

Perception about wind farm-related impacts on *Eudocimus ruber* (Linnaeus, 1758) birdwatching ecotourism in Pequenos Lençóis Maranhenses, NE, Brazil

Percepção dos impactos de parques eólicos sobre o ecoturismo de observação dos guarás, *Eudocimus ruber* (Linnaeus, 1758) nos Pequenos Lençóis Maranhenses, NE, Brasil

Percepción de los impactos de los parques eólicos en el ecoturismo de observación de guarás, *Eudocimus ruber* (Linnaeus, 1758) en los Pequenos Lençóis Maranhenses, NE, Brasil



Francisco das Chagas Vieira Santos

Universidade Federal do Piauí - Teresina - Piauí - Brasil

fcvieira2@hotmail.com



Roseli Farias Melo de Barros

Universidade Federal do Piauí - Teresina - Piauí - Brasil

rbarros@ufpi.edu.br



Anderson Guzzi

Universidade Federal do Delta do Parnaíba - Parnaíba - Brasil

guzzi@ufpi.edu.br

Abstract: The aim of the current study is to record the impact of wind farms on *E. ruber* populations and the importance of this species for ecotourism in the PLM region based on the perception of local tour drivers. The study was conducted in Paulino Neves and Barreirinhas counties / Maranhão State, from June to July 2019. The Rapport method was used for familiarization and trust purposes; it was followed by semi-structured interviews with 35 local drivers. In total, 46% of drivers have said that wind farm implementation and operation processes did not have negative impact on scarlet ibis; however, 23% of interviewees reported that buried ponds were one of the main issues generated by the venture. Four categories were analyzed to assess the importance of scarlet ibis to local ecotourism; however, 60% of interviewees has stated that the flock of these birds encourages tourism in the region and, consequently, it helps improving income sources. Interviewees have mentioned 13 tourist attractions with potential for scarlet ibis birdwatching. Alazão Pond (n = 27) was the most cited location; it was followed by Caburé (n = 25) and Assembleia Beach (n = 13). Most tour drivers did not perceive negative impacts of wind farms on scarlet ibis populations. In addition, they acknowledged the importance, behavior

and distribution of the species in the region. The fact that impacts have not been perceived does not mean that they are not occurring a fact that can compromise the region's potential for bird watching.

Keywords: Avifauna. Tour drivers. Conservation. Maranhão.

Resumo. Este trabalho teve como objetivo registrar, por meio de percepções dos condutores locais de turismo, os impactos dos parques eólicos sobre populações de *E. ruber* e a importância dessa espécie para o ecoturismo na região dos Pequenos Lençóis Maranhenses (PLM). O estudo foi realizado nos municípios de Paulino Neves e Barreirinhas/MA, entre junho e julho de 2019. O método Rapport foi utilizado para viabilizar a familiarização e a confiança dos entrevistados. Entrevistas semiestruturadas com 35 condutores locais foram realizadas posteriormente, sendo que 46% dos condutores responderam que tanto a instalação quanto a operação dos parques eólicos não causaram impactos negativos nos guarás e 23% deles relataram que o soterramento de lagoas é um dos principais problemas gerados pelo empreendimento. No que tange a importância dos guarás para o ecoturismo local, quatro categorias foram analisadas e 60% dos entrevistados responderam que a revoada desses animais incentiva o turismo na região e, conseqüentemente, impacta positivamente sua fonte de renda. Os respondentes citaram 13 atrativos turísticos com potencial de observação da espécie. As localidades mais citadas foram Lagoa do Alazão (n = 27), Caburé (n = 25) e Praia da Assembleia (n = 13). A maioria dos condutores não relatou impactos negativos de parques eólicos nos guarás, e demonstraram conhecer a importância, o comportamento e a distribuição dessa espécie na região. A não percepção dos impactos não significa que eles não ocorram - fato que pode comprometer o potencial da região para a observação de aves.

Palavras-chave: avifauna; condutores de turismo; conservação; Maranhão.

Resumen. Nuestro objetivo fue registrar, a través de percepciones de los impulsores del turismo local, los impactos de los parques eólicos en las poblaciones de *E. ruber* y la importancia de la especie para el ecoturismo en la región PLM. El estudio se desarrolló en los municipios de Paulino Neves y Barreirinhas-MA, de junio a julio de 2019. Para posibilitar la familiarización y confianza de los entrevistados, se utilizó el método Rapport y, posteriormente, entrevistas semiestruturadas a 35 conductores locales. El 46% de los conductores respondió que la instalación y operación de los parques eólicos no causó impactos negativos en los guarás, sin embargo, el 23% informó que el

sepultamiento de lagunas es uno de los principales problemas generados por el proyecto. Fueron analizadas cuatro categorías respecto a la importancia de los guarás para el ecoturismo local, de las cuales, 60% respondió que el revuelo de los guarás incentiva el turismo en la región y, consecuentemente, representa una mejoría en las fuentes de ingresos. Los informantes citaron 13 atracciones turísticas con potencial para la observación de la especie. La localidad más citada fue Lagoa do Alazão (n = 27), seguida de Caburé (n = 25) y Praia da Assembleia (n = 13). La mayoría de los conductores no notan impactos negativos de los parques eólicos en los guarás, además, muestran conocer la importancia, el comportamiento y su distribución en la región. El hecho de que los impactos no se perciban no significa que no se estén produciendo, lo que puede comprometer el potencial de la región para la observación de aves. Palabras clave: avifauna; conductores de turismo; conservación; Maranhão.

Introduction

Brazil is acknowledged for having the greatest biodiversity in the world, it ranks the second position in the rank of birds' richness, and only loses position to Colombia, with 1,971 species – this number corresponds to approximately 20% of the whole birdlife on the planet (PACHECO *et al.*, 2021, p. 97). Furthermore, our country ranks the first position in the Americas in the number of endemic bird species, with 189 species, in other words, almost 10% of the total biological diversity is composed of exclusively Brazilian species. (PIACENTINI *et al.*, 2015, p. 94). This diversity of bird species and their endemism are incomparable resources that can boost ecotourism and the national economy (FARIAS, 2006, p. 474).

