

Final Evaluation Report

Your Details	
Full Name	André Luis Sousa Gonçalves
Project Title	Spatial and temporal patterns in the occurrence of <i>Leopardus wiedii</i> in response to environmental, anthropogenic factors and potential intra-guild predation
Application ID	26067-1
Date of this Report	11 th May 2022

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
Place de camera traps in the two Ducke Forest Reserve and Cuieiras Biological Reserve				We were able to sample both reserves as planned.
Capture de cats to monitoring by telemetry				We did around 1 year of uninterrupted field sampling to try to capture the cats; however, despite being detected by the camera traps, the individuals did not enter the tomahawk traps, they are trap shy. So, we partnered with the rescue centre of wild animals in Manaus city to release two rescue animals. We had opportunity to receive other animals in the rescue center, but they are not surviving because they arrived at centre very weak and sick.
Mapping of houses and farms located around areas to understand human perceptions				When we were going to start this part of the work, the COVID pandemic started, making it impossible to execute it. However, we intend to resume this activity in a near future. Entry into some reserves is not yet allowed and in others there are some restrictions.
Compilation of dataset of camera traps in the Amazonian scale				We partnered with several national and international institutions throughout the Amazon, which made the felid data available to carry out our analyses.
Define population status, occurrence predictors, movement patterns, home range sizes, activity patterns				It was possible over this period of research to determine these patterns.
Contribute to the Species Action Plan for Brazilian small wild cats				We were invited to participate in the second meeting to update the national plan for small cats and we made great contributions.

Publication of results in various sources of media (academic and non-academic dissemination)				During this period of research, we publicised it in various media, we were invited by local TV channels to follow the release of felids and I was able to give lectures in some places to disseminate knowledge.
Training young people living near study areas				I had the opportunity to train undergraduate and master's students and young residents of the communities.

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

a). Our first findings related to temporal and spatial aspects were described, separately, in two manuscripts. First, we evaluated the temporal relationships between mesocarnivores in 17 reserves with different anthropic impacts with data from camera traps on an Amazonian scale, focusing on their relationship with the margay *Leopardus wiedii*. The species were margay *Leopardus pardalis*, jaguarundi *Puma yagouaroundi*, tayra *Eira barbara*, coati *Nasua*, crab-eating raccoon *Procyon cancrivorus*. We tested four ecological hypotheses that possibly shape the temporal relationships between these carnivores: temporal partitioning, competitor avoidance, risk allocation and prey synchrony hypothesis.

As predicted by the temporal partitioning hypothesis, the species exhibited preferences for a specific portion of the circadian cycle, with margay and crab-eating raccoons being primarily nocturnal, jaguarundi, tayra, and coati being primarily diurnal and ocelot being mostly nocturnal to cathemeral, though all showed crepuscular activity. The percentage of each diel pattern differed among areas and for some species, it was affected by disturbance levels. We found partial evidence for the hypothesis related to dominant competitor avoidance on a broader scale for some mesocarnivores.

Apparently, fine-tuned adjustments in peaks of diel activities and related to the effect of lunar illumination permits coexistence. As expected, the hypercarnivores synchronise their diel activities with their prey and, conversely, on a fine scale, prey avoided predators when moonlight was considered. Throughout the study, these mechanisms were explored in the context of these hypotheses. Our study indicates that, although the activity patterns exhibited by animals are shaped by long-term evolutionary forces, these are also fine-tuned by flexible responses to the short-term actual state of the environment, possibly to maximise foraging efficiency and reduce the chances for agonistic encounters. Our findings provide insights into the complex behavioural rhythms of tropical mesocarnivores and their plasticity to adapt to changes in local conditions.

