detected in the park, including serval, caracal, black-backed jackal, wildcat, miombo genet, honey badger, bat-eared fox, Cape fox, aardwolf, Selous mongoose and swamp mongoose. Of these species, serval, caracal, black-backed jackal and wildcat were the most common. Civet and side-striped jackal were notably absent, although both were observed at Mupa and may also be present at Bicuar.

During the surveys we observed elephants and seven species of ungulates (Table 3) including; common duiker, steenbok, roan, bushpig, warthog, kudu, and eland. Of these duiker and roan were the most common. A single zebra were reported by the park manager, and possible zebra spoor was seen at Tumbaeque water hole.

In the core area of Bicuar over the course of the survey, we travelled 92 km of spoor transects and 630 km of recon and wildlife observations surveys, totalling 723 km. We made direct observations on 148 individuals of large mammals (excluding primates) of five species, including 85 roan, 49 common duiker, seven warthog, four steenbok, and one kudu. While more roan were observed than duiker, they were also observed further away, with mean distance to animal of 265 m for roan and 72 m for duiker.

In the outer area of Bicuar, direct sightings were considerably lower. Over the course of the survey in the outer area of Bicuar, we travelled 62 km of transects and 635 km of recon and wildlife observations surveys, totalling 697 km. During these surveys we made direct observations of 12 common duiker only.

Most species were notably shy. Elephants were never seen and only observed on camera traps at night as they went to water. Elephants were heard at the main camp water hole twice during our survey. Other species were also not seen during that day, and those that were seen often ran away at considerable distances.

Other species of mammal observed included scrub hare, vervet monkey, springhares, and porcupines. Pangolin tracks were also observed near Central Camp. Baboons were notably absent from both Bicuar and Mupa.

There are numerous species missing from the species reported by Huntley (1973, 1974), including: side-striped jackal; lion; cheetah; bushbuck; reedbuck; blue wildebeest; impala; oribi; Cape buffalo; giraffe; black-faced impala; Defassa waterbuck; Damara dik-dik; and thick-tailed galago. Of these, side-striped jackal, dik-dik and galago may still have been present and undetected by our survey, but the remainder we judged to absent.

Abundances of remaining species were also evidently much lower than in the early 1970s. Huntley (1971a) reported seeing 400 animals of 12 species (including elephants, cheetah, roan, wildebeest and zebra) in a single morning. Our data on direct observation rates (Table 3) suggest that at current wildlife levels a 50 km drive would be expected to yield six roan, four duiker (and half a warthog!).

Table 1. Large carnivore observations and estimated densities for the core area of Bicuar. Data include observations from both spoor and camera traps. We had no direct observations of large carnivores. See methods for equations used.

Species	Camera traps		Spoor			
	Total Count	Count per 100 trap nights	Number Individuals Spoor	Spoor Index	Estimated Density (Ind. per 100 km^2)	Estimated Population*
Leopard	115	10.24	45	48.86	14.7	198
Spotted Hyaena	136	12.11	33	35.83	10.8	145
Wild Dog	12	1.07	2	2.17	0.65	9

* based on core area of 1,350 km^2

Table 2. Medium and small carnivore observations for core area of Bicuar. Measures of abundance from camera traps are shown for medium and small carnivore in the core area of Bicuar. We had no direct observations or spoor observations for these species. The information available for these species does not allow estimation of densities for these species, but the rate of capture of images per trap night may provide a useful measure of comparison with other sites or in the future if a repeat survey is done with the same design.

Species	Camera traps	
	Total Count	Count per 100 trap nights
Serval	17	1.51
Caracal	15	1.34
Black-backed Jackal	12	1.07
Wildcat	11	0.98
Miombo Genet	6	0.53
Honey Badger	6	0.53
Bat-eared Fox	4	0.36
Cape Fox	2	0.18
Selous Mongoose	1	0.09
Swamp Mongoose	1	0.09
Aardwolf	1	0.09

Table 3. Non carnivore mammal observations and estimated densities for core area of Bicuar. Measures of abundance from camera traps are shown for medium and small carnivore in the core area of Bicuar. Grey shaded blank cells indicate where there were no spoor or direct observations for those species.

Species	Camera traps		Spoor		Direct Observation		
	Total Count	Count per 100 trap nights	Number Individuals Spoor	Spoor index	Number Direct Observations	Direct Observations per 100 km	Mean Observation Distance
Common* Duiker	838	74.62	28	30.401	49	6.781	71.64
Steenbok*	present	present	8	8.686	4	0.554	286.25
Roan	169	15.05	83	90.119	85	11.762	265.00
Bushpig	120	10.69	1	1.086			
Scrub Hare	107	9.53					
Vervet Monkey	82	7.30					
Rodent	58	5.16					
Porcupine	55	4.90					
Warthog	40	3.56	57	61.889	7	0.969	42.50
Elephant	26	2.32	21	22.801			
Kudu	17	1.51	9	9.772	1	0.138	250.00
Eland	1	0.09	4	4.343			

* Duiker and steenbok were not distinguished in the species identification of images on CATalogue, so here all observations are attributed to duiker. Inspection of images and direct observations indicate that steenbok are present.

Table 4. Carnivore and herbivore observations and estimated densities for outer area of Bicuar. The few camera traps placed in the northern outer area are included in the core area data of Tables 1 and 3. In this area, the only direct observations were 12 direct observations of duiker for a mean of 1.72 observations per 100 km at a mean distance of 42.9 m.

Carnivores	Spoor					
	Species	Number Individuals Spoor	Spoor Index	Number Individuals Spoor incl. older spoor*	Estimated Density (Ind. per 100 km^2)	Estimated Population**
	Spotted Hyaena	37	59.77	40.49	17.95	807.64
	Leopard	9	14.54	11.50	4.37	196.45
	Wild dog	0	0.00	4.00	(0.00)	(0.00)
Herbivores	Common duiker / steenbok***	24	38.77	28.68		
	Elephant	36	58.15	39.99		
	Warthog	28	45.23	35.99		
	Bush pig	6	9.69	6.50		
	Roan	2	3.23	5.20		
	Eland	0	0.00	2.00		

* includes spoor older than one day, with older spoor discounted by age to estimate track density per 24 hour period
** based on an area of habitat in outer core of 4,500 km^2
*** species were not differentiated, but most observations were for duiker

Strengths and weaknesses of the different methods

All of the methods have strengths and weaknesses to keep in mind when considering these results. Together they provided a more complete picture of the mammal community than would any one alone.

Camera traps revealed a diverse fauna of small carnivores and other species, many of which are nocturnal. The measure used for relative abundance of each species from camera traps is Total Count (as shown in Tables 1 and 3 and maps by species in following section). When considering the measure used from camera traps, some caveats are worth mentioning.

Estimating number of individuals from camera traps has numerous complications. For some species (such as a duiker) a single individual may loiter in front of the camera and have ten or more images taken. Other species (such as an elephant) may travel in groups, and pass the camera one at a time, with images taken singly of the entire group. Another species such as a leopard may have individuals with regular routes that they use to patrol their territory that may pass by particular cameras, and over the course of four weeks have multiple images taken of the same individual. In analysing the camera trap data, any image taken at the same camera station of the same species within a 30 minute period was considered the same individual. A set of images of the same species within a 30 minute period from the same camera station is considered a single observation event. The number of individuals estimated to be observed in that observation event is the maximum number in any of the single images in that set. Our measure of Total Count for each species at each camera station is the sum across all observations at that station of the number of individuals in each observation event.

For species (such as elephants) that travel in herds and pass singly by the camera and rarely pass the same camera, the Total Count will underestimate the number of distinct individuals that have passed the camera station. For species such as leopards that usually travel alone, but may pass the same cameras numerous times over the trapping period, Total Count will overestimate the number of individuals seen. These effects can be reduced by further analyses based on individual recognition and capture-recapture analyses. Individual recognition was done to refine estimates for wild dogs, but not for any other species. Capture-recapture analyses were not done for any species.

For the purposes of this report, Total Count from the camera traps can be seen as a useful index of abundance, but the reader should bear the above caveats in mind, particularly when comparing across species.

Similar caveats apply when interpreting the direct observations and spoor observations. Direct observations favour common diurnal species, and spoor observations favour large, common species and those species that use roads. But together these different measures provide a more complete picture of the mammal fauna.

The highest priorities for further research into wild dogs would be to better establish their movements through the park and the threats on their population and population trends. One recommendation is to repeat the camera trap survey in three to five years using precisely the same camera trap stations but with two cameras per station in a paired design. This will allow direct comparison and estimation of trends for many key species of the indices of abundance based on the numbers of images and also allow mark recapture estimate of population density for some key species such as leopard, hyaena and possibly wild dog.

5.1.4. Wild dog

Wild dog presence was confirmed throughout Bicuar National Park, as a resident population of likely 40 to 50 dogs in numerous small packs. This population travelled widely in Bicuar and had extensive contact on the periphery of the park, but was likely quite isolated from other wild dog populations to the east. Our assessment that wild dogs were resident rather than transitory was based on reports from management and rangers that wild dogs were seen regularly (albeit not frequently) and did breed in the park, in combination with our evaluation that this population had little or no connectivity with other wild dog populations.

Camera traps recorded 20 images of wild dogs from ten occasions and seven camera stations (Figure 14). Multiple images were taken at different locations of some dogs, including one with distinctive black tip on tail shown on the cover.

No direct sightings of wild dogs were made by the survey team. Wild dog tracks were observed in seven places throughout Bicuar and scat was observed in two locations (Figure 14) and collected for further analysis. Estimates of density from spoor indices are generally done only from fresh spoor, and only two individuals in the core area of Bicuar were recorded as fresh tracks. This led to an estimate of 0.65 individuals per 100 km^2. The presence of older wild dog tracks throughout the outer area indicated that wild dog were at similar densities throughout the park. These dogs were likely persisting on duiker and accessing water at stock watering areas in the periphery of the park. With an area of effective habitat of 6,000 km^2, this led to an estimate of about 40 dogs in the park. It is likely to be slightly higher than this because of the relatively few fresh spoor encountered in the survey

relative to older spoor. Overall we estimated that a population of 40 to 50 wild dogs in Bicuar was a reasonable estimate from our observations.

As mentioned above, park staff report that wild dogs were seen throughout the year, were relaxed in the presence of humans, and were reported to be breeding. Dogs were reported to visit farms adjacent to the park, especially in the southerly areas and to be accessing the Cunene River on the southeast of the park.

While preferred prey species of mid-sized antelopes were conspicuously absent from the park, there were some steenbok, many duiker and also substantial populations of warthog, bush pigs and larger antelopes such as roan and kudu.

Spoor surveys and camera trap results suggested that dogs travelled in small packs of five or less, although larger packs of 7 to 20 were reported by park administration and from surrounding farms.

Key threats to the wild dog population included: prey depletion especially in preferred size and type, likely persecution in areas outside the park, and small size and likely isolation of population. Other potential threats (e.g. disease from domestic dogs) were not assessed by this survey.

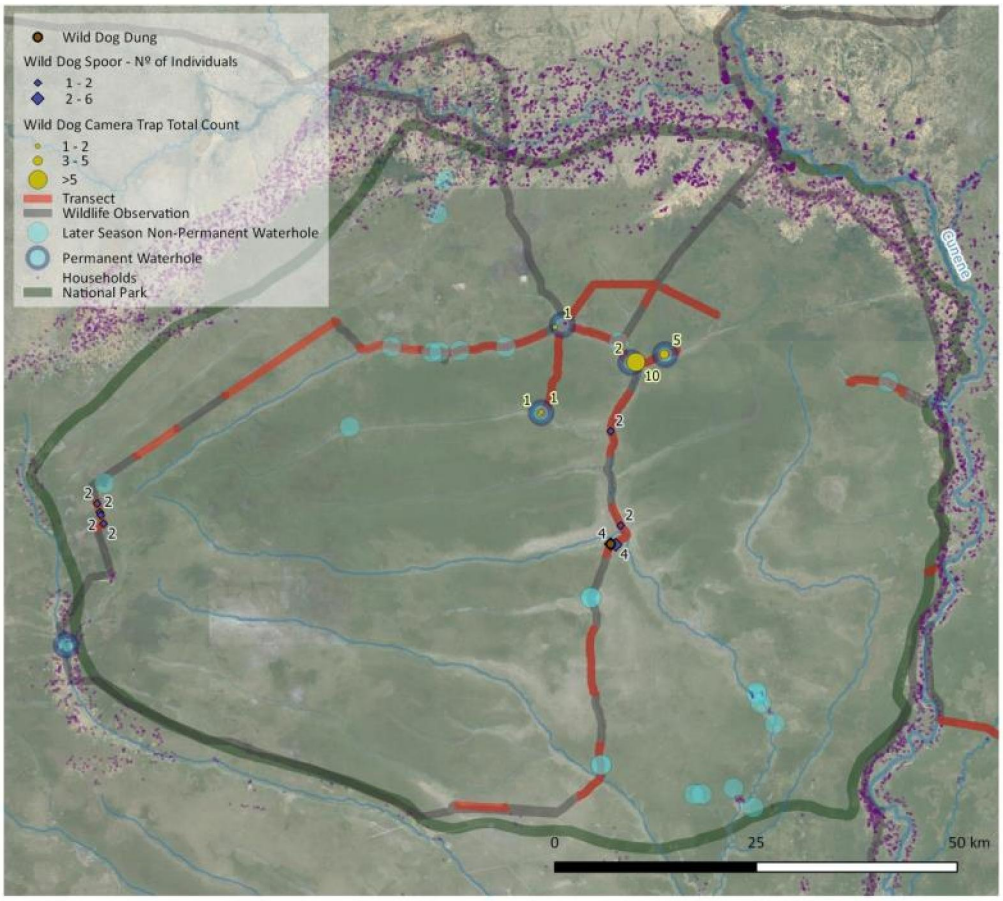

Figure 14. Map of observations of wild dog individuals from spoor and camera traps in Bicuar. Also included for reference are the seasonal and permanent waterholes, and human habitation as households (purple dots).


Figure 15. Selected camera trap images of wild dogs in Bicuar National Park.

5.1.5. Cheetah

Cheetah are absent from the Bicuar-Mupa system and have been for at least a decade.

We found no evidence that cheetah were present in Bicuar, or any evidence of recent presence. During the survey we found no tracks or dung of cheetah, and there were no camera trap images of cheetah. While a sparse species like cheetah may not be picked up in a fairly short survey, the lack of cheetah was confirmed by interviews of park staff from Bicuar familiar with the area since 2006 who reported no sightings of cheetah during that time.

Historically, Huntley (1971a, 1971b) report cheetah at Bicuar (but not at Mupa). Interestingly Huntley (1971a) is strangely contradictory about cheetah in Bicuar – in one paragraph there is mention of seeing cheetah on a morning game drive, and in the following paragraph mention of introduction of lion and cheetah.

5.1.6. Leopard

Leopard was present throughout Bicuar, and occurred at high densities in the core area and at lower densities in the outer area. This was a healthy and secure resident population of leopards.

While we had no direct observations of leopards, we had many observations of spoor and of leopards on camera traps. In the core area of Bicuar, camera traps recorded leopards at a rate of 10 leopards per 100 trap nights or one leopard for every 10 nights. In the core area, leopard tracks were observed at a rate of 48.86 new sets of fresh tracks per 100 km, or about one per every 2 km. This leads to a density estimate of 14.7 individuals per 100 km^2, or 198

individuals for the core area of Bicuar (Table 1). The outer area of Bicuar had lower estimated densities of leopards at 4.37 individuals per 100 km^2, but over a larger area leading to a similar number of 196 Leopards (Table 4). Most leopard images from camera traps were from the night, although a few were in the day.

