

Monitoring Threatened Mammals at Three Giants Biological Station, Paraguay

Final Report



people's trust for
**endangered
species**



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Introduction

Current rapid and extensive land use change in the Paraguayan Dry Chaco and the Pantanal is resulting in dramatic unplanned habitat conversion. Guyra Paraguay, concerned by this situation, started a small monitoring program in 2012 to try to understand the dynamics of the habitat as well as the fauna of the region in Three Giants Biological Station in the Pantanal. The aim of this monitoring program is to take advantage of the unexploited nature of the study site to obtain data which will serve as a non-shifting baseline of mammal species occurrence, density, and predator-prey relationships as a comparative reference across a gradient of land use throughout the region. Apart from deforestation in areas surrounding the reserve, there is an absence of information to support the conservation case for this type of habitat. If measures are not taken in advance, the reserve will become an isolated patch in between an entirely altered landscape. However, if we can prove through rigorous scientific methods that the reserve helps to conserve a certain number of species, along with mass media communications about the importance of this area, we would greatly enhance our argument of the importance of site conservation. With this information we would work with nearby landowners to help them develop good practices based on habitat management to conserve species in the long term. Ultimately, it will provide a solid argument to protect the habitat.

Hence, in 2014 thanks to the support of The World Land Trust and People's Trust for Endangered Species, we initiated an intense and systematic monitoring program using camera traps to focus on cat species particularly Jaguar (*Panthera onca*) currently under threat due to habitat destruction and retaliation from cattle ranchers. Although a wide ranging species (Argentina; Belize; Bolivia, Brazil; Colombia; Costa Rica; Ecuador; French Guiana; Guatemala; Guyana; Honduras; Mexico; Nicaragua; Panama; Paraguay; Peru; Suriname; Venezuela, El Salvador; Uruguay) much of the Jaguar's habitat is considered not to be suitable habitat and the species has become regionally extinct through many of the northern parts of its range. The species is now thought to be restricted to 46% of its original range (Sanderson et al. 2002). Paraguay, and in particular the northwestern part of the country (Chaco) was named a Jaguar Conservation unit in the Americas for long term conservation of the species. Despite this, there has been no systematic research into this species in Paraguay and studies such as ours are critical in order to inform future conservation actions. Although the focus species of this project is the Jaguar, the camera trapping methodology will provide information on a range of threatened and endangered species within this habitat.

Our project Monitoring threatened mammals at Three Giants Biological Station is the first project of its kind in the Paraguayan Pantanal as well as the first step to establish baseline information regarding the status of the species, which is basically non-existent in Paraguay and actions are based on occasional sightings and old data sets. Thus, this project will

provide robust estimates that can easily serve as a starting point for monitoring and management of large mammals. Also, it will demonstrate the importance of conserving habitat where very rare and threatened species occur. In turn, this will provide us with a set of tools to influence habitat management and the establishment of natural corridors in increasingly deforested area that are vital for wildlife.

Objectives

1. Estimation of the community composition of terrestrial mammals.
2. Density estimations of species with uniquely identifiable individuals.
3. Quantification of the composition of carnivore diets.

Study area

Our study area is located in the Paraguayan Pantanal. The Pantanal is the largest wetland in the world, containing and sustaining a vast mosaic of different ecosystems. These provide crucial habitat for a uniquely abundant wildlife, making it a major tourist destination.



Fig. 1. Location of the Pantanal in South America

The global importance of the Pantanal is recognized by Ramsar and UNESCO. Located in the heart of South America, the Pantanal spans more than 150,000 sq km, a fertile basin of tropical waterways and floodplains extending into Brazil, Bolivia and Paraguay. Oscillating between just 80 and 150m above sea-level, it is a vitally important flood catchment area, playing a key role in regulating water-flow further south. It is affected by precipitation cycles in the Brazilian and Bolivian highland plateaux to the North. In the rainy season, run-off from the plateaux floods into the Pantanal, spreading across the region before draining slowly, through dense vegetation, into the meandering Paraguay River. During these annual floods, the Pantanal's water levels rise by 2 - 5m and up to 80 percent of the region is submerged. Soils are saturated; plant growth stimulated and the area's varied tropical ecosystems are brought to life.

