



Tourist Activity and Disturbances over Nearctic Migratory Birds on the Coast of Piauí State, Brazil

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Keywords

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Abstract

The bird migration phenomenon makes thousands of individuals displace between different sites for feeding and breeding purposes. These displacements often make these birds cross geopolitical borders. This behavior is crucial for the survival of many species; however, anthropogenic impacts affect their habitats and contribute to bird–population decline. In light of the foregoing, the aims of the present study are to analyze disturbances caused by touristic activities over migratory birds who visit the estuaries of Cardoso and Camurupim rivers on the coast of Piauí State, and to suggest measures aimed at mitigating disturbances over birds. Samples were collected at three observation points to analyze changes in bird behavior, in response to touristic activities in these sites. Binoculars, a camera and a laser rangefinder were used to help drawing impact zones. Although several touristic activities are performed in the herein assessed region, the main disturbance in it is caused by both kitesurf practitioners and tourists who walk by these species' feeding or resting zones. *Calidris minutilla*, *Calidris pusilla*, *Calidris alba*, *Actitis macularius* and *Charadrius semipalmatus* were the species least sensitive to disturbances, and they more often reacted to them within impact zones $Z = 0-30\text{m}$ and $Z = 30-60\text{m}$, whereas species *Pluvialis squatarola*, *Numenius hudsonicus*, *Tringa melanoleuca*, *Calidris canutus*, *Limnodromus griseus* and *Pandion haliaetus* flee to distances. Based on the current results, kitesurfing and tourists walking by these sites account for the main impact on migratory birds in this region. This finding highlights the need of taking measures to mitigate such impacts. Accordingly, creating minimum protection zones to cover distances ranging from 160m to 200m radius is a recommendation to mitigate disturbances caused by bathers and kitesurf practitioners' approaching.

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INTRODUCTION

Tourism is the main economic activity on the globe and it is based on exploring natural and cultural resources in a given space (Sancho, 2022; Medeiros e Chávez, 2022). Based on the World Tourism Organization, tourism accounts for one of every four job positions on the planet, besides being responsible for 10.4% of the global GDP (Ribeiro e Alcântara, 2023).

According to Brasil (2023), ecotourism was the main reason for one out of every four leisure trips taken in Brazil in 2021. Based on the international ranking disclosed by The North American Forbes, Brazil was the best country in the world for ecotourism (Forbes Advisor, 2023). This news report highlighted Brazilian aspects such as that 30% of this country's territory comprised Conservation Units, besides the country's eight sites belonging to UNESCO World Natural Heritage (Brasil, 2023).

The Brazilian Association of Ecotourism (Associação Brasileira de Ecoturismo / Abeta – in Portuguese) (2022) defines sustainable natural and cultural patrimony using as a feature of the ecotourism sector, as well as conservation encouragement, ecological and environmental awareness development, environmental interpretation and well-being promotion for local populations involved in tourist activities. The aforementioned definition is substantiated by studies about ecotourism carried out by Gomes *et al.* (2021) and Val *et al.* (2022). Therefore, watching birds is an eco-touristic practice based on responsibly and sustainably exploring natural resources, such as biodiversity (Santos *et al.*, 2022). Yet, other studies have shown that bird watching can help conserving nature in different ways, as pointed out by Ribeiro and Silva (2016), Pereira (2017) and Lopes and Santos (2019). These authors have concluded that this activity can increase the awareness of both local populations and tourists about the need to conserve birds and their habitats, besides creating new income sources for local communities, a fact that can help protect natural sites. Bird watching is also a way to encourage social mobilization to develop nature-conservation public policies and to implement environmental education programs.

Tourism can be taken as a socioeconomic activity supported by people's displacement for a given period of time. Such a process subjects visited territories to visitors' presence and to consequent conflicts related to territorializing

spaces turned into touristic places. This process often leads to these spaces mischaracterization, to the re-territorialization of local symbols, as well as to conflicts inherent to the close relationship between tourists and residents (Castrogiovanni, 2013; Malta *et al.*, 2022). Thus, analyzing the impacts of tourist activities on birds' behavior implies elements inherent to these territories' regulation.

Accordingly, a tourism sector committed to the development of certain locations focuses on potentiating territories' natural, cultural, social and economic elements, based on dialogic relationships set with several actors who set their multiple territorialities on them (Pinheiro *et al.*, 2011; Melo *et al.*, 2021). It is essential mentioning that tourist activities take place in a disorderly way on the coast of Piauí State, Brazil, because they do not lead to economic development, besides having a strong negative impact on the local fauna and flora, which potentially attract tourists (Moura-Fé, 2015; Braga *et al.*, 2022).

When it comes to the spatial context of tourist activities, Barra Grande District, Cajueiro da Praia municipality, Piauí State, Brazil, is the location on Piauí's coastal region mostly presenting tourism growth in the last 15 years (Braga; Guzzi, 2021). According to Borges (2018), Putrick (2019) and Braga and Guzzi (2021), the main touristic activities carried out in the assessed territory regard the following segments: adventure, sun and beach, and sports tourism. Most visitors are attracted by the almost deserted beaches, by the quality of restaurants and by the hosting means (Araújo; Ros, 2014; Borges, 2018). Weather conditions, such as little rainfall, heat and strong winds are positive aspects forming the ideal conditions for sports practicing in this Brazilian region (Pereira; Dantas, 2019).