Figure 16. A female leopard was caught on camera while stalking prey.

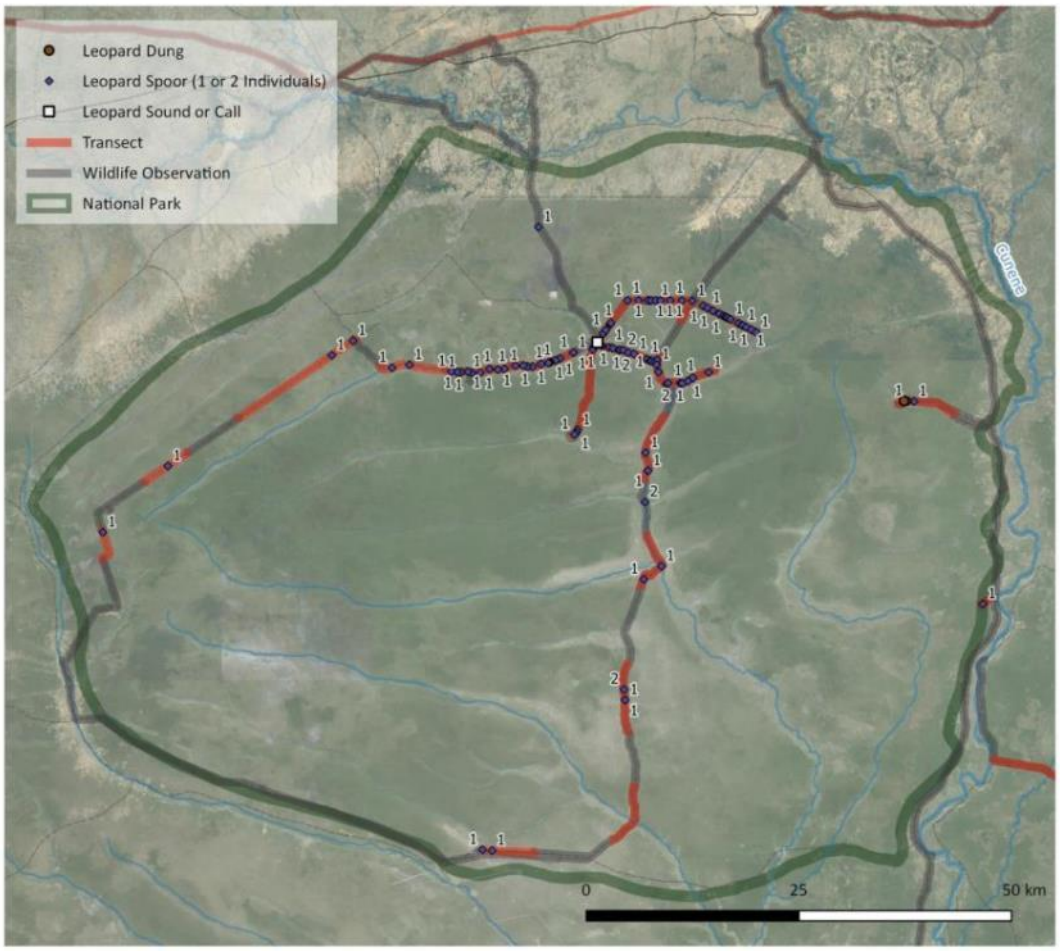

Figure 17. Map of observations of Leopard individuals from spoor in Bicuar.

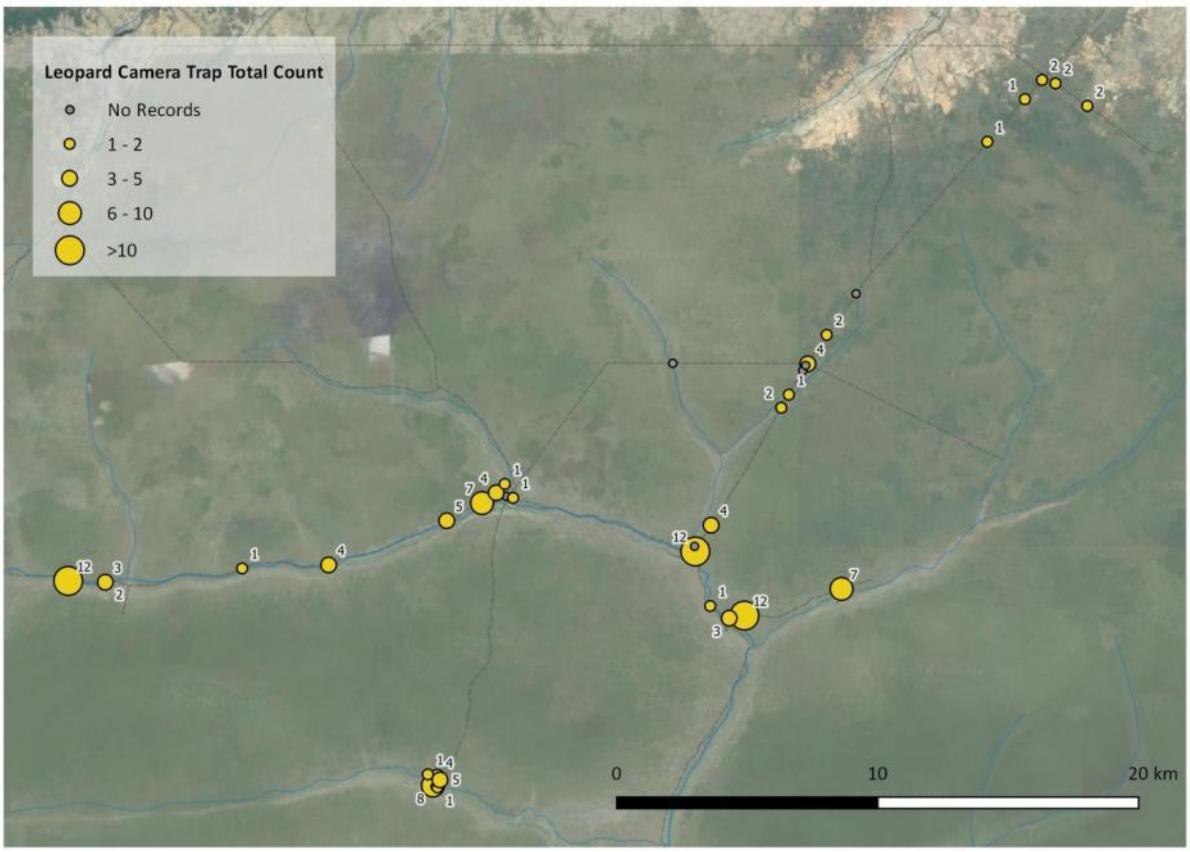

Figure 18. Map of observations of Leopard individuals from camera traps in Bicuar.

5.1.7. Spotted Hyaena

Spotted hyaena were present throughout Bicuar, and occur at high densities in both the core area and the outer area. This was a healthy and secure resident population of hyaena.

While we had no direct observations of hyaena, we had many observations of spoor and on camera traps. In the core area of Bicuar, camera traps recorded hyaena at a rate of 12 hyaena per 100 trap nights or just over one hyaena for every 10 nights. In the core area, hyaena tracks were observed at a rate of 35 new sets of fresh tracks per 100 km, or about one per every 3 km. This led to a density estimate of 10.8 individuals per 100 km^2, or 145 individuals for the core area of Bicuar (Table 1). The outer area of Bicuar had even higher estimated densities of hyaenas at 17.95 individuals per 100 km^2, and over a larger area of 4,500 km^2 leading to a large estimate of 807 hyaenas (Table 4).

No evidence was found of brown hyaena, and this species was not reported by Huntley (1973, 1974)

Figure 19. Well-fed hyaenas at Bicuar.

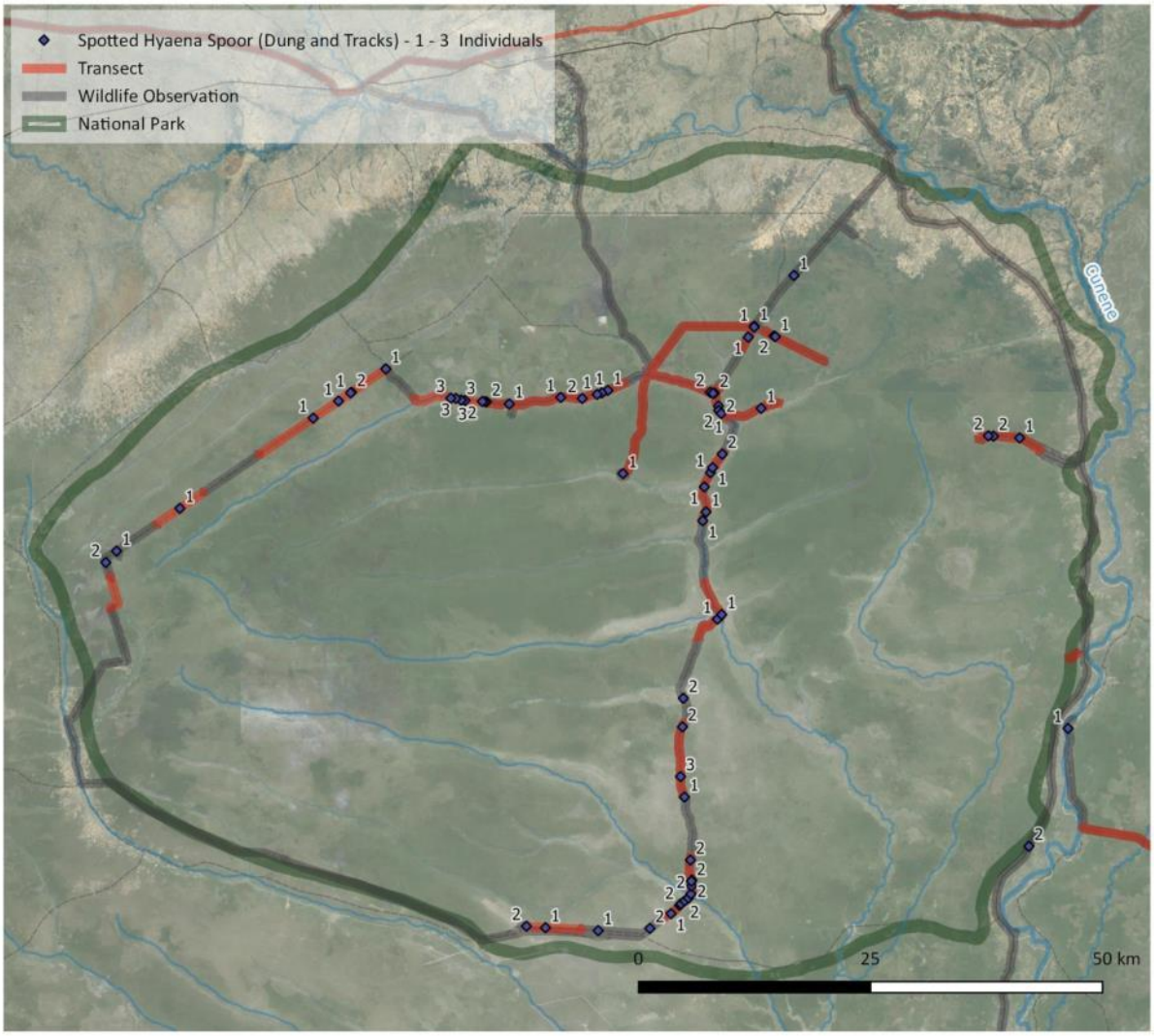

Figure 20. Map of observations of hyaena individuals from spoor in Bicuar.

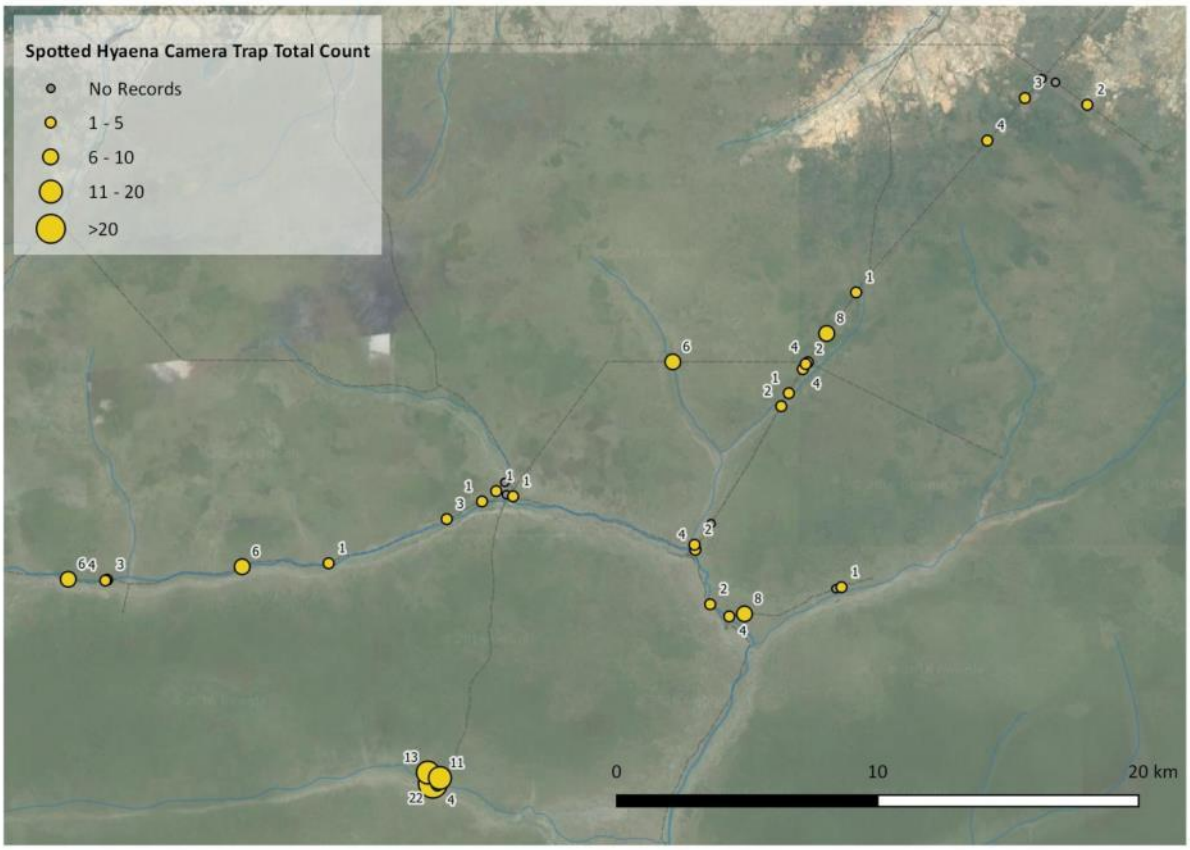

Figure 21. Map of observations of hyaena individuals from camera traps in Bicuar core area with camera traps.

5.1.8. Lion

Resident lion are absent from Bicuar National Park. No observations of lions were recorded during our visit.

Park staff report that lions were absent from Bicuar except as occasional vagrants. A female lioness travelled through the park in a recent year previous to the survey, travelling in a northerly to southerly direction.

Historically, Huntley (1973, 1974) report lion as present in Bicuar. Huntley (1971a) mentioned the possibility of introduction of lion into Bicuar.

5.1.9. Medium and small carnivores

Medium and small carnivores were well represented in Bicuar (Table 2), with ten species observed on camera traps (Figure 22).

