

# BIOLOGICAL IMPORTANCE OF FINCA LA SOLEDAD, SALTA PROVINCE, ARGENTINA -April, 2020-



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# Summary

La Soledad is an area of biological relevance in northwestern Argentina. It comprises 8,719 ha in the north of the province of Salta, close to Calilegua National Park, within the Las Yungas Biosphere Reserve. The dominant vegetation is that which characterizes the Yungas forest, with representation of three of the four typical vegetation stories, in an altitudinal range between 1,000 and 3,100 meters above sea level: Montane Forest, Montane Woods and Highland Grasslands.

Occupation of the territory dates back to over 10,000 years ago, having been colonized by groups of hunters-gatherers. The region was an important sector in the trade corridor of the Inca Empire, though apparently there were few human settlements within La Soledad. More recently, the property was inhabited by small isolated groups, in relation to activities of migratory herding. Today, there are about 15 dwellings or temporary abodes used by inhabitants of Valle Colorado and Santa Ana (Jujuy), who take their livestock to graze in La Soledad during the dry season.

Biological surveys carried out in 2019 together with complementary information compiled show that La Soledad holds significant biodiversity. It hosts species of great relevance such as the jaguar (Panthera onca) and the north Andean deer (Hippocamelus antisensis), which have been declared Natural National Monument; the Black-and-chestnut eagle (Spizaetus isidori), the Rufous-throated dipper (Cinclus schultzi), the torrent duck (Merganetta armata), the Andean condor (Vultur gryphus), the Tucumán amazon (Amazona tucumana) and the Redfaced guan (Penelope dabbenei). All these species are considered threatened in Argentina and some of them are under national or regional management plans. In addition, the existing forest cover is in a good state of conservation; we have recorded important stands of valuable forest species, with centenarian specimens and healthy seedlings and no evidence of logging past or present, except for the small-scale activities of the local inhabitants. In addition, it contains unique and important patches of tree ferns, scarce and restricted to certain sectors of northern Argentina. La Soledad is a provider of numerous ecosystem services that benefit neighboring communities and the society as a whole. These comprise resources such as safe drinking water and water for irrigation, and complex processes like regulation of water flow, soil erosion control, carbon sequestration and liberation of oxygen, among others. These are only some of the relevant conservation values of La Soledad; however, the region has been very poorly explored, so that there may be a greater potential for the property to contribute other significant values.

The wide extension of native forests in La Soledad, the rugged terrain that dominates the area and the scarce human activities in the area have allowed a process of recovery from past human interventions and it now presents a high biodiversity. All this places it among the private properties of high priority for conservation at a regional level, which in turn is highlighted by its location close to the largest national park of the Argentinean Yungas, generating a chance to guarantee the survival of species and natural ecological processes in the long term.

## Description

Finca La Soledad covers an area of 8,719 ha and is owned by Forestal Santa Bárbara S.R.L. It is located in the northwest of Argentina, in the province of Salta and its westernmost limit is the border with the province of Jujuy (Fig. 1). It extends on the western slopes of the Subandean Mountains, between the Zenta and the Calilegua mountainous ranges, with heights between 1,000 and 3,100 m.a.s.l. In the eastern sector, the landscape is conformed of high mountains with step slopes; their height and slope gradients diminish towards the east.

La Soledad is located in a sector with the highest difficulty of accession of the whole Yungas. Access to the property is only possible walking or riding horses or mules, using trails and entering by nearby sites, from which one needs to travel between one and two days to reach the limit of the property.



"La Soledad" (Oran Department, Salta Province)

Figure 1. Location of La Soledad, in the province of Salta (Northwestern Argentina).

The climate is subtropical, with marked seasonality; annual rainfall may reach 2,000 mm, following a monsoon regime. Winters are temperate to cold and dry, whereas summers are rainy and hot, although the altitudinal differences provoke changes in the general climate pattern. There may be occasional snows in the winter months (June-August), sometimes very copious in the higher areas. Climatic data for the region are scarce: records are only available in localities near the western sector (Yuto, Jujuy) and in the east (Hornillos, Jujuy) (Fig. 2). These records show the climatic variability that is recorded in different sectors of the property. The high mountains represent a barrier to the winds blowing from the Atlantic Ocean in the

northeast, forcing them to release the moisture when meeting the mountain slopes and originating appropriate conditions for a unique vegetation system termed Yungas.



The higher areas are covered by dense clouds most months of the year, and for this reason the Yungas are also termed cloudy forests. Rainfall largely occurs as fog that condenses on the vegetation and drips on the ground.





# Figure 2. Climate graphs corresponding to the climate stations closest to La Soledad, in the localities of Yuto and Hornillos (Jujuy), during the annual period 2018 (<u>http://siga2.inta.gov.ar/</u>).

The combination of the climate, the altitudinal gradient and the exposition of the slopes results in six units of vegetation cover (Fig. 3). These can in turn be grouped and represent the three higher altitudinal stories of the Yungas forest (of the four that are typical), with the following characteristics:

a) *Montane Forest:* this vegetation story constitutes around 22% of the property and is located on the mountain slopes, al heights between 1,000 and 1,500 m.a.s.l. It forms an altitudinal belt of maximum rainfall and cloudiness and in the canyons and ravines there are areas of denser forest cover. In this story we find the greatest species diversity of the Yungas. Among the dominant trees are the laurels (*Cinnamomum porphyrium, Nectandra pichurin, Ocotea puberula*), the Tipa (*Tipuana tipu*), the myrtle (*Blepharocalix salicifolius*), the Maroma (*Ficus maroma*), and the Coya cedar (*Cedrela lilloi*), among other species.

In the Montane Forest there are often important stands of large specimens of cedar, in good sanitary conditions.



b) Montane Woods: They are located between 1,500 and 3,000 m.a.s.l. and conform the most extensive vegetation story of La Soledad (approx. 58.5 %). Here, the presence of clouds is almost continuous all the year round. The denser woods face the west and among the most frequent species are the Pino del Cerro (Podocarpus parlatorei), the Cedro Coya (Cedrela lilloi), the Nogal Criollo (Juglans australis), the Peruvian elderberry (Sambucus peruviana), the Sauco (Ilex argentinum) and the Yoruna Colorada (Roupala meisneri).



c) Highland Grassland: it extends in approximately 16% of the property, between 2,400 and 3,500 m.a.s.l. and are generally located on the headwaters of rivers and streams, where rainfall is abundant and there are frequent fogs. It is composed of grasslands dominated by a wide diversity of grass species such as *Festuca, Calamagrostis* and *Stipa,* among others.



Highland grasslands are dominated by scrubland of clustered gramineous grasses of about 1.5 m or less and occasionally there are small isolated trees or small patches of Queñoa (Polylepis sp.) trees.



