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

Francisco das Chagas Vieira Santos1*, Wedson Medeiros Silva Souto2, Arthur Serejo Neves Ribeiro1, Reinaldo Farias Paiva de Lucena3 and Anderson Guzzi4

1Programa de Doutorado em Desenvolvimento e Meio Ambiente, Universidade Federal do Piauí, Avenida Universitária, 1310, 64049-550, Ininga, Teresina, Piauí, Brasil. 2Universidade Federal do Piauí, Teresina, Piauí, Brasil. 3Universidade Federal da Paraíba, Areia, Paraíba. 4Universidade Federal do Piauí, Parnaíba, Piauí, Brasil. *Author for correspondence. E-mail: fcovieira2@gmail.com

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 Parnaiba 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, Şekericioğlu, 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 (Instituto 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 Parnaíba 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 Ceará (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                  | 25 | 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              | 19 | 13%|
| Not mentioned            | 7  | 5% |
| 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 *; 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<sup>d</sup> | 7   | 5% |
| Anatidae Leach, 1820             |                          |              |     |    |
| Dendrocygnidae (Linnaeus, 1766)  |                          |              |     |    |
| Anas hardensis Linnaeus, 1758    | White-faced Whistling-Duck | Paturiri<sup>d</sup> | 12  | 8% |
| Anas penelope Leach, 1820        |                          |              |     |    |
| Cracidae Rafinesque, 1815        |                          |              |     |    |
| Penelope superciliaris Temminck, 1815 | Rusty-margined Guan  | Jacupembe    | 4   | 3% |
| Orthalis 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<sup>a</sup> | 3   | 2% |
| Phalacrocoracidae Reichenbach, 1849 |                          |              |     |    |
| Nannopterus brasilius (Gmelin, 1789) | Neotropic Cormorant    | Biguí         | 1   | 1% |
| Ardeidae Leach, 1820             |                          |              |     |    |
| Tigriomya lineatam (Boddaert, 1783) | Rufescent Tiger-Heron  | Socó<sup>d</sup> | 1   | 1% |
| Nyctanassa violacea (Linnaeus, 1758) | Yellow-crowned Night-Heron | Tamatã<sup>d</sup> | 21  | 14%|
| Butorides striata (Linnaeus, 1758) | Striated Heron          | Socozinho     | 25  | 17%|
| Bubulcus ibis (Linnaeus, 1758)   | Cattle Egret            | Garça-pequena<sup>d</sup> | 55  | 37%|
| Ardea alba Linnaeus, 1758         | Cattle Egret            | Garça-grande<sup>d</sup> | 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 Lefresnaye, 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, 1795) | Black Vulture          | Urubu-de-cabeça-preta<sup>a</sup> | 55 | 37%|
| Accipitridae Vigors, 1824        |                          |              |     |    |
| Rostrhamus sociabilis (Vieillot, 1817) | Snail Kite            | Gavião-caramujeiro | 22  | 15%|
| Urubitinga urubitinga (Gmelin, 1788) | Great Black Hawk       | Gavião-preto<sup>d</sup> | 1  | 1% |
| Rupornis magnirostris (Gmelin, 1788) | Roadside Hawk         | Gavião-carirê<sup>d</sup> | 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% |
| Aramiidae Bonaparte, 1852               |                          |            |    |    |
| *Aramus guarauna* (Linnaeus, 1766)     | Limpkin                  | Carão      | 28 | 19%|
| Rallidae Rafinesque, 1815              |                          |            |    |    |
| *Aramides cajaneus* (Statius Muller, 1776) | Gray-necked Wood-Rail  | Sircorà     | 30 | 20%|
| *Galilina galeata* (Lichtenstein,1818) | Common Gallinule         | Frango-d'água| 23 | 15%|
| *Porphyriops melanops* (Vieillot, 1819) | Spot-flanked Gallinule   | Capote-d'água| 11 | 7% |
| *Porphyrio martinus* (Linnaeus, 1766)  | Purple Gallinule         | Frango-d'água| 6  | 4% |
| Charadriidae Leach, 1820               |                          |            |    |    |
| *Vanellus chilensis* (Molina, 1782)    | Southern Lapwing         | Tetéu      | 22 | 15%|
| Scolopacidae Rafinesque, 1815          |                          |            |    |    |