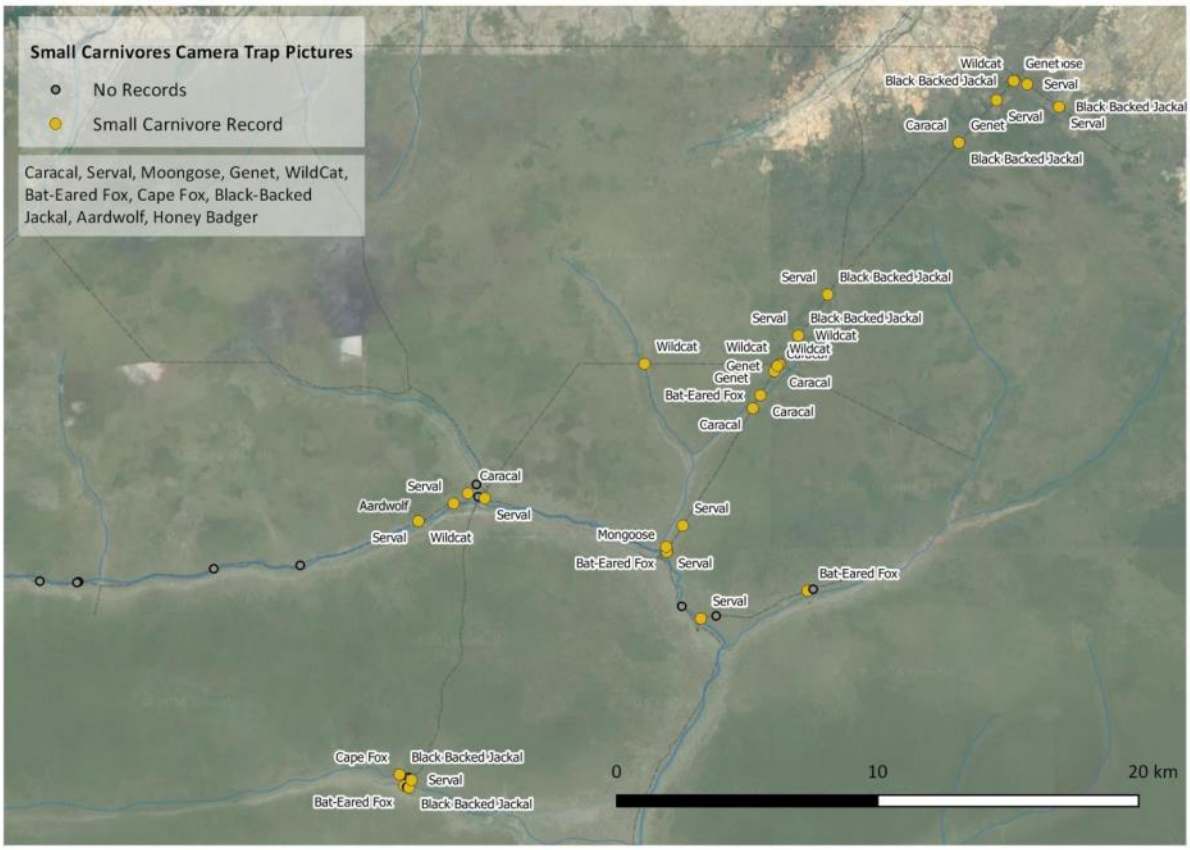

Figure 22. Map of observations of medium and small carnivore individuals from camera traps in Bicuar.

These species included serval, caracal, black-backed jackal, wildcat, miombo genet, honey badger, bat-eared fox, Cape fox, aardwolf, Selous mongoose and swamp mongoose. Civet and side-striped jackal were notably absent, although both were observed at Mupa and may also have been present in Bicuar.

These records show the diverse and largely intact assemblage of medium and small carnivores in Bicuar. They also reveal some intriguing interactions, such as the leopard marking the same spot that an aardwolf had marked five nights earlier (Figures 23 and 24). Notably all images of small carnivores were from the night time.

Figure 23. Aardwolf marking on a road in Bicuar.

Figure 24. This female leopard was marking the same spot as the aardwolf above, about five nights after the aardwolf marked above.

Figure 25. A serval hunting in Bicuar.

Figure 26. A caracal on the prowl in Bicuar.

Figure 27. Small carnivores at Bicuar. Species are (clockwise from upper left): bat-eared fox, miombo genet, swamp mongoose, honey badger, Selous mongoose, Cape fox.

Figure 28. Elephants at Bicuar.

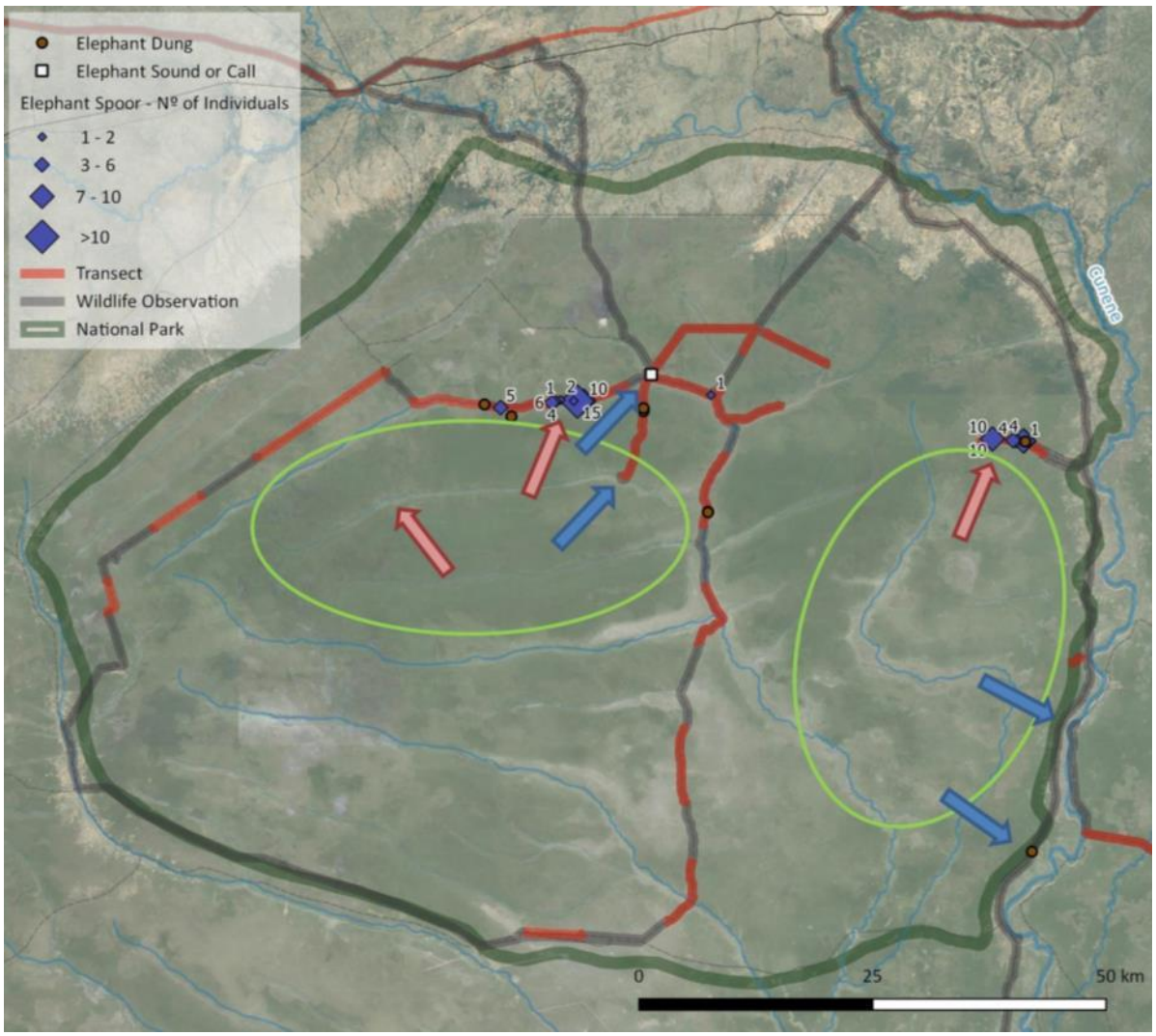

Figure 29. Map of spoor and dung observations for elephants. Green ovals show the main areas for elephants in Bicuar, in remote areas of thickets and forests. Arrows show key water used by elephants, including key seasonal (red) and permanent (blue). See text for more discussion.

5.1.10. Elephants

Figure 29 shows the two areas in Bicuar we considered to have significant elephant numbers. From the western area, elephants accessed ephemeral water at Malipi waterhole and the remote waterhole below (shown with red arrows). They also accessed permanent water at Tumbaeque waterhole and Main Camp (blue arrows). Judging from the spoor at Malipi, Tumbaeque and Central Camp waterholes, this western group numbered no more than 40 individuals, but the number could be greater if elephants were accessing water in the remote waterhole west of Tumbaeque shown in Figure 30 at the time of the survey, and hence their sign was not in accessible locations. Elephants in the eastern area were centered around Chipeio and accessed late dry season water at Lagoa da lueva and permanent water along the Cunene River. Judging from the spoor seen at Lagoa da lueva and along the Cunene river, this eastern group would have numbered about 20-30 elephants. There was likely considerable movement between the two areas (and elephant dung was observed in this area), but limited or no movement across the Cunene River.

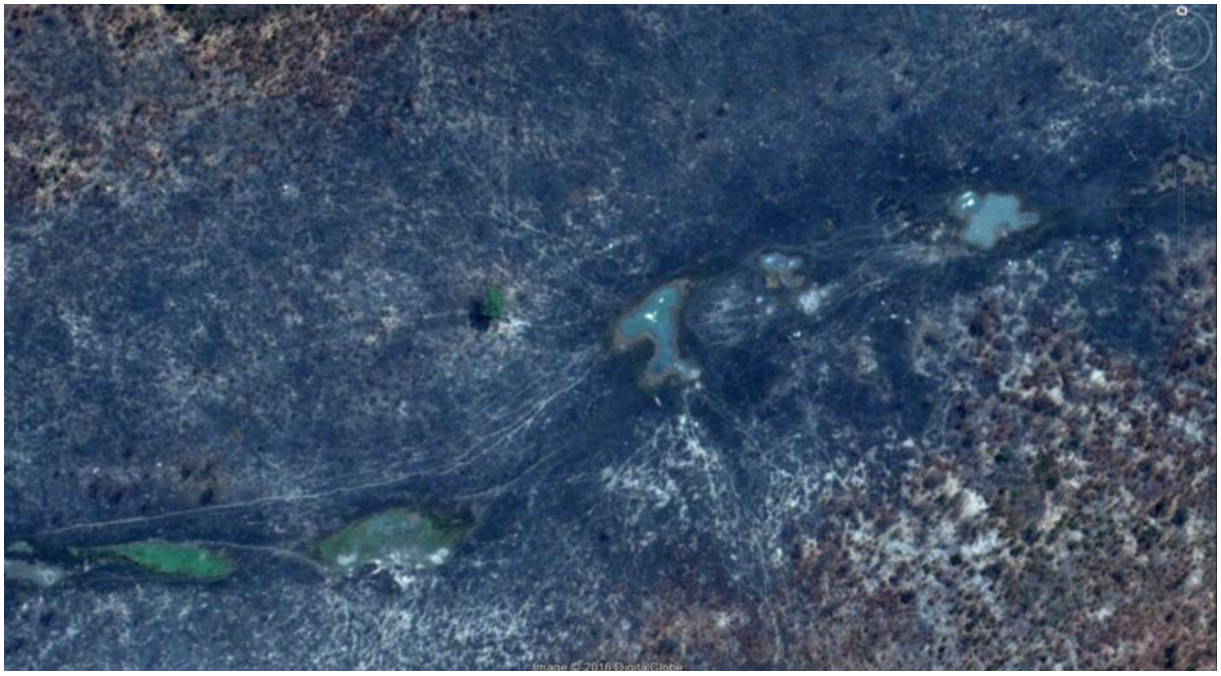

Figure 30. This imagery from Google Earth shows extensive game trails around a series of waterholes about 24 km west of Tumbaeque waterhole. These waterholes presumably lose their water in the late dry season. This waterhole complex is likely to be a key habitat feature for the elephant population and other species, and deserves better protection and road access.

The waterhole complex shown in Figure 30 was very remote and appeared to have extensive game trails. This waterhole was likely to be ephemeral, but to retain water late into the dry season. We attempted to access the waterhole during the survey, but the roads were too overgrown. However, it would only take about a week or two to clear the 18 km or so of overgrown roads to the waterhole and allow better patrolling and surveying of this waterhole. This waterhole was likely to be a key habitat feature for the elephant population and other species, and deserves better protection and road access. Given the likely importance of this waterhole to elephant and other species, we recommend that it receive better road access and regular patrolling. This would be an excellent choice of locations if more solar pumps and outposts were being developed.

5.1.11. Ungulate Species

5.1.11.1. Roan

Roan were the most common large antelope, and one of only three large antelope species remaining in Bicuar. We made direct observations of 85 roan in the core area of Bicuar at a mean distance of 265 m. We encountered 90 fresh sets of tracks from roan every 100 km, or about one per km. Roan tracks were also observed in the outer areas of Bicuar.

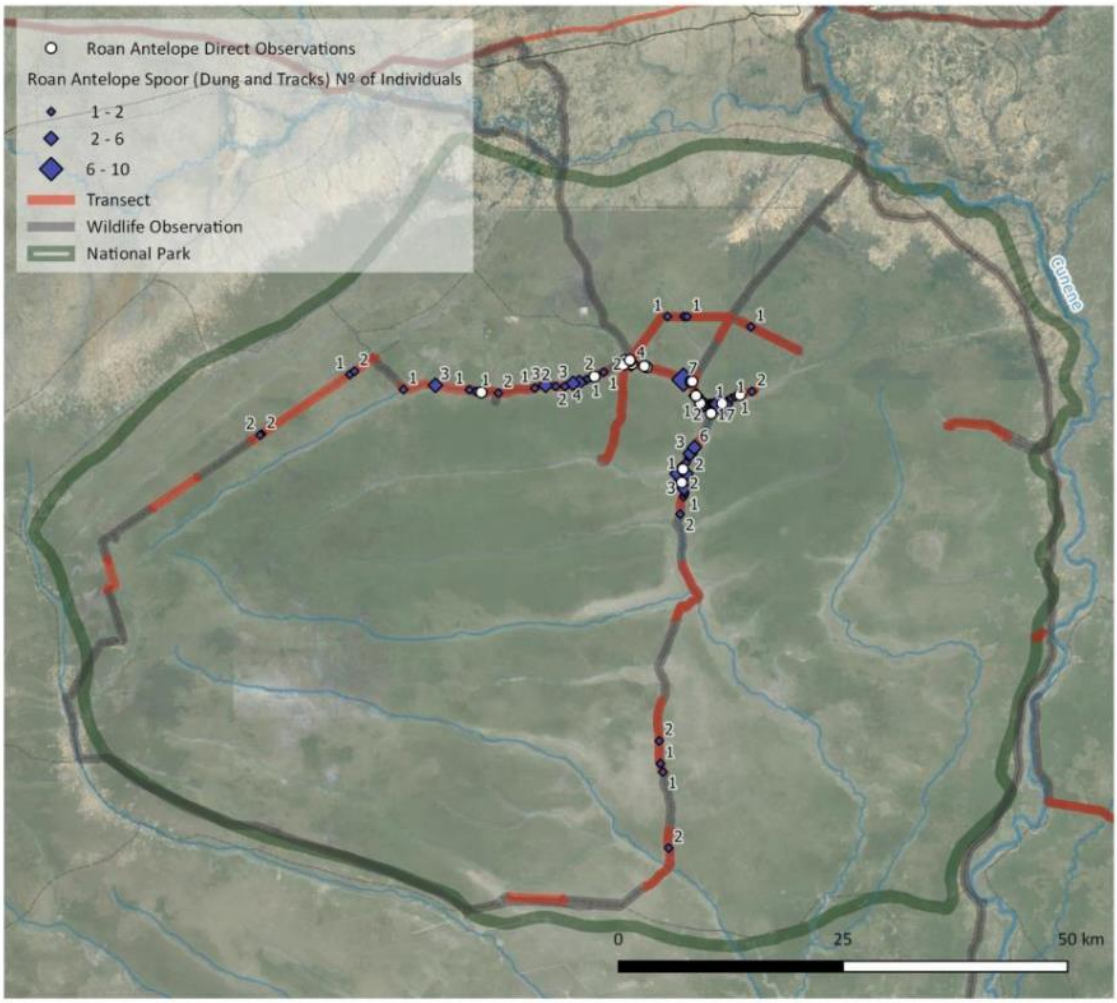

Figure 31. Map of observations of roan individuals from spoor and direct sightings in Bicuar.


