Final Evaluation Report

Your Details	
Full Name	Flávia Pereira Tirelli
Project Title	Effects of human disturbance on occupancy and activity patterns of Carnivora (Mammalia) species in the Uruguayan savannah
Application ID	32609-1
Date of this Report	4th April 2023

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
To estimate activity patterns of carnivoran species and compare the temporal overlap among them, as well as among these native species and exotic /domestic ones (e.g., European wild boars, cattle, dogs, etc.).				Canidae *Lycalopex gymnocercus* *Cerdocyon thous* Felidae *Leopardus geoffroyi* *Leopardus wiedii* Procyonidae *Procyon cancrivorous* *Nasua nasua* Menphitiidae *Conepathus chinga*
To evaluate probability of detection of carnivorans in the study areas.				Canidae *Lycalopex gymnocercus* *Cerdocyon thous* Felidae *Leopardus geoffroyi* Procyonidae *Procyon cancrivorous* *Nasua nasua* Menphitiidae *Conepathus chinga*
To estimate probability of occupancy of carnivorans in the study areas.				Canidae *Lycalopex gymnocercus* *Cerdocyon thous* Felidae *Leopardus geoffroyi* Procyonidae *Procyon cancrivorous* *Nasua nasua* Menphitiidae *Conepathus chinga*
To evaluate the spatial co-occurrence among native carnivorans and exotic/domestic species (e.g., European wild boars, cattle, dogs, etc).				Procyonidae *Procyon cancrivorous* *Nasua nasua* Menphitiidae *Conepathus chinga*
To generate and submit a formal document containing recommendations for the				

conservation of carnivorans based on the results of this project to governmental environment organisations and to local farmers of Brazil and Uruguay.				
To create a simplified documentary series about carnivorans of Uruguayan savannah and their importance and conservation, using images recorded in our study. We intent to use these videos in citizen science projects with local communities and to share them in social media (YouTube, Facebook, Instagram, etc).				Canidae *Lycalopex gymnocercus* *Cerdocyon thous* Felidae *Leopardus geoffroyi* *L. wiedii* *L. munoai* *Herpailurus yagouaroundi* Procyonidae *Procyon cancrivorous* *Nasua nasua* Menphitiidae *Conepathus chinga*

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

We have conducted the most extensive camera trapping sampling effort in the Uruguayan savanna ecoregion, comprising a total of 184 sites and an effort of 16,560 camera trap-nights. Our study has recorded a total of 31 mammalian species, which 23 were native and eight exotic. We recorded nine native carnivorans species. Furthermore, our study has documented the presence of the Muñoa's pampas cat (*Leopardus munoai*) in two different study areas, which is the rarest and threatened felid species in the ecoregion (Fig. 1). It is important to note that this species has been recorded in camera traps only twice in the history before these records. The data obtained have been utilised in four Master's theses and currently serve as base for two PhD dissertations.

