

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	MEYO OKONO Franck Patherson
Project Title	Effects of habitat disturbances on bat communities (Mammalia: Chiroptera) in and around the Campo-Ma'an National Park (South Cameroon).
Application ID	41754-1
Date of this Report	September 9, 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
<p>1) Provide the first examination list of bat species found in CMNP and vicinity, and target bat species with status of concern;</p>				<p>In 73 nights of successful captures on 20 sites spread over the 4 stations of the CMNP, the inventory documented 625 individuals of 32 bat species, in 20 genera across 6 families, including one nectivorous, 7 frugivorous and 24 insectivorous bat species. We noted 2 Data Deficient, one Near Threatened and one Endangered species in CMNP and around.</p> <p>The local acoustic database was built from recordings of 21 insectivorous bat species and <i>R. aegyptiacus</i>.</p> <p>Captures were carried out using mist nets (5-10 per site; 6 on average, 18m, 12 m, 9m and 6m, 16-mm mesh; Ecotone, Poland) mounted on ~3m high poles were placed in flyways, forest gaps, and near water points. Total mist net sampling effort was 5256 net-hours; A harp trap (1.8 m × 1.5 m; Austbat, Australia) was placed across narrow forest paths or cave entrances, totaling 876 trap-hours. Nets and traps were opened from 18:00-05:00 h and checked every 15 min. Methods were carried out following Sikes & the Animal Care and Use Committee of the American Society of Mammalogists, 2016).</p> <p>Tissue samples (wing punch membrane biopsies) were carefully collected on all bats captured for genomic DNA extraction and confirmation. This process has already taken place with 168 samples (and we obtained a phylogenetic tree of Rhinolophidae,</p>

				<p>Vespertilionidae and Hipposideridae families) and the other set is in the process for obtaining a new permits and additional funds for being shipping in the Field Museum of Natural History of Chicago, USA (where the first set have been analyzed).</p>
<p>2) Providing data on various habitat types occupied by bat species in CMNP, assess the level of degradation of each habitat type, and identify constraints and disturbance types to which these habitat types are subjected</p>				<p>Habitat types, driven by vegetation structure, fruit tree availability, watercourses, roosting plus foraging sites and disturbance levels were described and we noted which species were present in each habitat type. Indeed, primary forests supported the highest species richness (23 species), while farms had the highest abundance (31.2%), driven by frugivorous generalists like <i>Megaloglossus woermanni</i>. Seasonal peaks in abundance (Great Dry Season) and richness (Great Rainy Season) were linked to resource availability, aligning with regional patterns and guiding habitat-specific conservation strategies (Klingbeil & Willig, 2010; Atagana et al., 2021).</p>
<p>3) Providing data on comparison and location of communities' structures and species richness of bats in each habitat type.</p>				<p>According to habitat types, species richness was highest in primary forests (23 species, $H'=2.24$, $J'=0.71$), followed by human habitations (20), secondary forests (18), and farms (15). Seasonally, the Great Dry Season (GDS) recorded the highest abundance (34.72%), while the Great Rainy Season (GRS) showed the highest richness (22 species), reflecting fruit and insect fluctuations. The Small Rainy Season (SRS) had lower captures (15.84%) but higher evenness ($J'=0.77$), SDS as SRS were almost similar including abundance (16 species each season). Multivariate analyses combined season and habitat patterns (ANOSIM; PERMANOVA) confirmed significant habitat-season differences in bat assemblages.</p>

<p>4) Awareness campaigns will be carried out in some villages near capture sites to adequately demonstrate to riverside communities the bats' morphology using live specimens and to explain to them the physiology and ecological importance of bats.</p>		<p>Awareness campaigns were conducted in only 2 villages, engaging 10 and 12 participants respectively, with live bat demonstrations and ecological communication (Figure 1). However, in each village where captures were carried out, we allowed people to observe our handling of living bats, and we were answering to all their questions</p>
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2. Describe the three most important outcomes of your project.

