Final Evaluation Report

We ask all grant recipients to complete a project evaluation that helps us to gauge the success of your project. This must be sent in **MS Word and not PDF format**. We understand that projects often do not follow the predicted course but knowledge of your experiences is valuable to us and others who may be undertaking similar work – remember that negative experiences are just as valuable as positive ones if they help others to learn from them.

Please DO NOT fill in and submit this form until the project has been completed.

Complete the form in English. Note that the information may be edited before posting on our website.

Please email this report to jane@rufford.org.

Your Details	
Full Name	DJUIDEU TCHOUAMOU Christian Landry
Project Title	Assessing niche overlap and food competition between giant pangolin and aardvark to improve conservation actions in the Mpem and Djim National Park of Cameroon
Application ID	43315-1
Date of this Report	19/08/2025

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
Collect data on the abundance and interactions between aardvarks and pangolins across different habitats and seasons to understand their ecological interactions				21 Cameras were installed (from which 20 worked properly) along three linear transects with 7 cameras each, in the forest-savannah mosaic zone of the park. Within each transect, camera traps were spaced 1.5-2 km apart, reflecting the estimated home range of the target species. Two transects were separated by 2 km. The camera traps were designed to cover both dry and rainy seasons. Over 3,051 operational camera trap nights, a total of 47 photographic detections of target animals (TR= 1.54%) were obtained, with 30 events for the aardvark (TR= 0.98%) and 17 events for the giant pangolin (TR= 0.56%). Giant pangolins were observed in 10 photographic events in the savannah (TR = 0.82%), while they were recorded in 7 photographic events in the forest (TR = 0.38%). Regarding aardvark, it was evenly spotted both in savannah and forest environments, but the trapping rate showed it was relatively more abundant in savannah (TR= 1.23%) than forest (TR= 0.82%). The giant pangolin was more often recorded during the dry season (9 events, TR= 0.85%) than during the rainy season (8 events, TR= 0.40%). Meanwhile, the aardvark was twice as often recorded during the rainy season (20 events, TR= 1.04%) as during the dry

				season (10 events, TR= 0.94%). The burrow was the most effective placement site to record giant pangolins and aardvarks on camera traps during this study, with up to 35 events out of 47 (TR= 2.87%), followed by termite mounds with 10 events (TR= 1.31%). Aardvarks were almost exclusively recorded in burrows (26 events, TR= 2.13%), and slightly in feeding sites and termite mounds (2 events each, TR= 0.26%). Although the giant pangolin was slightly more often recorded in burrows (9 events) than on termite mounds (8 events), the trapping rate suggests that it was more abundant on termite mounds (TR= 1.05%) than in burrows (TR= 0.74%). No giant pangolin has been recorded in feeding sites like aardvarks. During this study, no direct interaction between giant pangolins and aardvarks was recorded using camera traps, although spotted on the same GPS points.
Use spatiotemporal distribution models to identify areas where these species overlap in their habitat				Based on animals' records from camera traps, time, and geographic location, the combined spatiotemporal distribution of pangolins and aardvarks was determined using spatial and temporal models and analysis. The analysis of aardvark and giant pangolin co-occurrences showed that both species are negatively correlated with each other based on the Pearson r correlation coefficient, but no significance was observed (r = -0.16, P= 0.69). The combined species occupancy models of giant pangolins and aardvarks show that the two species occupy the same spatial niche in the surveyed area. Additionally, the

				JSDMs residual correlation matrix showed a weak negative interaction (COR = -0.07) between the two species regarding spatial co-occurrence (Fig. 13). This suggests that the giant pangolin and the aardvark might display weak repulsive or avoidance behaviours when placed in the same environment simultaneously. However, it remains a hypothetical scenario, as no cameras have yet captured direct interactions between these species. Giant pangolins were captured on camera traps from 4 pm to 7 am (15 hours of daily activity), with a peak of activity around 11 pm (3 events). Aardvarks were captured on cameras between 9 pm and 6 am (9 hours of daily activity), with a peak of activity around 1 am (5 events). Giant pangolins occupied a longer period for their activity than aardvarks, but the latter were more active (more recorded events) than giant pangolins. Activity peaks of both species occurred at the same times: from 9 pm to 11 pm and from 1 am to 4 am. The temporal overlap coefficient showed a very high overlap (Δ= 0.83), indicating that both species share the same temporal niche at up to 83%.
Compare the diet composition of pangolins and aardvarks and assess how the interspecific competition affects their biological traits				Between June 2024 and June 2025, we collected three samples of stomach contents from dead target animals at Linté (from local people in the village at the outskirts of the park who unexpectedly got in contact with GP (hunting traps, cadavers, etc.)): two samples from giant pangolins and one from aardvarks. Unfortunately, we did not record identifiable faeces during camera trap installation, maintenance,