The Pantanal is home to more than 3,500 known terrestrial and aquatic plant species. Mixed grasslands cover seasonally flooded areas, while forests are usual in higher regions, which have deep sandy soils with relatively good drainage. The Pantanal is characterized by an extraordinary abundance of wildlife, on a par with the most densely concentrated sites on the African continent. Its varied habitats harbor hundreds of animal species, including many endangered species. A 2003 paper lists 463 bird species in the Pantanal, making it the richest wetland site for birds in the world. More than a quarter of these bird species are considered of conservation concern. Around 124 mammal species

inhabit the Pantanal, including capybara, seven armadillo, five primate, eight wild cat, eight opossum and 36 bat species. Other famous and charismatic species of the Pantanal include Southern Anaconda, False water cobra, Tropical rattle snake, Green Iguana, Caiman lizard,

Black tegu and incredible

numbers of

Yacare caiman. Spectacular fish

species include Piranha, Pacu,

Golden Dorado and Surubi Catfish.



Fig.2. Aquatic birds down the Rio Negro river

For many years, the Pantanal's seasonal floods prevented development, protecting the site, and its wildlife, from manmade damage. Today, intensified human activity threatens massive irreversible harm to the region. There is an urgent need for greater environmental awareness and action at the local, national and international level. Major threats to the Pantanal are: land use change, hunting poaching and fishing, invasive species, major developments, pollution. Current conservation in this ecoregion is restricted to a fragmented collection of privately and publicly owned reserves. Particularly in government-owned reserves, lack of funding and/or commitment means that sites are often protected in name only. Active stewardship and surveillance may be entirely absent.

Three Giants Station located in Guyra Paraguay's private reserve in the Paraguayan Pantanal. The station covers 14,600 hectares of a unique transition zone between the Dry Chaco grasslands (in the west) and the world's largest wetland, the Pantanal (to the east). The resulting region is an interesting mosaic of ecosystems that hold a great diversity of species. The station is named after three species that are located here: the Giant Otter (EN), the Giant Anteater (VU), and the Giant Armadillo (VU) but considered by The Centro de Datos de Conservación in Paraguay to be in imminent danger of extinction within the country. Other large animals that can be found are tapir, jaguar, puma, maned wolf, peccary and marsh deer.

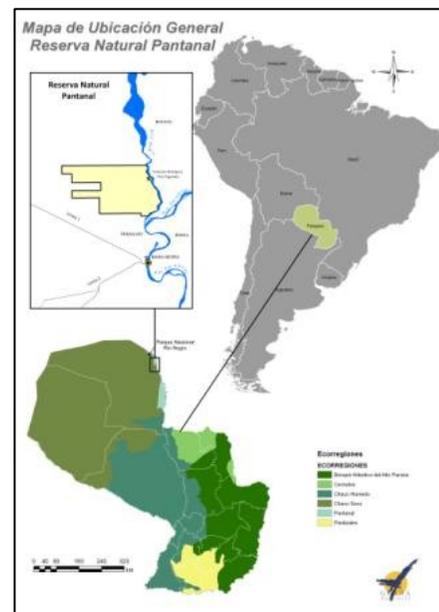


Fig. 3. Location on the Station in Paraguay.

The Chaco-Pantanal Reserve was established with support of WLT in partnership with Guyra Paraguay and currently protects almost 35,000 acres of habitat along the Río

Negro. (It is located in a strategically important area, providing trans-boundary protection with the Otuquis National Park in neighboring Bolivia. The annual flooding of the Chaco-Pantanal is particularly important for aquatic birds, including many migratory species, which stop here in their thousands from all over the Americas.

The Tres Gigantes (Three Gigants in Spanish) Station, is named after three local inhabitants - the Giant Otter (*Pteronura brasiliensis*), the Giant Anteater (*Myrmecophaga tridactyla*) and the Giant Armadillo (*Priodontes maximus*), all of can be seen in and around



the reserve. It is also an important area for many threatened bird species including the Endangered Hyacinth Macaw (*Anodorhynchus hyacinthinus*), Harpy Eagle (*Harpia harpyja*) and Endangered Crowned Solitary Eagle (*Harpyhaliaetus coronatus*).

Fig. 4. Three Giants Biological Station headquarters.

