# PANTANAL SCIENCE MAGAZINE

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WWF

## PECCARY PRESENCE INDICATES HEALTHY FORESTS PG 12

CONTROLLED BURNINGS REDUCE FIRE IMPACTS PG 20

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CAIMAN MANAGEMENT FAVORS CONSERVATION IN BOLIVIA PG 42

# COLLABORATION BEYOND BORDERS

New proposals for tax incentives, wildlife management, fire control, participatory zoning and tourism itineraries are of interest to all Pantanal residents. Along with maintaining traditions that teach and educate, these actions ease isolation and act as resources for indigenous resistance. These are some of the topics covered in this fifth issue of the Pantanal Science magazine, along with entertaining and little-known information about white-lipped peccaries, discussions about the importance of determining macrohabitats and understanding the infrastructure projects serial impacts that can interrupt natural water flow.

Since its creation, in 2014, the Pantanal Science magazine has been publishing studies and contributions from scientists to broaden knowledge about the Pantanal biome, both for Pantanal natives, workers and farmers (the *pantaneiros*) and visitors. Of course, by living and experiencing the Pantanal reality while taking care of farms, attending to tourists, unexpectedly encountering fauna, and fighting fires or the drought and flood extremes, the *pantaneiros* already hold precious knowledge about their surroundings. However, the experts technical eye can add another kind of knowledge, including information about distant locations on the same Pantanal or good initiatives and innovations that are worth replicating.

Integrating traditional and scientific knowledge is important for achieving the intended balance among different society sectors and to turn ideas and ideals into reality. Above all, this balance is needed to change two major global trends that greatly impact nature and people: the increase in emissions contributing to climate change and the biodiversity loss on the planet. Together and with

qualified information, everyone can contribute to reversing such worrying global trends by doing their part to change their daily routines and investing in environmental and economic sustainability for this unique region that is the Pantanal.

As this biome is not only Brazilian and extends across the territories of Bolivia and Paraguay, this magazine edition produced by WWF-Brazil presents a collaboration of researchers, the *pantaneiros* and indigenous peoples from both countries. All together they provide traditional knowledge and experiences from the Pantanal beyond our borders. For example, the wild caiman sustainable economic use carried out in the San Matías Integrated Management Natural Area in Bolivia, with support from WWF-Bolivia. Also, the participatory zoning underway in the Paraguayan Pantanal to plan the Bahía Negra District. Furthermore, from the Paraguayan Pantanal, come reports of the Yshir Chamacoco people who are resisting the Paraguayan bureaucracy and defending their ancestral lands.

WWF-Brazil is a non-profit, non-partisan, non-governmental Brazilian organization. Created in 1996, it operates throughout Brazil and is part of the WWF (World Wildlife Fund) Network, which is present in over 100 countries. We work in defense of life, with the purpose to change the social and environmental degradation current trajectory. Controlling and reversing the rising emissions trend, for example, depends on replacing the current "business as usual" models. Deforestation, native vegetation conversion to crops, pollution and burning oil should be replaced by environmentally friendly technologies. Also, the habitat and biodiversity accelerated loss leading to mass extinctions needs to be halted and reversed.

Changing these two trends - emissions and biodiversity loss - is the WWF-Brazil primary concern and purpose. For us, the Pantanal is a place of the possible, where tradition and sustainable development can align to promote these necessary and urgent changes. We believe in the possibility of building a new development vision, with a return to economic prosperity and political stability through a fair transition to a low-impact economy by adding efficiency, knowledge and technology to the natural resources use, and promoting inclusion, greater transparency and social participation.

Since 2015, WWF-Brazil has supported the Pantanal Observatory, which today comprises 27 civil society organizations active in the Upper Paraguay River Basin of Bolivia, Brazil and Paraguay. For this network members, the Pantanal resources conservation and sustainable use must be a common concern for society, governments and private initiatives to ensure the biome survival and integrity.

The Pantanal Science magazine also supports this idea, which is why we include such a diversity of authors and community members in our pages, who are united by their willingness to understand the Pantanal and look for ways towards a sustainable, diverse and collaborative future. This is a true collaboration across borders.

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Photo: Paulo Robson de Souza

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Photo: Sarah Caires

# FOOD SAFARIS, MUCH MORE THAN TERERÉ

Visitors roll up their sleeves and "invade" the private areas of lodges/hotels areas to experience the Pantanal's gastronomic culture

BY POLLIANNA THOMÉ

Observe the wildlife diversity, visit a remote destination and contemplate the paradisiacal landscape! These are the main goals of tourists from all over Brazil and around the world who visit the Pantanal. Jaguars, tapirs, peccaries, giant anteaters, anacondas, giant river otters, giant armadillos and other famous South American fauna species are what attracts such tourists to stay in the hotels and inns in the region. But there are other attractions scheduled during such trips, which often surprise visitors with a variety of opportunities to learn about the Pantanal lifestyle by tapping into authentic cultural elements, including (or above all) during mealtimes.

Coupled with the cultural tourism sector, offering gastronomic experiences is important nowadays for the competitive scenario of tourist destinations. Such experiences can even be a determining difference, shifting from a complementary attraction to the main draw.

Food is understood as a cultural habit as it involves human intervention on nature, modifying it accord-

ing to human needs, desires and abilities. In this context, since 2013, the Food Safaris Initiative has been organizing cultural experience tours in the Pantanal, focused on the *pantaneira* gastronomy, which involves much more than simply tasting or sharing traditional tereré – a cold, mate-based drink that is consumed inside a gourd using a *bombilla*.

In such travel itineraries, certain activities are offered to get travelers in touch with the local gastronomic production, including culinary techniques, ingredient preparation and food preservation.

One of the activities is carving a feral pig, a domestic pig breed that escaped from pens during the Paraguay War (1864 – 1870) and became wild (feral) again. During the butchering, the tourist learns from farmhands (cowboys) about the skinning and carving meat techniques. Then, in the kitchen, they discover the secrets of seasoning and cooking alternatives.

In the pastoral scenery of livestock farms, the rural worker routine (men and women) includes unique ways of relating to the environment, which visitors can observe and experience through this gastronomic adventure. A cowboy guides visitors on horseback rides, leading guests across flooded landscapes and pointing out the animals along the way. At other times, the same cowboy guides turn into boatmen, fishermen and ranchers, catching *piranhas* during boat trips and then learning how to prepare the well-known *Piranha* Stew. Guides can also show their cooking skills, teaching rancher cooking secrets, such as how to make and use the *soleada* beef (*pranchao soleada*), a specific round beef cut with a fat layer that is cured with salt and sun, which is typically taken on long cattle drives in the Pantanal.

*Sopa paraguaia, chipa, caribéu, macarrão de comitiva* and *paçoca de carne* are other dishes served during the Food Safaris, all of which are presented by cooks to educate tourists about the region's history and border influences.

Photo: Claudia Lunas

For visitors, interacting directly with the local population intensely enriches their travels. The groups get to visit the inn headquarters or food preparation areas, which are usually not seen by outsiders. The kitchen, food pantry, butcher, vegetable garden, and fishmonger are places that the tourists

Photo: Sarah Caires

Photo: Zig Koch

Tourists "occupy" kitchens to prepare cheese (previous page); to learn typical culinary techniques, such as cowhead barbecue (left); and get their hands dirty butchering a feral pig (above).

use intensely, transforming the hitherto private areas of the reception staff into public spaces.

Like other representatives of Brazil's rustic culture, Pantanal workers have developed unique ways to relate with the environment, food, and local cuisine and such cultural heritage can be observed, lived, and experienced, rather than simply tasted, by travelers.

In addition to offering a different kind of Pantanal experience and enhancing the regional culture, this initiative diversifies the activities and tours offered by the hotels & inns. Due to this, Food Safaris received the Tourism Innovation Award from SEBRAE (Brazilian Micro and Small Business Support Service) in 2017 and this program is already being replicated in other unique Brazilian cultural destinations. Therefore, through this initiative, the Pantanal is an example of innovation in tourism!

Photo: Julia Oshima

WHITE-LIPPED PECCARIES

# THE HIPPIES OF THE FOREST

Also known as peccaries, canela-ruiva, taiaçu, sabacu: there is no shortage of nicknames for these very social, essentially vegetarian and promiscuous mammals. They are considered bioindicators of healthy ecosystems and, yet, they are still poorly known.

BY ALEXINE KEUROGHLIAN, CIBELE BIONDO, MARIA LUISA S. P. JORGE E DONALD P. EATON

White-lipped peccaries are often confused with pigs or wild boars. However, they are neither of those, despite various similarities in appearance. They are Tayassuidae: an exclusive New World family of even-toed hoofed mammals with only three genera, each with a single species. The scientific name for the white-lipped peccary is *Tayassu pecari*. The other two species are the collared peccary (*Pecari tajacu*) and the Chacoan peccary (*Catagonus wagneri*). Contrarily, pigs and wild boars in the New World are a a swine single-species - *Sus scrofa* - originating from the Old World, which has been widely spread by man on most continents and many islands, especially during the Age of Exploration.

Forests, savannas and wetlands are the natural environments inhabited by peccaries; whose distribution extends from southeastern Mexico to northern Argentina. They are herbivores, but primarily fruit eaters, and preferentially consume mast native fruiting species. They are the only ungulates from neotropical forests to form large herds, with 50 to 300 individuals. Since each adult weighs an average of 30 kg, these herds represent the largest forest mammal biomass in the Americas. The spe-

cies has a large home range of ~5,000 hectares (19.3 sq miles) for each subherd.

Large white-lipped peccary herds tend to split into subherds that then regroup. In the Pantanal, these sub-herds have an average of 70 individuals, while in the highlands, there are about 50. Such a strategy is used to probably guarantee food; if 300 individuals were foraging together in the forest, there would not be enough fruit for all members.

The process of periodic division and regrouping of large herds is called fission-fusion. In this process, there is an exchange of individuals of both sexes between subherds and herds. During these fission events, individuals can stay with their close relatives or travel with more distant relatives.

For this reason, and recent genetic evidence, the 300 or so individuals in a large herd are primarily related in one way or another. This explains why such a large group is socially cohesive, as they travel, eat and sleep together, all the while taking care of each other. Furthermore, while resting they are continuously grooming or rubbing each other, displaying what appears as a friendly interaction. Both females and males have a gland on their dorsal part, near the tail, from which a liquid is emitted. Constant rubbing stimulates this gland and is seen as a way for animals to communicate with one another, which keeps the herd together.

When analyzing the white lipped peccaries mating system through paternity tests, we found that this species does not follow the same rules as other mammals whose social structures are frequently dominated by the so-called "alpha" male. In such a structure, stronger or larger males generally try to maintain the mating preference or exclu-

**White-lipped peccary herds are very cohesive and reach up to 300 individuals, all of which are related to each other**

sivity of mating by constantly fighting against other male members or those from other groups (unrelated). For white-lipped peccaries, all individuals are entitled to mating and both males and females have offspring with more than one partner. Thus, the mating system for these peccaries is promiscuity.

The absence of apparent sexual dimorphism (i.e. males and females present no differences in size or appearance) confirms such promiscuous mating system. The same system was also observed for the collared peccary, another tayassuid without sexual dimorphism that occurs in Brazil.

By observing all these traits – primarily a vegetarian diet, a social structure, and sexual freedom – researchers started referring to these peccaries as the hippies of the forest and Pantanal. Although humorous, the well-deserved nickname beholds a warning: the herds home range reduction, due to the negative impacts of human activities, does not only affect the resources necessary for these peccaries to survive, but can also alter their social structure, which is fundamental for survival of its populations. An isolated sub-herd that does not regroup with large-herd relatives, will probably not survive for very long.

Due to their multiple ecological roles, white-lipped peccaries are important to other native species and to the various habitats in which they live. They are favorite prey to large felines, as they help to maintain healthy populations, and even reduce attacks on domestic animals. They are both seed predators and dispersers, bringing consumed plant seeds to "sow" away from parent trees, and increasing their viability. Additionally, while foraging, they

# HABITAT BIOINDICATORS

Photo: Cezar Correia

Monitoring peccaries on the Araraúna ranch shows how herds (red dots) circulate through preserved forests (green areas with yellow boundaries) and do not enter cleared, human altered fields (clear central area with no red dots)

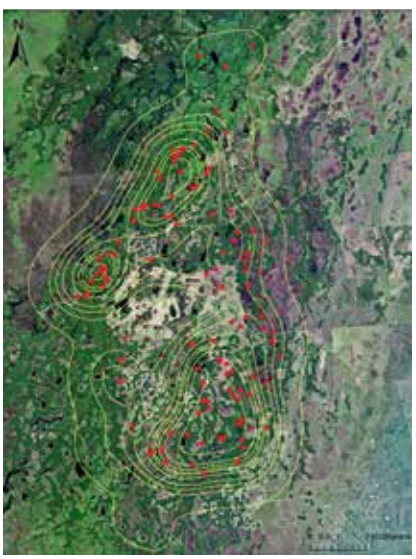


Photo: Julia Oshima

greatly impact the vegetation structure by shifting soil and leaf litter, plowing and rooting, or even by trampling shoots and seedlings, and such foraging activities impact the vegetation, wildlife, and water balance. For this reason, they are considered ecosystem engineers.

