

Final report large carnivore census Dinder NP, Sudan

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Summary

The objective of this mission was to survey populations of lion (*Panthera leo*) and spotted hyaena (*Crocuta crocuta*) in Dinder National Park (NP), Sudan, part of the Dinder-Alatash Transboundary Ecosystem. Lions are regularly observed inside both parks and in their immediate surroundings, but rarely, if ever, further than 10km outside the park. Hyaenas are rarely encountered and only at night but they are found in the entire landscape. We surveyed both species using call-ups or calling stations; counting individuals attracted to broadcasted sounds of prey species and hyaenas. We also tried to fit satellite collars to three lions.

Our main conclusions are:

1. We estimate the lion population size at 157 (± 26), and the spotted hyaena population at 180 (± 18) individuals. These numbers are possibly too optimistic, since data from the core zone were extrapolated to inaccessible areas that are less well protected, including the entire southern half of Dinder NP.
2. These numbers are based on the assumption of average response rates found across Africa; if we add uncertainty about local parameters and take the extreme values of response rates minimum and maximum population size ranges are 98-275 lions and 121-297 hyaenas. The number of callups was also limited due to logistic constraints; our estimate must be considered as a working figure.
3. We only found lions in the core area of Dinder NP, the $\sim 1000 \text{ km}^2$ area loosely defined here as a circle of 10km radius around main camp Gelego, which is obviously well protected and where prey densities are high. Outside the core area, prey densities are patchy but locally high, especially around permanent surface water. However, we never observed any lions in these outer areas (n.b. this is an area much larger than the official 5 km 'buffer zone' along the perimeter), but we did observe livestock there on many occasions. A possible hypothesis is that livestock is compatible with prey species, but that lions are selectively killed by livestock attendants. Our survey included data from core and non-core areas of the park, but callups inside the core area are overrepresented compared to area size. Data are insufficient to calculate densities separately and we extrapolated the observed lion density to the entire park.
4. To ensure a robust and viable lion population, and to enable recolonization of Dinder NP by leopard from neighbouring Alatash NP, it is highly recommended to extend the area with a high level of protection beyond the core area and preferably to the entire park except the official buffer zone where mixed use is legally allowed.
5. From opportunistic sightings, we were able to add various species to the mammal list, and we reconfirmed the presence of the rare and near-endemic Heuglin's gazelle (*Eudorcatilonura* – cover photo). Various observations reported here emphasise the importance of Dinder NP for Sudan savannah biodiversity conservation.
6. We did not succeed in collaring lions and propose to continue this activity in the next dry season.

Teams

The team was composed of:

1. Hans Bauer (WildCRU)
2. Ameer Awad (SWRC)
3. AbdelramanBeigi (Ministry of livestock Resources, veterinary department)
4. Mohamed Ahmed (Police, Wildlife Conservation General Administration)
5. Shukrallah (Scout, Wildlife Conservation General Administration)
6. Aboutaleb (driver)

Introduction

The lion is a charismatic species and there is considerable international interest in its status. Recent publications have highlighted declines of lion range and numbers across Africa, especially in West, Central and East Africa (Bauer, 2015a). The lion is listed as Vulnerable on the IUCN Red List of Endangered Species (Bauer et al, 2015b), but the Red List contains no information on population status from Sudan. We therefore undertook the present survey to fill an existing knowledge gap of national and international significance.

The mission reported here was undertaken with permission from the Sudan Wildlife Conservation General Administration (SWCGA). It was implemented in partnership by the Wildlife Conservation Research Unit, University of Oxford (WildCRU) and the Sudan Wildlife Research Center (SWRC) and the operational costs were partially covered by the Born Free Foundation (BFF) and the Lion recovery Fund (LRF).