Figure 3. Vegetation cover units in La Soledad.

Differences in physiognomy and composition of the vegetation are also reflected in the structure of the animal communities. These are characterized by species typical of the Amazonian Domain and in the higher sectors also of the Andean Domain, described below.

La Soledad is included in the Upper Basin of the Bermejo River and the medium sector of the Colorado River. Erosion by streams and rivers has produced deep canyons where the water drains, conforming the headwaters of the Colorado River. The drainage network crosses the property, and during the summer flooding contributes large amounts of sediments of different grain size. The first floods usually occur in late October and continue until mid-April. The flow generated in the Colorado River is used for irrigation in the productive zones of Colonia Santa Rosa, Tabacal and Pichanal (Paoli et al. 2011).



The beds of streams present in La Soledad are often rocky and narrow; they sometimes form canyons, rapids, small waterfalls and deep holes carved in the rock.



# Context of Biodiversity Conservation

The forests of northern Argentina have suffered a transformation process resulting from the advance of agriculture in the region that reflects in the increase of the loss and fragmentation of natural ecosystems, as well as a decrease of forest cover and of spatial heterogeneity (Correa *et al.* 2012). In the Argentinean Yungas, an estimated 90% of the Pedemontana (Foothill) Forest was transformed to croplands, placing it on the verge of extinction (Brown & Malizia 2004). On the other hand, the upper forest stories have been less affected by landscape transformation and still conserve the forest cover, although they have been largely degraded by livestock rearing and selective logging that cause changes in their structure and composition.

From the point of view of biodiversity conservation, the spatial location of La Soledad leads us to consider it among the most relevant properties at the eco-regional level. This is because the forest cover is maintained in the whole estate, inserted in a continuous natural matrix under an international conservation category and is near other already implemented protected areas, with a biological diversity typical of the different altitudinal stories that are represented and the fact that it is so difficult to access. These aspects are further developed in the next section of this report.

# Inclusion in the Las Yungas Biosphere Reserve and proximity to Protected Areas

La Soledad is comprised in Las Yungas Biosphere Reserve (Fig. 4), created in 2002 in the framework of the Man and the Biosphere Programme (MAB) of UNESCO. It comprises an areas

of approximately 1,350,000 ha, and is the second largest Reserve of this type in Argentina. The aim of this program is to achieve a management model in which conservation and sustainable use are compatible in certain designated areas. In this territory, around a quarter of a million inhabitants live mainly in the Pedemonte (Foothill) area. About 70% of the area of the Reserve corresponds to private properties, mainly devoted to small and medium-scale forestry activities; also, large agricultural and oil companies co-exist with small and medium-scale farmers, local communities and indigenous people, non-governmental organizations and the State, represented by the governments of the two provinces where it is located (Jujuy and Salta), 23 municipalities and the National Parks Administration, in charge of the three protected areas that form the nucleus of the Reserve (Lomáscolo *et al.* 2010).



La Soledad - Yungas Biosphera Reserve & National/Provincial Protected Areas

Figure 4. Location of La Soledad and the Las Yungas Biosphere Reserve relative to other national and provincial protected areas.

Besides, La Soledad is part of the buffer zone of Calilegua National Park, one of its borders (Fig. 4). This Park comprises an area of 76,306 ha and is the largest protected area in the Argentinean Yungas. La Soledad is also very close to El Pantanoso Wild Protected Area (4,480 ha), managed as a private protected area by Fundación Biodiversidad Argentina. This mosaic of protected areas and private properties support a significant portion of native forests and constitute a block of great biological magnitude in the region, because of the biological diversity it hosts. In addition, this area conforms the most important biological corridor of the region, connecting Calilegua National Park (Jujuy) to Baritú National Park (Salta). In the First Regional Meeting on Mountain Forests, it has been identified as a priority conservation area of the Yungas because of its large size (around 500,000 ha), its high tree diversity (over 150 species), its great importance in water regulation in most of the Bermejo River upper basin and the existence in the land of rural inhabitants and indigenous people who make intense yet ecologically sustainable use of the it (Brown 1995).

#### Areas of Importance for Wildlife

The Upper Basin of the Bermejo River in the Argentinean Yungas has been noted as the only area that can ensure long-term conservation of the complete biodiversity of the Yungas (Brown et al. 2001). La Soledad is situated in this portion of the Yungas where, in addition, human activity is scarce (Human Footprint, Fig. 5). The analysis of this information together with the likely presence of seven elements (species and ecosystems) of relevance to conservation, namely the jaguar (*Panthera onca*), the tapir (*Tapirus terrestris*), the white-lipped peccary (*Pecari tajacu*), the Tucumán amazon (*Amazona tucumana*), the rufous-throated dipper (*Cinclus schulzii*), the Roble Criollo (*Amburana cearensis*) and the Pedemontana Forest), place La Soledad and other neighboring properties as a priority in terms of wildlife conservation (Martinuzzi et al. 2018).



Figure 5. Gradient of Human Footprint values in the northeast of Argentina (in Martinuzzi et al. 2018). The location of La Soledad is shown with a red circle.



The Andean Condor (Vultur gryphus) is the bird of largest wingspan of the world. In La Soledad this bird nests in inaccessible rocky formations of steep slopes in the western mountains.

Birds are the most varied taxon of terrestrial vertebrates and their ecology, behavior, biogeography and taxonomy are relatively well known. Because they have different habitat requirements and are sensitive to disturbances that alter the vegetation architecture, they have shown to be effective indicators of biodiversity. For this reason, a program was implemented in Argentina on Important Areas for Bird Conservation (AICAs), aimed at identifying and protecting sites of particular importance that have been recognized by BirdLife International and by the Asociación Ornitológica del Plata/Aves Argentinas (Di Giacomo 2005). La Soledad is surrounded by several AICAs (Fig. 6); those closer to the property are Valle Morado (Sa29), Calilegua (Ju02) and Valle Colorado - Valle Grande (Ju21), where 270 bird species have been recorded and others might yet be recorded because of the immensity of the area and the great diversity it hosts. There are populations of some globally threatened species and some rare species like the Andean condor (Vultur gryphus), the Solitary eagle (Harpyhaliaetus solitarius), the Black-and-chestnut eagle (Spizaetus isidori), the Tucumán amazon (Amazona tucumana), the Zimmer's tapaculo (Sytalophus zimmeri), the Rothschild swift (Cypseloides rothschildi), the Rufous-throated dipper (Cinclus schultzi), the Tucumán mountain finch (Compsospiza baeri), the Rufous-bellied mountain tanager (Saltator rufiventris), the atajacaminos lira (Uropsalis lyra), birro gris (Polioxolmis rufipenis), chululú cabeza rojiza (Grallaria albigula) y fiofío plomizo (Elaenia strepera) (Moschione 2005).



