



BIOLOGICAL IMPORTANCE OF LA CANDELARIA PRIVATE PROPERTY IN NORTHWEST ARGENTINA

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Summary

La Candelaria is an area of great biological relevance in the Yungas Forests of northwestern Argentina. It comprises 34,690 ha neighboring Baritú National Park, close to the Nogalar de los Toldos National Reserve and to Laguna Pintascayo Provincial Park, located within the Las Yungas Biosphere Reserve. The dominant vegetation is Yungas Forests, with representation of its four stories: Pedemontana forest, Montane forest, Montane Woods and Highland Grasslands, in the altitudinal range composed between 700 and 3000 meters above sea level.

In past times, the region where La Candelaria is situated was a relevant trade corridor in the Inca Empire, later in the Yavi Marquisate, and was even the site of battles during the Spanish colonization and the wars of Independence in Argentina. In recent times, selective logging was carried out in some sectors of the property, mainly on Cedar and Quina trees, as well as extensive or “under the forest” cattle raising. In 1998, Empresa Forestal Santa Bárbara S.R.L. bought the estate and since then, no logging has been registered in the area. There are no settlers or temporary dwellings for rural workers within the property, and bovine cattle belonging to nearby residents only enters temporarily into certain marginal sectors.

Biological surveys carried out in 2018 and secondary information compiled show a great biodiversity in La Candelaria. The estate hosts species of significant relevance like the jaguar, the tapir and the north Andean deer - all of them declared Natural Monuments -, the solitary eagle, the rufous-throated dipper, the torrent duck, the condor, the Tucumán amazon and the dusky-legged guan. All these species are endangered in Argentina; for some of them, national and regional conservation plans have been developed, in which La Candelaria is a key component. Additionally, the existing forest cover is in an excellent conservation status, with important stands of valuable forest species, tree specimens of over 100 years and healthy seedlings. In addition, it contains unique and significant patches of tree ferns, which in general terms are scarce and restricted to certain portions in the north of the Argentine Yungas. La Candelaria is also a provider of numerous ecosystem services, which benefit neighboring communities and society as a whole. These services comprise basic and elemental resources such as water for human consumption and for irrigation in agricultural production, as well as complex processes related to regulation of water flow, control of soil erosion, carbon sequestration and oxygen liberation, among others. These are only some of the most relevant conservation values of La Candelaria; nevertheless, it is an almost unexplored region, so that there is a large potential for identifying other values in the future.

The great extension of native forests in La Candelaria, the rugged terrain that dominates the landscape and the current scarcity of human activity, have allowed this area to recover from past human intervention and to become the habitat of an outstanding biodiversity. At a regional level, this estate is one with the highest priorities among private properties in terms of conservation, enhancing its potential for securing the survival of wild species and of natural ecological processes in the long term.

Description

La Candelaria is located in northwestern Argentina, in Salta province, Iruya Department. It comprises an area of 34,690 ha. The northern limit of the property is the Baritú – Lipeo region, the eastern limit is Baritú National park, to the south Finca Rosario and to the west, the highland hills that separate the property from the West Santa Victoria region.

The relief is strongly rugged, presenting steep mountains with abrupt slopes between 10 and 50%, and an altitudinal range from 800 to 3,000 m above sea level. It is located on the Sub-Andean Hills, which form an orographic barrier to the easterly winds, giving rise to a climate that propitiates the existence of a unique vegetation system termed Las Yungas.

Las Yungas are an extension of the Cloudy Forest of Latin America that extends along the mountain ranges from Venezuela to the northwest of Argentina in the south. They are characterized by a great biological diversity, and play an important role as generators and regulators of water flow. In addition, these forests provide a large array of resources and services, which have been used by human inhabitants of the region in a continuous way, from past times to our days. Today, the Yungas are considered as one of the most fragile natural systems, especially vulnerable to human intervention, and their conservation is an international priority (Dinerstein *et al.* 1995).



The frequent presence of clouds or fog is the reason for considering the Yungas as Mountain Cloudy Forests. The greatest concentration of clouds is found between 500 m and 3,000 m, in the months of May to September. Moist contained in clouds results in “horizontal rain”, because of condensation of moist on the forest mass. This is an important water contribution, which in some cases represents over 60% of total rain during the dry seasons.

La Candelaria is located in one of the areas of highest rainfall within the Yungas of Argentina, with annual values of over 2,000 mm in some sectors. The climate is temperate to warm, humid, with habitual summer rains and winter fogs. There is also occasional snowfall during the winter months (June to August), which can sometimes be quite intense. Climate data for the region are scarce, with recorded data only for the localities of Los Toldos (1972-1989) and Lipeo (1978-1984) (Figure 1).

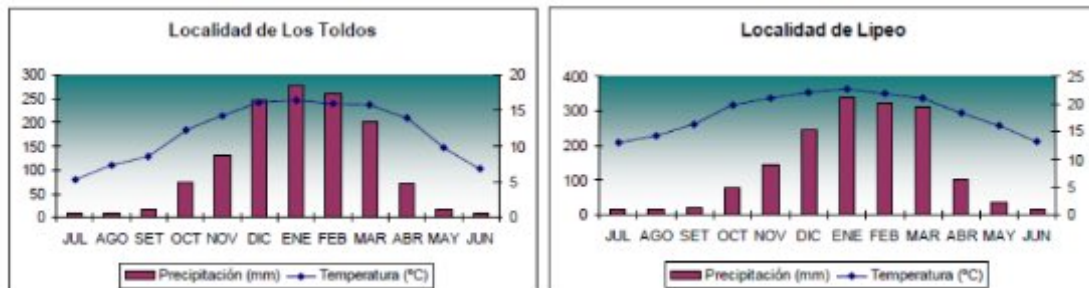


Figure 1. Climograms corresponding to the localities of Los Toldos and Lipeo (data from Bianchi & Yañez 1992, taken from Jiménez Bernal *et al.* 2016).

The characteristics of the climate in conjunction with the altitudinal gradient determines an important variation in species composition of the vegetation. The four altitudinal stories distinctive of the Yungas are represented in La Candelaria; their structural and floristic characteristics are distinguishable (Figure 2):

- a) *Pedemontana (Foothill) Forest*: it is scarcely represented in La Candelaria, found in the lower areas and associated to the main watercourses. This story is located between 400 and 700 m above sea level and the most common species are the Cebil (*Anadenanthera colubrina*), the Palo Blanco (*Calycophyllum multiflorum*) and the Palo Amarillo (*Phyllostylon rhamnoides*).
- b) *Montane Forests*: it is located in the mountain slopes between 700 and 1,500 m above sea level and it is the most extensively represented forest type in La Candelaria. It forms an altitudinal belt of maximum rainfall and cloudiness. This story also contains the greatest species richness of the Yungas. Among the dominant trees are the laurels (*Cinnamomum porphyrium*, *Nectandra pichurin*, *Ocotea puberula*), the Tipa (*Tipuana tipu*), the myrtle (*Blepharocalix salicifolius*) and the Maroma (*Ficus maroma*), among others.
- c) *Montane Woods*: it is situated between 1,500 and 3,000 m above sea level, in which the presence of clouds is continuous all the year round. Among the most common 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 Yoruma Colorada (*Roupala meisneri*). Epiphytes are abundant on the trees and ferns on the forest floor.
- d) *Highland Grassland*: it extends between 2,400 and 3,500 m above sea level, generally on the headwaters of river and stream basins, where rainfall is abundant and there are frequent fogs. It is composed of grasslands, with isolated Queñoa (*Polylepis* sp.) trees.

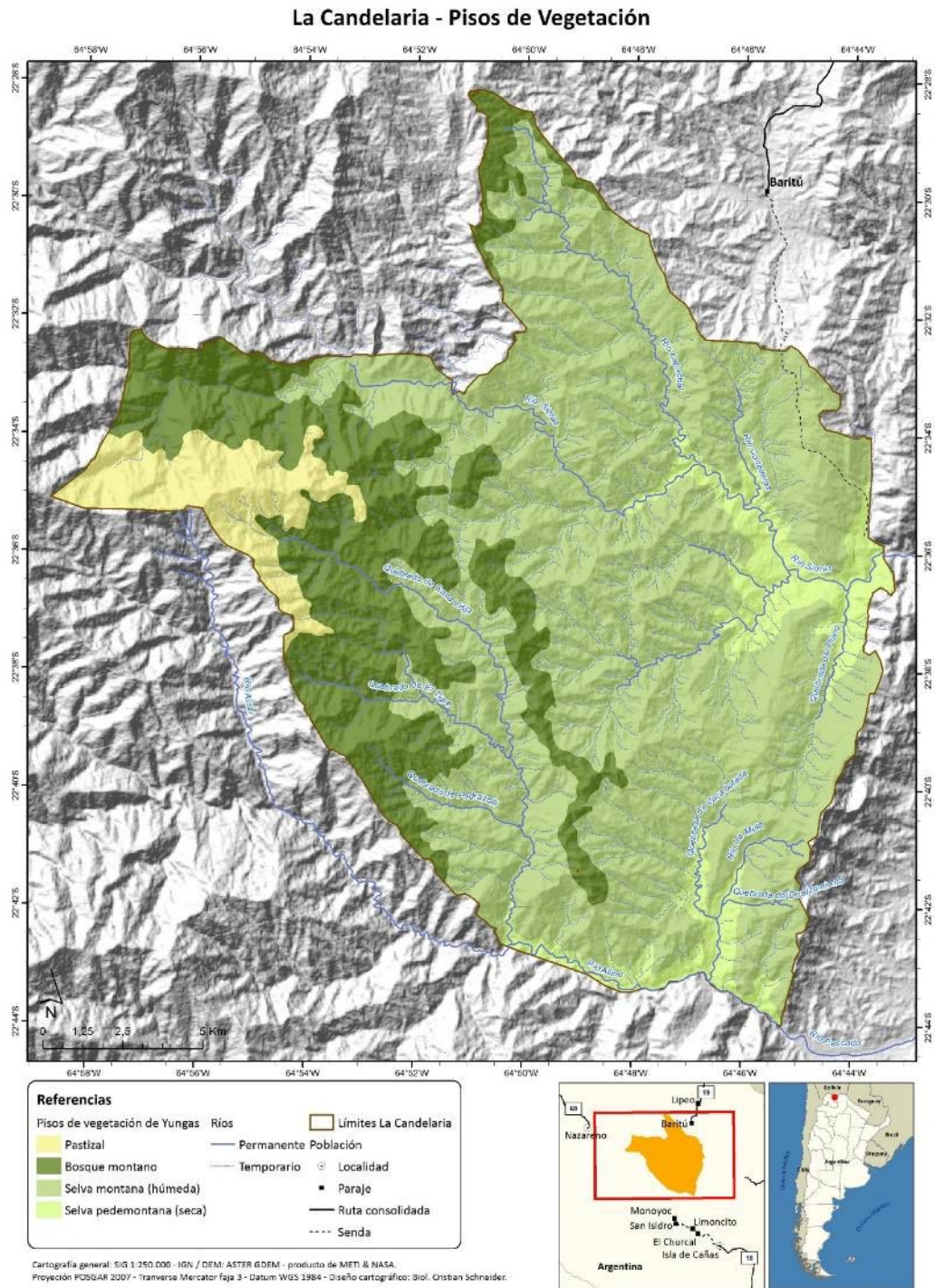


Figure 2. Vegetation stories of the Yungas in La Candelaria.



In the Montane Forest, perennial tree species predominate; these trees do not lose their foliage during the winter.



In La Candelaria there is a great diversity of epiphytes. Bromeliads of large size are frequent and are termed “tanks”, because they accumulate water from rain and fog at the bases of their leaves, generating an optimal habitat for the growth of larvae of arthropods and amphibians. The tender bases of their leaves are also a very palatable resource for tufted capuchins.



*The Bolivian squirrel (*Sciurus ignitus*), like other tropical species, reaches the limit of its Southern range in the Argentinean Yungas. It is a frequent species in the forest canopy and the montane forest, mostly associated to the Nogal Criollo (*Juglans australis*), whose fruits are their main food.*

The differences in physiognomy and vegetation composition are also reflected in the structure of the fauna, which is typical of the Amazonian Domain, while there are also some species typical of the Andean Domain in the highest areas. Vertebrates from the Amazonian Domain are the most studied group; estimated numbers are 86 mammal species, 310 bird species, at least 23 reptiles, 25 amphibians and 20 fish species (Jiménez Bernal *et al.* 2016), which illustrate the biological diversity of this region.

From a hydrological point of view, La Candelaria is included in the Upper Basin of the Bermejo River, on the headwaters and the middle portion of the Superior Sub-Basin of the Pescado River (Ledesma *et al.* 2011). A dense drainage net traverses the estate, whose headwaters are located to the west, in the high summits of the Eastern Cordillera, where vast basins capture the summer rains. Water flows are regulated by infiltration and gradual run-off, increasing downstream because of the abundant rains from the Sub-Andean Hills, and maintained in the dry season by the soil run-off and horizontal rains. The hydrological network comprises an undetermined number of secondary and tertiary beds, while the primary watercourses converge into the Pescado River, in a predominant West-East direction. The Sidras River to the north is one of the main rivers in the property and receives waters from the La Quinta, Seca, Cortaderas and Lapachal ravines. To the south and forming the limit of the estate flows the Alisar River, fed by the Pedrazzoli, Casa Vieja, Vaca Botada, La Mula, and El Deslizadero ravines, among others (Figure 2).



Riverbeds in La Candelaria present wide sectors, with beaches and many meanders; rivers also form canyons, rapids, small waterfalls and deep wells carved in the rock.