Methodology

Originally, our planned methodology was to employ two non-invasive techniques; camera trapping and scat analysis for our sampling. Unfortunately, due to unusually high rainfall and river levels during 2015, we were only able to conduct sampling with remote cameras in a limit area of the study are, as the large majority of the site remained flooded during the course of the year. We were unable to undertake the collection of scats for genetic analysis as the trails were flooded which limited our ability to collect samples. Furthermore, humid condition leads to the degradation of the fecal DNA and which would have made it's the replication difficult. Flooding also inhibited our ability to open new trails within the study site and consequently our initial deployment of the remote cameras was undertaken with three objectives in mind;

- 1) Examine picture quality and battery life of cameras since this was the first time that we were using Browning StealthCam cameras and within the context of the hot humid environmental conditions of the Pantanal,
- 2) Introduce the park rangers to the protocol and particularities of deploying and monitoring camera operations, as well as downloading and cataloging data from the cameras, and
- 3) Document species presence and composition and quantifying species-specific activity patterns.

From October 2014 to March 2015, 30 cameras were positioned in a combination of single and double camera stations along trails in riparian forest at intervals of approximately 400m. Starting in August of 2015 we were able to open approximately 3 km of trails in palm savanna within the study site where we established 7 single camera trap stations while also concurrently sampling at 13 sites in riparian forest during May 2015 and February 2016. This period of sampling was undertaken in an occupancy modeling framework to estimate species use of the habitat types and species-specific detection probabilities for use in the sampling design of future projects. Due to limited access within our field site we were unable to undertake sufficient sampling to estimate density of individual species as we had planned.

To quantify species-specific activity patterns we classified photographs taken between October 2014 and February 2016 by species, treating photographs of the same species taken at intervals >45 minutes at a sampling station as independent events. We then grouped the frequency of encounters per hour by species.

To model site occupancy, which we interpret as site use given that it was possible that individuals of most sampled species could be detected at more than one sampling site, from the concurrent sampling in riparian forest and palm savanna we employed a multi-species occupancy model within a Bayesian modeling framework. Our modeling approach allowed for estimating site use while incorporating incomplete detection which is the probability of detecting a species when it is using a site. We restricted the modeling to include species with >5 detections.

Results

▪ **First stage: Camera traps installation and calibration,**

In October 2014, we made the first trip to Three Giants Station to install the cameras, despite the fact that most of the station was flooded, except the tourist trails. Thus, after talking to the rangers and seeing the terrain, we decided to allocate the camera traps along the three tourist trails: Arirai (giant otter), Tatu carreta (giant armadillo) and Jurumi (giant ant eater).

We used this trip as a pilot period where we would determine if the cameras were installed at the right angle and height, test their endurance in extreme weather conditions (very hot days and rain) as well as test the endurance of the batteries.



Fig. 5. Tourist trails at the station.



Figs. 6 & 7. Browning camera trails.

After setting the cameras, we spent the next couple of days installing them in the dry parts of the trails. Every camera installed was registered with a GPS point, a specific number for the camera and the SD cards. After settings and installation, every camera was checked to verified the sensor is working and to correct the angle and height of the cameras (Fig. 8)

Figs. 8, 9 & 10. Sensor verification and flooded trails.



- Data obtained from the second stage

To date we have downloaded and process more than 80,000 images (including videos). From these, at least 35 % was discarded because they either contain images of people (mostly tourists walking on trails), no animal images (camera was activated by wind or leaves), other animals such as birds and reptiles.

The most frequently photographed species were: ocelot (*Leopardus pardalis*), jaguar (*Panthera onca*), paca (*Agouti paca*), gray brocket deer (*Mazama gouazoupira*), Carb-eating raccoon (*Procyon cancrivorus*), Fox (*Cerdocyon thous*), puma (*Puma concolor*), collared peccary (*Pecari tajacu*).



Figs. 11 & 12. Raccon and tapir captured at night on trails.

Table 1. Taxonomic classification and number of records per species.

Order	Family	Species	Number of records
Artiodactyla	Cervidae	<i>Blasthocerus dichotomus</i>	5
Artiodactyla	Cervidae	<i>Mazama gouazoubira</i>	236
Carnivora	Canidae	<i>Cerdocyon thous</i>	40
Carnivora	Canidae	<i>Chrysocyon brachyurus</i>	1
Carnivora	Felidae	<i>Leopardus pardalis</i>	180
Carnivora	Felidae	<i>Panthera onca</i>	52
Carnivora	Felidae	<i>Puma concolor</i>	30
Carnivora	Felidae	<i>Puma yagouaroundi</i>	13
Carnivora	Mustelidae	<i>Eira barbara</i>	1
Carnivora	Procyonidae	<i>Nasua nasua</i>	2
Carnivora	Procyonidae	<i>Procyon cancrivorus</i>	134
Cingulata	Dasypodidae	<i>Dasypus novemcinctus</i>	4
Cingulata	Myrmecophagidae	<i>Myrmecophaga tridactyla</i>	16
Cingulata	Myrmecophagidae	<i>Tamandua tetradactyla</i>	1
Perisodactyla	Tapiridae	<i>Tapirus terrestris</i>	11
Perisodactyla	Tayassuidae	<i>Pecari tajacu</i>	49