| *Numenius phaeopus* (Linnaeus, 1758)   | Eurasian Whimbrel        | Pirão-gordo| 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% |
| *Jacana jacana* (Linnaeus, 1766)       | Wattled Jacana           | Jaçanã     | 9  | 6% |
| Laridae Rafinesque, 1815               |                          |            |    |    |
| *Chroicocephalus cirrocephalus* (Vieillot, 1818) | Gray-hooded Gull     | Gaviota    | 11 | 7% |
| *Phaetus simplex* (Gmelin, 1789)       | Large-billed Tern        | Triña-reis-grande| 2 | 1% |
| Columbidae Leach, 1820                 |                          |            |    |    |
| *Columbina talpacoti* (Temminck, 1811) | Ruddy Ground-Dove       | Rolinha-sangue-de-boi| 24 | 16%|
| *Columbina squamata* (Lesson, 1815)    | Scaled Dove              | Fogo-apagou| 1  | 1% |
| *Columbina picui* (Temminck, 1815)     | Picui Ground-Dove        | Rolinha-branca| 109| 73%|
| *Columbina passerina* (Linnaeus, 1758) | Common Ground-Dove      | Rolinha-cinza| 20 | 13%|
| *Columba livia* (Linnaeus, 1789)       | Rock Pigeon              | Pombo      | 3  | 2% |
| *Patagioenas picazuro* (Temminck, 1815)| Picazuro Pigeon         | Asa-branca | 2  | 1% |
| *Leptotila verreauxi* (Bonaparte, 1855)| White-tipped Dove       | Juriti     | 5  | 2% |
| *Zenaida auriculata* (Des Murs, 1847)  | Eared Dove               | Avoante    | 17 | 11%|
| Psitacidae Rafinesque, 1815            |                          |            |    |    |
| *Eupsittula cactorum* (Kuhl, 1820)     | Cactus Parakeet          | Periquito-da-caatinga| 6 | 4% |
| *Forpus xanthopterygius* (Sпиx, 1824)  | Blue-winged Parrotlet   | Tuim       | 6  | 4% |
| *Thectocercus acuticaudatus* (Vieillot, 1818) | Blue-crowned Parakeet  | Periquito-de-testa-azul| 6 | 4% |
| *Amazona aestiva* (Linnaeus, 1758)    | Turquoise-fronted Parrot| Papagaio  | 8  | 5% |
| Cuculidae Leach, 1820                  |                          |            |    |    |
| *Pitaya cayana* (Linnaeus, 1766)       | Squirrel Cuckoo          | alma-de-gato| 4  | 3% |
| *Coccyzus euleri* (Cabans, 1873)       | Pearly-breasted Cuckoo   | Papa-lagarta| 2 | 1% |
| *Crotaphaga major* (Gmelin, 1788)      | Greater Ani              | Gorgoró    | 17 | 11%|
| *Crotaphaga ani* (Linnaeus, 1758)      | Smooth-billed Ani        | Anu        | 47 | 31%|
| *Guira guira* (Gmelin, 1788)           | Guira Cuckoo             | Piririguá  | 21 | 14%|
| Tytonidae Mathews, 1912                |                          |            |    |    |
| *Tyto furcata* (Temminck, 1811)        | American Barn Owl        | Coruja     | 10 | 7% |
| Strigidae Leach, 1820                  |                          |            |    |    |
| *Glaucidium brasilianum* (Gmelin, 1788)| Ferruginous Pygmy-Owl    | Caburé     | 11 | 7% |
| Nyctibiidae Chenu& Des Murs, 1851      |                          |            |    |    |
| *Nycitibius griseus* (Gmelin, 1789)    | Common Potoo             | Mãe-da-lua | 1  | 1% |
| Caprimulgidae Vigors, 1825             |                          |            |    |    |
| *Nycitromus albicolis* (Gmelin, 1789)  | Common Pauraque          | Bacurau    | 1  | 1% |
| *Podager nacunda* (Vieillot, 1817)     | Nacunda Nighthawk        | Corúcia    | 1  | 1% |
| Trochilidae Vigors, 1825               |                          |            |    |    |
| *Amazilia leucogaster* (Gmelin, 1788)  | Plain-bellied Emerald    | Beija-flor-de-barriga-branca| 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% |
| *Buccoidea Horsfield, 1821*            |                          |            |    |    |
| *Nystalus maculatus* (Gmelin, 1788)    | Spot-backed Puffbird     | Bico-de-latão| 2 | 1% |
| Pidicidae Leach, 1820                  |                          |            |    |    |
| *Melanerpes candidus* (Otto, 1796)     | White Woodpecker         | Pica-pau-branco| 1 | 1% |
| *Veniliornis 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-amarello| 2 | 1% |
| *Campephilus melanocephus* (Gmelin, 1788) | Crimson-crested Woodpecker | Pica-pau-vermelho| 3 | 2% |
| Thamnophilidae Swainson, 1824          |                          |            |    |    |
| *Taraba major* (Vieillot, 1816)        | Great Antshrike          | Choró-boi  | 2  | 1% |