Birdwatching has been practiced as tourist activity for decades in Northern Hemisphere countries (PINHEIRO, 2019). Current estimates point out that there are more than 100 million birdwatching practitioners worldwide, and almost half of this number – 45 million – is in the United States and England (LAMAS *et al.*, 2018, p. 8). This activity remains relatively new in Brazil, it started in the 1980s with the creation of the first clubs of birdwatchers countrywide. Despite the great initial boost in the practice of this modality in the 1990s, it faced a phase of relative stagnation (CARVALHO; HINGST-ZAHER, 2019, p. 10).

Recently, states such as São Paulo and Mato Grosso do Sul have been in the mainstream of birdwatching in the country. Campo Grande City (MS) is acknowledged as birdwatching tourism capital due to the valorization of its urban biodiversity and to the incorporation of this activity to local cultural practices (MAMEDE; BENITES, 2020, p. 410). Furthermore, this modality can boost the ecotourism potential of other regions. Although the Environmental Protection Area, also known as EPA, in Delta do Rio Parnaíba and Lençóis Maranhenses region (Northeastern Brazil) has a consolidated tourism sector, and despite the fact that rich birdlife encourages birdwatching, this activity remains poorly explored, except for scarlet ibis flocks, which are one of the greatest attractions in the region (SANTOS *et al.*, 2019, p. 861).

Tourism-related public policies, mainly in Maranhão State (Northeastern Brazil), are marked by initiatives boosted by the Regional Program for Tourism Development I and II (PRODETUR), which took place back in 1991, namely: Implementation of Emotions Route, in 2005, and the Popular Regional Development Plan of Maranhão State – PPDR and/or Major Plan - in 2008, which

aimed at seeking integration between civil and social organizations in order to boost sustainable regional development through tourism (MATOS; ARAÚJO, 2013, p. 39). However, these actions were more closely related to Sun and Beach Tourism; therefore, Ecotourism still occupies secondary position in local tourism public policies.

Pequenos Lençóis Maranhenses (PLM) region is part of the Emotions Route, which became a public policy set by the partnership between Tourism Ministry and the Brazilian Support Service for Micro and Small Enterprises – SEBRAE (ARAÚJO *et al.*, 2020). Consequently, environments with ecotourism activities need to be locally acknowledged and to have their own development plans in order to encourage community involvement and the conservation of local natural environments (CARVALHO *et al.*, 2020; SÁNCHEZ-RIVERO; SÁNCHEZ-MARTÍN; RANGEL, 2020).

We have adopted the ecotourism definition, according to which, this sector is a segment of the touristic activity focused on the sustainable use of the natural and cultural patrimony. It is done by encouraging its conservation and by seeking to form an environmentalist conscience (BRASIL, 2006). Accordingly, one can take the investigation of factors that have negative or positive impact on tourism development in partnership with local residents as relevant (SANTANA; NASCIMENTO; MARQUES-JUNIOR, 2020, p. 158).

Species richness and the natural landscape of PLM region are favorable for birdwatching activities (CARVALHO, 2015; SOARES; RODRIGUES, 2009). Scarlet ibis (*E. ruber*), which is a bird of exquisite beauty, is part of this birdlife; representatives of this species live in coastal areas, but they are also found in mangroves in South America, in part of Colombia, Venezuela, Trinidad and Tobago, Suriname, Guyana, French Guiana and Brazil (OLMOS; SILVA E SILVA, 2003; SICK, 1997). However, several wind farms were installed in PLM's region; they encompass the touristic activities' route. The planning process of great ventures in coastal zones, such as wind farms, as well as the touristic activity, must take into account that these are environmentally sensible sites featured by differentiated ecosystem. Therefore, they form one of the spaces mostly impacted by human actions (SOARES; MARQUES JÚNIOR; CHAGAS, 2018, p. 200).

The installation of wind farms in PLM region can have straight impact on birdwatching ecotourism, mainly when it comes to scarlet ibis (*E. ruber*) flocks, which are used by local communities as

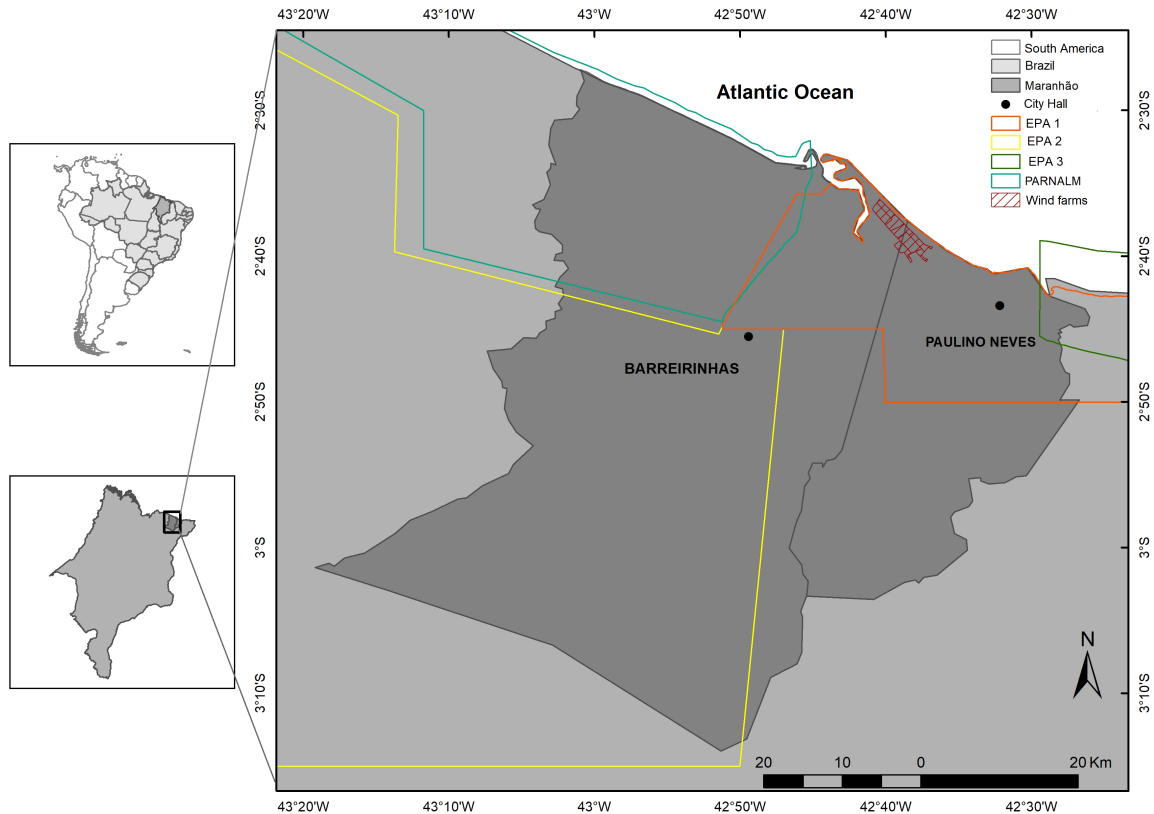
source of touristic resource. Thus, the aims of the current study were to register the impacts from wind farms on *E. ruber* based on the perception of local tourism conductors', as well as to assess the importance of this species for ecotourism in PLM region.

