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ARTICLE

Biological Corridors as a Connectivity Tool in the Region of the Great American Chaco: Identification of Biodiversity Hotspots in the Ecoregions of the Paraguayan Chaco

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ABSTRACT

This work presents the main biodiversity hotspots existing in the Paraguayan Chaco and is an update of the results obtained in the first Ecoregional Assessment of the Great American Chaco. These are the results of a series of workshops that included scientific and technical discussions carried out by local experts in zoology, botany, forestry, soil science, and hydrogeology applying a biodiversity vision of 25-30 years for the territory, after overlapping the maps of the first assessment with that of the advance of the changes of land use in the territory. Criteria for detecting biodiversity hotspots were discussed, including: permanent and temporary watercourses, other bodies of water such as fresh and salty lagoons, reserve areas of different categories, as well as important bird areas (IBAs), RAMSAR areas and others, which must be connected in the future, combining the production areas with the conservation of biodiversity.

1. Introduction

The boreal Chaco is the portion of Paraguay that lies west of the Paraguay River, occupying an area of approximately 244,840 km2, equivalent to 60% of the national territory which is 408,076 km2. It is part of the Great American Chaco, a large plain of 1,066,000 km2 shared with Argentina, Bolivia and a small portion of Brazil, where the Paraguayan Chaco occupies approximately 34% [34]. Both the region and the Paraguayan Chaco present marked climatic gradients. The Paraguayan Chaco

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present a decreasing rainfall from east to west, with values between 1400 and 400 mm/year close to the semi-arid region in the west end (Environmental System of the Chaco Project, 1992-97).

Considering its size, the Paraguayan Chaco is quite uninhabited, reaching about 300,000 inhabitants, over a total population of about 7 million inhabitants [22]. In relation to its demographic dynamics on a human scale, it has a small riverbank population located on the Paraguay River, another population concentrated in the center of the territory around the Mennonite colonies and an indigenous population in the extreme south as an extension of the capital, Asunción, and a very sparse population in the rest of the territory [38].

For the authors of this work, this territory presents unique characteristics that should be preserved, not only from the ecological point of view but also from the socio-historical one, recognizing that the portion with semi-arid characteristics located in the ecoregions of the Medanos and Dry Chaco (Figure 1) is being recognized as one of the world's last natural territories [23], which includes it as one of the conservation centers for large mammals such as the yaguareté (*Panthera onca*) [30], tagua (*Catagonus wagneri*) [1], tapirs and peccaries [33] and mammals in general [10].

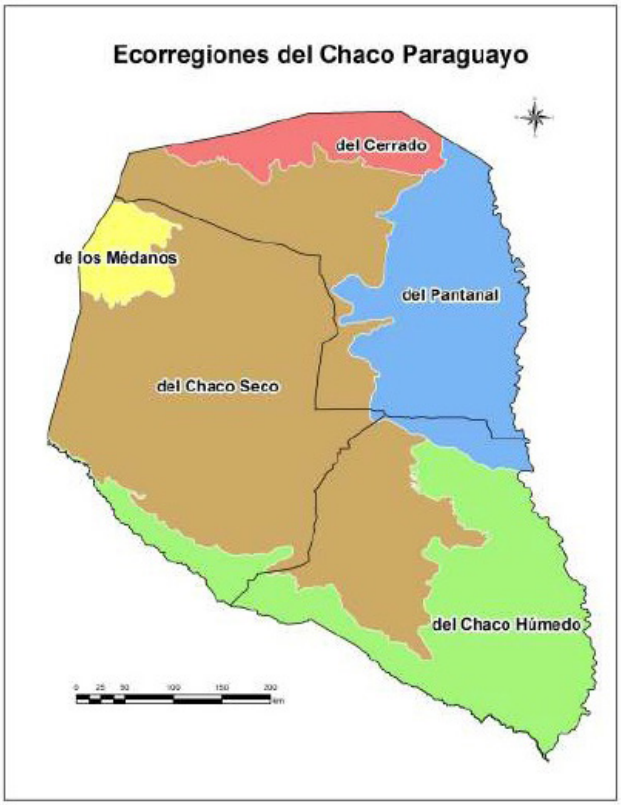

Figure 1. Ecorregions of the Paraguayan Chaco

The Chaco is not only very rich in biodiversity, but also it is a very prosperous territory, where the communities of Mennonite immigrants stand out due to the sustained growth of production. In fact, they have developed one of the most important dairy and meat basins in the country, with the result that citizenship has practically replaced the preference of imported dairy products (processed milk, cheese, yoghurt, dulce de leche and others) for these national products [38]. The Mennonites have also developed livestock, with high genetic breeds, currently exported not only in the form of commodities but also as breeding stock. In this sense, many Paraguayan and foreign producers of the territory have also prospered.