Studies show that the extinction of white-lipped peccaries in an ecosystem causes a series of negative impacts, including the loss of their predators (e.g. jaguar and cougar) in protected areas; reduced vegetation diversity; changes in resource availability (mainly native fruits); increased rodent populations ((explosion of resource availability); dissemination of diseases (associated with rodents) and general impoverishment of mammal and bird communities in forests. Indeed, the extinction of any tayassuidae species from a native vegetation area causes unquestionable changes to habitats and rapid biodiversity losses.

In 2010, the International Union for Conservation of Nature (IUCN), the Chico Mendes Institute for Biodiversity Conservation (ICMBio) and the official adviser to the Ministry of Environment's Red List of Endangered Species evaluated the conservation status of white-lipped peccaries in every Brazilian biome. This species was the only hooved mammal to be classified as "Critically Endangered" for the Atlantic Forest and "Endangered" for the Cerrado. For Brazil as a whole, the white-lipped peccary is considered to be threatened with extinction.

Many species are at risk of extinction in the Cerrado biome due to habitat fragmentation and excessive deforestation. The various types of savannah surrounding the Pantanal also suffer from deforestation, which threatens fauna and flora. In the Pantanal, over 95% of the land is privately owned, less than 3% lies within conservation units and, on average, between 60% and 70% of native vegetation cover in the highlands has already been converted into pasture or agriculture. Deforestation related threats are caused mainly by conversion of native habitats into pastures/agriculture accompanied by improper management practices that exacerbate the impacts of cutting and suppressing native vegetation. During this same period, deforestation and the loss or fragmentation of natural habitats has dramatically changed almost one fifth of the Pantanal.

The fragmentation caused by cattle ranching and crop plantations includes road construction, as well as changes in native vegetation, which have been replaced by exotic grasses and crops. This threatens the chances that wildlife disperses between the Pantanal highlands and flood basin. As a result, the white-lipped peccaries and their large herds range is now more restricted than ever before. Such isolation prevents white-lipped individuals dispersal between herds, impacting demographic and genetic variables. Among the most serious consequences of such changes are local extinctions of the peccaries and consequently, overall impoverishment of forest plant and wildlife communities that depend on them to maintain the forest balance.

A fragmented area - like a remnant forest isolated from other natural areas due to man-made infrastructure - is often too small to support a white-lipped peccaries herd, since resources are scarce and habitat diversity and water sources are reduced. In addition, the species social dynamics are quite unique and isolation resulting from fragmentation can negatively affect the herd dynamic between individuals and herds.

Given the important connection between the Pantanal basin and surrounding Cerrado highlands, in order to preserve the Pantanal, the Cerrado vegetation and the complex interactions between the two biomes needs to be maintained. How can this be done? How do we know which measures work? One way is to study a bio-indicator, like white-lipped

Photo: Alexine Keuroghlian

Peccaries sleep together in the cool sand (previous page) and avoid the heat in a muddy pool

peccaries, whose presence is a sign of healthy forests. Because white-lipped peccaries have diverse resource requirements, use large ranges, and travel in large herds, they strongly impact forest habitats, and therefore, are excellent bioindicators. For this reason. conservation efforts aimed at maintaining healthy populations of white-lipped peccaries also benefit regional biodiversity.

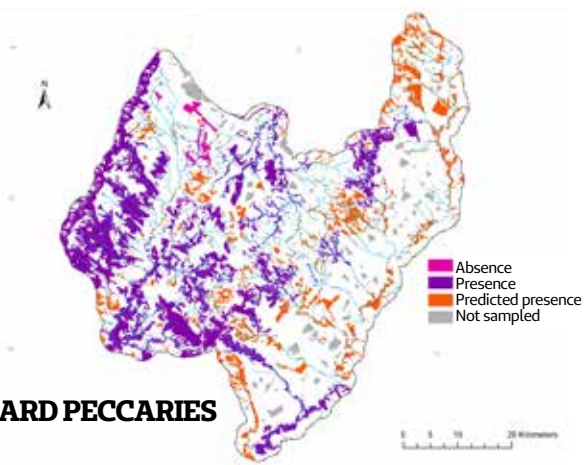
A project of the WWF-Brazil Critical Ecosystem Partnership Fund (WWF/CEPF) - called *Municipal Land Use Planning in Rural Municipalities of the Cerrado* - analyzes the characteristics of forest fragments in the Corguinho municipality, Serra de Maracaju, Mato Grosso do Sul – Pantanal highlands. Researchers used records of medium to large-sized mammals from camera traps set in different sized forest fragments. The mapping and modeling results use fragment metrics, such as the area used by the animals; connectivity among fragments (relative to distance and size of fragments within a 1 km radius); shape (measure of shape complexity, relative to a square forest fragment of the same area); and stream density (length of stream channel per area of forest fragment). All these measurements indicate that the white-lipped peccary is the species most sensitive to fragment size and vegetation loss. Their herds simply do not occur in less than 2,300 ha (5,683 acres) fragments in the highlands, the Southern Pantanal headwaters. Also, their needs surpass those of other large animals, such as the tapir and the collard peccary, which are present in remnants of 10 to 1,750 ha, as well as the red brocket deer which is found in 110 to 1,750 ha forests.

In addition to being restricted to relatively large forest fragments, the white-lipped peccary is less tolerant of degraded habitats compared to the tapir, collared peccary and agouti. This supports the value of this species as a sensitive bioindicator of intact native habitats.

To better understand their movements in the same region, they were also monitored via GPS and VHF (radio telemetry) collars. The study shows how herds and sub-herds use the landscape in agricultural land, the importance of suitable habitat, which helps explain the white-lipped peccaries absence in small forest frag-

# MAPED SENSITIVITY

Tapirs and collard peccaries are more tolerant to degraded environments and frequently cross open areas. Red Brocket deer are more sensitive and only risk crossing from time to time. White-lipped peccaries are restricted to preserved forests.



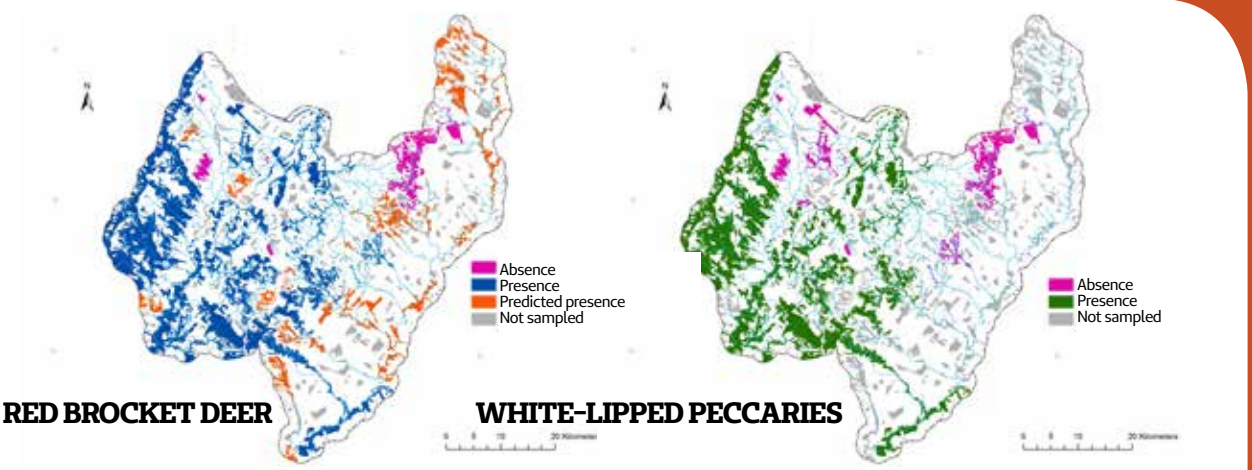

**TAPIRS & COLLARD PECCARIES**

ments. Only rarely do they risk moving from one isolated fragment into another by crossing through areas altered by humans. They prefer to stay in the larger forests - as this is where they find food - and move between fragments through healthy forest corridors.

Most of these corridors follow watercourses, integrating the headwaters and springs with the Pantanal. The main environmental concerns for these important wildlife corridors are siltation, sedimentation, erosion, and lack of vegetation cover along river and stream banks. In monitoring their movement through these pathways, white-lipped peccaries serve as bioindicators of healthy corridors and forest fragments. Identifying the main habitat types and main routes used by them helps decision makers prioritize and protect areas and corridors that can maintain the gene flow of individuals between populations of peccaries and other wildlife species.

It is worth noting that when some individuals leave a population and settle in another to reproduce, they promote gene flow between these populations. Such flow maintains genetic diversity within the population, which is essential for adapting to environmental changes and for the long-term persistence of populations.

In the corridors between fragments that are not used by peccaries, ecological restoration is proposed to recover and reconnect forest remnants to benefit peccaries and other species that are dependent on forest cover and native fruits. Preservation of these areas, which encompass numerous private farms, has been (and continues to be) considered essential for maintaining the biodiversity, ecological connectivity and ecosystem services in the Pantanal. Native habitat remnants best suited to maintain white-lipped peccary herds and corridors actively used to increase connectivity between fragments, should be priorities for protection during conservation planning. Therefore, during site assessments in the Pantanal or Cerrado exposed to different intensities of land-use change, the white-lipped peccary populations status serves as an excellent indicator of overall ecosystem health and consequently white-lipped peccaries should be considered an umbrella species regarding conservation.




**RED BROCKET DEER** **WHITE-LIPPED PECCARIES**

# KEEPING FIRE ON A SHORT LEASH

**The Pantanal is both dependent and disturbed by wildfires. Therefore, focused research and controlled burnings are vital for all: flora, fauna & people**

BY DANILO BANDINI RIBEIRO, ALEXANDRE DE MATOS MARTINS PEREIRA, GILBERTO PIRES, RUDI RICARDO LAPS, FABIO DE OLIVEIRA ROQUE, RAMON LUCIANO MELLO, PAULO ROBSON DE SOUZA, GERALDO ALVES DAMASCENO JUNIOR, IEDA MARIA BORTOLOTTO, ERICH FISCHER, LETÍCIA COUTO GARCIA, BRUNO HENRIQUE DOS SANTOS FERREIRA, FÁBIO PADILHA BOLZAN, ALINE ALVES LOPES, MAXWELL DA ROSA OLIVEIRA, CYNTIA CAVALCANTE SANTOS, ÁUREA DA SILVA GARCIA, RAFAELA DANIELLI NICOLA, JULIO FRANCISCO ALVES FERNANDES, LÍLIAN RIBEIRO PEREIRA, FERNANDA PRADO SANTANA SHAKIHAMA, ALLISON ISHY, THIAGO SILVA TELES, FRANCIANY ISHIKAWA DA SILVA, KEYCIANE LIMA PEDROSA, SYLVIA TORRECILHA, RAFAELA APARECIDA MARIANO FERNANDES E ALEXANDRE DO NASCIMENTO SILVA

Photo: Silvio Xavier

Three Brazilian biomes are fire dependent: Cerrado, Pampa and Pantanal. They are biomes with well-marked rain and drought seasons, whose evolutionary history has seen fire as a disturbing and sometimes inducing agent for ecological processes.

In the Pantanal floodplain, the dry and flood seasons generate important contrasts regarding ecological and vegetation factors. The region has an increasing east-west rainfall deficit. Thus, in the higher portions of the Upper Paraguay Basin, rainfall can reach over 1,500 millimeters per year, while in Corumbá the

average annual rainfall falls between 800–1,100 mm. The region is extremely flat, with slopes ranging from 30 to 50 centimeters per kilometer in an east-west direction, and even less (only 3 to 5 cm / km) in a north-south direction. Thus, even with low rainfall compared to Central Brazil, the Pantanal plain is subject to flooding, mainly due to the difficulty of surface runoff of river waters. Depending on the combination of headwater distance from the river and the plain slope, flooding can be relatively synchronous with rainfall. This is the case for the Cuiabá and Miranda River basins. At the other extreme, floods are completely out of sync with the rainy season, as occurs in the Paraguay River plain, where water rises three months after the rainfall ends.