La Candelaria is located in one of the most rugged sectors of the Yungas and access is notably difficult. In the past, the estate was traversed by Provincial Route N° 19. Circulation of vehicles along its whole extension was only possible in 1981. Today, the portion of this route within Candelaria is completely closed. Access is restricted to walkers or horse-riders, from Baritú, Isla de Cañas or Nazareno. The best way to enter the estate is through the trail that unites paraje Baritú and the town of Nazareno, because of the continuous transit. This trail traverses La Candelaria in an east-west direction. From Isla de Cañas, a locality situated SW of the property, on the beach of the Iruya river, a sector of the trail is often prepared to allow circulation of a tractor northward, reaching Finca Rosario. Then, it is connected to Baritú through the old trail of Route N°19, but it is completely closed in the rest of its length.



Some sectors of the old trail of Provincial Route N° 19 are maintained by the local inhabitants and used as trails for themselves and their cattle. Entry into La Candelaria is only possible through these trails, either on foot or on horseback.

Context of Biological Conservation

The forests of Northern Argentina have suffered a process of fragmentation resulting from agricultural activity in the region, reflected in an increase in the number of patches, habitat loss, decrease of forest cover and spatial heterogeneity that affect its biological diversity (Correa *et al.* 2012). It has been estimated that 90% of the Pedemontana Forest has been transformed into croplands, and this vegetation story of the Yungas is on the brink of extinction (Brown & Malizia 2004), whereas the upper stories have been widely degraded because of cattle rearing and selective logging.

However, there are still remaining sectors of Yungas that maintain a good forest structure and host wildlife communities that are scarcely altered, as in the case of La Candelaria. This property, because of the area it comprises, the ecosystem representation of the altitudinal range, the continuity of the dominant landscape, the natural recovery that occurred after the disturbances of past human activity, the outstanding biodiversity it hosts and its proximity to protected areas already implemented, place it among the properties of highest eco-regional relevance, from the point of view of biological conservation.

The most outstanding characteristics of La Candelaria are the following:

Las Yungas Biosphere Reserve

La Candelaria is included in Las Yungas Biosphere Reserve (Figure 3), created in 2002 in the framework of the Man and the Biosphere Programme (MAB). It comprises an area 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 development are compatible in certain designated areas. In this territory, around a quarter of a million inhabitants live mainly in the Pedemonte 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 three protected areas that form the nucleus of the Reserve (Lomáscolo *et al.* 2010).

Proximity to Protected Areas

La Candelaria is part of the buffer zone of Baritú National Park, its eastern limit (Figure 3). The Park comprises an area of 72,439 ha and is one of the largest protected areas in northern Argentina. To the northeast of the property is El Nogalar de los Toldos Reserve, with a total area of 3,275 ha; while to the southeast is Provincial Park Laguna de Pintascayo, comprising an area of 12,969 ha (Figure 3). Among the conservation values identified in each of the protected areas and shared by La Candelaria the following may be mentioned: 1) the large area of the forest ecosystem, 2) the presence of watercourses with good water quality, 3) species of special value, unique and endemic and 4) associated cultural practices and knowledge (Jiménez Bernal *et al.* 2016, Saravia & de Bustos 2008). This mosaic of protected areas together with La Candelaria and other private properties support a significant portion of native forests that constitute a block of great biological magnitude in the region, because of the biological diversity it hosts.

La Candelaria - Reserva de Biósfera de las Yungas - Áreas Protegidas Nacionales y Provinciales

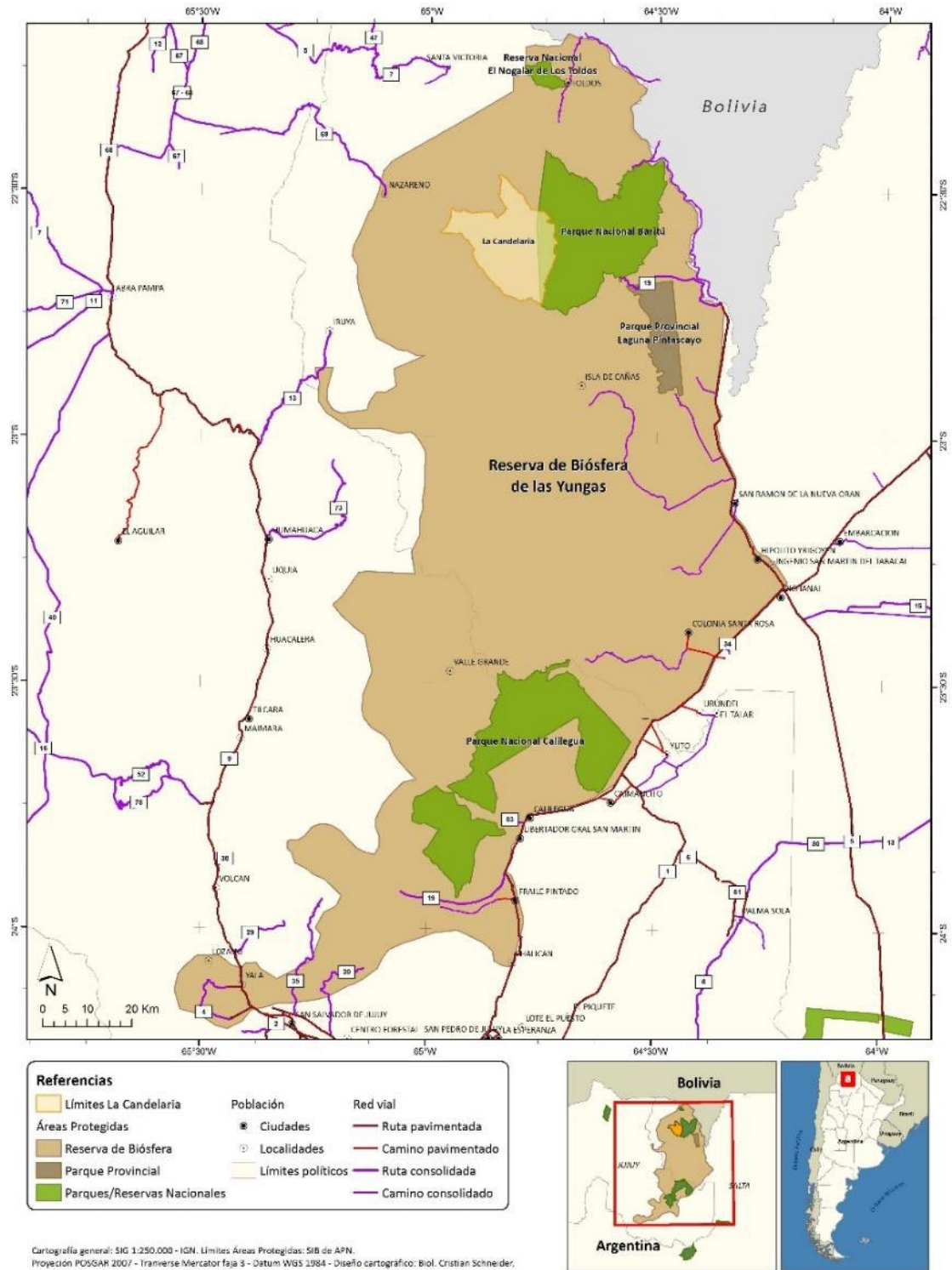


Figure 3. Relative location of La Candelaria in Las Yungas Biosphere Reserve and other protected areas.



In situ nature conservation allows the existence of a great diversity of species and warrants the continuity of complex interactions that have developed over many years. View of Baritú National Park (top), Nogalar de los Toldos Nature Reserve (bottom, left) and Laguna Pintascayo Provincial Park (bottom, right).

Areas of Importance for Wildlife

The Upper Basin of the Bermejo River has been noted as the only area that can ensure the long-term conservation of the complete biodiversity of the Yungas (Brown *et al.* 2002). La Candelaria is situated in this portion of the Yungas where, in addition, human activity is scarce (Human Footprint, Figure 4). 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 (*Tayassu pecari*), the Tucumán amazon (*Amazona tucumana*), the rufous-throated dipper (*Cinclus schulzi*), the Roble Criollo (*Amburana cearensis*) and the Pedemontana Forest, place La Candelaria as a priority in terms of wildlife conservation (Martinuzzi *et al.* 2018, Figura 4). In addition, this property as well as other neighboring areas are considered to have high conservation value, focusing on individual species or groups of species, some of which are described below.

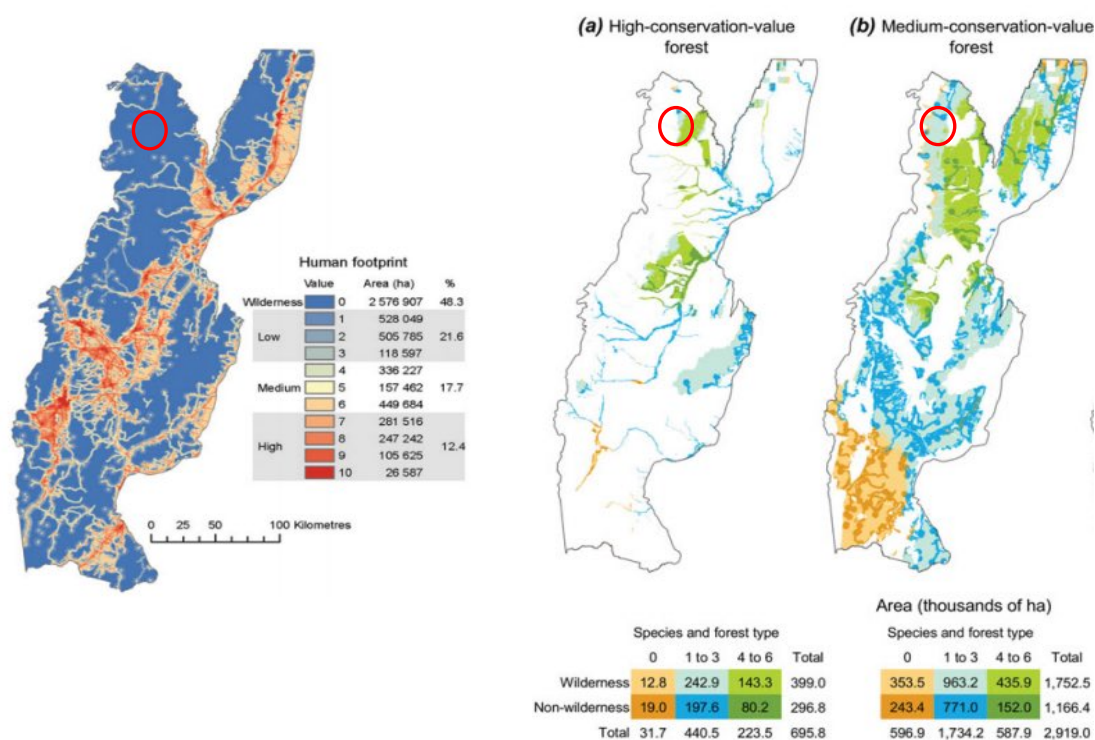


Figure 4. Gradient of Human Footprint values (left) and distribution of wildlife areas in the Yungas of Northwestern Argentina (in Martinuzzi *et al.* 2018). The relative location of La Candelaria is shown in the maps (red circles).

Birds are the most varied terrestrial taxon and their ecology, behavior, biogeography and taxonomy are relatively well known. Since the diverse species have different habitat requirements (for example, from the forest floor to the canopy) and are sensitive to disturbances such as forestry, cattle-raising and habitat fragmentation, among other factors that alter the vegetation architecture, they have shown to be effective indicators of biodiversity. For this reason, the program Areas of Importance for Bird Conservation (AICAs) was created, with the aim of identifying and protecting sites of particular relevance that have been identified and recognized by BirdLife and Asociación Ornitológica del Plata/Aves Argentinas. La Candelaria neighbors the AICA of Baritú National Park (SA04), where 270 species of birds have been recorded and an equal number could be still be identified, given the vastness of the area and its rich biodiversity. Besides, other three AICAs are found at a short distance: Pintascayo (SA15), San Andrés (SA30) and Santa Victoria-Lipeo (SA27), which include species typical of the Yungas and of the Puna (Di Giacomo 2005). In addition, this area was identified as key for the conservation of Neotropical threatened birds. Among the species of great value, mention may be made of the forest eagles (*Harpyhaliaetus solitarius*, *Spizastur melanoleucus*), the red-faced guan (*Penelope dabbenei*), the Andean condor (*Vultur gryphus*), the Tucumán amazon (*Amazona tucumana*), the blue-capped puffleg (*Eriocnemis glaucopoides*), the slated Elaenia (*Elaenia strepera*), Zimmer's tapaculo (*Scytalopus zimmeri*), the white-throated Antpitta (*Grallaria albigula*), and the rufous-throated dipper (*Cinclus schulzi*).



Figure 5. Areas of Importance for Bird Conservation (AICA, areas in turquoise) in the province of Salta and the relative location of La Candelaria (red circle) (from Di Giacomo 2005).

The region has also been considered relevant in terms 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*). The two latter have been listed as threatened in Argentina (Ojeda *et al.* 2012) and in the Yungas, two units of high conservation value have been identified and La Candelaria included in one of them (Taber *et al.* 2008). In turn, the north Andean deer has been declared National Natural Monument and categorized as endangered in Argentina (Ojeda *et al.* 2012). It inhabits the Andean steppes and prairies in the Northeast, with fragmented populations and low densities. In the highland grasslands of El Nogalar de Los Toldos and the neighboring areas, including La Candelaria, is found one of these Argentinean populations.



Tapirus terrestris is the largest native mammal of Argentina and was declared Natural Monument in some provinces it inhabits. It is considered an “engineer species” because it modifies the architecture of the secondary forest and the forest structure.

The Jaguar: top predator in the trophic chain of the Argentinean Yungas

In Argentina, the jaguar is the most important predator of the forests and the dry and humid subtropical woods. However, its original geographic range has decreased in about 95% (Di Bitetti *et al.* 2016) and today, the species is only present in the Yungas, the Paranaense Forest and some sectors of the Chaco. Given the vulnerable situation of this species in the country, it is considered a Natural Monument and it has been recently categorized as Critically Endangered (Paviolo *et al.* in rev.).

