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Traditional knowledge and perception of birds in the Parnaíba Delta environmental protection area, Northeast Brazil

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ABSTRACT. Local inhabitants retain a vast knowledge about the bird richness surrounding them, as well as many of their ethological and ecological aspects, and can identify the importance of those birds to the maintenance of ecosystem integrity. The present study sought to document the traditional knowledge retained by members of the Labino community concerning the avifauna of the Delta do Rio Parnaíba Environmental Protection Area (APA), Piauí State, Brazil. We interviewed 76 male (51% of the sample) and 74 female (49%) residents. The interviewees indicated the occurrence of 97 bird species belonging to 21 orders and 40 families. Men could identify more bird species than women. Older individuals recognize more bird species than younger members of the community. Individuals with less schooling demonstrated greater knowledge of species richness than those with more formal educations. A very significant percentage (45%, n = 68) of the interviewees reported consuming native birds, principally *Aramides cajaneus*, *Columbina squammata*, and *Zenaida auriculata*. A total of 48 species were perceived as having their populations reduced in recent years, principally *Mimus gilvus*, *Icterus jamacaii*, *Aramides cajaneus*, *Turdus rufiventris*, and *Cacicus cela*. The residents of the Labino community were therefore found to have a detailed knowledge of the local avifauna and perceived impacts caused mainly by hunting in the Parnaiba River Delta region.

Keywords: Avifauna; Hunting; Conservation; Labino community.

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Introduction

Traditional knowledge is defined as that collection of knowledge and know-how concerned with natural and supernatural realms that is orally transmitted from generation to generation in traditional societies (Diegues, 2000). The preservation, recovery, and recognition of the importance of traditional knowledge can reinforce positive relationships between the inhabitants of an area and their environment, and can form the basis for fomenting activities directed towards its conservation and conscientious use, including ecotourism and bird watching (Chiwanga & Mkiramweni, 2019).

Humans have developed an incredibly diverse repertoire of interactions with birds dating back to remote times (Duncan, Blackburn, & Worthy, 2002), and birds can likewise be encountered cohabiting with human societies throughout the world (Sodhi, Şekercioğlu, Barlow, & Robinson, 2011). In that light, it is not surprising that local inhabitants detain a vast knowledge of the birds that surround them, including species richness and many other ethological and ecological aspects, and understand the enormous importance of those animals to the equilibrium and integrity of the environment they share (Alves, Leite, Souto, Bezerra, & Loures-Ribeiro, 2013).

An approximation with local inhabitants based on those aspects could aid in efficiently passing concepts linked to ecological conservation and realigning some of their cultural and daily practices, with the least interference possible, and help coordinate practical actions. Those subtle course alterations could presumably be attempted while simultaneously evaluating populations of the local fauna and observing the effects of human pressure on them (including subsistence hunting or the protection of cultivated areas), while simultaneously stimulating community participation in species conservation activities (Santos, 2019).

As such, our efforts to examine traditional knowledge combined cognitive and linguistic anthropological

factors through a scientific approach that sought to interpret folk knowledge concerning the use of the regional avifauna (Tidemann & Gosler, 2011). Variations of that folk knowledge must also be considered, as traditional knowledge may vary, even within the same community, according to the age or income of individuals and/or the frequencies and manners in which they utilize or come into contact with those animals (Gichuki & Terer, 2001; Nobrega, Barbosa, & Alves, 2011). Wild birds represent one of the principal hunting/food resources in northeastern Brazil, principally due to their great diversity and the absence of large mammals (Alves, Gonçalves, & Vieira, 2012).

The present study sought to document the traditional knowledge retained by members of the Labino community concerning the avifauna of the Delta do Rio Parnaíba Environmental Protection Area (APA), Piauí State, Brazil, and test the research hypothesis that folk knowledge of the local avifauna is influenced by socio-economic factors such as gender, age, schooling, and time of residence.

Material and methods

Study area

The Labino community is located in the municipality of Ilha Grande in Piauí State (PI), and is separated from the municipality of Parnaíba (2°51'02" S and 41°46'26" W) by the PI-116 state highway. The municipality of Ilha Grande had a population (in 2015) of approximately 9211 (Institudo Brasileiro de Geografia Estatística [IBGE], 2015), and the local Residents Association indicated that the Labino community is composed of 200 families and approximately 400 residents. The community is located within the Parnaiba Delta Environmental Protection Area (APA) – created by Federal Decree no. 99.274 on August 28, 1996; the APA comprises the entire coastline of Piauí State, as well as parts of the states of Maranhão and Ceara (Figure 1). The Parnaíba Delta APA was created to protect the mouths of the Ubatuba, Timonha, and Parnaíba rivers, improve the quality of life of resident populations by orienting and disciplining local economic activities, foment ecological tourism and environmental education, and preserve local cultures and traditions (Vieira & Loiola, 2014). The regional climate is type Aw by the Koppen classification system, with a rainy season from January to June and a dry season from July through December (Bastos, Andrade Junior, & Rodrigues, 2011). The vegetation is typical regional "restinga", composed of a mosaic of three basic vegetation formations: open field (campestre), shrub, and arboreal (Santos-Filho, Almeida Jr, Soares, & Zickel, 2010).

