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Evaluation of the impact of anthropogenic activities threats on pangolins population in the Deng-Deng National Park (DDNP)-Cameroon

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Final Report submitted to The Rufford Foundation

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Data Availability Statement

The datasets generated during and/or analyzed during the current study are not yet publicly available and could not be used without the author consent due to [REASON(S) WHY DATA ARE NOT PUBLIC] but will be available from the corresponding author on reasonable request.

Photo cover: First record of the black-bellied pangolin using camera traps in Deng Deng National Park. Photos of this report should be credited as follows: **Photo credit: @ Ghislain Difouo F. _ Rufford Foundation/ University of Yaoundé 1**

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Field team members: Team A and team B at MINFOF post office in Deng Deng village

Abstract

Habitat loss and fragmentation are increasing threats to pangolins. Deng-Deng national park has been recognized to be a high priority for conservation as it is situated within a zone where social and economic operations from logging, construction of petrol pipeline, and hydroelectricity dam, are exerting enormous pressure on wildlife. The development of effective conservation strategies for threatened species passes through the understanding of ecological features. The potentiality of anthropogenic threats to the pangolin population needs to be evaluated in these potential reintroduction areas. To measure the impact of anthropogenic threats on the pangolin population in this park, we deployed 2 grids of camera traps to cover areas with habitats susceptible to present different levels of disturbance. Over 1571 operational camera trap nights in both north and center sectors; 3 pangolin species were recorded. 66 photographic events (4.20%) of white-bellied pangolin were recorded in the two main habitat types including Near primary forest and Secondary Forest of the parks, while 1 event (0.063%) of giant pangolin and 1 event (0.063%) black-bellied pangolin were recorded. Road infrastructure negatively affects the pangolin population decreasing the capture probability of camera traps located near them. The white-bellied pangolin trapping rate was significantly higher (6.02%, 52 events) in the center sector than in the north sector (1.97%, 14 events). The probability to capture the species was three times higher in the center (CP=0.06) than in the north. The number of detections of white-bellied pangolin has increased proportionally with the distance of human signs increasing.

Keywords: pangolins, anthropogenic, activities threats, conservation, protected area

Introduction

Pangolins are an unusual mammal in the world covered with scales and they are today the most trafficked one because of the large demand for its meat considered delicacy and its scales largely used in traditional Asia medicine (Challender et al., 2012). Habitat loss and fragmentation are increasing threats to pangolins (Challender and Hywood 2012). Deng-Deng national park (DDNP) has been recognized to be a high priority for conservation park as it is situated within a zone where social and economic operations from logging, construction of petrol pipeline, and hydroelectricity dam, are exerting enormous pressure on wildlife (Diangha, 2015). In June 2018, a great number of white-bellied pangolin detection have been recorded in the forest zone of this pack (Simo et al. 2020). However, Deng Deng NP has a high level of disturbance by human activities and these activities seemed to be a threat to pangolins in this park (Difouo, 2019) and could have a negative impact on their populations (Pietersen et al., 2019). Understanding ecology requirements and threats patterns are immensely important for any long-term species-specific conservation plan.

Pangolin reintroduction programs are a key component of their conservation. These programs might benefit from prior, knowledge of pangolins' geographical origin, the insect assemblages as food resources, and the different types of vegetations considered as relevant habitats in the potential reintroduction zones as well as the presence of prey known to satisfy their feeding ecology (Lee et al., 2017). While an improved understanding of these ecological features will help a long-term design and management of more viable pangolins sanctuaries by ensuring that an adequate mix of different habitats is included within sanctuaries and that sufficient area of key insect prey is incorporated to be able to sustain viable populations of each species. Apart from statistics of pangolin scale seizures incriminating poaching, little information is available on other threats affecting directly pangolins or which contribute indirectly to their population decline by increasing hunting pressure. It is important to know how anthropogenic activities affect pangolin populations in their home range. Efforts have been done to check off the natural history of African pangolin species with relevant methods develop recommended and applied in some Cameroonian protected areas (Ichu et al. 2017; Simo et al. 2020), their diet and habitat preferences are currently surveyed (Difouo et al. 2020). Unfortunately, the threats towards these species seemed to be unchanged regarding the increased statistics of scale seizures in this last decade and of the recent years (Ingram et al. 2016; 2019). The habitat of these species is being fragmented and lost (Pietersen et al. 2019, Difouo, 2019). Moreover, pangolins are difficult to farm (Challender et al. 2019). The development of effective conservation strategies for these threatened species throughout reintroduction and maintaining of a viable population in wild will be efficient in conservation. This passes through the understanding of ecological features and discovery of stable populations in safe areas where conservation is feasible such as national parks. The potentiality of anthropogenic threats to the pangolin population needs to be evaluated in these potential reintroduction areas.