Materials and Methods

Delimiting and featuring the study site

The study was carried out on the coast of Paulino Neves (2°43'24.65" S / 42°32'9.31" W) and Barreirinhas counties, Maranhão State (2°45'41.02" S / 42°49'25.10" W), in the region known as PLM, which is a buffer zone of Lençóis Maranhenses National Park (PNLM). This park was created by Decree n. 86.060, from February 6th, 1981 (ICMBIO, 2020). The aforementioned counties comprise 3 Environmental Protection Areas (EPAs), namely: one at federal level (Parnaíba River Delta) and two at state level (Upaon-açu/Miritiba/Upper Preguiças River and Preguiças River Mouth/Pequenos Lençóis/Adjacent Lagoon Region) (CASTRO; PIORSKI, 2002; ICMBIO, 2018). The wind farm complex is located approximately 35 km from downtown Barreirinhas County (MA) and approximately 3 km from downtown Paulino Neves County (2°38'16.99" S / 42°38'58.14" W) (Figure 1). The estimated population living in Paulino Neves and Barreirinhas counties, in 2019, comprised 16,035 and 62,528 inhabitants, respectively (IBGE, 2019). According to Köppen classification, the climate in the region is of the hot and humid tropical type (As), with high rainfall rate due to the Equatorial Atlantic mass influence, between January and June (ALVARES *et al.*, 2014). Lagoons between dunes evaporate during Summer and form again in Winter (CARVALHO, J. C. de A., 2015). The region comprises free dunes, interdune lagoons and specific vegetation composed of a mosaic of *phytophysionomies*, which are often dominated by coastal ecosystems, such as *restingas* and mangroves (MIRANDA; COSTA; ROCHA, 2012; RODRIGUES *et al.*, 2019, p. 55).

Figure 1- Barreirinhas and Paulino Neves counties' location, Maranhão State, Northeastern Brazil



Legends. EPA1: Environmental Protection Area of Preguiças River/ Pequenos Lençóis/Adjacent Lagoon Region. EPA 2: Environmental Protection Area Upaon-açu/Miritiba/Alto Preguiças. EPA3: Environmental Protection Area Delta do Parnaíba. PARNALM: National Park of Lençóis Maranhenses.

Source: IBGE (2010), adapted by Santos (2020)

Data collection

The research was registered in the National System for the Management of Genetic Heritage and Associated Traditional Knowledge (SisGen) under number A5462DF, provided by Biodiversity Authorization and Information System - SISBIO (number 47565-6). It was approved and substantiated by the Ethics Committee on Human Research (CEP - Comitê de Ética em Pesquisa) of Federal University of Piauí - UFPI (number 3.221.565). The interviews were carried out from May to July 2019. The Rapport method was used to enable interviewees' familiarity with, and trust in, the research team. Subsequently, semi-structured interviews

(BERNARD, 2017) were conducted with 35 local tour drivers in the age group over 18 years whose income derived from the ecological tourism in the region. Interview form covered issues such as interviewees' socioeconomic aspects, knowledge about and importance of *E. ruber* populations for regional ecotourism, as well as their perception about the impacts of the wind farm complex operation on the investigated species. Respondents were selected based on the snowball technique (BAYLEY, 1982), which consists in selecting interviewees based on indications by the previous participant. The nature and aims of the research were explained to each respondent before each interview; all respondents permitted the recording of information provided by them. The Free and Informed Consent Form (FICF) was handed out to, and signed by, those who have agreed on participating in the research. In addition, geographic coordinates were collected through the Global Positioning System (GPS) to enable the spatial elaboration of tourist attractions for birdwatching mentioned by respondents.

Data analysis

Data collected in interview forms were organized into electronic spreadsheet (MS EXCEL[®] 2016). High-resolution (300 dpi) graphs were plotted in MS EXCEL[®] 2016 with the aid of the open-source add-in tool DANIEL's XL TOOLBOX version 6.60 (KRAUS, 2014). The spatial distribution of tourist attractions for scarlet ibis birdwatching was organized into 3 main stages. The first stage lied on inserting the geographic coordinates of the places mentioned by respondents. The second stage comprised the creation of a layout based on a georeferenced cartographic base (Sheets SA-23-ZB-II and SA-23-ZBV) of the investigated counties (IMESC, 2020). The third stage comprised data interpretation in Geographic Information System environment (GIS), carried out in the ArcGIS Software version 10.3. It was done to transform data into spatial or geographic information (ESRI, 2019).

Results and discussion

Socioeconomic aspects

With respect to the socioeconomic profile, it was possible observing that all participants belonged to the male sex, most of them were in the age group 30-39 years (29%). The largest group, comprised 29% of respondents, who had from 1 to 2 years of professional experience. It is important highlighting that 17% of respondents belonged to the category of individuals with 10-20 years of professional experience as tour drivers. Most participants had complete high school (63%). Monthly family income ranged from 1 to 4 minimum wages, with emphasis on 49% of respondents who earned up to 2 minimum wages, on average (Table 1).