Figure 32. A roan gets comfortable with the camera traps.

5.1.11.2. Bambi -- Common Duiker and Steenbok

Common duiker and steenbok were not distinguished by the staff at Bicuar, so these are lumped here according to the local name Bambi. Similarly we did not ask CATalogue volunteers to distinguish these species when identifying camera trap images.

Both species were present at Bicuar, and duiker was common (Table 3). Duiker and steenbok together had 838 individuals recorded on camera traps, or almost one per trap night. We had 49 direct observations of duiker and four direct observations of steenbok. No direct observations of either species were made in the outer areas of Bicuar, but spoor was recorded. Note that spoor is under-recorded for small species such as duiker and steenbok, especially in sandy substrates.

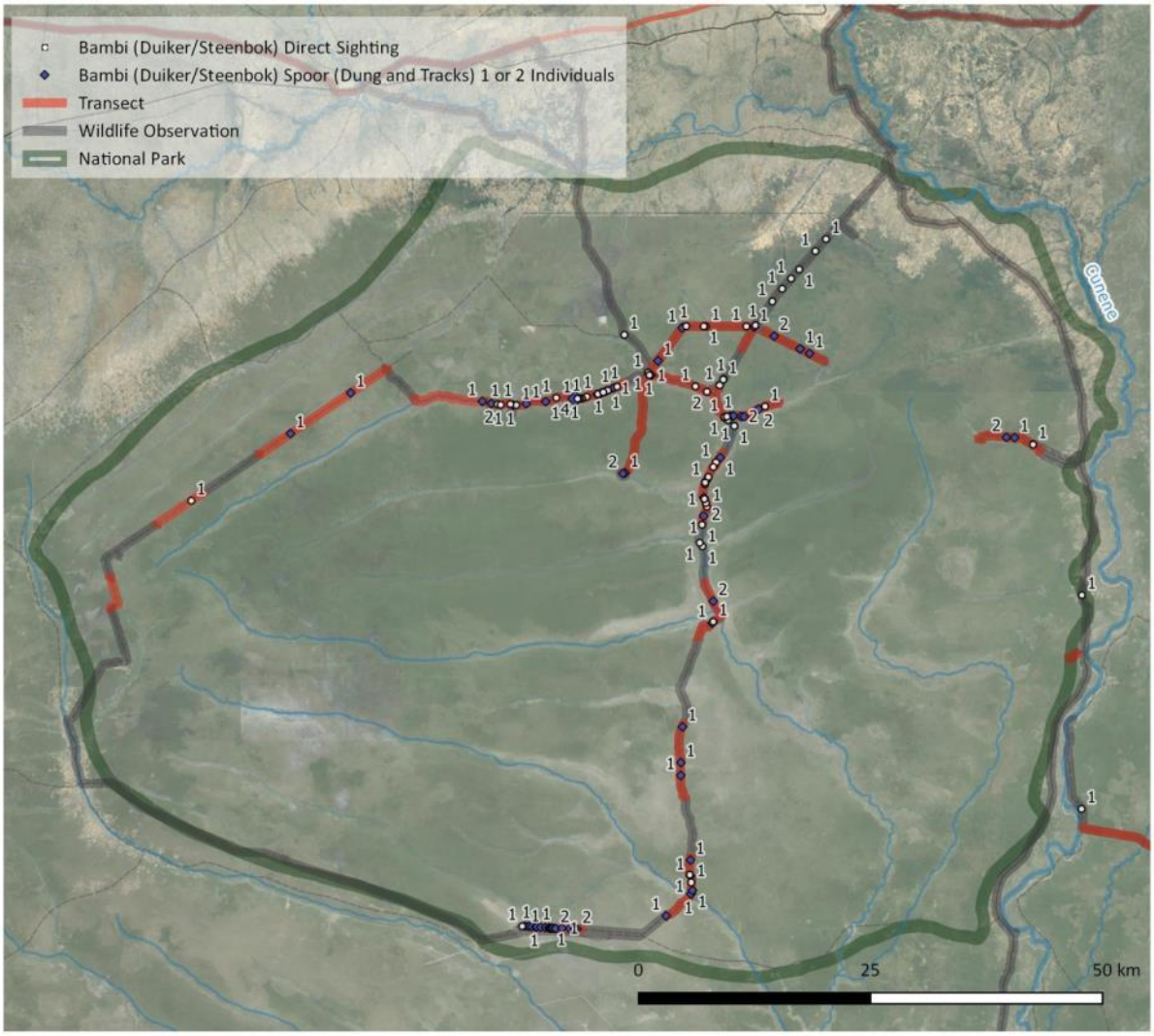

Figure 33. Map of observations of duiker and steenbok individuals from spoor and direct sightings in Bicuar.

Figure 34. Camera trap images of steenbok and duiker from Bicuar. Steenbok are the two images in the left hand column and common duiker are two images in right hand column.

5.1.11.3. Kudu

Kudu were present in Bicuar in low densities as indicated by spoor, direct observations and camera trap images (Table 3).

Figure 35. Kudu and Eland at Bicuar.

5.1.11.4. Eland

Eland were present in core and outer Bicuar at low densities as indicated by spoor and camera trap images (Table 3).

5.1.11.5. Buffalo

Buffalo were absent from Bicuar. Buffalo were reported to have been a major part of the fauna of Bicuar, and were in fact used as the symbol or mascot of Bicuar.

There was interest in the reintroduction of buffalo to Bicuar (J. Kandungo pers. comm.). This idea has considerable merit and should be considered further. Reintroduction of buffalo would restore a major component of the mammal fauna, provide the basis for reintroduction of lions, and also reduce fuel loadings for fires. The first step to advance this idea would be to attract funding to do a feasibility and reintroduction plan with costings.

5.1.11.6. Zebra

Zebra may still have present at Bicuar at the time of the survey. A single zebra was reported (J. Kandungo pers. comm.), and this may have been confirmed by possible zebra tracks during our survey. Whether there were more than one is not known, but in any event the population was likely very small with limited viability.

5.1.12. Flight distances

Many species in Bicuar were observed to be quite shy and to flee at fairly long distances. Similarly Ron (2015) reported long flight distance and vigilant behaviour of wildlife at Bicuar. Such behaviour can be an indication of poaching or other disturbance and affects the wildlife experience of tourists. Quantification of flight behaviour allows comparison with future surveys or with other wildlife areas. To characterize the flight behaviour of animals observed in Bicuar, we calculated an index of flight distance. The index is an estimate of the distance at which 50% of the animals are fleeing. We calculated this separately for the two species (duiker and roan) for which we have sufficient direct observations to allow robust estimation, and we also calculated a combined estimation across all species. The number of individuals directly observed for each species is shown in Table 3. Note that we made no direct observations of carnivores or elephants, and all direct observations were ungulates of five species. Animals observed in one group were treated as a single observation for these analyses. Because animals such as roan typically travel in groups, the number of flight distance observations is smaller than the number of individuals observed and reported in Table 3.

The distance at which 50% of roan flee is estimated at 264 m with an 80% confidence limits of [180,388]. The distance at which 50% of duiker flee is 209 m with 80% confidence limit of [111,360]. Across all ungulate species, the distance at which 50% of individuals flee is 226 m with an 80% confidence interval of [169,317]. Figure 36 shows the curves and data used to estimate the index.

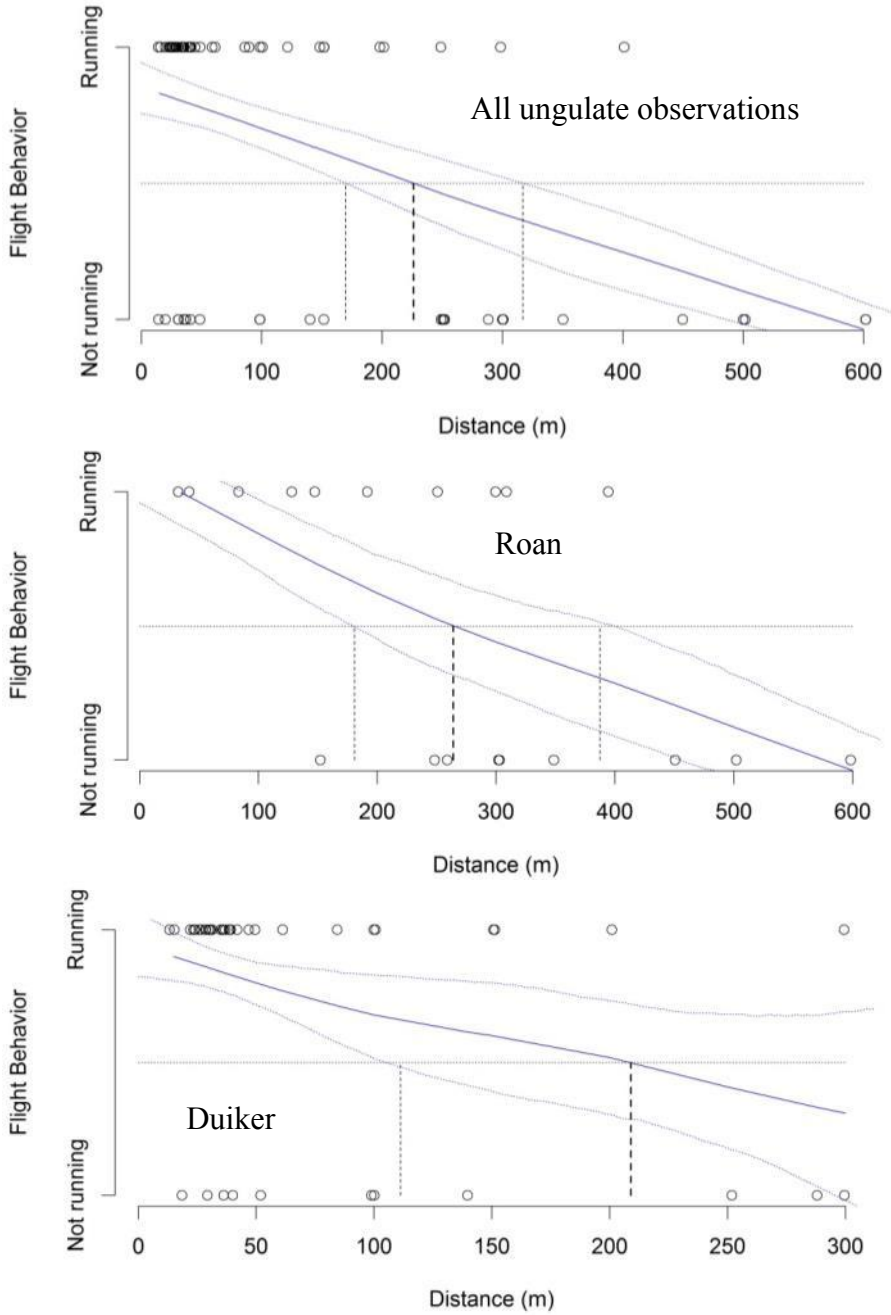

Figure 36. Graphs used to estimate the index of flight distance: (top) all ungulates; (middle) roan and; (bottom) duiker. For each graph, the behaviour (running or not running) is graphed against distance observed. The regression of the proportion running is given by the solid blue line. Where this line crosses halfway provides the estimated distance at which 50% of the animals are running away. Blue dotted curves show 80% confidence limits of the regression.

5.1.13. Pressures

The park manager Jose-Maria Kandungo reported that poaching was well under control in Bicuar. Consistent with this view, we observed no evidence of poaching in Bicuar during our visit. However, we did not spend much time on the periphery of the park, where poaching would be more likely. Clearly wildlife numbers were well depressed from potential capacities, took flight at considerable distance, and major species such as buffalo were missing. Elephants were in low densities and very shy. Most likely this was the result of the history of poaching and depletion rather than current activities. Together these were consistent with low current poaching and a recovery from massive depletion in the time prior to 2006.

Extractive activities in Bicuar were generally low. Gathering of grass for thatching grass was fairly widespread. This activity seemed to be reasonably managed with persons encountered having some sort of permit (Figure 37). Evidence of dove shooting was also observed at some water holes. With current wildlife levels, these activities were relatively harmless. But as wildlife recovers, these sorts of uses will become increasingly in conflict with animals and will exclude the shy wildlife from important areas. We suggest that management periodically review the extent to which these extractive activities are contributing to (and detracting from) the objectives of the park.

Fires were present in the park and having a large impact. During our visit a number of camera traps were lost to fire (Figure 38), and we also observed numerous large trees killed by hot, late season fires (Figure 39). It may be that fires were reducing the woodland areas of the park by killing large trees and converting the woodlands into thickets. But this is simply a casual observation on our part that needs further investigation.

Fires were likely to be exacerbated by loss of large biomass of buffalo and great reduction in elephant biomass. Both of these species would greatly reduce fuel loadings when at natural densities. This suggests that the best solution for this fire problem may be to recover game densities, especially buffalo and elephant.

Direct fire management may also help, such as by early burning of certain areas. Burning early in the dry season can greatly reduce the heat of the fires and allow grasses more time to grow back while there is moisture in the soil. However, different grass, shrub, tree and animal species all respond differently to fire, so there are no simple solutions to fire. We recommend that MINAMB may want to contact an organization such as The Nature Conservancy (TNC) that has considerable experience in managing fire in similar ecosystems such as Kafue National Park in Zambia. However, it should be noted that the key threats on the park are poaching and encroachment, and care should be taken not to let fire management drain resources important to manage those primary threats.

Figure 37. Scouts on the tracker seat checking the permit of people in Bicuar gathering grass.


Figure 38. A camera trap destroyed by fire.

Figure 39. Trees killed by fire in Bicuar.

5.1.14. Tourism potential

Bicuar has the potential to be an iconic wildlife destination for Angola. As way of comparison, the park that perhaps best showcases the kind of tourism success that Bicuar could enjoy is Hwange National Park in Zimbabwe. Bicuar would likely support similar game densities as Hwange, including large herds of buffalo and elephant. Huntley (1971 a) was similarly complimentary of Bicuar, stating that "Bicuar has the fastest growing game population I have ever seen – a superb example of what efficient protection can achieve in a few years". Like Hwange, Bicuar does not have the dramatic scenery of parks like Iona, so the tourism would be based largely around the wildlife. While the future of the park tourism is certainly in its wildlife, currently the wildlife is relatively scarce and the animals are often quite shy. For instance while the elephants occasionally come to the water hole at Main Camp, they only come at night. Therefore the initial allure of the park will likely be to those that want to travel off the usual tourist tracks and want an adventure in a relatively unknown national park. Bicuar currently has much to offer those that want an adventure off the usual tourist route. However, it must be emphasised that the longer term prospects for Bicuar as a major wildlife destination are entirely dependent on the recovery of wildlife, and hence continued protection of the wildlife from poaching and other pressures. Importantly too, the better the park is protected, the faster wildlife populations can recover. We suggest the initial objectives would be to raise the profile of the park for tourism, and slowly build infrastructure and human capacity in the park for catering to tourists.