The most important population and maybe the most viable one in the long term, compared to other populations in the country, is found in the Yungas. It inhabits an area of approximately 11,600 km² and the population comprises 150 individuals (Perovic *et al.* 2015a). A study carried out in 2013 using trap cameras in an area of 681 km² in Baritú National Park and La Candelaria resulted in the identification of 12 individuals. Estimated density was between 0.003 and 0.011/km² and each individual's home range was estimated in about 138 km² (without differentiating sexes, Perovic *et al.* 2015b). The study, compared to others carried out in various sectors of the Yungas, permits to state that this landscape mosaic is a nucleus zone for the species' conservation.



Jaguar male photographed by a trap camera in 2013, in the area of Baritú National Park-La Candelaria.

Amphibians are more susceptible to extinction events than mammals and birds and there is growing evidence worldwide of the decrease their populations are suffering. *Gastrotheca chrysosticta* is one of the three species of marsupial frogs endemic to the Yungas (Akmentins *et al.* 2012) and categorized as highly endangered (Vaira *et al.* 2012). This frog is very cryptic, specializes in habitats of rock cracks and tree holes, and is only known in a few isolated localities in Salta province (Laurent *et al.* 1986). The last record of this species in the Yungas was made in 2002 (Lavilla *et al.* 2004) and there were no new records after that date, in spite of the search efforts. In 2018 the species was re-discovered in the "Camino a Sidras" (Baritú National Park - La Candelaria: 22°33'46.8"S; 64°45'7.8"W; 1,468 meters above sea level) (Akmentins 2018), evidencing the conservation status of the forest in this area.



*The marsupial frog (*Gastrotheca chrysosticta*) was re-discovered in 2018 in the border of La Candelaria with Baritú National Park (Photo S. Akmentins).*

Tree Ferns

Tree ferns (*Alsophila odonelliana* and *A. nova*) present in La Candelaria and neighboring areas are endemic to the Montane Forest. In the Argentinean Yungas they are very restricted to certain sectors, especially to some mountain slopes, ravines and humid hills or areas close to rivers and streams. They form patches, which are sometimes vast, and reach heights of 8 m or more.



Tree ferns are sensitive to microclimatic changes and their distribution in Argentina is restricted to areas between 900 and 2,200 m above sea level.

Ecosystem Goods and Services

Ecosystem goods and services are the elements of nature used by society for its wellbeing and enjoyment. La Candelaria is a provider of many goods and services; the model used as a basis for analysis is the one proposed for the Millennium Ecosystem Assessment (Figure 6).

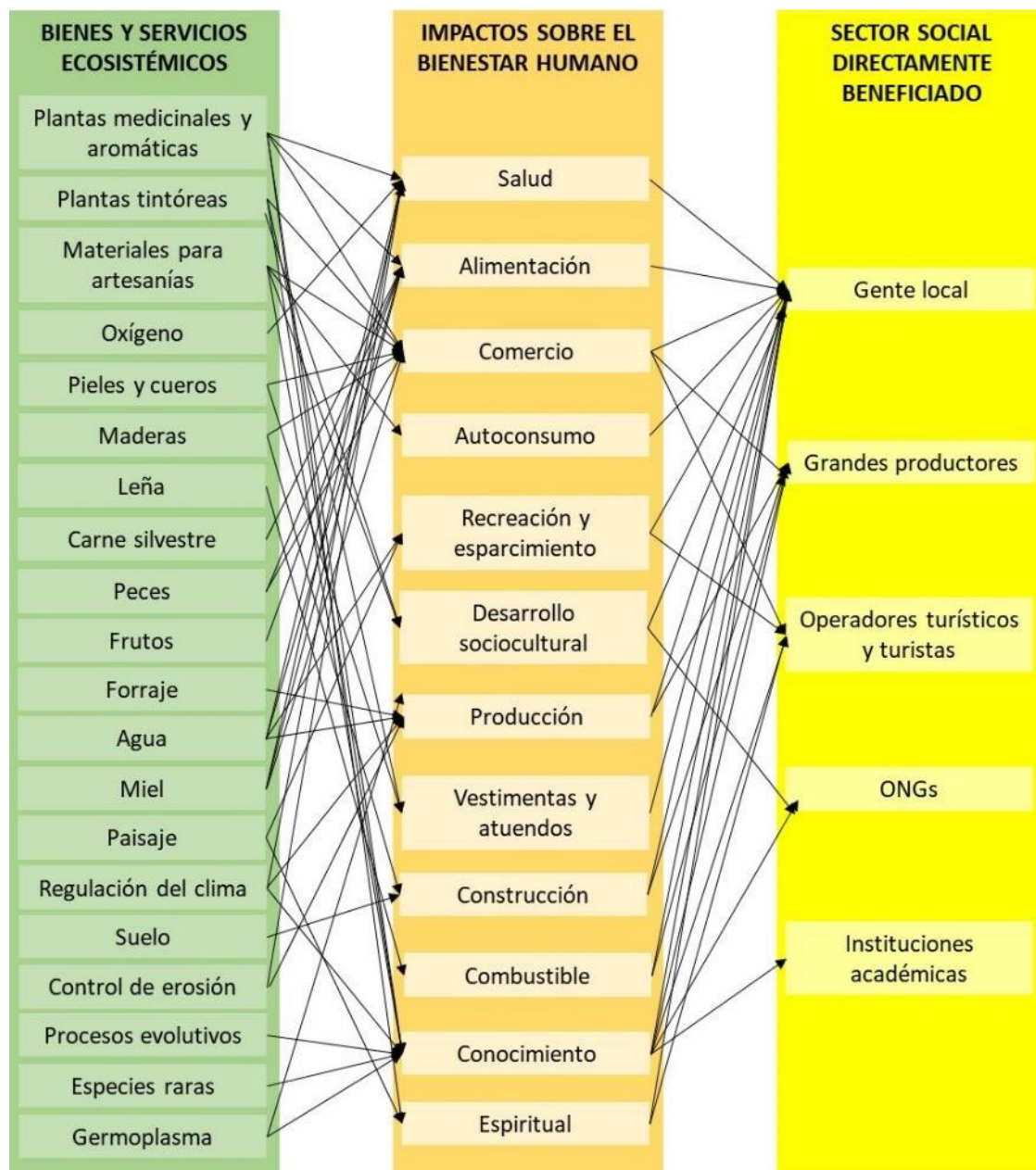


Figure 6. Analysis of the main ecosystem goods and services provided by La Candelaria.

Absence of Cattle

In the Southern Yungas of Argentina, cattle raising is the most widely distributed activity; it is carried out extensively ("under the forest"). There are almost no sectors free from the habitual or circumstantial presence of cattle. Absence of cattle in most of La Candelaria currently represents a very significant value for the area and cattle is estimated to have been absent in the central and southern sectors of the estate at least for the last 20 years. This benefits the

native forest, since the presence of cattle brings about changes in the vegetation structure, both spatially and in terms of species composition. The rugged landscape and the presence of “angostos” (very narrow passages), abundant and deep in some sectors of the main rivers and tributaries, impede or hinder the passing of livestock (cows and horses).



Extensive (or “under the forest”) livestock rearing is a widely distributed activity in La Candelaria and the Yungas in general. This activity generates changes in forest composition and affects the regeneration of high value tree species. In addition, the cattle competes with native herbivores, causes soil erosion and pollutes water

Biodiversity Surveys

Between August and October 2018, four field surveys were carried out in different sectors of La Candelaria, with the aim of studying plant, mammal and bird diversity in greater detail. Two of these surveys were carried out from August 1st to August 7th and from September 10th to September 14th and focused on the Southeast sector of the property: Alisal River, Mula, Vaca Botada, Casa Vieja, El deslizamiento ravines and Cinco Picachos Mountain Range. The other two surveys were carried out between September 27th and October 2nd and between November 11th and November 16th, in the Northeastern sector: Sidras River, Lapachal, Astilleros, Cortaderas and La Quinta ravines and on the trail of the old Provincial Route N° 19. Se detallan a continuación los relevamientos considerados.

Vegetation Study

Aim

- To survey and describe the general state of the forest, identifying tree dominant and accompanying species, species of interest as timber, regeneration and growth.

Methodology

We walked covering different sectors of the estate and examined areas with and without past forestry activity, signs of human activity, natural disturbances and disturbances produced by humans, dominating and accompanying forest species. In addition, we obtained wood samples in five specimens of Cedar and two of Nogal, using a Pressler borer (Annex 1). These few samples were obtained at random with the aim of compiling additional information to that available in the literature regarding growth of these species along the years. The samples were sent to the Laboratory of Wood Anatomy of the Faculty of Forest Sciences, National University of Santiago del Estero.



The transversal perforation of the trunk using a borer permits the obtention of a sample on the basis of which the approximate age of the tree will be calculated by counting the rings

Results

In our tours in the southern and northern sectors of La Candelaria we observed a continuous landscape, mostly represented by the latitudinal strata of the Montane Forest and the Montane Wood, and at a distance the highland grasslands on the western mountains. The area presents a good state of conservation, evidenced by the composition and structure of the existing forest. Vegetal cover varies from 3 to 5 in strata, with individuals over 20-24 meters of total height in the dominant or co-dominant strata, and tree tops surpassing 10-12 meters in radius. We observed some natural disturbances, mainly clearings in the forest caused by falling of trees and landslides in slopes; these clearings are now in a natural process of re-colonization. We found no signs of recent fires, clearings for agriculture or presence of domestic animals; however, we did find traces of logging and timber trails, logs and tree stumps, as well as traces of old lumber camps. The last year during which timber was extracted was 1998 (south, southeast sector). Since then, terrestrial acceses became gradually deteriorated and obstructed transit of vehicles, allowing the process of natural regeneration of the vegetation.

In the southern sector, no tracks of hunters, fishers, residents or passersby were recorded, maybe because of the inaccessibility from the closest locations (Limoncito, San Ignacio and Monoyoc) and also because of the great distances from the most densely populated center: Isla de Cañas. In order to access La Candelaria from this locality, a large part of the way is along the wide beach of the Iruya River, which becomes totally impassable for vehicles and machinery, especially in the summer periods, and conditioning to allow transit in the winter requires hard work and monetary investment. In the northern sector, the old Route N° 19 is open only as a trail to circulate on foot or on horseback to the vicinity of Las Sidras ravine. A large portion of this trail passes through Baritú National Park, so that it is sporadically guarded by park rangers. In general, the inhabitants of Baritú do not enter the estate because of the distance (over 15 km); only a few take their animals to graze in the proximities of the northeast sector.

Tree species recorded during the circuits are detailed in Table 1, discriminating whether they were dominant or accompanying species and how frequently they were found in the region.

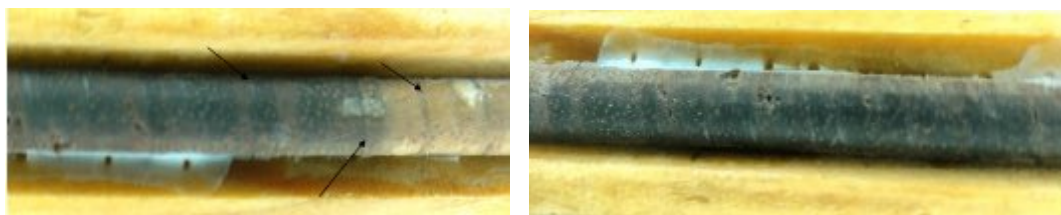
Estimation of age and growth in the specimens of *Cedrella lilloi* (Cedro) and *Juglans australis* (Nogal) are presented in Table 2 (Annex 1), showing the existence of large specimens over 60 years old.

Table 1. Dominant and accompanying plant species most frequently recorded in La Candelaria.