a). Comprehensive bat species inventory and conservation prioritization

A comprehensive inventory documented 32 bat species, in 20 genera across 6 families, including notable recording such as *Casinycteris cf. campomaanensis*, *Myotis dieteri* (both Data Deficient), *Scotonycteris zenkeri* (Near Threatened), and *Pseudoromicia roseveari* (Endangered), confirming CMNP's conservation significance (Hassanin, 2014); IUCN, 2025); in addition, we recorded species like *Neoromicia sp.* and *Pipistrellus sp.*, and *Glauconycteris cf. humeralis* (6 individuals and obviously seems to be a first record for the country) classified as Not Assessed, underscoring the need of taxonomic confirmation with more methods (integrative taxonomy, including barcoding of wing punches) for a better understanding of their distributions and the requirements for their conservation (Patterson et al., 2020; Montauban et al., 2025).

b). Habitat characterization and Habitat-specific and seasons insights

Habitat Insights:

Primary forests, (e.g forests inside protected area) (Figure 2A&B) characterized by dense evergreen canopies and watercourses, fitting ecological niche and hosting specialists as *kerivoula phalaena*, *Myotis dieteri*, *Nycteris arge*, and *Pipistrellus (Pipistrellus) nannulus*. The presence of fruit trees highlighting their role in seed dispersal within low-disturbance habitats within tropical and subtropical forests (Kunz et al., 2011; Happold & Happold, 2013). There were low evidences of anthropogenic activities (except some hese characteristics underscore primary forests as critical habitats for conservation-dependent species.

Secondary forests, (e.g forest pocket in Forest Management Units 09-021, 09-24, 09-025) (Figure 2D) with regenerating vegetation and open flyways, showing moderate disturbance indicating adaptability of species collected there to varied elevations and moderate disturbances.

Farms, including cocoa and banana plantations (Figure 2G), CAMVERT entrance driven by frugivorous generalists like *Megaloglossus woermanni* and *E. franqueti* exploiting fruit trees under moderate to high disturbances. These observations

support ecological claims about low species richness, high abundance, and frugivorous bat dominance in agricultural landscapes.

Human habits, (e.g houses roofs, between houses) (Figure 2C) while marked by high disturbance and fruit trees (*Cola acuminata*, *Garcinia kola*, *Dacryodes edulis*, *Psidium guajava* etc) shows the second most high species richness reflecting tolerance of dominant species such as *R. aegyptiacus*, *M. woermanni*, *E. franqueti*, *H. ruber* and some Rhinolophids for disturbed landscapes.

Seasonal insights:

Seasonally, the Great Dry Season (GDS) recorded the highest abundance (34.72%), likely due to increased insect availability, while the Great Rainy Season (GRS) showed the highest richness (22 species, $H'=2.33$), reflecting fruit and insect fluctuations (Klingbeil & Willig, 2010). The Small Rainy Season (SRS) had lower captures (15.84%) but higher evenness ($J'=0.77$), suggesting equitable species distribution, SDS as SRS were almost similar including abundance (16 species each season).

Combined habitat and season patterns on bat assemblages:

Multivariate analyses on combined season and habitat type patterns (ANOSIM: $R = 0.4041$, $P = 0.0023$; PERMANOVA: $F = 2.528$, $P = 0.0019$) confirmed significant habitat-season differences in bat assemblages, consistent with findings in other Cameroonian forests (Waghiiwimbom et al., 2020; Atagana et al., 2021). Indeed, moderate R and F values suggest additional influences maybe, microclimate, specific fruit for frugivorous consumers or prey availability, while the study hasn't yet been replicated in time, this suggest a requires for further research; in addition, relationships of particular characteristics with landscape structure that may affect bats communities and distribution are season-specific. SIMPER analysis identified *H. ruber*, *M. woermanni*, and *R. aegyptiacus* as the most important contributors to assemblage dissimilarity (65%), reflecting their ecological flexibility.

c). Establishment of the first acoustic library for CMNP.