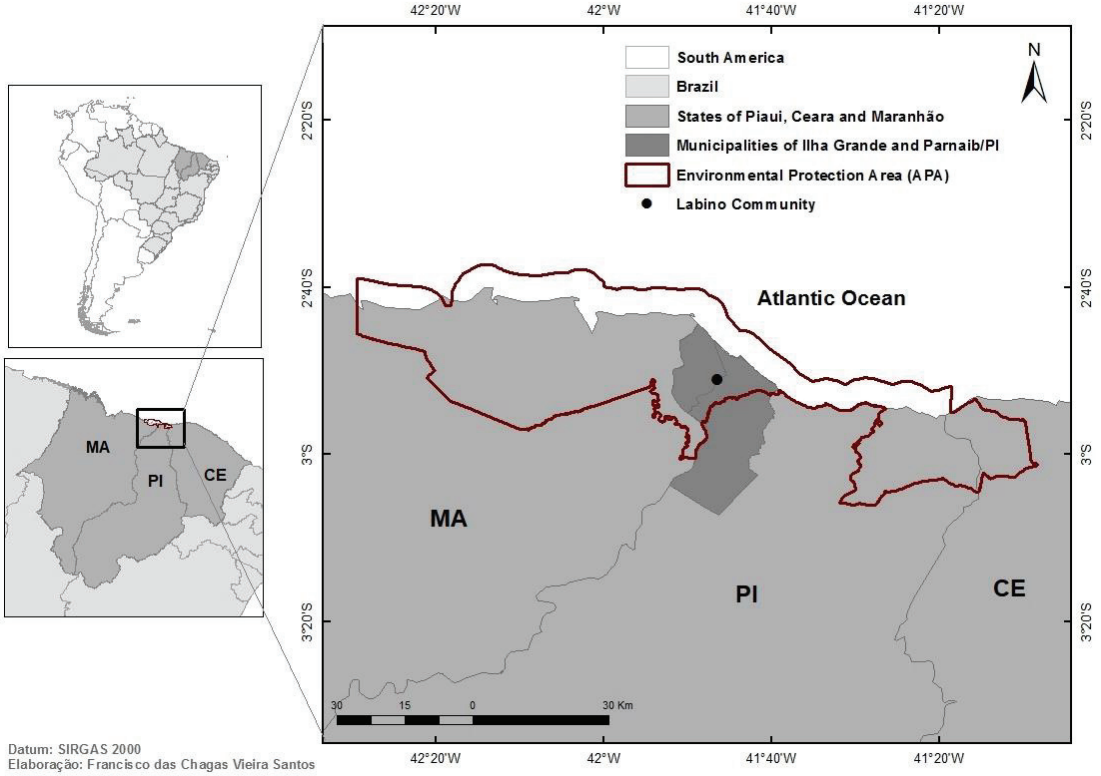

Figure 1. Location of the study area - Labino community between the Municipalities of Ilha Grande and Parnaíba , PI, Brazil.

Data collection and analysis

Data were collected during the period between November/2015 and January/2016. Similar to other ethnozoological studies (Alves et al., 2013; Alves & Souto, 2015; Van Den Bergh, Kusters, & Dietz, 2013), the investigations were undertaken using semi-structured questionnaires that included questions concerning: the socio-economic lives of the interviewees; their perceptions of the importance of the local avifauna, and the identification of local species.

One hundred and fifty local residents were interviewed, representing 37.5% of the focal population; the selection criteria was individuals older than 18. The sampling error was calculated to be 5%, with a 95% confidence interval (Bernard, 1988). To avoid biasing the information solicited (Albuquerque, Cunha, Lucena, & Alves, 2014), all of the interviews were held individually. Before each interview, the interviewees were asked to sign a Consent Form (TCLE) indicating their understanding of the project and free choice in participating. The present study was approved by the Research with Humans Ethics Committee of the *Universidade Federal do Piauí* – Campus Parnaíba (registry number 1.323.297).

Species identifications

The birds mentioned by the interviewees were identified to the species level using a field guide (Ridgely & Tudor, 1994; Sigrist, 2009). The taxonomic names are according to the determinations of the Brazilian Committee of Ornithological Registration for Birds (CBRO) (Piacentini et al., 2015); vernacular names follow, as provided by members of the community investigated.

The data were organized into digital archives (MS EXCEL© 2016) and the graphs were prepared at high resolution (300 dpi) with the aid of the DANIEL's XL TOOLBOX, version 6.60 add-on open source tool (Kraus, 2014). The data were analyzed using univariate statistics to verify the existence of influences by socioeconomic factors on local ethno-ornithological knowledge. Statistical analyses were performed using SPSS© version 23 software (IBM© Corp., 2014), consistently using a significance level of 5% ($p < 0.05$).

Results and discussion

Socioeconomic aspects

The sample population was composed of 150 interviewees (51% men [n = 76] and 49% women [n = 74]); their ages varied from 18 to 87. In general, participant schooling levels were quite low, with 11.33% (n = 17) being illiterate while 40.67% did not complete grammar school. Family incomes in the Labino community varied between 1 and 4 minimum wages (the Brazilian minimum wage in May 2016 was ~ USD $248), but most of the informants (n=92; 61%) earned approximately 1 to 2 minimum wages. The municipality of Ilha Grande had a mean human development index (MHDI) of 0.563 in 2010. The gap between the MHDI of the municipality and the maximum value of that index (1.0) was reduced by 73.45% between 2000 and 2010 (Brasil, 2013). The socioeconomic data of the interviewees are summarized in Table 1.