The colonies are very prosperous not only in the areas mentioned but also in the production of forage sorghum and export of the confectionery peanut, the latter with more than 10,000 hectares cultivated and a yield of more than 2 tons per hectare [38]. Obviously all this is accompanied by the use of modern technology, which has required a lot of investment in infrastructure.

There are also prosperous enterprises in the northern part of the territory that mainly involve the production of meat of high genetics, placing the country in a privileged place in the export of these commodities, to the point that all the ecoregions of the territory have been impacted to a greater or lesser extent by the modifications of natural systems.

Due to all of the above, there were accelerated changes in land use [36,37], giving way to other types of productive systems implanted (Figure 2). Unfortunately, a complete lack of territory ordering caused that the best areas for production as well as those for the conservation of biodiversity were not protected.

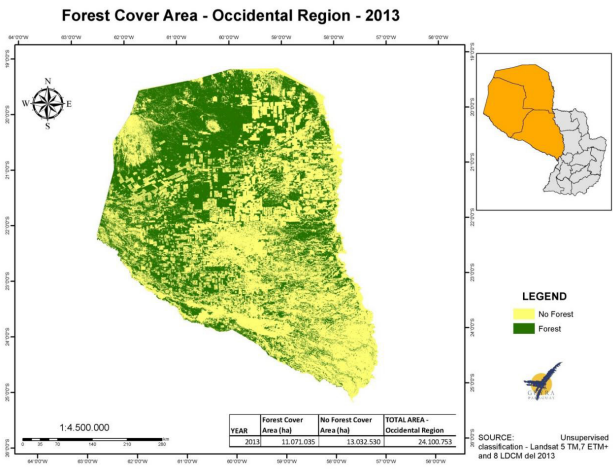

Figure 2. Changes in land use

Considering the Gran Chaco ecoregion at a regional scale, Nori et al. [26] highlights the fact that, in spite of the common problematic and the urgency of conservation ac-

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tions, little is known about the priority conservation areas of the Gran Chaco, and even less about the efficiency of the priority areas network in this threatened ecoregion.

That is why it has been proposed to work not only with the distribution of biodiversity hotspots but also with the biological corridors tool, trying to maintain a long term vision of biodiversity, which maintains the connection between areas important for conservation. It is intended that these biodiversity areas or hotspots do not suffer from endogamy in the future, due to the fragmentation and isolation of the remaining natural systems. On the other hand, it is also intended that a future economic development capable of combining production with the conservation of biodiversity with positive and sustainable results for both will be achieved in the territory.

The regional Chaco has had a first assessment regarding the knowledge of its main biodiversity hotspots [34], but unfortunately the results of the work of national and international experts did not produce public policies tending towards sustainable conservation of those hotspots. Although some of them are maintained, others probably have disappeared or are in the process of deterioration with the sustained fragmentations. Moreover, as mentioned by Nori et al. [26] those analyses were performed over 12 years ago, period in which the agricultural frontier drastically advanced in the ecoregion. According to these authors, there is a need to update existing data and provide new and more accurate information that can guide current conservation decision-making processes.

Some of these hotspots still exist in the peri-urban areas, around important cities such as Filadelfia and Loma Plata and the best way to try to connect them will have to be found, so that their permanence benefits future populations, not only from the point of view of a better quality of life but also of the landscape point of view.

In this first work, the objectives were: (1) to identify the main current biodiversity hotspots in the territory; (2) to draw and project through a preliminary map, a first qualitative approximation of the connectivities of the main biodiversity hotspots, joining the important points mentioned in the results and to overlap the map generated in this work with the one already carried out during the first ecoregional assessment of the Great American Chaco [34]; (3) to identify biodiversity hotspots in peri-urban areas and project the importance of this.