For the second chapter, we investigated the spatial relationships between two congeners, *Leopardus wiedii* and *Leopardus pardalis*. Habitat use was evaluated in a context that considered the entire Amazon biome; the metric used for this was occupancy. We related habitat use by species to environmental, anthropic, and food resource factors in 17 reserves. Although the species were related to different factors,

they responded positively to the distance from secondary roads avoiding such environments. On the contrary, the ocelot preferred flatter and lower areas than the margay, positively related to elevated areas. In a context of interaction, the species avoided each other in the use of space, but in heavily anthropised areas, they were detected in similar locations. We attribute this to the fact that they are forced to be in the core areas of the disturbed reserves due to the human impact caused in their peripheral region. Our study is an example of how collaborative approach that combines small-scale datasets utilises bycatch data can be powerful tool to fit occupancy models at a broader spatial scale and enables us to make generalisations about variables influencing occupancy of the Neotropical cats on a scale not previously possible for these species and therefore have conservation management implications applicable across the global range of the species, especially in protected areas.

b). Over 1 year of capture, it was possible to capture different species and test different techniques (live quails, urine of domestic animals, vanilla and others), for capturing small felids. Small felids are elusive animals and have a low density, which was expected in the context of our proposed work. Among the baits used to attract the animals, live quails were the most efficient because they visually and audibly attract carnivores. Not only them, but several other species such as tortoises, opossums, lizards, and more than five species of hawks.

Although it was not possible to capture the cats in the tomahawk traps on the reserves, we had the opportunity to release rescue animals. These animals were rehabilitated for a while and after evaluation by the veterinarian and other professionals involved, they were released in a previously chosen location in these reserves. We monitored two specimens, one in the Ducke Reserve where was possible to follow a margay in the wild for about 15 days and different behaviours were observed, such as choices for environments close to the headwaters of streams for rest. In addition, a jaguarundi was released in the Cuieiras Biological Reserve and followed for 8 days. It was possible to detect the animal preying in the wild and we observed a choice for environments close to the edges of the terra firma. These preliminary findings will be reported in scientific communications.

During the captures was possible to talk to local residents and educate them about the importance of preserving these animals, as they are species that are often killed in retaliation because they prey on farm animals such as chickens and pigs. We also talk to people about the importance of taking their domestic animals, such as dogs and cats, to veterinarians to avoid the transmission of diseases and about the importance of avoiding hunting other vertebrates that are important for the maintenance of the forest.

c). Our camera trap data comprised a set of 17 reserves, all in terra-firma environments across the Amazon. However, the biome is composed of other less representative environments, but of great importance for its maintenance. In this context, we investigated with a specific set of data from our research group, the importance of wetlands in the use of space by *Leopardus wiedii* and its congener *Leopardus pardalis* and other terrestrial mammals. We evaluated several ecological parameters, such as richness, abundance, equitability, in addition to analysis of

species occupancy, where we compared between terra firma and igapó environments to understand the dynamics of space when these environments are available to forage by terrestrial vertebrates.

Our findings showed that the igapó and terra firma forests had similar species richness, although the last forest type had higher species abundance and biomass probably due to its higher primary productivity, yet igapós were evenness when compared to terra firma forests. We also found a marked difference in non-volant mammal species composition between those forest types despite sharing 84% of the species, which was then explored in a more refined way for 20 mammal species in terms of habitat use using the occupancy models. The observed differences were associated more with higher abundances of some specific functional groups i.e., frugivores/granivores than with turnover of species, but others also had similar occupancy between forest types i.e., carnivores. These findings reinforce seasonal flooding as the relevant factor structuring the composition of nonvolant mammal assemblages between terra firma and floodplain forests, even in nutrient-poor habitats such as igapós. Also, highlights the importance of maintaining the mosaic of natural habitats on the scale of the entire landscape, with major drainage basins representing management units to provide sufficiently large areas to support a range of ecological processes (e.g., nutrient transport, lateral movements, and the persistence of apex predators).

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

There was a certain delay in acquiring telemetry equipment, among others, due to the difficulty to bring to Brazil. However, some partner researchers from outside Brazil helped us bring the equipment and carry out the proposed work. In addition, the lack of Brazilian investment in research hampered us in terms of logistical assistance for the work areas.

When it is necessary to capture free-living animals and contact local people from the communities inside conservation units, authorisation must be given by supervisory institutions and the ethics committee. These processes are a little time-consuming and took some time for us to start the work, but we obtained all the necessary licenses.