Table 1 – Socioeconomic profile of tourist drivers in PLM region, Maranhão State, Brazil

Profile	<i>n</i>	%
Sex		
Female	-	-
Male	35	100%
Age		
20 - 29 years	8	23%
30 - 39 years	10	29%
40 - 49 years	7	20%
50 - 59 years	7	20%
> 60 years	2	6%
Did not inform their age	1	3%
Professional experience		
1 - 2 years	10	29%
3 - 4 years	8	23%
5 - 6 years	6	17%
7 - 8 years	2	6%
9 - 10 years	3	9%
10 - 20 years	6	17%
Schooling		
Illiterate	3	9%
Elementary School	8	23%
High School	22	63%
College Degree	2	6%

Monthly family income

< 1 minimum wage	4	11%
1 minimum wage	5	14%
2 minimum wages	17	49%
3 minimum wages	8	23%
4 minimum wages	1	3%

Source: Elaborated by the authors (2021)

Part of the economically active population in Lençóis Maranhenses region lives on agriculture, livestock, forestry and extraction (IBGE, 2019). This region is rich in 'burity' crops, which are used in furniture manufacturing, as well as on the construction of boats and as food resource, mainly when it comes to extraction for producing handcrafting to be sold to tourists (VIEIRA *et al.*, 2019, p. 8). Fishing remains an important economic activity in this region, mainly for the subsistence of the poorest communities. However, cashew nut is one of the most important agricultural products in this region (SALDANHA *et al.*, 2017, p. 473).

Although the agricultural activity mainly prevails in the territory, the service sector – including tourism – has been developing in the region; nowadays, it is the main sector for the local economy (IBGE, 2019). Barreirinhas County stands out in the region, since it accounted for growing touristic demand in the last decades (GRAÇA, 2010; PINHO, DANTAS; SANTOS, 2019). This phenomenon promoted a new socioeconomic and special dynamics, given, somehow, its proximity to PNLM, a fact that has broadened the touristic visibility in the region (PINHO; DANTAS; SANTOS, 2019, p. 545). It is important highlighting that PNLM ranks the 10th position in the rank of the most visited National Parks in Brazil (ICMBio, 2020).

The challenge of improving their own quality of life, be it in the urban or rural zone, has encouraged many communities to seek alternative economic activities that can generate income and development in their territory. In 2010, the rate of people with regular jobs in the age group over 18 years, in the agricultural sector, reached 47.72%, whereas such a rate reached 27.61% in the service sector (ATLAS DO DESENVOLVIMENTO HUMANO DO BRASIL, 2019). Wealth generated in the same period was significant in the service sector: R\$ 149.036 million, in comparison to the

to the agricultural sector: R\$ 30.397 million (IBGE, 2020). Accordingly, tourism has been an alternative for these communities (OLIVEIRA; PEREIRA, 2019). Thus, based on such a perspective, birdwatching in natural environments is an outdoor, educational ecotourism activity in compliance with environmental preservation (FARIAS, 2007; PINHEIRO, 2019). PLM region is inserted among four Conservation Units (CUs), one of them is of the integral protection nature and one of the most visited National Parks in Brazil (PNLM). The other sites are Environmental Protection Areas (EPAs) of sustainable use (CASTRO; PIORSKI, 2002; ICMBIO, 2018). PNLM ranks the 10th position in the rank of the most visited parks in Brazil; it hosted 151,786 visitors in 2019. The flow and existing structure to host tourists encouraged the Ministry of the Environment (MMA) to include this park in the National Privatization Program by the Federal Government, also known as PND, through Decree n. 10.147, from December 2nd, 2019.

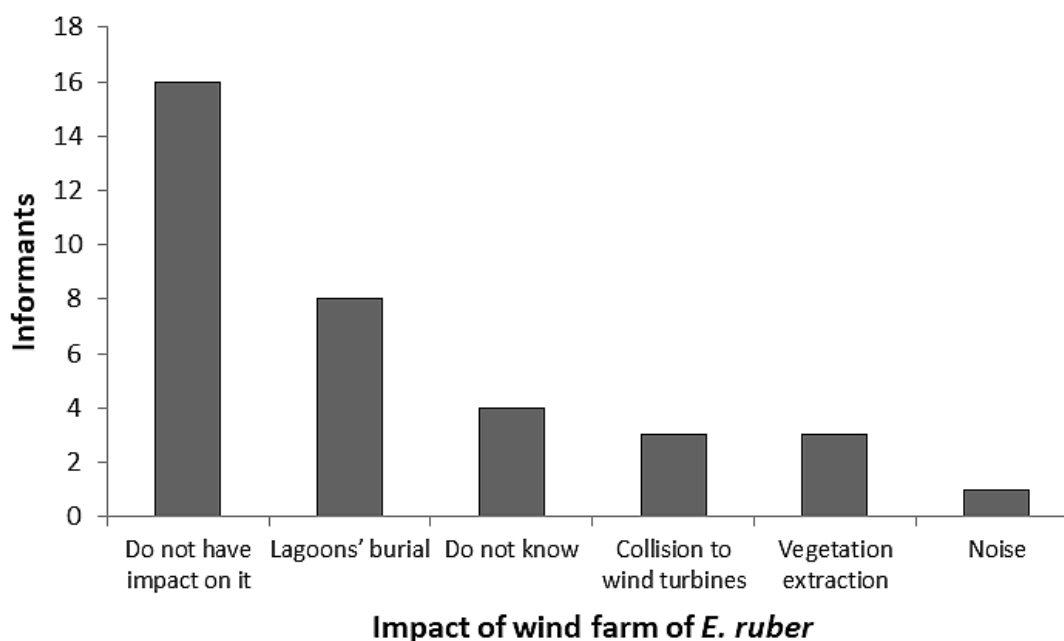
At first, three national parks were included in the program: Lençóis Maranhenses, Jericoacoara and Foz do Iguaçu. Visitation in PNLM has been significantly growing in the last years, it almost doubled between 2013 (42,000 visitors) and 2017 (89,540 visitors). There was increase by 69.5% between 2017 and 2019 (ICMBIO, 2020).

Impacts of wind farms on *E. ruber*

Fifty-seven percent (57%) of participants used to see flocks comprising 50 to 100 *E. ruber* individuals in the wind farm complex during tour drives; they were followed by 26% of participants in the category of those who used to see flocks comprising 5 to 50 birds and by 17% of those who used to watch flocks comprising more than 100 individuals. In addition, based on respondents' comments, June and May stood out as the months when the investigated species was mostly seen - 31% and 23%, respectively. A third group of participants has mentioned January, July and November as the months when the investigated species was mostly seen (9%, each); these months were followed by February, March and August (6%, each) - 3% of participants were unable to answer this question. Among the analyzed categories, 46% of tour drivers believed that wind farm implementation and operation did not have negative impact on scarlet ibis. However, it is worth mentioning that 23% of them reported that lagoons' burial is one

mentioning that 23% of them reported that lagoons' burial is one of the main issues generated by this type of venture; moreover, 11% of respondents were unable to answer this question (Figure 2).