Therefore, the Pantanal fits into the flood pulse concept, that is, its wetlands are subject to flood and drought stress. Its vegetation is rich in herbacious plants and shrub species, found mainly in the most frequently flooded areas. These form floodplains associated with sparse trees (savannah physiognomies) or even *campos limpos* (open grasslands), which are used as pasture by wildlife and cattle.

During the dry season, fire events are frequent but more localized compared to other savannas throughout the world. Natural fires are initiated by lightning that strikes and ignites them. Generally, these fires are put out by the rain that follows soon after the lightning strikes, only burning available combustible materials, such as leaves, branches, stumps that are already dead and dry.

Various plants and animals have evolved in such scenario and present characteristics of resistance and resilience to the fire, creating defense mechanisms - and even physiological processes. However, there are also vegetation formations in this region that are especially sensitive to fire, such as riparian forests. If burned, some of their species die easily, including "jenipapo" (*Genipa americana*), "iporuru" (*Alchornea castaneifolia*) and "tucum" (*Bactris glaucescens*), among others. In seasonal forests, it is common to see thick-bark trees that can withstand fire and sprout, such as "saraguai" (*Rhamnidium elaeocarpum*). Furthermore, some species' roots start budding, that is, they can generate new plants after the fire,

including "quixabeira" (*Sideroxylon obtusifolium*) and the majestic "jatoba" (*Hymenaea courbaril*). Other undergrowth or herbacious species tend to increase with frequent fire events. This is the case for the "caraguatá-do-mato" (*Bromelia balansae*) and a type of Malva (*Croton sarcopetaloides*). In areas that are directly influenced by the Cerrado, several tree species that also

enter the Pantanal are fire resistant, either with thick bark or subterranean regrowth system after fires such as "lixeira" (*Curatella americana*), "muxiba-do-cerrado" (*Erythroxylum suberosum*), "pau-terra" (*Qualea grandiflora*) and "pau-marfim" (*Agonandra brasiliensis*).

With the arrival of humans and the consequent land-use changes, fire management methods were used that changed the natural fire regime. In some environments, fires have been excluded or events have been fought and reduced. In other environments, both the frequency and number of events with intentional burns have increased.

In the Pantanal, the deliberate use of fire stems from the need to promote the native pasture regrowth for extensive livestock production. This technique is widely used in regions with large organic matter accumulation and a lack of nutrients (dystrophic), where there are grasses such as Andropogon, with excess cellulose (scleromorphic). The caronal formations, where the carona grass (*Elionurus muticus*) is a dominant grass species, is also frequently burned. This species secretes essential oils, which in turn makes it burn quickly. Generally, this grass is unpalatable to cattle but can be eaten after burning. Other repeatedly ignited formations are *paratudais*, with trees known as "paratudo" (*Tabebuia aurea*),

Photos: Silvio Xavier

Fire management decreases combustible material and reduces fire intensity in the dry season

and carandazais, where caranda palm trees (*Copernicia alba*) form clusters.

In order to accelerate the burning process, which saves time and money, the most intense fires are set during the region's driest months: August and September. The most common consequence of such management is that fires get out of control and reach larger areas, which propagates high intensity fires that can potentially burn all biomass, including living biomass. These fires can even reach forested areas such as *cordilheiras* and *capões*. Satellite and fire monitoring have been carried out since 1998 in the Pantanal, based on the heat points data obtained from the National Institute for Space Research (Inpe). With this information, it is possible to detect the fire occurrence in any Pantanal region, almost in real time. It can also determine which periods and regions are most critical, as well as identify burning patterns. Such data sets and studies are great for planning prevention, proper management and firefighting.

The monitoring historic data shows a downward trend in heat point records throughout the past few years. In 2002 and 2005, the highest heat point rates were recorded: 12,486 and 12,536, respectively. For comparison purposes, 2018 ended with 1,691 fire points and 2014 with 1,568 points; the two lowest rates in this historical series. Of course, the most critical months for the Pantanal biome are the driest ones, with September having the largest number of outbreaks, followed by August and October, respectively. A pattern outlined in the follow-up years seems to be the occurrence of a significant increase in the number of fire outbreaks in years after those with low fire indices. Such patterns could be explained by the low consumption of unburned biomass by herbivores, which accumulates as combustible material for the following year. Thus, the fire spreads more and lasts longer, fueling the intense fire occurrence. The regional and global climate variation influences - drier or wetter years, warmer or milder winters, El Niño or La Niña - and the variation in

peak and flood duration in the Pantanal should also be considered.

Based on this data, some public policies were created to regulate the fire use in the Pantanal. The main one being the Joint Resolution Semac-Ibama /MS, which prohibits using fire for controlled burns from August 1st to October 31st in the Pantanal biome of Mato Grosso do Sul state. The purpose of the ban is to reduce the negative fire effects on ecosystems and human health. As shown above, this is the period when flames are most likely to spread and, even after the law prohibiting fires during this period, hot spots are still registered. In a survey conducted in 2010 during the period in which fire was prohibited for agricultural management, an average of 5,000 hectares was burned per day in Corumbá/MS alone!

Conflictingly, in order to effectively implement fire management policies in the Pantanal, the Brigades for Forest Fire Prevention and Fighting are fundamental. They are composed of residents from the region and by indigenous people in indigenous lands. These people are trained, equipped and hired to act for six months, during the highest fire period from June to December. They are responsible for fire prevention to fire combat.

Prevention actions focus on educational campaigns for schools and orientation about when and how to use fire as an agropastoral management tool for small and large farmers. At the peak of the dry season, brigades move by land and/or water to reach remote areas and fight fires.

The brigades are also responsible for managing combustible materials through predetermined burns. The main objective of such measures is to reduce the straw, grass, leaves and branches load when it is not the critical fire period, allowing low intensity fires to consume only dry/dead biomass. This creates landscape mosaics of burnt and unburned areas, favoring the cycles of plant and animal species that depend on the presence of fire, which is why this ecological disturbance cannot be eliminated completely. This "mosaic" environment favors the reduction of large fires during the drought peak and facilitates fire control. Burning prescribed as a management tool is still incipient in the Pantanal, but was effectively applied in 2017, with the Kadiwéu Indi-

From the Kadiwéu's sampling (above), trees from the Cerrado-Pantanal transition that evolved with fire and are resilient (right).

genous Land being the largest laboratory.

In summary, some of the factors that cause large fires in the Pantanal are climate variations, the peak and duration of floods, the availability of combustible materials and ignition (by lightning or people). Of these, only combustible materials can be managed, which must be done correctly. Inadequate fire use - that is, in times of extreme drought combined with short, frequent and limited floods - can greatly damage the entire Pantanal biome conservation. Knowledge about the interaction between flooding, production and biomass accumulation (fuel for fires) is essential for creating new policies that regulate fire use in order to manage and conserve the environment.

Photos: Fernanda Prado

Since 2009, different Integrated Fire Management Programs have been implemented in Cerrado Conservation Units, which provided important contributions for generating knowledge and public policies. However, in a country with continental proportions, such as Brazil, local research is necessary, especially when considering areas subject to fire interactions with different flood regimes and indigenous lands, as observed in the Pantanal of Mato Grosso do Sul.

To complement these programs, the Noleedi Project was created, whose name means fire in the Kadiwéu language. The project evaluates the fire effects on the biota (all living things in a region) in the Pantanal of Mato Grosso do Sul and how it interacts under different flooding regimes. Several related national and state institutions participate in this project, integrating three biodiversity postgraduate programs: Ecology and Conservation, Animal Biology and Botany, from the Mato Grosso do Sul Federal University (UFMS):.

The objective is to collect data about the fire and flooding effects on biodiversity to establish a protocol on controlled burning practices. This is a demand from both the Brazilian Institute of the Environment and Renewable Natural Resources National Center for Prevention and Combat of Forest Fires (Prefogo / Ibama), which operates in the region, as well as from the indigenous populations in the Kadiwéu Indigenous Land. However, the results may extrapolate the study areas, serving as a basis for other Pantanal regions, as well as other continental wetlands in Brazil and throughout the world.

**THE PROTOCOL WILL BE CREATED COLLABORATIVELY THROUGH A WORKSHOP WITH ALL PARTICIPATING PARTIES. THUS, THE PROJECT PLANS TO STRENGTHEN PUBLIC MANAGEMENT OF FIRE BY:**

» Generating data about the fire effects on biota, according to demands from the parties that are already involved in fire fighting and prevention (Ibama, indigenous populations);

» Verifying the interaction between different flood patterns and fire effects on certain biota groups in a Cerrado to Pantanal transition area in Mato Grosso do Sul;

» Cooperatively creating a fire management protocol and a fire impact assessment protocol with state officials, traditional populations and biota researchers;

» Evaluating fire management as a passive restoration strategy that favors natural regeneration and selects for species with potential to help restore ecosystems subject to fire and flooding, ensuring resources that maintain wildlife and the successful recruitment of new individuals;

» Predicting the effects of different fire regimes on the reproduction of key flora species used by the indigenous community.

The integration and management of data obtained by the Noleedi Project will provide more information about disturbance agents (fire and floods), as well as their interactions at a local scale. This will therefore help determine the best times to apply prescribed burns and establish an integrated fire management protocol for areas that are naturally subjected to burning and flooding.

Photos: Fernanda Prado

Danilo Ribeiro coordinates the species survey that are fire protected by thick bark (left) or by their ability to sprout when burned (right)

DAMS

# CUMULATIVE IMPACTS

Infrastructure constructions are important for the regional economy, but should be evaluated as a whole, as they can irreversibly change the Pantanal

BY LIANA JOHN

Photo: Alcides Faria

Reservoirs, dams, hydroelectric dams, underground water pipelines, power lines, roads, bridges, ports, waterways, railways, and mines all have positive and negative, predictable or inevitable impacts on an environment. Regarding the Pantanal biome, such impacts mainly affect water flow, which is vital to keep all ecosystems functioning and to maintain the living conditions for the immense and rich biodiversity.

Of course, infrastructure constructions are necessary, and yes, the water flow in this wetland varies naturally, benefiting some species while stressing others. However, these impacts vary depending on the type of construction and how it is evaluated and performed. With the potential to amplify, alter or prevent the natural flood pulses fluctuations, such impacts do not "only" affect the various natural environments and their inhabitants or visitors, but also affect economic activities.

"We have always emphasized the importance of water for biodiversity, but we must also highlight how essential water is for the Pantanal econo-

my," observes Júlio Sampaio da Silva, from WWF-Brazil's Cerrado-Pantanal Program. "The Pantanal is a wetland with a dynamic that is different from other biomes. Economic agents need to consider this difference: Cerrado or Amazonia dynamics do not work in the Pantanal".

According to the Pantanal Observatory strategic planning for the 2019-2021 period, the most controversial and potentially most impacting initiative is the Parana-Paraguay Waterway, which has been under discussion since the 1990s. The Paraguay River has 2,793 navigable kilometers (1735 mi), of which 1,272 km (791 mi) already transport large cargo in Brazil, with another 58 km on the Bolivian border and 322 km (200 mi) on the Paraguay border, totaling 1,652 km (1026 mi) between Cáceres, Mato Grosso, and Nueva Palmira, in Uruguay. According to the National Department of Transport (DNIT), there are already 140 meter long by 24 meter (131 ft x 79 ft) wide boat trains with maximum capacity of 500 tons that pass through the Pantanal between Cáceres and Corumbá (MS), and 290 m x 48 m (951 ft x 157 ft) boat trains with a maximum capacity of 24 thousand tons that pass between Corumbá and the Paraguay border.