Area description

Dinder NP (DNP) was created in 1935, but the boundaries were extended to include important wet season range so that the area is now 10,291km² (Fig. 1). DNP has a flat topography at an altitude of about 500 m *asl*. DNP has two seasonal rivers; the Dinder river and its tributary Gelego stream which have their confluence at Gelego Camp (DNP main station) and continue as Dinder, and the Rahad which is the northern boundary. These rivers are small in Ethiopia, but they gather more water from their basins and further downstream, especially in the West of the park, they have very large and wide permanent water ponds, locally called 'maya', and wildlife concentrates around these ponds. In addition to Dinder and Rahad rivers there are many small streams like khor Gelago, khor El Sunate and khor Masaweek. DNP is contiguous with the 2700 km² Alatash NP (ANP) in Ethiopia.

Rainfall is highest in the south-easterly portion of the biosphere reserve (800 – 1000mm), decreasing to 600 – 800mm in the North-East. The rainy season extends from May through November, with the peak in August. From November to February there is a cool dry period with daily maximum temperature averaging 30°C. From March to the onset of the rains, the weather is hot and dry with daily maximum temperatures averaging 38 °C and a maximum of 44°C (Dasmann1972).

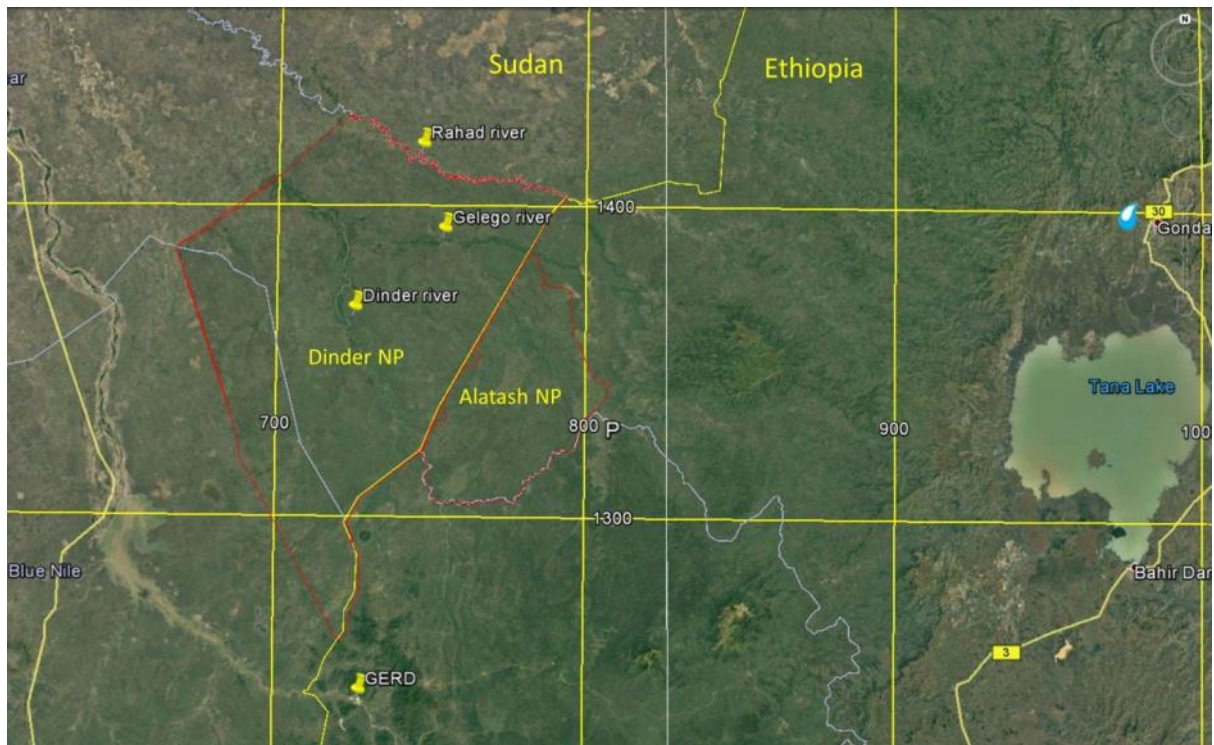


Figure 1: Map of Dinder-Alatash Trans Frontier Conservation Area, projected on Google earth (GERD = Great Ethiopian Renaissance Dam).

