Final Evaluation Report

Your Details	
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Project Title	Evaluation of the impact of anthropogenic activities threats on pangolins population in the Deng-Deng National Park (DDNP)-Cameroon
Application ID	31760-2
Grant Amount	£4000
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1. Indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.

Objective	Not achieved	Partially achieved	Fully achieved	Comments
(1) evaluate relative abundance of pangolins in Deng national Park different sectors			✓	We installed 35 camera traps on fallen logs in two main habitat types (including near primary forest and secondary Forest) in both the north and central sectors of Deng Deng National Park. Over 31 camera traps worked properly, and 1571 operational camera trap nights were accumulated. We have calculated a trapping rate (TR) used as the relative abundance index of pangolin species. Overall, 68 photographic events of three pangolin species were recorded, 66 of white-bellied pangolin (TR=4.20%) in two main habitat types, one (TR=0.063%) of giant pangolin and one of (TR=0.063%) black-bellied pangolin.
(2) characterize anthropogenic threats and their impact on pangolins population			✓	Several signs of human activities were identified in the park and encountered frequencies of each human sign were calculated. Overall, logging hereafter tree cut to created human paths (39.51%) were the most frequently encountered human signs, followed by human paths (23.41%), livestock (e.g., cow scats) (17.07%), and "kimba" extraction (8.29%) only in the northern sector, road infrastructure (4.88%) and bullets. These human signs had a negative impact on the relative abundance of pangolin. We found that the number of detections of white-bellied pangolin increased proportionally with the distance of human signs increasing.
3) Travel in Ngoyla and surrounding localities to record the black-bellied pangolin			✓	We travelled in Ngoyla situated 300 km from Deng Deng but failed to observe the species. However, scales of black-bellied pangolin were recorded at Bertoua and Lomie, respectively 200 and 50 km from Ngoyla. Three records

				of the black-bellied pangolin were reported after we departed from the city by our local guides. People interviewed reported that the species were widely found in Messok situated 30 km from Ngoyla. We also informed our laboratory about our research and objective and asked them to provide any evidence of this species during their travel. Five other records were reported in five localities.
(4) retrieval camera traps and update results of the previous grant research				Data from our previous Rufford grant project were analysed and results enhanced our understanding of pangolin species occurring in Deng Deng National Park and their diet composition in Mpem et Djim National Park another protected area where we also conducted our research. 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 other manuscripts are in preparation.

2. Please explain any unforeseen difficulties that arose during the project and how these were tackled.

After receiving funds in October 2020, we retrieved camera traps from our previous project from the field (see first report update). Afterwards, our camera traps were not available for 8 months, they were used in another survey led by our collaborator. This delayed our project starting date, particularly for the next camera trap surveys. Additionally, several camera traps were not functioning well due to exposure to moisture in the forest during previous research (since 2018). We requested supplementary cameras from Zoological Society of London for our survey and waited again for 2 months. However, this time was profitable to extract data from previous project photo data, we finalised our analysis, and I wrote my PhD thesis dissertation. Once having the cameras and due to the limited funds that we have during this project, we were focused on our data collection and analysis of human threat impact on the white-bellied pangolin. This species was more likely detected using camera traps (from our previous research results objective 4) and could provide sufficient data for robust analysis and provide strong conclusions.

3. Briefly describe the three most important outcomes of your project.

- Over 1571 operational camera trap days accumulated in both north and central sectors of Deng Deng National Park: 66 photographic events of white-bellied pangolin for trapping rate of 4.20% meaning four events every 100 days. This is the highest trapping rate ever recorded for this species showing

that a targeted log-based camera trap survey is relevant to monitor this species. Most of the human activity signs encountered in the park were recent (94, 31%). We found that road infrastructure negatively affects the pangolin population, decreasing the capture probability of camera traps located near them (CP=0.01 per camera day meaning one event of pangolin every 140 days, followed by those near snare and human paths (CP=0.02 per camera day) or one event every 65 and 45 days respectively. The number of detections of white-bellied pangolin has increased proportionally with the distance of human signs increasing. In other words, closer to camera stations where there were signs of the human activities, the number of detections was lower, meaning anthropogenic activities reduce the relative abundance index of white-bellied pangolin and their detection probability.

- The trip to Ngoyla city situated 300 km from Deng Deng provided three records of the black-bellied pangolin. Interviewed people reported that the species were widely found in Messok situated 30 km from Ngoyla. From our informer (laboratory collaborators) four other records of black-bellied pangolin were made in Djoum, in Boumba bek National Park, Nki National Park, and in Yaoundé at the market. During our trip in Ngoyla, scales of black-bellied pangolin were also recorded at Bertoua and Lomie. Moreover, we successfully recorded black-bellied pangolin in Deng Deng National Park where we failed to record after 4 years of the survey, a total accumulated sampling effort of 10,887 camera trap days.