Some difficulties were related to in-field logistics. The regions isolation in Cuieiras that is 60 km from Manaus, aggravates the impact of unforeseen events that inevitably occur during fieldwork (e.g., damage and subsequent repairs to the boat's engine and cars). However, it was possible to find solutions to these unexpected difficulties and solve them without major impacts on the pre-established activities.

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

The two reserves sampled had totally different local contexts. While the Ducke Reserve is in a peri-urban context, the Cuieiras Biological Reserve, which is more isolated, has only a few traditional communities living in its vicinity. In both cases, the communities surrounding these reserves were involved. In meetings with the presence of community members in the Cuieiras Reserve, it was possible to present preliminary

results of the images captured by the camera traps. Some of them knew about the species but had never seen video footage of them, which impressed them. We took the opportunity to educate about the importance not only of felids but of other mammals. One of the great benefits was this change of perception about the species. In the camera trap installations, we always choose to hire community members to generate incomes for their families and insert them into the context of the activities promoted in the reserves. During the sampling, it was possible to make two editions of the course called "Natural History of the Cuieiras River", which aimed to immerse both students and community members in the universe of research and scientific knowledge.

5. Are there any plans to continue this work?

Yes! The results of both camera traps and telemetry monitoring raised several other questions. We would like to maintain as partners the rescue centre of wild animals in Manaus city to release and monitor several other mammals when it is possible to return them to nature after rehabilitation.

During the execution of the project, it was not possible to evaluate the human dimensions related to felids due to the covid pandemic. However, we would like to continue the studies along these lines and understand the issues related to the impact of diseases from wild animals on the local fauna, especially small cats in a near future. However, the priority is to finish writing the scientific articles that make up my thesis.

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

During the project execution period, about dissemination to the academic community, a manuscript about temporal relationships between felids was "awaiting recommendation" for publication in the Journal of Mammalogy. The other is in the submission process, one to Peerj and the third will be send to Nature Scientific Reports. We had the opportunity to be filmed by a local broadcaster "Manaus Selvagem" when we released a jaguarundi cat in the region of the Cuieiras River Basin. This dissemination had a great impact on local viewers. It involved a series of partners, from private institutions, such as the Museum of the Amazon, to government institutions, such as IBAMA and INPA.

We have been publicising the studies on web pages, such as our website of the Research Group on Amazon Mammals. In addition, we also created two profiles on Instagram to publicise the results generated in the two reserves. The profiles are: "Ducke Reserve Mammals" and the other "GPMAInpa." In both, we disclose to the general public videos of the camera traps and other information related to the felids and other Amazonian mammals.

During the research, I could share preliminary data with experts who make up the National Action Plan for Small Cats. This information is essential to define guidelines for the conservation of these species.

Finally, throughout the sampling, it was possible to participate of the two editions of the course called "Natural History of the Cuieiras River," which aimed to immerse both

students and local communities in the universe of research and scientific knowledge. This is a permanent and annual course promoted by the National Institute for Research in the Amazon and is intended to encourage young researchers to do quality science in the Amazon region. I was able to teach field classes in this course and share knowledge about mammals.

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

I believe it is essential to continue studies with telemetry monitoring of species in the Amazon. The advancement of technology related to the monitoring of free-living species and the reduction of the costs of these technologies will make this type of study increasingly viable. Although camera traps generate a range of extraordinary results, following these species in real time is necessary. Understanding the dynamics of space use in environments close to rural communities would be one of the priorities at this time. Mainly from peri-urban areas like the Ducke Reserve which is becoming more and more isolated increasing the chances of conflicts with human beings. Allied to this, we intend to carry out vaccination campaigns for domestic animals in these areas close to the reserves, to reduce the chance of transmission of pathogens to free-living species.

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 logo has been used in all of the preliminary presentations I've made related to the project and will continue to be used whenever necessary. In the final presentation of my thesis, I will refer to The Rufford Foundation and its importance for the conclusion of my doctoral thesis. This reference to the institution will be textually highlighted in the acknowledgments of the thesis and has been used in all the articles I submitted.