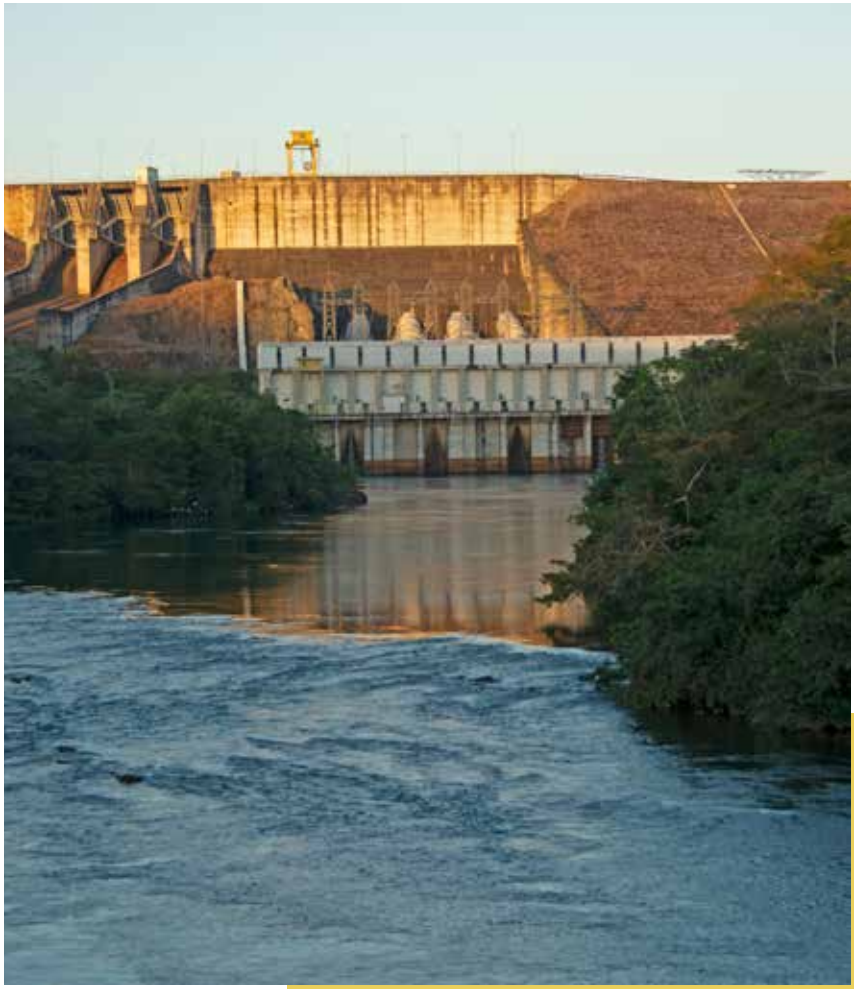


Photo: Marcos Piovesan

Waterway transport is cheaper and more efficient than road transport, and is more advantageous for transporting soybean, rice, maize, timber, cement, and iron and manganese ore derivatives. Boat train sizes and year-round navigability are major issues. In order to operate with greater load capacity - and to continue to be used during the dry season - the Paraguay River would need to be rectified in some sections and have its riverbed lowered. This would (greatly) increase river speed and bank erosion, as well as (greatly) reduce the range of natural flooding.

If the riverbed was lowered by 10 meters (33 ft) there would be 1,430 to 2,410 $km^2$ (930 sq mi) less flooded areas in the Pantanal, and if deepened by 25 meters (82 ft) this number would range from 3,830 to 5,790 $km^2$ (2,235 sq mi), according to a study published in 1999 by Stephen K. Hamilton, a specialist in Ecosystem Ecology at Michigan State University. The difference between the two measurements reflects the drought and the flood peaks

and the flood duration would also be seriously shortened.

These impacts would be extensive and irreversible. Such magnitude changes in the flood pulse would produce multiple ecological consequences, leading to the degradation of all Pantanal ecosystems. The river

The Paraná– Paraguay waterway impacts the flood peaks (previous page). Hydroelectric dams, as Manso (left), and highways, such as BR-262 (this page) affect wildlife.

Photos: Walfrido Tomás

channelization was suspended due to the lack of technical feasibility and environmental impact studies. The waterway today operates without major changes in the Paraguayan riverbed. However, such discussion arises whenever the river's load capacity decreases with the water fluctuations, therefore, it is necessary to monitor possible plans resumption.

With much smaller but more numerous impacts per unit, Small Hydroelectric Centers or PHCs are another major concern in the Pantanal. Considered clean electricity sources, they generate from 5 MW to 30 MW, are built on rivers with 500 m (1,640 ft) altitudes, have small reservoirs (13 $km^2$ (5 sq mi), employ local labor and do not require large power lines. However, in a biome such as the Pantanal, the river fragmentation possibility is high, turning the water flow into an obstacle course, especially for spawning fish.

In the Brazilian portion of the Upper Paraguay River Basin, 52 PHCs have already been installed and more than 90 are being planned for years to come. Although environmental impact assessment is done individually and (state) licensing is undertaken by enterprise, the small dams consequences are regional. As is well known, the Pantanal rivers, lakes, oxbow lakes, ponds, flooded grasslands, floodplains, soda lakes and floodplain channels, are all somehow linked and function together. Therefore, the PHCs impacts are synergistic and cumulative in the biome and should be analyzed as such.

Similarly, roads and railways are evaluated and built one by one but produce combined effects. Both types of infrastructure are essential for the livestock and other product transportation. Addition-

ally, the highways are critical for tourist traffic, which is now vital for the Pantanal economy. Solutions to avoid disturbing watercourses exist and have been adopted on some roads, such as BR-262, which is built on embankments between Corumbá and Ladário (MS), with several passages and bridges to ensure water flow underneath.

However, walkways and bridges make roads and railways more expensive to design and maintain. Judging by most of these infrastructures state, there are not enough resources for more expensive constructions, as half of all federal and state roads in the Upper Paraguay Basin (54%) are not even paved, according to the Pantanal Observatory.

In fact, many Pantanal back roads remain underwater during floods, making routes to farms and inns even longer. Drivers often exchange information with each other whenever they cross paths, whether coming or going. At the flood peak, there are many places that are only accessible by plane and others that simply remain isolated.

For wildlife, roadways are oftentimes a way to avoid fences that divide the landscape, however, it puts them at high risk of being runover. The animals do not understand such risk, and many drivers don't either, despite the signs and warnings. Even worse is that some initiatives run counter to all logic and ignore technical recommendations to reduce roadkill. Instead of building wildlife passages and installing speed reducers, those responsible for BR-262 decided to install long fences on both sides, near the Paraguay river bridge!

Photos: Marcos Piovesan

"Fences are barriers and can become animal traps if they (those animals) get onto the highway. And during peak flooding, the bridges are flooded under the roads, so animals tend to go over them", explains Walfrido Tomás, from Embrapa Pantanal. Deer, tapirs, capybaras, collared peccaries, and white-lipped peccaries can break the fence and become trapped on the road. This already happens without the fence, simply with the metal barriers (guard rails). "Recent-

ly, a 150-kg female marsh deer came onto the road by jumping over the 1.50 m (4.9 ft) fence and, startled by the vehicles, could not jump back. She ended up being run over", says Tomás. Long fences act as even worse traps. Within Pantanal farms, several constructions promote significant alterations, even when they are small or in restricted areas. Again, the issue lies in the Pantanal context and the general water flow. No one is isolated, as all are part of the interconnected ecosystems. A plantation embankment or drainage, a reservoir, or a managed pasture all need attention and care. And that includes the Cerrado at the edge of the Pantanal.

Without contour ploughing, cattle trails (bottom left) mark the plateau edges and make way for erosion, changing river courses in the floodplain (top left)

Researcher Ivan Bergier from Embrapa Pantanal, warns about the improper land use impacts in the current climate change context. "Many producers fail to make land contours and erosion is increasing in the plateau, with sediment being carried to the Pantanal," he says. "The biggest problem is livestock: the rains are already more frequent and more intense as a climate change result, and cattle trails open gullies. The forest cover removal increases even more the water flow down to the plain with enough energy to break into avulsions (breaking marginal dikes, changing the river direction, as in the Taquari River)".

With climate change, more and more extreme events are expected to occur. In the Pantanal, floods and droughts tend to become even more pronounced. In order to avoid contributions from agriculture to such scenario, it is essential to stimulate sustainable practices, such as Integrated Crop-Livestock-Forest Systems (ILPF), which is already practiced in other Brazilian regions and encouraged by the Bergier team, especially within Pantanal borders.

Concerns about the magnitude of cumulative impacts of different constructions and the need to see the entire biome as complex interactions has led the Pantanal Observatory to engage in awareness projects with public agencies and private companies, including banks that finance these large constructions. WWF is committed to ensure the public infrastructure expansion in the Upper Paraguay Basin area with quality, providing sustainable development, including cases provided for privatization contracts, under the Investment Partnership Program (PPI), through concessions and Public-Private Partnerships (PPPs).

The goal is to provide sustainable development, but not only to the Brazilian side. The Pantanal Observatory strategic planning for 2019-2021 also analyzed licensing systems and constructions in Bolivia and Paraguay, since cumulative impacts ignore boundaries, as well as biodiversity and water flow. Together and attentively, all Pantanal residents can improve the infrastructure that serves them, with more socio-environmental safeguards and fewer unforeseen impacts.


Photo: Liana John

COMMUNICATION

# ON THE RADIO WAVES

From information to entertainment, Pantanal residents want to keep the company of presenters, broadcasters and guitar players close by

BY BÁRBARA FERRAGINI
E LAÉRCIO MACHADO DE SOUSA

Almost one-hundred years old, the radio is still a means of communication and counterpoint to isolation in the world's largest wetland. An important Pantanal's history and culture icon, radio was for a long time almost the only information source for people who lived in remote areas, along with direct communication between residents via PX amateur radio. Despite the new information and communication technologies advent - such as the cell phone and the internet - the simple battery-powered transistor box remains widely used by Pantanal residents to this day.

José Erinaldo da Silva, better known as Nardo, has devoted his entire life to work in the countryside and knows the rich biome intimately. According to him, to communicate in isolated regions such as the Abobral it was - and still is - essential to have a radio. "The bosses sent messages to us employees through the radio stations, because in many parts we didn't have electricity. That was about 25 years ago, but the radio is still used this way, depending on the region", he explains. In addition, to ensure that important messages arrived, radio was oftentimes their only contact with reality. "It was always nearby, because it picked up a signal anywhere. When I went to milk the cows in the corral, I took the opportunity to listen to the weather report and what was happening in the world", he says.

His wife, Telma, is also very

fond of the old device. As she always accompanies her husband while working in the Pantanal, she says she does not drop the old habit, even for a minute. "I get up early, already listening to the radio, and it stays on all day while I work. I love to hear the news from the region and the big city, the songs and also the horoscopes", she confesses.

Although it is easy to acquire new communication devices nowadays, Nardo has not given up the good old radio, whether it be to distract or to inform himself. "I returned to live in the city, I have cell phones and television for practical reasons, but I really trust the radio. It's safer, right? It picks up everywhere, just needs a battery" he says, without taking his hands off the device.

Democratic, versatile, and popular, radio was born with the promise of disseminating real-time information and shortening geographical distances through clear, colloquial language. As radios do not require any skill level to use, people of all ages, social classes and education can hear news about the weather, politics, economy, as well as be entertained by live broadcastings of soccer games, music and educational programs, radio soap operas, among others.

In isolated regions, such as the Pantanal and the Amazon, broadcasters maintain message programs with large audiences. During such programs, a family learns if their grandfather who went to town to treat an illness has been hospitalized or is already returning home; a son communicates where he is and how long he will be away; a boatman informs how long his boat engine repair will last; a teacher tells students if any class have been suspended; a boss tells the farmhand where the bulls were seen; a single man appeals to the nearby bachelorettes, confirming serious intentions to marry, and so on.

Access to information is a fundamental human right and radio has made it accessible due to its low costs and the creation of programs that are truly adapted to the different Brazilian regions unique realities.

# RESILIENT PIONEER

In the Pantanal, the first regional radio station was created in 1930, at the same time as the famous Tupi and Record in São Paulo.The old PRI-7, now called Difusora Pantanal, was practically one of the only stations to transmit information to isolated locations. It was through this station that the entire Pantanal communicated and still communicates, albeit to a lesser extent. In 2016, it migrated from AM (Amplitude Modulated) to FM (Modulated Frequency), improving transmission quality. The broadcast can also be accessed on the internet at www.difusorapantanal.com.br.

PARAGUAYAN PANTANAL

# THE DOOR TO A SUSTAINABLE FUTURE

In the remote and poorly known Paraguayan Pantanal portion, participatory zoning promises to meet social, economic and biodiversity conservation needs

BY ALBERTO ESQUIVEL, ANDREA GARAY, KARINA MANSILLA, PATRICIA ROCHE E KARIM MUSALEM

Photo: Andrea Garay

Paraguay is a relatively small country compared to its bordering neighbors but is big in biodiversity richness terms. Contained within its 406,752 km² (157,048 sq mi) territory there are globally important ecoregions such as Atlantic Forest, Cerrado, Chaco and Pantanal, which shelter a high fauna and flora diversity.