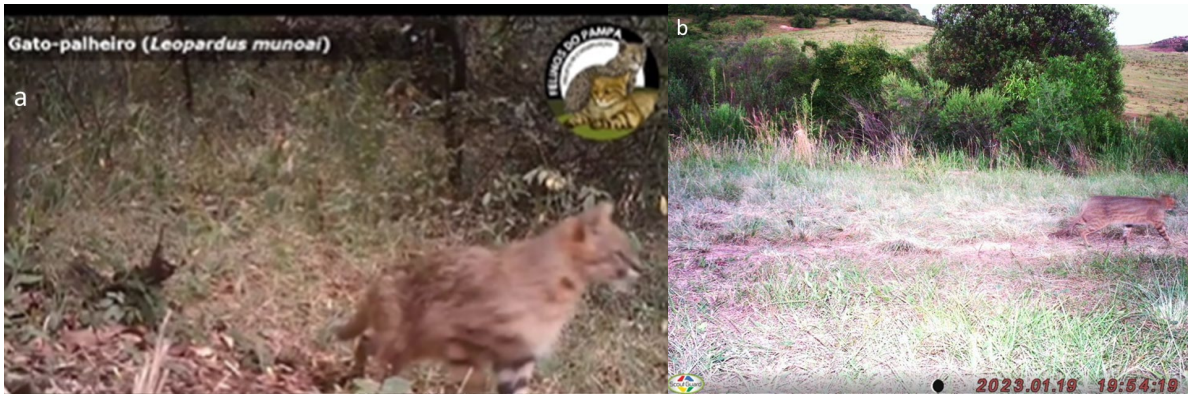

Figure 1: Muñoa's Pampas Cat (Leopardus munoai). a) Record from 2022 in Dom Pedrito RS, Brazil; and b) a record of the species in Santana do Livramento in 2023, RS, Brazil.

I. **Scientific** - The understanding of ecological characteristics of carnivorans in Uruguayan savannah and how land use and invasive species affect their spatial and temporal patterns will fill several knowledge gaps and will help to define some important management actions.

Master's theses:

Santiago Turcatti – finished his Master Science (in UdelaR University – Uruguay). The objective of his Master's was to determine daily activity patterns and habitat use through different detection and occupancy models for crab-eating fox (*Cerdocyon thous*), pampas fox (*Lycalopex gymnocercus*), and Geoffroy's cat (*Leopardus geoffroy*) in the mosaic of anthropic landscapes in the Uruguayan savanna ecoregion), using camera trap records. The three meso-carnivores were predominantly nocturnal, with crab-eating fox exhibiting a mostly vespertine-nocturnal activity pattern, showing a peak of activity at dusk, in contrast to pampas fox, which showed a peak of activity at dawn, being mostly crepuscular-nocturnal. These opposite peaks in the daily activity pattern between fox species have not been recorded in other regions. Regarding Geoffroy's cat, this species showed a mostly nocturnal activity pattern. After applying the different models, the highest detection and occupancy probability for crab-eating fox and Geoffroy's cat were in the native forest environment, and for pampas fox, it was in the natural field environment. Despite a higher use of the forest environment by Geoffroy's cat, the species showed some degree of adaptability to habitat alterations produced by agricultural activities. The results obtained constitute a very important contribution to the region where this study was carried out, as well as allowing us to compare the results with other studies conducted for these species in other regions. Link to the thesis https://www.colibri.udelar.edu.uy/jspui/handle/20.500.12008/31064

Jordani Dutra – finished his MSc (in UFRGS University – Brazil). We focused on evaluating site occupancy and describing the daily activity patterns of three species occurring in the Uruguayan savanna: the coati (*Nasua nasua*), the crab-eating raccoon (*Procyon cancrivorus*) (Procyonidae: Musteloidea); and Molina's hog-nosed skunk (*Conepatus chinga*) (Mephitidae: Musteloidea). Using occupancy models, we estimated the probability of detection and occupancy of the coati and the Molina's hog-nosed skunk in the ecoregion. We were unable to model occupancy and detection of the crab-eating raccoon due to the low number of detections of this species. We tested the uniformity of daily activity using Rayleigh's test. The coati showed a higher detection probability in habitats with taller vegetation ($p<0.05$); also, its occupancy probability was higher at sites with a greater percentage of forest (p-value<0.05). Molina's hog-nosed skunks were more detected in sites with less canopy cover ($p<0.05$), shorter vegetation ($p<0.05$), and higher livestock frequency ($p<0.05$). None of the occupancy variables of the Molina's hog-nosed skunk was significant. The average detection of the coati was 0.26 (0.30 – 0.41: CI) and for the Molina's hog-nosed skunk was 0.18 (0.09 – 0.29: CI). The average occupancy probability of the coati was 0.18 (0.07 – 0.41: CI) and for the skunks was 0.38 (0.15 – 0.70: CI). When extrapolating the occupancy to all the Uruguayan savanna ecoregion, the coati, showed higher probably of occupancy in the shrub grassland ecological system, just south of the Atlantic Forest. The daily activity pattern of the two species was significant non-uniform, with the coati