General objective: The objective of this study was to fill the gap of knowledge of human activities' impact on pangolins population and favorite habitats found in the forest-savannah transition zone of the DDNP

Specific objectives: (1) evaluate relative abundance of pangolins in Deng Deng National Park different sectors using camera traps; (2) characterize anthropogenic threats and their impact on pangolins population; (3) record the black-bellied pangolin presence evidence in Deng Deng and nearby localities; (4) retrieval camera traps and update results of the previous grant research.

Survey area

Deng-Deng National Park (DDNP) was created by a Prime Ministerial decree (Décret No 2010/0482 pm du 18 Mars 2010 portant création du Parc National National de Deng Deng), DDNP is located in the East Region of Cameroon precisely in the Lom &Djerem division. At its creation, the park was covering an area of about 523 Km2 which was extended. The park harbors vulnerable wildlife species including gorilla, chimpanzee and forest elephant, plus a variety of other animals from forest and savanna habitats (Maisels et al., 2011). The Park is bounded by the Lom-Pangar River to the east, a segment of the Cameroon railway line and settlement (villages) to the west, by a continuous stretch of natural forest and savanna mosaic to the north, and by roads and settlement to the south. These villages surrounding the park represent a major component in conservation effort because they are too close and share their boundaries with the park, while people who have been there before the creation of the park were living of the hunting activity and poaching as the main source of income and the feeding, this has led to enormous pressure on the park. The Deng-Deng national park has shown a high level of disturbance by human activities including flooding due to hydroelectric dam construction, road construction, and pipeline management (Difouo, 2019).

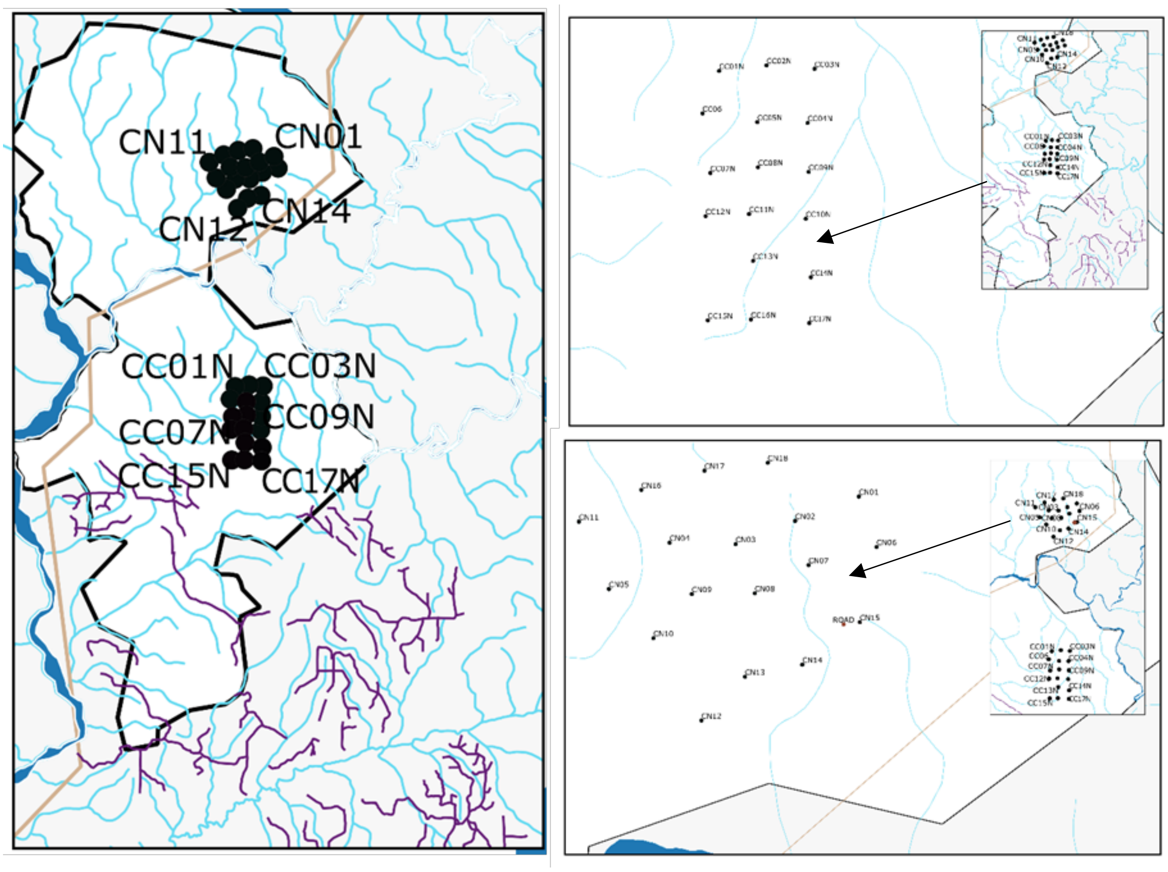

Figure 1: Location of camera trap stations in the northern and center sectors of Deng Deng National Park

Methodology

Interviews

We traveled to Ngoyla a boundary city between Cameroon and the Republic of Congo located at 40 km in the Eastern region of Cameroon; where the Black-bellied pangolin was reported to be present and carried out informal interviews with local people using a photo of this particular species.