2. Materials and Methods

Identification of biodiversity hotspots: Territorial biodiversity hotspots were identified by ecoregions (Figure 1). For this purpose, the scientific community (fauna and flora), representatives of several institutions specialized in biodiversity and individuals including zoologists, botanists, foresters, soil scientists and hydrogeologists were summoned by the Environment Secretariat (SEAM).

In order to determine the biodiversity hotspots, the following criteria were applied: (1) presence of general reserve areas (national parks, managed resource reserves, private reserves such as: Médanos del Chaco, Defensores del Chaco, Río Negro and Teniente Agripino Enciso, Cabrera-Timane, Tinfunké, among others), which protect by their extensions groups of emblematic species such as living fossils, big cats, specific and transitional vegetal formations of ecological and landscape value; important bird areas or IBAs, (Figure 3) and RAMSAR areas, which concentrate the greater diversity of birds in the territory; wetlands (main water courses [Paraguay and Pilcomayo]) and its tributaries, salty lagoons of the center of the Chaco, which concentrate some endemisms and fresh water, but also are interesting because of the ecological processes that occur in a territory where water is scarce and (2) known biodiversity hotspots in private properties such as the *Bulnesia sarmientoi* (palo santo) reserves, currently in the Appendix II of Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). It was also considered to form a large corridor through the entire border area with Bolivia (dry frontier), only cut by international roads, so as to project inter-country connections in the future.

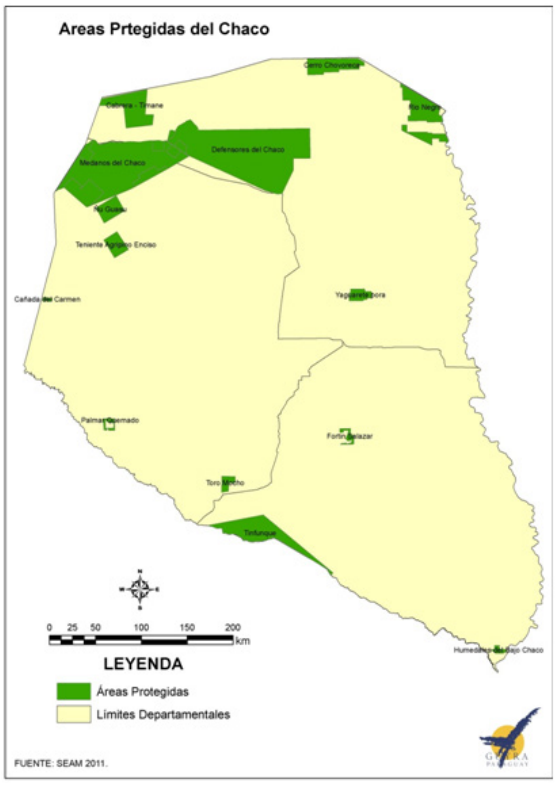

Figure 3. Wild protected areas in the Paraguayan Chaco

It is noted that for the hotspots important to the flora, the records of the scientific collections that remain in the national herbariums were taken into account.

Six consecutive workshops were held; these workshops developed interdisciplinary discussions in order to identify the priority areas where the biological corridors should pass and the subsequent elaboration of a preliminary map of the interconnection of the biodiversity hotspots.

To complement the information on biodiversity, the following bibliographic references on the subject were used: Altritcher et al. [1]; Cabral & Ruíz Díaz [5]; Cacciali & Scott [6]; Cacciali et al. [7]; Cartes et al. [9], Cartes et al., in press [10]; De Egea et al. [11]; D'Elía et al. [12]; González Parini et al. [13]; Guyra Paraguay [14]; Junk et al.[15]; Mereles et al. [16]; Mereles [17]; Mereles et al.[19]; Mereles [21]; Mereles et al. [22]; Navarro [25]; Pérez de Molas & Mereles [27]; Sanderson et al. [30]; Spichiger et al. [32]; Taber et al. [33]; Timm et al. [35]; Weiler et al. [39].