such as body size and weight				and retrieval missions due to their scarcity. Overall, we recorded 25 arthropod prey species from stomach content analysis, from which 16 species belonged to the ant group (Insecta: Hymenoptera, Formicidae), 8 species belonged to the termite group (Insecta: Blattodea, Termitoidae), and one species belonged to the millipede group (Myriapoda: Chilopoda). From the diet results, giant pangolins fed on 24 prey species, while the aardvark fed on 6 species. All prey species consumed by aardvark were also consumed by giant pangolins, except for *Microcrotermes progrediens*. The gap of prey species is quite huge and can be explained by two reasons: (1) the fact that only one aardvark sample was recorded might significantly reduce the true diversity of prey species; and (2) the stomach content from the sole aardvark individual was digested at an advanced stage, remaining only head capsules, while giant pangolin' samples were still containing legs and abdomen parts. The most consumed prey species by giant pangolins were *Tetramorium acculeatum* (342 individuals, 26.59%), followed by *Crematogaster* (*Orthocrema*) sp. (154 individuals, 11.98%), *Nasutitermes arborum* (121 individuals, 9.41%), and *Pseudacanthotermes militaris* (92 individuals, 7.15%). Regarding aardvark, the most consumed prey species were *Camponotus maculatus* (89 individuals, 36.78%), followed by *Pseudacanthotermes militaris* (53 individuals, 21.90%), and

				Microcerotermes progrediens (48 individuals, 19.83%). The Pianka overlap index revealed a weak competition between the giant pangolin and the aardvark for available prey (*O* = 0.15), suggesting that both species compete for about 15% of their combined prey species. However, this value appears to be largely underestimated due to the small number of samples collected and the high level of degradation of aardvark samples. More data are needed to shed light on real food competition between these species. Additionally, it was not feasible to correlate the animals' body size to the competition level because animals were shot at different distances from the camera and in different positions, preventing the use of a standard estimation modelling. A different method need to be employed, using distance markers and cross-shooting cameras for better results.

2. Describe the three most important outcomes of your project.

a) Records of giant pangolins and aardvarks in the Mpem & Djim National Park

This study underscores the co-occurrence of giant pangolins and aardvarks within the forest–savannah transitional zone of Mpem and Djim National Park, evidenced by 30 photographic records of aardvarks and 17 of giant pangolins. Given the rarity of giant pangolin sightings in recent camera trap surveys, these findings offer a promising signal for the conservation of this critically endangered species.

Both species were more frequently detected in savannah habitats than in forested areas, highlighting the ecological significance of the savannah for their survival. However, recent reports from Mpem and Djim National Park reveal that forest encroachment is increasingly threatening the integrity of the savannah ecosystem. This trend risks diminishing the habitat essential for these species. Urgent and targeted conservation measures are therefore needed to safeguard the remaining savannah patches and ensure the long-term viability of the giant pangolin population.

The camera trap strategy focused on burrow sites proved effective in detecting both species, aligning with recommendations from previous studies. Notably, this study found that targeting termite mounds yielded a higher detection rate for giant pangolins. A combined approach—deploying cameras at both burrows and termite mounds—may enhance detection success and improve future monitoring efforts for giant pangolins

b) Spatiotemporal niche overlap between giant pangolins and aardvarks

This study revealed a significant spatiotemporal niche overlap between giant pangolins and aardvarks. Both species inhabit the same environments within their home ranges, and their daily activity periods coincide by approximately 81%. Although no direct interactions were observed during the study, various ecological indices and modelling approaches suggest that this cohabitation may exert negative effects on both species. With the continued reduction of savannah habitats in the park, competition for suitable environments is likely to intensify, potentially influencing species behaviour and population dynamics.

The residual correlation matrix from the Joint Species Distribution Models (JSDMs) indicated a weak negative spatial association between the two species, implying possible repulsion or avoidance behaviours when they occupy the same habitat simultaneously. This subtle avoidance may explain the absence of direct interactions, despite evidence that both species utilize the same burrows. Such findings underscore the complexity of interspecific relationships and the need to consider behavioural dynamics in conservation planning.

c) Insights into the food competition and food intake reduction between giant pangolins and aardvarks

This study provides evidence that giant pangolins and aardvarks compete for similar food resources within Mpem and Djim National Park. All prey species identified in the aardvark's diet were also consumed by giant pangolins, except *Microcrotermes progrediens*. Notably, *Pseudacanthotermes militaris* emerged as a key shared prey species for both myrmecophagous mammals.

A total of six prey species were identified in the aardvark sample, compared to 24 in the giant pangolin. This disparity likely stems from the limited sample size—only one aardvark specimen was analyzed—and the advanced degradation of its stomach contents, which preserved only head capsules. Despite these limitations, the Pianka overlap index revealed a low dietary overlap (O = 0.15), suggesting that the two species compete for approximately 15% of their combined prey spectrum. However, this figure is likely underestimated due to the restricted data and degraded sample quality.