Unlike Hwange which is well connected to other parts of the Kavango-Zambezi Transfrontier Conservation area (KAZA TFCA), Bicuar does not enjoy a connection to other large wilderness areas. There is some possibility for connection to Mupa and from there to the Cuando-Cubango region, but our results indicated that this connection was not operating and would need to be recovered.

As discussed above, the park has invested in sufficient infrastructure in buildings, artificial water and roads to allow recovery of wildlife and development of tourism. However, at the time of the survey tourist facilities in Bicuar were essentially non-existent, and international tourism mostly absent. Hence the obvious next step is to advance the tourism potential that is made possible by the well-conceived investment in the recovery of the park. The tourism opportunities could be easily developed at very low cost initially. There are two possibilities for a nice camping area at Central Camp in Bicuar. Both of these offer a camping area with a gathering area with a thatched roof, drinking water, and one of them has easy access to a toilet (Figures 40 and 41). Either or both of these camping areas could be made ready for camping in a short time at very low cost. While most overseas visitors with 4WD vehicles will prefer to camp, there are also cabins that are available that could be rented to travellers.

In the short term, Bicuar could easily become popular as a two to three day side trip for organized tours or 4WD convoys while travelling to or from Namibia in the south to Lubango and the beaches to the north or west. The proximity to Lubango makes it quite feasible for organised tours to visit Bicuar on two to three day trips. Remote campgrounds could also be established at minimal costs near solar water pumps for use by 4WD enthusiasts. A few routes around the park that are currently overgrown could at minimal cost be kept clear for travelling by hard-core 4WD enthusiasts and these routes could be popularized by the use of social media and forums.

In summary, Bicuar needs to have some basic camping facilities available, and then put up a big "Open for Tourists" sign on various media. This could include actual road signs on the routes into Bicuar from north and south off major highways in the region. Given the currently limited wildlife and low recognition of Bicuar, we suggest keeping entry fees reasonable until such time as wildlife recovers.

Figure 40. A potential camping area in Main Camp, Bicuar. This area was used by the survey crew, and provided an excellent camping area with water and toilet nearby. This could easily be made available as a camping area for tourists, and would likely prove very attractive to 4WD enthusiasts.

Figure 41. A second potential camping area in Main Camp, Bicuar. This area could also be an excellent camping area for tourists, but would need some water provided and toilet facilities.

5.1.15. Co-management arrangements

MINAMB could consider entering into some sort of co-management relationship for Bicuar. This could involve various types of arrangement in which an NGO contributed to the management of the park. This would likely provide resources to the park that are not currently available for staff salaries, protecting wildlife, and tourism development.

5.2. Mupa

5.2.1. Overview

Like Bicuar, Mupa suffered drastic declines in the late 1970s and early 1980s, when buffalo, giraffe and probably impala were extirpated from the system due to army ration hunting. Many areas within the original 'colonial' boundaries were heavily settled, and all permanent water was dominated by humans. Seasonal water was available in the interior of the park, but this was reported to dry up late in the dry season. As a result, the water independent species were persisting in the interior of the park, and highly mobile species such as hyena and wild dog persist by ranging widely in the park and commuting to water. Interestingly, species such as roan, warthog and bush pig were widespread in more remote areas of the park, and it was unclear how these species get water at the end of the dry season.

Evidence of poaching was found throughout the park, consistent with small scale commercial poaching. This included duiker bushmeat for sale along the highway south of Cuvelai, motorcycle tracks leading to a remote (then dry) waterhole with four duiker and one steenbok skins, and sticks to support a set gun over a remote waterhole in central Mupa, together with numerous hunters' camps.

Given the high levels of human habitation inside the original (so called 'colonial') boundaries of the park and the almost complete lack of wildlife in inhabited areas, we focused our efforts

on the portions of the park that were mostly still uninhabited. This formed a 'de-facto' park in the central and western portion of the original park. We also investigated the area between Bicuar and Mupa parks for evidence of significant animal movement between the parks.

The Administrator Adjunto in Cuvelai, Domingos José de Oliveira, was very helpful and organized a meeting in Cuvelai of 12 people including three sobas and cecolos, and officials from his office and from the IDF, RADRP and Agricultural organisations. This meeting was very informative, and served as a briefing to inform us on the species distributions and conditions in the park, and also introduced our team and our activities to the officials and some traditional leaders in the park.

Figure 42. Discussing GIS information on Mupa at meeting in Cuvelai. The Administrator Adjunto in Cuvelai, Domingos José de Oliveira is seated second from right.

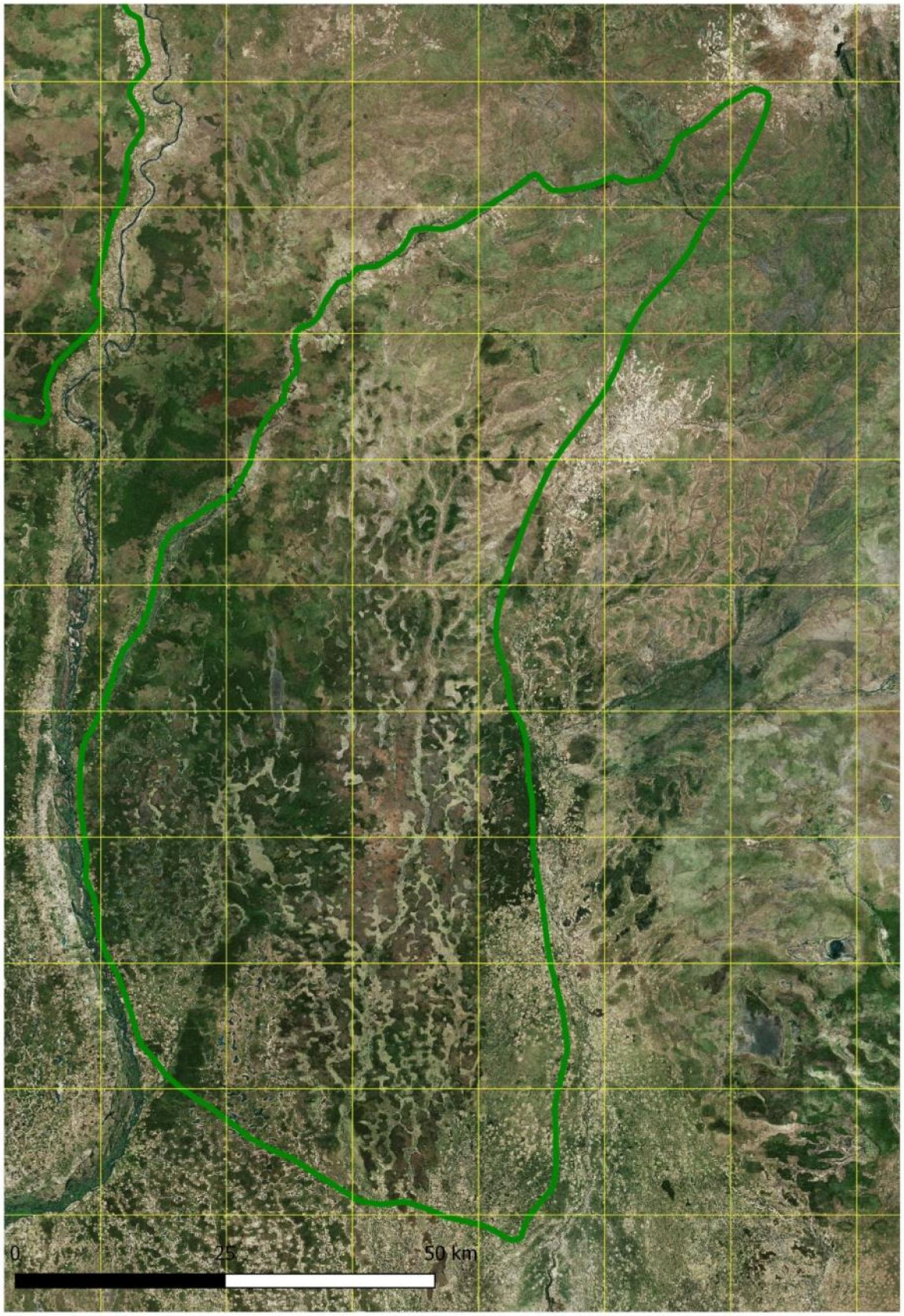

Figure 43. Map of Mupa, with original 'colonial' boundaries in green. The southeast corner of Bicuar NP is visible in the upper left corner. Settlements in and around the park are visible as light areas in the imagery. The 15 km grid that Panthera uses to organize all Angola surveys is shown in yellow.

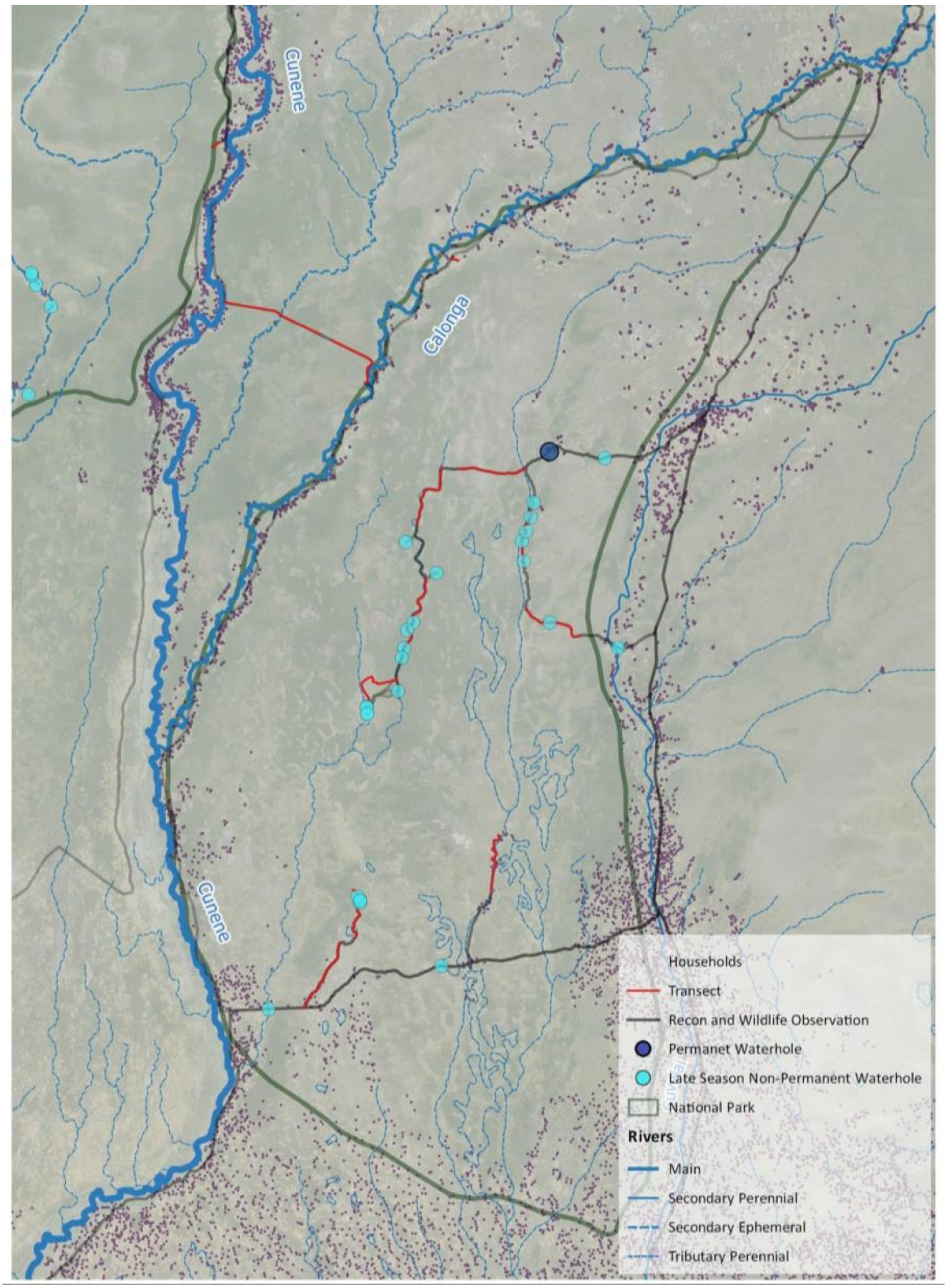

Figure 44. Map of Mupa showing survey effort, with tracks of spoor transects and recon and wildlife observation surveys. Also shown are the mapped households in purple. Survey effort concentrated in areas without settlement and those areas reported to have water and animals by locals. Late season water was recorded only along the routes travelled in this survey and includes artificial wells. An additional late dry season waterhole was reported by locals but not found by the survey, but likely supports roan (see Figure 56).

Figure 45. Well and livestock water in remote Mupa. Here a well is surrounded by thorn fence, and water trough is provided outside. Wells and troughs such as this likely play a role in supporting some wildlife species in sparsely settled areas when late season water sources dry up.

Figure 46. A soba (headman) on the northwestern boundary of Mupa. Interviews with headmen and other locals were an important source of information for the surveys.

5.2.2. Survey Effort

The survey team consisted of Jake Overton, Fernando Naufila, and guards Fernando, Joaquim and Andonio. The team was joined at times by local sobas, hunters or officials from IDF. There were over 2,000 km of recon and wildlife observation surveys and over 100 km of spoor transects. Access to the interior parts of the park was extremely limited, and some surveys were done on foot.

There were 29 cameras set for about three weeks in Mupa. One trap was set and within one day was cut down by curious village children and is not counted in this total, but otherwise traps were not disturbed in Mupa. One trap set over a sandy well pit ran out of batteries or filled the memory card taking images of birds, but in the meantime recorded a pack of wild dogs. The total camera trap days (including partial days) was 584, or an average of 20.1 days per trap.

We conducted 35 interviews of officials, headmen and villagers in and around Mupa National Park. Interviews were spread around the entire perimeter of the park, inside the park and the area between Mupa and Bicuar.

5.2.3. Mammal Communities

Mammals were much lower in abundance and also lower in diversity in Mupa than in Bicuar and were generally restricted to areas with low human settlement.

As in Bicuar, leopards and spotted hyaena were the most common large carnivores in Mupa, although at much lower densities than Bicuar (Table 5). Wild dog were also present at lower densities in areas of the park with little or no human settlement.

Nine species of medium and small carnivores were detected in the park, including serval, caracal, black-backed jackal, side-striped jackal, civet, honey badger, Selous mongoose, banded mongoose and an unidentified species of mongoose. Notable species seen in Bicuar but not in Mupa include wildcat, miombo genet, bat-eared fox, Cape fox, aardwolf, and swamp mongoose.

During the surveys we observed six species of ungulates (Table 6) including; common duiker, steenbok, roan, bushpig, warthog, and kudu. Of these duiker, steenbok and bushpig were the most common, with kudu also reported to be widespread. Roan show many direct observations and camera trap images, but many of these were multiple observations of the same herd of 17 or 18 individuals. Of the species reported from Bicuar, only elephants, eland and zebra were missing from Mupa, and the latter of these are at very low densities in Bicuar.