Dasmann (1972) described two types of soils in Dinder biosphere reserve, the vertisols and entisols. The former, which are the most extensive in the park, are dark, heavy clay soils also known as 'black cotton soil' with deep cracks during the dry season. The entisols dominate the eastern limits of the biosphere reserve towards the foothills of the Ethiopian plateau and along riverbanks. This type of soils occurs in patches of sandy loam and sandy clay. They intersperse with the vertisols.

The main threat to the park is livestock encroachment, poaching and in the longer term possibly agricultural encroachment. Human presence in the park is evident and is said to be most worrisome in the southern parts, bordering the Gumuz areas, where charcoal making is severe. A special threat to lions is indiscriminate killing, especially by nomadic herdsman and prime among them are the 'Felata', who are pastoralists originally from West Africa but now with Sudanese nationality. They are armed with modern and traditional weapons and spend several months per year inside the park, with their livestock.

DNP has one grader, five tractors, seven Land Cruiser trucks (many with cannons), 35 camels (used for patrols) and a few boats. There are 290 scouts in active service. The effective headquarters is Gelego; the camp has a GSM tower for the Zain cellphone network, has permanent solar and generator power, and has running water and a few buildings with beds ('hotel'). The park has several miradors and a dense road network in the core area with most mayas (waterholes), but also has remote zones with hardly any roads. At most of the important mayas, there is a camp for scouts with seasonal huts, a water pump, and in some cases additional infrastructure such as facilities for fishing. Mayas and their associated wildlife concentrations are thus guarded 24/7 throughout the dry season, and occasionally on camelback patrols in the wet season. Scouts are constantly rotated and spend at least half their time effectively patrolling the park. Their official DNP Headquarters is in

the town of Dinder, with 90 staff, various infrastructures and a small zoo. It is 3 hours' drive away from the park and is mostly concerned with administration.

Sudan has a Ministry of Tourism, Heritage and Wildlife and a Ministry of Environment, but both ministries do not appear to have any presence on the ground. DNP is entirely managed by the SWCGA, which is a branch of the police and therefore falls under the Ministry of the Interior. Technically SWCGA falls under the supervision of ministry of Tourism, Heritage and Wildlife.

Tora hartebeest (*Alcelaphusbuselephus* ssp. *tora*) were last observed in 1999, giraffe (*Giraffacamelopardalis*) werelast observed in 1983 and elephants have not been seen for a long time. No particular reason was given for these extirpations, which may be partly due to climate and partly due to human influence. Presumably the leopard has recently been extirpated which would be due to the very intense poaching pressure on this particular species, linked to the strong culturally determined demand for leopard skin slippers throughout Sudan and the region.

A census using camera traps failed last year in Alatash NP, mainly due to theft of cameras and the risk thereof; there is no reliable estimate of large carnivores in ANP (Ethiopia). The survey, however,



did provide evidence of the presence of leopard (*Pantherapardus*) (Fig. 2). Leopards are probably fairly widespread at low densities throughout Ethiopia, and their presence in ANP is not very special for Ethiopia, but our photo is a significant observation for DNP in Sudan where the species is believed locally extinct.

Figure 2: Leopard filmed by a camera trap in Alatash NP, Ethiopia

DNP has developed in relative isolation for decades, perhaps not unexpected considering the wider political context of Sudan. As a consequence, conservation practice and conservation academia appear to be locally grounded but are not necessarily in synchrony with international best practice. A park like this in any other country in the Sudan-savanna belt would have attracted a lot of attention, participation and investment. DNP is currently a 'secret treasure' with a much higher potential; it could be a major destination for tourism, research and international cooperation.