Perisodactyla	Tayassuidae	<i>Tayassu pecari</i>	7
Primates	Atelidae	<i>Alouatta caraya</i>	9
Rodentia	Cavidae	<i>Hydrochoerus hydrochaeris</i>	12
Rodentia	Dasyproctidae (Agoutidae)	<i>Dasyprocta azarae</i>	28



Figs. 13 & 14. Giant ant eater and a group of white lipped peccary along the trail.





Figs. 15 & 16. Puma and jaguar along the trails.



Species activity patterns

We observed three different activity patterns by the mammals detected in our sampling: nocturnal, diurnal and cathemeral.

The species of the order Artiodactyla were recorded across all hours but were mostly diurnal with *Mazama gouazoubira* showing peaks of activity from 0600 to 1800. *Pecari tajacu* was recorded between 0500 to 1800, exhibiting peaks of activity from 0600 to 1100, while *Tayassu pecari* was only recorded during the day with greater activity between 0500 to 1700 (Fig. 17).



Fig. 17. Gray brocket deer posing for the camera.

Species of the order Carnivora such as *Cerdocyon thous* illustrated peak activity between 2000 and 0900 and *Procyon cancrivorus* was more active between 1800 to 0600. For the family Felidae, *Puma yagouaroundi* was only recorded during the day with activity peaking between 0500 and 1200. *Leopardus pardalis* was one of the most recorded species and demonstrated peak activity between 1500 and 0800. *Panthera onca* was most active between 1800 and 1100, while *Puma concolor* exhibited peak activity around 1800, 0100 and 0500 (Figs. 18 & 19).

Figs. 18 & 19. Ocelot and jaguar.



Myrmecophaga tridactyla was most active between 0700 and 0900 and *Tapirus terrestris*, was only recorded from 2000 to 0600, exhibiting peaks at 2000, 0000 and 0600. *Alouatta caraya*, a principally arboreal species was only recorded during the day between 1000 and 1700. For rodents, *Dasyprocta azarae* had a peak activity during 0700 to 0900 and *Hydrochoerus hydrochaeris*, although detected throughout the day, was illustrated peak activity at 0700 (Figure 20).



Fig. 20. Agouti on trail.

The activity of *Panthera onca* overlapped with the activities of *Leopardus pardalis* and *Puma concolor*, suggesting that the temporal avoidance is not present in these species at the study sight. The number of records of *Puma yagouaroundi*, however, was higher during periods when other felines demonstrated reduced activity. There was little overlap in peaks of activity of predators and principal prey species *Pecari tajacu*, *Tayassu pecari* and *Mazama gouazoubira*. Conversely, activity patterns of *Panthera onca* greatly coincided with that of *Tapirus terrestris*.



Fig. 21. Marsh deer posing for our camera trap.

Fig. 22. Proportion of detections by hour for species with ≥ 5 photographs. n = number of photographs per species.



Species occurrence and habitat use

For all modeled species estimated occurrence was higher in riparian forest compared to palm savanna although variance was very high due to the relatively small number of cameras and low number of detections (Fig. 23). Consequently differences were not significant based upon 95% credibility intervals.

Detectability, however, was higher in palm savanna compared to riparian forest for all species and despite high variability we demonstrated a significantly higher detectability of gray brocket deer (*M. gouazoubira*) in palm savanna based upon 95% credibility intervals and a near significant difference for crab eating raccoon (*P. cancrivorus*). The observed higher detectability in palm savanna we attribute to the more frequent use of trails by all species as the undergrowth in the palm savanna of the study area is very dense and subsequently the trails facilitated movement by individuals.

