BALDUINIA
Núcleo de Estudos Botânicos
Balduíno Rambo
ISSN 1808-2688 (impresso)
ISSN 2358-1980 (online)

BALDUINIA, ano XX, nº 73: 29-37. 2024.
Publicado em 30 de setembro de 2024.
DOI: 10.5902/2358198089232

New biodiversity index for anthropized and natural areas

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Abstract. New biodiversity index for anthropized and natural areas

The Earth suffers increasing pressures that modify the composition of habitats and globalization fragments its ecosystems while introducing species from diverse places. The result is the emergence of increasingly monolithic environments and increased entropy because foreign species can displace natural biodiversity. To estimate the biodiversity of ecosystems, an error is made if exotic species are excluded and an error is also made if they are included in the calculation as if they were natural. To solve the problem, the methodology consisted of deducing the Natural Biodiversity Index (NB'). The results demonstrate that NB' detected the urban-rural gradient. The NB' is projected as an indicator applicable in populations of different organisms, easy to calculate and interpretable and translatable into a probabilistic discourse. Furthermore, the NB' index could be a complement to human development indices that want to relativize industrial development and evaluate the pressure exerted by the most advanced human societies on the degradation of their ecosystems.

Keywords: anthropization, gradient, probability, natural biodiversity.

Resumo. Novo índice de biodiversidade para áreas naturais e antropizadas

A Terra sofre pressões crescentes que modificam a composição dos habitats e a globalização fragmenta os seus ecossistemas ao mesmo tempo que introduz espécies de diversos locais. O resultado é o surgimento de ambientes cada vez mais monolíticos e o aumento da entropia porque as espécies introduzidas podem deslocar a biodiversidade natural. Para estimar a biodiversidade dos ecossistemas, comete-se um erro se forem excluídas espécies exóticas e também se comete um erro se estas forem incluídas no cálculo como se fossem naturais. Para solucionar o problema, a metodologia consistiu na dedução do Índice de Biodiversidade Natural (NB'). Os resultados demonstram que o NB' detectou o gradiente urbano-rural. O NB' é projetado como um indicador aplicável em populações de diferentes organismos, fácil de calcular e interpretável e traduzível em um discurso probabilístico. Além disso, o índice NB' poderia ser um complemento aos índices de desenvolvimento humano que pretendem relativizar o desenvolvimento industrial e avaliar a pressão exercida pelas sociedades humanas mais avançadas sobre a degradação dos seus ecossistemas.

Palavras-chave: antropização, gradiente, probabilidade, biodiversidade natural.

Starting in the 20th century and so far in the 21st century, our planet receives increasing disturbances. Ecosystems are not immune to the consequences that modify the original patterns and alter the composition of the diversity of habitats. Globalization processes are the bridge that allows the introduction of new species that come from distant areas and favor homogeneity in ecosystems. From a physical environmental point of view, the fragmentation of ecosystems increases entropy and ignorance of the previous temporal state that local biodiversity had.

One of the predominant topics in urban ecology has been the study of the effects of urbanization on biodiversity (McPhearson *et al*. 2016). In cities there are strategic corridors that facilitate the connectivity and transit of fauna, the source of food, the refuge and rest of different species (CBIMA 2021), however the continuous opening of natural areas imposes new conditions for birds (Leveau & Leveau 2004). Birds are sensitive indicators of environmental changes and their study is essential for the conservation of nature. Through their observation and monitoring it is possible

Accepted on August 19, 2024.
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to understand the complexity of life on Earth. The inventory and monitoring of birds in cities is a tool that allows generating management and biological conservation strategies (Ortega *et al*. 2015; Ramírez *et al*. 2016) because it facilitates understanding of the factors that generate pressure and impacts for periods prolonged (Lindenmayer *et al*. 2012). The key to monitoring is identifying the intensity of the changes, their direction, their extent and their trend (Hellawel 1991; Thompson *et al*. 1998).