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

André Luis Sousa Gonçalves – Principal investigator of the project. He was the main responsible for all the phases of the project.

Wilson Roberto Spironello – André's Doctoral advisor. Assisted with the project elaboration and he will assist with the paper elaboration, expeditions and by lending camera traps and research equipment's.

Tadeu Gomes de Oliveira – André's co advisor. He assisted with the project elaboration, and he will assist with the paper elaboration.

Lucian Veras Canto - He is a graduate student with experience in camera traps, ecology and natural history of mammals in the Amazon. He has helped with all expeditions.

Natalia Aparecida de Souza Lima - She is an environmental analyst of IBAMA (Brazilian Institute for the Environment and Renewable Natural Resources) responsible for the wildlife rescue center of Manaus.

10. Any other comments?

I would like to thank you immensely for your kindness and that of the committee in providing the sponsorship for this pioneering research, without which none of this would be possible. Carrying out this study was a great personal and professional challenge but having the help of renowned institutions such as The Rufford Foundation gives us the necessary courage to work in environments with difficult logistics such as the Amazon.

Especially in Brazil, we are passing by a political crisis where funds to research are being reduced. In this scenario, young research has every time fewer chances to get grants for development their research and carrier. So, initiatives like RF are enabling that we, undeveloped countries ecological and conservation research, can-do high-level research in ecology and conservation on threatened environments and species. Below are some records of the unique moments of this work.



Figure 1. Team responsible for releasing the small cats in the Cuieiras Biological Reserve.



Figure 2. Partnership between several institutions (INPA, IBAMA, MUSA) and a local broadcaster to publicize the release of the felids.