Figure 2 - Activities performed by wind farms that have impact on *E. ruber*



Source: Elaborated by the authors (2021)

The literature has few studies available about the behavior and distribution of species *E. ruber* in Maranhão State. However, bird monitoring conducted in wind farms implemented in the PNL region recorded 30,831 individuals belonging to 70 species distributed into 27 families. These monitoring procedures recorded 1,190 *E. ruber* individuals from 2017 to 2020 (*in prep.*). A colony comprising approximately 2,500 *E. ruber* individuals was recorded in mangrove area in Cajual Island, in 1991. The largest number of birds were observed in May and June (RODRIGUES, AAF, 1995); this outcome is similar to data collected from participants in the present study. Subsequently, a survey on the spatial and reproductive distribution of scarlet ibis in the aforementioned island was carried out in 1994, when it was possible recording approximately 3,500 individuals (HASS; MATOS; MARCONDES-MACHADO, 1999).

The incidence of mangroves in areas adjacent to wind farms mostly explains *E. ruber* birdwatching along the tourist route. Since Maranhão is the Brazilian state housing the largest mangrove area in the country (505 thousand ha), these ecosystems' conservation is of paramount importance because they house high biological diversity of resident and migratory birds (ICMBIO, 2018). According to a study focused on investigating individuals' perception about the conservation of mangrove areas, most respondents have emphasized the need of developing further active conservation policies aimed at favoring environmental services, such as habitat protection (LEWIS; GRANEK; NIELSEN-PINCUS, 2019) and the availability of specific food resources for bird species *E. ruber*, such as crabs belonging to genera *Uca* and *Ucides* (MARTÍNEZ, 2004),

A study about the impacts of onshore wind farms on a rural area in the United Kingdom has shown that 63% of respondents (both residents and tourists) had stated that these ventures did not have negative impact on tourism activities and that they are considered clean energy generators that account for little damage to the environment (HARALDSSON *et al.*, 2020). However, despite the benefits of wind power generation, wind turbines can have negative impact on fauna, mainly on birds and bats' mortality rates (EVERAERT; STIENEN, 2007; FALAVIGNA *et al.*, 2020; FARFÁN, M. Á. *et al.*, 2017).

With respect to the impact caused by lagoons' burial, it is worth mentioning that these habitats in Directly Affected (DAA) and Indirect Influence Areas (IIA) of the wind farm complex (Figures 3C and 3D) work as connection bridge and important bird refuge sites; i.e., they work as important connection and refuge bridge for birds (Figures 3C and 3D). They are not just shelter for resident species, but feeding, breeding and resting site for a large number of migratory birds (SILVA, 2020). These environments may have had positive influence on differences in the number of species recorded in wind farms in Parnaíba River Delta (PEREIRA *et al.*, 2019). An environmental perception study conducted in this same region recorded several impacts based on local informants, namely: changes in coastal landscape, noise pollution, ponds' burial and vegetation removal (BEZERRA *et al.*, 2017).

Figure 3 - Records of *E. ruber* in the PLM region, Northeastern Brazil



Source: Direct research (2021)

Environmental perception studies aim at learning the causes setting the reality of a given environmental issue, as well as the man-environment relationship, in order to use or transform it to solve problems (OLIVEIRA, 2009). Accordingly, environmental perception deriving from local knowledge can be an instrument of positive public participation in wind farm licensing processes, and result in the identification of both negative impacts and their

indicators, which are important for decision-making processes (NUNES *et al.*, 2019).

Importance of *E. ruber* for birdwatching ecotourism in PLM

Four categories regarding the importance of scarlet ibis for local ecotourism were analyzed: 60% of tour drivers answered that scarlet ibis flocks (Figures 3A and 3B) boost tourism in the region and, consequently, improve locals' income source; 30% of them have mentioned the species as PLM symbol; 11% of participants highlighted the beauty of this bird species, which is a fundamental feature for tourism activities. Finally, 9% of participants were unable to answer the question.

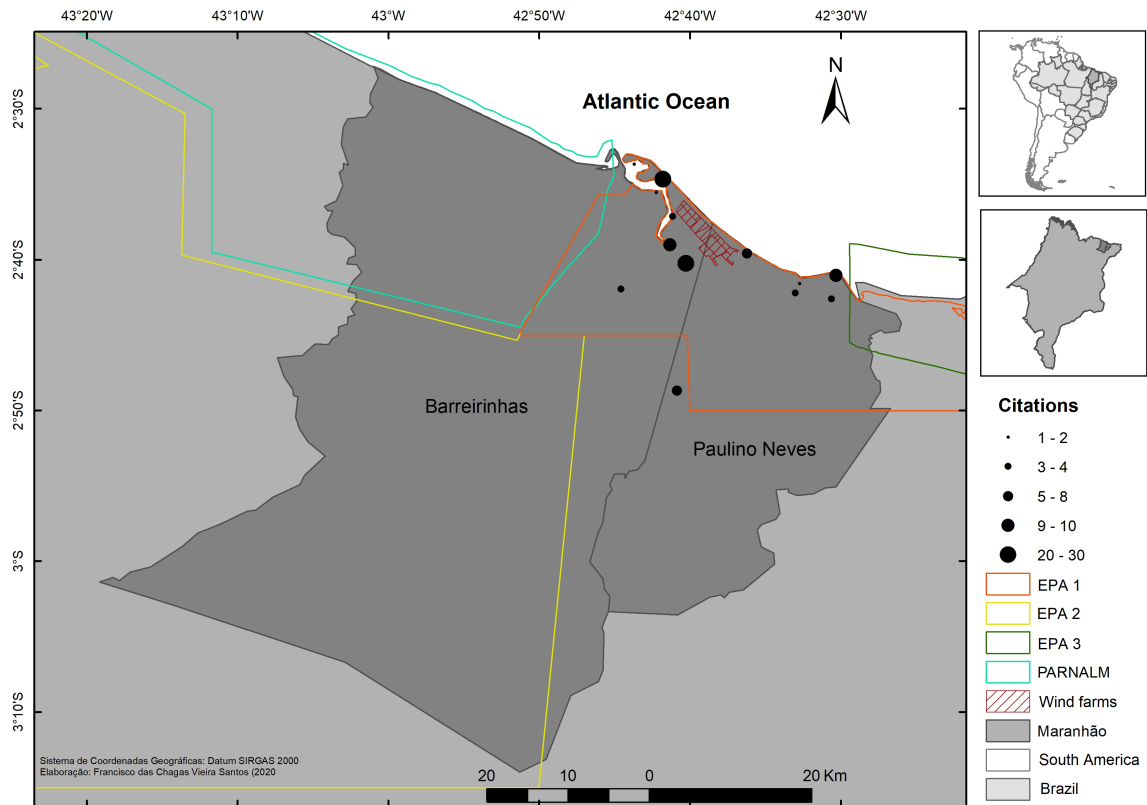
The “flock of scarlet ibis” in Parnaíba River Delta region is one of the greatest ecotourism attractions in Route of Emotions. It is also considered a symbol species that strengthens the birdwatching tourism in the herein assessed EPA (SANTOS *et al.*, 2019). According to riverside communities living in Guaratuba County (PR), besides being one of the main symbols of the county, scarlet ibis represents several positive attributes, such as the beauty of the bay, beach, forest and of other local spaces (SCHERER; BALDIN, 2014). Thus, scarlet ibis watching is an option for income generation for the local population (ALEXANDRINO; QUEIROZ; MASSARUTTO, 2012, p. 30).