Other species of mammal observed included scrub hare, vervet monkey, springhares, aardvarks and porcupines. Baboons were notably absent from both Bicuar and Mupa.

There are many species missing from the species reported by Huntley (1973, 1974), including: giraffe, elephant, lion, Hippopotamus, zebra, eland, black face impala, red hartebeest, and reedbuck

Table 5. Carnivore observations and estimated densities for Mupa. Numbers of observations from different methods for carnivores in Mupa. We had no direct observations of large carnivores.

Species	Camera traps		Spoor				Direct Observation	
	Total Count	Total Count per 100 trap nights	Number Individuals Spoor	Spoor Index	Number Individuals Spoor incl. older spoor*	Estimated Density (Ind. per 100 km^2)	Number Direct Observations	Mean Observation Distance
Spotted Hyaena	26	4.45	5	4.62	8.965	1.42	0	
Leopard	18	3.08	0		1.000		0	
Wild Dog	10	1.71	0		0.182		0	
Side-striped jackal	13	2.23	0**	0	0		0	
Black-backed jackal	3	0.51	1	0.92	1.500		2	42.5
African Civet	3	0.51	0				0	
Caracal	4	0.68	0				0	
Serval	1	0.17	0				0	
Honey Badger	2	0.34	0				0	
Selous mongoose	1	0.17	0				0	
Banded mongoose	0	0.00	0		0.000		1	10.0
Mongoose sp.	0	0.00	0		0.000		1	10.0

* includes spoor older than one day, with older spoor discounted by age to estimate track density per 24 hour period

** Side-striped jackal and black-backed jackal were not distinguished by spoor, so we attributed all records to black-backed jackal.

Table 6. Non-carnivore mammal observations and estimated densities for Mupa. Measures of abundance from camera traps are shown for non-carnivore mammals in Mupa. Grey shaded cells indicate measures not recorded or calculated for that species.

Species	Camera Traps		Spoor			Direct Observation	
	Total Count	Total Count per 100 trap nights	Number Individuals Spoor	Spoor Index	Number Individuals Spoor incl. older spoor*	Number Direct Observations	Mean Observation Distance
Aardvark	2	0.34	0	0	0	0	
Bushpig	68	11.64	0	0.000	7.901	1	45.0
Common Duiker	260	44.52	9	8.313	11.102	2	25.0
Steenbok**	present	present	0	0.000	0.000	7	30.0
Kudu	55	9.42	2	1.847	9.183	0	
Vervet monkey	140	23.97					
Porcupine	4	0.68					
Scrub hare	32	5.48					
Roan	93	15.92	18	16.626	26.413	35***	190.0
Rodent	17	2.91					
Warthog	28	4.79	9	8.313	16.266	0	
Domestic animal	549	94.01					

* includes spoor older than one day, with older spoor discounted by age to estimate track density per 24 hour period
** Duiker and steenbok were not distinguished in the species identification of images on CATalogue or by spoor, so here all observations were attributed to duiker. Direct observations and inspection of images indicate that steenbok were present.
*** The same herd of 17 or 18 roan was observed twice in the same area

5.2.4. Wild dog

Wild dog were widely reported both by officials and locals to be present at low densities in the central uninhabited regions of the park, and along the eastern boundary. Officials also reported wild dog presence in the northern tip of the park, although limited interviews with locals in those areas did not support the reports from officials. The patterns of the reports of wild dogs were consistent with a population of wild dogs that traded back and forth from the populations to the east of the park and used habitats within Mupa, but on balance did not indicated a resident and self-sustaining population within Mupa itself. Wild dog were reported by officials to be persecuted and shot by locals when possible.

We estimated that a population of about 20-30 wild dogs were in Mupa, but that these dogs were not resident solely in Mupa but moved back and forth across the Cuvelai River on the eastern boundary of the park to wildlife areas further east. Given the lack of permanent water that was not dominated by humans the wild dog may not be resident year round. Because of this likely movement, the number of dogs in Mupa may vary considerably. It is unlikely that the wild dog population in Mupa was mixing with the population in Bicuar.

The camera traps in Mupa recorded 10 individuals from three occasions and four cameras. The number of wild dog records per 100 trap nights for wild dog is higher at Mupa (1.71) than the core area of Bicuar (1.07). As for the outer areas of Bicuar, no fresh spoor were recorded for wild dogs in Mupa, so no useful estimates of abundance are possible. Scat was observed in 3 locations and collected for further analyses. Spoor and camera trap evidence suggested that wild dogs and other carnivores were using human made wells and water provided for livestock. As in Bicuar, spoor surveys and camera trap results suggested that dogs travel in small packs less than five individuals.

The prey composition in Mupa was similar to Bicuar, but much more depleted and remaining mostly in uninhabited areas. Some dogs were seen to be painfully skinny in some of the images, which is common in areas with depleted populations of preferred prey species.

Key threats for this wild dog population included: heavy prey depletion especially in preferred size and type, extensive human habitation and livestock in park, likely increase in human habitation to east of park which may stop movement to wildlife areas to the east which may be critical to sustaining this population, small population size, lack of permanent water that is not dominated by humans and reported direct persecution. Other possible threats (e.g. disease) were not assessed in this survey.

Figure 47. Selected camera trap images of wild dogs in Mupa. The upper images are from a simple, artificial well in the sand.

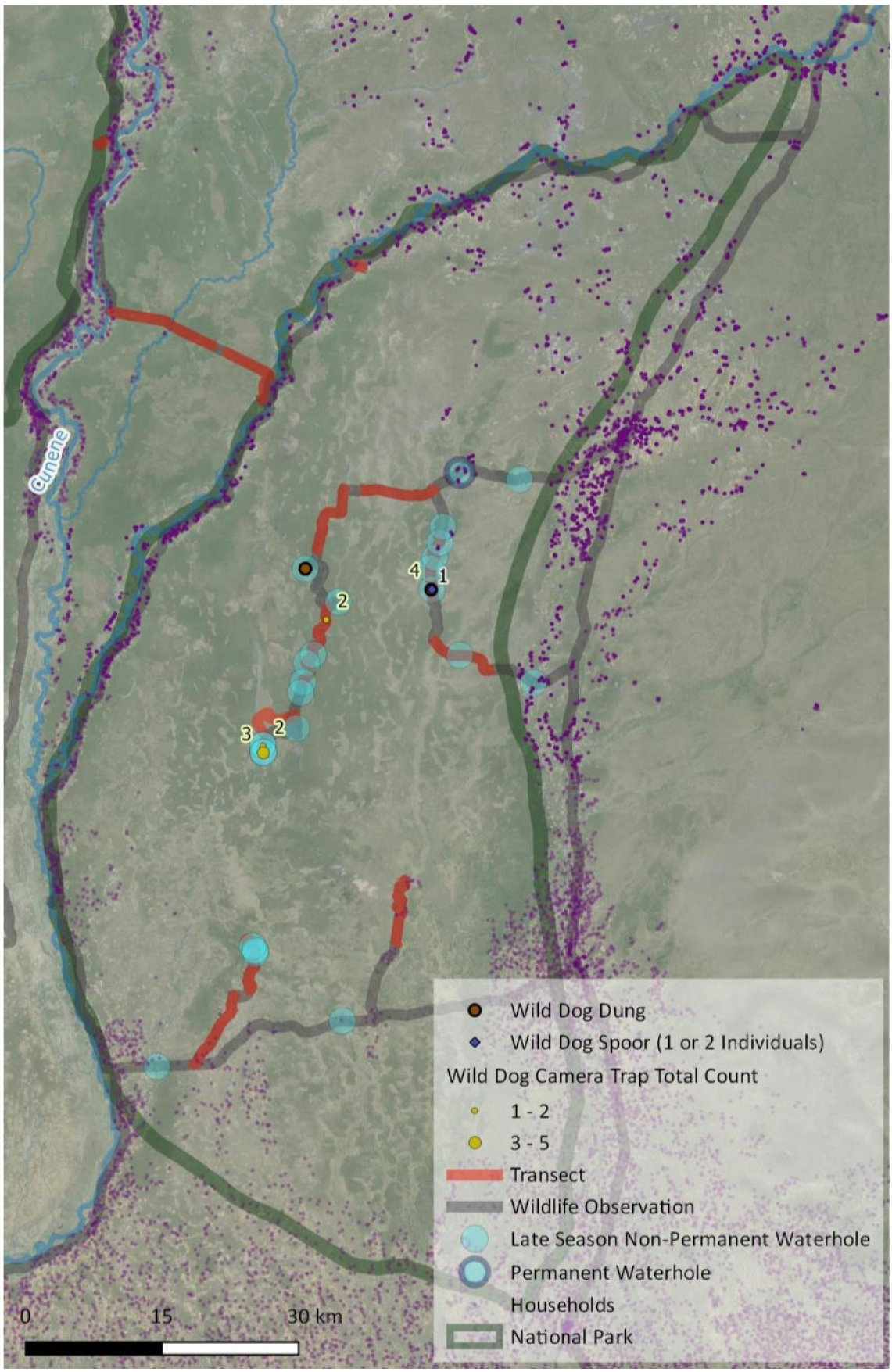

Figure 48. Wild dog observations on camera traps and spoor in Mupa. Also included for reference are the seasonal and permanent waterholes, and human habitation as households (purple dots).

5.2.5. Cheetah

Cheetah were absent from Mupa, with no indication that the species has been present since 1970. There were no observations of the species, including no direct observations, spoor or camera trap images.

Out of 35 interviews of officials, headmen and villagers in Mupa, only one headman from northern Mupa reported cheetah as present. This headman reported that cheetah had been present in 2008 in the area. We have considered this report not credible in light of the consistent information from others of cheetah absence and the difficulties in identifying cheetah for persons not familiar with the species (especially when shy individuals are glimpsed in the distance) and the overall vagaries of local interviews. But it is worth keeping this report of cheetahs in mind for future work.

Of the other interviews, there were no reports of cheetah presence or of any past presence of cheetah, or of any knowledge of cheetah in the area. Huntley (1971b, 1974) did not report cheetah at Mupa.

5.2.6. Leopard

Leopards were present at low numbers in many areas of the park near permanent water. This included near the rivers and near human provided water, such as livestock troughs in remote areas.

Leopard densities were much lower in Mupa than in Bicuar. The number of individuals on camera traps per 100 trap nights was 3.08 in Mupa, or about 30% of that in the core area of Bicuar. There were no fresh leopard spoor recorded in Mupa, so estimates of density are not made from spoor. The lower abundance in Mupa is probably due to the human dominance of permanent water and much lower prey densities in Mupa.

Figure 49. Selected camera trap images of Leopard from Mupa.

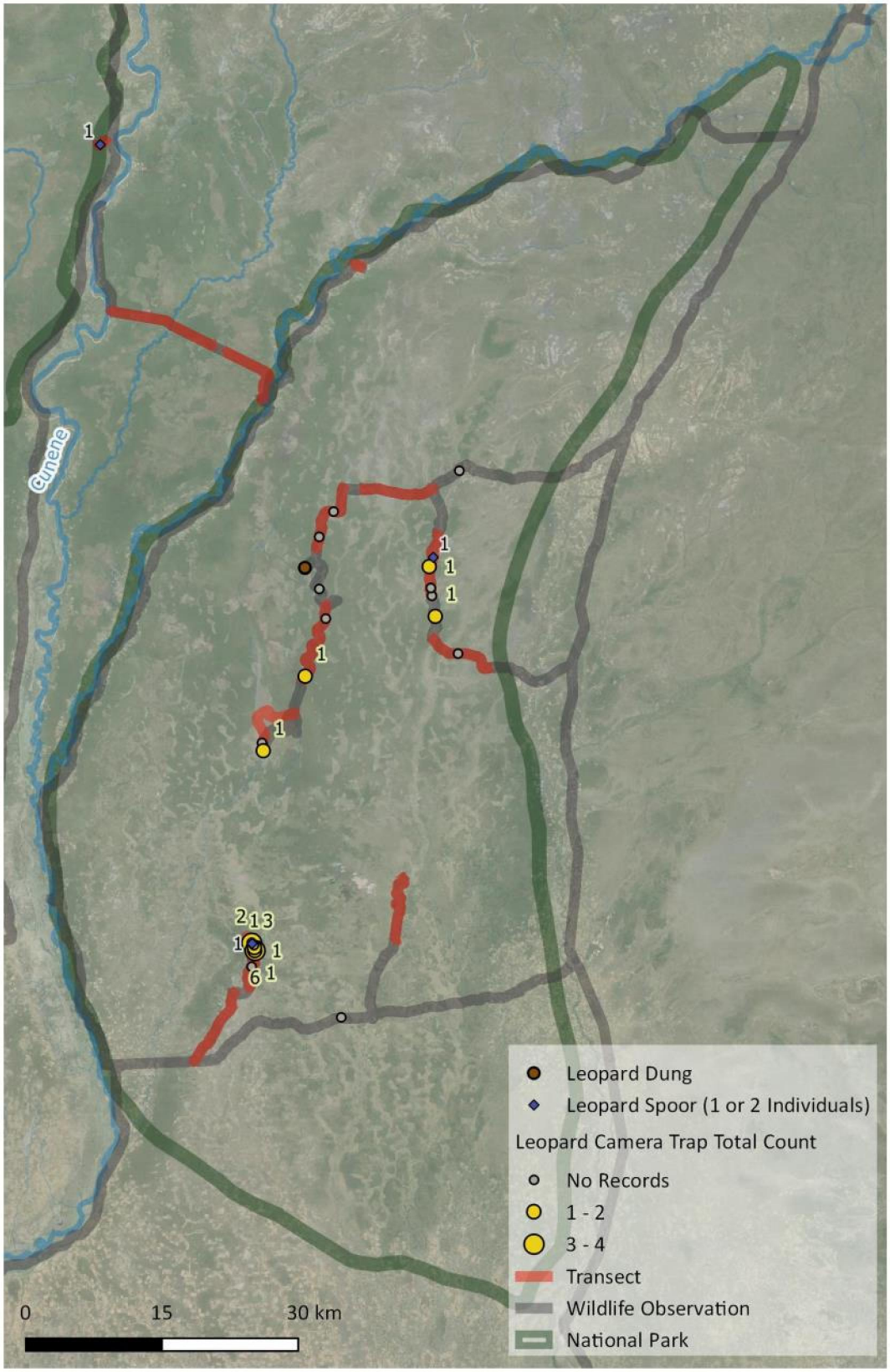

Figure 50. Observations of leopard from spoor and camera traps in Mupa.

5.2.7. Spotted Hyaena

Spotted hyaena were widespread, although never abundant throughout the park and surrounding areas, including widespread reports in areas that were lightly settled by humans. This species was also lower in abundance in Mupa than in Bicuar, with number of individuals per 100 camera trap nights of 4.45, which is about 1/3 of that at Bicuar. Estimated density from spoor was 1.42 individuals per 100 km^2, or about 10% of the density of Bicuar. Hyaena spoor was also observed along the side of the Cunene River in the area between the two parks.

Reports of hyaena predation on livestock were widespread (including an ox killed two nights before our visit), but not at high levels.

Figure 51. Selected camera trap images of spotted hyaena from Mupa.