Deployment of two grids of camera-traps

To measure the impact of anthropogenic threats on the pangolin population in this park, we deployed 2 grids of camera traps to cover areas with habitats susceptible to present different levels of disturbance. However, data on anthropogenic activities were collected along the transect. A total of 35 camera traps split into two grids of camera traps were installed (see Fig.1). The camera traps were established for 60 trapping nights during the late rainy season and dry season. In the same grid, each camera trap was separated from the other by a 1km line transect. Over the course of all conducted surveys, 1571 effective camera trap days of data were collected over 2100 days expected, with a camera trap day defined as the number of 24-hour periods that each camera was operational and capable of recording species encounters. Camera traps were installed in three types of habitats including Near Primary Forest, Secondary Forest, Swamp.

Camera trap setting

The marks used for this survey included 26 Bushnells (Bushnell Essential E Brown 119837, Bushnell Trophy Cam HD 119873, Bushnell Trophy Camera Brown 119836), 5 Vision Camera, and Moltrie 30i camera traps. Camera traps were strapped on trees settled to target active dead fallen trunks (see Simo et al. 2020). Camera traps were set at the distance of 3-4 m from the target, and at a height of 30-40 cm above the ground and 70-80 cm for the dead fallen trunks that were not directly in contact with the ground (see Simo et al., 2020). According to Ancrenaz et al. (2012), setting the camera so that the sensor is 30-40 above the ground gives good results for small animals.

Figure 2: Camera traps deployment A) Principal investigator setting on camera trap; B) fallen dead trunk targeted, C) test of camera functioning

Determination of habitat disturbance

We have evaluated the human activities pressure on the pangolin population in the park's northern and central sectors. During a trek on the transect, the coordinates of habitats were recorded after every 250 m walk along the transect or recces followed by the surveyed team. Their characteristics were described and relevant parameters like altitude, slope, canopy cover, undergrowth composition (herb, lianas …), and visibility were recorded (Bhandari & Chalise, 2014). The camera traps were installed in three types of habitats including Near Primary Forest, Secondary Forest, Swamp. We calculated the frequency of each human sign encountered in each park sector.

Statistical analysis

Identification of pangolin from images

The cumulative sampling effort of the survey period was estimated. All images contained in a camera-trap station stored in Drive Disk were viewed on a laptop using WILDID software. Details of animals observed were recorded, namely, the species (common and scientific name), on the number of individuals Data was extracted from WildID into Microsoft Excel format which was also used to generate frequencies of independent events.

Pangolin trapping rate (TR)
We used the trapping rate (TR) to determine a relative abundance index (RAI) (Tobbler et al., 2008, Bruce et al., 2018) of pangolin species in the national park sector, disturbed station, or non-disturbed. We assumed that a target species will trigger cameras in relation to their abundance. We calculated the trapping rate (TR) of each species in each type of habitat as the number of events of the species divided by the sampling effort multiplied by 100 using Microsoft Excel 2016following the formula: $\text{TR} = \frac{\text{Number of event}}{\text{Sampling effort}} x100$

Capture Probability (CP)
Capture probability is used in this survey as an index of relative abundance. Dividing the total number species events by the number of camera trap days in the survey provides the average frequency that a particular species will be recorded on any given day during the survey period (McPhee, 2015)

Results

Human signs in Deng Deng National Park
Overall, logging including tree cut (39.51%) were the most encountered human signs, followed by human paths (23.41%), livestock (17.07%) and Kimba extraction (8.29%) only in the north, road infrastructure (4.88%), and gun bullets (1.95%; Fig.3). Most of the signs encountered in the park were recent (94, 31%), while a minority were old (5.68%).