Traditionally, wildlife is valued beyond its economic and simple utilitarian importance when cultural factors associated with their use are considered. On the other hand, there are aspects more directly anthropocentric and utilitarian when birds are recognized as resources to be used for an individual's own benefit (Costa-Neto, Santos Fita, & Clavijo, 2007). In that sense, social, economic, and cultural factors play an important role in how individuals and communities use those natural resources, leading to a very widely discussed conflict: development versus species preservation (Nobrega et al., 2011).

Local knowledge of the avifauna and social aspects

The Parnaíba Delta has a rich and diversified avifauna, as 97 bird species were cited by the interviewees (individual mean of 8.8 ± 4.87 s.e. [standard error]) from the Labino community in the municipality of Ilha Grande/PI. The birds recognized by the interviewees belonged to 85 genera, 40 families, and 21 orders (Table 2). Although traditional knowledge can often be informative in terms of new species (Cozzuol et al., 2013), all of the species mentioned in the ethno-ornithological survey had been previously recorded in earlier scientific surveys (Guzzi et al., 2015); it is impressive, however, that approximately 60% of the birds recorded in scientific surveys (of a total of 161 species) are recognized on a day-to-day basis by members of the Labino community.

Table 1. Socio economic profile of community interviewees Labino municipality of Ilha Grande, Piauí State, Brazil.

Profile	*n*	%
Gender		
Female	74	49%
Male	76	51%
Age		
Less than 30 years old	45	30%
30 - 39	28	19%
40 - 49	28	19%
50 - 59	23	15%
60 or older	19	13%
Not mentioned	7	5%
Residence time in the community		
< 5 years	9	6%
5 - 10 years	19	13%
11 - 15 years	12	8%
16 - 20 years	24	16%
21 - 25 years	13	9%
26 - 30 years	18	12%
60 or older	42	28%
Not mentioned	13	9%
Schooling		
Illiterate	17	11%
Elementary school incomplete	48	32%
Elementary school complete	13	9%
Middle school incomplete	17	11%
Middle school complete	46	31%
High school incomplete	2	1%
High school complete	7	5%

Table 2. Classification of wild bird species identified as occurring in the community of Labino, rural area of the Municipality of Ilha Grande (Piauí State, Brazil) according to local informants. Birds used as food [a]; Bird populations reduced over the years [d].

Taxa	Piacentini et al. (2015)	(Informants)	*n*	%
Tinamidae Gray, 1840				
Crypturellus undulatus (Temminck, 1815)	Undulated Tinamou	Jaó	10	7%
Crypturellus parvirostris (Wagler, 1827)	Small-billed Tinamou	Nambú[d]	7	5%
Anatidae Leach, 1820				
Dendrocygna viduata (Linnaeus, 1766)	White-faced Whistling-Duck	Paturi[a d]	12	8%
Anasba hamensis Linnaeus, 1758	White-cheeked Pintail	Marreca[a d]	35	23%
Cracidae Rafinesque, 1815				
Penelope superciliaris Temminck, 1815	Rusty-margined Guan	Jacupemba	4	3%
Ortalis superciliaris (Gray, 1867)	Buff-browed Chachalaca	Aracuã	1	1%
Podicipedidae Bonaparte, 1831				
Tachybaptus dominicus (Linnaeus, 1766)	Least Grebe	Mergulhão-pequeno	6	4%
Podilymbus podiceps (Linnaeus, 1758)	Pied-billed Grebe	Pecapara[d]	3	2%
Phalacrocoracidae Reichenbach, 1849				
Nannopterum brasilianus (Gmelin, 1789)	Neotropic Cormorant	Biguá	1	1%
Ardeidae Leach, 1820				
Tigrisoma lineatum (Boddaert, 1783)	Rufescent Tiger-Heron	Socó[a d]	1	1%
Nyctanassa violacea (Linnaeus, 1758)	Yellow-crowned Night-Heron	Tamatião[a d]	21	14%
Butorides striata (Linnaeus, 1758)	Striated Heron	Socozinho	25	17%
Bubulcus ibis (Linnaeus, 1758)	Cattle Egret	Garça-pequena[a d]	55	37%
Ardea alba Linnaeus, 1758	Cattle Egret	Garça-grande[a d]	5	3%
Egretta caerulea (Linnaeus, 1758)	Little Blue Heron	Garça-parda	3	2%
Threskiornithidae Poche, 1904				
Eudocimus ruber (Linnaeus, 1758)	Scarlet Ibis	Guará	9	6%
Theristicus caudatus (Boddaert, 1783)	Buff-necked Ibis	Curicaca	4	3%
Cathartidae Lafresnaye, 1839				
Cathartes aura (Linnaeus, 1758)	Turkey Vulture	Urubu-de-cabeça-vermelha	3	2%
Cathartes burrovianus Cassin, 1845	Lesser Yellow-headed Vulture	Urubu-de-cabeça-amarela	2	1%
Coragyps atratus (Bechstein, 1793)	Black Vulture	Urubu-de-cabeça-preta [d]	55	37%
Accipitridae Vigors, 1824				
Rostrhamus sociabilis (Vieillot, 1817)	Snai lKite	Gavião-caramujeiro	22	15%
Urubitinga urubitinga (Gmelin, 1788)	Great Black Hawk	Gavião-preto [d]	1	1%
Rupornis magnirostris (Gmelin, 1788)	Roadside Hawk	Gavião-carijó[d]	1	1%