Resident and migratory birdlife in Cajual Island provides one of the most beautiful wildlife phenomena in Northern Maranhão State. It comprises migratory whimbrel birds who visit the island's muddy beaches for few months during the year in order to flee Canada's harsh winter (RODRIGUES, 2000). On the other hand, heron, scarlet ibis and taquiri nests in luxuriant mangroves in the Northern region of the island (MARTINEZ; RODRIGUES, 1999; RODRIGUES, 1995), are a powerful attraction for tourists visiting the region. The flocks of thousands of birds heading towards their nests in the late afternoon, coming from Golfão Maranhense hinterlands where they spend the day eating, are particularly spectacular (CASTRO; NORONHA; MEDEIROS, 2016).

A growing wind farm implementation process was observed in the PLM region throughout the research. Based on participants' responses, it was possible recording 13 tourism attractions with potential for the birdwatching of *E. ruber* and/or other resident and

migratory species (Figure 3). Lagoa do Alazão was the mostly cited location (n = 27); it was followed by Caburé (n = 25), Praia da Assembleia (n = 13) and Vassouras community (n = 11).

Figure 4 - Spatial distribution of the main sites for watching *E. ruber* and other bird species in PLM region, Northeastern Brazil



Legend. EPA1: Environmental Protection Area Foz do Rio Preguiças/Pequenos Lençóis/Adjacent Lagoon Areas. EPA2: Environmental Protection Area Upaon-açu/Miritiba/Alto Preguiças. EPA3: Environmental Protection Area Delta do Parnaíba. PARNALM: Lençóis Maranhenses National Park.

Source: IBGE (2010), adapted by Santos (2021)

It gets easier to prepare tourism routes based on the identification of these important birdwatching sites or areas. Once the area is formally acknowledged as element of the tourism landscape within specific itineraries, it increases the quality of life of resident populations and makes the places more attractive for visitation (PINHEIRO, 2019). However, it is necessary taking multisectoral strategic actions focused on the management,

permanence, protection and conservation of elements of nature and living natural attractions necessárias (MAMEDE; BENITES, 2020, p. 12).

Besides expanding ecotourism in the PLM region, birdwatching has the significant potential to complete resources for the local community – in this case, tourist drivers who earn R\$ 300.00 per ride, on average. This activity has been standing out as sustainability alternative and tourism model that prioritize interaction with nature and respect to natural environments, and to their biodiversity (MAMEDE; BENITES, 2020; PINHEIRO, 2019; SANTOS *et al.*, 2019; SILVA, 2020). Other positive aspect lies on several biological cycles and bird migration patterns that allow birdwatching not to suffer from one of the most common issues affecting the national tourism: seasonality (ALEXANDRINO; QUEIROZ; MASSARUTTO, 2012).

Final Considerations

According to the perception by local tour drivers, ecotourism and wind farms do not affect scarlet ibis populations. By considering that both economic activities – tourism and power generation – are relevant for economic and social development in the PLM region, it is essential to make sure that they will keep on growing, but without having negative impact on scarlet ibis populations. Such a goal can be reached through further studies about load capacity focused on defining the limits for the expansion of the aforementioned activities. It is important highlighting that data in the present research are contrary to the common sense, and even to some studies conducted in the region, which see tourism and wind turbines as the major cause of environmental impacts on birds. It is likely that participants' perception about environmental impact has been influenced by the economic return generated by tourism activities carried out in the assessed community.

Wind farms take large areas and occasionally lead to bird death due to collision; however, this fact is not perceived by local tour drivers. According to participants' reports, most scarlet ibis' sighting points in the PLM region are located in Sustainable-Use Conservation Units, in EPAs between Barreirinhas and Paulino Neves counties – although there is no control and monitoring over

such an impact on birds. Finally, it is essential clarifying that the fact that impacts are not perceived by participants does not mean that they do not affect scarlet ibis populations. Such a scenario raises a red flag, because, if the impacts are not observed, they do not demand mitigation actions by local populations. Therefore, the region's potential for birdwatching can be compromised even before it becomes an alternative for ecotourism in PLMs.

Acknowledgement

The authors are grateful to *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES)* for the financial support from PhD scholarships granted until February 2022 and to all tourist drivers in Paulino Neves and Barreirinhas Counties (MA), for collaborating with the current research.