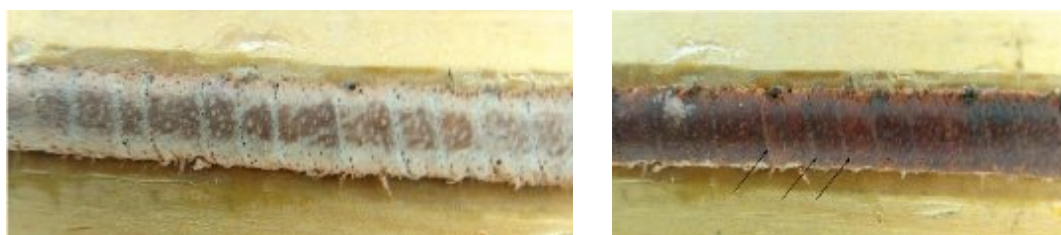
Common name	Scientific name	Family	Habitual use
Afata	<i>Cordia trichotoma</i>	Boraginacea	Woodworking
Afata blanca	<i>Heliocarpus americanus</i>	Tiliacea	Tool handles
Aguay	<i>Crysophyllum gonocarpum</i>	Sapotacea	Food (fruit)
Aliso del cerro	<i>Alnus jorullensis</i>	Betulacea	Chest of drawers/wood carving/furniture
Arrayán	<i>Eugenia uniflora</i>	Mirtacea	Ornamental/food(fruits)/firewood
Caña	<i>Chusquea lorentziana</i>	Poaceacea	
Cascaron	<i>Cascaronia astragalina</i>	Leguminosa	
Cebil colorado	<i>Anadenanthera colubrina</i>	Leguminosa	Firewood/rural articles/floors
Cedro rosado o coya	<i>Cedrela lilloi</i>	Meliacea	Furniture/wood/ tintura
Ceibo rosado	<i>Erytrina falcata</i>	Leguminosa	Ornamental/handicrafts
Chalchal	<i>Allophylus edulis</i>	Sapindacea	Food (fruit)
Chilto	<i>Cyphomandra betacea</i>	Solanacea	Food (fruit)
Cochucho	<i>Fagara coco</i>	Rutacea	Medicinal/dyes
Duraznillo	<i>Azara salicifolia</i>	Salicacea	Firewood/medicinal
Guarán	<i>Tecoma stands</i>	Bignoneacea	Ornamental
Guayabil	<i>Saccellium lanceolatum</i>	Borraginacea	Hand tools/woodworking
Guili	<i>Pseudocaryophyllus guili</i>	Mirtacea	
Helecho arborescente	<i>Alsophila odonelliana</i>	Cyatheaacea	Dyes for textiles
Helecho arborescente	<i>Alsophila nova</i>	Cyatheaacea	Dyes for textiles
Higuerilla	<i>Oreopanax kuntzei</i>	Araliacea	Medicinal
Horco cebil	<i>Parapiptadenia excelsa</i>	Leguminosa	Firewood/rural articles
Horco mato	<i>Myrcianthes mato</i>	Mirtacea	Ornamental/food (fruits)/firewood
Huancar	<i>Bougainvillea stipitata</i>	Nictaginacea	
Jacaranda	<i>Jacaranda mimosifolia</i>	Bignoneacea	Ornamental/woodworking

Lanza amarilla	<i>Terminalia triflora</i>	Borraginacea	Hand tools/woodworking
Lanza blanca	<i>Patagonula americana</i>	Borraginacea	Hand tools/woodworking
Lapacho amarillo	<i>Tabebuia lapacho</i>	Bignoneacea	Woodworking/floors/tools
Laurel amarillo	<i>Oocotea puberula</i>	Laureacea	Drawers/woodworking
Laurel blanco	<i>Nectandra pichurim</i>	Laureacea	Drawers/woodworking
Laurel de la falda	<i>Phoebe porphyria</i>	Laureacea	Drawers/woodworking/medicinal
Laurel peludo	<i>Styrax subargentus</i>	Estiracacea	Drawers/woodworking
Lecheron	<i>Sapium saltensis</i>	Euforbiacea	
Malvisco	<i>Croton multiflora</i>	Euforbiacea	
Mandor	<i>Coccoloba tiliacea</i>	Poligonacea	Ornamental
Mara	<i>Loxopterygium grisebachii</i>	Anacardiacea	Woodworking
Maroma	<i>Ficus maroma</i>	Moracea	
Matico	<i>Piper tucumanum</i>	Piperacea	
Mato	<i>Myrcianthes sp</i>	Mirtacea	Ornamental/food (fruits)/fierwood
Molulo - Sauco	<i>Sambucus peruviana</i>	Caprifoliacea	Medicinal/fruits
Nogal - Nogal criollo	<i>Juglans australis</i>	Juglandeacea	Furniture/wood/dyes/medicinal
Ortiga	<i>Urera sp.</i>	Urticacea	Medicinal
Ortiga brava	<i>Urera baccifera</i>	Urticaceas	
Pacar	<i>Enterolobium contortisiliqun</i>	Leguminosa	Woodworking/rural
Pacay - Inga	<i>Inga edulis</i>	Leguminosa	Fruits/firewood/carpintera
Palo barroso - Horco molle	<i>Blepharocallys gigantea</i>	Mirtacea	Hand tools/woodworking
Palo bobo - Aliso de ro	<i>Tessaria integrifolia</i>	Compuesta	Firewood (local use)/small posts
Palo luz	<i>Prunus tucumanensis</i>	Rosacea	Firewood
Palo plvora	<i>Trema micranta</i>	Ulmacea	Firewood
Palo yerba	<i>Ilex argentina</i>	Aquifoliacea	
Papaya silvestre - Higuern	<i>Carica quercifolia</i>	Caricacea	
Picantillo	<i>Lithraea ternifolia</i>	Anacardiacea	

Pino del cerro	<i>Podocarpus parlatorei</i>	Podocarpacea	Woodworking/cellulose
Quebrachillo	<i>Diatenopterix sobifolia</i>	Sapindacea	Rural articles
Quina blanca	<i>Lonchocarpus lilloi</i>	Leguminosa	Woodworking /rural
Quina colorada	<i>Myroxilon peruiferum</i>	Leguminosa	Woodworking /rural
Ramo	<i>Cupania vernalis</i>	Sapindacea	Ornamental
Sacha pera	<i>Acanthosyris falcata</i>	Santalacea	Fruits
San Antonio	<i>Myrsine coriacea</i>	Mirsineacea	
Sauce	<i>Salix humboldtiana</i>	Salicacea	Firewood/medicinal
Suncho amargo	<i>Bocconia pearcei</i>	Papaveracea	
Tabaquillo	<i>Solanum ripanum</i>	Solanacea	Firewood/medicinal/feed
Tala	<i>Celtis spinosa</i>	Ulmacea	Feed
Tipa blanca	<i>Tipuana tipu</i>	Leguminosa	Tools/floors/boards/handicrafts
Tusca - Espinillo	<i>Acacia aroma</i>	Leguminosa	Firewood/feed/medicinal
Vilcaran	<i>Piptadenia viriflora</i>	Leguminosa	Firewood/rural articles
Viraru	<i>Ruprechia laxiflora</i>	Poligonacea	Firewood/rural articles/ woodworking
Yerba colorada	<i>Citronella apogon</i>	Cardiopteridacea	
Yoruma colorada	<i>Roupala meisneri</i>	Proteacea	
Zapallo caspi	<i>Pisonia ambigua</i>	Nictaginacea	Woodworking/boards



Juglans australis presents well defined rings with a dark band that allows the identification of the ring limit (indicated with arrows). It has semi-circular pores and a marked difference between the sapwood and the heartwood.



Cedrela lilloi presents well defined rings and based on samples obtained in La Candelaria, a mean annual growth of 3.65 mm was determined. Macroscopically, the large, circular pores characteristic of this species may be observed in the young log, whereas the small pores of the old log are hardly visible with this magnification. The ring limit is formed by a pale strip corresponding to the terminal parenchyma (shown with arrows).

Table 2. Age and thickness of the rings in each individual sampled at La Candelaria.

ID	Species	Age	Mean ring thickness (mm)
AL1	<i>Juglans australis</i>	77	4.23
Sidras 2	<i>Juglans australis</i>	67	4.24
Sidras 1	<i>Cedrela lilloi</i>	85	3.81
188	<i>Cedrela lilloi</i>	62	4.38
189	<i>Cedrela lilloi</i>	88	2.71
P2	<i>Cedrela lilloi</i>	111	3.93
155	<i>Cedrela lilloi</i>	116	2.86

Conclusions

La Candelaria is characterized by a continuous matrix of Yungas native forest, in which the different units or vegetation in good conservation state appear interspersed. This is evidenced by the existing forest type, its composition, richness, frequency, condition of pre-existing roads, among others.

The forestry history of the property shows that logging has been carried out in different sites, using selective and conventional methods (local uses and customs), not based on integral resource management. However, natural recovery of the forest has taken place, so that today there are important stands of valuable forest species such as Quina, Cedar, Nogal, Lapacho, Pacará and Tipa, among others, with significant numbers of specimens of large size and good health.

Growth of Cedar and Nogal based on ring counts corresponds to values found in the literature and was estimated in 0.5 to 1 cm of diameter per year. Also, growth varies greatly with height and possibly with latitude. In the case of *Juglans australis*, values of 0.55 cm of growth in diameter per year was observed for diameter classes 30 to 50 cm (Gasparri *et al.* 2003), whereas in *Cedrela lilloi* the maximum growth found was 2 cm per year for individuals between 30 and 40 cm of DBH, with mean growth between 0.5 to 0.95 in individuals located in well-illuminated sites (Gasparri & Goya 2006). In conditions of closed forest, mean growth rates are substantially lower and potential logging shifts are considerably extended (Brown *et al.* 2001). These values suggest that in good growing conditions, these species reach minimum logging values at the age of 50 years. In samples obtained at La Candelaria, very high values were observed because the area contains important stands of valuable forest species that widely exceed that age.

Study on Mammals

Aim

- To survey the diversity of medium-sized and large mammals based on records of trap cameras and direct and indirect records.

Methodology

We set 25 trap cameras, some 2 km apart, in different environments such as river and stream beaches, ridges and slopes, always on animal trails (Figure 7, Annex 2). Trap cameras were programmed to remain activated during the whole day and were withdrawn a month after their installation. Species were identified using the Canevari & Vaccaro 2007 guide and were classified using the national conservation categories (Ojeda *et al.* 2012). We then grouped species according to their trophic preferences. We estimated relative abundance based on photographic events by species, during the nighttime, standardized to 100 night trap events. The record of a species during a one-hour period was considered an independent photographic event.

In order to enrich the survey based on trap cameras, we also considered records of sightings, tracks, traces, burrows, roosting sites, bone remains and leftovers of predatory activity.



The trap camera methodology permits the identification of conspicuous species, of nocturnal habits and/or very sensitive to human presence.

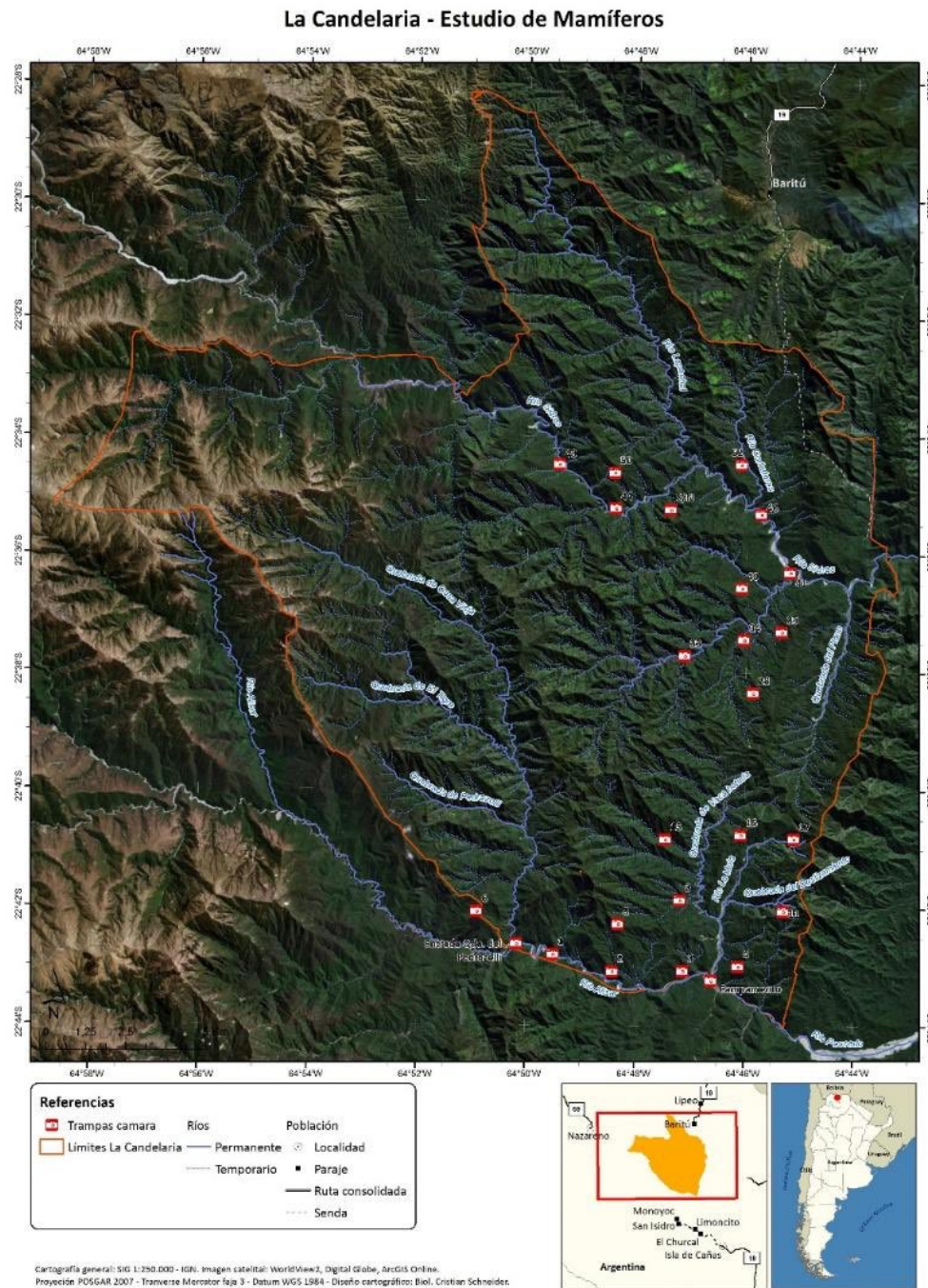


Figure 7. Location of trap cameras placed in La Candelaria.

Results

The sampling effort applied in La Candelaria was 1,032 traps/night. Twenty species of medium-sized and large mammals were recorded (Table 3), of which 17 species were photographed in the trap cameras, while the 3 remaining species were recorded only on the basis of their tracks or of direct sightings. We classified species in four trophic groups (Table 4), in which representation of herbivores and carnivores was similar and these species were the most abundant, followed by the omnivorous and insectivorous species (Figure 8). Among recorded species, six are threatened at the national level, whereas the jaguar (*Panthera onca*) and the tapir (*Tapirus terrestris*) are classified as Endangered (Table 3).

Table 3. Medium-sized and large mammals recorded in La Candelaria. * species recorded outside trap cameras. National conservation category: DD= Deficient Data, LC= Least Concern, NT= Nearly Threatened, VU= Vulnerable, EN= Endangered, NE= Not Evaluated.