Methods

We used the following methods:

1. Call-up (using 2x40 watt 100V amplifier and horn speaker system to play buffalo, pig and hyaena sounds; these sounds have a high probability to attract large carnivores within audible range).
2. Lion immobilisation and collaring equipment.
3. Interviews with park staff.
4. Interviews with other stakeholders.

Low carnivore densities and poor infrastructure in many areas across their range make surveying large carnivores expensive and time consuming. Therefore indirect methods are preferable (Midlane et al, 2015). Our study used call-ups, broadcasting recorded animal distress calls to attract lions and spotted hyenas (Ogutu and Dublin, 1998). Here we present the results of a call-up survey using the same methodology as Bauer (2007).

Call-ups were done (cf. adapted according to Ogutu and Dublin, 1998, Mills et al., 2001; Thorn et al., 2010) using the same protocol as Bauer (2007). We used a 2 x 40W amplifier (Real Max SSB-80) and two speakers of 40W/100V (Ahuja, SUH-40XT) to play hyena, buffalo and pig calls (courtesy of the African Lion Working Group) from a car (Toyota Hilux) roof. Each call-up was a cycle of three sessions of ten minutes of broadcast and ten minutes of silence, in which the recordings were alternated. After five minutes of broadcast, the speakers were turned 90 degrees to cover the area evenly with the call-ups. After each broadcast, the area around the car was scanned with a weak red light for eye reflections. The area was again scanned with a strong spotlight afterwards to assess the presence of lions or spotted hyenas.

To minimize effects of weather, broadcasting time and habituation on response, we designed and executed the call-up surveys as followed: call-ups were played when carnivores were most active, from 7 pm to 12 pm. Secondly, we selected a random point on the main road, and thereafter spaced survey points 6 km apart on roads (straight-line distance; Figure 1). When visibility was limited by the vegetation, we relocated the call-up point a maximum of 500m in either direction. Each point was recorded with a GPS. No broadcasts were made with rain or high wind velocities, although wind speed and luminosity were not specifically recorded.

Many animals which were attracted by the call-ups were skittish, so approaching lions and hyenas were mainly counted based on their vocalisations and eye reflections. When animals were close, individuals could be observed, followed with a torch and counted. The spotlight was also used to check for possibly undetected hyenas and lions after each call-up (Bauer, 2007). To minimise double counting the same individual, calls that originated from the same location and could not be differentiated clearly, were counted as one individual. The eye reflections counts were only a minimum count and more individuals could have been around the car.

Due to logistic and ecological constraints, local calibration of the call-ups was not possible. In order for the call-up surveys to be compatible for comparison, we followed Bauer's (2007) assumptions; both species had an effective range of 3 km and response rate of 75%, to give a mean (\pm SD) density per call-up. This calibration was selected, because (1) the survey took place in the same habitat type, (2) in the same period of the dry season, (3) the same buffalo calf distress and hyena call audio track

were used and (4) there were non-baited call-ups. Since large carnivore densities in our survey areas are low, double counting is unlikely (Kirsten *et al.*, 2016). Furthermore, we generated a plausible range of the population size using the extreme values for the response rate (50-100%) found in the literature (Ogutu and Dublin, 1998; Mills *et al.*, 2001; Ferreira and Funston, 2010; Cozzi *et al.*, 2013; Ferreira and Funston, 2016).

Results

The diversity and abundance of wildlife in DNP is impressive, and for an outsider also surprising since DNP is not much advertised and hardly known in internationally accessible scientific literature. Our opportunistic sightings and observations are listed in Table 1; it is possibly not exhaustive and more species are likely to be found in future. There is an urgent need for a critical review of surveys in the past, for a camera trapping study and for a properly designed survey using standard distance transects on foot.