Figure 6. Areas of Importance for Bird Conservation (AICAs) surrounding La Soledad (from <u>https://www.avesargentinas.org.ar/aica</u>).

The region is also relevant because of the presence of large mammals, such as the jaguar (*Panthera onca*), the North Andean deer (*Hippocamelus antisensis*), the tapir (*Tapirus terrestris*), and the White-lipped peccary (*Tayassu pecari*). These species have been categorized as threatened in Argentina (SAyDSN & SAREM 2019) and in the Yungas forests contains two units of high conservation value for the two species of ungulates, and La Soledad is included in one of them (Taber *et al.* 2008). Both the North Andean Deer and the jaguar have been declared National Nature Monuments<sup>1</sup> and the jaguar also in the provinces of Salta<sup>2</sup> and Jujuy<sup>3</sup>.

<sup>&</sup>lt;sup>1</sup> Ley Nacional N° 24.702/1.996 y Ley Nacional N° 25.463/2.001 respectively.

<sup>&</sup>lt;sup>2</sup> Decreto N° 1.660/2.001.

<sup>&</sup>lt;sup>3</sup> Ley Provincial N° 5.984/2.016.



The jaguar (Panthera onca) is the largest predator of America and in northeastern Argentina we find the southern limit of its range. In Argentina the original range of the species has decreased around 95%. The largest viable population In Argentina of less than 200 individuals is found in the Yungas (Photo obtained with a trap camera in the El Pantanoso Private Wild Area (Jujuy, Fundación Biodiversidad, 2018).



The north Andean deer (Hippocamelus antisensis) lives above 1,800 m.a.s.l. in mountain slopes dominated by grasslands and rocky outcrops. Since the habitats it usually occupies are fragmented, the deer populations are distributed in patches (Photo credit: Francisco Erize).

# **Biodiversity Surveys**

Between July and September 2019 we carried out two field trips in La Soledad, with the aim of surveying mammals, birds and the general state of the area. We entered the area on foot through Valle Colorado (Jujuy), west of La Soledad, walking from the highland grassland to the montane forest. It was only possible to carry out the field survey in the eastern portion of the property. The work is described in detail in the next section of this report.

## Mammal Survey

## Methodology

We set 8 trap cameras, some 2 km apart, in different environments such as river and stream beaches, ridges and slopes, always on animal trails (Fig. 7, Annex 2). Trap cameras were programmed to remain activated during 24 hours a day between 26 and 34 days of July and September. The relative abundance was estimated based on photographic events per species during the time the traps remained active (nights) and standardized to 100 traps/night. The record of a species during a one-hour period was considered an independent photographic event.

We also carried out sightings and occasional records of tracks, bone remains, faeces and other indirect evidence of the species. Species identification was based on the bird guide by Canevari & Vaccaro 2007, and the species were later classified in groups according to their feeding preferences; we used the national classification of endangered species (SAyDSN & SAREM 2019).



The trap-camera methodology allows the identification of species that are inconspicuous, nocturnal and/or very sensitive to human presence.



"La Soledad" (Oran Department, Salta Province) - Mammals Survey



Figure 7. Location of the trap cameras installed in La Soledad.

#### <u>Results</u>

We recorded ten species of native large and medium-sized mammals, and also cows. The sampling effort implemented with trap cameras was 218 traps/night and this allowed us to record five species and their respective relative frequencies (Tabla 1). Cows were the most frequently recorded animals, followed by the Red brocket (*Mazama americana*), the Pampas fox (*Lycalopex gymnocercus*), the skunk (*Conepatus chinga*) and finally the tayra (*Eira barbara*) (Table 1, Fig. 8). Considering all the records obtained, three trophic categories were identified and the omnivorous were the most represented species, followed by herbivores and then carnivores (Table 1, Fig. 9). Among recorded species, four are threatened at the national level, while the jaguar (*Panthera onca*) is classified as in critical danger and the North Andean deer (*Hippocamelus antisensis*) as endangered (Table 1).

Table 1. Large and medium-size mammals recorded in La Soledad. The standardized frequency of photographic capture is presented for those species recorded in trap cameras. Categories of national conservation: LC= Least Concern, NT= Near Threatened, VU= Vulnerable, EN= Endangered, EC= Critically Endangered. \*Domestic species.

ORDER / Family	Species	Common name	Type of record	Conservation category	Trophic group	Frequency of photographic capture
CARNIVORA						X 1 03
Canidae	Lycalopex gymnocercus	Pampas Fox	Track, photo	LC	Omnivorous	2.52 <u>+</u> 6.67
Felidae	Panthera onca	Jaguar	Track	EC	Carnivore	-
Felidae	Puma concolor	Puma	Track, faeces	LC	Carnivore	
Mustelidae	Eira barbara	Tayra	Photo	NT	Omnivorous	0.43 <u>+</u> 1.15
Mustelidae	Lontra longicaudis	Neotropical otter	Track	NT	Carnivore	-
Mephitidae	Conepatus chinga	Skunk	Photo	LC	Omnivorous	2.16 <u>+</u> 5.73
Procyonidae	Procyon cancrivorus	Crab-eating racoon	Track	LC	Omnivorous	-
CETARTIODACTYLA						
Bovidae	Bos taurus*	Cow	Sighting, Track, Photo	-	Herbivore	13.86 <u>+</u> 20.09
Cervidae	Mazama americana	Red brocket	Track, bone remains,	VU	Herbivore	4.82 <u>+</u> 6.61
			photo			
Cervidae	Hippocamelus antisensis	North Andean Deer	Track	EN	Herbivore	-
Tayassuidae	Pecari tajacu	Collared peccary	Sighting	VU	Omnivorous	-



Figure 8. Richness Curve – Abundance of medium-size and large mammals surveyed with trap cameras in La Soledad.



Figure 9. Representation of trophic groups in La Soledad, including records in trap cameras, sightings and indirect evidences.



Some of the species recorded in trap cameras were the skunk (Conepatus chinga) and the Red brocket (Mazama americana).

#### **Conclusions**

Results of the assemblage of medium-size and large mammals obtained in La Soledad contribute baseline information to plan future monitoring. In particular, this biological group was very diverse, although scarce. Recorded species represent 32.5% of those cited for the Argentinean Yungas (35 species, Jayat & Ortiz 2010).

Especially noteworthy was the presence of species that because of their conservation status or their role in the ecosystem are considered biologically significant. This is the case of the jaguar (*Panthera onca*) and the North Andean deer (*Hippocamelus antisensis*), which have been nationally classified as Critically Endangered and Endangered, respectively (Paviolo *et al.* 2019, Guerra & Pastore 2019) and considered as Natural Monuments. We also detected species in the category of Vulnerable, such as the collared peccary (*Pecari tajacu*) and the Red brocket (*Mazama americana*).