To better understand the extent of food competition between these species, further sampling and dietary analyses are essential. Expanding the dataset will help clarify whether resource overlap significantly influences their ecological interactions and inform targeted conservation strategies.

3. Explain any unforeseen difficulties that arose during the project and how these were tackled.

Delay in Research Permit Delivery: Following the receipt of project funding, applications for the necessary research permits were submitted and associated fees paid. However, the permits were not officially granted until late August 2024, resulting in the postponement of the stakeholder engagement meeting originally scheduled for July 2024. The meeting was eventually held in September 2024.

Delay in Equipment Delivery: Camera traps and other essential supplies were ordered from the United States to support data collection. Due to uncertainties surrounding the presidential election in the USA, the delivery of some items was delayed until October 2024.

Delays in Camera Installation and Retrieval: Upon receiving the equipment and securing all required permits, a meeting was convened with local stakeholders to coordinate project activities. Discussions revealed that installing camera traps in the park's savannah habitats prior to January 2025 would be impractical due to seasonal bushfires, typically set in late December to clear dry grasslands. Consequently, camera installation was deferred to late January 2025, following approval from park authorities. To capture data across two consecutive seasons, cameras were retrieved in June 2025. Data management and analysis commenced thereafter, leading to the production of results and report writing until August.

Inability to organise Restitution Meeting: As recommended by proposal reviewers, a restitution meeting with local stakeholders was planned for the project's conclusion. Unfortunately, significant delays in implementation prevented timely report submission, making it impossible to organise the restitution meeting within the intended timeframe. This meeting is however planned to be organised in the future.

Operational Challenges and Budget Constraints: A change in park management policy required the presence of two park rangers during each field mission, rather than one as originally budgeted. Additionally, ranger daily allowances were increased by park administration to £13.50 per person. A major financial challenge emerged when it was discovered that £675 allocated for staff payments had not been included in the final budget. To mitigate these constraints, the number of camera traps purchased was reduced from 21 to 16, and savings were made across other project expenses to ensure adequate funding for essential operations. We however received 5 camera traps from the Zoology Laboratory of the University of Yaoundé 1 to obtain the 21 cameras installed. Unfortunately, we did not receive the 4 camera traps requested to Idea Wild in time for the camera deployment. Furthermore, a local collector was compensated for providing stomach contents of target species, necessitating further budget adjustments to maintain project viability.

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

This project vitally involved the local community, thus bringing economic benefits, capacity building, and sustainable resource management. Strengthening local expertise in conservation and pangolin ecology, this project contributed to a

improve natural resource management and fostered long-term stewardship of biodiversity. The local people involved included six porters, two local guides and four park rangers

The project provided salaries to guides and porters, supporting household expenses and reinforcing financial stability. Additionally, local people acquired valuable ecotourism and research skills, mastering navigation tools such as GPS and compasses. Their integration as ecotourism guides and their participation in wildlife population monitoring reinforced conservation efforts.

5. Are there any plans to continue this work?

This project has raised new insights and perspectives of research both in this park and other protected areas and surrounding villages. We will look for funds to continue research in giant pangolin conservation and integrate community-based conservation initiatives to preserve its habitat and foster community engagement toward wildlife protection in Cameroon. Our future work could explore the following points:

- **Bushfire management in savannah to preserve wildlife**: Unregulated, human-induced bushfires pose a significant threat to wildlife inhabiting savannah ecosystems. In contrast, natural bushfires play a crucial ecological role by reshaping the savannah landscape and curbing forest encroachment, thereby helping to maintain the savannah over time. Within Mpem and Djim National Park, the occurrence of natural bushfires has become increasingly rare, allowing forested areas to expand at the expense of the savannah. This shift in habitat dynamics raises concerns for species such as the giant pangolin, which rely on savannah environments for survival. Future research could investigate how strategically implemented, managed bushfires—under controlled conditions—might contribute to preserving the savannah ecosystem while supporting the conservation of giant pangolin populations.

- **Educational campaigns in surrounding villages**: We could launch educational and awareness campaigns in villages around the Mpem and Djim National Park to improve conservation actions by fostering local engagement in giant pangolin conservation as cultural heritage. This could involve restitution meetings to inform about past and current studies conducted in the park, school education campaigns, and support for ecotourism development.

- **Population density studies**: Building on insights from previous camera placement strategies, we propose a targeted camera trapping approach to estimate the population density of giant pangolins within the forest–savannah transition zone of Mpem and Djim National Park. This method would involve strategically positioning camera traps at burrows and termite mounds—key activity sites identified in earlier studies—to maximise detection rates. Such an approach is expected to yield more accurate estimates of population dynamics, enabling the identification of species hotspots. These findings will be instrumental in informing realistic and site-specific conservation strategies aimed at safeguarding giant pangolin populations in the park.