Taxa	Piacentini et al. (2015)	(Informants)	*n*	%
Falconidae Leach, 1820				
Caracara plancus (Miller, 1777)	Southern Caracara	Carcará	15	10%
Herpetotheres cachinnans (Linnaeus, 1758)	Laughing Falcon	Acauã	2	1%
Aramidae Bonaparte, 1852				
Aramus guarauna (Linnaeus, 1766)	Limpkin	Carão[a d]	28	19%
Rallidae Rafinesque, 1815				
Aramides cajaneus (Statius Muller, 1776)	Gray-necked Wood-Rail	Siricora[a d]	30	20%
Gallinula galeata (Lichtenstein,1818)	Common Gallinule	Frango-d'água[a d]	23	15%
Porphyriops melanops (Vieillot, 1819)	Spot-flanked Gallinule	Capote-d'água	11	7%
Porphyrio martinicus (Linnaeus, 1766)	Purple Gallinule	Frango-d'água	6	4%
Charadriidae Leach, 1820				
Vanellus chilensis (Molina, 1782)	Southern Lapwing	Tetéu[d]	22	15%
Scolopacidae Rafinesque, 1815				
Numeniu sphaeopus (Linnaeus, 1758)	Eurasian Whimbrel	Pirão-gordo [d]	4	3%
Tringa melanoleuca (Gmelin, 1789)	Greater Yellowlegs	Maçarico-grande	2	1%
Calidris alba (Pallas, 1764)	Sanderling	Maçarico-branco	21	14%
Calidris minutilla (Vieillot, 1819)	Least Sandpiper	Maçarico-pequeno	4	3%
Jacanidae Chenu & Des Murs, 1854				
Jacana jacana (Linnaeus, 1766)	Wattled Jacana	Jaçanã[a]	9	6%
Laridae Rafinesque, 181				
Chroicocephalus cirrocephalus (Vieillot, 1818)	Gray-hooded Gull	Gaivota[d]	11	7%
Phaetusa simplex (Gmelin, 1789)	Large-billed Tern	Trinta-réis-grande	2	1%
Columbidae Leach, 1820				
Columbina talpacoti (Temminck, 1811)	Ruddy Ground-Dove	Rolinha-sangue-de-boi [a d]	24	16%
Columbina squammata (Lesson, 1831)	Scaled Dove	Fogo-apagou [a d]	1	1%
Columbina picui (Temminck, 1813)	Picui Ground-Dove	Rolinha-branca [a d]	109	73%
Columbina passerina (Linnaeus, 1758)	Common Ground-Dove	Rolinha-cinza [d]	20	13%
Columba livia Gmelin, 1789	Rock Pigeon	Pombo	3	2%
Patagioenas picazuro (Temminck, 1813)	Picazuro Pigeon	Asa-branca[a]	2	1%
Leptotila verreauxi Bonaparte, 1855	White-tipped Dove	Juriti	3	2%
Zenaida auriculata (Des Murs, 1847)	Eared Dove	Avoante[a d]	17	11%
Psittacidae Rafinesque, 1815				
Eupsittula cactorum (Kuhl, 1820)	Cactus Parakeet	Periquito-da-caatinga [d]	6	4%
Forpus xanthopterygius (Spix, 1824)	Blue-winged Parrotlet	Tuim[d]	6	4%
Thectocercus acuticaudatus (Vieillot, 1818)	Blue-crowned Parakeet	Periquito-de-testa-azul [d]	6	4%
Amazona aestiva (Linnaeus, 1758)	Turquoise-fronted Parrot	Papagaio[d]	8	5%
Cuculidae Leach, 1820				
Piaya cayana (Linnaeus, 1766)	Squirrel Cuckoo	alma-de-gato	4	3%
Coccyzus euleri Cabanis, 1873	Pearly-breasted Cuckoo	Papa-lagarta [a d]	2	1%
Crotophaga major Gmelin, 1788	Greater Ani	Gorgoró[a d]	17	11%
Crotophaga ani Linnaeus, 1758	Smooth-billed Ani	Anu[d]	47	31%
Guira guira (Gmelin, 1788)	Guira Cuckoo	Piririguá [d]	21	14%
Tytonidae Mathews, 1912				
Tyto furcata (Temminck, 1811)	American Barn Owl	Coruja[a]	10	7%
Strigidae Leach, 1820				
Glaucidium brasilianum (Gmelin, 1788)	Ferruginous Pygmy-Owl	Caburé	11	7%
Nyctibiidae Chenu& Des Murs, 1851				
Nyctibius griseus (Gmelin, 1789)	Common Potoo	Mãe-da-lua [d]	1	1%
Caprimulgidae Vigors, 1825				
Nyctidromus albicollis (Gmelin, 1789)	Common Pauraque	Bacurau	1	1%
Podager nacunda (Vieillot, 1817)	Nacunda Nighthawk	Corucão	1	1%
Trochilidae Vigors, 1825				
Amazilia leucogaster (Gmelin, 1788)	Plain-bellied Emerald	Beija-flor-de-barriga-branca[d]	21	14%
Alcedinidae Rafinesque, 1815				
Megaceryle torquata (Linnaeus, 1766)	Ringed Kingfisher	Martim-pescador-grande	2	1%
Chloroceryle amazona (Latham, 1790)	Amazon Kingfisher	Martim-pescador-verde	8	5%
Bucconidae Horsfield, 1821				
Nystalus maculatus (Gmelin, 1788)	Spot-backed Puffbird	Bico-de-latão	2	1%
Picidae Leach, 1820				
Melanerpes candidus (Otto, 1796)	White Woodpecker	Pica-pau-branco [d]	1	1%
Veniliorni spasserinus (Linnaeus, 1766)	Little Woodpecker	Pica-pau-anão	16	11%
Colaptes melanochloros (Gmelin, 1788)	Green-barred Woodpecker	Pica-pau-verde	2	1%
Celeus flavescens (Gmelin, 1788)	Blond-crested Woodpecker	Pica-pau-amarelo [d]	2	1%
Campephilus melanoleucos (Gmelin, 1788)	Crimson-crested Woodpecker	Pica-pau-vermelho [d]	3	2%
Thamnophilidae Swainson, 1824				
Taraba major (Vieillot, 1816)	Great Antshrike	Choró-boi [d]	2	1%