We performed 21 callups (see annex 1), during which we had responses of 8 hyaenas (Standard Deviation 0.80) and 7 lions (Standard Deviation 1.54). Hyaenas mostly approached the car and were visible in the dark, but running away from light; in contrast, no lion approached the car in response to any of our callups and all responses were roars. Assuming an effective range of 3 km, our callups covered an area of $21 \cdot \pi \cdot 3^2 = 594 \text{ km}^2$; extrapolation to the size of DNP gives a population size of 157 (± 26) lions and 180 (± 18) spotted hyaenas.

These numbers are based on the assumption of average response rates found across Africa (0.75); if we add uncertainty about local parameters and take the extreme values of response rates (0.5-1) then our minimum and maximum population ranges are 98-275 lions and 121-297 hyaenas. Lion numbers were sensitive to an exceptional response of 5 lions at the main camp, Gelego; if this observation is treated as an outlier and removed from the dataset the lion estimate drops to 47 (± 27) with a range of 15-112. On the other hand, the fact that no lions approached the car demonstrate that response rate was probably low with lions being skittish due to persecution and/or limited exposure to cars due to the absence of tourists; this suggests that we may have underestimated population size.

We only found lions in the core area of Dinder NP, the $\sim 1000 \text{ km}^2$ area loosely defined here as a circle of 10km radius around main camp Gelego plus a western extension along the Dinder river, which is obviously well protected and where prey densities are high (Fig. 2). Outside the core area, prey densities are patchy but locally high, especially around permanent surface water. However, we never observed any lions in these outer areas (n.b. this is an area much larger than the official 5 km 'buffer zone' along the perimeter), but we did observe livestock there on many occasions. A possible hypothesis is that livestock is compatible with prey species, but that lions are selectively killed by livestock attendants. Our survey included data from core and non-core areas of the park, but callups inside the core area are overrepresented compared to area size (Fig. 3). Data are insufficient to calculate densities separately and we extrapolated the observed lion density to the entire park. The result may be an optimistic figure under present conditions. To ensure a robust and viable lion population, and to enable recolonization of Dinder NP by leopard from neighbouring Alataash NP, it is highly recommended to extend the area with a high level of protection beyond the core area and

preferably to the entire park except, maybe, the official buffer zone where mixed use is legally allowed.

Table 1: List of mammal species of Dinder NP, updated from Mohammed (2014); last column indicates information obtained on our 2017 and 2018 trips.

English name	Scientific name	Source / remarks
Carnivores	Carnivora	
Lion	<i>Pantheraleo</i>	Observed
Civet	<i>Civettictiscivetta</i>	Observed
African (golden) wolf and/or golden jackal*	<i>Canisanthus (Canislupaster)</i>	Mohammed (2014)
Striped hyaena	<i>Hyaena hyaena</i>	Mohammed (2014)
Spotted hyaena	<i>Crocutacrocuta</i>	Observed
Egyptian mongoose	<i>Herpestes ichneumon</i>	Observed
White-tailed mongoose	<i>Ichneumiaalbicauda</i>	Observed
Wild cat	<i>Felissylvestris</i>	Observed
Honey badger	<i>Mellivoracapensis</i>	Observed
Genet	<i>Genettagenetta</i>	Observed
Rodents	Rodentia	
Crested Porcupine	<i>Hystrixcristata</i>	Observed
Ungulates, even-toed	Artiodactyla	
Warthog	<i>Phocochoerusafricanus</i>	Observed
Buffalo	<i>Synceruscaffer</i>	Observed
Bushbuck	<i>Tragelaphusscriptus</i>	Observed
Waterbuck	<i>Kobus ellipsiprymnus</i>	Observed
Roan antelope	<i>Hippotragusequinus</i>	Observed once
Greater kudu	<i>Tragelaphusstrepsiceros</i>	Mohammed (2014)
Heuglin's gazelle ¹	<i>Eudorcatilonura</i>	Observed
Reedbuck	<i>Reduncaredunca</i>	Observed
Oribi	<i>Ourebiaourebia</i>	Observed
Kob ²	<i>Kobus kob</i>	Observed
Primates	Primates	
Olive baboon	<i>Papioanubis</i>	Observed
Moustached monkey ³	<i>Erythrocebuspoliophaeus</i>	Observed
Vervet	<i>Cercopithecus aethiops</i>	Observed
Bushbaby, presumably Senegal galago	<i>Galagosp. (senegalensi?)</i>	Observed

1: Often incorrectly listed as red fronted or Thomson's gazelle

2: There are several kobs among the groups of reedbuck, a range expansion for the species of >400 km north and east, also the first record East of the river Nile.