We developed an initial acoustic library for CMNP, archiving over 1885 echolocation call sequences from 21 insectivorous and one frugivorous identified bat species, collected via handling recording and in flight within a 2×4m mosquito-net flight tent with Anabat Walkabout. This library, processed using Kaleidoscope Pro (v5.4.8, Wildlife Acoustics), calls were identified based on peak frequency, characteristic frequency, duration, and sonotype. Ambiguous calls were assigned to genus or family or excluded from species counts. The dataset, cross-referenced with country and continental references (Bakwo Fils et al., 2018; Monadjem, 2020), addresses a critical gap in Central African bat acoustics. It will be shared online via platform like Chirovox, enabling researchers and conservationists to improve species identification and monitor bat populations across the Congo Basin, enhancing CMNP's role in regional biodiversity research.

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

Equipment failure: The triple-high mist net accidentally broke after only two uses, limiting canopy-dwelling bat sampling. The use of this material was not really understood by one assistant who accidentally tried to fix one pole on the ground by strength. We advocate the use of this kind of material by people already trained

with it, and we underline here the need for more capacity building workshops to train many people to use the equipment and become familiar with it.

This challenge was mitigated by increasing reliance on acoustic monitoring (SM4BAT FS and AnaBat Walkabout) to detect high-flying species, though some canopy species may remain under-sampled.

Logistical constraints: Bad weather (heavy rains) and bad roads in remote CMNP areas (generating high transportation costs sometimes) have delayed fieldwork. Also, the long distance to walk from villages to PA, was sometimes challenging). We adjusted schedules to prioritize accessible sites and held captures during acceptable weather and, collaborated with local guides to navigate challenging difficult areas.

Limited community outreach: Resource and time constraints reduced the number of awareness campaigns, in addition timing according to local riversides peoples timing sometimes have make us cancelling some awareness campaigns. We held awareness campaigns in only two villages: V15 in Nyété ([2.581579N, 10.047013E] by the East side of the park) and Nlomoto ([2.793899N, 10.509082E, 406 m], by the North side of the park), and used live specimens and visual aids to maximize engagement within limited sessions.

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

Local communities benefited from trainings, indeed, local guides, porters and field assistants (including both Fangs and Pygmies tribes) from these communities were employed, providing income and building capacity in biodiversity monitoring.

We held meetings in chieftaincies at our arrivals with many peoples. So, although formal awareness campaigns weren't held, the information on bats and, about our works was transmitted to the public.

While we noted an increase in positive attitudes within local peoples where team members demonstrated bat morphology using live specimens and explained their ecological roles, but the objective is marked as low partially achieved due to limited follow-up to assess long-term impact and coverage of only a subset of local communities. Expansion to additional villages is absolutely needed.

5. Are there any plans to continue this work?

Yes, we plan to continue this work by: **(1)** conducting follow-up surveys to detect potentially unobserved species, as suggested by Chao-1 estimates (yet we noted 29 species in human habitations) (Chao et al., 2014), and increasing triple-high deployments to capture canopy species, this should be done in all the Technical Operational Unit (Figure 3), while industrial (Kribi Industrial Port Complex, the Memve'ele Hydroelectric Dam, a second planned dam on the Ntem river), agro-industrial concessions (HEVECAM SA, hevea production; CAMVERT SARL and SOCAPALM, palm oil production) are implemented (Engolo et al., 2024); **(2)** we will develop a more comprehensive and robust acoustic database by adding call recordings (with SM4 FS) and genetic wing punch barcoding (while we have a quarter of samples already analysed) to enhance species identification,

collaborating with regional (not yet tagged) and international institutions (Field Museum of Natural History, Chicago, USA); **(3)** organize and scaling up community formal awareness campaigns to cover all the villages around the protected area; **(4)** suggest to authorities integrating findings into CMNP's management plan to designate bat roosting sites and forest corridors; and
Funding applications, including a follow-up 2nd Rufford Foundation grant, are in preparation to support these efforts.