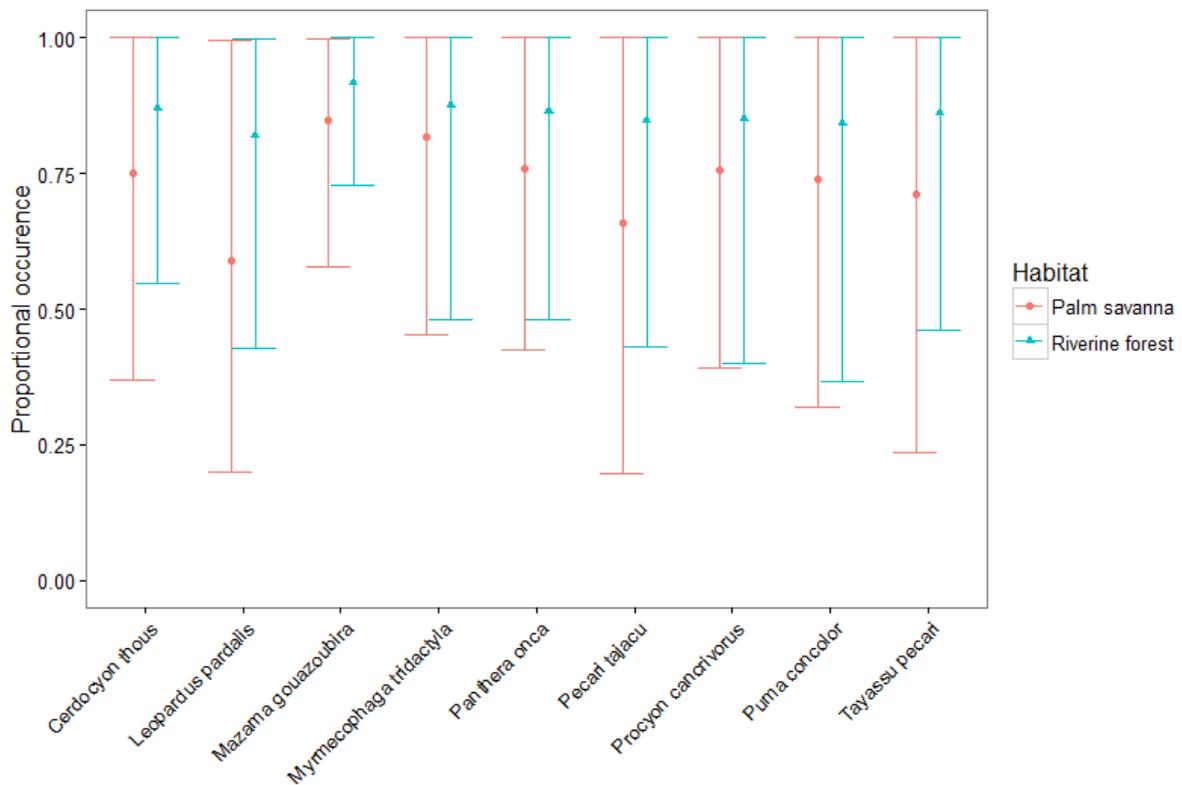


Fig.23. Proportional occurrence of species with >5 detections during the sample period in riparian forest and palm savanna. Error bars represent the 95% credibility intervals.