Counting birds in cities is challenging because traditional methods suitable in other habitats are restricted by urban buildings and social factors such as land ownership (Van Heezik & Seddon, 2017). In this sense, the cities of Rivera (Uruguay) and Sant' Ana do Livramento (Brazil) make up an urbanized nucleus of almost 200 thousand people located in the southeast of South America. There, both cities are merged and the birdlife does not respond to political limits, but on the contrary, they share the same urban ecosystem. Uruguay has a high wealth of birds in relation to its territorial area, in this small country nearly 450 species have been recorded, to the point that in the language the native name of Uruguay refers to a river of painted birds. According to Azpiroz & Menéndez (2008), the Uruguayan birdlife contains species from the fields, the Chaco region and the Atlantic Forest, as well as migrant birds from different parts of America. Although no species is limited exclusively to the political boundaries of Uruguay, the country is home to regional endemic species, such as: *Limnoctites rectirostris*, *Sporophila cinnamomea*, *S. palustris and S. zelichi* (Arballo & Cravino 1999; Azpiroz, 2003; Azpiroz *et al*. 2012). However, at the same time there are several species of threatened birds such as: *Rhea americana, Tryngites subrufi collis, Limnoctites rectirostris, Xolmis dominicanus, Sporophila ssp. Gubernatrix cristata* and *Sturnella defilippii* (Azpiroz 2003).

To evaluate biodiversity there are several quantitative indices. The goodness of these indicators lies in considering the richness of species, recognizing the abundance of individuals, considering the balance between species, being applicable to different ecosystems and also being adaptable to diverse populations of animals and plants. As additional characteristics, an ideal index should also address the origin of species in ecosystems, discriminating whether they are native or natural species of the place or, on the contrary, foreign or introduced. In addition to the above, an index must be easy to interpret probabilistically and therefore translate into a spoken text. Among the indices that house almost all of the above properties is the Simpson biodiversity index. However, this index does not discriminate between native and introduced diversity and does not consider the degree of entropy and anthropogenic actions that introduced foreign species and that displaced native species in a disturbing manner. An error would be made if in the ecosystem in question there was evidence of individuals of exotic species, because this would report the probability of a natural diversity that is not such. In short, it is a mistake not to include exotic species when calculating a biodiversity index and it is also a mistake to include them in the calculation as if they were native.

Therefore, to avoid the aforementioned drawback, the need to evaluate the degree of entropy and ignorance of the original ecosystems using a probability index is justified. That is why the purpose of this research is to generate a biological index that includes the desirable qualities already mentioned. As a specific objective, it is proposed to evaluate the goodness of the index deduced through its application in the birdlife of the urban center of Rivera (Uruguay) and Sant'Ana do Livramento (Brazil).

Materials and Methods

To include and discriminate exotic species and native species, an index was developed that answered the following question: when choosing two individuals at random from an ecosystem? What is the probability that they are from two different native species? As an example, suppose that a field plot was composed of 21 individuals of which six individuals are of one native species (na), five of another native species (nb) and four of a third native species (nc). Furthermore, in the same plot, suppose there are three individuals of one exotic species (ea), two of another exotic species (eb), and one individual of a third exotic species (ec). The above could be represented according to table 1, where the native species are shown in primary colors (blue, red and yellow) and the exotic species in secondary colors (green, orange and violet). Consistent with the above, for this hypothetical plot the translated question is the following: what is the probability that when two individuals are extracted they will be blue-red, blue-yellow, red-blue, red-yellow, yellow-blue? or yellow-red?

Table 1. Exemplification of a hypothetical field plot and calculation of natural biodiversity (NB').

Individuals
Species
(total=21)

6					
Na	**5**				
Na	**Nb**	**4**			
Na	**Nb**	**Nc**	**3**		
Na	**Nb**	**Nc**	**Ea**	**2**	
Na	**Nb**	**Nc**	**Ea**	**Eb**	**1**
Na	**Nb**	**Nc**	**Ea**	**Eb**	**Ec**

Species: native (N), exotic (E)

1st. Extraction (1/21)	**2nd. Extraction (1/20)**	**Favorable, cases**	**Total, cases**
na (6)	**nb (5)**	6*5=30	21*20=**420**
na (6)	**nc (4)**	6*4=24	
nb (5)	**na (6)**	5*6=30	
nb (5)	**nc (4)**	5*4=20	
nc (4)	**na (6)**	4*6=24	
nc (4)	**nb (5)**	4*5=20	