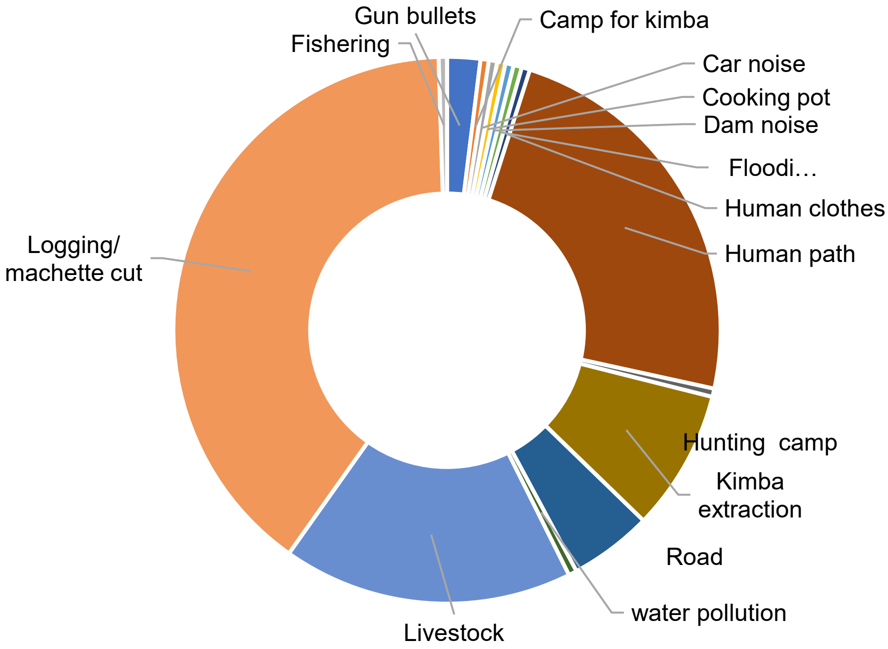

Figure 3: Proportion of each type of human activities encountered in Deng Deng


Left: Water pollution. Right: Road.


Left: Tree cut for “kimba” harvesting. Right: Flooded habitat.


Left: Camp used during “kimba” harvesting. Right: Shrub cut and used as material for camp.

Figure 4: different type of human activities observed in Deng Deng National Park

Kilometric Index of Abundance of human signs

The northern sector recorded the highest IKA of logging activity (3.8 indices/ km); while the center sector recorded the highest frequency of gun bullets encountered (0.18 index/km). The north sector was the only zone where livestock activity (2.05 indices) and Kimba extraction (1 index/ km) were recorded with a very high frequency along with other human signs, including car noise, dam noise, road infrastructure (0.58 index/km), fishing (0.05 index/km) and water pollution.

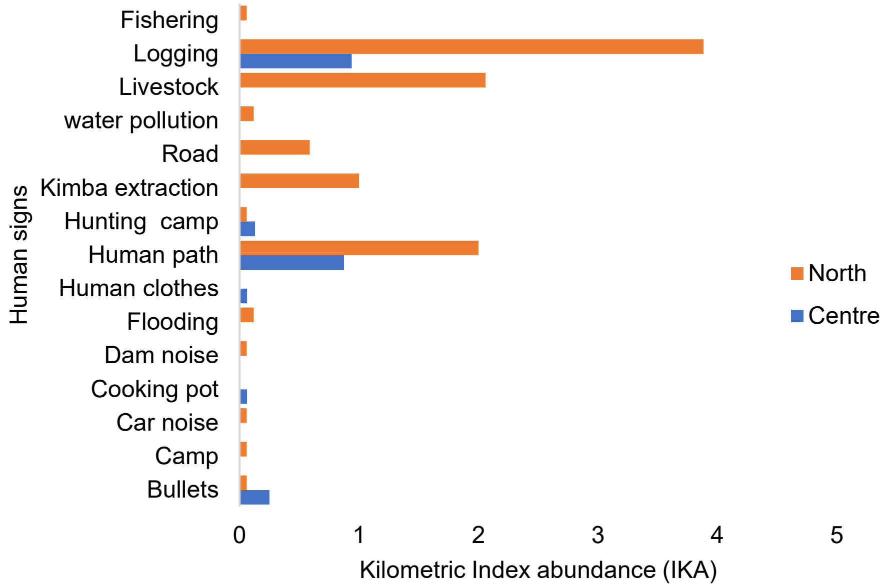

Figure 5: Kilometric Indices of Abundance of each human sign observed in the center and northern sectors of the park

Pangolin species in Deng Deng national park

Over 1571 operational camera trap nights in both north and center sectors; 66 photographic events (4.20%) of white-bellied pangolin were recorded in two main different habitat types including Near primary forest and Secondary Forest of the parks, while, 1 event (0.063%) of giant pangolin and 1 event (0.063%) black-bellied pangolin were recorded.

Relative abundance of pangolin species

White-bellied pangolin

The white-bellied pangolin trapping rate was significantly higher (6.02%, 52 events) in the center sector than in the north sector (1.97%, 14 events). The probability to capture the species was three times higher in the center (CP=0.06) than in the north.

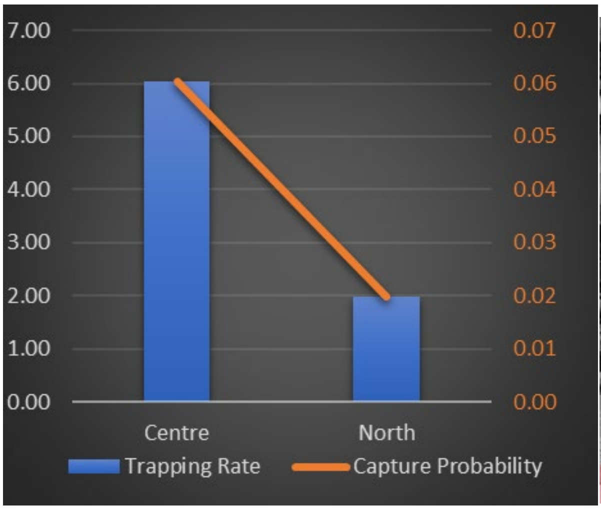

Figure 5: Tapping rate and capture probability and evidence of white -bellied pangolin presence in the surveyed area habitats

Giant pangolin

A single photographic event of the giant pangolin was recorded in the northern sector of the park and no record occur in the center sector. We obtained a capture rate of 0.063 event per 100 trap days.