ORDER/Family	Species	Common name	Conservation category	Trophic group	Capture frequency
					X ± DS
DIDELPHIMORPHIA					
Didelphidae	<i>Lutreolina crassicaudata</i>	Comadreja colorada	LC	Carnivore	0.10 ± 0.51
XENARTHRA					
Myrmecophagidae	<i>Myrmecophaga tridactyla</i>	Oso hormiguero	VU	Insectivore	0.10 ± 0.51
PRIMATES					
Cebidae	<i>Sapajus cay</i>	Mono caí	DD	Omnivore	*
CARNIVORA					
Canidae	<i>Cerdocyon thous</i>	Zorro de monte	LC	Omnivore	*
Felidae	<i>Leopardus pardalis</i>	Ocelot	LC	Carnivore	0.29 ± 0.80
	<i>Leopardus wiedii</i>	Margay	VU	Carnivore	0.41 ± 1.60
	<i>Leopardus sp.</i>			Carnivore	0.09 ± 0.43
	<i>Panthera onca</i>	Yaguareté, Jaguar	EN	Carnivore	0.80 ± 1.78
	<i>Puma concolor</i>	Puma	LC	Carnivore	0.99 ± 1.02
	<i>Puma yagouaroundi</i>	Yaguarundi	LC	Carnivore	0.29 ± 1.08
Procyonidae	<i>Nasua nasua</i>	Coatí	LC	Omnivore	
	<i>Procyon cancrivorus</i>	Mayuato	VU	Carnivore	0.31 ± 1.12
Mustelidae	<i>Eira barbara</i>	Hurón mayor	NE	Omnivore	0.90 ± 1.90
PERISSODACTYLA					
Tapiridae	<i>Tapirus terrestris</i>	Tapir	EN	Herbivore	10.76 ± 15.97
ARTIODACTYLA					
Tayassuidae	<i>Pecari tajacu</i>	White-collared peccary	VU	Herbivore	0.73 ± 1.45
Cervidae	<i>Mazama americana</i>	Corzuela colorada	NT	Herbivore	5.66 ± 15.84
	<i>Mazama gouazoubira</i>	Corzuela parda	LC	Herbivore	0.17 ± 0.60

RODENTIA					
Sciuridae	<i>Sciurus ignitus</i>		NT	Herbivore	3.07 ± 9.27
Dasyproctidae	<i>Dasyprocta punctata</i>	Acutí	NT	Herbivore	1.74 ± 2.99
Hydrochaeridae	<i>Hydrochoerus hydrochaeris</i>	Carpincho	NT	Herbivore	*
LAGOMORPHA					
Leporidae	<i>Sylvilagus brasiliensis</i>	Tapeti	LC	Herbivore	2.17 ± 5.98

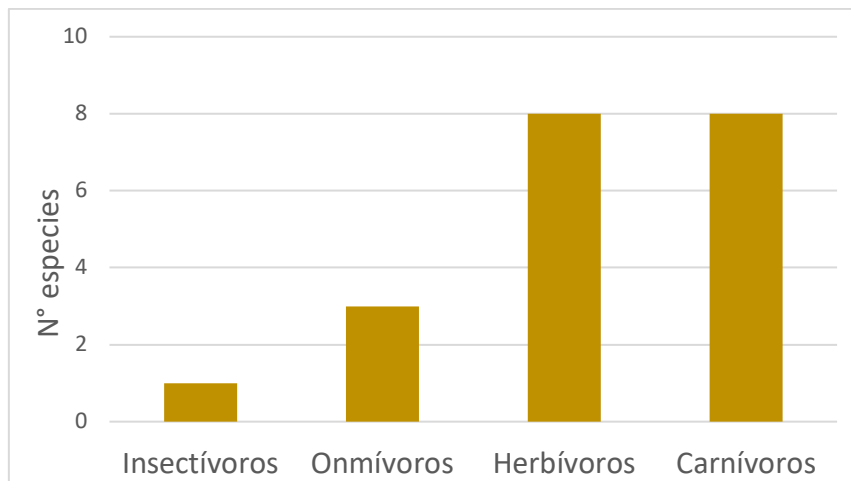


Figure 8. Representation of trophic groups in La Candelaria.

The tapir was the most frequently found species, followed by the red brocket (*Mazama americana*). The jaguarundi (*Puma yagouaroundi*) was less abundant in the first sampling period, whereas the less frequent species were the lutrine opossum (*Lutreolina crasicaudata*), the giant anteater (*Myrmecophaga tridactyla*) and a non-identified small feline (*Leopardus sp.*, Figure 9). Five specimens of jaguar were recorded, which could be individually identified by the spot pattern in each one.

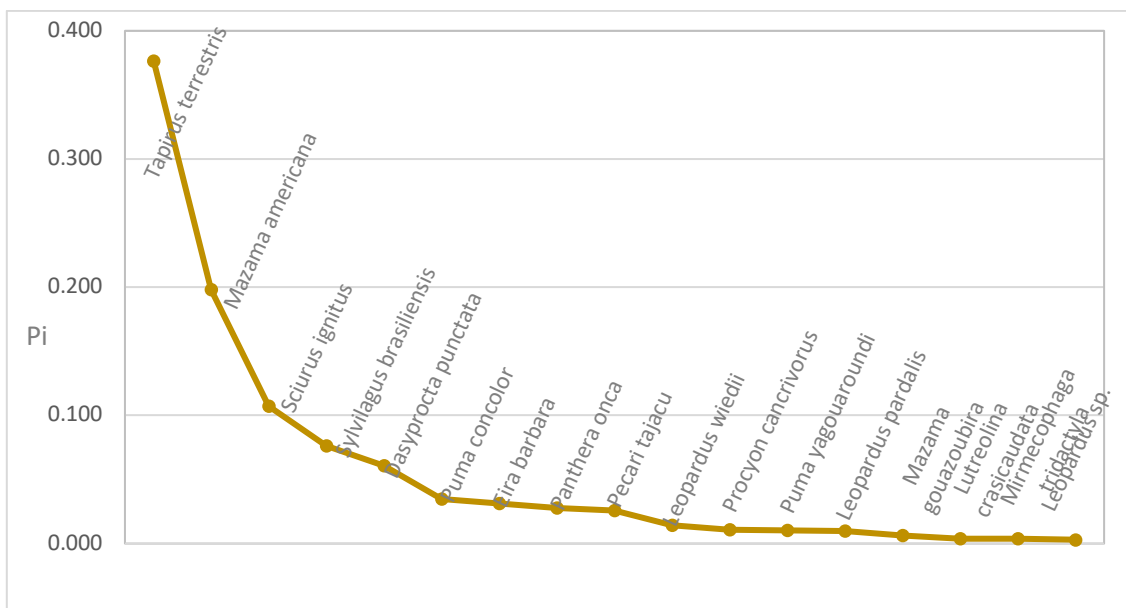


Figure 9. Richness curve – Abundance of medium-sized and large mammals surveyed with trap cameras in La Candelaria.



Tapir (*Tapirus terrestris*)



White-collared peccary (*Pecari tajacu*)



Red brocket (*Mazama americana*)



Brown brocket (*Mazama gouazoubira*)



Agouti (*Dasyprocta punctata*)



Red squirrel (*Sciurus ignitus*)



Tapeti (*Sylvilagus brasiliensis*)



Tayra (*Eira barbara*)



Ocelot (*Leopardus pardalis*)



Puma (*Puma concolor*)



Crab-eating raccoon (*Procyon cancrivorus*)



Giant anteater (*Myrmecophaga tridactyla*)



*Five different individuals of jaguar (*Panthera onca*) were photographed by trap cameras set in La Candelaria.*

Conclusions

The assemblage of medium-sized and large mammals surveyed in La Candelaria was very diverse and represents 65% of the total present in the Argentinean Yungas. This percentage may be considered very significant, because of the habits of some of the species included in this group which make them difficult to detect (for example, the Brazilian porcupine, the river otters), or that are mostly associated to degraded or drier environments (white-eared opossum, Pampas fox) and also considering the great diversity of environments and the complexity of the relief La Candelaria.

It is worth noting the presence and abundance of species which because of their conservation state, their role in the ecosystem and hunting value cinegético are considered of biological importance. This is the case of the jaguar, classified as Endangered in Argentina and declared Natural Monument, as well as the tapir, which was found very abundantly and forming breeding pairs. The white-lipped peccary was recorded with offspring, highlighting the value of the area as a breeding ground. Other species present in La Candelaria such as the red brocket, the giant anteater and the crab-eating raccoon are classified as threatened.

Results obtained in La Candelaria provide basic information to program future monitorings, both of the assemblage of medium-sized and large mammals, as well as of species of regional relevance, contributing information to the conservation plans of each one of them.

Study on Birds

Aim

- To assess the composition and abundance of birds in the area.

Methodology

Bird sampling was carried out in 63 counting points (Figure 10, Annex 3) of 50 m fixed radius and 10 minutes of duration, separated from one another by distances ≥ 150 m. Bird species sighted or heard were identified (Ralph *et al.* 1996). The presence of all species sighted or heard outside the counting points was also recorded, without considering their abundance. Sampling was carried out during the morning hours (between 7:00 am to 11:00 am) and in the afternoon (between 4 pm and 7 pm), so as to coincide with the peak of greater activity of birds 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 Ornithologists' Union (AOU, <http://www.museum.lsu.edu>). Recorded bird species were classified in groups according to the environment in which they were typically found: species typical of the mature forest; species that use mature forests, regardless of the fact that they may also use other types of forest; species that mainly frequent the forest margins and secondary forests; species of Yunga forest wetlands; and species of non-forest wetlands (Stotz *et al.* 1996, Blendinger y Álvarez 2009). The conservation state of these species at the global level was determined using the IUCN Red List of Threatened Species (IUCN 2018), while the conservation state for Argentina is based on information provided by Aves Argentinas and the ex-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 total number of individuals found in the sampling. We used standardization provided by the rarefaction method based on individuals to assess the adequacy of the sampling (Magurran & Mc Gill 2011).

Results

A total of 99 species of birds were recorded in counting points and non-systematic samples. In the counting points, 996 individuals of 85 species were recorded. Of the total species recorded in La Candelaria, 75.2% are species of mature Yungas forest, 12.8% are species of the forest margins and of the secondary forest, 7.9% are species of forest wetlands and 1.9% of non-forest wetlands (Table 4).

La Candelaria - Estudio de Aves

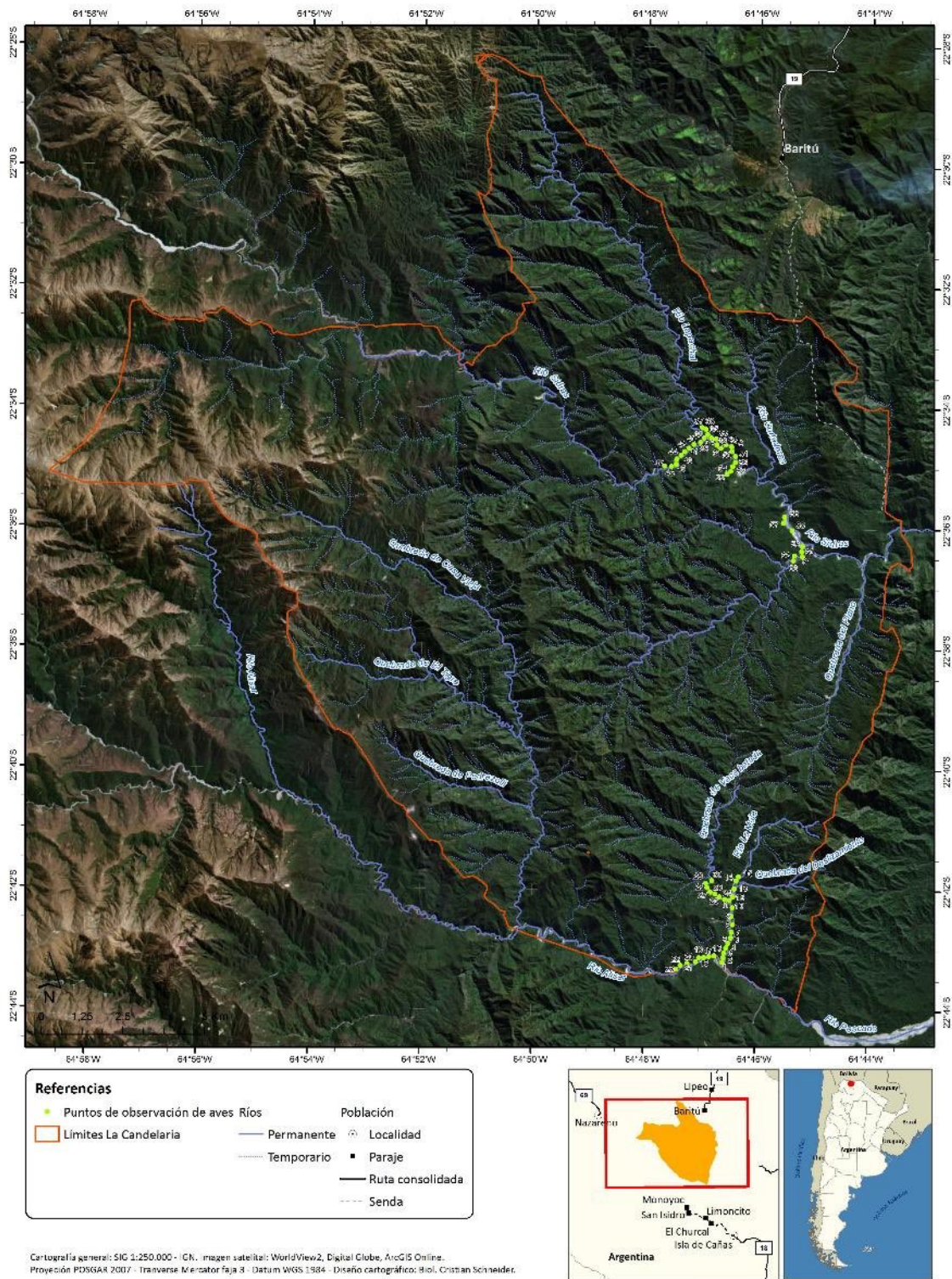


Figure 10. Location of counting points of birds in La Candelaria.