The absence of records of other mammals does not necessarily imply that they are not present in the property. The difficult of accession to the area limited this study to he western sector of the property, in the highest portion, with less vegetation and extreme low temperatures, so that certain species could have been present in low numbers or seasonally absent. Also, the detection of certain species of particular habits require specific methodologies. However, the frequent human presence and the hunting activity in the area both past and present suggests the local elimination of some species as a likely event. This would require a more detailed study comprising other areas that have not been surveyed in this study.

#### Bird survey

#### <u>Methodology</u>

The bird survey was carried out between July 31 and August 7, 2019. The methodology consisted in the establishment of 30 counting points (Ralph *et al.* 1996), of 50 m fixed radius and 10 minutes of duration, separated from one another by distances  $\geq$ 150 m (Fig. 10, Annex 2). In each point, bird species sighted or heard were recorded, as well as their abundances. In a non-systematic way, we also recorded the presence of all species sighted or heard outside the counting points. Sampling was carried out during the morning hours (8:00 - 11:00 hs) and in the afternoon (16:00 - 19:00 hs), so as to coincide with the peak of greater activity of birds and to have better light conditions. The identification of species was carried out using the identification guide of Narosky & Yzurieta (2010). For bird scientific nomenclature we followed the classification of the American Ornitologists' Union (AOU, http://www.museum.lsu.edu). The conservation state of species at a global level was determined using the IUCN Red List of Threatened Species (IUCN 2019), while the conservation state for Argentina is based on the report provided by Aves Argentinas and the Ministry for Environment and Sustainable Development of Argentina (MAyDS & AA 2017).

The absolute abundance was defined as the number of individuals of a species recorded in the total sampling. Relative abundance is the percentage of participation of each species referred to the number of individuals found in the sampling. We used the rarefaction method based on individuals for standardization, in order to assess the adequacy of the sampling (Magurran &

Mc Gill 2011). To analyze the true, we generated the "diversity profiles", using the family of diversity indices proposed by Chao & Jost (2015). To calculate the "effective number of species" we used total species richness (the true diversity of zero order), the exponential of Shannon's index (the true diversity of first order), and the inverse Simpson Index (the true diversity of the second order 2) (Moreno *et al.* 2011). These diversity estimators are mainly designed to take into account the effect of non detected species in the samples, thus eliminating most of the biases associated with empiric profiles. The rarefaction and diversity analyses were carried out using the iNEXT package (Hsieh *et al.* 2013), in the free software R (R Development Core Team 2018). Data from the counting points were used to estimate the relative abundance of species and the biodiversity indices. To determine the composition of the bird assemblage we used data both from counting points and from non-systematic observations.





Figure 10. Location of counting points of birds in La Soledad.

#### Results

A total of 75 species of birds were recorded based on counting points and non-systematic samples. In the counting points we recorded 250 individuals of 44 species (Table 1).

Bird records were made using binoculars and identifying bird songs, both in fixed counting points as in random walks.



Table 2. Composition of bird species recorded in La Soledad. \*Species recorded outside the systematic sampling.

Ν	Common name	Scientific name	Abundance
1	Águila mora	Geranoaetus melanoleucus	1
2	Águila poma	Spizaetus isidori	*
3	Águila viuda	Spizaetus melanoleucus	*
4	Aguilucho cola corta	Buteo brachyurus	*
5	Alilicucu yungueño	Megascops hoyi	*
6	Arañero ceja amarilla	Myiothlypis signata	5
7	Arañero corona rojiza	Myioborus brunniceps	2
8	Arañero coronado grande	Myiothlypis bivittata	5
9	Atajacaminos colorado	Antrostomus rufus	*
10	Bandurrita chaqueña	Upucerthia certhioides	*
11	Boyero ala amarilla	Cacicus chrysopterus	3
12	Cabecitanegra picudo	Spinus crassirostris	*
13	Calancate cara roja	Psittacara mitratus	*
14	Carpintero oliva oscuro	Leuconotopicus fumigatus	1
15	Catita serrana grande	Psilopsiagon aymara	*
16	Celestino	Thraupis sayaca	
17	Cerquero cabeza castaña	Atlapetes fulviceps	45
18	Cerquero vientre blanco	Arremon torquatus	14
19	Chingolo	Zonotrichia capensis	*
20	Choca común	Thamnophilus caerulescens	*
21	Choca corona rojiza	Thamnophilus ruficapillus	1
22	Churrín ceja blanca	Scytalopus superciliaris	*
23	Coludito canela	Leptasthenura fuliginiceps *	
24	Cóndor andino	Vultur gryphus	2
25	Curutié común	Cranioleuca pyrrhophia	7
26	Espinero serrano	Phacellodomus maculipectus 1	

27	Frutero yungueño	Chlorospingus ophthalmicus	43
28	Golondrina barranquera	Notiochelidon cyanoleuca	2
29	Guaipo	Rhynchotus maculicollis	*
30	Halcón montes grande	Micrastur semitorquatus	1
31	Jote cabeza roja	Cathartes aura	*
32	Loro alisero	Amazona tucumana	4
33	Macuquito	Lochmias nematura	1
34	Mirlo de agua	Cinclus schulzii	8
35	Monterita ceja canela	Microspingus erythrophrys	11
36	Monteriza pecho gris	Poospiza hypochondria	*
37	Mosqueta común	Phylloscartes ventralis	7
38	Mosqueta corona gris	Phyllomyias sclateri	2
39	Negrillo	Spinus atratus	*
40	Pato de los torrentes	Merganetta armata	2
41	Pava de monte alisera	Penelope dabbenei	*
42	Pava de monte común	Penelope obscura	1
43	Pepitero colorado	Pseudosaltator rufiventris	*
44	Pepitero gris	Saltator coerulescens	*
45	Picaflor andino	Oreotrochilus leucopleurus	*
46	Picaflor cometa	Sappho sparganurus	*
47	Picaflor frente azul	Eriocnemis glaucopoides	*
48	Picaflor vientre blanco	Amazilia chionogaster	7
49	Picaflor yungueño	Adelomyia melanogenys	2
50	Picolezna rojizo	Xenops rutilans	1
51	Pijuí ceja caneja	Synallaxis azarae	4
52	Piojito de los pinos	Mecocerculus hellmayri	2
53	Piojito gargantilla	Mecocerculus leucophrys	3
54	Piquitodeoro común	Catamenia analis	*
55	Pitiayumí	Setophaga pitiayumi	1
56	Ratona ceja blanca	Troglodytes solstitialis	21
57	Ratona común	Troglodytes aedon	*
58	Remolinera castaña	Cinclodes atacamensis	5
59	Remolinera común	Cinclodes fuscus	*
60	Rey del bosque	Pheucticus aureoventris	1
61	Saí común	Conirostrum speciosum	1
62	Saira de antifaz	Pipraeidea melanonota	2
63	Taguató común	Rupornis magnirostris	*
64	Tangará alisero	Thlypopsis ruficeps	4
65	Ticotico común	Syndactyla rufosuperciliata	15
66	Vencejo blanco	Aeronautes andecolus	*
67	Vencejo pardo	Cypseloides rothschildi	1
68	Viudita plomiza	Knipolegus cabanisi	1
69	Viudita de río	Sayornis nigricans	*