showing mostly diurnal activity (Rayleigh -Z0,6679, p-value < 0.05), and the Molina's hog-nosed skunk mostly crepuscular-nocturnal activity (Rayleigh -Z0.6386, p-value 0.05). We also described the activity of the crab-eating raccoon in the Uruguayan savanna using two datasets, the first with records obtained from 2013 to 2015, and the second with records obtained from 2019 to 2022. The crab-eating raccoon revealed to be crepuscular-nocturnal (Rayleigh -Z0.5538; p-value < 0.05). Of the 125 independent detections, 106 were from solitary individuals and 19 from groups of two or more animals. Here we have important results for this species. We showed that the coati occupies when its higher percentage of forest are present in the environment, while the Molina's hog-nosed skunk showed to be less selective about its preferential habitats.

Marcelo de Oliveira – finished his MSc (in UFRGS University – Brazil). Site occupancy and daily activity remain mostly unknown for many species of armadillos. Seeking to address this issue for four cooccurring species (*Cabassous tatouay*, *Dasypus novemcinctus*, *D. septemcinctus* and *Euphractus sexcinctus*). Most records belonged to *D. novemcinctus*. We modelled the site occupancy probability of this species as a function of environmental covariates (i.e., distance to water, distance to urban areas and site occupancy of exotic species). Models revealed that site occupancy probability increased along with the distance to urban areas. However, when analysing either domain separately, no covariates influenced site occupancy. To understand the daily activity patterns of armadillos, we measured the nocturnality of each species. All showed highly nocturnal activity, averaging between 22:00 and 00:00. This was unexpected for *D. septemcinctus* and *E. sexcinctus*, regarded as mostly diurnal in scientific literature. Then, we estimated the temporal overlap between *D. novemcinctus* records in either domain and between *D. novemcinctus*, other armadillos and the exotic species *Canis familiaris* and *Sus scrofa*. *Dasypus novemcinctus* activity did not vary between domains, showed high overlap with that of other armadillos, intermediate overlap with *S. scrofa* and low overlap with *C. familiaris*. These results add to our understanding of armadillo ecology, especially that of *D. novemcinctus*, while also providing valuable insights into threats to this species' conservation, particularly the urbanisation of its natural habitat. Link to the thesis:
https://lume.ufrgs.br/handle/10183/2/browse?localeattribute=es&type=author&value=Caetano%2C+Marcelo+Oliveira

Mateus Zimmer – is finishing his MSc (in UFRGS University – Brazil) focusing on occupancy, activity pattern and spatiotemporal analysis of *Mazama gouazobira*, *Hydrochoerus hydrochaeris*, and the exotics *Sus scrofa* and *Axis axis*. The study is ongoing.

Marina Favarini – started her PhD at UFRGS University – Brazil with activity patterns and density of *L. wiedii* in Uruguayan savanna. According to IUCN, this is the southern limit of the species distribution and would be very important to understand if this region support populations of the species. We already observed that we found different populations of this arboreal species in this open ecoregion. To estimate density, we will need to cover more areas in Uruguay, and Brazil with a specific camera design. We intent to submit a project to Rufford to continue this study in Uruguayan Savanah ecoregion.

Felipe Peters – started his PhD at UFRGS University – Brazil with activity patterns and density of *L. geoffroyi* in Uruguayan savanna. This study also needs to cover more areas with a specific camera design. We intent to submit a project to Rufford to continue this study in Uruguayan savana ecoregion, including Uruguay, Brazil and Corrientes in Argentina. This project will cover Marina Favarini and Felipe Peters PhD fieldworks.

II. **Community and governmental engagement –** To generate and submit a formal document containing recommendations for the conservation of carnivorans based on the results of this project to governmental environment organisations and to local farmers of Brazil and Uruguay.

We participated of Territorial Action Plan in Brazil (https://www.diariooficial.rs.gov.br/materia?id=582998) including a threatened species of small wild cat (Leopardus munoai).

I am member of technical group of Brazilian Small Wild Cats Action Plan https://www.gov.br/icmbio/pt-br/assuntos/biodiversidade/pan/pan-pequenos-felinos

We participated in a local governmental online event with participation of the mayor, deputy mayor and environment secretary of Alegrete city, Brazil (https://fb.watch/7JSa4PuCg0/).