However, the Paraguayan Pantanal portion is almost unknown to the country's population and its borders still generate debate. Regional maps, for example, tend to show the Pantanal southernmost part as a small section with a few kilometers that shyly enters Paraguay, while national official maps present the biome as a much larger area, extending to the west of the country.

In fact, such controversy includes the entire Pantanal: although the biome is considered the largest tropical wetland on the planet, there is no consensus about its actual size. Depending on the source, the numbers are extremely divergent, ranging from 180,000 (69, 498 sq mi) to 340,000 km² (131,274 sq mi)!

In any case, there are Pantanal official sizes in each of the three countries where the biome extends. According to the Geography and Statistics Brazilian Institute (IBGE), the Brazilian portion size is 150,355 km² (58,052 sq mi). In Bolivia, the non-governmental entities group known as the Pantanal Observatory mentions 31,898 km² (12,315 sq mi). Additionally, according to government data, the Paraguayan portion is about 42,000 km² (16,216 sq mi), with only 16% of the total surface being protected; 3.8% in conservation units and 12.2% in indigenous territories.

Photo: Lucas Mongelos/WWF-Paraguay

Exact biome delimitation is difficult to measure due to the high heterogeneity of the Pantanal landscape. There are several mixed ecosystems, including forests with various sizes and plant compositions, wet and dry savannas, natural pastures with and without palm groves, lakes, soda lakes, flooded grasslands, water bodies of all sizes, areas of sediment deposition, areas influenced by floods (with annual variations in flooded area) and so on.

In Paraguay, the region west of the Paraguay River is known as the Chaco, which is technically the ecoregions union of the Dry Chaco, Wet Chaco, Cerrado, Médanos (alluvial dune systems) and the Pantanal itself. Such variety explains the immense biological richness within this relatively small region; the Paraguayan Pantanal alone holds over 60% of bird species records for the country. This area also contains some of the most well-preserved habi-

Situated on the Paraguay River banks (right), Bahía Negra (left) has had a Pilot Plan for Urban & Territorial Planning since 2017

Photo: Fabianus Flierveot /WWF Paraguay

Photo: Fabianus Flierveot /WWF Paraguay

tats, essential for many terrestrial mammal species, some of which are endangered. Among these species is the largest feline, the jaguar (*Panthera onca*), whose home range is very large. Each individual adult jaguar needs an average territory of 237 km$^2$ (91 sq mi), which is larger than the Buenos Aires city in Argentina.

The riches and consequences of the Pantanal's flood pulses shape the production, roads and even the pace of life of its population. In these floodplains, dominated by savannas, mounds and palm groves, the traditional economic activity is cattle ranching. Native pastures are used in rotating schemes – grasses are adapted to rest, flooding and drought - to survive the difficult times of the year. This is an example of ecosystem-based management in which production depends on the conditions imposed by nature, with minimal changes. But there is room for territorial planning, including its challenges and opportunities.

In 2005, the Paraguayan government created the Bahía Negra district, containing 9% of the country's surface area (35,057 km$^2$ or 13,535 sq mi). The district includes protected areas and indigenous communities of over one million hectares (2,471,054 ac), that conserve Chaco, Cerrado and Pantanal priority ecosystems. In addition, local fisheries hold one of the highest national productivity rates. The district is one of the least populated (less than 5,000 inhabitants) and most remote (located 800 km (497mi) from the capital, Asunción) in the country. Access by land is very limited, especially in the rainy season, which is why the region is highly dependent on river transportation.

Since 2017, Bahía Negra has been part of an Urban and Territorial Ordinance Plan pilot project based on technical support for zoning and a vision for the territory future. This was developed according to an Organic Municipal Law promulgated in 2010, whose normative framework represents an opportunity for districts to start effectively planning their territories, regarding the inhabitants needs.

The process is characterized by its participatory approach, coordinated through a Multi-Stakeholder Roundtable comprised of 18 institutions, including governmental, local and national sectors, the productive sector, indigenous communities, civil society organizations and academia. The main objective is to ensure the territory development by meeting its social, economic and biodiversity conservation needs.

Access to information is a limiting factor in Paraguay, especially in the district that is farthest away from the capital, where 26% of rural and urban properties have not even been registered by the National Register Service. Thus, it is truly challenging to provide technical and scientific studies about the Pantanal. Therefore, generating information to better understand the water dynamics, socioeconomic and topographic characteristics, the biological importance zones and integrated indigenous territories anthropological studies are indispensable for supporting the decision-making process. Fortunately, such information is being generated!

Photos: Latitud25-WWF

The natural richness (left) and flood pulse of the Pantanal (top) control the productivity and the populations' rhythm of life (above)

By the end of 2019, the Multi-Stakeholder Roundtable will finalize the Bahía Negra Ordinance Plan. Implementing this plan is the main challenge for the future. If successful, this territorial planning will ensure sustainable development and life quality for the country's second largest district: the gateway to the Paraguayan Pantanal.

CAIMAN

# WHEN MANAGEMENT LEADS TO CONSERVATION

Wild caiman sustainable economic use in the San Matías Integrated Management Natural Area helps control illegal poaching, maintain a healthy 'lizard' population and conserve the Bolivian Pantanal ecosystem

POR ALFONSO LLOBET E MARCEL CABALLERO

Just like the abundant caimans of the Brazilian Pantanal, these reptiles are also the *Caiman yacare* species. However, in Bolivia they are traditionally called 'lizards'. This is not the only difference between the two countries: in the Bolivian Pantanal, adult male caimans from the wild population in the San Matías Integrated Management Natural Area (IMNA), located in Santa Cruz, are used for economic purposes. Controlled hunting has become a sustainable alternative for many indigenous communities and local ranchers and also contributes to the wetland conservation.

Created in 1997 to conserve fauna and forests, the San Matias IMNA contains

almost 3 million hectares (2,918,500 ha – 7,211,770 ac) and is the largest protected area in the Bolivian Pantanal. Its perimeter covers the municipalities of San Matías, Puerto Suarez, Puerto Quijaro, San Jose de Chiquitos, San Rafael de Velasco, Roboré and El Carmen Rivero Tórrez. Its rivers and streams supply the Paraguay River right bank, after crossing mountain ranges, large lakes, extensive palm groves, savannas and natural pastures, where at least 14 different native vegetation units have been identified.

The category "Integrated Management Natural Area" was chosen to match the biological diversity conservation and the local human population sustainable development, as well as to maintain territorial spaces and traditions of the Chiquitan and Ayoreos indigenous groups that inhabit the region. The traditional use of natural resources use by these peoples has served as a sustainability example for the other parties involved in the caiman management.

Although there has been sporadic information about Bolivia's 'lizards' since the 1970s, few studies have focused on their conservation. It was at this time that the first crocodilian survey took place in the country, which included information about the Bolivian populations

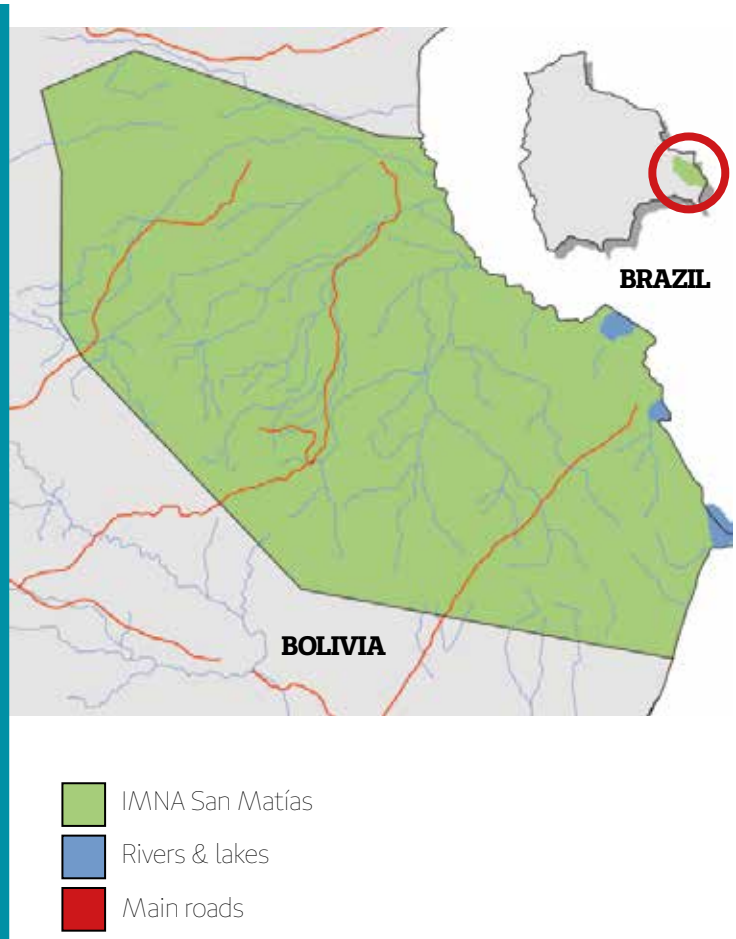
Only 180 cm long males are captured (left), so females are protected. The economic use of caimans (below) inspires appreciation of other species and their habitats

Photos: WWF-Bolívia

# SAN MATÍAS INTEGRATED MANAGMENT NATURAL AREA

natural history. Afterwards, a second nationwide study was conducted with solid data about species distribution and status for some of the previously evaluated caiman populations. From then on, numerous works have emerged that broadened the knowledge about the caiman populations in different country regions.

One of the main results and objectives of the research carried out since the 1990s was the creation of the protected area. At the time, the *Caiman yacare* was in a good conservation state in Bolivia. In large regions of the country, including the Pantanal zone, high species densities were recorded. Consequently, discussions began about the viability of a sustainable use program at San Matias IMNA, provided that the regulation conditions were specifically developed to control such activity.




In general, there are three alternatives for the caimans economic use: wild animal captures; collection of eggs and/or newborn hatchlings to raise in captivity; and maintenance of reproductive adults in full captivity (farms). Each system presents advantages and disadvantages in terms of conservation value, ease of control and regulation, costs and economic return. Thus, each method application must be preceded by an analysis of both the biological (species) and socioeconomic (region in

which it is intended to work) reality.

In this context, the same year the San Matias IMNA was created (1997), the National Program for Conservation and Sustainable Use of Lizards (PNASL or Lizard Program) was initiated, based on individual land quotas that were granted according to data obtained from the annual caiman population monitoring. The model chosen was the wild animal capture. This method requires less economic investment and landowners earn the most. Regulated hunting only allows animals over 180 cm long (71 in), which are generally male, to be killed. Thus, breeding females are protected due to their smaller size.

In 2005, researchers at the Noel Kempff Mercado Natural History Museum collected information from local people and caiman population counts (in the north of the protected area) to evaluate the program's first years. Based on this survey, a Pilot Plan for the Sustainable Use of the 'lizard' was developed at the San Matías IMNA to seek greater benefits for local participants. The plan was coordinated by the National Protected Areas Service (SERNAP) in collaboration with the Kempff Museum.

This Pilot Plan implementation had varied results. Although some of the proposed activities were executed, others could not be carried out due to lack of staff, budget problems or interinstitutional coordination difficulties. However, it was a breakthrough to rely on a process supervised by park rangers and to raise awareness among local communities about their rights and responsibilities regarding caiman management in San Matías.

In 2008, the first General Management Plan for the protected area was established from the Pilot Plan. This proposed protected area internal zoning, whereby the natural resources sustainable management was allowed according to more detailed management plans, specific rules and regulations. The 'lizard' management plan was built participatively, with the main objective of conserving the caiman (*Caiman yacare*) and the habitats it occupies, as well as improving the local parties income within the San Matías IMNA, reinforcing sustainable management. This new plan required more accountability and beneficiaries participation in managing economic performance.

### THE 'LIZARD' MANAGEMENT PLAN MAIN HIGHLIGHTS WERE:

- Ensure the caimans conservation and preserve the habitats they occupy through their sustainable use;
- Strengthen the local parties social organization for adequate caiman management at San Matías IMNA;
- Generate sufficient local capacities to implement the management plan technical and administrative aspects;
- Establish local control and

inspection mechanisms that contribute to effective caiman and its habitats conservation in the San Matías IMNA;

» Obtain fair economic benefits that will increase the local parties income at the San Matías IMNA;
» Establish a monitoring and research system for the caiman and its management to enable timely decision-making according to adaptive management logic, and
» Establish a system for the dissemination and information exchange among different local and regional groups to foster understanding and this resource valorization, as well as the importance of ensuring its conservation.