Table 4. Composition of bird species recorded in La Candelaria. *Species recorded outside the systematic sampling. BM= Mature Forest; BBS= Borders and Secondary Forests; HB= Forest Wetlands; and HN= Non-forest Wetlands.

N	Species	Absolute abundance	Association to hábitat type
1	<i>Buteogallus solitarius</i>	*	BM
2	<i>Geothlypis aequinoctialis</i>	6	BBS
3	<i>Myioborus brunniceps</i>	31	BM
4	<i>Myiothlypis bivittata</i>	41	BM
5	<i>Chiroxiphia boliviana</i>	3	BM
6	<i>Theristicus caudatus</i>	2	HB
7	<i>Batara cinerea</i>	1	BM
8	<i>Myiodynastes maculatus</i>	7	BM
9	<i>Pyrrhomyias cinnamomeus</i>	*	BM
10	<i>Cacicus chrysopterus</i>	1	BM
11	<i>Caracara plancus</i>	3	BBS
12	<i>Picumnus cirratus</i>	5	BM
13	<i>Piculus rubiginosus</i>	1	BM
14	<i>Campephilus leucopogon</i>	2	BM
15	<i>Veniliornis frontalis</i>	*	BM
16	<i>Thraupis sayaca</i>	68	BM
17	<i>Arremon flavirostris</i>	6	BM
18	<i>Arremon torquatus</i>	1	BM
19	<i>Zonotrichia capensis</i>	6	BBS
20	<i>Aramides cajanea</i>	1	HB
21	<i>Pyrrhura molinae</i>	46	BM
22	<i>Vireo olivaceus</i>	33	BM
23	<i>Thamnophilus caerulescens</i>	14	BM
24	<i>Thamnophilus ruficapillus</i>	1	BBS
25	<i>Cariama cristata</i>	1	BBS
26	<i>Vultur gryphus</i>	*	BM
27	<i>Cranioleuca pyrrhophia</i>	10	BM
28	<i>Elaenia obscura</i>	2	BM
29	<i>Elaenia parvirostris</i>	1	BM
30	<i>Elaenia strepera</i>	12	BM
31	<i>Chlorospingus flavopectus</i>	58	BM

32	<i>Butorides striata</i>	*	HB
33	<i>Ardea cocoi</i>	*	HN
34	<i>Pygochelidon cyanoleuca</i>	2	BM
35	<i>Stelgidopteryx ruficollis</i>	16	BM
36	<i>Coragyps atratus</i>	*	BM
37	<i>Cathartes aura</i>	2	BM
38	<i>Sarcoramphus papa</i>	*	BM
39	<i>Cyclarhis gujanensis</i>	6	BM
40	<i>Amazona tucumana</i>	12	BM
41	<i>Pionus maximiliani</i>	13	BM
42	<i>Lochmias nematura</i>	4	HB
43	<i>Primolius auricollis</i>	22	BM
44	<i>Megaceryle torquata</i>	1	HN
45	<i>Elanoides forficatus</i>	*	BM
46	<i>Cinclus schulzii</i>	2	HB
47	<i>Poecilotriccus plumbeiceps</i>	1	BM
48	<i>Phylloscartes ventralis</i>	20	BM
49	<i>Phyllomyias sclateri</i>	13	BM
50	<i>Leptopogon amaurocephalus</i>	5	BM
51	<i>Myiophobus fasciatus</i>	4	BBS
52	<i>Hemitriccus margaritaceiventer</i>	2	BBS
53	<i>Phyllomyias burmeisteri</i>	5	BM
54	<i>Merganetta armata</i>	18	HB
55	<i>Penelope obscura</i>	2	BM
56	<i>Saltator coerulescens</i>	1	BBS
57	<i>Sappho sparganurus</i>	10	BM
58	<i>Chlorostilbon lucidus</i>	20	BM
59	<i>Microstilbon burmeisteri</i>	*	BM
60	<i>Phaethornis pretrei</i>	9	BM
61	<i>Amazilia chionogaster</i>	21	BM
62	<i>Adelomyia melanogenys</i>	3	BM
63	<i>Tolmomyias sulphurescens</i>	17	BM
64	<i>Xenops rutilus</i>	7	BM
65	<i>Synallaxis scutata</i>	6	BM
66	<i>Synallaxis azarae</i>	9	BM

67	<i>Serpophaga nigricans</i>	5	BBS
68	<i>Camptostoma obsoletum</i>	5	BBS
69	<i>Setophaga pitaiyumi</i>	83	BM
70	<i>Calidris bairdii</i>	1	HN
71	<i>Troglodytes solstitialis</i>	3	BM
72	<i>Troglodytes aedon</i>	31	BBS
73	<i>Cinclodes atacamensis</i>	7	HB
74	<i>Conirostrum speciosum</i>	5	BM
75	<i>Pipraeidea melanonota</i>	7	BM
76	<i>Sublegatus modestus</i>	3	BBS
77	<i>Tyrannus melancholicus</i>	2	BBS
78	<i>Trogon curucui</i>	3	BM
79	<i>Rupornis magnirostris</i>	2	BM
80	<i>Euphonia cyanocephala</i>	*	BM
81	<i>Euphonia chlorotica</i>	4	BM
82	<i>Thlypopsis sordida</i>	5	BM
83	<i>Sittasomus griseicapillus</i>	8	BM
84	<i>Crypturellus tataupa</i>	8	BM
85	<i>Syndactyla rufosuperciliata</i>	39	BM
86	<i>Piaya cayana</i>	1	BM
87	<i>Xiphocolaptes major</i>	*	BM
88	<i>Ramphastos toco</i>	2	BM
89	<i>Legatus leucophaeus</i>	*	BM
90	<i>Cyanocorax chrysops</i>	3	BM
91	<i>Cyanocorax cyanomelas</i>	2	BM
92	<i>Sayornis nigricans</i>	31	HB
93	<i>Psarocolius decumanus</i>	12	BM
94	<i>Leptotila megalura</i>	7	BM
95	<i>Turdus amaurochalinus</i>	*	BBS
96	<i>Turdus chiguanco</i>	5	BM
97	<i>Turdus rufiventris</i>	35	BM
98	<i>Turdus nigriceps</i>	30	BM
99	<i>Catharus dryas</i>	1	BM
Total		966	

The rarefaction analysis showed a curve that stabilizes above 750 individuals, indicating an adequate sampling effort (Figure 11). The most abundant species were *Setophaga pitaiyumi*, *Thraupis sayaca* and *Chlorospingus flavopectus* (Figure 12). A group of 10 species represent almost 50% of the total abundance registered.

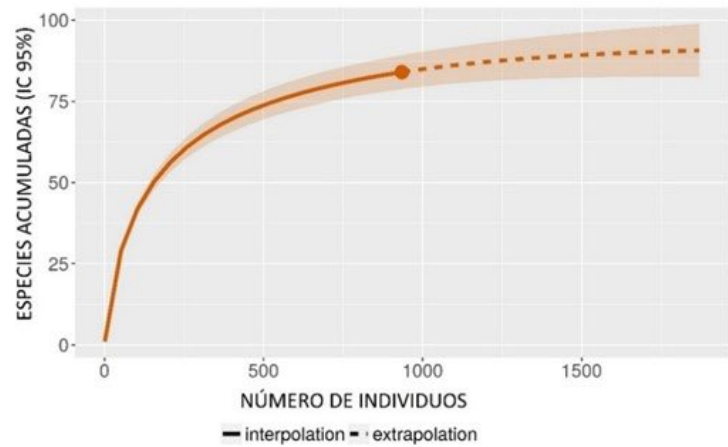


Figure 11. Rarefaction curve of interpolation (continuous line) and extrapolation (discontinuous line) based on sample size of birds in La Candelaria.

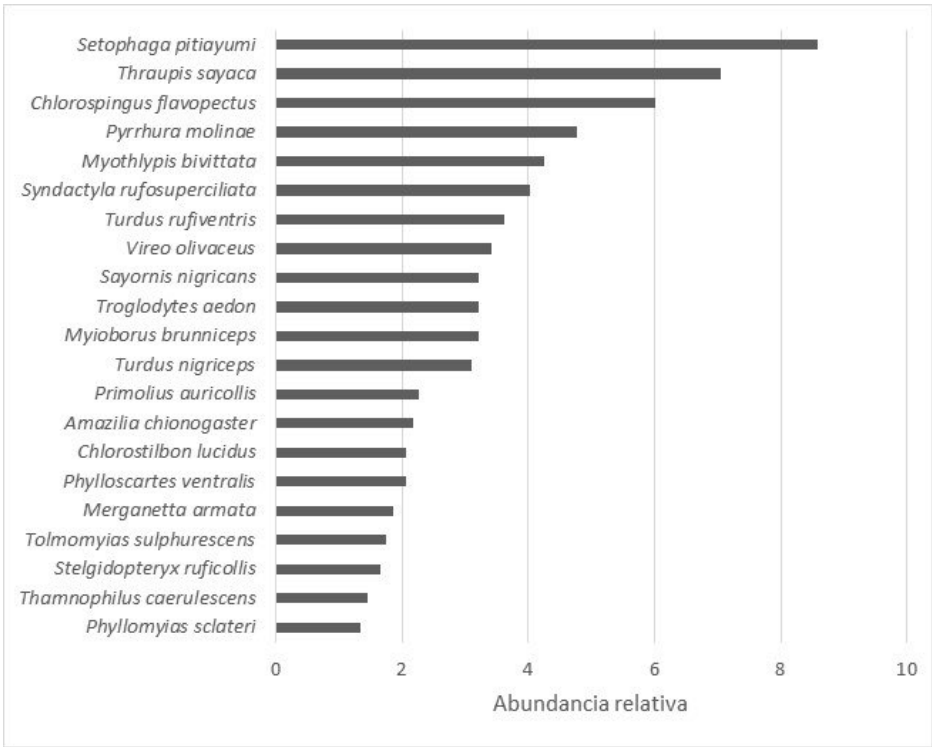


Figure 12. Relative abundance of the 21 most abundant species of the assemblage of birds surveyed in La Candelaria.



Solitary eagle (*Buteogallus solitarius*)



Sharp-tailed streamcreeper (*Lochmias nematura*)



Male and female torrent duck (*Merganetta armata*)



Torrent duck duckling



King vulture (*Sarcoramphus papa*)



Andean condor (*Vultur gryphus*)



Crested oropendola (*Psarocolius decumanus*)



Blue-crowned trogon (*Trogon curucui*)



Rufous-throated dipper (*Cinclus schulzii*)



Rufous-capped antshrike (*Thamnophilus ruficapillus*)



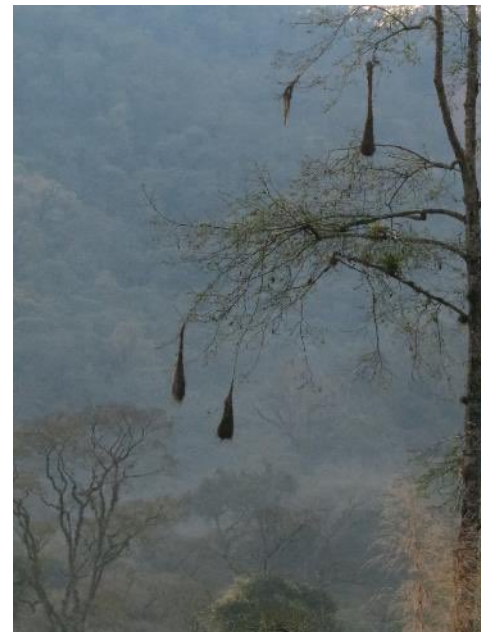
Roadside hawk (*Rupornis magnirostris*)



Toucan (*Ramphastos toco*)



Flock of golden-collared macaw (*Primolius auricollis*)



Nests of crested oropendola (*Psarocolius decumanus*)

Conclusions

The community of birds surveyed in La Candelaria represents 10% of the total of birds of Argentina. Given the expansion, diversity and complexity of the environments in Argentinean territory, this percentage can be considered very significant in the representation of the group.

Also, 82% of recorded species are considered mature forest species and species of forest Yungas wetlands, which supports the classification of these environments as of high and very high conservation priority.

Among the bird species, mention may be made of the presence of various species that because of their conservation status, for having a restricted geographic range or because of their role in the ecosystem are important species for conservation. Such is the case of the solitary Eagle, classified as endangered in the Argentinean territory according to Resolución 348/2010 of the Secretariat for Environment and Sustainable Development of Argentina. This species was observed in courtship ritual, so that the area may be considered valuable as a potential breeding ground. Other species present in La Candelaria are classified as threatened (Resolución 348), species like the Andean condor, the Tucumán amazon, the rufous-throated dipper, the torrent duck and the dusky-legged guan. The site is significant as breeding ground of the torrent duck, since we recorded one nest of the species and various couples with chicks.

According to the IUCN, which classifies the conservation status of wild species at the international level in its Red Lists, the Tucumán amazon and the rufous-throated dipper are species categorized as Vulnerable (IUCN 2018), while species such as the condor and the solitary eagle are in the category of Almost Threatened. Other species like the King Vulture and the torrent duck are classified as of Least Concern, yet their populations are decreasing (IUCN 2018).

The sharp-tailed streamcreeper and the rufous-throated dipper are species of distribution restricted to forest rivers and water bodies and are scarcely found in the country. The Sharp-tailed Streamcreeper is found in the Atlantic Forest and the Yungas of Salta and Jujuy. In the case of the rufous-throated dipper, it is only found in the Yungas. También se destaca la observación y un evento de cortejo de individuos de bailarín yungueño. Rivera and Politi (2015) recently documented this species for Argentina, in the area near Pintascayo, Salta. The records of this survey contribute to the knowledge of the species' range in Argentina.