We are working with local government in Candiota, one of our study areas, where we also work with the rural community.

We generated a formal document containing recommendations for the conservation of carnivorans based on the results of this project to submit to governmental environment organizations and to local farmers of Brazil and Uruguay.

III. **Environmental education –** To create a simplified documentary series about carnivorans of Uruguayan savannah and their importance and conservation, using images recorded in our study. We intent to use these videos in citizen science projects with local communities and to share them in social media (YouTube, Facebook, Instagram, etc).

We produced videos, here are the links:

https://youtu.be/glATDKKDCrI
https://youtu.be/GusG3ZsWb00
https://youtu.be/ZbdXh8g1qhg
https://youtu.be/MtogKtp0w2o
https://youtu.be/jOLmgMLdTXA
https://youtu.be/94o6JtgrG3s
https://www.instagram.com/p/CjGq2tqMnrn/

Also our record of the Muñoa's pampas cat was on the Brazilian national news: https://g1.globo.com/sp/campinas-regiao/terra-da-gente/noticia/2022/06/07/felino-exclusivo-do-pampa-ameacado-de-extincao-e-filmado-no-rio-grande-do-sul.ghtml

And this other news explain about one of our study areas https://g1.globo.com/rs/rio-grande-do-sul/noticia/2022/11/04/fotos-gato-de-especie-ameacada-de-extincao-e-fotografado-em-vinicola-no-rs.ghtml

Figure 2: Educational environmental in local communities.

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

Due to the pandemic caused by COVID-19, we were more restricted to go to fieldwork in each country, but we did it, respecting all recommendation from World Health Organisation and local agencies. We sampled 72 sites 48 in Brazil and 24 in Uruguay. Since our team possesses members from Brazil and Uruguay and even with the border crossing restrictions, we were able - in some moments - go to fieldwork in each of the two countries with different teams. We used the lockdown time to study more about the analytical methods and to create spatial variables to our models. We also used these moments "to spread the word" about mammalian carnivores from Uruguayan savanna participating of different online events/live from Uruguay and Brazil. After the pandemic we returned to the field and we sampled more 103 sites, a total of 184 sites, but we would like to sample more areas in Uruguay.

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

We participated of different events in local communities, showing our project and we discussed about the solutions. Some members are native to the region of our study areas; therefore, we are in a unique position to understand each regional cultural characteristics, which help in local community engagement.

For example: I'm working in the region where I was born, in Brazil. This is a rural school and a local market (picture bellow) in my local community, the teachers there tell the kids they know me since I was a kid, and these students look at me with hope.

Figure 3: Left: Meeting of ranchers from Uruguayan Savana ecoregion, Alegrete, Brazil. Right: Local farmers in Rivera, Uruguay.

5. Are there any plans to continue this work?

Yes, we intend to focus now most on felid species and density analysis, but as we collect data from all species that cross the in front of the camera, we can use these data to future studies. We will apply for a second round of Rufford applications grants. In addition, we will continue the community/ governmental engagement and environmental education indefinitely.

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

We are submitting the results of this project in different formats and focusing according to our goals.

We intend to submit a formal document containing recommendations for the conservation of carnivorans based on the results of this project to governmental environment organisations and to local farmers of Brazil and Uruguay. We already submit some partial results in the Annual Reports 2020, 2021 and 2022 of Pró-Carnívoros Institute (IPC) (https://procarnivoros.org.br/o-instituto/transparencia/).

Additionally, the results of our study will help to reach part of the objectives 2, 3, 4 and 6 from the Brazilian National Conservation Action Plan on small wildcats (https://www.icmbio.gov.br/portal/faunabrasileira/plano-de-acao-nacional-lista/2835-plano-deacao-nacional-para-a-conservacao-dos-pequenos-felinos), which I'm also involved.

The documentary series about carnivorans of Uruguayan savanna, using images recorded in our study will be used as citizen science with local communities and we will share this in social media.