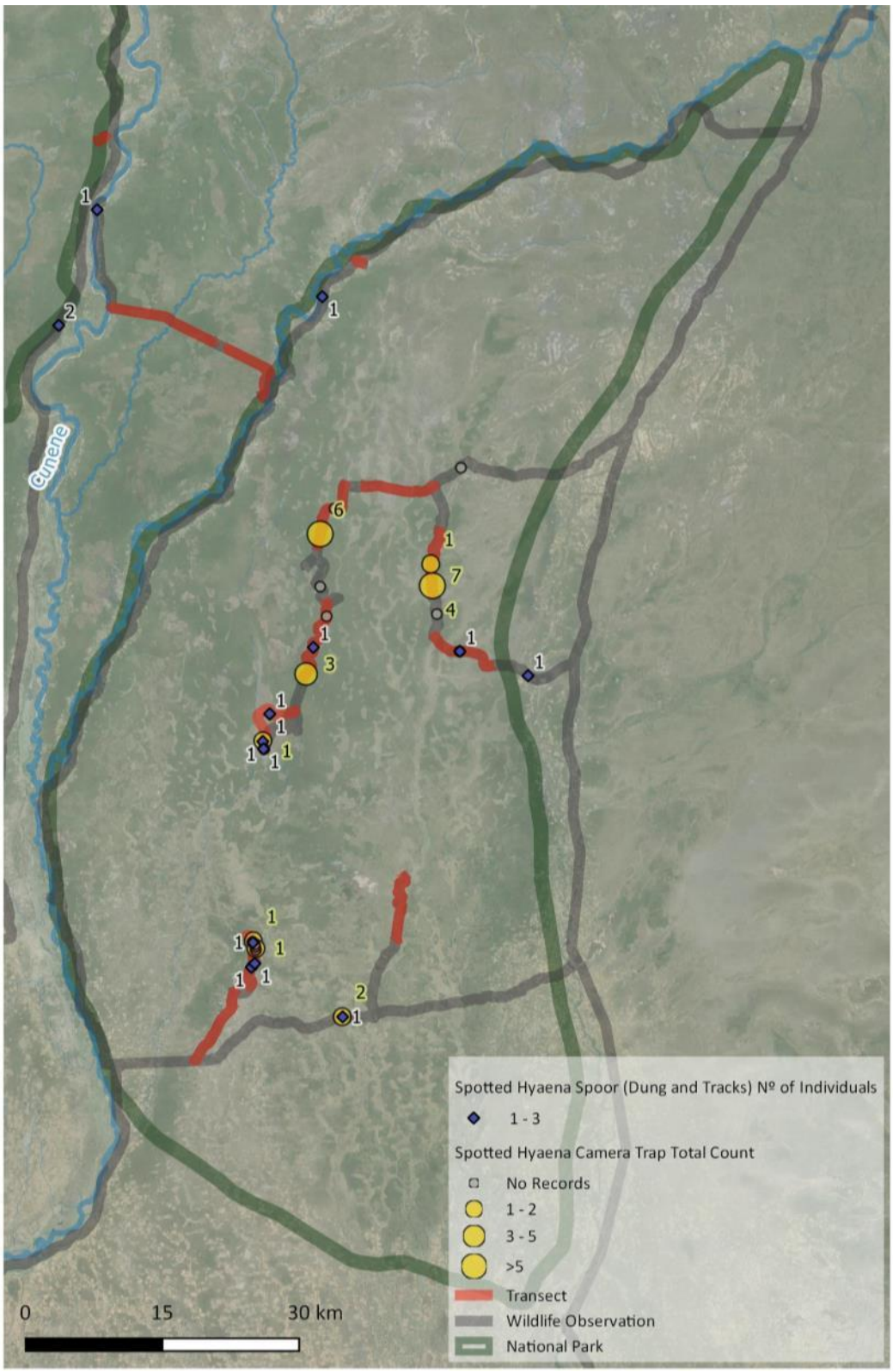

Figure 52. Records of hyaena from spoor and camera traps in Mupa.

5.2.8. Lion

While generally absent from the system (and not recorded at all in our survey), lion were reported by a few respondents to occasionally move through the area, travelling from wildlife areas to the east and northeast. Historically, lion were reported by Huntley (1971b, 1974).

5.2.9. Medium and small carnivores

A number of species of medium and small carnivores are present at low densities through lightly inhabited or uninhabited parts of Mupa, including side-striped jackal, black-backed jackal, serval, caracal, civet, and several species of mongoose (Figure 53).

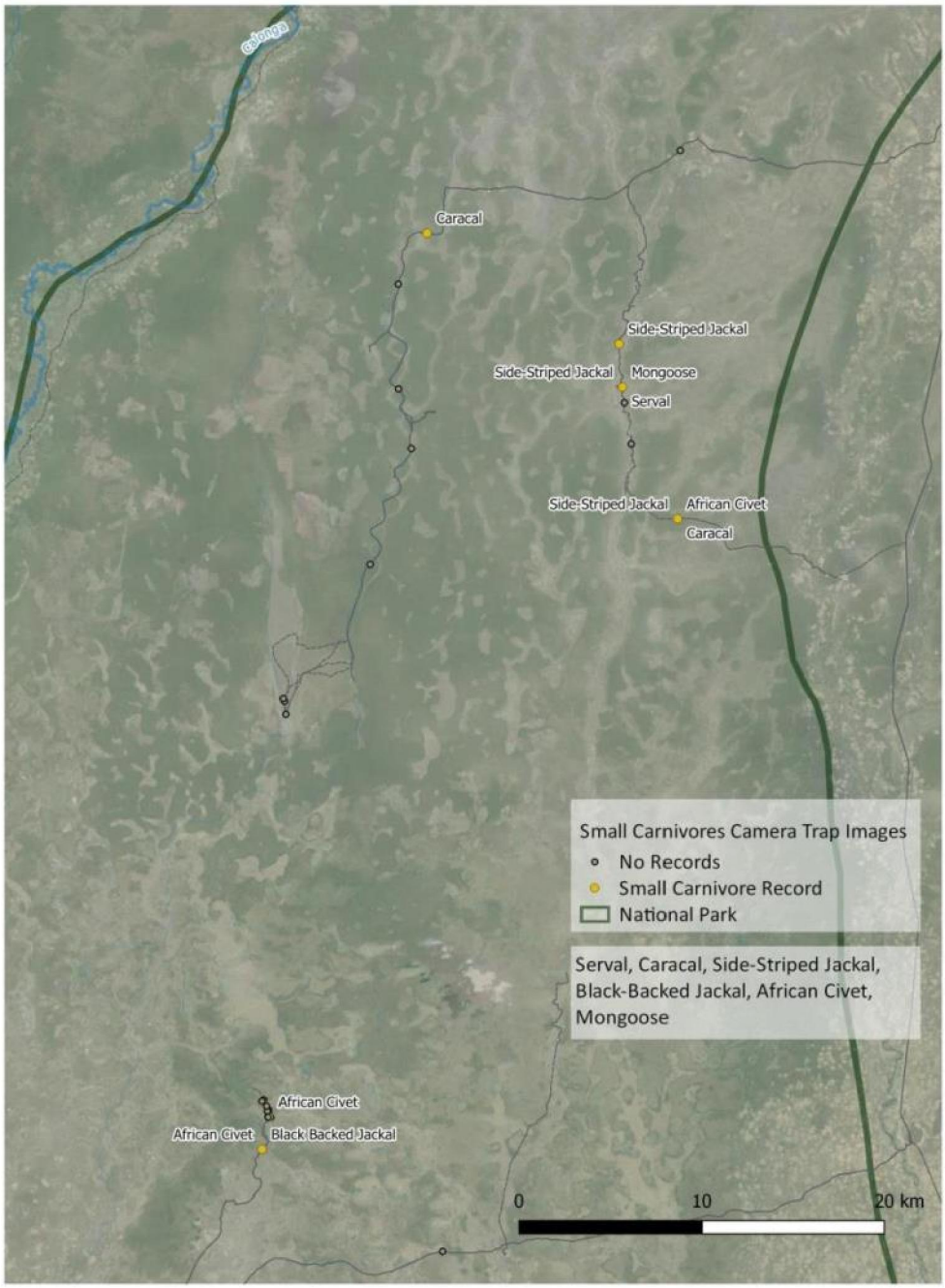

Figure 53. Medium and small carnivores at Mupa, as recorded on camera traps.

5.2.10. Elephants

Elephants were only reported to visit the east side of Mupa NP along the Cuvelai River during the wet season. Here they were reported to come from the areas to the east and raid crops during the wet season. We found no other evidence of elephants in the park, and no reports of elephants later than 2010.

5.2.11. Game Species

5.2.11.1. Roan

Roan were present at low densities in remote areas, especially near seasonal water. Roan were observed by spoor and camera traps in several locations in the central, uninhabited area of Mupa. At two different times in the same area, we directly observed one herd of roan of about 17 or 18 individuals. Roan seem much less tolerant of humans and domestic animals than are kudu, and were only seen in the most remote part of Mupa.

Despite its remoteness, the area that the roan herd was seen was being accessed by poachers on motorbikes. Motorcycle tracks were observed in the area and we directly observed two poachers with a gun on a motorcycle on the access route into that area along a well-used motorcycle track. Also in the same area as the roan is where we observed set guns.

On both of the occasions when we directly observed the herd of roan, we were able to approach within 200 m on foot, well within the range of a modern rifle. Furthermore, the water they were using is reported to be seasonal water, and we observed that it was drying up fast. When this remote water dried up the roan would be pushed to permanent water that is dominated by humans and would be very vulnerable for at least two months until the rains filled the seasonal waterholes again. Together this suggests that the few remaining roan in Mupa are extremely vulnerable.

Figure 54. A herd of roan (palanca vermelha) observed in remote central Mupa.

Figure 55. Selected camera trap pictures for roan at Mupa. A young roan from the above herd spooks from the camera, and then days later comes for a closer look

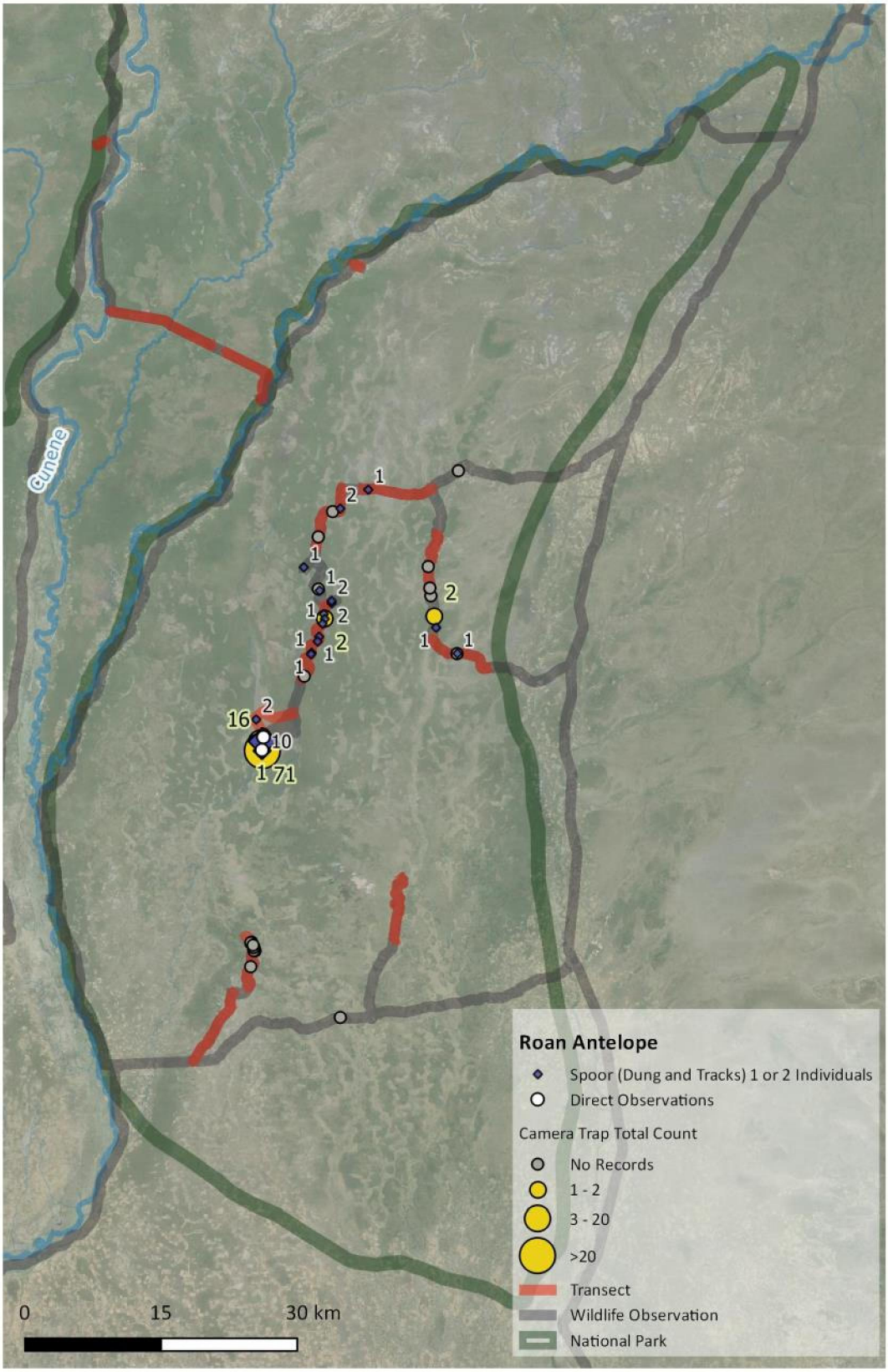

Figure 56. Observations of roan from spoor and camera traps at Mupa. The spoor and camera trap observations on the eastern side are near an area that locals reported seasonal water that we did not find.

5.2.11.2. Kudu

Kudu were present in low numbers near water. Kudu were widely reported even in areas which have light human settlement.

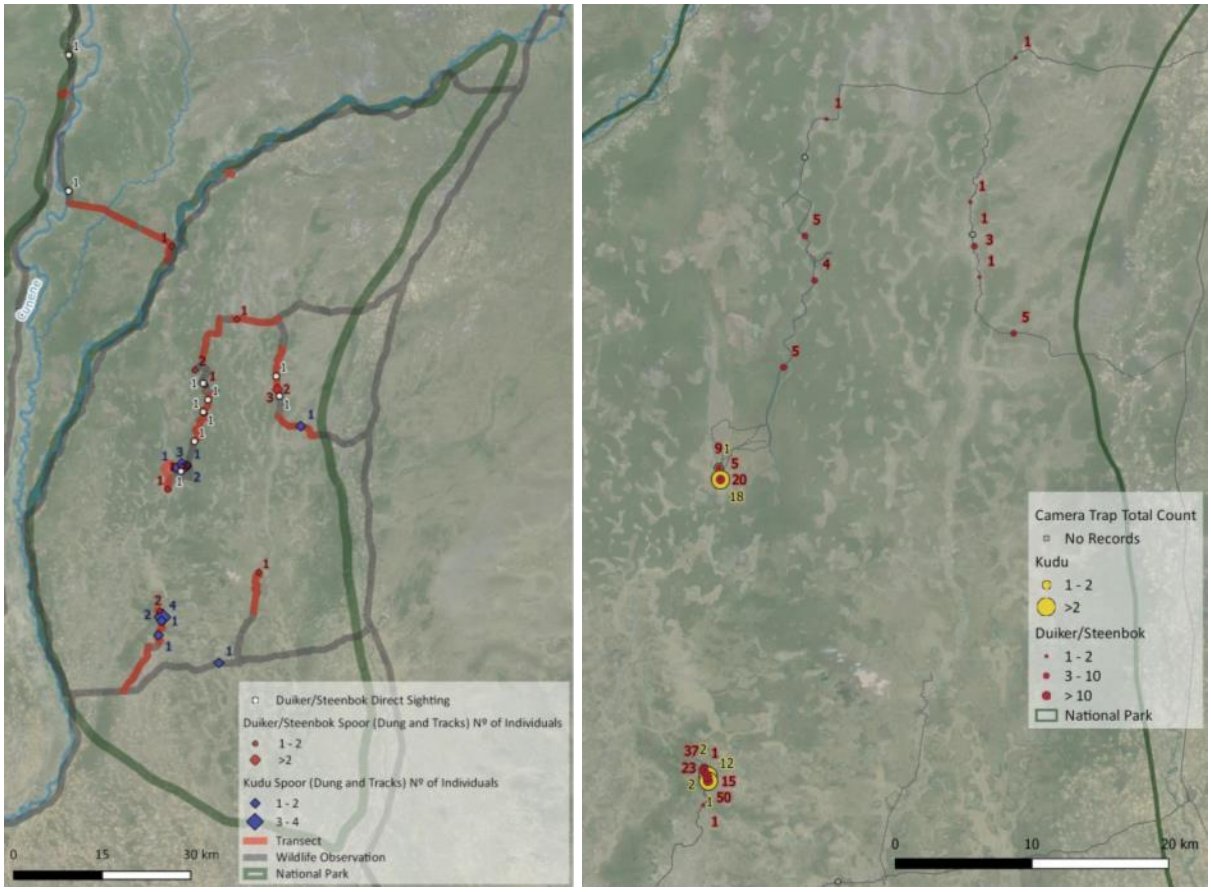

Figure 57. Observations of duiker/steenbok and kudu from spoor and camera traps at Mupa.