Preliminary map of mapping of connectivities: Subsequently, a preliminary outline was drawn up, linking the biodiversity hotspots found (Map 1), to which the results of the First Ecoregional Assessment of the Great Chaco [34], Paraguayan chapter, were overlapped. This assessment showed the significant areas for biodiversity at that time which were: (1) terrestrial ecological systems, (2) aquatic ecological systems, (3) important bird areas d), important areas for amphibians and reptiles, (4) important areas for mammals and (5) areas important for vegetal species and communities (Map 2).

Importance of peri-urban biodiversity hotspots: As an example of the union of biodiversity hotspots in peri-urban areas, the District of Philadelphia was considered as it is one of the most populated of the Chaco and contains several conservation hotspots (Figure 4).

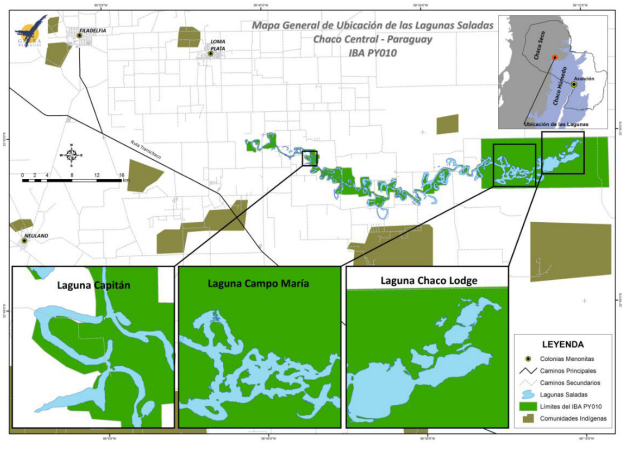

Figure 4. Locations of the peri-urbans corridors around Filadelfia, Mariscal Estigarribia and Loma Plata, Central Chaco

The professionals that participated in the workshops were representing the following institutions: Museo de Historia Natural and Secretaría del Ambiente (SEAM), Facultad de Ciencias Exactas y Naturales (FaCEN) of the Universidad Nacional de Asunción (UNA), Herbario of the Facultad de Ciencias Químicas (FCQ) of the Universidad National de Asunción (UNA), Guyra Paraguay, World Wildlife Fund, Paraguay, Wildlife Conservation Society (WCS), Fundación Moisés Bertoni (FMB), Centro para el Desarrollo de la Investigación Científica (CEDIC), Asociación Etnobotánica Paraguaya (AEPY), Cooperativa Fernheim, Filadelfia, Centro para la Conservación del Chaco Paraguayo (CCCPY), Sobrevivencia, Amigos de la Tierra, Itaipú Binacional margen derecha, Paraguay and individual professionals.

3. Results

The vast majority of wild protected areas of the territory are located (Figure 3) in the Dry Chaco, the Medanos and Cerrados ecoregions which are in the northwest, north and extreme north-east of the Chaco. These protected areas concentrate and protect important diversity areas with large mammals such as: *Priodontes maximus* (giant armadillo, tatú carreta), *P. onca* (yaguareté, Paraguayan species), *Tapirus terrestris* (tapir), *Mazama americana* and *M. guazoubira* (deer), three species of peccaries including *Parachoerus* [*C.*] *wagneri*, (tagua, pecari quimilero), a living fossil and currently in the UICN red list of threatened species, *Myrmecophaga trydactyla* (anteater) and reptiles and amphibians, some of them endemic to the area. The Médanos is also the limit of the distribution of the *Lama guanicoe* (guanaco) and the unique place of appearance of this species in the Paraguayan Chaco. Others importants biodiversity elements are: *Chelonoidis carbonaria* and *C. chilensis* (tortugas terrestres), *Boa constrictor occidentalis* (boa constrictora), *Epicrates alvarezi* (boa arcoíris) and endemic anfibians: *Leptodactylus laticeps* (rana coralina) and the genus *Lepidobatrachus* (ceratófrido).

The northern zone protects these three ecoregions, unique within the Great Chaco. In fact, the Medanos ecoregion or sandy formations of eolian origin, whose sands come from the Grande and Parapiti rivers in Bolivia, appears only in this zone, presenting a great sandy expanse with unique and almost endemic vegetal formations of the Great Chaco and an important species richness. The continuous formations of *Schinopsis cornuta* on the crests of the dunes and recently described species also endemic to the region such as *Cissampelos arenícola*, *Ceiba samauma*, etc. are found in this area.