Total, favorable case **148** **Probability: (148/420)** **NB' = 0,352**

NB´= 2*[(n1).(n2)+(n1).(n3)+ . . . (n1).(nn) + (n2).(n3)+(n2).(n4)+. . . (n2).(nn)+ . . . (nn-1).(nn)]/N.(N-1)

NB´= 2*[(6).(5)+(6).(4)+ (5).(4)]/21.(20) = 148/420= **0,352**

In classical probability, the possibilities are estimated by calculating the favorable cases over the total number of cases. To answer the initial question, when carrying out two extractions without replacement in the hypothetical plot, one possibility is that the individual in the first extraction was from the native species (na) (blue) and the second from the native species (nb) (red). In these two extractions, six are favorable cases for blue and five for red, according to the product rule for independent events there would be 30 favorable cases (6*5). Also by the product rule, the total number of cases amounts to the value of 420 (21*20), because in the first extraction there are 21 total individuals in the plot, counting natives and exotics, and in the second extraction there are 20 individuals among natives and exotic. Another way to obtain favorable cases would be to obtain native species (na) (blue) in the first extraction and native species (nc) (yellow) in the second extraction, which would be 6*4 (24) additional favorable cases. However, the count of favorable cases continues successively because we could obtain an individual of the native species (nb) (red) in the first extraction and an individual of the native species (na) (blue) in the second, which would be 30 additional favorable cases and so on where the products would be twice. If we continue with our calculations for this example, the value of the Natural Biodiversity Index (NB') would be 148 favorable cases and 420 total cases, which would report a probability of 0.352.

Since all individual counts must be performed, the generalization of equation one (1) is necessary:

$$NB' = \frac{\sum_{i=1}^{i=n} (n_i).(n_i)^c}{N.(N-1)}$$ Equação 1

where: (i), are the native species in the evaluated plot, from the first to the nth native species found
(ni), is total individuals of the native species (i) that is being evaluated
$(ni)^c$, is total individuals of all native species complement of the species (i)
N is the total number of individuals of all species (native and exotic)

$$\sum(ni)*(ni)c = [(na).(nb)]*2 + [(na).(nc)]*2 + [(na).(nd)]*2 + \ldots [(na).(nz)]*2 + [(nb).(nc)]*2 + [(nb).(nd)]*2 + \ldots [(na).(nz)]*2 + [(nc).(nd)]*2 + \ldots [(nc).(nz)]*2 + [(nd).(nz)]*2$$

It is possible to take the value two (2) as a common factor, then the numerator expression becomes:

$$\sum(n_i)*(n_i)^c=2*[(na).(nb)+(na).(nc)+(na).(nd)+(na).(nz)+(nb).(nc)+(nb).(nd)+(na).(nz)+(nc).(nd)+(nc).(nz)+(nd).(nz)]$$

Generalizing the previous expression, if there were (n) native species we would have the simplified numerator as follows:

$$\sum(n_i)*(n_i)^c = 2*[(n_1).(n_2)+(n_1).(n_3)+(n_1).(n_4)+ \ldots + (n_1).(n_n) \\ (n_2).(n_3)+(n_2).(n_4)+(n_2).(n_5)+ \ldots + (n_2).(n_n) \\ (n_3).(n_4)+(n_3).(n_5)+(n_3).(n_6)+ \ldots + (n_3).(n_n) \\ \vdots \\ \ldots + (n_{n-1}).(n_n)$$

where: (ni), is the total number of individuals of the native species (i)

Finally, the natural biodiversity index (NB') can be obtained from equation two (2) which facilitates the calculation of the final value:

$$NB' = \frac{2*[(n1).(n2)+(n1).(n3)+ \ldots(n1).(nn) + (n2).(n3)+(n2).(n4)+\ldots(n2).(nn)+ \ldots(nn-1).(nn)]}{N.(N-1)}$$

Equação 2

where:
n1, n2, n3, . . . nn; are the total number of individuals of each native species (i) present in the evaluated plot
(N), is the total number of individuals in the plot (exotic and native)

The answer to the original question reports a natural biodiversity in which "there is a 35,2% chance that when two individuals are extracted they will be of different native species." The probability value sought is equal to 0,352, this value includes richness, abundance, equitability, species origin and can be applied to real ecosystem plots. At the same time, if the ecosystem did not have exotic individuals, the index would behave without difficulties because its value would increase, given that the denominator would decrease due to the departure of the exotic species. Now the denominator would be 15*14, that is, 210 cases in total. In this scenario, a probability of 0,701 is obtained, that is, "70% probability that in two successive extractions the individuals are from two different native species." The dominance complement is also valid, that is: "there is a 30% probability that in two successive extractions the individuals will be of the same native species."