70	Yal negro	Rhopospina fruticeti	*
71	Yal plomizo	Geospizopsis unicolor	*
72	Yerutí yungueña	Leptotila megalura	1
73	Zorzal chiguanco	Turdus chiguanco	4
74	Zorzal colorado	Turdus rufiventris	4
75	Zorzalito overo	Catharus dryas	1

The rarefaction analysis shows a curve that tends to stabilize above 300 individuals (Fig. 11). A group of 10 species represents 70 % of the total recorded abundance and the most abundant species were the fulvous-headed brush finch (*Atlapetes fulviceps*), the common bush tanager (*Chlorospingus ophthalmicus*) and the mountain wren (*Troglodytes solstitialis*) (Fig. 12).







Figure 12. Relative abundance of the 10 most abundant bird species recorded in La Soledad.

The true diversity according to effective number of species was 0D= 58,01 (40,55 - 103,36 confidence Intervals 95%) for diversity of zero order; 1D= 22,52 (19,65 - 25,10 IC 95%) for the divessity of the first order; and 2D= 12,16 (10,39 - 14,59 IC 95%) for the diversity of the second order (Fig. 13).



Figure 13. Profiles of diversity of the bird assemplage in La Soledad.



Andean condor (*Vultur gryphus*) and rufous-bellied mountain tanager (*Pseudosaltator rufiventris*). Foto: E. Tallei.



Black-and-chestnut eagle (*Spizaetus isidori*) and spot-breasted thornbird (*Phacellodomus maculipectus*).



Brown-capped tit-spinetail (*Leptasthenura fuliginiceps*) and rufous-thrated dipper (*Cinclus schulzii*).

## **Conclusions**

The assemblage of birds recorded in Finca la Soledad represents 8% of the total of birds of Argentina. This percentage may be considered very important in the representation of the group, bearing in mind that several of the species recorded have ranges restricted to the Yungas. This is the case of the Black-and-chestnut eagle (*Spizaetus isidori*), the Red-faced guan (*Penelope dabbenei*), the Smoky-brown woodpecker (*Leuconotopicus fumigatus*), the Yungas screech owl (*Megascops hoyi*), Buff-banded tyrannulet (*Mecocerculus hellmayri*) and the Gould's nightingale-thrush (*Catharus dryas*). On the other hand, we recorded species of distribution restricted to rivers and forest water bodies, with limited range in the country: the Sharp-tailed streamcreeper (*Lochmias nematura*), the Black phoebe (*Sayornis nigricans*) and the Rufous-throated dipper (*Cinclus schulzi*). The Sharp-tailed streamcreeper is found in the Yungas of Salta and Jujuy. On the other hand, the rufous-throated dipper is only found in the Yungas and in this case, its population is decreasing (Sardina Aragón *et al.* 2015).

In the bird assemblage recorded several species are noteworthy because of their conservation status and these deserve to be duly taken into account in management and conservation plans. Such is the case of the Black-and-chestnut eagle, listed as Endangered in Argentina

(Resolución 348/2010 de la Secretaría de Ambiente y Desarrollo Sustentable de la Nación). Other species present in the estate are classified as threatened under Resolución 348: the Black-and-white hawk-eagle (*Spizaetus melanoleucus*), the Andean condor (*Vultur gryphus*), the Tucumán amazon (*Amazona tucumana*), the rufous-thrated dipper, the Red-faced guan (*Penelope dabbenei*) and the Torrent duck (*Merganetta armata*). We also recorded species listed as Vulnerable: the Dusky-legged guan (*Penelope obscura*), the Collared forest falcon (*Micrastur semitorquatus*), the Buff-banded tyrannulet (*Mecocerculus hellmayri*), the Blue-capped puffleg (*Eriocnemis glaucopoides*) and the Rufous-bellied mountain tanager (*Saltator rufiventris*) (MAyDS & AA 2017). One species we recorded is listed as insufficiently known (the Rothschild's swift *Cypseloides rothschild*).

According to the IUCN and its international classification of the global conservation status of species, the Black-and-white hawk-eagle (*Spizaetus isidori*) in endangered, Tucumán's amazon (*Amazona tucumana*) and the Rufous-thrated dipper (*Cinclus schulzi*) are species listed as Vulnerable (IUCN 2019), while the populations of the Andean condor (*Vultur gryphus*) and the Rufous-bellied mountain tanager (*Saltator rufiventris*) are decreasing and are in the category of Almost Threatened. Other emblematic species like the torrent duck (*Merganetta armata*), are listed as Least Concern, though their populations in Argentina tend to decrease (Cerón & Trejo 2012; IUCN 2019).

The three most abundant bird species are mainly associated to the altitudinal stories Montane Woods and Montane Forest. Among the ten species of greatest abundance is the rufous-throated dipper, which might be indicating that this is a site of great conservation significance for this species considered as a habitat specialist (Sardina Aragón *et al.* 2015). Finca la Soledad hosts a very diverse assemblage of species, including many species typical of the Yungas forest. The presence of numerous species classified as Threatned both nationally and globally places this property as of very high importance for bird conservation.

# Socio-economic Context

## Historical Settement and Land Tenure

The Argentinean Yungas (Bermejo River Upper Basin) are part of a complex and wide scenario of exchange of diverse cultural goods, dating back to 10,000 years ago. The Pre-Hispanic history starts with the arrival of groups of hunters-gatherers in the late Pleistocene. One of the particular features of these human groups that settled in the region was the diversified use they made of space, although they apparently inhabited mostly the Puna and pre-Puna regions in the proximity of water courses and used the forest and wood resources, such as nuts, canes, furs, feathers from multi-colored birds and water snails, among others (García Moritán & Cruz 2012). This area was a site of cultural confluence of cultures relared with populations inhabiting a wide extension, from the Puna to the Chaco plains. In the 15<sup>th</sup> century, another cultural influence arrived from the Yungas valleys of the Upper Bermejo River Basin, coming from Cuzco: the Inca Empire. The fertility of these lands and the forest resources attracted the attention of these peoples, creating different situations of expulsion and domination of existing human populations (García Moritán & Ventura 2007). Several peoples who had been re-located by the Inca Empire settled in the proximities of La Soledad, with the aim of carrying our agricultural tasks, working with metals and defending the frontier of the Empire from the

attacks of the Chiriguana populations that threatened them from the plains. The re-located peoples involved the Ocloya and the Churumata, that had been brought from southern Bolivia (even though their sites of origin were others) and who had settled in the Andean foothills (Ventura 2007); in the higher, drier portions to the west were the Omahuaca (García Moritán & Cruz 2012).