Of the ten most abundant species recorded, the red-eyed vireo and the Andean slaty thrush (which jointly represent 6.8% of the total abundance) are considered Neotropical migratory species. Other less abundant recorded species are migratory, and are both Nearctic (Baird's sandpiper) and Neotropical (piratic flycatcher, tropical kingbird, swallow-tailed kite and streaked flycatcher), highlighting the importance of this area as habitat for species that arrive in the Yungas during the summer season.

La Candelaria hosts a diverse assemblage of birds, comprising species with characteristics of mature forests as well as others typical of the forest margins and secondary forests. In addition, we highlight the importance of rivers and streams within this property for the species of forest wetlands, since many of them are habitat specialists and are classified as threatened. Records of bird species in breeding courtship, with nest or with chicks, also reflect the quality of this habitat for the reproduction of certain species. The assemblage of birds in La Candelaria represents a great portion of the avifauna of the Southern Yungas, and the record of threatened species enhances the high priority of this area in terms of bird conservation.

Socio-economic Context

Historic Settlement and Land Tenure

Human activities in the Upper Bermejo region date back to at least ten thousand years, when diverse cultures converged and the interactions among them shaped local identities. Historic chronicles mention that prior to the expansion of the Inca Empire, there existed a real “ethnic mosaic” (Lorandi 1980, Delcourt 2003). The region was probably inhabited by groups from the Altiplano (Highlands) and the forest, amongst which were the Carangas from the southern region and east of Tarija (Presta 1996). In the late 16th century, with the expansion of the Inca Empire, this region became the eastern border of the empire or Collasuyu. In the early 16th century, the Chiriguano groups exerted a growing pressure and finally made an incursion in this region and disrupted Inca dominance of the territory (Delcourt 2003).

Later, with the arrival of the Spaniards, Inca dominance was further disrupted. Also in the 16th century, the region became part of the territory handed over to Velásquez de Ovando by the Spanish Crown (Ventura 2001), and later it became integrated to the Yavi Marquisate initiated by Juan José Fernández Campero, the most important one in the Río de la Plata Viceroyalty in terms of territorial size. After the Revolution of 1810 in Argentina, the region was the site of numerous battles and confrontations carried out by the regular independence armies (such as the “Ejército Auxiliar del Perú o Ejército del Norte” commanded by General Belgrano), the Spanish or Realista army and the gaucho militias from Tarija, Jujuy and Salta, which responded to General Martín Miguel de Güemes (Solá 2006). In 1813, the so-called Assembly of the Year XIII, titles of nobility were terminated and the Yavi Marquisate disappeared; however, the lands remained under control of the Campero family until the late 19th century, when the region was gradually subdivided and sold (Gil Montero & Maseé 2004). The indigenous communities continued inhabiting the region and co-existed with criollo residents (mestizos), and they still claim possession of the land in our days, having been in some cases successful (for example the Tinkunaku community in Finca San Andrés).



The indigenous communities are organized for decision making at different levels. In the case of the Kolla people each community is grouped in regional organizations of second order and all together they conform the Kollamarca.

The current land registry N° 108 denominated La Candelaria, owned by Empresa Forestal Santa Bárbara, presents to some extent current traditional and public occupation by the Aboriginal Kolla Community of San Pedro (Legal Entity Resolution N° 132/04 RENACI), in the extreme W of the property, and the Aboriginal Community of El Lipeo and Baritú (Legal Entity Resolution N° 298/01 IGPI Salta), in the NE. The Under Secretariat for Indigenous Affairs of the province of

Salta informed only with regard to the San Pedro Community, and manifested that although no formal claim had been filed in that institution by this community, did not provide details of the territorial survey performed, since such information is confidential. This is probably related to the inscription in the land title of La Candelaria of an annotation of a claim for twenty-year possession. At the other hand, the National Institute of Indigenous Affairs informed that under the Law No. 26,160 and the National Program of Survey of Territorial Indigenous Communities (Re.TE. CI) two communities present current traditional and public occupation to some extent in La Candelaria: Aboriginal Community of El Lipeo and Baritú and Kolla Aboriginal Community of San Pedro. Large inconsistencies were observed with regard to the area claimed by San Pedro Community according to the national and provincial sources consulted.

On the other hand, based on the analysis of the cadastral boundaries we performed, considering the public information available¹, we noted that the eastern sector of La Candelaria overlaps Baritú National Park in a sector of 5,651 ha (Figure 13). This merits a deeper analysis, and consultation with the pertinent organisms involved (National Parks Administration and the Direction of Properties of Salta Province).

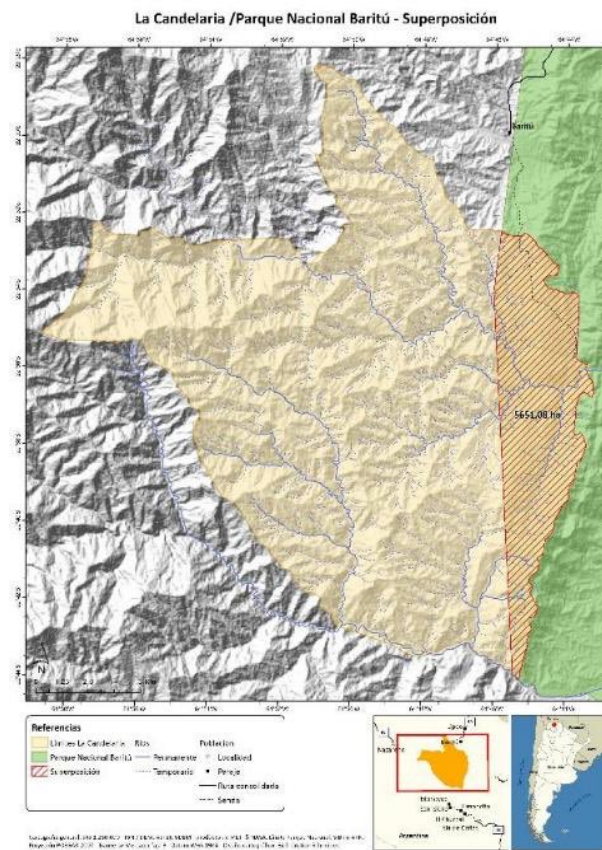


Figure 13. Overlapping of limits between La Candelaria and Baritú National Park.

¹ Polígono del Parque Nacional Baritú, considerado por la Administración de Parques Nacionales: <http://sib.gob.ar>; <http://geoportal.idesa.gob.ar> y Polígono de La Candelaria provisto por la Empresa Forestal Santa Bárbara.

Neighboring Populations

La Candelaria is surrounded by various local communities which are mostly of Kolla origin. The closest localities are Nazareno (7 km)² and Los Toldos (25.7 km) in the Santa Victoria Department, to the northwest and the northeast respectively, and Isla de Cañas (21.4 km) to the south, in the Iruya Department. These three localities are heads of the homonymous municipalities and urban centers, which host most public institutions: Municipalities, Schools, Health Centers, Cours of Peace, Police, Communal Centers, among others. Although these are the most important towns in terms of number of inhabitants (Figure 14), there are also a number of areas and small villages closer to La Candelaria, such as Baritú (5.3 km), Lipeo (9.6 km) Monoyoc (10.7 km), San isidro (11.9 km), Limoncito (12.7 km) and El Churcal (14 km); Baritú is the most densely populated area, with about 100 inhabitants (Jiménez Bernal *et al.* 2016).

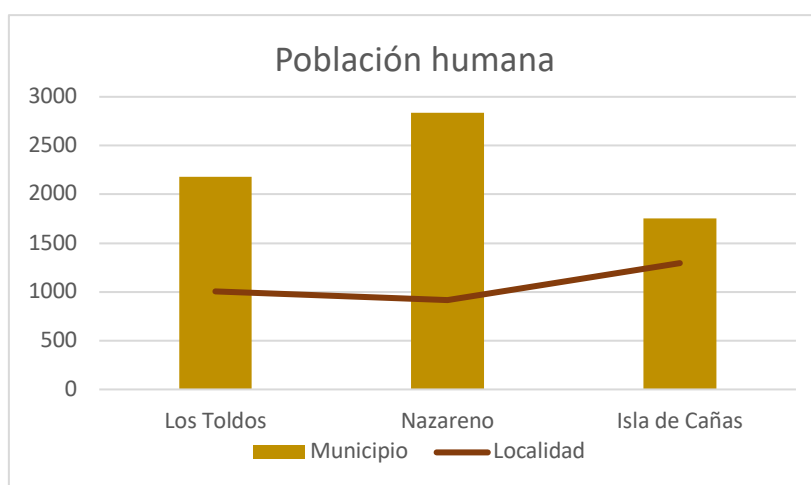


Figure 14. Human population settled in the municipalities and localities closest to La Candelaria (Source: 2010 Census).

In the less populated areas, the socio-productive practices developed by the communities for hundreds of years allowed them to sustain certain levels of autonomy which are maintained nowadays. The ways of being and of acting of these local residents are very much related to the sequential use of the altitudinal gradient associated mainly to cattle. They also sow corn, cayote, potato, beans, pumpkins, sweet potatoes and peanut in small temporary plots and the women spin wool to make handicrafts, carpets, puyos, and saddlebags. The scarce availability of jobs in the region encourages the migration of young and adults to the nearby cities or to important producing centers in search of labor opportunities. In the last twenty years, public policies of the government have generated a change in the economic structure of the rural populations, allowing access to new forms of feeding, of goods and services, while this exchange is not exclusively dependent on goods produced locally (Jiménez Bernal *et al.* 2016).

² Distance from the closest point of La Candelaria along a straight line.



Activities of slash-and-burn consists in the elimination of the forest cover in small plots, on the hillsides, to produce different crops during a couple of years. The site is then abandoned and a process of natural recovery of the vegetation occurs.

Recent Human Activities in La Candelaria

Recent Human Activities in La Candelaria

In La Candelaria, until approximately 40 years ago, there were permanent inhabitants in the areas of Quebradas La Quinta and Casa Vieja. Besides, in sectors of the north of the property there were dwellings for temporary residence of rural caretakers. Livestock rearing was carried out extensively in a wide area and residents raised cattle and some horses. Currently, there are no records of human settlements, nor of sporadic presence. However, some inhabitants of relatively close communities like Nazareno and Baritú take their cattle to graze to the northwestern and northeastern areas, respectively, in a certain time of the year (Figure 15, Falke & Lodeiro Ocampo 2008). It has been estimated that the size of the area under grazing is not greater than 20% of the total area of La Candelaria.

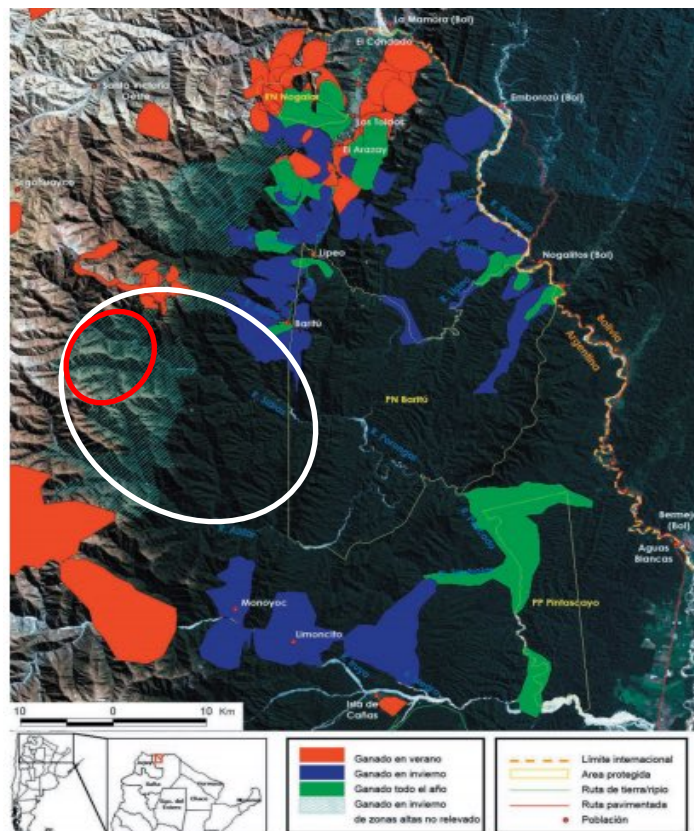


Figure 15. Areas of cattle-raising activity around and within La Candelaria (white circle). The red circle marks the area of cattle-raising activity by the Nazareno community (from Falke & Lodeiro Ocampo 2008).

According to the information provided by local inhabitants and neighbors of La Candelaria, forest extraction activities started within the property in 1974 and continued for seven consecutive years. Sowing was focused in the area of Quebrada Las Sidras and La Quinta. Timber products were removed using roads that were re-opened every year, when the rains ceased, crossing the sites of Baritú and Lipeo toward Los Toldos in the north. During the last years of extraction, a road was opened from Isla de Cañas, crossing the Monoyoc and Rosario farms and the Alisar River, in the southern sector of La Candelaria.

In the winter of 1981 and on the basis of an existing timber trail, Provincial Route N° 19 was inaugurated, connecting the localities of Isla de Cañas with Los Toldos and crossing La Candelaria in a north-south direction. This was the only year during which transit was possible along its entire length; later, because of lack of maintenance, its use was interrupted. The re-opening of this route is a permanent aspiration of local inhabitants, especially of the communities inhabiting the north sector of La Candelaria (Baritú, Lipeo, Los Toldos), who have to cover 100 km through the Bolivian route and then re-enter Argentina in the locality of Aguas Blancas (Orán Department, Salta).