In 2014, with support from WWF-Bolivia, the General Management Plan was updated for implementation between 2015 and 2020. This plan is currently being used to control the caiman use in the protected area. Presently, there are seven indigenous communities benefiting from this management: Candelaria, San Miguelito, Tornito, San Fernanda, Villazón, Pozones and Natividad de Bahía. There are also seven rural properties whose main activity is livestock that participate. Between 2016 and 2018, annual caiman catches fluctuated from 1,000 to 1,500 individuals per year, including all participants. This number is considered conservative as the maximum annual amount is 2,159 individuals.

It is important to restate that hunting is only intended to extract some 180 cm (71 in) adult males from the population. Capturing females is prohibited, which protects the species reproductive potential.

**AFTER THE NEW SUSTAINABLE MANAGEMENT PLAN IMPLEMENTATION UNDER THE PROTECTED AREA PARTNERS SUPERVISION, THE GOAL IS TO REACH THE FOLLOWING RESULTS:**

» Increase each participating community household income;
» Achieve an income equitable sharing from hunter families, communities and local organizations. In addition, communities must allocate 5% of their earnings to support San Matías IMNA's inspection and control actions;
» Strengthen the community and sub-community local parties traditional structures;
» Democratize decision-making so that resource users define activities and their planning;
» Plan production and commercialization,
» Structure a self-assessment system - both for biological monitoring and economic benefits - to protect resources and internally disseminate good practices with support from San Matías IMNA.

In short, the goal is to promote comprehensive resource management with the greatest benefits, which also ensures long-term sustainability. At the same time, fundamental data about caiman biology and ecology are obtained, including information about the species' reproduction.

Thanks to its participatory development, the Man-

Photos: WWF-Bolivia

agement Plan for caiman use in the San Matías IMNA has also allowed greater focus on indigenous organizations, communities and livestock farmers, with local parties and their representative organizations acting in implementation phases such as: field studies, specific norms and regulations creation, zoning, monitoring, production chain self-assessment and obtaining benefits. Furthermore, it was possible to establish the caiman management spatial arrangement by identifying traditional capture and protection sites.

**The integrated management plan involves indigenous people and ranchers in all phases (above). This ensures more economic benefits and effective species conservation**

Such active participation means regaining control of resource use and management, enabling progress towards more effective *Caiman yacare* conservation and the habitats it occupies preservation throughout the Pantanal. Additionally, economic self-sustainability has been achieved, providing higher income through better organization and progress, with the reinvestment possibility in animal-related productive projects. In turn, socio-cultural and organizational self-sustainability strengthens local capacities through dialogues between organizations and people. Technical sustainability has been increasing through human resources empowerment at different levels and aspects. All of which contributes to economic sustainability through the local populations and their organization active involvement in their natural resources management and conservation.

The economic incentives received by the Management Plan beneficiaries are reflected in the biodiversity and ecosystems conservation that the caiman depends on. Once a species becomes economically valuable, local parties not only change their assessment of other species but increase poaching controls and work toward maintaining habitats. In turn, all of these actions positively affect the large wetlands conservation.

CULTURE

# THE CHARM OF MYTHICAL CREATURES

BY ÁLVARO BANDUCCI JÚNIOR

**The wide-range of Pantanal communities that have direct contact with nature has resulted in unique stories and characters which still teach life lessons, and influence the beliefs and the customs of Pantanal residents**

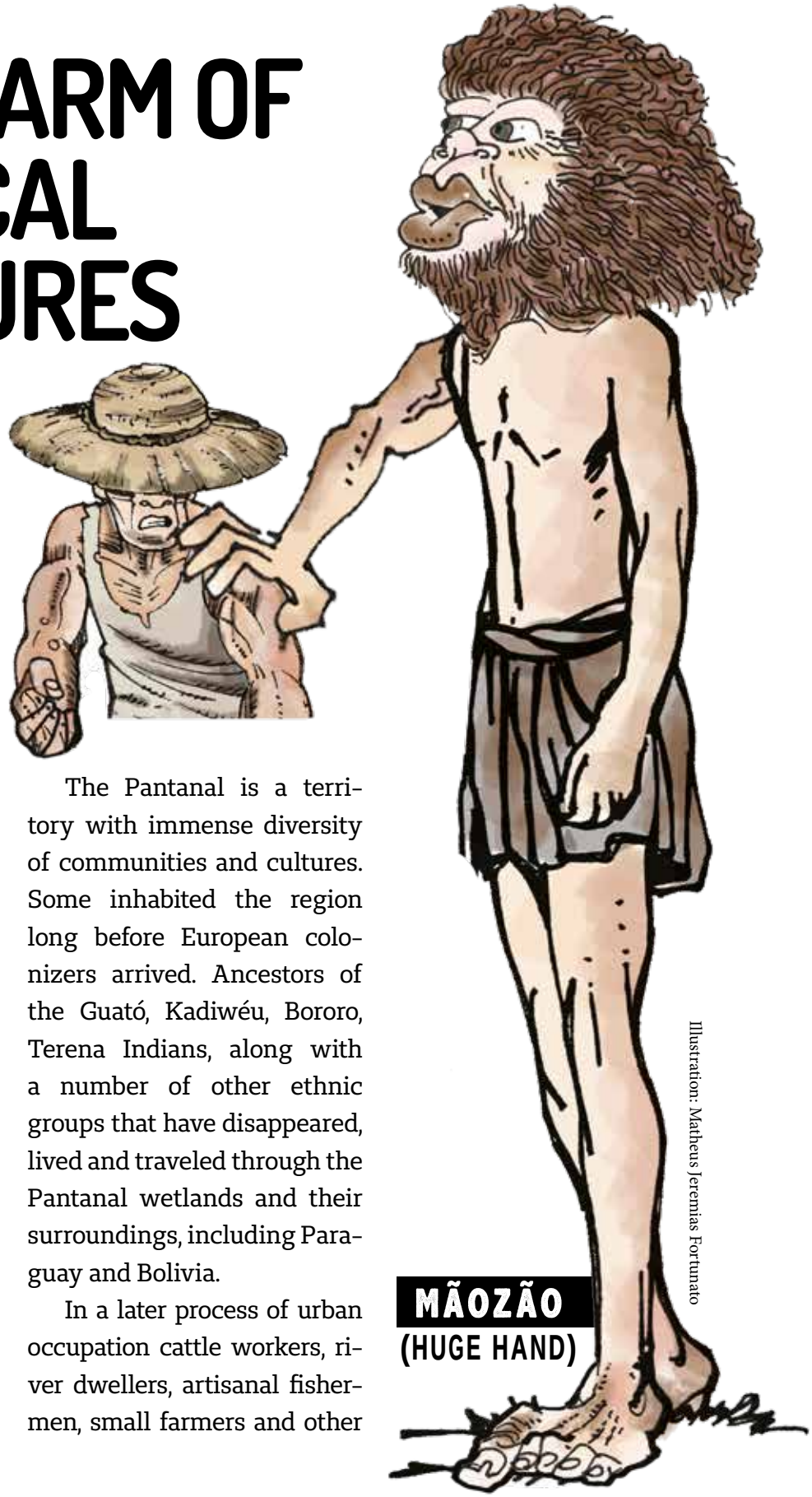



Illustration: Matheus Jeremias Fortunato

The Pantanal is a territory with immense diversity of communities and cultures. Some inhabited the region long before European colonizers arrived. Ancestors of the Guató, Kadiwéu, Bororo, Terena Indians, along with a number of other ethnic groups that have disappeared, lived and traveled through the Pantanal wetlands and their surroundings, including Paraguay and Bolivia.

In a later process of urban occupation cattle workers, river dwellers, artisanal fishermen, small farmers and other

Photo: Paulo Robson de Souza

groups joined these indigenous groups in the Pantanal. Being established for approximately two hundred years, these groups constantly interact with each other and with the different habitats of the Pantanal flood basin.

The Pantanal people reside, work and sustain themselves in this vast floodplain, holding amazing knowledge about the regional ecosystems, including flora, fauna and the ecological cycles that provide rhythm to life in the region.

They know about the food qualities and medicinal powers of plants. They also have a profound knowledge of wildlife and domestic animals. They are guided by the moon phases when planting crops, fishing and rearing livestock.

Cowboys know that the new moon is the best time to give cattle salt because it is a time when animals are weaker. The carpenter who builds corrals and fences, usually waits for the waning moon to extract wood in order to obtain sturdier and more durable pillars. The fruits, cassava and other crops cultivation is more productive when done during the crescent moon.

The Pantanal inhabitants interpret the different nature manifestations as messages. Sometimes they are based on practical foundations and the environment careful observations, for example, when fireflies fly low it is a sign of heavy rain. Other times they

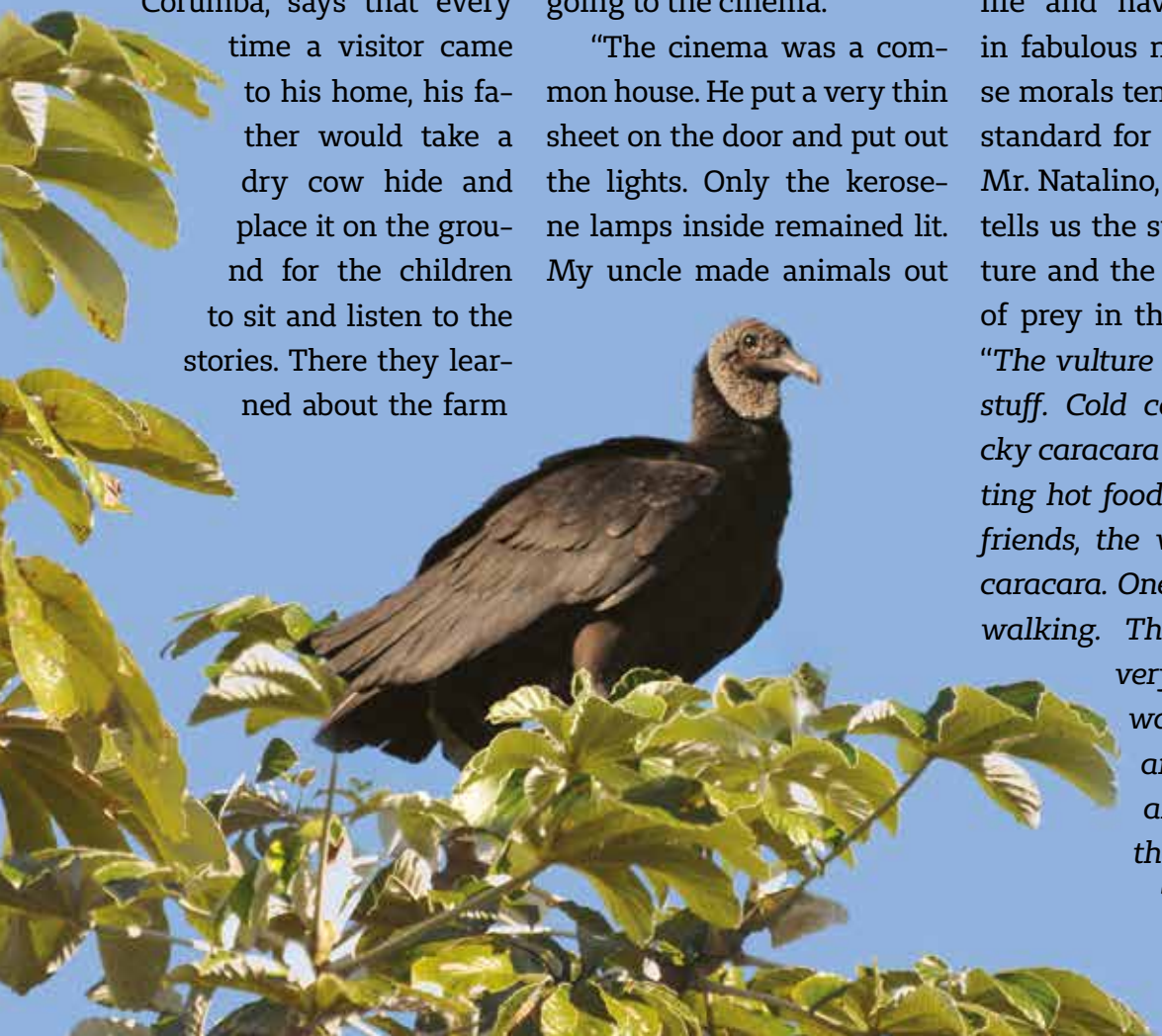
are determined by faith and magic: to find a lost horse, you simply have to conjure these animals' protector - *Campeirinho*, which is similar to the *Negrinho do Pastoreio* myth. Offering a little bit of tobacco at a gate, a lit candle and strong faith are enough for the entity to point you in the direction of the missing horse.