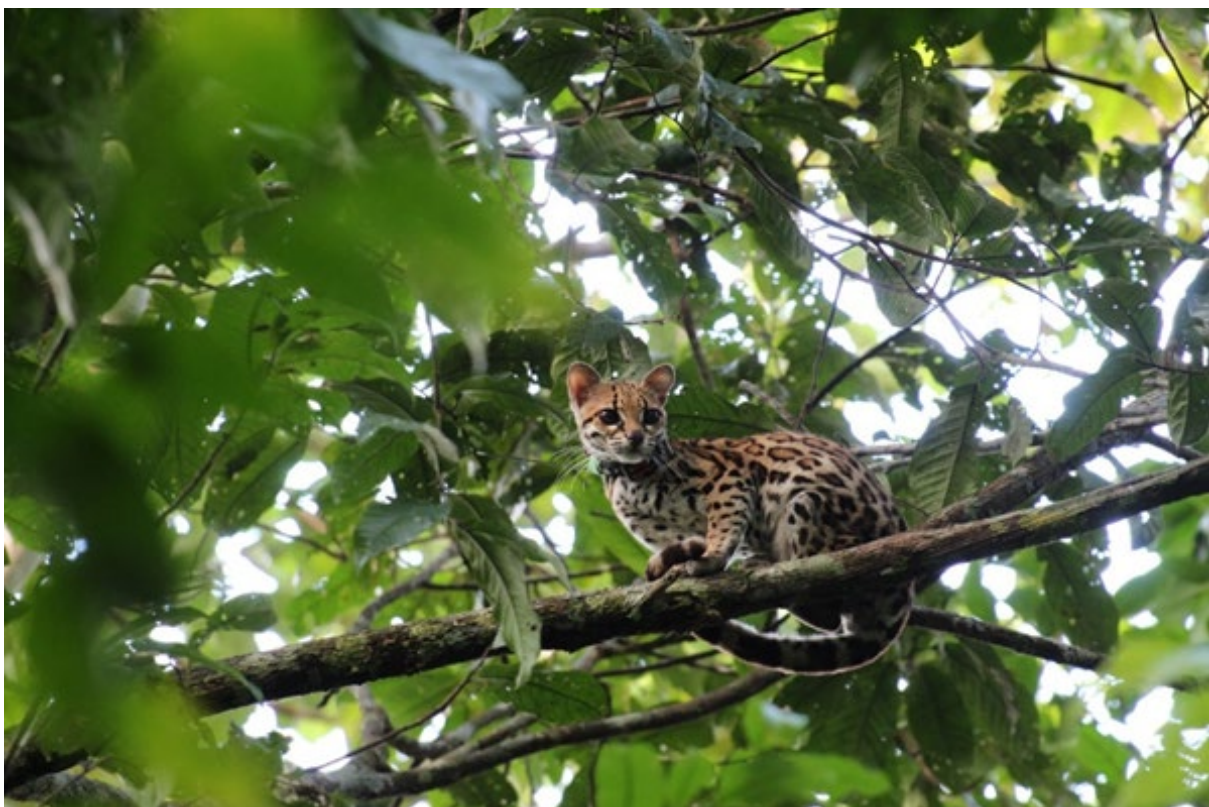


Figure 4. Record of *Leopardus wiedii* released and monitored near Reserva Ducke Located in Central Amazon, Brazil.



Figure 3. Records of *Leopardus wiedii* and *Puma yagouaroundi* individuals with monitoring collar before release in the wild.



Figure 5. Record of *Puma yagouaroundi* before to be released and monitored in the Rio Cuieiras Biological Reserve located in Central Amazonia, Brazil.



Figure 6. Annual meeting of specialists responsible for the elaboration of the National Action Plan for the Conservation of Small Cats in Brazil in Atibaia, São Paulo, Brazil.



Figure 7. Disclosure on the Instagram page of the work being carried out by the Research Group on Amazon Mammals of the National Institute for Research in the Amazon-INPA, located in the city of Manaus, Amazonas, Brazil.



MUSEU NA FLORESTA

II História Natural no Museu na Floresta no Rio Cuieiras

Base Alto Cuieiras/Inpa, Manaus, Amazonas

VAGAS:
o curso oferece 18 vagas

ALUNOS:
-Estudantes de graduação ou início de mestrado
-Estudantes e comunitários ligados ao turismo ambiental e comunitário
-Estudantes e profissionais da área de foto/vídeo documentação de natureza

COMO SE INSCREVER:
-Preencher formulário de inscrição no endereço <https://forms.gle/Cvze7WhV85Uz3rW9>
-Enviar para museunafloresta@gmail.com o Curriculum VITAE caso não tenha informado o link no formulário online.

PROGRAMA:
O curso terá professores/monitores de várias linhas do conhecimento tais como Aves; Mamíferos; plantas e fungos; Feltes; Interações planta-animal, além de conhecimento em comunicação (vídeo/imagem) e documentação da natureza. Durante a primeira semana os alunos experimentarão todas as linhas temáticas e na segunda semana desenvolverão projetos em grupo ligados à linha de sua escolha. Esses projetos devem contribuir com produtos e/ou propostas de atividades de turismo científico de natureza.

25 de Maio a 08 de Junho de 2019

OBJETIVO DO CURSO:
Este curso integra o Projeto Museu na Floresta, parceria do Instituto Nacional de Pesquisas da Amazônia (INPA) com a universidade de Quioto e apoio da Agência de Cooperação Internacional do Japão (JICA).
Como parte do Museu, foi inaugurada em 2018 uma estação de campo no Rio Cuieiras para atividades de turismo e educação científica.
O curso tem os seguintes objetivos:
1) Introduzir os ecossistemas amazônicos, a identificação de organismos, interações ecológicas e outros aspectos de "história natural";
2) construir com os alunos propostas de atividades científicas que possam ser implementadas como atividades educativas e de turismo científico;
3) experimentar novas tecnologias para de coleta de dados biológicos;
4) produzir informação sobre a biodiversidade da área.

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APOIO
INPA
WRC
JICA

Figure 8. Call folder for the Natural History Course of the Cuieiras River held in 2019.



Figure 9. Record of the Natural History Course where there was a lot of exchange of knowledge at the most diverse academic and non-academic levels.