Taxa	Piacentini et al. (2015)	(Informants)	*n*	%
Furnariidae Gray, 184				
Furnarius rufus (Gmelin, 1788)	Rufous Hornero	João-de-barro	1	1%
Tyrannidae Vigors, 1825				
Pitangus sulphuratus (Linnaeus, 1766)	Great Kiskadee	Bem-te-vi[a d]	97	65%
Tyrannus melancholicus Vieillot, 1819	Tropical Kingbird	Severina[a]	11	7%
Fluvicola nengeta (Linnaeus, 1766)	Masked Water-Tyrant	Lavadeira-mascarada	7	5%
Corvidae Leach, 1820				
Cyanocorax cyanopogon (Wied, 1821)	White-naped Jay	Cancão [d]	5	3%
Troglodytidae Swainson, 1831				
Troglodytes musculus Naumann, 1823	Southern House Wren	Rouxinol	2	1%
Turdidae Rafinesque, 1815				
Turdus rufiventris Vieillot, 1818	Rufous-bellied Thrush	Sabiá-verdadeira[a d]	71	47%
Mimidae Bonaparte, 1853				
Mimus saturninus (Lichtenstein, 1823)	Chalk-browed Mockingbird	Sabiá-da-mata [d]	13	9%
Mimus gilvus (Vieillot, 1807)	Tropical Mockingbird	Sábia-da-praia [d]	5	3%
Thraupidae Cabanis, 1847				
Coryphospingus pileatus (Wied, 1821)	Pileated Finch	Tico-tico	5	3%
Tangara sayaca (Linnaeus, 1766)	Sayaca Tanager	Sanhaçú[d]	2	1%
Paroaria dominicana (Linnaeus, 1758)	Red-cowled Cardinal	Galo-de-campina [d]	18	12%
Sicali flaveola (Linnaeus, 1766)	Saffron Finch	Canário-da-terra	1	1%
Volatinia jacarina (Linnaeus, 1766)	Blue-black Grassquit	Tiziu	1	1%
Sporophila lineola (Linnaeus, 1758)	Lined Seedeater	Bigode	12	8%
Sporophila bouvreuil (Statius Muller, 1776)	Copper Seedeater	Caboclinho	1	1%
Coereba flaveola (Linnaeus, 1758)	Bananaquit	Sibiti	2	1%
Cardinalidae Ridgway, 1901				
Cyanoloxia brissonii (Lichtenstein, 1823)	Ultramarine Grosbeak	Azulão	1	1%
Parulidae Wetmore, Friedmann, Lincoln, Miller, Peters, van Rossem, Van Tyne & Zimmer 1947				
Basileuterus culicivorus (Deppe, 1830)	Golden-crowned Warbler	Pula-pula	3	2%
Icteridae Vigors, 1825				
Procacicus solitarius (Vieillot, 1816)	Solitary Black Cacique	Iraúna	1	1%
Cacicus cela (Linnaeus, 1758)	Yellow-rumped Cacique	Xexéu[d]	29	19%
Icterus pyrrhopterus (Vieillot, 1819)	Variable Oriole	Primavera[d]	7	5%
Icterus jamacaii (Gmelin, 1788)	Campo Troupial	Corrupião [d]	71	47%
Gnorimopsar chopi (Vieillot, 1819)	Chopi Blackbird	Chico-preto/graúna [d]	26	17%
Sturnella superciliaris (Bonaparte, 1850)	White-browed Meadowlark	Papa-arroz	2	1%
Fringillidae Leach, 1820				
Euphonia chlorotica (Linnaeus, 1766)	Purple-throated Euphonia	Vim-vim	4	3%
Passeridae Rafinesque, 1815				
Passer domesticus (Linnaeus, 1758)	House Sparrow	Pardal[d]	54	36%
Total = 97 Species				

Passeriformes were the best represented among the species reported by the interviewees, comprising 29% (n = 28 species) of the total number of species cited, followed by the orders Pelecaniformes, Charadriiformes, and Columbiformes (8%; n = 8 species each); Gruiformes, Cuculiformes, and Piciformes (5%; n = 5 species each). This expressive total of Passeriformes may reflect a preference of the interviewees for singing birds, principally the families Icteridae and Turdidae (species kept as pets), and the Tyrannidae, as well as the abundance of species within that family.