Among the regional endemisms of the Gran Chaco including the Paraguayan Chaco, *Arachis* (wild peanuts)

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species, such as *A. batizocoi, A. duranensis* and *A. cardenasii* are considered to be very important phytogenetic resources as they are wild relatives of commercial species. The north is also the place where the Cerrado ecoregion develops, a formation coming from Brazil and Bolivia and recently described for the Paraguayan Chaco. In the same area, woody species of the ecoregion have been mentioned for the first time for Paraguay, such as: *Commiphora leptophloeos, Simira sampaioana, Zeyheria tuberculosa, Sterculia striata, Magonia pubescens, Cochlospermum regium*, among others, elements completely foreign to the Chaco formations. The Cerrado is also seat of important phytogenetic resources like wild species of *Manihot* (wild cassava).

In the north-eastern and eastern ends, the Pantanal ecoregion stands out, where very diverse transitional forests appear, with species foreign to the territory such as *Cordia trichotoma* and C. *glabrata* (petereby), two timber trees found only in this part of the Paraguayan Chaco. In rivers, streams, lagoons and other bodies of water, aquatic mammals such as *Pteronura brasiliensis* (giant otter, arirai) are found, being this one of the few stable populations in the water courses of the north of the country. *Blastocereus dichotomus*, *Dracaena paraguayensis* (teyú viborón) and important aquatic reptiles such as *Caiman latirostris* and *C. yacaré* (yacaré overo and common cayman), *Iguana iguana*, among others, can be found in this area. In this ecoregion, there are also records of species populations whose distribution is more southern such as *Mimon crenulatum, Sciurus ignites* and *Mico melanurus*.

In the Dry and Humid Chaco ecoregions, seven of the ten families of amphibians represented in the Chaco are found, with a total of 63 species known to date, representing 74% of the country's amphibians. These include endangered species such as *Chtonerpeton indistinctum*, endemic families such as *Chacophrys pierottii*, *L. asper* y *L. llanensis* (Ceratophryidae family) and *L. laticeps*, endemic of the arid paraguayan Chaco. *Ceratophrydae*, whose five species are found only in the Chaco region and finally *Melanophryniscus paraguayensis*. Bufonidae, a species endemic not only to the region but also to the country, and reptiles (turtles, lizards, crocodilians, amphibians and snakes) are represented by 24 families, with the *Acanthochellys pallidipectoris* being a species classified by IUCN as vulnerable and very threatened at national level due to the loss of their habitat. Other prominent reptiles threatened by illegal hunting and fires are *Bothrops matrogrossensis* (jarara), a semi-arboreal snake, very rare in the genus, *Caiman spp., B. constrictor occidentalis* (boa constrictor) and turtle species of the genus *Chellonoidis*. During the preparation of this work, a new species of legless lizzard, *Ophiodes luciae*, was recorded, indicating that other riches still remain to be discovered in this territory.

The Dry Chaco ecoregion also stands out for birds; thus, it is the only site in the country where *Phoenicopterus chilensis* and *Ph. jamesii* (flamingos) appear, migratory birds that concentrate only in the salty lagoons of the territory. The birds constitute, next to the mammals and great reptiles, the most valuable of the Chaco territory. The fifteen important bird areas (IBAs) make up more than 2.4 million hectares in total, of which 6 are associated with riparian environments in connection with watercourses in private areas, totaling more than 100,000 hectares.

The salty lagoons in the same ecoregion form a complex of sites important for conservation and are home to at least three IBAs: Laguna Capitán (RAMSAR site), Chaco Lodge and Laguna Campo Maria, totaling about 23,400 hectares. Concerning vegetal species, salt flats are sites with typical vegetation, which supports higher concentrations of salt in the soil. Although the species found there are not unique to the country, these are the only sites where *Heterostachys ritteriana*, *Sarcocornia perennis, Cyclolepis genistoides* (much appreciated for its medicinal qualities) and an endemic species of the site, *Tillandsia mereliana* [31], appear. These sites are also the ones that concentrate the larger quantity of *B. sarmientoi* (palo santo), already mentioned above.