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| 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-vi⁴  | 97 | 65% |
| Tyranus melanocholicus Vieillot, 1819     | Tropical Kingbird        | Severina²    | 11 | 7%  |
| Fluvicola nengeta (Linnaeus, 1766)        | Masked Water-Tyrant      | Lavadeira-mascarada | 7  | 5%  |
| Corvidae Leach, 1820                      |                          |              |    |     |
| Cynocorax cyanopogon (Wied, 1821)         | White-naped Jay          | Cancão⁴      | 5  | 3%  |
| Trogloidytiidae Swainson, 1831            |                          |              |    |     |
| Tyrannus marchicus Naumann, 1825          | Southern House Wren      | Rouxinol     | 2  | 1%  |
| Turdidae Rafinesque, 1815                 |                          |              |    |     |
| Turdus rufiventris Vieillot, 1818         | Rufous-bellied Thrush    | Sabiá-verdadeira⁴ | 71 | 47% |
| Mimidae Bonaparte, 1853                   |                          |              |    |     |
| Minus saturinus (Lichtenstein, 1823)      | Chalk-browed Mockingbird | Sabiá-da-mata | 13 | 9%  |
| Mimus gilvus (Vieillot, 1807)             | Tropical Mockingbird     | Sábia-da-praia | 5  | 3%  |
| Thraupidae Cabanis, 1847                  |                          |              |    |     |
| Coryphopterus pileatus (Wied, 1821)       | Pileated Finch           | Tico-tico    | 5  | 3%  |
| Tangara sayaca (Linnaeus, 1866)           | Sayaca Tanager           | Sanhaçã³     | 2  | 1%  |
| Paroaria dominicana (Linnaeus, 1758)      | Red-cowled Cardinal      | Galo-da-campina | 18 | 12% |
| Sicali flavola (Linnaeus, 1766)           | Saffron Finch            | Canário-da-terra | 1 | 1%  |
| Volatinaia aracarna (Linnaeus, 1766)      | Blue-black Grassquit     | Tiziu        | 1  | 1%  |
| Sporophila lineola (Linnaeus, 1758)       | Lined Seedeater          | Bigode       | 12 | 8%  |
| Sporophila bouvreuil (Stalii Muller, 1776)| Copper Seedeater         | Caboalinho   | 1  | 1%  |
| Coereba flavola (Linnaeus, 1758)          | Banaquaquit              | Sibiti       | 2  | 1%  |
| Cardinalidae Ridgway, 1901                |                          |              |    |     |
| Cynolaxia brissonii (Lichtenstein, 1823)  | Ultramarine Grosbeak    | Azulão       | 1  | 1%  |
| Parulidae Wetmore, Friedmann, Lincoln, Miller, Peters, van Rossum, van Tyne & Zimmer 1947 |              |              |    |     |
| Basileuterus cuicurvarus (Deppe, 1830)    | Golden-crowned Warbler   | Pula-pula    | 3  | 2%  |
| Icteridae Vigors, 1825                    |                          |              |    |     |
| Proccricus solitarius (Vieillot, 1816)    | Solitary Black Cacique   | Iraúna       | 1  | 1%  |
| Cacicus cela (Linnaeus, 1758)             | Yellow-rumped Cacique    | Xexué⁴      | 29 | 19% |
| Icterus pyrocephalus (Vieillot, 1819)     | Variable Oriole          | Primavera⁴  | 7  | 5%  |
| Icterus jamacaii (Gmelin, 1788)           | Campo Troupial           | Corrupião⁴  | 71 | 47% |
| Gnorimopsar chopi (Vieillot, 1819)        | Chopi Blackbird          | Chico-preto/grauña | 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            | Pardal⁴     | 54 | 36% |

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); Cuculidae 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](image-url)  
**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., 2015; Pangau-Adam, Noske, & Muehlenberg, 2016).
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).

Educational levels likewise influence 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 Benedetto, 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).

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.
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 (5%). 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 jamaiaeii (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, 2005).

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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