Migratory birds on the coast of Piauí State, Brazil

Most Nearctic migratory birds are long-distance migrants loyal to and dependent on wintering grounds to maintain their life cycle (Mestre *et al.*, 2010; Swift *et al.*, 2020). Birds change their plumage and recover their energy reserves in these places to get ready to return to their reproduction grounds on the Northern Hemisphere (Schulz-Neto *et al.*, 2008). However, their dependence on specific habitats, in association with the multiple risks faced by them during the migration process, make them prone to population decline (Hardesty-Moore *et al.*, 2018), a fact that leads to considerable

losses for their populations (Rosenberg *et al.*, 2019).

It is important to highlight habitat fragmentation and loss, hunting, invasion by exotic species, climate changes, aquatic environment draining and real estate speculation as the main threats posed to these birds (Lees *et al.*, 2022; Mestre *et al.*, 2010). Besides, human presence, itself, can be a threat because birds can see humans as likely predators (Cestari, 2008; Yasué, 2005). Furthermore, increased people flow in birds' feeding grounds can make them reduce their foraging time, and it affects energy accumulation, which is essential for them to cross their long migration routes (Swift *et al.*, 2020).

If one has in mind that Nearctic migratory birds contribute with approximately 40% of birds' biodiversity on coastal regions (Campos *et al.*, 2008), tourism increase in them can have impact on these birds' population, because they are highly vulnerable to human-leisure activities, mainly in coastal environments (Cardoso; Cestari, 2008; Cardoso; Nascimento, 2007). According to Navedo *et al.* (2019), no matter if there is a low density of people in a given region, birds can significantly reduce their foraging opportunities in these areas, and it can affect species' physical conditions necessary for their migration process.

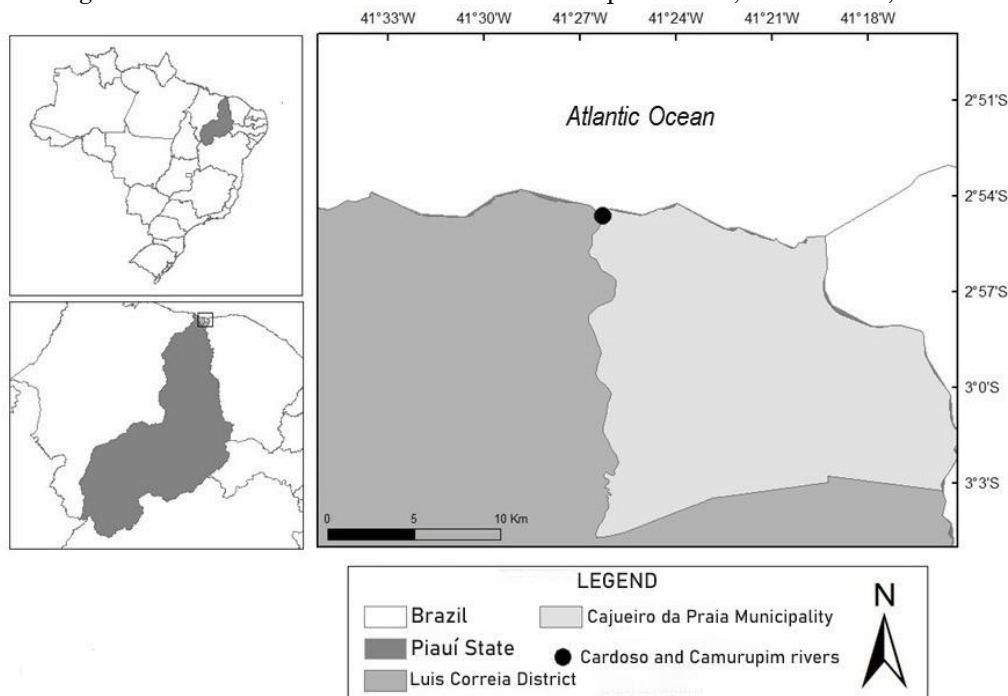
Thus, the aims of present study were to analyze the impact of touristic activities over Nearctic migratory birds visiting the estuaries of Cardoso and Camurupim rivers, and to suggest measures to mitigate disturbances posed to them. These outcomes may contribute to guide protection measures applied to birdlife at Área de Proteção Ambiental Delta do Parnaíba (Delta do Parnaíba Environmental Protection Area). It can also support processes to order touristic activities in the herein assessed region.

MATERIALS AND METHODS

Study site

The study site covered the estuaries of Cardoso and Camurupim rivers, which are located in Western Piauí State, Brazil, at coordinates 02°54'52" S and 41°26'28" W (Figure. 1). This location lays on Área de Proteção Ambiental Delta do Parnaíba, which was launched through Federal Decree issued on August 28, 1996, to protect the coastal ecosystem formed by dunes and mangroves. This area covers the coast of Piauí State, and part of Maranhão and Ceará states, Brazil (Araújo; Gomes, 2017; ICMBio, 2020).