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

Results will be shared through: **(1)** the University of Douala, while this project is a part of my PhD, then my thesis will be deposit at the library of the University and, results will be defended in front of a jury; **(2)** a peer-reviewed publication in a scientific journal (*Acta Chiropterologica* or *Biodiversity and Conservation*, not yet decided), with the draft already prepared (titled: "*Diversity and distribution of bats in Campo-Ma'an National Park and vicinity, South Cameroon: A seasonal inventory and initial acoustic database*"); **(3)** presentations at regional and international conferences and workshops, in addition we intend to organize one "My field for dummies" (webinaire) on at least one aspect in our findings; **(4)** technical reports and infographics shared with MINFOF, CMNP authorities and conservation NGOs (AWF, WWF and Zoogranby Cameroon) to inform management plans; **(5)** community workshops and awareness campaigns in additional villages to disseminate findings; and **(6)** depositing the acoustic call library in a public repository (Chirovox, Global Biodiversity Information Facility), and with international organisation where we are student representative and fellows (GBatNet and BCI) for use by researchers and conservationists.

All outputs will acknowledge the Rufford Foundation's support.

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

The next steps include: **(1)** Developing SDM models to map bat distributions and prioritize conservation areas under future land-use scenarios, using tools like MaxEnt, coupled with expanding the acoustic database with the integration of SM4 recordings and analysis (Razgour et al., 2016; Hintze et al., 2021); **(2)** Conduct taxonomic resolution with barcoding of wing punches collected to confirm identities of species like *Glauconycteris cf. humeralis*, *Neoromicia sp.* and *Pipistrellus sp.* for accurate conservation prioritization; **(3)** Expand formal and well organized awareness campaigns to additional villages (all around the PA), focusing on youth education, promote bats' ecological value and support sustainable livelihoods (UNESCO, 2018); and **(4)** Collaborating with MINFOF, CMNP's authorities, regional NGOs and universities to integrate CMNP bat's data into conservation on national biodiversity frameworks and, into park management plans, prioritizing primary forest protection and agroforestry enhancements.

These steps will build on our baseline to ensure sustained protection of CMNP's bats amid ongoing threats (Hansen et al., 2013).

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?

The Rufford Foundation received publicity at my University (Douala) via my presentation slides during seminars on progress of the works, also during a

workshop on "Building Capacity for Bat Conservation in Central Africa" in DRC, where I presented capture identification methods used in my work in August, 2024. The Rufford Foundation logo was included in awareness campaign through my presentation slides used during community talk in Nlomoto village. The Foundation was acknowledged during oral presentations at local stakeholder meetings with CMNP authorities and conservation partners. Our project's draft manuscript has credited The Rufford Foundation as a key funder, ensuring further publicity.

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

The team (Figure 4) was composed as follow:

- **MEYO OKONO Franck Patherson** – *Principal Investigator*: lead project design, conducted bat capture and identification, data analysis (including acoustic analysis, and habitat assessments), and manuscript preparation.
- **Prof Eric BAKWO FILS** (Head of Department of Environmental Sciences, University of Ebolowa)– *My scientific Advisor*: Advised on study design, provided taxonomic expertise, and reviewed data outputs; globally he oversaw all the work.
- **Dr Patrick Jules ATAGANA** (Lecturer at the University of Ngaoundéré) – *My Mentor*: helped a lot for giving orientations for carrying out each step of the work.
- **Dr OFFONO ENAMA Michel Leger** (Assistant at the University of Garoua) and **Mrs AGODIGO AYANGMA Eugénie Flore** (postgraduate Master Sc at the University of Douala) – *Field Assistant*: they helped a lot in bat captures and identification during the 2 first field trips.
- **ESSOME NGUESSE Laurent and MBARGA François Roland** – *Field Assistants*: these Master students (University of Ebolowa) helped a lot in bat capture and identification during the 3 last field trips.
- **NGOUNET MBOGNI Boris Parfait** - *Field Assistants*: A Master student (University of Dschang) helped in bat captures and identification in the last field trip.
- **Théophile TOKARI LANDO, MBA Patrick** (Nkoelone); **Georges DOUMBA MOTTO** and **Samuel** (pygmy at Efoulan 1); **Second**, and **Allure NYELA** (pygmy at Nko'ongop); **Jean-Marie MEMENDE** (pygmy at Nyamabandé); **BENDAMANE Jorel** and **MENGUE Didier Brice** (Nsébito), **BEKA MEZUI Wilfried** and **ZANG MEZUI Keddy** (Minkan-Mengalé) – *Field guides*: Provided site knowledge, assisted with captures, and supported community outreach and communication.
- Mr. **NWANA Michaël** (Campo), **NKEL Gaël** (Campo), **KOMÈ** (Akom 2) and **ELEBE BESSALA Adalbert Christian** (Nyété) – *Ecoguards*: according to each site and station, wildlife authorities have made rangers available to us, they help for our security (if we face wild animals and poachers), also helped in communication with riverside peoples.