Birds are highly sensitive to environmental changes and are excellent biological indicators in urban ecosystems (CBIMA 2021). To apply to the NB' field, 43 random urban plots were established in four strata increasingly further away from the reference urban center. In the Uruguay-Brazil International Park of the cities of Rivera and Sant'Ana do Livramento, the first plot located at the origin of the urbanization at zero distance (0) was established. The two merged cities were considered a single urbanization nucleus. The plots located at a distance between 0 and 2000 meters from the International Park formed stratum I. Stratum II was formed with plots located more than 2000 m and up to 4000 m. Stratum III was made up of plots located at more than 4000 m and up to 6000 m. Finally, stratum IV was formed with plots located at a distance greater than 6000 m from the urban center and less than or equal to 8000 m. The variables collected in the plots were: geographical coordinates, distance to the center of the urbanization (m), species of birds found, number of individuals recorded and origin of the species detected. In the plots, the observer counted birds while slowly walking along a 50-meter linear path for 20 minutes (MacGregor-Fors et al. 2010). The plots were established through random walks coinciding with urban squares, gardens, tree-lined streets or vacant lots.

Field sheets and binoculars were used for the study (Ortega et al. 2012). Birds were determined by direct visualization and acoustic recognition of songs (Fuller et al. 2012). Censuses were carried out in the first three hours of the morning when the birds were most active. The study included the austral seasons of autumn, winter and spring as it extended from April to October 2023. To support recognition, species recognition manuals (Ralph et al, 1996) and two observers were used to achieve greater detection. The coordinates of the plots were determined using GPS (Global Positioning System).

After the field survey, the information was processed. The coordinates of the plots were entered into the Google Maps program. Within this program, the distances of all bird and tree plots to the center of origin of the urban center (International Park) were measured. All the information was included in a Microsoft Excel matrix, where the bird species were grouped by order, family and origin [native (n) and exotic (e)]. The Natural Biodiversity Index (NB') was calculated for each plot. The Curve Expert program was used to obtain the Natural Biodiversity (NB') model that best fits depending on the distance to the urbanization.

Results

In this research it was possible to detect 68 species (66 native and 2 exotic) belonging to 17 orders and 31 families. The pigeon species detected were: Columba livia, Columbina picui, Patagioenas picazuro and Zenaida auriculata. Of the above, only C. livia is an introduced species, the other exotic species detected is Passer domesticus (Appendix).

The Natural Biodiversity Index (NB') showed a value in the range 0.1-0.2 in the plots closest to the center of the urbanization, until converging on a value close to 0.85 at an approximate distance of 8 km. At this distance is the limit with rural environments. The correlation between the distance to the urban center and the NB' is 0.93 and the coefficient of determination was 0.87. The results show that as the distance to the center of the urbanization increases, the probability also increases that when choosing two individuals at random they belong to different and native species. The possibilities reach 85% (Figure 1).