3: Hitherto listed as patas (*Erythrocebuspatas*), but recent morphological evidence described the population East of the river Nile as a separate species (Gipolitti 2017).

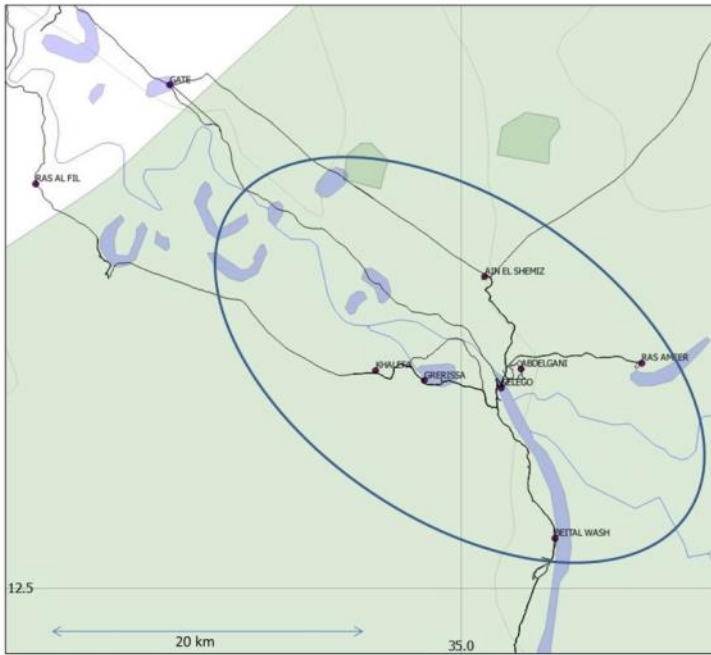


Figure 2: Core area of Dinder NP

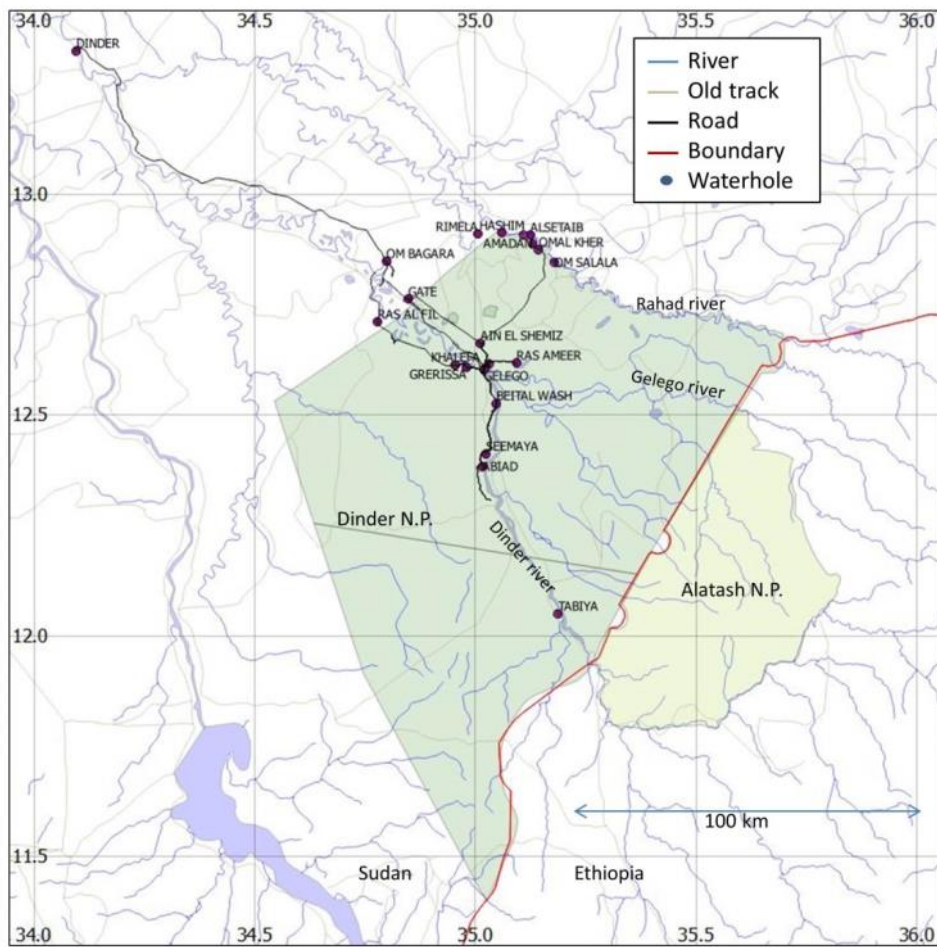


Figure 3: Map of Dinder ecosystem

Collaring

We purchased three Iridium-GPS satellite collars from African Wildlife Tracking, South Africa. We used a Teledart RD706 dart rifle in combination with 3cc Daninject darts with VFH tags. We used a mixture of ketamine and medetomidine. We did a few tours trying to find and free dart from the back of a pickup, but the encounter probability is low and we invested most of our time in baiting at two strategic locations where lions regularly pass. After a total of 11 nights using a total of 6 shoats we were not able to collar any lions, and we recommend working with leghold pit traps next season.

Discussion and recommendations

With 157 (± 26) lions and 180 (± 18) spotted hyaenas, populations DNP are potentially viable; they are below the threshold of 500 which is considered 'safe', but they are above the critical threshold of 50 individuals. Viability of the lions and other species in DNP is boosted by connectivity with ANP where the population appears to be small, but which is important as a source for possible recolonization of the leopard. There is some uncertainty inherent to our methods, but the ranges of values that we calculated when various parameters are considered do not substantially alter this finding.

There are ~100 populations with a total of ~25,000 lions in Africa (Bauer et al., in prep.); on the scale of the continent the DNP lions are not game changers for species survival. However, at the national level it is probably the only population that is effectively protected and that is expected to be secure for future