10. Any other comments?

This project has laid a critical foundation for bat conservation in CMNP, addressing a significant knowledge gap in one of Cameroon's most biodiverse regions, in addition, it has established CMNP as a biodiversity hotspot, revealing critical insights into bat ecology amid escalating habitat threats.

We deeply want to thanks The Rufford Foundation, while the support they offers us was pivotal in achieving these outcomes, enabling the first systematic bat inventory and community engagement efforts. We are committed to building on this work to address knowledge gaps and enhance conservation strategies, particularly for

species of conservation concern. We welcome feedback to refine future efforts and maximize impact, and, welcome opportunities to collaborate with the Rufford Foundation and other stakeholders to advance biodiversity conservation in the Congo Basin.

Future funding will be crucial to sustain and expand this work, particularly for SDM, acoustic database progression, awareness campaigns over all the TOU Campo-Ma'an.

Appendix

Unfortunately, we were unable to publish the final species list including pictures, and the table resuming acoustic data (while we are currently preparing an article), but this can be available on request.

Few references cited

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Figures

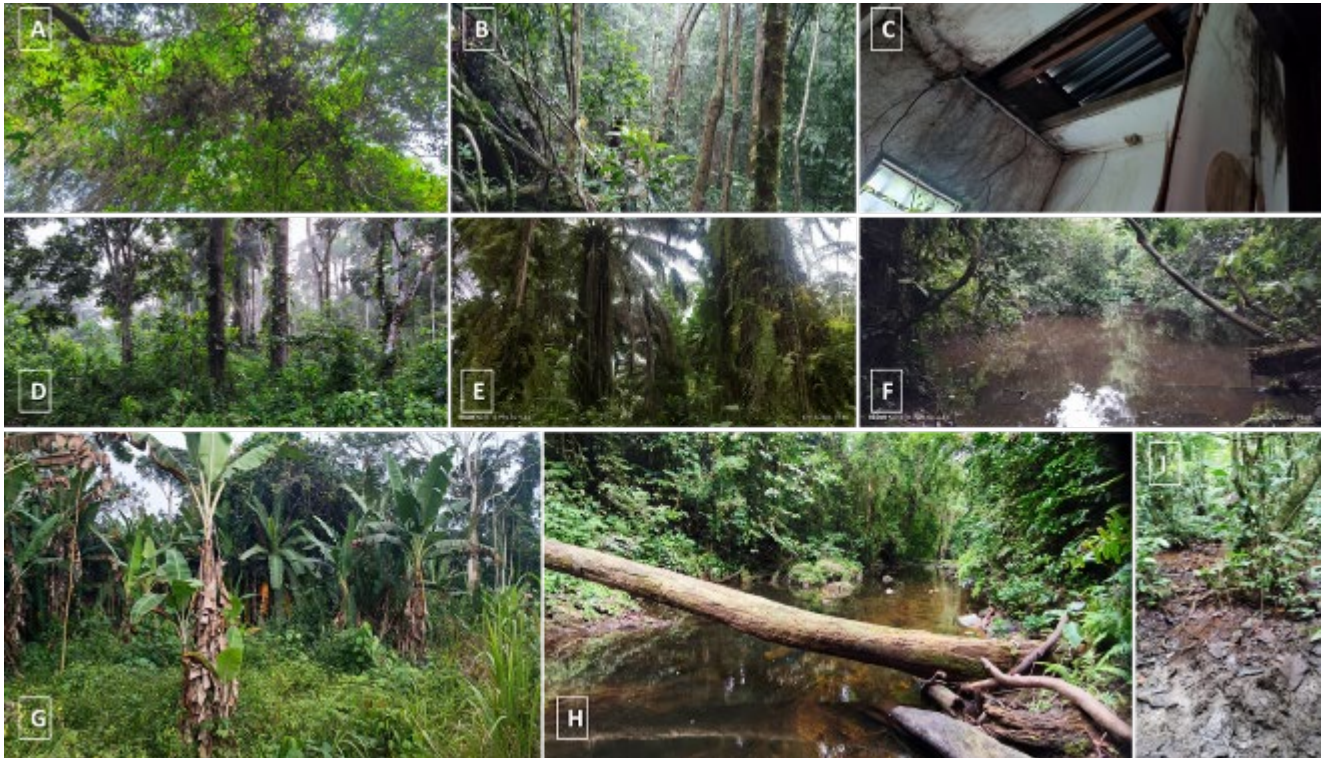


Figure 1: Some capture places and Habitat types in CMNP (©Franck Meyo)

A & B: Primary forest (A: canopy, B: enclosed space); **C:** Ecolodge roof (bats were found in); **D:** opened flyways in secondary forest; **E:** palm grove; **F:** water point; **G:** banana plantation; **H:** watercourse in primary forest; **I:** swamp

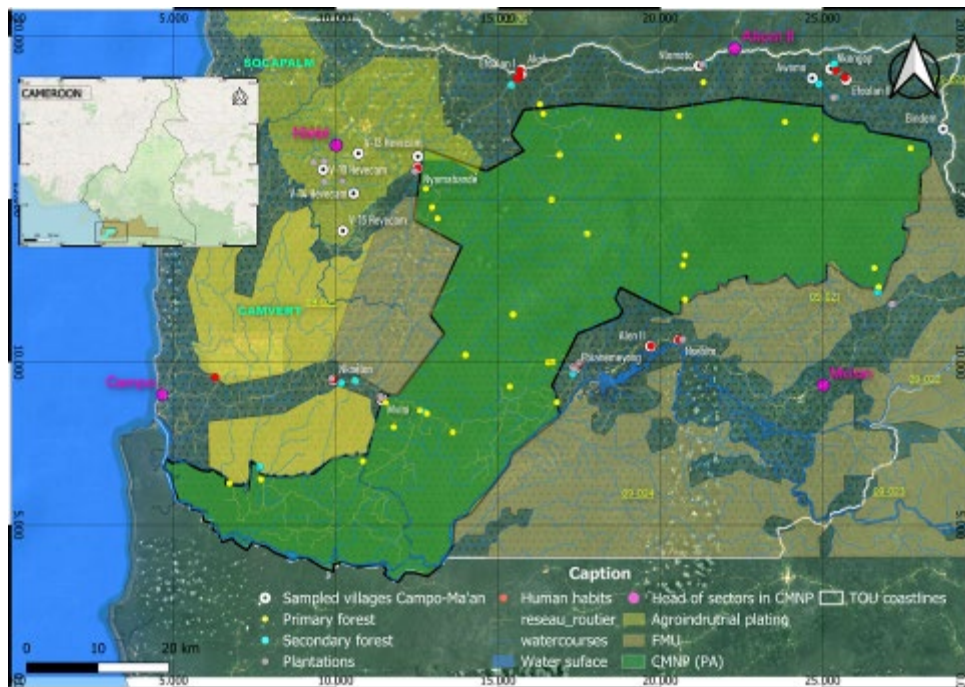


Figure 2: Map of sampled points in the CMNP and around including the composition of the TOU Campo-Ma'an (©Franck Meyo, 2025)



Figure 3: Field team members (©Franck Meyo)