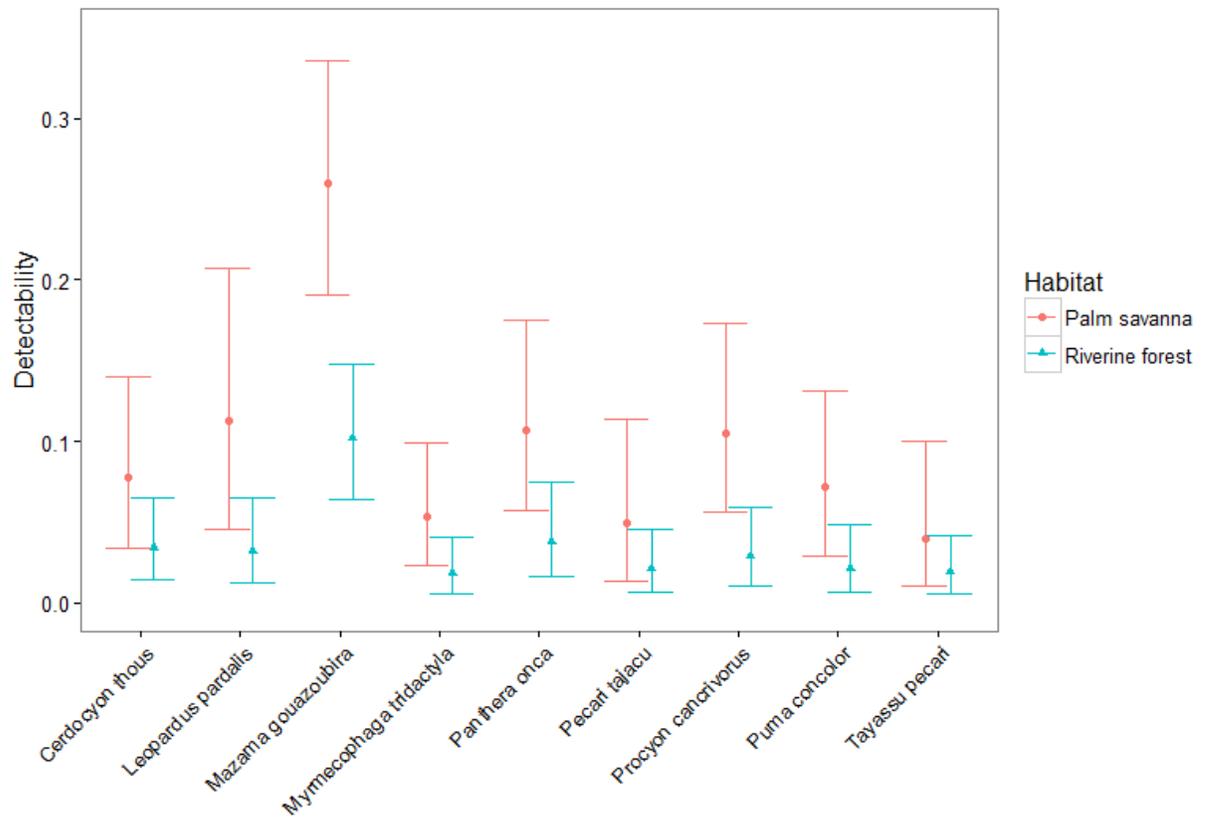


Fig.24. Detectability of species with >5 detections during the sample period in riparian forest and palm savanna. Error bars represent the 95% credibility intervals.

- Communication.

Dissemination of our project and some images were constantly communicated to the general public since the beginning of our project. For this purpose, we mainly used our weekly Bionoticias (mailing list) and our Facebook page, including videos and images on the later.

Moreover, our images and videos where featured on the most viewed nature TV program in the country called SNT al Natural. Our videos where shown in three episodes and have had great repercussion.

Finally, one of the images of our camera trap monitoring was awarded the top price in World Land Trust trail camera completion with an image of a jaguar walking on a flooded trail . Even though this image was not the result of the current project, this image shows the importance of a project like this which monitors endangered wildlife and provides proof of why it is important to conserve natural areas.

Links regarding information on the project.

1. http://www.guyra.org.py/index.php?option=com_k2&view=item&id=605:monitoreo-de-mamiferos-amenazados-en-la-estacion-tres-gigantes&lang=es
2. http://www.guyra.org.py/index.php?option=com_k2&view=item&id=891:monitoreo-de-mamiferos-en-los-tres-gigantes&lang=es
3. http://www.guyra.org.py/index.php?option=com_k2&view=item&id=795:organizacion-de-datos-de-proyecto-de-monitoreo-de-mamiferos&lang=es
4. http://guyra.org.py/index.php?option=com_k2&view=item&id=1135:monitoreo-con-trampas-camara-oho-hese-hina-papapy-nuha-camara-guive-tujurusupe-monitoring-with-camera-traps&Itemid=149&lang=es
5. http://guyra.org.py/index.php?option=com_k2&view=item&id=340:nuevo-proyecto-de-biodiversidad-para-tres-gigantes-os-tembiapora-pyahu-tres-gigantes-pe-new-biodivieristy-project-for-three-giants&lang=en
6. http://www.guyra.org.py/index.php?option=com_k2&view=item&id=1214:el-guasuvira-el-mas-asiduo-ante-camaras-trampa-en-el-pantanal-paraguayo-guasuvira-os-meme-camara-nuha-tujurusupe-gray-brocket-deer-a-common-resident-of-the-paraguayan-pantanal&lang=es
7. http://www.guyra.org.py/index.php?option=com_k2&view=item&id=1183:esperanza-doras-imagenes-muestran-a-crias-de-pecari-en-el-pantanal-paraguayo&lang=es
8. http://www.guyra.org.py/index.php?option=com_k2&view=item&id=1079:pecari-labiado-en-las-trampas-camara-de-la-reserva-pantanal-paraguayo-white-lipped-peccary-herd-recorded-by-camera-traps-in-the-paraguayan-pantanal-reserve&lang=es
9. http://guyra.org.py/index.php?option=com_k2&view=item&id=1171:visualizan-yaguarete-en-el-pantanal-paraguayo-tujurusu-paraquaipe-ojehecha-yaguarete