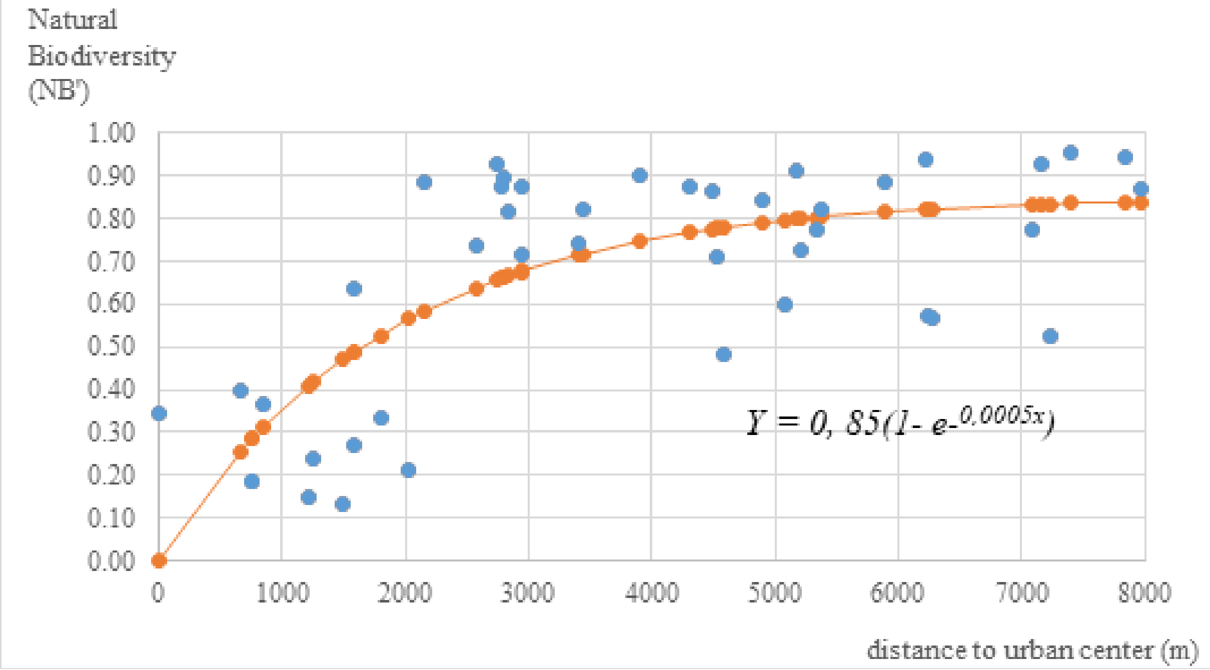

Figure 1. Regression between the distance to the center of the Rivera (Uy)-Sant'Ana do Livramento (Br) urbanization and the Natural Biodiversity Index of the NB´.

Discussion

In the core of the urban area, the introduced species *Columba livia* appears in large proportions, generally nesting on church facades and other horizontal surfaces that have exposed cavities. This species together with *Passer domesticus* make up the avifauna of exotic species. Both adapt to urban environments, choosing places where they are commonly fed by people. The data coincide with Nolazco (2012), who determined that the Columbidae family has great adaptation in urban green areas by feeding on grains and seeds that can be easily found. They are also opportunists that adapt to disturbed areas with reduced forest cover.

The Natural Biodiversity Index (NB') appropriately evaluates the entropy and degradation of the most urbanized ecosystems that host less diversity and in turn a greater probability of finding the two foreign species C. livia and P. domesticus. The results obtained confirm changes in species richness along the urban gradient (Ordóñez-Delgado et al. 2022).

Vegetation cover, understood as the number of trees and shrubs, is positively correlated with the richness and diversity of birds and with the proximity of large forested areas (Melles et al. 2003; Filloy et al. 2019). Urban growth affects the composition of bird species, reducing diversity and increasing the abundance of some generalist species (Nolazco 2012). Trees provide food and provide a place of rest and shelter, in addition to serving for the construction of nests and the reproduction of species (Clares 2017).

In urban areas, vegetation and buildings can provide nesting sites for birds (Tomasevic and Marzluff 2017). However, species diversity has been shown to be lower along the urban-rural gradient (McKinney 2002). Furthermore, in urban environments the supply of insects for birds is lower, which partly explains the lower reproductive success of insectivorous birds and the smaller size of chicks (Seress et al. 2018; de Satgé et al. 2019). Urbanization significantly influences the nesting period of birds, the nesting location and the selection of nesting material. Likewise, spatio-temporal nesting ranges differ between urban and rural birds (Fangyuan 2021). Added to the above, along an urbanization gradient the proportion of frugivorous and omnivorous species increases and the proportion of insectivorous species decreases (Kale et al. 2018).

Conclusions

The diversity patterns found indicate that we should not reject the hypothesis implicit in this study that proposes the existence of greater native biodiversity as the distance to the center of origin of urbanization increases.