The order Passeriformes consistently shows the greatest species richness in ethno-ornithological studies of the uses and commercialization of birds (Barbosa, Silva, Medeiros, & Chaves, 2014; Galvagne-Loss, Costa-Neto, & Flores, 2014). This order includes birds that are appreciated for their singing and plumage in practically all areas of the tropics, and it is also the most representative order among neotropical birds, with 5,739 known species (Silvius, Bodmer, & Fragoso, 2004) – which helps explain their frequent citations by the interviewees from the Labino community. Columbiformes represent important food resources throughout South America, and species of this order are generally well-known by local human inhabitants (Souza & Alves, 2014). The Columbiformes are important targets for local hunters in northeastern Brazil, and all of its species are killed, captured, and illegally sold for their bush meat. Species of the orders Pelecaniformes and Gruiformes include large birds and those with significant diurnal activities in aquatic environments, which facilitates their observation and recognition by humans (Alves et al., 2012; Souza & Alves, 2014).

The most representative families were Columbidae and Traupidae (8 species each); followed by Ardeidae and Icteridae (6 species); Cuculidade and Picidae (5 species); Rallidae, Scolopacidae, and Psittacidae (4 species). The species with the largest numbers of citations were *Columbina picui* (n = 109; 73%), *Pitangus sulphuratus* (n = 97; 65%), *Turdus rufiventris*, *Icterus jamacaii* (ambas, n = 71; 47%), *Bubulcus ibis* and *Coragyps atratus* (n = 55; 37% each), and *Passer domesticus* (n = 54; 36%).

Some of the families mentioned as having high species richness in the present study were likewise well-represented in other ornithological surveys in the Parnaíba Delta region (Guzzi et al., 2012, 2015), principally the families Scolopacidae, Ardeidae, and Icteridae in terms of species richness.

Although the richness curve of known species (S(est)) is asymptotic, it is only slightly inclined, and shows a tendency towards stabilization (Figure 2). We were apparently able to record essentially the entire inventory of birds known to the local residents, as Chao2 estimated a richness of approximately 104 species (s.e.= ±5.36 spp.) and second-order Jackknife (Jack2) estimated approximately 114 species (s.e. = 0). The curves of both estimators achieved asymptote with 86 interviewees (Jack2) and 104 interviewees (Chao2) (Figure 2). Consequently, the species inventory demonstrated a sampling effort of 92.3% (comparing S(est) with Chao2) or 84.21% (comparing S(est) with Jack2).

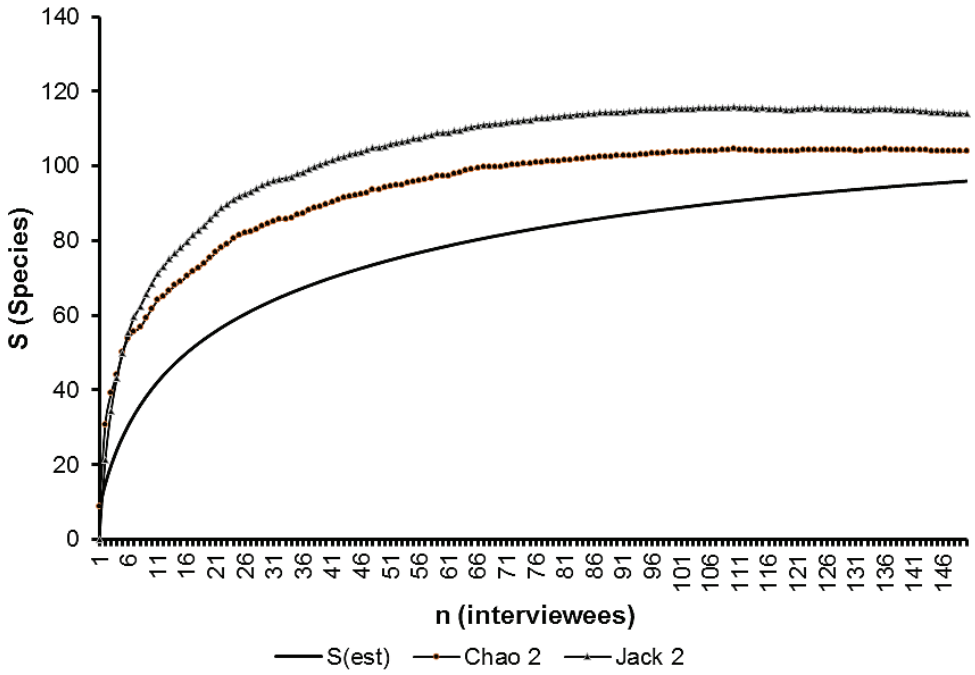

Figure 2. Accumulation curve of known species mentioned (S (est)) and expected to be known (Chao2 and Jackknife2).

Men recognize more local bird species than women (mean per man = 9.76 ± 5.11; mean per woman = 7.57 ± 4.37; median per man = 9, median per woman = 6). These differences were significant (Mann-Whitney U = 3,613.5; d.f. = 1; p = 0.002; mean ranking (men = 86.05; women = 64.67) (Figure 3A).

The fact that men recognized more bird species than women was not surprising, as hunting activities that involve birds are more frequently or exclusively undertaken by men throughout the tropics, increasing the chances of males utilizing or being aware of more kinetic resources and the ethnoecological aspects of bird species (Alves et al., 2012; Van Vliet et al., 2014). A study undertaken in Pernambuco State (NE Brazil) demonstrated that men retain greater local knowledge about shorebirds and migratory birds than women, which may be related to greater male participation in fishing activities undertaken near avifauna feeding and resting areas (Andrade, Silva-Andrade, Lyra-Neves, Albuquerque, & Telino-Júnior, 2016).