The Dry Chaco ecoregion is also house to important endemisms of the group of succulent plants such as *Gymnocalycium*, *Quiabentia* and *Echinopsis* species, as well as typical representatives of the Great Chaco such as species of the *Prosopis* genus (carob trees in general), *Sch. heterophylla* and *Sch. quebracho-colorado* (quebrachos). One of the most coveted trees in the northern part of the eastern region, *Amburana cearensis* (clover), is remarkably found in the Dry Chaco, probably associated with soils with calcareous inlays and high pH as well as other utilitarian species such as *Capsicum chacoense* (wild pepper, ky'ỹi), one of the only wild *Capsicum* of more austral distribution in South America, which gains importance because it is also considered a phytogenetic resource, and some species of *Manihot* (wild cassava) already mentioned.

The Humid Chaco and Pantanal ecoregions are watered by two large rivers of the three which are in the Great American Chaco: the Paraguay and Pilcomayo rivers. In the first of them, floods and falls of the waters, called "flood pulse", occur periodically on its floodplain, creating an aquatic-terrestrial transition zone where important ecological processes occur such as a high rate of primary productivity, the development of unique habitats for the survival of certain species, the spawning and growth of ju-

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venile migratory fishes such as *Pseudoplatystoma corruscans, Salminus brasiliensis, Prochilodus lineatus* and other species important for sport fishing such as *Raphiodon vulpinus*.

The torrential waters of the Pilcomayo River carry tons of sediment per year and revitalize the Chaco plain in benefit of its biodiversity and population in general. This is one of the most important niches of the migratory species *Proch. lineatus* (tarpon) which is well-used in the region.

Both water courses with their tributaries are not only rich in biodiversity but are in themselves, formers of important natural corridors for the Chaco fauna and flora as a whole.

In both regions, the wooded formations of *Sch. balansae* (red quebracho), an emblematic species due to its high content of natural tannin, are also developed, constituting one of the most diverse ecotonal formations in the Great Chaco where vegetal species converge, the Atlantic Forest, the Cerrado, the Amazon and the Dry Chaco, among others.

In relation to connections, two maps were generated:

(1) One that unites the areas mentioned above (Map 1, preliminary outline): this north tract concentrates the protected wild areas of the department of Alto Paraguay: Médanos del Chaco, Cabrera-Timane, Defensores del Chaco, Río Nero and Teniente Agripino Enciso national parks. It was also considered the proposal of Reserve for Chovoreka National Park, with the concentration of the area of the Cerrados, unique formations of this type in the territory of the Chaco. These corridors basically connect four ecoregions: Médanos, Cerrados, Pantanal and Dry Chaco.

A central-east corridor, trying to cover existing private reserves and others that do not yet have a well-defined status like the Tifunké managed resources reserve, located on private land and with large wetland areas. This corridor connects the ecoregions of humid Chaco and dry Chaco.

Of the fifteen important bird areas (IBAs) eleven are mentioned, which are those outside the reserve areas (since the others coincide with protected territories) and are as follows: Pozo Hondo, Estancia Gran Siete, Fortín Toledo and Pirizal in Boquerón department; Laguna Ganso, Lagunas Saladas-Riacho Yacaré, Reserva Tinfunké-Estero Patiño, Estancias Golondrina - El Trébol, Estancia La Rafaela, Estancia Santa Asunción and Río Negro-Bajo Chaco in Presidente Hayes department.

(2) the one generated by overlapping the first one with that of the first ecoregional assessment of the Great American Chaco, Paraguayan Chaco chapter.

With the overlap of both maps, the biodiversity hotspots still existing in the territory will be reflected (Figure 5).