Figure 6: Evidence of giant pangolin presence in the surveyed area habitats

Black-bellied pangolin record

One camera trap provided a single photographic event of the black-bellied pangolin was recorded in the northern sector of the park and no record in the center sector. The first-ever record of black-bellied in DDNP event was recorded in a secondary forest on 21st December 2021 at 11:47 pm after 35 camera trap days and yielded three photos. The record occurred on a tree cut by humans to extract “kimba” a local spice whose harvesting activity was the second most abundant human sign in the northern sector of the park. In this habitat, the canopy was opened (75%), shrubs and herbs were the main understory components making visibility under the canopy relatively close. We obtained a capture rate of 0.063 event per 100 trap days.

Figure 7: Evidence of black-bellied pangolin presence in the surveyed area habitat

Impact of anthropogenic threats on pangolins population

Capture probability and trapping rate

In human signs absence around the camera trap station, the camera from the grid's center recorded a significantly higher trapping rate of white-bellied pangolin (5.34%, 46 events) than in the north (0.70%; 5 events). Likewise, the probability to capture the pangolin in the center was higher (CP=0.053 per capture day or one event every 19 days) than in the north (CP=0.032 per capture day one event every 142 days.

When human signs were present, the grid north recorded a higher trapping rate (1.27%, 9 events) while the center grid recorded a low trapping rate (0.70%, 6 events). Although the probability to capture white-bellied pangolin were similar in both grid (CP=0.01 per trapping day) the grid north required 79 days to record one event; while the grid center required 144 days.

Table I. Trapping rate and capture probability according to human activity signs presence

Human signs presence		**Centre**	**North**	**Total**
	NbE	46	5	51
No	CP	0.053	0.007	0.032
	TR	5.343	0.704	3.246
	1/CP	18.717	142.000	30.804
	NbE	6	9	15
	CP	0.01	0.01	0.01
Yes	TR	0.70	1.27	0.95
	1/CP	143.50	78.89	104.73

Main human threats to pangolin

Road infrastructure negatively affects the pangolin population decreasing the capture probability of camera traps located near road (CP=0.01 per camera day) or one event every 140 days, followed by those near snare and human paths (CP=0.02 per camera day) meaning they recorded one event every 65 and 45 days respectively. The camps used by people extracting kimba spice had the lower impact of detection with a capture rate (CP=0.04 per camera trap day) or 1 event every 24 days.

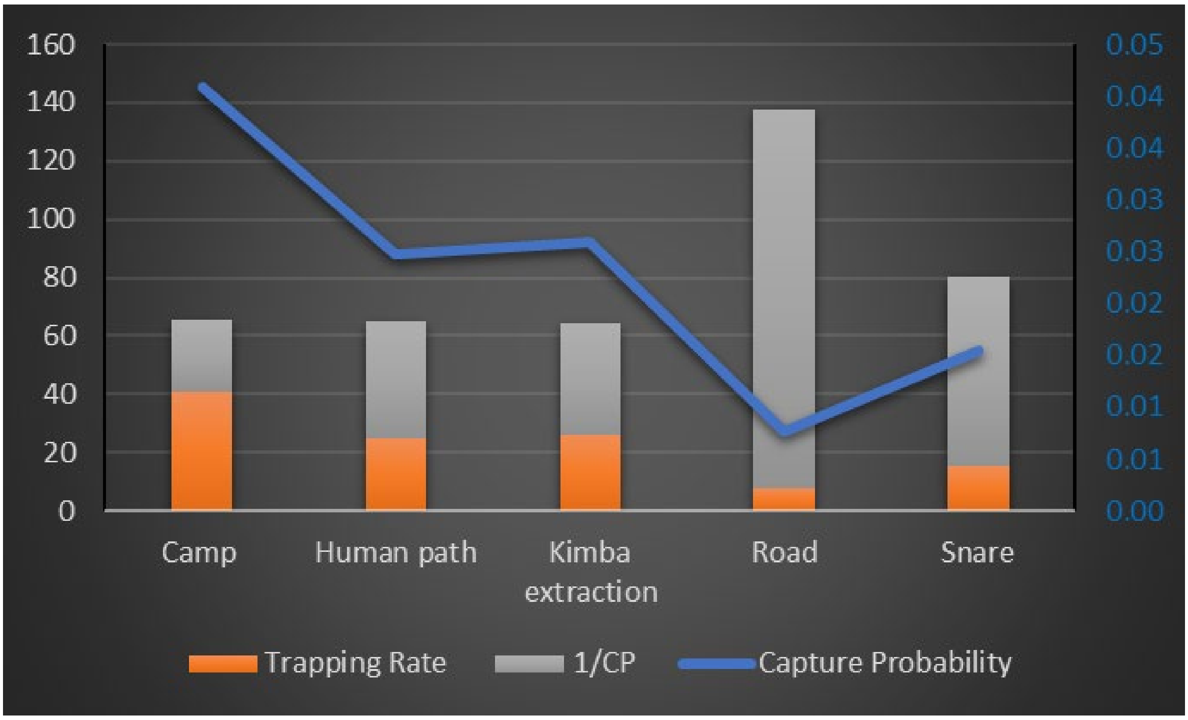

Figure 8: Main human activities influence on trapping rate and capture probabilities