References

- ALEXANDRINO, E. R.; QUEIROZ, O. T. M. M.; MASSARUTTO, R. C. O potencial do município de Piracicaba (SP) para o turismo de observação de aves (Birdwatching). **Revista Brasileira de Ecoturismo**, v. 5, n. 1, p. 27–52, 2012.
- ALVARES, C. A. *et al.* Köppen's climate classification map for Brazil. **Meteorologische Zeitschrift**, v. 22, n. 6, p. 711–728, 2014.
- ARAÚJO, L. M. *et al.* Influência da roteirização em cenários turísticos brasileiros: Rota das Emoções- Parnaíba/Piauí (2005-2018). **Tourism and Hospitality International Journal**, v. 15, n. 1, p. 40–58, 2020.
- ATLAS DO DESENVOLVIMENTO HUMANO DO BRASIL. **Barreirinhas, MA**. Disponível em: http://atlasbrasil.org.br/2013/pt/perfil_m/barreirinhas_ma. Acesso: 20 maio 2019.
- BAYLEY, K. D. **Methods and of social research**. New York: Free Press, 1982.
- BERNARD, H. R. **Research methods in anthropology: qualitative and quantitative approaches**. 6. ed. Newbury Park, CA: Rowman & Littlefield Publishers, 2017.
- BEZERRA, M. B. C. *et al.* Percepção dos impactos socioambientais decorrentes da implantação do complexo eólico Delta do Parnaíba. **Gaia Scientia**, v. 11, n. 1, p. 17–31, 2017.
- BRASIL. MINISTÉRIO DO TURISMO. **Segmentação do Turismo: marcos conceituais**. Brasília: Ministério do Turismo, 2006.
- CARVALHO, G.; HINGST-ZAHER, E. **Observação de aves: torres, abrigos e mobiliário de apoio**. São Paulo: Tjtd Editora, 2019.
- CARVALHO, J. C. A. Turismo e Desenvolvimento Sustentável nos Lençóis Maranhenses. **Revista CEDS**, v. 1, n. 3, p. 1–20, 2015.
- CARVALHO, V. C. *et al.* A percepção autóctone sobre os ambientes naturais com potencial ecoturístico em Luminárias (MG): dinâmica e consequências. **Revista Brasileira de Ecoturismo (RBEcotur)**, v. 13, n. 1, p. 49–68, 2020.

CASTRO, A. C. L.; PIORSKI, N. M. **Plano de Manejo do Parque Nacional dos Lençóis Maranhenses, 2002**. Disponível em: <<https://www.icmbio.gov.br/parnalencoismaranhenses/planos-de-manejo.html>>. Acesso em: 7 ago. 2020.

CASTRO, L. L. C.; NORONHA, G. S.; MEDEIROS, M. A. A. Ecoturismo como alternativa de Desenvolvimento Socioeconômico na Ilha do Cajual, Alcântara (MA). **Revista Brasileira de Ecoturismo**, v. 9, n. 3, p. 418–432, 2016.

ESRI. Environmental Systems Research Institute. **ArcGIS Professional GIS for the desktop, versão 10.5**, 2019.

EVERAERT, J.; STIENEN, E. W. M. Impact of wind turbines on birds in Zeebrugge (Belgium). **Biodiversity and Conservation**, v. 16, n. 12, p. 103–117, 2007.

FALAVIGNA, T. J. *et al.* Changes in bird species composition after a wind farm installation: A case study in South America. **Environmental Impact Assessment Review**, v. 83, n. 1, p. 1–7, 2020.

FARFÁN, M. Á. *et al.* Testing for errors in estimating bird mortality rates at wind farms and power lines. **Bird Conservation International**, v. 27, n. 3, p. 431–439, 2017.

FARIAS, G. B. A observação de aves como possibilidade ecoturística. **Revista Brasileira de Ornitologia**, v. 15, n. 3, p. 474–477, 2006.

GRAÇA, I. M. **Barreirinhas em tempo de mudança: reconstrução de identidades nas rotas do turismo**. 2010. Tese de Doutorado - Universidade de Aveiro, Portugal, 2010, 371 f.

HARALDSSON, M. *et al.* How to model social-ecological systems? – A case study on the effects of a future offshore wind farm on the local society and ecosystem, and whether social compensation matters. **Marine Policy**, v. 119, n. 1, p. 1–13, 2020.

HASS, A.; MATOS, R. H. R.; MARCONDES-MACHADO, L. O. Ecologia reprodutiva e distribuição espacial da colônia de *Eudocimus ruber* (Ciconiiformes: Threskiornithidae) na Ilha do Cajual, Maranhão. **Ararajuba**, v. 7, n. 1, p. 41–44, 1999.

IBGE. INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA. **Estimativa da população 2019 dos municípios de Paulino Neves e Barreirinhas – MA.** Disponível em: <http://www.cidades.ibge.gov.br/>. Acesso em: 12 ago. 2020.

ICMBIO. INSTITUTO CHICO MENDES DE CONSERVAÇÃO DA BIODIVERSIDADE. **Atlas dos Manguezais do Brasil.** Brasília: Instituto Chico Mendes de Conservação da Biodiversidade, 2018.

ICMBIO. INSTITUTO CHICO MENDES DE CONSERVAÇÃO DA BIODIVERSIDADE. **Parque Nacional dos Lençóis Maranhenses, 2020.** Disponível em: <https://www.icmbio.gov.br/parnalencoismaranhenses/planos-de-manejo.html>. Acesso em: 30 abr. 2020.

IMESC. INSTITUTO MARANHENSE DE ESTUDOS SOCIOECONÔMICOS E CARTOGRÁFICOS. **Bases cartográficas municipais, 2020.** Disponível em: <http://www.zee.ma.gov.br/subsidio/html/cart1.html>. Acesso em: 12 ago. 2020.

KRAUS, D. Consolidated data analysis and presentation using an open-source add-in for the Microsoft Excel® spreadsheet software. **Medical Writing**, v. 23, n. 1, p. 25–28, 2014.

LAMAS, I. R. *et al.* **Observação de Aves na Costa do Descobrimento:** educação, conservação e sustentabilidade. Rio de Janeiro: Conservação Internacional, 2018.

LEWIS, C. L.; GRANEK, E. F.; NIELSEN-PINCUS, M. Assessing local attitudes and perceptions of non-native species to inform management of novel ecosystems. **Biological Invasions**, v. 21, n. 3, p. 961–982, 2019.

MAMEDE, S.; BENITES, M. Identification and mapping of hotspots for observation of birds based on social and environmental indicators: tourism routing fo Campo Grande, MS. **Revista Brasileira de Ecoturismo**, v. 13, n. 2, p. 409–434, 2020.

MARTÍNEZ, C. Food and Niche Overlap of the Scarlet Ibis and the Yellow-crowned Night Heron in a Tropical Mangrove Swamp. **Waterbirds**, v. 27, n. 1, p. 1–8, 2004.

MARTINEZ, C.; RODRIGUES, A. A. F. Breeding Biology of the Scarlat Ibis on Cajual Island, northern Brazil. **Journal of**

Ornithology, v. 70, n. 4, p. 555–666, 1999.