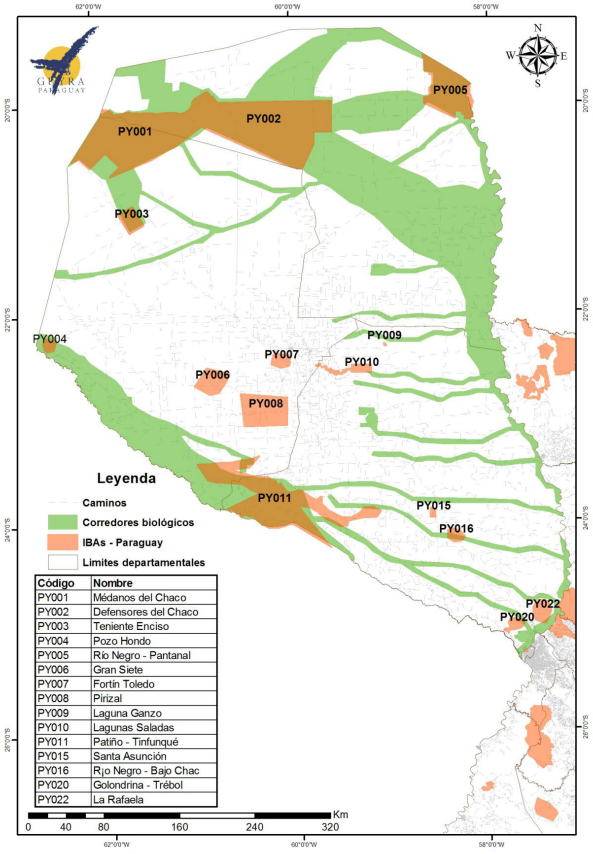

Figure 5. Map with the aproximate location of the proposed Biological Corridors

Finally, the conservation areas surrounding the city of Philadelphia total approximately more than discontinuous 65,000 hectares. These were created thanks to the union of the forest reserves required by the Law 422/73 Forestry. Those disconnected hotspots will be joined by the protection curtains of crops, generating resilience in the natural formations of the peri-urban area. The objective of the union of the peri-urban reserves was to protect biodiversity and water for the future. This corridor totals more than 65,370 hectares and is made up of the following reserves: Kannland, Mellizos, Central, Cauce Moro, Campo Norte and Laguna.

4. Discussion

The Paraguayan Chaco is undoubtedly the most diverse in comparison to the Argentine and the Bolivian Chaco, for the variety of vegetal formations and the great amount of wild fauna that still remains. Clearly, one of the most important groups is the birds, which are concentrated in the five ecoregions of the area. Other important aspects are its value as a territory where there are niches of phytogenetic

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resources linked to food, particularly in the north of the territory, developed on eolian and hydric sands: *Arachis* and *Manihot* species (peanuts and wild manioc respectively), as well as species of *Capsicum* (wild pepper). These niches are not only important components of biodiversity but are wild relatives of economically important species, so other conservation strategies for these elements should be considered. One of these strategies is to know what and how many are, where they are and somehow find a way for them to remain in their habitats. Other reasons are the presence of endemic large mammals (*C. wagneri*), the concentrations of threatened species such as birds and amphibians, and the concentrations of big cats, among others.

In fact, the Paraguayan Chaco is considered by some as a land rich in wildlife or *Wilderness Area* [23], because it still contains large pristine and biodiversity rich areas which in practical terms means that approximately 60% of the territory is in a natural state not yet fragmented, with continuous natural formations that are rapidly being lost by changes in land use, intended for production.

Why a *Wilderness Area* and not a *Hotspot*? This last concept, developed by Myers [24], requires a minimum of 1,500 species of endemic plants in a region, which is difficult for the Gran Chaco to have due to the homogeneity of the substrate and its uniformity, but at the same time the area is under much threat. In contrast, the Paraguayan Chaco is a unique territory in relation to its particular vegetal formations, since it keeps most of the representation of the current dry forests (last remnants in all Latin America), very threatened due to the great changes in the land use and a rich mastozoological and ornithological fauna.

Due to this, we suggest that the current concepts of *hotspots* are redefined or at least complemented by those presented by Myers [24], since the Gran Chaco and the Paraguayan Chaco in particular contain some similar characteristics as a great threat due to the accelerated changes in land use, and whose habitat and biodiversity losses are very high and rapid over time. On the other hand, more detailed quantitative analyzes of formations and endemic vegetal species will have to be carried out, since there are large information gaps in this area and also to take this region as a whole: Great Chaco. Threats do not only attack forest formations but also the aforementioned fauna, with special emphasis on the large mammals, including big cats and the outstanding ornithological fauna.