By observing elders, assisting in production activities, listening to fantastic tales, stories and narratives, children learn from an early age to make sense of and to behave in the natural world. When he was young, Roberto, a cowboy from Nhecolândia, Corumbá, says that every time a visitor came to his home, his father would take a dry cow hide and place it on the ground for the children to sit and listen to the stories. There they learned about the farm chores, the animals, and the mythical creatures that appear to challenge those who doubt them or misbehave.

Learning often takes place in a playful way: bathing in the river and paying attention to its dangers; working in the corrals and figuring out ways to control the cattle; playing with canoes and lassos; caring for domestic animals, among others. In the 1950s and 1960s, Silvério, a former foreman on a Pantanal farm, reports that when he was young, his uncle put on a shadow play. For farm kids on the Taquari River banks, it was the same as going to the cinema.

"The cinema was a common house. He put a very thin sheet on the door and put out the lights. Only the kerosene lamps inside remained lit. My uncle made animals out of leather. Then he would put them on a long stick. He had something that he put in his mouth so he could imitate all the animals. Then it was our turn: we would reenact bull fights; we made horses neigh, running back and forth. I was a young kid, about nine, ten years old. I remember the adventures to this day", he recalls. Through these adventures staged by a visionary uncle in a makeshift shadow "cinema" on the Taquari River banks, the children learned about animals and their behaviors, about dangers, fears ...and about courage.

Animals also come to life and have personalities in fabulous narratives, whose morals tends to serve as a standard for social behavior. Mr. Natalino, a cattle worker, tells us the story of the vulture and the caracara, a bird of prey in the falcon family. "*The vulture likes to eat cold stuff. Cold carrion. The tricky caracara brags about eating hot food. These two are friends, the vulture and the caracara. One day they were walking. The vulture was very hungry. He was waiting for an animal to die and cool down so that he could eat. They sat on a*



*post top. Then a pigeon appeared. The caracara provoked the vulture saying "Oh, I'm going to eat that pigeon. I'm hungry and I'm going to eat it hot." The vulture, which was hungrier than the caracara, couldn't do anything, so he said: I doubt you'll catch that pigeon. "I'll get it", said the caracara. "No, you won't", retorted the vulture. Then the caracara went after the pigeon. The pigeon flew fast and dodged him; flying back and forth so many times that he got stuck in a tree. The pigeon flew away. The vulture approached the caracara, and the caracara said: "So now what my friend? I am stuck". The vulture said: "Now, I will let you cool down so I can kill my hunger." Then, he let the caracara die and ate him.*

Photos: Liana John

The caracara (above) ignored a friendship with the vulture (previous page) and wanted to be clever by hunting a pigeon. But the prey escaped, and the predator died, becoming the vulture's meal

The vulture's attitude can hardly be justified by any ethical principle. But for listeners who are attentive to the Pantanal's narrative, there is an important lesson to be learned about the friendship meaning. Before we are guided by pettiness and vanity, we must instill on solidarity and respect.

Mythical creatures are in constant contact with the Pantanal people. They can be summoned by improper social attitudes and to intervene against disproportionate actions imposed on the environment, such as excessive hunting, fishing and deforestation.

This is what happened to a reckless hunter in the northern Pantanal who took his canoe and went hunting for peccaries to feed his family. Arriving at the hunting grounds, he slaughtered eight peccaries for fun, which was far more than he needed for food. While returning to his boat with only two of the peccaries he had killed, he heard a strange noise, a thud on the floor and a voice that complained, "Six more to go!"

Startled, he hastened his pace, but soon he saw a tall, thin old black man with a staff in one hand and a pipe in the other. He was followed by a herd of injured peccaries that were unsuccessfully killed by other hunters. He was the owner of the peccaries and ordered the hunter to leave the two peccaries in the canoe and return to fetch the rest. Begrudgingly, the hunter had to carry all six animals at one time. Back on the boat, he was warned by the man that: "Every animal has an owner! You should only kill what you are going to eat". As he spoke, he emptied the tobacco of his pipe on the hunter's leg, rendering him immobile for some time.

Rivers are also inhabited by supernatural beings. One of the most threatening presences is the *Minhocão (Great Worm).* A huge, black worm that sometimes resembles a very large snake with a pig or a dog head. A mythical creatures expert, cowboy Roberto explains that his father once saw the creature in the Paraguay River: "*It looked like a wooden barge. It was rolling in the middle of the river, that thick animal was rolling. He thought it was a canoe. He looked carefully and saw that it was the Minhocão*".

The creature lives in the Pantanal river whirlpools and curves, churning the waters, destroying the banks, and mucking up the rivers. Fishermen and river dwellers should always be aware and cautious of *Minhocão*, as it can manifest itself to those who fish at night or who treat the rivers improperly.

"*In Corumbá, on the other side of the river, there is a port where a man lived. In front of the port there was a whirlpool in the river. The man always threw broken glass cups and bottles into the whirlpool. Because he threw so many into the river, the worm decided to*

Photo: Paulo Robson de Souza/Illustration: Matheus Fortunato

## MINHOCÃO
## (GIANT WORM)

*take him down. It dug and dug and crumbled the river bank. The man lived far from the river bank, but the beast made a hole and dug so much that the man had to move away. The beast moved underground, uprooting mango like trees. Day by day, the animal moved forward to tear down his house and sink it into the river. To escape the beast, the man had to move to the city*", explains cowboy Roberto.

Supernatural entities not only regulate people's action in the environment, but also guide their social conduct. This is the case of *Mãozão (Huge Hand),* which sometimes looks like a tapir, sometimes a big black, hairy person-shaped animal. This creature makes people go crazy and get lost in the fields. *Mãozão* has normal-sized but extremely powerful hands; a circular movement over a person's head is enough to stun them and make them get lost or follow him into the woods. To avoid encountering this entity, farmhands, cowboys, and other farm workers must behave according to strict social standards. Walking alone in the fields, especially at night, shouting unnecessarily and messing around are improper behaviors for a farm worker. If they don't abide by these social norms, they will eventually attract uncontrollable creatures from other worlds, like *Mãozão*.

Thus, the imagination of the Pantanal people is enchanted by beings who live in the most diverse floodplain environments; in the interstitial spaces between this and other worlds. The charm of mythical creatures lies in mediating people's actions with one another and with nature, in ordering the world, giving meaning to dialogues woven between different domains - social, natural and supernatural - that only exist when in relationship, in permanent contact and balance with nature.

RESEARCH

# IN FAVOR OF LIFE

Classifying places with favorable environmental and geographical conditions for the development of animal and plant species – the macrohabitats – is a tool to improve the protection and proper use of the Pantanal wetland

BY CATIA NUNES DA CUNHA, ERICA CEZARINE DE ARRUDA, ELIANA PAIXÃO E WOLFGANG J. JUNK

"Wetlands" is the most generic name by which we call *veredas, varjões, varzeas, brejos*, as well as extensive floodplains such as the Pantanal. They are ecosystems at the interface between terrestrial and aquatic, continental or coastal, and natural or artificial environments, permanently or periodically flooded by shallow waters or with soaked soils. The waters can be fresh, brackish or salty, with plant and animal communities that are adapted to their water dynamics. However, to be considered a wetland they must shelter higher, aquatic or marsh (swamp) plant species, at least periodically, and/or have a wet substrate layer or soil.

The main factor is hydrology, which is what determines the ecological conditions in wetlands and influences the flora and fauna. In Brazil, the vast majority of these areas belong

Photo: Eliana Paixão

to a group whose water level fluctuates. This is because the Brazilian territory is dominated by climates with defined dry and rainy seasons. Thus,

Photo: Cátia Nunes da Cunha

Photo: Érica Cezarine de Arruda

Photo: Cátia Nunes da Cunha

Soda lakes (previous page) earth mound fields (above), sandy river beaches (top right), Mimoso grasslands (bottom right) & floodplain channels (next page) are some of the macrohabitats named according to the Pantanal language

the dramatic fluctuation of water availability resulting from periods of excess rain or no rain causes periodic flooding, called flood pulses.

For the Brazilian wetland classification, regarding the hydrological differences, the Pantanal is considered a floodplain located in the Upper Paraguay River Basin, subject to a "predictable, low-amplitude monomodal pulse". Above all, the region consists of annually flooded savannas.

A wetland extent is determined by the shallow flooding or soaking – either permanent or periodic– or areas influenced by maximum average inundations, in places exposed to flood pulses. This includes native vegetation in the region that is dominated by seasonally- and slightly higher forested regions called *cordilheiras*. These areas are vital habitats for maintaining functional integrity and local biodiversity.

The outer limits of the Pantanal are indicated by the absence of soils formed by water (hydromorphic) and/or by the permanent or periodic absence of plants that only live in water or with a

lot of water (hydrophytes), as well as by the absence of trees and shrubs (woody species) adapted to periodically drenched soils.

To understand the complexity of the Pantanal and facilitate a general understanding by everyone, scientists have divided it into smaller units called macrohabitats. This helps plan comparative scientific studies and indicates the different forms of sustainable use and the protection level required for each type of environment. In a way, before this complex classification, the Pantanal inhabitants already had a similar classification to manage its farm, fishing, and all economic activities. The macrohabitat classification detailed below is intended to synthesize and summarize the huge and complex Pantanal components. Several of its units have been named according to the names traditionally used by Pantanal residents.

Photo: Cátia Nunes da Cunha

In this classification system, the Pantanal is included in the **class** category. Afterwards the **functional units** are designated, which includes "macroregions with similar hydrological conditions", that is, large areas with similar annual water phases or similar variations between the waterlogged phase and the (drier) terrestrial phase.

Below **functional unit** is the **subclass**. In addition to the specific hydrological conditions, subclass also has a certain type of upper vegetation characteristic. This is then followed by the smallest classification unit – **macrohabitat** – defined as "subclass subunit, characterized by indicator plant species or groups".

In other words, macrohabitat is the unit that is most sensitive to changes in environmental conditions. Therefore, these are best to use for comparative scientific studies, defining ecosystem services (production units), analyzing environmental impacts, and developing legal approaches to wetland management and protection.

For research, this classification provides new approaches. For example, it allows for comparative studies between large wetlands. With more than 74 macrohabitats, the Pantanal is more complex than other previously classified, large Brazilian wetlands, such as Amazonian *varzeas* and *igapós* (with 36 and 25 macrohabitats, respectively), as well as those from the Araguaia River (27 macrohabitats) and Paraná River (28 macrohabitats). This is due to the fact that the Pantanal contains many forest and savannah macrohabitats, with very complex geomorphology. Comparative studies

can also be applied for plant and animal species, both between large wetlands and between their respective macrohabitats.

The impact of climate and human-induced hydrological changes can best be observed in macrohabitats arranged along the flood gradient. The effects of wetter or very dry multi-year events can dramatically affect different macrohabitats. For example, studies related the advance of a tree species, "cambara" (*Vochysia divergens*), to the wettest multi-year period since 1974.

In the past, human interference was minimal regarding management practices in the Brazilian wetland, maintaining most vital structures and functions, as well as biodiversity. However, more recent management techniques introduced in the last decades have become more aggressive than traditional ones and impact much larger areas. Furthermore, they have reduced macrohabitat diversity, causing major damage to the environment.

In the Pantanal, ranchers own about 95% of the land, and traditional livestock practices have maintained microhabitat diversity. Since this biome is currently used for ecotourism, the landscape beauty, biodiversity and emblematic plants and animals species in these environments need to be preserved.

But new ranchers, with increasing cattle production goals, destroy essential habitats for the multiple services and functions provided by the Pantanal. Replacing the large variety of native field (or grassland) plants with a single exotic species for large-scale pasture formation decreases the native herbaceous plant species diversity. These conversions decreases the capacity to sustain the fauna associated with these native grassland plants.

Inadequate management can lead to the simplification of forest that accompany landis (below) or polyspecific swamps (next page, bottom), harming the function of the mosaic of microhabitas in the Pantanal. (next page, top)

Photo: Erica Cezarine de Arruda

**MANY POLITICIANS, PLANNERS & AGROBUSINESS REPRESENTATIVES CONSIDER THE CLASSIFICATION PRESENTED HERE TOO COMPLICATED TO BE PRACTICED. THIS ARGUMENT IS INVALID FOR TWO REASONS:**

» Complex systems, such as the Pantanal, require complex management meth-

Photo: Cátia Nunes da Cunha

simplification will result in serious ecological, economic and social damage.