[imbovymava-ohovo-a-jaguar-sighted-in-the-paraguayan-pantanal&Itemid=149&lang=es](#)

10. http://www.guyra.org.py/index.php?option=com_k2&view=item&id=1244:camaras-trampa-registran-especies-amenazadas-en-el-pantanal-paraguayo-tekotev-naipysyro-pyae-jaguarete-jurumi-ha-ambue-mymba-camera-traps-record-threatened-species-in-the-paraguayan-pantanal&lang=en
11. http://www.guyra.org.py/index.php?option=com_k2&view=item&id=1157:el-puma-en-television-las-camaras-trampa-capturaron-a-un-hermoso-ejemplar-ta-anga-nuha-rupive-jahecha-ko-jaguarete-neporava-a-puma-in-tv-camera-traps-captured-a-beautiful-specimen&lang=en
12. http://www.guyra.org.py/index.php?option=com_k2&view=item&id=902:las-camaras-trampa-instaladas-en-la-reserva-pantanal-paraguayo&lang=es
13. http://guyra.org.py/index.php?option=com_k2&view=item&id=699:imagen-del-yaguarete-es-galardonada&Itemid=149&lang=es
14. <http://www.worldlandtrust.org/news/2015/03/guyra-paraguay-receives-grant-monitor-jaguar>
15. <http://www.worldlandtrust.org/news/2015/02/paraguayan-jaguar-image-wins-top-prize-wlt-trail-camera-competition>

Videos taken with camera traps on Guyra's youtube channel:

1. Yaguareté: <https://www.youtube.com/watch?v=NUJH73GaNnM>
2. Estiramiento del yaguareté: <https://www.youtube.com/watch?v=xTYvJ43fMOY>
3. Tapir: https://www.youtube.com/watch?v=V_dtZGlrXVM
4. Yaguarundi: https://www.youtube.com/watch?v=Slk_qqJeG98
5. Karaja: <https://www.youtube.com/watch?v=0yo6YCXBohE>
6. Yaguareté tomando agua: <https://www.youtube.com/watch?v=1UdKo94mt4E>
7. Pecarí de collar: <https://www.youtube.com/watch?v=EeYjQEe6j54>
8. Jurumí en la estación Tres Gigantes: <https://www.youtube.com/watch?v=Er3PB0k2gew>

Challenges and Next Steps

The 2014 - 2015 El Niño event profoundly affected the weather in Paraguay, with its repercussions still being felt. In the case of the Pantanal, which regularly floods on, usually between late October to early March, El Niño events altered the hydrological cycles so that flooding lasted throughout the year. As shown on the pictures below, during the 2014-2015 and even in 2016, El Niño event made the only road to the Pantanal and the dirt airstrips in the region unusable for a long period. Consequently, the only way to access the Pantanal was by boat which can take up to 7 days roundtrip.



Figs. 25 & 26. Flooded roads in the Pantanal.