During the rule of the Inca Empire, the whole area of influence was united by a network of roads and structures related to communication, the exchange of goods and defense, extending over 30,000 kilometers, that is currently known as Qhapaq Ñan or Great Inca Road, and these roads are partly used today to enter La Soledad through the east.

At the time of arrival of the Spaniards in the region, there was a situation of conflict among populations of diverse origins of Incaic influence, threatened by the advance of the peoples from the plains. With the fall of the Inca Empire and the effective entry of the Spanish conquerors there were new population movements (García Moritán & Ventura 2007). The culture and forms of perceiving the environment of the Spanish conquerors led to the destructuring of indigenous territories and the region, previously densely populated especially in the high areas, gradually became less populated. The Spanish domination in the region became effective based in two social institutions: the Merced de Tierras and the Encomienda. Even though the fate of La Soledad during those years cannot be clearly established, the property is included in an area that was neither conquered nor inhabited by the Spaniards until the second half of the 18<sup>th</sup> century. Possibly at least one sector (the western sector) may have formed part of an Encomienda, which was handed over to Juan Villanueva and Martín Monje

by Francisco Pizarro in 1540, transferring at the same time the labor rights of several populations of the Puna of Jujuy province, the Quebrada de Humahuaca and the Eastern valleys. Land ownership was exercised by a few landowners who collected taxes from its inhabitants and obtained personal services from them (García Moritán & Ventura 2007).

The arrival of new resources, of European crops and livestock in the region, brought along drastic and fundamental changes (Ventura 2007). In particular, the entry of thousands of heads of cattle, horses and sheep into the region as from the 17<sup>th</sup> century modified the use of space by the pastoral communities that based their livelihoods on llama raising. The new ways of cattle-rearing implied seasonal movements for the use of space, so that the forest environments might have been modified because the populations of the higher sectors migrated seasonally with their livestock (cows and horses) to the forest (transhumance or migratory herding). Towards the late 18<sup>th</sup> century, there were clear differences between the agrarian structure of the highlands, devoted mainly to the agro-pastoral activity of domestic production with a relative articulation to the market both of goods and of work and pluriactivities, among which textile production historically played a significant role (Teruel y Gil Montero, 1996)and the lowlands, where sugar cane became the dominant crop, causing notable social and economic changes (Ventura 2007, García Moritán & Ventura 2007).

Since the 19<sup>th</sup> century, the indigenous communities included in the high Yungas together with other populations of Andean areas and of the Calchaquí valleys, became identified in Argentina under the name Kollas.

#### **Neighboring Populations**

The villages closest to La Soledad are found in the west, in Jujuy province, and they are part of the department of Valle Grande. They are: Valle Colorado (3 km), Valle Grande (8 km) and Santa Ana (11 km)<sup>4</sup>, where the main institutions and communcal infrastructures have settled, such as the municipal Delegation, schools, health centers, Justice of Peace, Police, Communal Centers and churches. Valle Grande is the head of the department of the same name and the most densely populated, followed by Santa Ana and Valle Colorado, where the indices of Unsatisfied Basic Needs (NBI) are inversely proportional to human density (Fig. 14).

<sup>&</sup>lt;sup>4</sup> Distance along a straight line to the point nearest to La Soledad.



Figure 14. Human population settled and Homes with Unsatisfied Human Needs (NDBI) in the localities closest to La Soledad (Source: Population Census 2010, INDEC).

The area of the department of Grande, even though it has been inhabited for a long time, exhibits some particular features that distinguishes it from the surrounding areas (Chacoan foothills, High ravines and Puna). Such singularities endow it with a marked and recognizable local identity, reflected in the field of social organization, the high endogamy and the use of characteristic garments, especially among the women, that single out these populations (Ferreiro, 2014).



Villages are situated among the mountains, in a matrix of woods and natural grasslands.

Most of the local inhabitants are considered as "campesinos" (farmers) because of their way of life and the productive activities they carry out along the year. Also, these communities are mainly Kollas and their socio-productive practices have structured their society along hundreds of years and have allowed them to sustain levels of autonomy that continue to our days. The ways of being and of acting of local inhabitants are strongly related to the ancestral sequential use of the altitudinal gradient associated mainly with livestock grazing, even though they also keep sheep, horses, goats and corral animals such as pigs and hens. They also carry out familyscale agriculture. The care and herding of cattle among the different altitudinal stories persists today, although the frequency is becoming gradually lower, and consists of "veranadas" (summer stays) in the highland grasslands and "invernadas" (winter stays) in the montane valleys and woods. Livestock is considered an economic asset, available for self consumption and also as a reserve to be sold if money is needed when there is surplus. Agricultural activities are carried out in different types of plots (fences), some on the basis of brief alternation ("barbecho") and others with prolonged resting times (García Moritán & Brown 2007). Between 1500 and 2000 msnm, the main crops are maize, potato and pumpkin. In higher areas tubercle crops (potato, oca and ulluco) become more diversified, and there are legumes like beans and more locally, quínoa and alfalfa. The women spin wool to make handicrafts, puyos (cloaks), mats and saddlebags. The low availability of jobs in the region encourages the migration of young people and also of adults to the nearby cities or to important production centers, in search of emplyment opportunities. In the last twenty years, governmental public policies have generated a change in the economic and cultural structure of rural populations, allowing their access to new forms of feeding, goods and services, not exclusively dependent on that which they produce or exchange. Some people work in government positions and others perceive retirements, pensions or social plans.





The environment surrounding La Soledad is conformed by Kolla communitie. Women largely maintain the use of traditional garments, characterized by bright colors, ornamented with embroideries, straps and/or fringes. The colors both of the cloak and of the fringes and straps are indicative of the civil status of the bearer and in some cases, identify the person's community of origin. This links them to ancient and extended Andean traditions related to the social role of textiles.