generations of the people of Sudan. It is almost certain that the lions in Sudan belong to the sub-species *Pantheraleleo* found across India and West, Central, North Africa. This sub-species has declined precipitously over the last two decades and only ~10 populations remain, with an estimated ~1500 lions. The lion population of DNP is therefore one of the more robust populations and is of regional conservation interest.

Recommendations:

1. Continue current good management practices with a strong emphasis on law enforcement; management currently practised in the core area should be extended to the entire park, except the buffer zone where mixed use is allowed.
2. Carry out wildlife census (aerial survey, foot transects);
3. Set up a permanent camera trapping grid to survey and monitor wildlife;
4. Promote greater awareness for this area, within Sudan and internationally, starting with a good website including professional pictures and video clips.
5. Gradually improve tourism development, community development, fire management, ecological monitoring, introduction of SMART and other technologies;
6. Perform an institutional review of park management by the police and the potential role of other stakeholders to support further park development;
7. While the wildlife sector in Sudan has a long tradition, it has also been in isolation for a long time; overall capacity development of all stakeholders is highly recommended.
8. Promote further cooperation with Ethiopia, aiming at harmonisation of management, particularly in terms of infrastructure development, law enforcement and ecological monitoring of DNP and ANP;
9. Seek joint dialogue with stakeholders, especially Felata communities;
10. Actively seek international financial support for this important area.

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Annex 1: Locations of the calling stations