Variation of pangolin detection with distance to threats

The number of detections of white-bellied pangolin has increased proportionally with the distance of human signs increasing. In other words, more closed to the camera station were the signs of the human activities, lower was the number of detections (Fig.9), meaning anthropogenic activities reduce the relative abundance of white-bellied pangolin and their detection probability.

Consumption and scales exploitation

During the interview carried out, one participant reported having black-bellied pangolin scales in their house in Bertoua which was being conserved for middleman collectors. Another report from Lomie was a 50 kg of pangolins scales both white-bellied and black-bellied pangolins stored at home. These participants reported also the trade price of black-bellied pangolin scale to be comprising between 2500 FCFA and 5000 FCFA. These participants reported that the species were widely found in Messok situated 30 km from Ngoyla our main target city. We traveled in Ngoyla situated 300 km from Deng Deng but failed to observe the species directly. However, scales of black-bellied pangolin were recorded at Bertoua 200 km and Lomie 50 km from Ngoyla. Record (3 records) of the black-bellied pangolin was reported just one day after we departed from the city by our local guide. We also informed some research of our laboratory about our objective and to provide us any evidence of this species during their travel. Thus, evidence of the species presence was observed in Djoum situated at 125 km from Ngoyla, another in Boumba bek situated at 75 km from Ngoyla.

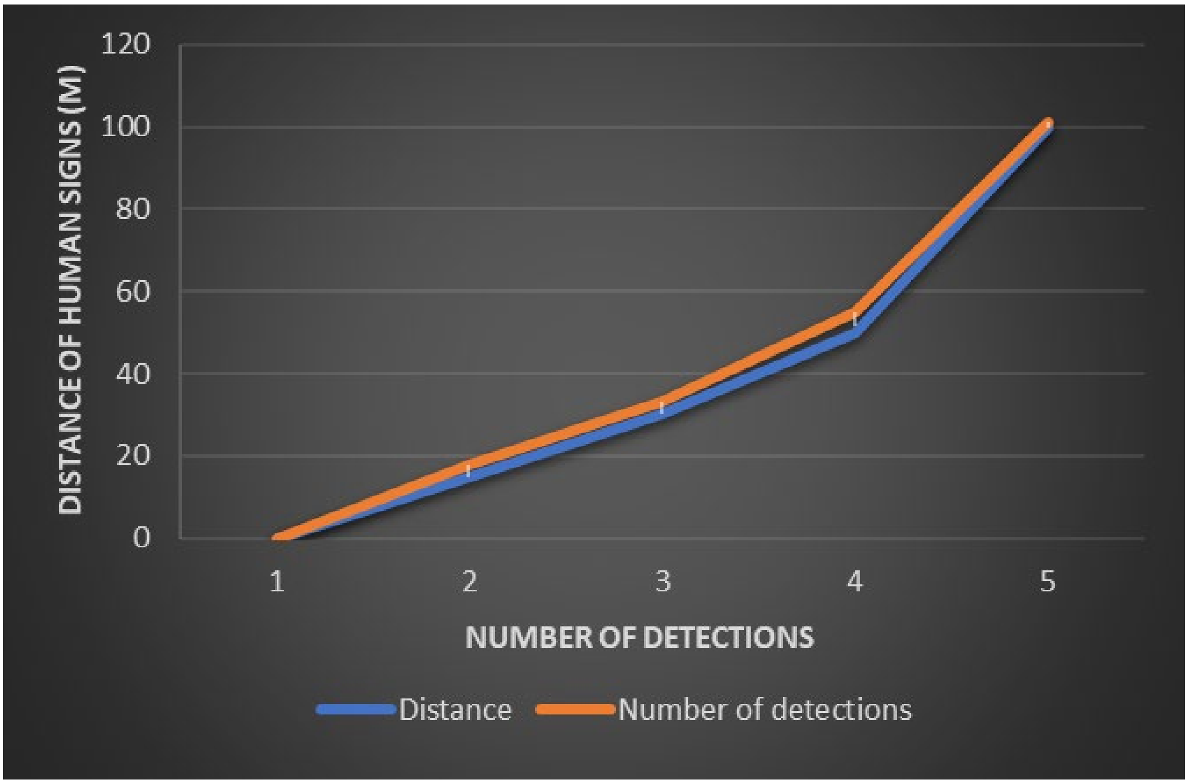

Figure 9: Influence of human activities distance on detections of white-bellied pangolin.