# Recent Human Activities in La Soledad

Until approximately 40 years ago, La Soledad was inhabited during a large part of the year, there were inhabitants who spent many months in the property and whose lives were associated to extensive "under the forest" livestock rearing. Migratory herding was a habitual practice, with their cows and some horses. Today, the main activity is still livestock rearing, carried out by local inhabitants who live in nearby villages, such as Santa Ana and Valle Colorado (Jujuy). Even though there are no permanent residents in the property, there are between 10 and 15 "puestos" or temporary dwellings situated in the flatter areas that are used by different families when they bring in their cattle to graze.

These local inhabitants often fish and hunt during the periods when they are looking after their cattle. The large felines are viewed as enemies and are trapped because of the fear they inspire and the fact that they attack their animals. They also mention the peccaries and deer as animals they opportunistically hunt and eat, and they fish trout (*Oncorhynchus mykiss*, an alien species in the highland rivers) and other native fish. Besides, they obtain wood for the construction and maintenance of their homes, corrals and firewood. Within the property, no evidence of commercial logging was recorded and this was corroborated by the testimony of the local inhabitants who frequent the area.



In La Soledad there are "puestos" or temporary dwellings used for short periods especially during the dry season and associated to care of cattle. Most of the caretakers live in Valle Colorado and a few in Santa Ana (Jujuy).

## Conclusions and Recommendations

La Soledad constitutes an area of biological relevance in the Yungas of the province of Salta and northeastern Argentina. This may be attributed to its geographic location as compared to other neighboring lands, the biodiversity it hosts, the ecosystem services it provides and consequently, its contribution to human wellbeing. For these reasons, La Soledad is a key element for the conservation of these forests, in regional and national management plans for different species and also for neighboring protected areas and even for the Las Yungas Biosphere Reserve. Because of the difficulty to access the property, the filed survey in this first stage was limited to one sector. For this reason and since the region has been poorly explored from a biological point of view, the potential to contribute further conservation values is greater. Therefore, we recommend to carry out more surveys to cover the eastern sector and record the presence of species that have already been identified as well as new ones.

The fact that the property is used by local inhabitants that live in nearby localities and that the activities are carried out extensively in the whole property hinders the establishment of areas that function as refuges, mainly for the mastozoological fauna. Therefore, we also recommend to work with the local inhabitants to build a shared vision of sustainable and organized use. In this way, it will be possible to limit and restrict the impacts on the forest both by livestock and by men to certain zones, allowing the recovery and restoration of the other sectors.

# Literature Cited

Brown, A. D. 1995. Introducción conclusiones de trabajo en talleres de la Primer Reunión Regional sobre Selvas Subtropicales de Montaña. Pp. 1-8. En: Brown, A. D. & H. R. Grau (Eds.) Investigación, conservación y desarrollo en las selvas subtropicales de montaña. Laboratorio de Investigaciones Ecológicas de las Yungas, UNT.

Brown, A. D., Grau, H.R., Malizia L. R. & Grau, A. 2001. Los Bosques Nublados de la Argentina. Pp. 623-659. En: Bosques Nublados de Latinoamérica, Kappelle M. & Brown, A.D. (Eds.). Editorial INBio, Costa Rica.

Brown, A. D. & Malizia, L. R. 2004. Las Selvas Pedemontanas de las Yungas: En el umbral de la extinción. Ciencia Hoy 14(83):52-63.

Canevari, M. & Vaccaro, O. 2007. Guía de mamíferos del sur de América del Sur. Editorial L.O.L.A., 413 pp. Buenos Aires.

Cerón, G., & Trejo, A. 2012. Torrent Duck (*Merganetta armata*) population trend in Northwestern Patagonia, Argentina. Ornitología Neotropical 23:407-415.

Correa, J. J., Volante, J. & Salgado, L. 2012. Análisis de la fragmentación y la estructura del paisaje en Bosques Nativos del Norte Argentino. Avances en Energías Renovables y Medio Ambiente 16:97-103.

Di Giacomo, A. 2005. Áreas importantes para la conservación de las aves en Argentina. Aves Argentinas.

Ferreiro, J. P. 2014. Los apellidos, la organización familiar y los circuitos productivos como determinantes de la cotidianeidad en el oriente jujeño, Siglo XIX. En: Ghirardi, M. (Comp.) Territorios de lo cotidiano. Argentina, siglos XVI-XX. Ed. Prohistoria, Rosario.

García Moritán, M. & Ventura, B.N. 2007. Caracterización Sociohistórica pp. 67-82. En: Brown A. D., M. García Moritán, B. N. Ventura, N. I. Hilgert & Malizia L.R. Finca San Andrés: Un espacio de cambios ambientales y sociales en el Alto Bermejo. Ediciones del Subtrópico.

García Moritán, M. & Brown, A. D. 2007. Organización social: Conflictos sociales y diversidad de actores. Pp. 129-157. En: Brown A.D., M. García Moritán, B. N. Ventura, N. I. Hilgert & Malizia L.R. Finca San Andrés: Un espacio de cambios ambientales y sociales en el Alto Bermejo. Ediciones del Subtrópico.

García Moritán, M. & Cruz, M.B. 2012. Comunidades Originarias y Grupos Étnicos de la provincia de Jujuy. Población & Sociedad 19 (2):155-173. http://poblacionysociedad.org.ar/archivos/19/P&S-V19-N2-GarciaMoritan-Cruz.pdf

Guerra, I. C. & Pastore, H. 2019. *Hippocamelus antisensis*. En: SAyDS–SAREM (eds.) Categorización 2019 de los mamíferos de Argentina según su riesgo de extinción. Lista Roja de los mamíferos de Argentina. Versión digital: <u>http://cma.sarem.org.ar</u>.

Hsieh, T. C., Ma, K. H., & Chao, A. 2013. iNEXT online: interpolation and extrapolation (Version 1.0)[Software]. <u>http://chao.stat.nthu.edu.tw/blog/software-download</u>

IUCN. 2019. The IUCN Red list of threatened species. Versión 2019. http://www.iucnredlist.org

Jayat, P. & Ortiz, E. 2010. Mamíferos del pedemonte de Yungas de la Alta Cuenca del Río Bermejo en Argentina: una línea de base de diversidad. Mastozoología Neotropical 17(1):69-86.

Lomáscolo, T., Brown, A. D., Malizia, L. R., García Moritán M. & Reid Rata, Y. 2010. Reserva de Biósfera de las Yungas. Guía visual. Fundación Proyungas. Ediciones del Subtrópico.

Magurran, A. E., & Mc Gill, B. J. 2011. Biological diversity: frontiers in measurement and assessment. Oxford University Press.

Martinuzzi, S., Rivera, L., Politi, N., Lizárraga, L., Chalukian, S., de Bustos, S., & Ruiz de los Llanos, E. 2018. Enhancing biodiversity conservation in existing land-use plans with widely available datasets and spatial analysis techniques. Environmental Conservation 45(3):252-260.