As for what remains of its pristine area, it is possible that already the Paraguayan Chaco has lost between 60-70% of its original surface, for the reasons explained.

How do we maintain these last biodiversity hotspots? This remains a challenge and one option is undoubtedly to find the connectivities between them, which are commonly known as biological biodiversity corridors. It is worth noting that the concept of biological corridors has generated numerous conflicts and discussions at scientific, political and social levels, since some maintain the hypothesis that they are only tools for modified landscapes, while others mention that they are complements for the conservation of protected areas [8]. However, so far, there are no other options; evidently a rapid action for the construction of these connectivities will be what the Mennonite predecessors have done: to unite their forest reserves under the Law in the central Chaco. This private initiative is a first and only example in the country of a biological corridor already established, from which secondary corridors can start to maintain priority areas for biodiversity, close to urban centers.

The management mode with which these reserves were left in the middle of the productive areas proved to be very innovative, since the owner-producers came together to match their forest reserves to the national legislation (Forest Law 422/73) in order to form a greater continuous mass of natural formations, emphasizing in this sense the importance of the reserves in the semi-urban areas; obviously they also concentrate biodiversity hotspots.

The Chaco territory in Paraguay has been developing steadily since the 1930s, but it is only since the 1990s that it began a process of massive land clearance that accelerated when the moratorium of the changes on land use in the Eastern region entried into force [4]. Thus, the Western region, like the Eastern region in previous decades, has been subjected to major transformations, which have resulted in some cases in a complete change of forest matrix to suburban and urban areas [18]. Unfortunately, it has not been foreseen that the expansion of this development, concentrated in the livestock activity (milk and meat) and other agricultural items for export, could have affected the conservation of the biodiversity to less than 100 years of the beginning and with only 8% of the population.

An ideal prevention would have been possible with the application of a territorial ordering, work not done for various causes, which is why we again turned to a tool that tries to connect areas that must maintain their homeostasis in time and not fall into endogamy, such as the large reserve areas concentrated in the north of the territory.

One of the aspects that could be noticed in Map 1 is the absence of corridors in the north-south direction, except for the Paraguay River trunk. The reason is that permanent and temporary water courses have a west-east direction, with a large number of lagoons of different sizes in between, which must be connected. Probably the hardest job is to connect these areas empty of watercourses that cross

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private, mostly productive, land.

The final identification and subsequent design of the biological corridors for the Paraguayan Chaco requires a second stage of work consisting of a numerical valuation for each corridor, considering whether it passes between protected areas, which represents a low value for the biodiversity, as it occurs in the north of the territory or if it passes through private lands, where the cost for the fauna biodiversity would be higher.

On the other hand, reaching the biodiversity reserves is not always easy. Therefore, in those places where costs will be high for the diversity of fauna, a major management effort, led by local authorities (municipalities and governorates) and the Secretaría del Ambiente (SEAM), should be made. The call in this second phase should be addressed to the representatives of all groups and associations that live in each municipality: producers, landowners, rural, scientists, natives, and others, since each of them will have enough to contribute in the construction of each corridor that has to go through the districts.

Obviously, to put into practices the proposal of biological corridors does not guarantee the conservation of important biodiversity rich areas, especially those outside the reserve areas. Success in the implementation of the corridors will depend on the management work, which must be carried out with the rigor and the required and selected community participation.

At sites associated with corridors, physical and biological connectivity would occur in an excellent way if productive establishments, mostly livestock farmers, adopt biodiversity-friendly practices such as those implemented around Filadelfia, joining the forest reserves trying to cover a larger area, protection of springs and watercourses, among some examples. For their construction, the work tables must adopt criteria to follow, in order to maintain or initiate a connectivity process in the best possible way, according to the physical conditions of the environment and the products to be conserved.

The tool of biological corridors will generate conflicts almost surely, since to be effective, they must pass through private properties in the process of establishing the connectivities [21] and those are the conflictive situations that must be settled for a better territorial planning.

As a projection for the future, the corridors should be biological-cultural in the broad sense, incorporating to the territory those steps by which the indigenous people obtain the resources for their forms of life.

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