The natural biodiversity index (NB') perceives the disturbance in disturbed ecosystems. Its value increases considerably over a small distance of approximately eight kilometers, thus highlighting the growing biodiversity associated with the gradient that goes from a completely urbanized core to an almost rural area.

The index is easy to calculate and applicable in both urban and completely natural environments. It is also interpretable in the sense that numerical value can be explained with a discourse of probabilistic meaning and mathematical hope. In this sense, it implies a more sensitive indicator than the Simpson index, which does not discriminate between native and introduced biodiversity.

For perspective, the index would also be applicable in botanical studies that attempt to assess plant diversity. This means that it could be extended to ecological studies that assess the entropy of ecosystems in an increasingly degraded biosphere. Furthermore, it could also be included as a complement to assess the pressure that human societies exert on ecosystems. Based on the above, the proposed index would serve to complement the human development indices and the ranking of countries, as those countries with a lot of industrial development could be relativized in their ranking if their diversity estimated by (NB') was not so natural.

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Appendix. List of birdlife in the Rivera (Uy)-Sant'Ana do Livramento (Br) urbanization, by order, family, scientific name, common names, stratum and number of individuals detected per species.

Order	Family	Scientist Name	Spanish Name	Portuguese Name	Stratum	Plots detected
Accipitriformes	Accipitridae	*Busarellus nigricollis*	Águila Pampa	Gavião-belo	II	1
		Buteogallus urubitinga	Águila Negra	Águia Preta	II	1
		Rupornis magnirostris	Taguató Común	Balança-rabo-de-máscara	IV	1
Anseriformes	Anatidae	*Anas geórgica*	Pato maicero	Marreca-parda	IV	1
		Dendrocygna Viduata	Pato cara blanca	Irerê	II	1
Apodiformes	Trochilidae	*Chlorostilbon lucidus*	Picaflor Común	Besourinho-de-bico-vermelho	I, III,IV	4
		Hylocharis chrysura	Picaflor Bronceado	Beija-flor-dourado	I,II	2
Cathartiformes	Cathartidae	*Cathartes aura*	Jote Cabeza Colorada	Urubu-de-cabeça-vermelha	I, II. III, IV	6
Charadriiformes	Charadriidae	*Vanellus chilensis*	Tero Común	Quero-quero	I, II. III, IV	23
	Jacanidae	*Jacana jacana*	Gallareta	Jaçanã	IV	1
Columbiformes	Columbidae	*Columba livia*	Paloma Doméstica	Pombo-doméstico	I,II,IV	13
		Columbina picui	Palomita de la virgen	Rolinha-pé-de-anjo	I,II,III,IV	23
		Patagioenas picazuro	Paloma de monte	Pomba-asa-branca	I,II,III,IV	27
		Zenaida auriculata	Torcaza Común	Pomba-de-bando	I,II,IV	8
Coraciiformes	Alcedinidae	*Alcedo atthis*	Martin Pescador	Martim-pescador	II,III	2
Cuculiformes	Cuculidae	*Guira guira*	Pirincho	Anu-branco	I,II,III,IV	13
Falconiformes	Falconidae	*Caracara plancus*	Carancho	Carcará	I,II, III	3
		Falco sparverius	Halconcito Colorado	Quiriquiri	III,IV	3
		Milvago chimachima	Chimachima	Carrapateiro	II, III,IV	4
		Phalcoboenus chimango	Chimango	Chimango	II	1
Galliformes	Cracidae	*Penelope obscura*	Pava de monte	Jacú	II, III, IV	3
Gruiformes	Rallidae	*Aramides ypecaha*	Gallineta	Ipacaá	II, III, IV	8
		Gallinula melanops	Polla Pintada	Galinha d'agua	II	1
Passeriformes	Cardinalidae	*Cyanocompsa brissonii*	Reina mora	Azulão verdadeiro	II,III,IV	3
	Corvidae	*Cyanocarz chrysops*	Urraca común	Gralha	III	1
	Emberezidae	*Paroaria coronata*	Cardenal copete rojo	Cardeal	I, II, III, IV	9
		Sicalis flaveola	Dorado	Canário-da-terra-verdadeiro	I, II, III, IV	9
		Sicalis luteola	Misto	Tipio	III, IV	2
		Sporoshila caerulescens	Gargantillo	Coleirinho	IV	1
		Zonotrichia capensis	Chingolo	Tico-tico	I, II, III	3
	Fringillidae	*Carduelis magellanica*	Jilguero	Pintassilgo	I,II,III,IV	10
	Furnariidae	*Asthenes pyrrholeuca*	Coludo	Menino canastero	II	1
		Cinclodes fuscus	Remolinera Común	Corruira	IV	1
		Furnarius rufus	Hornero	João-de-barro	I,II,III,IV	38
		Phacellodomus striaticollis	Espinero Pecho Manchado	Tio-tio	IV	2
	Hirundinidae	*Progne tapera*	Golondrina Parda	Andorinha-do-campo	IV	1
		Pygochelidon cyanoleuca	Golondrina Barranquera	Andorinha-pequena-de-casa	I,II,III,IV	9
	Icteridade	*Agelaioides badius*	Tordo Músico	Avoante	I,II,III,IV	5
		Agelasticus thilius	Alferez	Sargento	IV	1
		Molothrus bonariensis	Tordo Renegrido	Asa-de-telha	I,II,III,IV	6
	Mimidae	*Mimus saturninus*	Calandria	Sabiá-do-campo	I,II,III,IV	13
	Passeridae	*Passer domesticus*	Gorrión Común	Pardal	I,II,III,IV	19
	Thraupidae	*Embernagra platensis*	Verderón	Verdelhão	IV	1
		Stephanophorus diadematus	Cardenal azul	Sanhaço-frade	III	1
		Tangara sayaca	*Celestino Común*	Sanhaço-cinzento	II,III	2