A: Field team members at the fifth field trip, just before moving to inside the PA; **B:** from the left to the right = Head sector Nyété (Mr. Nformelu); Principal investigator (Franck Meyo); Field assistant (Laurent Essome) and, Ranger (Elebe Bessala Adalbert); **C:** bootcamp; **D:** a resting moment after a long walk; **E:** time to drink water in a little watercourse after a long walk; **F:** PI with Allure Nyela, a field guide (a way for inclusion by involvement of pigmees in this project); **G:** team crossing a bridge on Awomo river (limit between the PA and FMU 09-021)



Figure 4: Some methodology used on the field (©Franck Meyo)

A: Mist net deployed; **B:** Harp trap deployed; **C & D:** SM4 FS deployed (D: in a cocoa plantation); **E & I:** Recording of bat's calls with ANABAT Walkabout (E=Handrelease; I= in flight within a 2×4m mosquito-net flight tent); **F:** bat's wingspan measuring; **G:** principal investigator showing how measuring to field guide and field assistant; **H:** principal investigator controlling bat's processing from field assistants (after showing them)



Figure 5: Some caves within the CMNP (©Franck Meyo)



Figure 6: Some underdeveloped locations in remote areas in Campo-Ma'an
 (©Franck Meyo)

A: Very damaged bridge (not yet in use) to reach Dipikar island by road; **B:** Damaged road to reach one village; **C:** A lateral view of a school (in Nko'ongop village); **D:** bridge to on the track to reach the PA by the North Side (by Awomo village); **E:** Monkey bridge (tree trunk) to navigate on Dipikar island (during the GRS, the swamp was impassable)

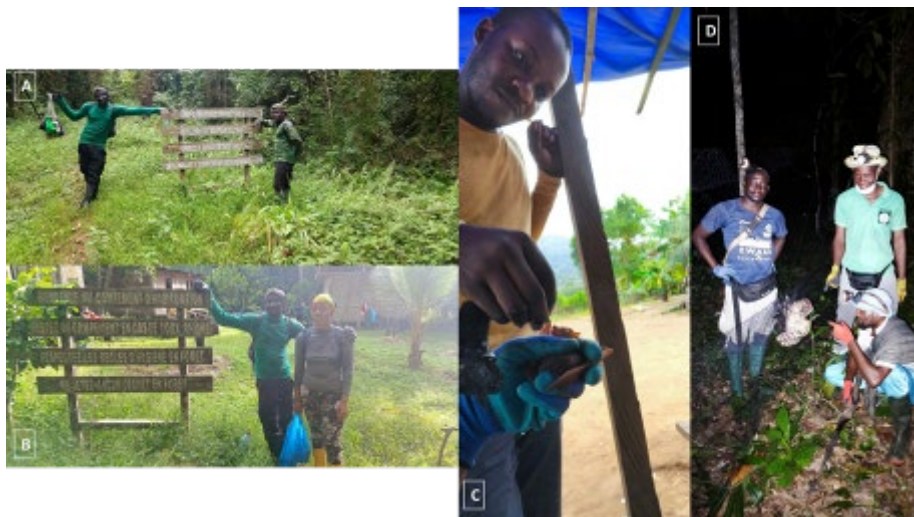


Figure 7: Some additional pictures (©Franck Meyo)

A: PI standing with ranger (Gael Nkel) at North entry of Dipikar island (after visiting a roosting site, and collected some bat's individuals); **B:** PI and field assistant (Eugénie Agodigo pausing at the Gorilla habituation camp on Dipikar island); **C:**

Field assistant (Laurent Essome feeding a *Scotonycteris zenkeri* with sweet water, after processing, before release); D: we don't always only found bats in mist nets (here we found an Owl)



Présentation :

**Identification des chauves-souris
(mensurations externes et
cranio-dentaires)**

Par

Pr Paul Webala, Pr Eric Bakwo Fils & M. Franck Meyo



Présentation :

Méthodes de captures des chiroptères

Par

Pr Eric Bakwo Fils & M. Franck Meyo

Figure 8: Slides of Presentation given (in French) in DRC, August 2024

ANNEX – Financial Report
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