Transgenerational diffusion of ethnozoological knowledge has been cited by a number of authors (Alves & Souto, 2015; Fita, Neto, & Schiavetti, 2010; Souto, Barboza, Rocha, Alves, & Mourão, 2012). We indirectly identified this phenomenon in relation to local ethno-ornithological knowledge, as older individuals generally recognized more bird species than younger members of the community, although this correlation was quite weak (Pearson correlation = 0.164; p = 0.05) (Figure 3B).

The greater levels of knowledge of older individuals corroborated earlier studies focusing on the capture and commercial uses of the tropical fauna (Lindsey et al., 2013; Pangau-Adam, Noske, & Muehlenberg,

2012; Souza & Alves, 2014), suggesting that local knowledge concerning the native fauna is directly influenced by a synergy of factors, including, principally, knowledge transmitted from older individuals to younger relatives, as well as the involvement of a given person in activities that favor frequent contacts with the regional fauna (as, for example, agriculture, land clearing, hunting, and the commercialization of animal products).

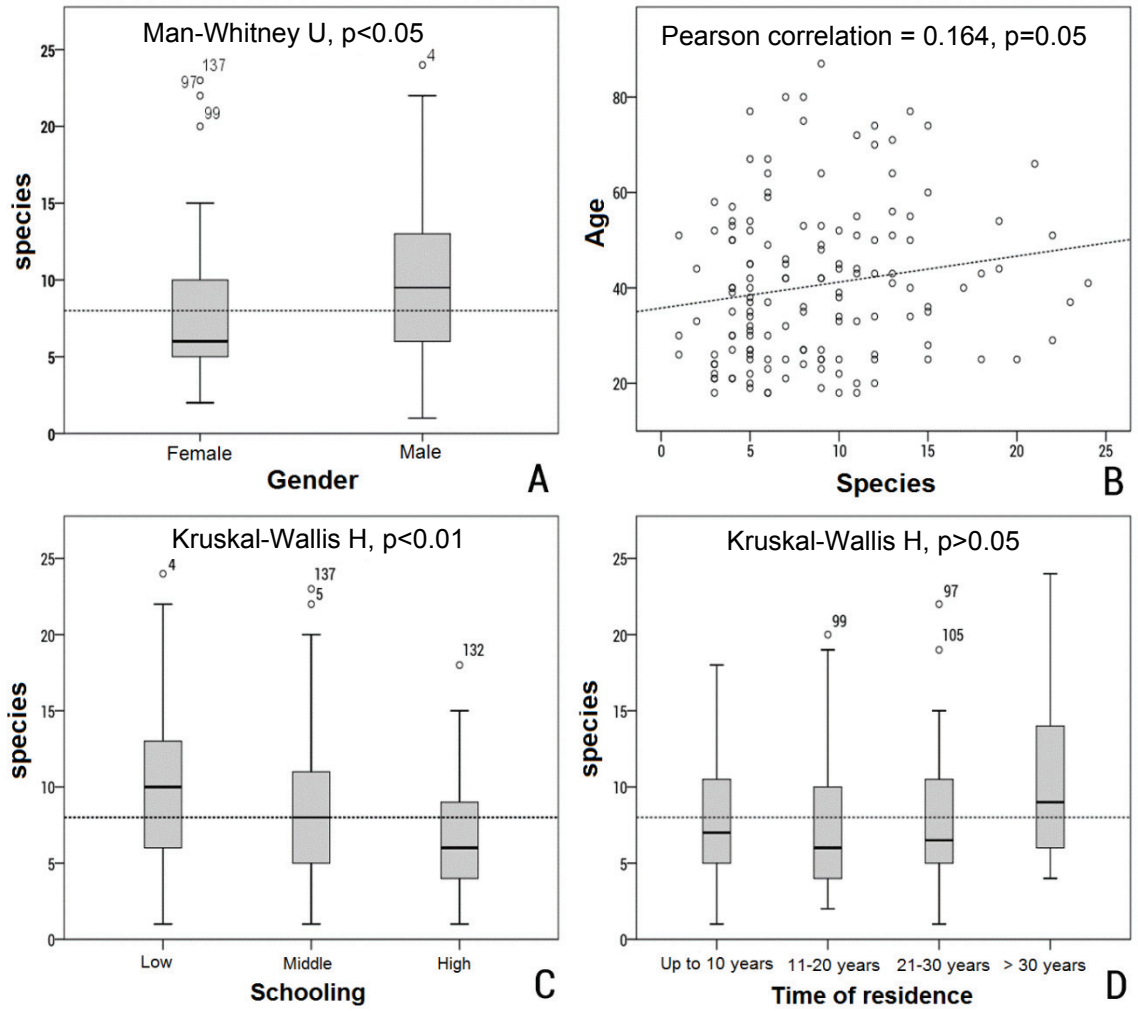

Figure 3. Influence of social aspects on the knowledge of species richness. In 3A, 3C and 3D the dashed line is the median of species richness reported by the entire sample set. In 3B the dashed line is the equation line of the relationship between age and the knowledge of local fauna species. Points external to boxplots in 3A, 3C and 3D represent extreme values (outliers), although they did not significantly alter the median.