The high macrohabitat diversity is the expression of the system's complexity. Efforts to protect Pantanal structures and functions should be based on and for the different phases of their lifecycles, such as searching for food and breeding sites. The destruction of one of these macrohabitats – let's say, one essential for reproduction – could lead to population collapse, even though other macrohabitats with food remain available.

Photo: Cátia Nunes da Cunha

ods. That is, the productive sector must adapt its simplified methods to the system's complexity rather than try to adapt the complex system to its simple methods.

» The simple application management method only leads to the destruction of the Pantanal's mains structure and functions. and functions destruction. In the medium and long term, maintaining this diversity. Botanical surveys show that many species prefer certain macrohabitats. For example, *capões* and *cordilheiras* deforestation would eliminate many species, especially those with little flood resistance, since one of the ecological function of these macrohabitats is to limit the reach of flooding.

For animals, the situation is even more complex. Many species use different macrohabitats during the water cycle

## THUS, PANTANAL PROTECTION SHOULD BE BASED ON THREE PILLARS:

» Implementation of protected areas, such as national and state parks, Private National Heritage Reserves (RPPNs) and park roads, among others.

» No protection is effective without local population participation. As about 95% of Pantanal lands are owned by cattle ranchers, key protection mechanisms of macrohabitats need to be discussed with this sector. Ecotourism, which has already been adopted by many traditional farmers is an important approach.

» Appropriate legislation can provide financial support to those who protect key Pantanal habitats, to compensate for inevitable economic losses from the development of protectionist activities.

# AT THE SERVICE OF A SUSTAINABLE FUTURE

BY FÁBIO BOLZAN E FÁBIO ROQUE

Nature's Contributions to People (NCP) concept can make the environmental tax compensation instruments more impartial and broader

Photo: Liana john

Of the 26 Brazilian states, 17 have already implemented the Ecological ICMS and in 16 of them, environmental indicators are used to define resource allocation. ICMS stands for Tax on the Goods and Services Circulation, a tax anchored in the 1988 Federal Constitution, which represents the principal tax and the majority of municipal revenue.

The Ecological ICMS emerged in the late 1980's as a fiscal transfer political-economic instrument following Paraná municipalities' political mobilization against the restriction of productive enterprises on protected lands. Banned from carrying out their traditional economic activities due to the parks and reserves creation in part or all of their territories, such municipalities demanded some form of compensation.

Subsequently, the Ecological ICMS came to be considered a way of encouraging the creation of new protected areas, as well as rewarding

municipalities for the quality of management in their areas. With 25% of this tax attributed to municipalities, the state is free to distribute up to a quarter of this amount (1/4 of 25%) as it desires. Thus, the priorities of the municipalities can be influenced by the creation and establishment of the Ecological ICMS.

In the state of Mato Grosso do Sul, the Ecological

ICMS has been operating effectively since 2001, with total transfers exceeding R$ 800 million by 2018. Currently, resource distribution is defined by the Municipal Environmental Index, which reflects the quality and quantity of protected areas in the municipal territory, as well as the quality and quantity of protected areas.

From these two index components, 70% of the resources are related to the protected areas strategy. This is the primary and most traditional means to minimize human action impacts on biodiversity and ecosystems, affecting natural habitat loss and species extinction risk.

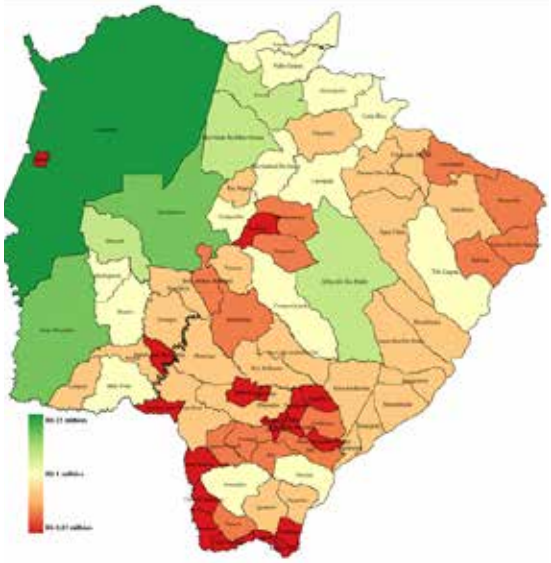
To improve the Ecological ICMS in Mato Grosso do Sul, evaluating the policies and strategies that are already in place is crucial, especially when addressing biodiversity and ecosystem service issues. In this regard, this study incorporates to the Ecological ICMS plan an approach that is beyond the protection of areas, by also representing ecosystem services of municipalities in a more integrated and holistic form. It also includes Nature's Contributions to People (NCP) concept: where culture is central to all the links between people and nature.

The data used encompasses both the biodiversity conservation importance and the provision of ecosystem services, It also considers mitigating climate change.

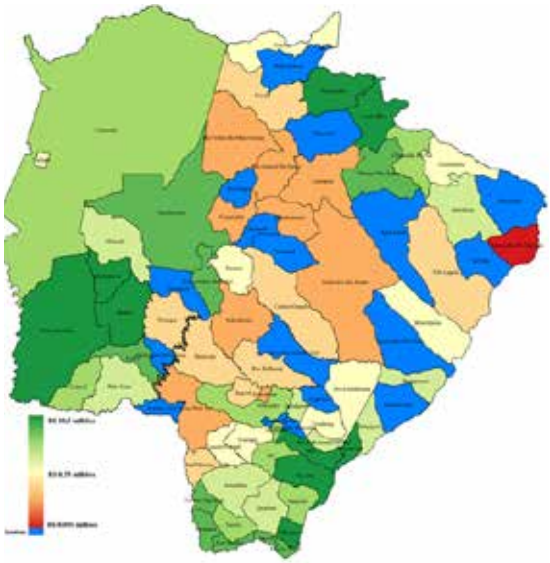
**THE INTEGRATED DATA SET IS BASED ON GEOSPACIAL INFORMATION OF MATO GROSSO DO SUL LANDSCAPES AND IS COMPOSED BY THE FOLLOWING LAYERS:**

- Carbon stock: representing above ground biomass (native vegetation);
- Ecological resilience: considering the biota (group of living beings in a region) ability to recuperate local losses through landscape scale immigration;
- Potential ecosystem services: assuming that the performance of such services is directly related to the structure, composition and function of native vegetation;
- Priority areas for conservation: seeking to define which areas are irreplaceable for biodiversity conservation through systematic conservation planning, and
- Biodiversity corridors: considering linear designs capable to integrate landscapes with a high connectivity degree, associated with riparian forests and connected to conservation units.

In order to unite all the layers, after data standardization, the arithmetic mean



ICMS distribution according to Nature's Contributions to People (NCP)



ICMS distribution according to the 2018 Municipal Environmental Index

was used to order each municipality. Finally, to simulate the result of layer integration in the Ecological ICMS interface of Mato Grosso do Sul, we considered the R$ 77 million transferred in 2018 and their respective municipal environmental indexes.

Thus, when using a data set based on the NCP, municipalities with the most positive situation, that is, where the integrity of ecological functions is most preserved and the priority conservation issues are met, will be awarded.

This approach differs from the strategy currently adopted by the municipal environmental index, which is predominantly focused on protected areas. By considering NCP as a criterion for transfers, the management model now includes public and private areas. The strategy based on NCP is also more equitable, as it rewards everyone. On the other hand, given the discrepancy in nature conservation between the municipalities in Mato Grosso do Sul, especially between the Paraná and Paraguay river basins, the amplitude of transfer values would increase considerably.

For example, in 2018, Jateí municipality received the most Ecological ICMS resources: R$ 10.5 million. If the NCP criterion were used, Corumbá would be awarded almost R$ 25 million; more than double of Jateí's benefits.

Using mixed strategies can not only affect the predominantly public protected areas management but can also highlight the importance of private areas. By spreading actions and, consequently, their positive effects, the benefits of ecosystem services can flow from the places where they originate to where they are consumed. This reinforces

Photo: Liana john

Potential Ecosystem Services (blue), Ecological Resilience (green), Carbon Stock (brown), Biodiversity Corridors (pink) and Priority Conservation Areas (yellow) representations in Mato Grosso do Sul.

the need to use integrative public policies focused on corporate responsibility to maintain natural capital, as well as the representativeness of the various civil society participants involved in the natural resources governance and the design of new development options.

Data about NCP has explored important biodiversity conservation aspects and the establishment of ecosystem services by focusing mainly on nature's material contributions, However, there is still a lack of information regarding the immaterial values that natural resources generate for the well-being of people. These include those related to ecotourism, scenic beauty, and spiritual and cultural aspects.

In this sense, integrating biodiversity, ecosystem services and human well-being becomes fundamental to continuously improve economic policies and tools, such as the ICMS. Finally, this political-economic tool of fiscal transfer encourages and recognizes NCP, with the potential to enable social and economic development, as well as to construct a more sustainable future.

# YSHIR, A PANTANAL RESISTANCE

In Upper Paraguay, every newborn from the Yshir Chamacoco nation comes into the world with a mission: to care for their ancestral gods and face the challenges of conserving nature and the globalization effects

BY MÓNICA BAREIRO

Photo: Mónica Bareiro

The water (*Eshynwyrta*), wind (*Nehmur*) and forest (*Pawthiata*) are the main deities for the traditional people who inhabit seven indigenous communities, located about 800 kilometers from Asuncion, the Paraguay capital. In Puerto Diana, Karcha Bahlut, Puerto Pollo, Dos Estrellas, Puerto Esperanza, Virgen Santísima and Buena Vista, children are already born as guardians of their ancestral culture and deities, whose importance goes far

Pressured by businessmen and entraped by regulations imposed by bureaucrats, indigenous communities (above) seek strength in ancestral traditions to avoid losing their lands

beyond religion and its territory in a worldwide relevant region such as the Pantanal.

The seven communities are located on the Negro and Paraguay river banks and are parts of the Yshir nation, a wide group of people forgotten by the Guarani authorities. Leaders like Marciano Barboza, one of Puerto Diana's chiefs, recall the bravery of their ancestors that struggled to guard their lands. If an outsider got too close, he would be expelled with arrows. Today, enemies attack differently; they come with documents and oblige Indians to comply with administrative procedures and bureaucracy.

Previously, according to the Yshir Chamacocos people, their gods provided the water and food necessary for survival. They did not need this "invention of whites" – money – which is now fundamental to travel to the country's capital and fulfill bureaucratic procedures. If they don't have their documents in order, they lose their land. This has already happened. Several places traditionally occupied by this indigenous nation are now attributed to foreigners, which is completely illegal according to Paraguayan legislation.

The impact of land loss is huge. Today, rituals like *Delivyvy* are no longer enough to stop the raids. Formerly, this was a dance done in honor of *Eshynwyrta* (the water god) to ward off evil spirits. Now, enemies force them to remain in places where they cannot secure their own supplies. "Before, if we were hungry, we would go into the woods to hunt animals, but only to eat. We looked for fruits and honey. All from the woods. Nowadays, entrepreneurs come with their machines to blow it all away. And they leave us without our "supermarket", laments Roberto Campos García, another Puerto Diana leader.

For women, like Rumilda García, being born in the Pantanal is not a privilege. "We have a very strong ancestral culture and we value it. But sometimes this becomes a heavy burden", she says. "We are committed to defending this land and do not have the same fighting tools as our enemies. They come with a lot of money, with machines. We just cling to the wisdom of our ancestors, and act like them: we fight, despite everything".

Another leader, María Estela Barboza, insists on recalling that none of the communities would continue if it were not for the chiefs' wisdom and the gods' force. She points out forms of resistance: "We have water, air and forests, which changes over time. Now there are more white men coming with their things. But we must be strong. Our children learn Yshir, Castilian, some Guarani, and a lot of Portuguese, because now we have to sell things like honey and handicrafts to survive".

In the communities, generally, people are far more hostile and unfriendly compared to other Paraguayans. Their mission of defending their culture and deities is difficult when in their homes, there is a constant and inescapable concern: hunger. But their commitment to Chamacocan language and customs, and their efforts to protect them are evident. The Pantanal itself seems to transmit its strength to the last Yshir guardians.

**DELIVYVY RITUAL**

Photo: Mónica Bareiro

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