MATOS, F. O.; ARAÚJO, L. L. B. Considerações sobre a regionalização do turismo no “meio-norte” brasileiro. **Caminhos de Geografia**, v. 14, n. 46, p. 38–49, 2013.

MIRANDA, J. P.; COSTA, J. C. L.; ROCHA, C. F. D. Reptiles from Lençóis Maranhenses National Park, Maranhão, northeastern Brazil. **ZooKeys**, v. 246, p. 51–68, 2012.

NUNES, A. C. DE P. *et al.* Percepção ambiental na proposição de indicadores para avaliação de impactos ambientais de parques eólicos. **Confins**, v. 41, n. 1, p. 1–45, 2019.

OLIVEIRA, A. P.; PEREIRA, B. Turismo de base comunitária na Amazônia Legal brasileira: organização da atividade ou estratégia de marketing? **Revista Brasileira de Ecoturismo**, v. 12, n. 4, p. 488–505, 2019.

OLIVEIRA, L. Percepção ambiental. **Revista Geografia e Pesquisa**, v. 6, n. 2, p. 56–72, 2009.

OLMOS, F.; SILVA E SILVA, R. **Guará**: ambiente, flora e fauna dos manguezais de Santos-Cubatão Brasil. São Paulo: Empresa das Artes, 2003.

PACHECO, J. F. *et al.* Annotated checklist of the birds of Brazil by the Brazilian Ornithological Records Committee – Second Edition. **Ornithology Research**, v. 1, n. 29, p. 94–105, 2021.

PEREIRA, O. A. *et al.* Diversidade de aves em parques eólicos na APA Delta do Parnaíba, nordeste, Brasil. **Gaia Scientia**, v. 13, n. 4, p. 109–129, 2019.

PIACENTINI, V. Q. *et al.* Annotated checklist of the birds of Brazil by the Brazilian Ornithological Records Committee. **Revista Brasileira de Ornitologia**, v. 23, n. 2, p. 91–298, 2015.

PINHEIRO, R. T. Birdwatching tourism in the Protected Area of the Ilha do Bananal, Cantão Region (TO, Brazil). **Revista Brasileira de Ecoturismo**, v. 12, n. 4, p. 400–433, 2019.

PINHO, T. R. R.; DANTAS, E. W. C.; SANTOS, J. DE O. Turismo e sustentabilidade em comunidades costeiras: reflexões sobre

mudanças socioambientais em Jericoacoara (CE) e Barreirinhas (MA). **Revista Brasileira de Ecoturismo**, v. 12, n. 4, p. 531–562, 2019.

RODRIGUES, A. A. F. Ocorrência da reprodução de *Eudocimus ruber* na ilha do Cajual, Maranhão, Brasil (Ciconiiformes, Threskiornithidae). **Ararajuba**, v. 3, n. 1, p. 67–68, 1995.

RODRIGUES, A. A. F. Seasonal abundance of Neartic Shorebird in the Gulf of Maranhão, Brazil. **Journal of Field Ornithology**, v. 71, n. 1, p. 665–675, 2000.

RODRIGUES, M. L. *et al.* Vascular flora of lençóis maranhenses national park, maranhão state, brazil: Checklist, floristic affinities and phytophysionomies of restingas in the municipality of Barreirinhas. **Acta Botanica Brasilica**, v. 33, n. 3, p. 498–516, 2019.

SALDANHA, M. A. *et al.* Diagnóstico do emprego turístico gerado na cidade de Barreirinhas (MA). **Revista Brasileira de Ecoturismo**, v. 10, n. 2, p. 466–497, 2017.

SÁNCHEZ-RIVERO, M.; SÁNCHEZ-MARTÍN, J. M.; RANGEL, M. C. R. Characterization of birdwatching demand using a logit approach: Comparative analysis of source markets (National vs Foreign). **Animals**, v. 10, n. 6, p. 1–19, 2020.

SANTANA, C. S. C. DE M.; NASCIMENTO, M. A. L.; MARQUES-JUNIOR, S. Fatores que afetam o apoio dos residentes ao desenvolvimento do turismo em áreas naturais protegidas. **Revista Brasileira de Pesquisa em Turismo**, v. 14, n. 2, p. 156–172, 2020.

SANTOS, F. C. V. *et al.* O Potencial do Birdwatching na Área de Proteção Ambiental do Delta do Parnaíba (Piauí, Brasil). **Revista Brasileira de Ecoturismo**, v. 12, n. 5, p. 854–865, 2019.

SCHERER, F. A. S.; BALDIN, N. A representação social do Guará (*Eudocimus ruber*) nas falas e percepções das comunidades ribeirinhas de Guaratuba (PR): a educação ambiental necessária. **Desenvolvimento e Meio Ambiente**, v. 31, n. 1, p. 61–75, 2014.

SICK, H. **Ornitologia brasileira**. Rio de Janeiro: Nova Fronteira, 1997.

Perception about wind farm-related impacts on *Eudocimus ruber* (Linnaeus, 1758) birdwatching ecotourism in Pequenos Lençóis Maranhenses, NE, Brazil

Francisco das Chagas V. Santos · Roseli F. Melo de Barros · Anderson Guzzi

SILVA, J. A. D. DA. Birdwatching como uma proposta de valorização do espaço ecoturístico da Lagoa Rodrigo de Freitas, Rio de Janeiro (RJ). **Revista Brasileira de Ecoturismo**, v. 13, n. 3, p. 587–599, 2020.

SOARES, A. M. C.; MARQUES JÚNIOR, S.; CHAGAS, M. M. DAS. Fatores que afetam o comportamento ambiental de residentes em destinos turísticos costeiros. **Revista Turismo em Análise**, v. 29, n. 2, p. 196–215, 2018.

SOARES, R. K. P.; RODRIGUES, A. A. F. Distribuição espacial e temporal da avifauna aquática no Lago de Santo Amaro, Parque Nacional dos Lençóis Maranhenses, Maranhão, Brasil. **Revista Brasileira de Ornitologia**, v. 17, n. 3–4, p. 173–182, 2009.

VIEIRA, I. R. *et al.* Percepção de extrativistas sobre os buritizais na região dos Lençóis Maranhenses, Brasil. **Sociedade & Natureza**, v. 31, n. 1, p. 1–15, 2019.