Figure 10: Black-bellied pangolin scales recorded in household in Bertoua

Retrieval of camera traps of my previous Rufford project research
I retrieved the camera traps which were on the field at the end of our previous project for seasonal variation. Data analysis of two years of the survey including the 1st Rufford project helped us for progress done to finalize our PhD dissertation which is at the expertise. Below is the summary of the main point extracted from my PhD thesis.

A total of 4,184 operational camera trap nights were accumulated on all target types in DDNP. The trapping rate of WBP in DDNP (2.75%, 115 events) was higher than giant pangolin. A total of 3,444 operational camera trap nights were accumulated on non-log targets including burrows, feeding signs, termite mounds etc in DDNP. The trapping rate of GP was relatively lower (0.32%, 11 events) was recorded in DDNP. No evidence of black-bellied pangolin (Phataginus tetradactyla) presence was recorded during the survey period. For diet composition of pangolins, stomach content samples from 13 examined white-bellied pangolin specimens contained 165,161 individuals of invertebrates including 165,000 Arthropoda belonging to 6 Orders, mostly Blattodea (39.65%) and Hymenotpera (60.34%). We identified 134 insect species in the stomachs of 13 white-bellied pangolins individuals, including 33 termite species and 101 ant species. Details of the relative importance of ant and termite genera and the number of species eaten by white-bellied pangolin are provided (see appendix 1 and appendix 2).

For giant pangolin and white-bellied pangolin diet composition
see our first manuscript published in the African Journal of Ecology available online from (https://onlinelibrary.wiley.com/doi/abs/10.1111/aje.12829) and we are preparing others manuscripts for example Relative importance and Species richness of ants and termites in African white-bellied pangolin (Phataginus tricuspis) diet composition.

Conclusion

The white-bellied pangolin population is relatively higher in the central sector of the park than in the northern sector. However, the northern sector recorded one photographic event of the giant pangolin and black-bellied pangolin respectively, while these species were not recorded in the center sector. Apart from hunting activity highest in the center sector, the northern zone of Deng Deng National Park is highly disturbed but human activities, including logging to extract kimba spice and livestock. Another mega infrastructure impact on the pangolin population is still to be evaluated through relevant data analysis.

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Appendices

Appendix 1: Relative importance of ant's subfamilies from WBP and their species richness into brackets

Families	Subfamilies/Genera	Ar	Fo	RI	Cat
Formicidae		60.34 (99650)	100	60.34	C
	Dolichoderinae (9)	**0.86 (1424)**	**84.62**	**0.73**	**C**
	Axinidris (3)	0.07 (123)	23.08	0.02	Acl
	Tapinoma (3)	0.34 (554)	53.85	0.18	A
	Technomyrmex (3)	0.45 (747)	53.85	0.24	A
	Dorylinae (1)	**0.1 (162)**	**53.85**	**0.05**	**Acl**
	Dorylus (5)	0.1 (162)	53.85	0.05	A
	Formicidae sbfam (3)	**2.97 (4911)**	**69.23**	**2.06**	**C**
	Formicidae gen (3)	2.22 (3669)	69.23	1.54	C
	Formicinae (32)	**18.25 (30148)**	**100**	**18.25**	**C**
	Anoplolepis (2)	11.13 (18380)	76.92	8.56	C
	Camponotus (15)	5.53 (9128)	100	5.53	C
	Cataulacus (2)	0.07 (111)	15.38	0.01	Acl
	Lepisiota (2)	0.47 (778)	30.77	0.14	A
	Polyrachis (8)	0.91 (1506)	92.31	0.84	C
	Pseudolasius (1)	0.15 (244)	23.08	0.03	Acl
	Tapinoleplis (1)	0 (1)	7.69	0	Acl
	Myrmicinae (44)	**31.81 (52538)**	**100**	**31.81**	**C**
	Cardiocondyla (1)	0.5 (820)	15.38	0.08	Acl
	Cataulacus (1)	0.04 (74)	23.08	0.01	Acl
	Crematogaster (20)	17.28 (28535)	100	17.28	C
	Monomorium (4)	2.19 (3621)	46.15	1.01	C
	Myrmicaria (1)	0 (1)	7.69	0	Acl
	Phasmomyrmex (1)	0 (1)	7.69	0	Acl
	Pheidole (11)	11.39 (18805)	92.31	10.51	C
	Tetramorium (4)	0.45 (681)	38.46	0.16	A
	Ponerinae (12)	**0.08 (124)**	**69.23**	**0.05**	**Acl**
	Anochetus (1)	0 (1)	7.69	0	Acl
	Hypoponera (3)	0.01 (13)	30.77	0	Acl
	Leptogynys (6)	0.06 (106)	61.54	0.04	Acl
	Ondontomachus (1)	0 (1)	7.69	0	Acl
	Ponera (1)	0 (3)	7.69	0	Acl