Figure 58. A nice herd of Kudu at a waterhole in Mupa.

5.2.11.3. Common Duiker (bambi)

Common duikers were present at low numbers in human settled areas and moderate numbers in remote areas. Their distribution was helped by their water independence and their ability to persist in areas with light human settlement.

Figure 59. Camera trap images of common duiker from Mupa.

5.2.11.4. Steenbok (bambi)

Steenbok were present at low to moderate numbers in more remote areas. Their distribution was facilitated by their water independence.

Figure 60. Camera trap images of steenbok from Mupa.

5.2.11.5. Warthog

Warthog sign, including tracks, scat and rooting, was widespread in more remote areas of park, especially around areas in which seasonal water still persisted. Warthog were represented in low numbers on camera traps.

5.2.11.6. Bushpig

Like for warthogs, bush pig sign including tracks, scat and rooting, was widespread in more remote areas of park, especially around areas in which seasonal water still persisted. Bushpigs were represented in moderate numbers on camera traps, although at higher rates than in Bicuar.

Figure 61. Camera trap images of warthog and bushpig from Mupa.

5.2.11.7. Unidentified ungulate (gazelle)

The trackers identified the tracks of a medium sized ungulate, slightly larger than an impala, as gazelle. There are no species of the genus *Gazella* resident in the area, so this species is currently unidentified. One possible species that is the correct size and is within the species range and reported by Huntley (1973, 1974) is southern reedbuck. Another possibility is hartebeest, although hartebeest tracks are larger and much differently shaped than these tracks.

5.2.11.8. Other species not present

The following species previously reported by Huntley (1973, 1974) were absent from Mupa at the time of our survey.

Giraffe Giraffe were widely reported by officials and all locals to be absent since 1975. In fact Huntley (1971a) noted the plight of giraffe in Mupa at the time, and suggested relocating the Mupa giraffe to Bicuar. His view of the peril of giraffe in Mupa was well founded, but his view of their security in Bicuar less so.

Buffalo Buffalo were widely reported to be absent since the late 1970s, mainly due to ration hunting during the war.

Impala Inconsistent reports were given by a few locals that impala were once common, but there were no reports or other evidence of presence at the time of the survey.

Eland No evidence of eland in Mupa was found in the survey, and we had no reports of their presence.

Oribi Although both Bicuar and Mupa are within this species range, and contain suitable habitat, we found no evidence of this species in either park. Their preference for open habitats and water dependence would make them particularly vulnerable to extirpation from the park at the same time the buffalo were extirpated.

Zebra Zebra were widely reported to be absent from Mupa, and we found no evidence of them during the survey.

Hartebeest We found no evidence of hartebeest in Mupa. There is a small possibility that this is the species that the trackers are calling gazella.

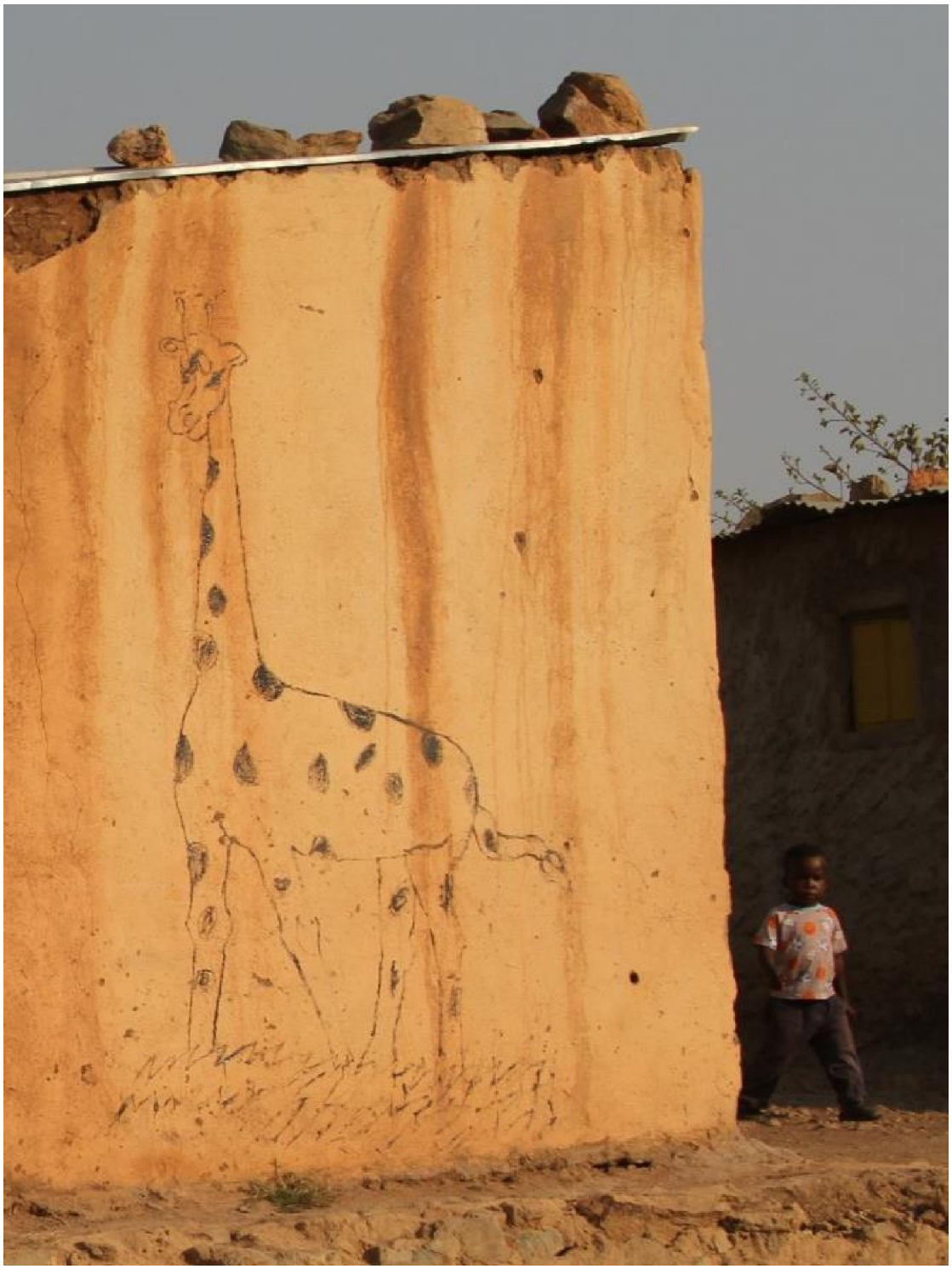

Figure 62. A giraffe was observed north of Mupa National Park.

5.2.12. Pressures

5.2.12.1. Poaching

Figure 63. A set gun placement observed in remote Mupa. Here a guard's gun is used to demonstrate the use of sticks designed to aim a gun at a waterhole. A string to the trigger will fire the gun when an animal (or a person) trips the string.

Numerous evidence of poaching for bushmeat was found in our survey of Mupa. Bushmeat was observed being sold along the roadside between Mupa and Cuvelai. In the remote interior, we encountered several hunters' camps and found skins of duiker and steenbok. Sticks to hold a set gun over a waterhole (Figure 63) were found in the remote area inhabited with roan. A well-used motorcycle trail showed frequent access into the main remote area with roan and other species. Camera trap images showed a man on a motorcycle with gun on the motorcycle path mentioned above, and a hyaena with a snare wound. We also directly observed persons on the motorcycle with gun leaving wildlife areas of Mupa when we were going to recover camera traps at the end of the survey. In addition, many observations (both direct and from camera traps) were made of persons with bows for hunting small game.

Figure 64. Mupa bushmeat. Evidence of bushmeat poaching in Mupa, including (clockwise from upper left): bushmeat for sale on the roadside on the eastern boundary of the park; duiker and steenbok skins from a hunters camp in a remote area; a poacher on a motorbike and gun in the park; and a hyaena with a snare injury on its neck.

5.2.12.2. Settlement and livestock

Human settlement was widespread through large parts of the colonial boundary of Mupa with associated livestock grazing and bushmeat poaching. Domestic animals were the most common animals on the cameras (Table 6), despite placement of the cameras into the most remote areas possible.

5.3. Area Between parks

At their closest, the colonial boundaries of Bicuar and Mupa National Parks are only 25 km apart. However, the two rivers that run between the parks were both heavily settled (Figures 43 and 44) and this was likely to create a significant impediment to movement.

The Bicuar park director Jose-Maria Kandungo reported that elephants moved from the southeast portions of Bicuar park to the Cunene River to access water, particularly between Munquete and Tchipeio on the west side of the Cunene River. This was supported by our observations of elephant dung in that area, and was also widely supported by interviews with locals, which indicated that elephants and wild dogs visited that area of the river from Bicuar park to the western side of the river. However, all interviewees agreed that they did not visit the area between the parks between the Cunene and Calonga rivers. Elephants were reported to have not crossed the Cunene River into the area between the parks since 2005, and we found no direct sign of their presence between the parks. Locals reported that when elephants do cross the river, they are shot by hunters. Animals reported between the parks included duiker, kudu, leopards and hyena. We had direct observations of one duiker individual and also observed tracks of hyena in this area.

Together, this suggests that, at least in the areas between the parks that we visited, that the movements of elephants had been stopped for 10 years by the time of the survey, and that the cultural knowledge in the elephant population of the movement corridor may also have been lost. Given their low densities and ability to move through landscapes without being observed, wild dogs may still have been rarely moving through the area between the parks, serving to connect the Bicuar populations with the populations in Mupa and the Cuando Cubango regions to the east. However we found no direct evidence of this. Given their greater ability to persist in human inhabited landscapes, carnivores such as leopards, hyena and jackal were still likely moving between the parks, and herbivores such as duiker and kudu likely may have had dispersal and genetic flow between the parks.

6. RECOMMENDATIONS

6.1. Management Recommendations: Bicuar

Bicuar has an excellent management and dedicated staff. Together with well-designed infrastructure this has resulted in significant recovery of wildlife and provides an excellent foundation for continued recovery of wildlife populations and attracting tourism. The highest priority for Bicuar is to maintain current staffing levels and continuity of staff salaries. This is extremely urgent and important. Maintained vigilance against poaching and encroachment is vital for the park.

Tourism to the park could be dramatically increased with little cost, by opening existing camping facilities to tourists and low cost promotion that the park is open and welcoming of tourism. Detailed recommendations are provided.

The management has ideas for reintroduction of species extirpated from Bicuar, especially buffalo. This idea has considerable merit. The best first step for advancing this would be to attract funding to do a draft feasibility and reintroduction plan with costings. Other species could also be considered for reintroduction, but only those species known previously from Bicuar should be considered.

The remote waterhole east of Tumbaeque (see Figure 30) should be surveyed and if important for the elephant population deserves better road access and protection. Given the importance of Tumbaeque waterhole itself, care should be taken to avoid activities that disturb the waterhole and exclude elephants.

Bicuar management could consider approaching an organization such as The Nature Conservancy, which has considerable experience in managing fire in similar ecosystems, for recommendations for fire management in Bicuar.

Bicuar management could consider periodic evaluation of extractive activities in Bicuar, and assess how the activities contribute to (and detract from) the management objectives of the park. As wildlife populations recover, these activities will come in more conflict with wildlife objectives.

Bicuar would be an excellent candidate for a co-management arrangement to help provide funds and other support to manage and protect the park.

6.2. Management Recommendations: Mupa

Mupa is highly depleted and encroached. However, while mammal densities in the core area of Mupa are considerably lower than that of the core area of Bicuar, Mupa still retains most of the species found in Bicuar, with the exception of elephant, eland and zebra. The latter two of these species are at low densities in Bicuar. This together with significant areas with little or no human settlement suggests that recovery is possible.

Recovery of Mupa could consist of a formal or de facto re-gazettal of the park to contain the remaining core areas without significant settlement, where the remaining wildlife populations are, as well as a formal expansion to include some of the currently unprotected wildlife areas to the east of the park. This should be accompanied by paying the people inside the new park boundaries to relocate into de-gazetted areas.

Several key issues would need to be addressed in the recovery of this redefined park. First the poaching would need to be reduced to very low levels. The current low levels of wildlife can only recover if there is little or no harvest from them. This would require scout outposts and permanent law enforcement presence and support. Second, there would need to be a sustained program to exclude settlement and livestock from the park area. Third, artificial water would need to be provided to supplement one or two existing waterholes in the park to make them permanent water, and enforcement would need to be in place to prevent them from being used by poachers, livestock or settlers. Fourth, corridors should be defined and opened along the Cuvelai River to allow movement of animals along between Mupa and the wildlife areas to the east. This will allow self-reintroduction of animals such as elephants and lions into Mupa and facilitate the maintenance of the current wild dog and other populations.

Re-establishing connection between Mupa and Bicuar could considerably help Bicuar, by providing connections to the wildlife populations to the east, but this is unlikely to be easy, given the heavy settlements along both the Cunene and Calonga rivers and the apparent loss of cultural knowledge of the route by animals.

The small roan population of at least 17 individuals in western central Mupa is highly vulnerable. The area of this population inhabits is remote, but significant evidence of

poaching in the area and lack of permanent water that is not dominated by humans mean that this herd is under significant risk. Urgent protection of this remnant population is required to prevent it from being extirpated. This may be the only and last roan population in Mupa.

Mupa also has significant potential for adventure tourism by 4WD enthusiasts.

6.3. Further research and monitoring

For wild dogs, further understanding of their population status, movements and threats would facilitate management. Opening up connectivity to the east and formally protecting some of the key wildlife areas between Mupa and Luengue-Luiana would significantly benefit the species and improve the long term viability of the species in Mupa National Park. Research would need to be conducted in this vast landscape to determine the key areas for protection.

We recommend that a similar camera trap survey be repeated in three to five years using precisely the same camera trap stations but with two cameras per station in a paired design. This will allow direct comparison and estimation of trends for many key species of the indices of abundance based on the numbers of images and also allow mark recapture estimate of population density for some key species such as leopard, hyaena and possibly wild dog.

A feasibility analysis and costed reintroduction plan would be the first step for reintroduction of species such as buffalo into Bicuar.

Further surveys of the area would be advised if a re-gazettal of Mupa is planned.

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A boy and his burro along the Cunene River between the parks