Wood extraction was started once again in 1986, when the person who at that time was the owner leased areas of logging and harvest to contractors and the logs were transported to the city of Orán, passing through Isla de Cañas, for processing. Harvests were aimed at extraction of cedar, selecting specimens of good form and sanity, and no technical criteria or silvicultural techniques were applied to favor the remaining vegetation; logged trees were those over a minimum diameter of 50 cm at breast height (DBH). As accompanying species, Nogal, Quina and in lower and more accessible sectors, Cebil, were extracted in small amounts and only upon request. These loggings were carried out for the last time in 1998, in a sector close to the Alisar River. We noted that in the design and construction of roads, areas for timber stocking and logging routes, the minimum measures for the general protection of the environment, protection of the remaining vegetation and of the water drainage were often disregarded. This is currently evidenced by the formation of profound drainage gullies. On the other hand, logged sectors show a significant recovery, both in forest cover and in presence of timber species, with important stands of Nogal and Cedar.

In 1998, La Candelaria was purchased by Empresa Forestal Santa Bárbara with the aim of carrying out forestry activities in the native forest. To date no logging activity has been conducted, so that the forest has been in recovery for at least 22 years since the last timber extraction.



In the areas of past extraction conspicuous stumps of Cedro, Nogal, Quina and Cebil may be found.



General Conclusions

La Candelaria is an area of great biological relevance in the Yungas of Northeastern Argentina. This estate hosts a rich biodiversity, including species of significance like the jaguar, the tapir and the Andean deer, which have been declared Natural Monuments; also the solitary eagle, the rufous-throated dipper, the torrent duck, the condor, the Tucumán amazon and the dusky-legged guan. All these species are considered threatened in Argentina and there are conservation plans at the national and regional levels for some of them, in which La Candelaria plays an important role.

The forest cover is in an excellent conservation status, including the four different vegetation stories of the Yungas, with important stands of valuable forest species, and trees of over 100 years of age and healthy seedlings. In addition, it contains unique and important patches of tree ferns, which are scarce and restricted to the Yungas.

These are only some of the relevant conservation values of Candelaria; however, it is a largely unexplored region, so that other biological values will very likely be identified in the future.

Additionally, the ecosystem services provided to nearby communities and to society as a whole, including basic resources such as safe drinking water and water for irrigation, and complex processes related to flow regulation, control of soil erosion, carbon sequestration and oxygen liberation, among others.

La Candelaria is regionally considered one of the private properties of highest priority in terms of regional conservation, because it significantly contributes to the conservation of the native forest, hosts an enormous biological diversity, provides valuable ecosystem services and is situated close to already implemented protected areas, enhancing its role as guardian of the survival of wild species and natural ecological processes in the long term.

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Annexes

Annex 1. Final report of growth assessment in samples of tree specimens collected in La Candelaria in 2018.



PERITAJE TÉCNICO

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Asunto:

Determinación, medición de espesores de anillos de crecimiento en tarugos de *Cedrela liliei* y *Juglans australis* obtenidos en la Finca La Candelaria del departamento Iruya de la provincia de Salta.

Material

Muestra	Identificación	Especie
1	Sidras 1	<i>Cedrela liliei</i>
2	188	<i>Cedrela liliei</i>
3	189	<i>Cedrela liliei</i>
4	P2	<i>Cedrela liliei</i>
5	155	<i>Cedrela liliei</i>
6	Sidras 2	<i>Juglans australis</i>
7	AL1	<i>Juglans australis</i>

Metodología

Los tarugos se acondicionaron y se montaron sobre listones de pino para su mejor manipulación. Para lograr una mejor visualización de los límites de los anillos, se alisaron sucesivamente con lipeadora orbital manual con juego de lijas de granulometría ascendente de 100 a 1200, hasta la obtención de una superficie lisa que permite ver con mayor claridad los bordes, de acuerdo a la metodología de Stokes y Smiley (1968). El recuento y medición de los espesores de anillos se realizó con el Equipo ANIOL (1991) y el programa Proy Anillos con una precisión de centésima de milímetro.

Resultados

Cedrela liliei

Es una especie con anillos bien demarcados, macroscópicamente se observan los poros grandes del leño temprano correspondiente a la porosidad circular (característica de este género), los poros pequeños del leño tardío no pueden observarse con este aumento. El límite del anillo está formado por una banda clara que corresponde a una banda angosta de parenquima terminal (Imagen N°1y2).



Imagen N°1

Las flechas indican los bordes de los anillos marcados por bandas de parenquima terminal.



Imagen N°2

El promedio general de los incrementos medidos en las muestras de cedros fue de **3,61mm** el individuo con mayores incrementos fue el P2 tal como muestra el gráfico N°1.

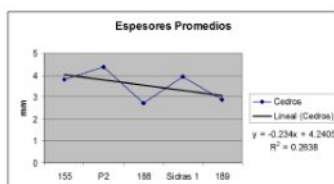


Gráfico N°1 "Espesores Promedios de Anillos"

Si consideramos la totalidad de los datos se obtiene el Gráfico N°2 donde queda expuesta el comportamiento de los incrementos con la siguiente relación polinómica

$$Y = -1E-05x^2 + 0.002x + 3.8878$$

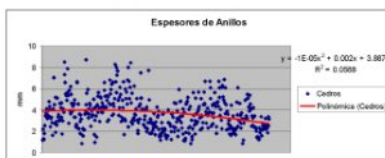


Gráfico N°2 Función Polinómica de los espesores de anillos en función de la edad.

Gráfico 2 función polinómica de los espesores de anillos en función de la edad de todas las muestras (tarugos), en función de la edad. La baja correlación de la función se debe probablemente a que no se tiene la certeza que todos los tarugos extraídos llegaron hasta la médula.

Construyendo la relación del diámetro de referencia (DAP) con la edad el comportamiento de los cedros es lineal como se observa en el gráfico N°3.



Gráfico N°3

El crecimiento medio que presentan los cedros analizados se mantienen dentro de un corto rango (0.5 y 1cm) a lo largo de los años.

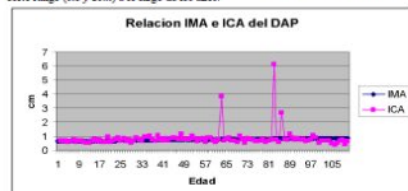


Gráfico N°4

La Edad aproximada* de los árboles medidos fueron:

Cedros	Edad (Años)	DAP	Espesor promedio de cada muestra
Sidras 1	85	79.7	3,811mm
188	62	42.9	4,38mm
189	82	68.9	2,71mm
P2	111	95.5	3,93mm
155	118	108.1	2,86mm

- * Esto se debe a que no se tiene la certeza de que la extracción de las muestra (narugos) hayan llegado hasta la médula.

Juglans australis

Con millos demarcados con una banda oscura que permite identificar el límite del millo, posee porosidad semicircular y marcada diferencia entre albura y duramen.

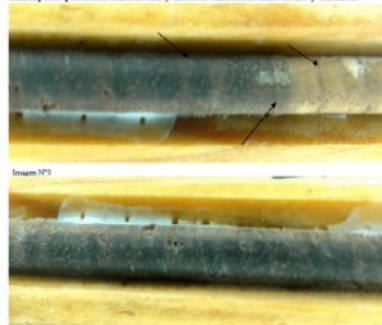


Imagen N° 3

Imagen N° 4

Gráfico N°6

Juglans	Edad (Años)	DAP	Espesor promedio por muestra
AL1	77	66.1	4,24mm
Sidras 2	67	64.1	4,23mm

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Los espesores promedio obtenidos para los dos individuos de Nogal son casi idénticos 4,24mm. Las edades son 77 y 67 años para AL1 y Sidras 2 respectivamente. En el gráfico N° 3 se observa que los incrementos disminuyen con la edad, siendo los primeros diez años donde se observa su mayor crecimiento.

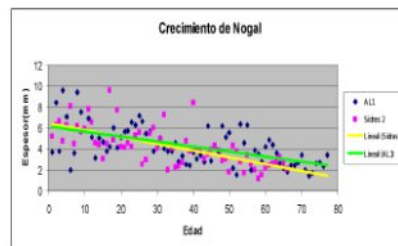
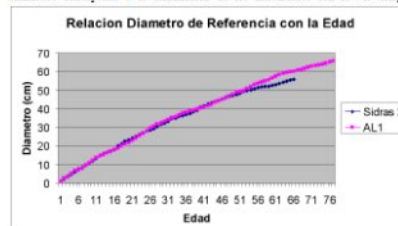


Gráfico N°3 "Crecimiento en función de la Edad"

El comportamiento del diámetro con la edad que se construyeron para los Nogales analizados corresponde a la disminución de los incrementos con la edad.



Annex 2. Coordinates of location of trap cameras during the survey carried out in 2018.

Station	Latitude	Longitude	System of Coordinates	Altitude	Environment
1	312550	7487074	UTM	1045	Playa río
2	314413	7486566	UTM	1178	Filo
3	316629	7486618	UTM	1050	Playa arroyo seco
4	318355	7486772	UTM	1272	Ladera
6	310143	7488377	UTM	1694	Filo
8	314574	7488052	UTM	1628	Filo
9	316495	7488833	UTM	1139	Playa arroyo
11	319744	7488531	UTM	1660	Filo
15	316009	7490727	UTM	1283	Playa río seco
16	318367	7490899	UTM	1482	Filo
17	320026	7490801	UTM	1668	Filo
Entrada Qda. Pedrazolli	311399	7487388	UTM	1085	Playa río
Campamento	317519	7486323	UTM	933	Playa arroyo seco
46	22 35 18.9	64 45 44.3	gms	1022	Terraza
41	22 36 17.9	64 45 12.6	gms	998	Playa río
40	22 36 34.2	64 46 5.3	gms	1283	Filo
33	22 37 43.2	64 47 7.4	gms	1260	Playa arroyo
34	22 37 26.7	64 46 2.5	gms	1213	Filo
28	22 38 20.9	64 45 52.44	gms	1363	Aguada
52	22 34 28.2	64 46 6.7	gms		Terraza
49	22 34 28.7	64 49 26.1	gms	1206	Playa río
44	22 35 13.3	64 48 24.2	gms	1146	Playa río
50	22 34 37	64 48 25.4	gms	1650	Filo
35	22 37 18.6	64 45 21.4	gms	1207	Ladera
s/n	22 35 14.5	64 47 23.9	gms	1430	Filo

Annex 3. Coordinates of location of counting points during the bird survey in La Candelaria, 2018.

Point	Latitude	Longitude
1	22°43'12.19"S	64°46'35.37"W
2	22°43'7.38"S	64°46'34.13"W
3	22°43'2.42"S	64°46'33.48"W
4	22°42'57.78"S	64°46'31.39"W
5	22°42'52.99"S	64°46'29.19"W
6	22°42'47.61"S	64°46'26.18"W
7	22°42'41.97"S	64°46'25.42"W
8	22°42'34.23"S	64°46'24.38"W
9	22°42'26.03"S	64°46'25.99"W
10	22°42'17.38"S	64°46'24.72"W
11	22°42'10.24"S	64°46'27.99"W
12	22°42'6.42"S	64°46'24.27"W
13	22°41'58.74"S	64°46'22.85"W
14	22°41'50.55"S	64°46'21.01"W
15	22°41'46.40"S	64°46'18.20"W
16	22°43'5.21"S	64°46'43.84"W
17	22°43'6.17"S	64°46'49.66"W
18	22°43'7.13"S	64°46'54.97"W
19	22°43'7.20"S	64°47'0.34"W
20	22°43'11.53"S	64°47'3.70"W
21	22°43'13.13"S	64°47'12.98"W
22	22°43'15.17"S	64°47'20.07"W
23	22°43'18.96"S	64°47'24.92"W
24	22°42'8.94"S	64°46'33.05"W
25	22°42'6.52"S	64°46'38.72"W
26	22°42'3.57"S	64°46'43.45"W
27	22°42'1.90"S	64°46'48.75"W
28	22°41'57.66"S	64°46'51.92"W
29	22°41'53.15"S	64°46'53.77"W
30	22°41'50.55"S	64°46'46.96"W
31	22°34'39.82"S	64°46'40.91"W
32	22°34'36.42"S	64°46'45.27"W
33	22°34'30.53"S	64°46'45.78"W
34	22°34'29.70"S	64°46'51.25"W
35	22°34'26.24"S	64°46'55.11"W
36	22°34'21.13"S	64°46'57.09"W
37	22°34'19.11"S	64°47'1.08"W
38	22°34'29.52"S	64°46'59.15"W
39	22°34'34.13"S	64°47'2.80"W
40	22°34'36.12"S	64°47'9.63"W
41	22°34'40.04"S	64°47'15.12"W
42	22°34'43.59"S	64°47'19.72"W
43	22°34'46.98"S	64°47'23.56"W

44	22°34'50.98"S	64°47'28.19"W
45	22°34'55.98"S	64°47'28.68"W
46	22°34'58.12"S	64°47'33.93"W
47	22°34'57.85"S	64°47'41.06"W
48	22°34'36.36"S	64°46'35.56"W
49	22°34'38.14"S	64°46'29.47"W
50	22°34'43.23"S	64°46'29.14"W
51	22°34'47.70"S	64°46'25.25"W
52	22°34'53.86"S	64°46'25.19"W
53	22°34'58.02"S	64°46'28.02"W
54	22°35'2.53"S	64°46'30.10"W
55	22°35'5.76"S	64°46'34.15"W
56	22°35'47.97"S	64°45'32.06"W
57	22°35'53.91"S	64°45'33.10"W
58	22°36'1.51"S	64°45'23.86"W
59	22°36'17.10"S	64°45'12.79"W
60	22°36'22.29"S	64°45'13.35"W
61	22°36'27.14"S	64°45'12.55"W
62	22°36'26.55"S	64°45'20.97"W
63	22°36'31.32"S	64°45'22.35"W