Ar= relative abundance; Fo= frequency of occurrence; RI=relative importance of prey; C= Constant or common prey/consumed preferentially; A= Accessory or uncommon prey/ secondarily consumed; Acl= Accidentally or less common prey/rarely eaten

Appendix 2: Relative importance of the termite main subfamily from WBP and their species richness into brackets

		Ar	Fo	RI	Prey cate-gory
Rhinotermitidae (3)		0.27 (439)	53.85	0.14	C
	Coptotermitinae (1)	**0.05 (91)**	**30.77**	**0.1**	**A**
	Coptotermes (1)	0 (4)	23.08	0	Acl
	Rhinotermitinae	**0.26 (435)**	**46.15**	**0.12**	**A**
	Schidorhinotermes (2)	0.26 (435)	46.15	0.12	A
Termitidae (30)		39.38 (65043)	100	39.38	C
	Amitermitinae (3)	**0.05 (87)**	**23.08**	**0.01**	**Acl**
	Microcerotermes (3)	0.05 (84)	23.08	0.01	Acl
	Cubitermitinae (2)	**0.01 (20)**	**30.77**	**0**	**Acl**
	Cubitermes (1)	0.01 (18)	30.77	0	Acl
	Ophiotermes (1)	0 (2)	7.69	0	Acl
	Macrotermitinae (19)	**16.11 (26607)**	**100**	**16.11**	**C**
	Acanthotermes (1)	0.18 (303)	38.46	0.07	A
	Allodontotermes (1)	0.02 (29)	15.38	0	Acl
	Macrotermes (4)	3.42 (5656)	76.92	2.63	C
	Microtermes (2)	0 (5)	23.08	0	Acl
	Odontotermes (8)	1.21 (1998)	61.54	0.74	C
	Protermes (1)	0.07 (109)	23.08	0.02	Acl
	Pseudacanthotermes (1)	10.97 (18124)	92.31	10.13	C
	Nasutermitinae (3)	**20.8 (34355)**	**92.31**	**19.2**	**C**
	Nasutitermes (2)	18.49 (30545)	92.31	17.07	C
	Trinervitermes (1)	2.31 (3810)	7.69	0.18	A
	Sphaerotermitinae (1)	**0.39 (642)**	**30.77**	**0.12**	**A**
	Sphaerotermes (1)	0.39 (642)	30.77	0.12	A
	Termitinae (1)	**0 (1)**	**7.69**	**0**	**Acl**
	Pericapritermes (1)	0 (1)	7.69	0	Acl

Ar= relative abundance; Fo= frequency of occurrence; RI=relative importance of prey; C= Constant or common prey/consumed preferentially; A= Accessory or uncommon prey/ secondarily consumed; Acl= Accidentally or less common prey/rarely eaten

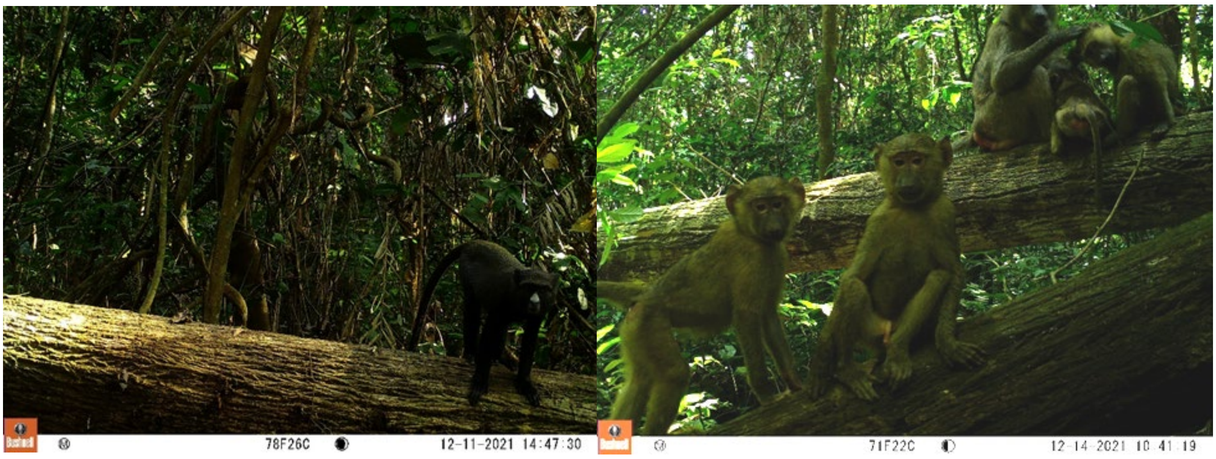
Appendix 3: First record of African golden cat (*Felis aurata*) in Deng Deng NP

Appendix 4: Catalogue of other mammal species recorded in Deng Deng National Park

Left: Bosman potto. Right: African palm civet

Left: March mongoose. Right: Moustached guenon.

Left: Black-legged mongoose. Right: Genet.



Left: Spotted-nose guenon. Right: Baboon.