- **Species-specific threats to the giant pangolin and consequences on its distribution and activity**: Although threats to pangolins have been documented in several parks of Southern Cameroon, there is little knowledge about the species-specific threats to the giant pangolin and how they affect its distribution and activity. We could conduct a study to assess human-led threats to giant pangolins in their habitat and correlate them to its behaviour and distribution.

- **Resource competition between giant pangolins and aardvarks**: This study laid the ground work for the assessment of resource competition between giant pangolins and aardvarks. However, the quantity of data collected is not sufficient to conclude on the true state of food competition between both species. More data need to be collected from faecal/stomach contents and processed to improve the quality and accuracy of the results. Additionally, more camera trap nights are required to record direct interactions between both species and conclude on the type of interactions involved.

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

We are currently preparing two manuscripts for submission to esteemed peer-reviewed journals, including *Mammal Ecology* and *Biodiversity and Conservation*. In parallel, we are actively exploring opportunities to present our findings at national and international conferences and workshops. These platforms will enable us to foster dialogue with the broader scientific and conservation communities, share insights from our research, and contribute meaningfully to ongoing efforts in wildlife conservation.

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

The following steps could help to refine conservation strategies and improve the conservation status of the giant pangolin in Cameroon:

- **Continuous ecological monitoring**:
    - Deploy additional camera trap networks to cover the entire home range of the giant pangolin in the Mpem & Djim National Park to grasp more accurate information on the population dynamics and distribution
    - Explore the usage of GPS collars to track the activities and movements of some giant pangolins to get a clear view of their habitat preferences, daily activities, and spatial coverage.

- **Reintroduction suitability assessment**:
    - Investigate interspecific competition with other mammals within the myrmecophagous guild to identify parameters underlying the selection of suitable environments for giant pangolin reintroduction in the park.
    - Assess the community engagement to support the reintroduction of captive pangolins in the park.

- **Environmental education and awareness**:

- Develop designed awareness campaigns to address misunderstandings and false beliefs that promote the hunting of pangolin species and reinforce the conservation message.
- Organise stakeholder workshops to explore hunting transitioning activities in communities relying on illegal hunting to reduce hunting pressure in natural habitats.

- **Protected areas management**:
  - Develop and implement management strategies to enhance the persistence of critical habitats such as savannah ecosystems in the park to improve the survival of inhabiting endangered wildlife such as giant pangolins
  - Organise integrated conservation initiatives where local communities are actively taking part in the management of the park to reinforce a participatory conservation approach.

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

We proudly acknowledged The Rufford Foundation during this study by using its logo in support documents shared with local stakeholders during the organisation of project activities (Terms of References, Project description, payment discharge slips, etc.).

9. Provide a full list of all the members of your team and their role in the project.

Dr. DJUIDEU T Christian, Project leader, and principal investigator, contact the project team members, organised meetings, applied for project permits, coordinate the teams and their activities, coordinated administrative and financial aspects designed the survey, collected and analysed data and wrote the report.

Drs. SIMO T Franklin, and DIFOUO F Ghislain have provided advice for the camera trap strategies and implementation of activities.

Mr. Krauss Arnaud, Master Student, University of Yaoundé 1 (Biostatistician, Research assistant, Assisted the principal investigator in in organising, cleaning and analysing data from camera traps.

Mr. MABANGUEL Bruno, PhD Student University of Yaoundé I (field assistant), Assisted the principal investigator to implement the project protocol, conducting camera-trap installation in selected locations in the field.

Mrs. ZONG TEMO Ignace, MBILLA Bernard, NTOUMBA Achille, Ministry of Forest and Wildlife (Park rangers), Government representatives; Protecting the team from dangerous animals during the fieldwork.

Mr. NDJIBE ISSA (local guide), assisted the team in field biomonitoring, helping to create tracks in the forest.

Mrs. **TSEDJI Prosper, GBANDJI Hubert, TAGOURA Christian, NGOMANE Jean, and TAMONE Gidéon** (porters), carried the field materials including scientific equipment, camping material, and food for all the team members.

10. Any other comments?

We acknowledge the Rufford Foundation for their financial support to this research through the 1st Rufford Small Grant.

ANNEX – Financial Report

[Intentionally removed]

Appendix: Some photos of the project

Camera trap survey team members at one entry point in the Mpem & Djim National Park (two park rangers in green outfits)

Landscape view of the Mpem & Djim National Park

Aardvark and giant pangolin spotted on the same camera targeting a burrow in a secondary forest (top: aardvark, bottom: giant pangolin)