The responsible institution of this project is Pró-Carnívoros Institute (IPC) has the mission is to promote the conservation of Neotropical carnivores and their habitats. As a member of IPC, I present different lectures about our studies on carnivorans to schoolchildren, rural communities, etc.

We are also participating of many "lives" and podcast about environmental education on carnivorans, and posting videos and photos about our studies in social media of IPC, BiMaLab-UFRGS and Felinos do Pampa, such as:

- Podcast https://www.desabrace.com.br/bicho-048-gato-do-mato-grande-leopardus-geoffroyi/
- Podcast https://www.desabrace.com.br/091-felipe-peters-fronteiras-gatos-e-serras/
- Podcast https://www.desabrace.com.br/bicho-075-gato-palheiro-pampeano-leopardus-munoai/
- Pampas Day (please see at https://fb.watch/7JSpTkfN7q/)
- a local governmental on-line event with participation of the mayor, deputy mayor and environment secretary (https://fb.watch/7JSa4PuCg0/)
- Lives and news about the Muñoa's Pampas cat (https://ladiaria.com.uy/ciencia/articulo/2021/5/nuestro-gato-de-pajonal-esta-en-riesgo-de-extincion/ and https://www.youtube.com/watch?v=JbCtfwpoWzI&t=169s)
- Threatened fauna from Uruguayan Savanna (https://www.uniritter.edu.br/noticias/noticias/iv-semana-academica-de-veterinaria-acontece-de-24-a-28-de-maio)
- and many others (https://www.instagram.com/p/CSb0OPRNZeP/?utm_source=ig_web_copy_link
https://instagram.com/bimalab.ufrgs?utm_medium=copy_link
https://instagram.com/institutoprocarnivoros?utm_medium=copy_link

Finally, the theses and dissertation that are completed are online, and we intend to publish the results in scientific journals. The study with armadillos is already accepted in Mammalian Biology. The study with the Procyonidae and Mephitidae is in process of submitting. The others are ongoing.

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

I think it is important to go deeper in the understanding of ecology and response of each species of Carnivora of Uruguayan savanna, especially those they are threatened and those that are more affected by human actions.

The local community engagement is the key to help the carnivore fauna. In addition, people need to know about a subject to get involved to sensibiliser, therefore citizen science in social media it is also a very important next step.

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?

Yes, the Rufford Foundation logo was used in the Annual Reports of IPC (https://procarnivoros.org.br/o-instituto/transparencia/)) and in some presentations/ lives (e.g., https://fb.watch/7JSpTkfN7q/, https://fb.watch/7JSa4PuCg0/).

It was also used in videos on YouTube, such as this one https://www.youtube.com/watch?v=GusG3ZsWb00 or this one https://youtu.be/glATDKKDCrI

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

Flavia Pereira Tirelli, PhD. Design of experiment, collect data/ fieldwork, data organization, data analysis and interpretation, writing of the article or reviewing and/or revising the text and/or figures, divulgation in social media, reports, and community engagement.

Jordani Dutra - data organization, data analysis and interpretation, writing of the article or reviewing and/or revising the text and/or figures, divulgation in social media, community engagement.

Marcelo Oliveira - data organization, data analysis and interpretation, writing of the article or reviewing and/or revising the text and/or figures, divulgation in social media, community engagement.

Mateus Zimmer - data organization, data analysis and interpretation, writing of the article or reviewing and/or revising the text and/or figures, divulgation in social media, community engagement.

Santiago Turcatti - data organization, data analysis and interpretation, writing of the article or reviewing and/or revising the text and/or figures, divulgation in social media, community engagement.

Maria João Pereira, PhD. Design of experiment, collect data/ fieldwork, data organization, data analysis and interpretation, writing of the article or reviewing and/or revising the text and/or figures, divulgation in social media, community engagement.

Diego Queirolo, PhD. Design of experiment, collect data/ fieldwork, data organization, data analysis and interpretation, writing of the article or reviewing and/or revising the text and/or figures, community engagement.

We added two more members to our team **Felipe Peters** and **Marina Favarini**, they are starting their PhDs and are already working in collect data/ fieldwork, data organization, data analysis and interpretation, community engagement.

10. Any other comments?