Educational levels likewise influences local knowledge about birds (Kruskal-Wallis H = 14.21; d.f. = 2; $p < 0.001$) (Figure 3C). This difference was observed between individuals with low levels of schooling (illiterate individuals or those that did not finish grammar school) and community members with more education (middle schooling completed or higher) (Dunn *post-hoc* test, $p < 0.05$) – with individuals with less schooling demonstrating greater knowledge of species richness than those with more formal educations (Mean ranking low schooling = 88.32, and median = 10; Mean ranking higher education = 58.5, and median = 6). These results demonstrate that a low level of formal schooling do not necessarily imply a poor knowledge of species of the local fauna; these results were similar to those found while studying reproductive aspects of the Psittacidae (Saiki, Guido, & Cunha, 2009) and the ecology of the mangrove crab *Ucides cordatus* (Cortês, Zappes, & Di Beneditto, 2014) – and may reflect teaching/learning processes – as most school books stress exotic faunas, and more applied students may have less contact with the local avifauna. Time of residence in the community was not found to influence knowledge concerning bird species richness (Kruskal-Wallis H = 7.22; d.f. = 3; p = 0.065) (Figure 3D).

Perceptions of impacts on the avifauna, and the use of birds as bush meat

Residents of the Labino community indicated hunting (68%, n=45) as the principle anthropogenic factor impacting the local avifauna. Other factors mentioned were: forest clearing (7% of the respondents), keeping birds as pets (6%), and the illegal commerce in live or dead birds (3%). The predominant perception of hunting as having the greatest impact on the local avifauna is presumably associated with the ample popularity of that activity in northern and northeastern Brazil – areas where birds are frequently converted into bush meat, medicinal products, pets, and adornments (Alves, Lopes, & Alves, 2016; Nascimento, Czaban, & Alves, 2015).

Twenty-three bird species are consumed by the residents of Labino (Table 2), with *Aramides cajaneus* (Siricora), belonging to the family Rallidae, being the most cited (n=21; 14% of the interviewees), followed by the columbids *Columbina squammata* (Rolinha-fogo-apagou) (n=19; 13 %) and *Zenaida auriculata* (Avoante) (n=13; 9%). Columbids, tinamids and birds associated with aquatic environments (e.g., Anseriformes, Gruiformes) were previously identified as preferential hunting targets in different parts of the tropical Americas (Bucher, 1982; Souza & Alves, 2014).

Some bird species can be harvested in large numbers during a single hunting expedition, although they do not present large volumes of meat per individual, nor are they especially appreciated in terms of their flavors, as for example most of the columbids (Bezerra, Araújo, & Alves, 2012; Von Ihering, 1935). *Zenaida auriculata*, *Columbina* spp., *Anas bahamensis* and *Aramides cajaneus* were frequently mentioned by the interviewees in that context. There was no influence of gender (Mann-Whitney $U = 3.074$, $p > 0.05$), age (Pearson correlation, $p > 0.05$), schooling (Kruskal-Wallis H, $p > 0.05$), or time of residence (Kruskal-Wallis H, $p > 0.05$) on the richness of bird species consumed by the interviewees.

Perception concerning avifauna population reductions

A total of 48 bird species were perceived as having their populations reduced in recent years (Table 2). The species most cited in this sense by the interviewees were: *Mimus gilvus* (Sabiá-da-praia) (n=15), *Icterus jamacaii* (Corrupião) (n=13), *Aramides cajaneus* (Siricora) (n=12), *Turdus rufiventris* (Sabiá-laranjeira) (n=9), *Cacicus cela* (Xexéu), *Pitangus sulphuratus* (Bem-te-vi) (n=8), *Anas bahamensis* (Marreca) (n=6), *Columbina picui* (Rolinha branca) (n=5), *Vanellus chilensis* (Quero-quero), and *Tangara sayaca* (Sanhaçu) (n=4). With the exception of *Aramides cajaneus*, the diminishing species normally show only low sensitivity to environmental alterations and considerable plasticity in terms of their tolerance of anthropogenic impacts (according to the interviewees) (Silva, Souza, Bieber, & Carlos, 2003).

The species cited as demonstrating population reductions are not considered threatened species (Instituto Chico Mendes de Conservação da Biodiversidade [ICMbio], 2018) by the International Union for the Conservation of Nature (IUCN, 2019), being classified in the "less concern" conservation category (category LC) (IUCN, 2019). The red list, however, considers species populations throughout their entire distribution range, even while some local populations could be depleted or eradicated. Ecological studies of bird populations in the Parnaiba Delta are urgently needed in light of the information provided by local residents.

The socioeconomic aspects of the residents of the Labino community, such as their gender (Mann-Whitney U, $p > 0.05$), age (Pearson correlation, $p > 0.05$), levels of schooling (Kruskal-Wallis H, $p > 0.05$), and time of residents in the community (Kruskal-Wallis H, $p > 0.05$) were not found to influence their perception of reduced species richness.

Conclusion

The information obtained in the present study demonstrated that the residents of the Labino community possess a detailed knowledge of the local avifauna and perceive impacts caused mainly by hunting – suggesting that those observers should be included when developing strategies for bird conservation through interactions with governmental institutions, and scientists. Conservation plans must seek to minimize impacts on bird species, and lists and illustrations of local bird species should be produced to complement biology studies in regional schools and include local animals – as schoolbooks generally do not contain any information about regional species and landscapes.

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