Ministerio de Ambiente y Desarrollo Sustentable (MAyDS) & Aves Argentinas (AA). 2017. Categorización de las Aves de la Argentina. 2015. Informe del Ministerio de Ambiente y Desarrollo Sustentable de la Nación y de Aves Argentinas, edición electrónica. C. A. Buenos Aires, Argentina.

Moreno, C. E., Barragán, F., Pineda, E., & Pavón, N. P. 2011. Reanálisis de la diversidad alfa: alternativas para interpretar y comparar información sobre comunidades ecológicas. Revista mexicana de biodiversidad, 82(4), 1249-1261.

Moschione, F. 2005. AICA JUO2 Parque Nacional Calilegua. En Di Giacomo, A. Ed. Areas importantes para la conservación de la aves en Argentina. Sitios prioritarios para la conservación de la biodiversidad. Temas de Naturaleza y Conservación. Monografía de Aves Argentinas Nº 5.

Moschione, F. 2005. AICA JU21 Valle Colorado - Valle Grande. En Di Giacomo, A. Ed. Áreas importantes para la conservación de la aves en Argentina. Sitios prioritarios para la conservación de la biodiversidad. Temas de Naturaleza y Conservación. Monografía de Aves Argentinas Nº 5.

Moschione, F. 2005. AICA SA29 Valle Morado. En Di Giacomo, A. Ed. Áreas importantes para la conservación de la aves en Argentina. Sitios prioritarios para la conservación de la biodiversidad. Temas de Naturaleza y Conservación. Monografía de Aves Argentinas Nº 5.

Narosky, T., & Yzurieta, D. (2010) Aves de Argentina y Uruguay: guía de identificación. Birds of Argentina and Uruguay: a field guide. 16a. ed. Vazquez Mazzini.

Paoli, H., Elena, H., Mosciaro, J., Ledesma, F. & Noé Y. 2011. Cuenca Alta Río Bermejo: Subcuenca Colorado. En: INTA-EEA Salta. Caracterización de las cuencas hídricas de las provincias de Salta y Jujuy. <u>https://inta.gob.ar/sites/default/files/script-tmp-colorado 1.pdf</u>

Paviolo, A., De Angelo, C. D., de Bustos, S., Perovic, P. G., Quiroga, V. A., Lodeiro, N., Lizarraga, L. & Varela, D. 2019. *Panthera onca*. Categorización de los mamíferos de Argentina. Sociedad Argentina para el Estudio de los Mamíferos (SAREM) y Secretaría de Ambiente y Desarrollo Sustentable de la Nación.

R Development Core Team (2018). R: A Language and environment for statistical computing. R foundation for statistical computing. Vienna, Austria.

Sardina Aragón, P. N., N. Politi & R. M. Bárquez. 2015. Nests and nest site characteristics of Rufous – throated Dipper (*Cinclus schulzii schulzi*) in mountain rivers of Northwestern Argentina. Waterbirds 38: 315 – 320.

Secretaría de Ambiente y Desarrollo Sustentable de la Nación (SAyDSN) y Sociedad Argentina para el Estudio de los Mamíferos (SAREM) (eds.). 2019. Categorización 2019 de los mamíferos de Argentina según su riesgo de extinción. Lista Roja de los mamíferos de Argentina. Versión digital: <u>http://cma.sarem.org.ar</u>.

Taber, A., Altrichter, M., Chalukian, S., Minkowski, K., Lizárraga, L., Sanderson, E., Rumiz, D., Ventincinque, E., Moraes Jr., E., De Angelo, C., Antúnez, M., Ayala, G., Bodmer, R., Boher, S., Cartes, J. L., de Bustos, S., Eaton, D., Emmons, L., Estrada, N., de Oliveira, L. F., Fragoso, J. M., García, R., Gómez, C., Gómez, H., Keuroghlian, A., Ledesma, K., Lizcano, D., Lozano, C., Montenegro, O., Neris, N., Noss, A., Palacio Vieira, J. A., Paviolo, A., Perovic, P., Portillo, H., Radachowsky, J., Reyna-Hurtado, R., Rodriguez Ortiz, J., Salas, L., Sarmiento Duenas, A., Sarria Perea, J. A., Schiaffino, K., de Thoisy, B., Tobler, M., Utreras, V., Varela, D., Wallace, R. B. & G. Zapata Rios. 2008. El destino de los arquitectos de los bosques neotropicales: Evaluación de la distribución y el estado de conservación de los pecaríes labiados y los tapires de tierras bajas. Tapir Specialist Group IUCN – Wildlife Conservation Society - Wildlife Trust. New York, USA. pp. 182.

http://atrium.tapirs.org/documents/bibliofile\_20090616134207\_TaberEtAl2008\_ElDestinoDeL osArquitectosBosqueEstadoConservacionPecariTapir.pdf

Ventura, B. N. 2001. Los últimos mil años en la arqueología de las Yungas. 447-492 pp. En: Historia Argentina prehispánica, Berberián, E. & Nielsen, A. (Eds.), Tomo 1. Editorial Brujas, Córdoba.

# Annexes

# Station	Latitude	Longitude
1	-23.417	-64.84043
2	-23.44009	-64.89984
3	-23.43684	-64.88289
4	-23.43715	-64.86038
5	-23.43281	-64.83875
6	-23.45853	-64.86132
7	-23.45344	-64.84131
8	-23.46341	-64.85094

# Annex 1. Coordinates of location of trap cameras in the mammal survey.

# Annex 2. Coordinates of location of counting points in the bird survey.

Counting point	Latitude	Longitude
1	S23 27.077	W64 51.648
2	S23 27.107	W64 51.736
3	S23 27.134	W64 51.822
4	S23 27.052	W64 51.852
5	S23 26.969	W64 51.870
6	S23 27.092	W64 51.560
7	S23 27.142	W64 51.488
8	S23 27.190	W64 51.417
9	S23 27.213	W64 51.330
10	S23 26.934	W64 50.774
11	S23 26.920	W64 50.681
12	S23 26.833	W64 50.674
13	S23 26.747	W64 50.676
14	S23 26.663	W64 50.650
15	S23 26.602	W64 50.587
16	S23 26.542	W64 50.532
17	S23 26.471	W64 50.488
18	S23 26.396	W64 50.492
19	S23 26.338	W64 50.426
20	S23 26.263	W64 50.386
21	S23 26.203	W64 50.447
22	S23 26.118	W64 50.380
23	S23 26.574	W64 50.670

24	S23 26.627	W64 50.739
25	S23 26.681	W64 50.826
26	S23 26.723	W64 50.912
27	S23 26.786	W64 50.970
28	S23 26.620	W64 53.011
29	S23 26.640	W64 52.890
30	S23 26.699	W64 52.813