	Troglodytidae	*Troglodytes aedon*	Ratonera	Corruíra	I, II, III, IV	10
	Turdidae	*Turdus rufiventris*	Zorzal Colorado	Sabiá-laranjeira	I, II, III, IV	17
	Tyrannidae	*Machetornis rixosa*	Picabuey	Suiriri-cavaleiro	II,III,IV	5
		Pitangus sulphuratus	Benteveo comum	Bem-te-vi	I, II, III, IV	39
		Pyrocephalus rubinus	Churrinche	Bola de fuego	III	1
		Serpophaga nigricans	Piojito Gris	João-pobre	I	1
		Suirií suirirí	Suirií común	Suiriri	I	1
		Tyrannus melancholicus	Suirirí Real	Siriri comum	II,III,IV	3
		Tyranus savana	Tijereta	Tesourinha	III, IV	5
		Xolmis irupero	Monjita Blanca	Noivinha	II, IV	3
Pelecaniformes	Ardeidae	*Ardea alba*	Garza Blanca	Garça-branca-grande	II,III,IV	4
		Botaurus pinnatus	Avetoro Mirasol	Socó-boi-baio	II,III, IV	4
	Threskiornithidae	*Harpiprion caerulescens*	Bandurria mora	Maçarico real	III	1
		Phimosus infuscatus	Cuervillo Cara Pelada	Tapicuru-de-cara-pelada	II,III	4
		Theristicus caerulescens	Bandurria Mora	Maçarico-real	III,IV	2
		Theristicus caudatus	Bandurria común	Maçarico-real	I, II, III, IV	4
Piciformes	Picidae	*Colaptes campestris*	Carpintero Campestre	Pica-pau-do-campo	II,III	6
		Colaptes melanolaimus	Carpintero Real Común	Pica-Pau-Carijó	II,III,IV	5
		Veniliornis mixtus	Carpintero Bataraz Chico	Pica-pau-chorão	II	1
Psittaciformes	Psittacidae	*Cyanoliseus patagonus*	Loro barranquero	Periquito-das-barreiras	IV	1
		Myiopsitta monachus	Cotorra	Caturrita	I, II, III, IV	16
Strigiformes	Tytonidae	*Tyto furcata tuidara*	Lechuza de Campanario	Coruja branca	III,IV	2
Struthioniformes	Tinamidae	*Nothura maculosa*	Perdiz	Codorna-amarela	II,III,IV	3