  During this project, one camera trap event provided a single photographic event of the black-bellied pangolin in the northern sector of the park and no record in the central sector. This was the first-ever record of black-bellied in DDNP; it occurred in the secondary forest on 21st December 2021 at 11:47 pm. This project permitted to obtain another first ever recorded of a felid species in Deng Deng National Park, the African golden cat (*Felis aurata*) after 4 years of the survey.

- Finalising data analysis of the previous Rufford project enhanced our understanding of the pangolin population and their ecology in this park. Over 4,184 operational camera trap nights were accumulated in DDNP during 2 years of the survey. The trapping rate of white-bellied pangolin (TR=2.75%, 115 events~3 events every 100 days) 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. The trapping rate of giant pangolin was relatively low (0.32%, 11 events) in DDNP. No evidence of black-bellied pangolin (*Phataginus tetradactyla*) presence was recorded during the previous survey period. For diet composition of pangolins, stomach content samples from 13 examined, white-bellied pangolin specimens and one scat of giant pangolin. We identified 134 insect species eaten by white-bellied pangolins, 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 3 and appendix 4).

4. Briefly describe the involvement of local communities and how they have benefitted from the project.

This project helped us to build capacity in the research of local people involved. We trained them to use navigation tools such as compass and GPS to facilitate their further integration as professional ecotourist guides (Appendix 1), as team compass holders during inventory and wildlife population monitoring by park staff and showed some individuals how to install camera traps. This is an introduction of local people to participative management of their natural resources. As guides and porters, they received a salary which helped them to cover some of their expenditure. We discussed with them the importance of pangolin conservation, how it is necessary to protect them from different human activities. We hired two students and one former local previously trained in Campo Ma'an to install camera traps as assistants who benefited from capacity building in field research in camera traps survey.

5. Are there any plans to continue this work?

This project has raised other perspectives of research both in this park and other protected areas and surrounding villages. We confirmed for the first time the presence of the black-bellied pangolin which wasn't recorded during 4 years of camera trap surveys carried out by our research team. We will look for other funds to continue research on the pangolin population and conservation in Cameroon with a special focus on the black-bellied pangolin. For example, testing the effectiveness of camera trapping targeting fallen logs and low understory tree branches to confirm the presence of black-bellied pangolin in other areas in Cameroon. We will assess the trend of pangolin populations in both seizures and households of surrounding villages of this park. Assessment of black-bellied pangolin to IUCN to upgrade their classification seems to be neglected due to a lack of data. We will establish the distribution map of the pangolin species in southern Cameroon and proposed the establishment of a pangolin sanctuary.

6. How do you plan to share the results of your work with others?

We are preparing several manuscripts to be published in peer-reviewed journals such as: (1) First record of black-bellied pangolin and African golden cat in Deng Deng National Park using camera taps; (2) Impact of anthropogenic activities threats on white-bellied pangolins population in the Deng-Deng National Park (DDNP)-Cameroon; (3) Relative importance and species richness of ants and termites in African white-bellied pangolin (*Phataginus tricuspis*) diet composition; and (4) Observing feeding behavior of pangolin using camera traps in ecotone zone of Cameroon. The PhD thesis dissertation is ready to be defended publicly at the University of Yaoundé 1 before the end of the year 2022. I will also apply for participation in national and international conferences to share my research findings.

7. Timescale: Over what period was the grant used? How does this compare to the anticipated or actual length of the project?

The Rufford Small Grant covered the expenses of this proposal during a 1-year period, starting in January 2021 and ending January 2022. This matches perfectly with the anticipated length of the project 12 months. However, we could not carry out awareness-raising campaigns that were not funded in this project.

8. Budget: Provide a breakdown of budgeted versus actual expenditure and the reasons for any differences. All figures should be in £ sterling, indicating the local exchange rate used. It is important that you retain the management accounts and all paid invoices relating to the project for at least 2 years as these may be required for inspection at our discretion.

Item	Budgeted Amount (£)	Actual Amount (£)	Difference (£)	Comments
Transportation (travel costs) from Yaoundé to Belabo – Deng-Deng- Yaoundé for 4 persons during 6 trips	500	500		
Accommodation of four persons for 8 nights	250	250		
Food of 7 persons for 132 days of field works	774	774		
Per diems for 8 potters and 2 guides, 2 rangers and 2 assistants and 1 team leader for 54 days of field works	1082	1185	+103	
Memory cards	51	51		
Batteries for Camera traps	200	200		
Head torches	93	93		
Tents	300	300		
Travel cost to Ngoyla and surrounding location	500	500		
Research permit renewal	250	250		
TOTAL	**4000**	**4103**	+103	

Notes to budget: The currency used in Cameroon is XAF (CFA franc). The exchange rate is 1 GPB= 755 XAF, please note that the exchange rate fluctuates constantly.