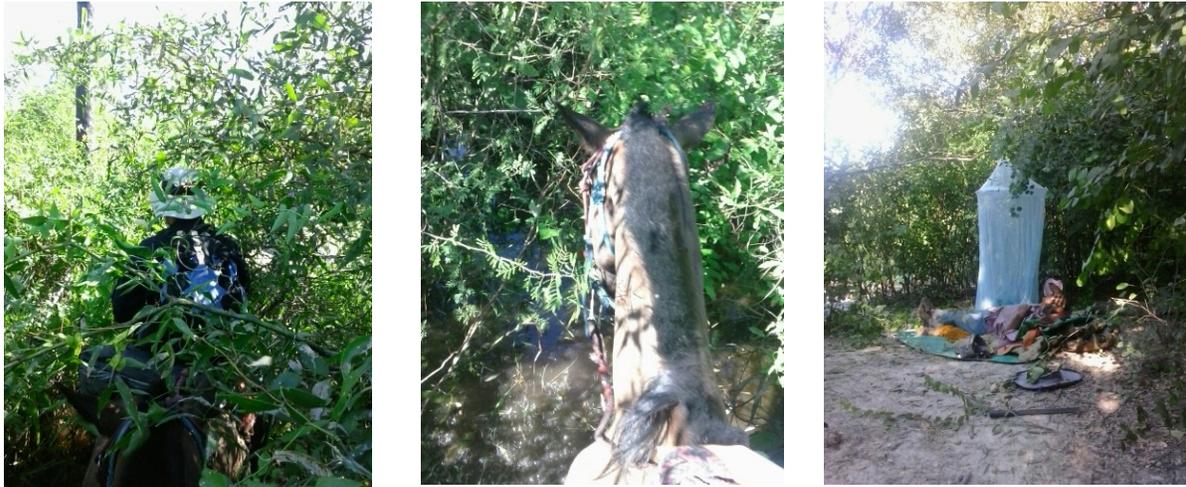
As a consequence we were not able to undertake our planned sampling design with the necessary frequency and when we did the flooding that occurred prohibited us undertaking the sampling we desired to do. However, given the circumstances we took advantage of the situation to undertake a pilot study to assess camera function and to train field staff in camera trapping methodology. Furthermore, we were able to quantify activity patterns of the sampled species as a result of this effort.



In March 2015 we were preparing a second visit to install the cameras within palm savanna and Chiquitano forest with the Station, called Pantalla; however, additional rains prevented us from undertaking this trip. Nevertheless, we hired locals and horses to access the property as soon as the weather improved enough (the dirt road is too small and does not allow trucks) to start clearing the road to provide access for sampling the other ecosystems inside the

reserve.

Fig. 25. The bus that goes to Bahia Negra (Pantanal) stopped for several days due to the state of the road.



Figs. 26, 27 & 28. The staff trying to access Pantalla.

Despite the logistical challenges that we were forced to deal with, the field work we were able to undertake was successful when measured within in the context of our original research plans, albeit more limited than was hoped for. We documented the presence of the entire community of large and medium sized mammals typical of riparian forest and palm savanna of the region, with the data suggesting a greater use of riparian forest compared to palm savanna for the more frequently detected species. Furthermore, we obtained abundant data on activity of a large number of species. In both cases these are the first data of this type for the Paraguayan Pantanal.

The images obtained from the sampling have served an important role in public education, being used in social media (Facebook, Twitter), newspaper articles, and television documentaries and interviews. Furthermore, the data have been incorporated into a draft manuscript on activity patterns of mammals for a peer reviewed publication. Additionally, as the jaguar program of Guyra Paraguay (Programa Yaguarete) is part of the team developing a national management plan for the jaguar in Paraguay for the Ministry of the Environment, the data from this project have been used in the delimitation of the distribution of the jaguar in Paraguay and for documenting prey availability within the drafting of the management plan.

Taking a more regional and longer-term perspective perhaps best demonstrates the importance of this project through its role in capacity building and as it forms the nucleus for several larger scale projects that have been born out of our this project. Through our experiences from this project we have successfully been funded through the national science and technology council (CONACYT) for two separate projects, *Chacoan mammals and economic development: patterns perspectives and system sustainability* and



Livestock-Carnivore Conflicts: searching for solutions for this problem in the Paraguayan Pantanal.

For both of these new projects camera trap sampling comprises an important role within the data collection methodology. Through the PTES funded project we and the field staff obtained invaluable experience in camera deployment and intimate knowledge of the strengths and limitations of the cameras we employed. These experiences are invaluable as they, and the data from the PTES funded project, serve a role as a pilot study whereby we were able to confidently develop robust study designs that are logistically feasible. Furthermore, we were able to refine our data cataloging methodologies and database development to be applied in our new projects based upon our work on the PTES funded project.

- Next steps
 - ✓ Augment our sampling area within the Tres Gigantes Biological Station, include newly acquired properties in the Pantanal and neighboring ranches in our sampling in conjunction with sister projects funded by national science and technology council and the Woodland Park Zoo Jaguar Fund.
 - ✓ Implement a sampling scheme to determine jaguar density through camera trapping
 - ✓ Scat collection to identify individual jaguar from fecal DNA and to quantify diet.
 - ✓ Work with indigenous groups near Bahia Negra to improve their cattle management practices to increase yields and reduce losses from jaguar and puma depredation.
 - ✓ Capacity building for students and professionals on the application of camera traps for data collections and data analysis from camera trap sampling.