9. Looking ahead, what do you feel are the important next steps?

- Inferential statistical analysis to evaluate the impact of ecological factors (habitat, targeted log parameter (e.g., termite presence or absence, log diameter) and other major anthropogenic infrastructures such Lom-pangar

dam, Ngaoundéré-Douala national railway and Chad-Cameroon pipeline present in this park on the population of pangolins will be done during manuscript preparation with data we collected during this project.

- We will combine different methods to gather more information and help gain a preliminary understanding of ecological features and population status of black-bellied pangolin, the least studied pangolin species in Africa using IUCN criteria.

- We will organise awareness and education campaigns including the petroleum companies and hydroelectric dam personnel, sustaining the educational programme to ensure villagers and politicians, forestry and non-forestry workers understand the importance of protecting these species, induce changing behaviour throughout the community.

- Publish the results of our two Rufford Small Grants in the peer-reviewed journals and make them available to the local authorities in charge of wildlife management and other stakeholders in Cameroon.

- Continuing to share and divulge the obtained results in different scientific events and teaching activities.

**10.	Did you use The Rufford Foundation logo in any materials produced in relation to this project? Did The Rufford Foundation receive any publicity during the course of your work?**

Yes, I have used the logo of Rufford Foundation during the presentation of my PhD thesis progress process and national conference of Bioscience and also the report production to be published online. Rufford Foundation's name as a funder of our research has been mentioned in the acknowledgment section of articles (see https://onlinelibrary.wiley.com/doi/abs/10.1111/aje.12829) published peer-reviewed and we will continue.

**11.	Please provide a full list of all the members of your team and briefly what was their role in the project.**

Difouo Fopa Ghislain, Project leader, and principal investigator, designed the survey, collect and analyze data and write the report.

Mr Simeu Noutchom Alain and **Simo Talla Franklin**, PhD Candidate University of Yaoundé I (Research assistant). Assist the principal investigator to implement the project protocol, in the field assist in camera-trap installation,
Mr. Tchana Christian, Master Student University of Yaoundé I (Research assistant). Assist the principal investigator to implement the project protocol, in the field assist in camera-trap installation,

Mr. Oboulo Elyse, Ministry of Forest and Wildlife (Eco guard). Government representative; Protect the team from dangerous animals during the fieldwork.

Mr. Iya, Ministry of Forest and Wildlife (Eco guard). Government representative; Protect the team from dangerous animals during the fieldwork.

Mr. Eya Maxime, Ministry of Forest and Wildlife (Eco guard). Government representative; Protect the team from dangerous animals during the fieldwork.

Mr. Ndocta Molar Stephane (local guide). Field biomonitoring local guide help to create tracks in the forest and the savannah to enable the team to pass.

Mrs. Abba Jackson, **Bouba Claude Aristide, Waman Floribert** and **Elizé** (porters), Carry the field materials including scientist equipment, camping material, and food for all the team members.

12. Any other comments?

We acknowledge The Rufford Foundation for their financial support to this research through the Rufford Small Grant. We greatly thank our referees Dr David Olson and supervisor Professor Sévilor Kekeunou for their support. And the field team members and all the population of Deng-Deng village.

13. Appendices

All photos of this report should be credited as follows: *Photo credit: Ghislain Difouo F. _ Rufford Foundation/ University of Yaoundé 1*

Appendix 1: Camera trap installation

Principal investigator setting camera trap

Appendix 2: Capacity building of local people

Principal investigator training local guide to compass use.

Appendix 3: Main anthropogenic activities observed in the park

Left: Flooding damage in habitat in DDNP. Right: Tree cut for kimba extraction in DDNP.

Left: Water pollution in DDNP. Right: Road infrastructure in DDNP.

Appendix 4: Relative importance of ant 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

		Ar	Fo	RI	Prey category
	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 5: Relative importance of the termite main subfamily from WBP and their species richness into brackets

		Ar	Fo	RI	Prey category
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

Appendix 5: Pangolin species in Deng Deng National species

White-bellied pangolin (Phataginus tricuspis) in Deng Deng NP

First record of black-bellied pangolin (Phataginus tetradactyla) in Deng Deng NP and the second in Cameroon using camera trap.

Giant pangolin (Smutsia gigantea) in Deng Deng NP.

First record of African golden cat (Felis aurata) in Deng Deng NP.