Figure 1 – Estuaries of Cardoso and Camurupim rivers, Piauí State, Brazil.



Source: Elaborated by the authors (2023).

The study site is influenced by semi-diurnal tides (up to 3m) at syzygy periods (Mai; Rosa, 2009), when the low tide provides broad muddy habitat areas important for migratory birds' foraging (Silva; Rodrigues, 2015). Climate in this region is of the Aw type: tropical, with seasonally distributed rainfall – maximum rainfall is recorded in October (Rocha, 2016; Costa e Passos, 2023).

Data collection and analysis

Previous visits were made to the sites in order to choose the sampling points. It was done in such a way to better identify the feeding grounds of birds who suffer the most from touristic and sports activities, such as kitesurf practicing, sailing, banana boat riding, jet skiing, kayaking, and from the large numbers of bathers. In total, 3 watching points were selected and they were placed 500m from each other. These points were taken as feeding grounds of birds suffering from high touristic activity interference.

Data were collected between March and October 2019, from 08:00 am to 12:00 pm or from 02:00 pm to 06:00 pm, during two monthly expeditions – collection took into account the times of higher touristic activity in the region. Researchers would remain 100m away from the birds, on average, after getting to the watching point, so they would be able to see the flocks or the individuals, alone. Watching would allow identifying the species based on the method by Pacheco *et al.* (2021), with the aid of 8x50 binoculars and a camera.

One single individual was selected for analysis after species identification, and this specimen would be classified as a focal individual (Altmann, 1974). Each point would be sampled for approximately 2 hours, in each expedition. Before starting the watching process, researcher would wait up to 20 minutes before start taking notes. It was done to avoid likely disturbances in the behavior of birds due to researchers' arrival at the watching point. Similarly, researchers would wait 15 minutes before starting a new analysis in the same location after recording any disturbance in the individual's behavior.

Disturbances over birds were analyzed at times tourists would approach them, be it by walking by them or by performing leisure and sports activities (kitesurfing, sailing, banana boat riding, kayaking). Pre-determined categories were created to record changes in birds' behavior in response to the following

activities: vocalizing, stop feeding, running away and flying away (these categories are seen as 'initial flight distance', which consists of the exact distance from which birds started fleeing from the activities) (Blumstein *et al.*, 2003). These distances were represented by impact zones that, in their turn, were categorized as follows: Z = 0-30m, Z = 31-60m, Z = 61-90m, Z = 91-120m, Z = 121-150m, Z = 1501-200m and Z = >200m (it corresponds to the radius where birds had some sort of fleeing reaction). Laser rangefinder (900m range – distance accuracy of ± 1 m) was used to help set the impact zones and to measure the distance in which activities could cause disturbances over birds.

Species' name was recorded during the sampling process, as well as whether the bird was alone or in a flock, the number of individuals in the flock, foraging or resting behavior, and the touristic activity being performed close to focal birds. In case two or more activities were simultaneously observed around focal birds, the sample was discarded, because the bird's fleeing response could be ultimately attributed to the human activity in the site. The herein-adopted methodology followed adjustments made by Stolen (2003). Data analysis was carried out through graphic plotted in R statistic software.

RESULTS

There were 138 records of disturbances caused by touristic activities over 14 Nearctic migratory bird species belonging to families Charadriidae, Scolopacidae and Pandionidae. These species were *Calidris minutilla*, *Actitis macularius*, *Calidris pusilla*, *Charadrius semipalmatus*, *Calidris alba*, *Arenaria interpres*, *Pluvialis squatarola*, *Calidris canutus*, *Tringa flavipes*, *Numenius hudsonicus*, *Tringa semipalmata*, *Tringa melanoleuca*, *Limnodromus griseus* and *Pandion haliaetus* (Figure 2). Most species presented least concern (LC) threat status; however, species *C. canutus* and *C. pusilla* are globally seen as Near Threatened with Extinction (NT) (IUCN, 2019), while in Brazil, *C. pusilla* is classified as an endangered species (EN), whereas *C. canutus* is categorized as a Critically Endangered (CR) species, just as species *L. griseus* (ICMBio, 2018).

Figure 2 - Birds registered in the study site



Legend: (A) *Calidris alba*, (B) *Calidris canutus*, (C) *Calidris minutilla*, (D) *Calidris pusilla*, (E) *Limnodromus griseus*, (F) *Numenius hudsonicus*, (G) *Tringa semipalmata*, (H) *Tringa melanoleuca*, (I) *Actitis macularius*, (J) *Arenaria interpres*, (K) *Pluvialis squatarola*, (L) *Charadrius semipalmatus*.

Source: Elaborated by the authors (2023).

Although several touristic activity types are observed in the study site, such as kayaking, jet skiing and banana boat riding, disturbances over birds in this location were mainly caused by both kitesurf practitioners and tourists

walking by birds' feeding and resting grounds (Figure 3). The other activities were performed outside the impact zones, so disturbances over birds were not recorded.

Figure 3 - Touristic activities recorded in birds' feeding and resting grounds.

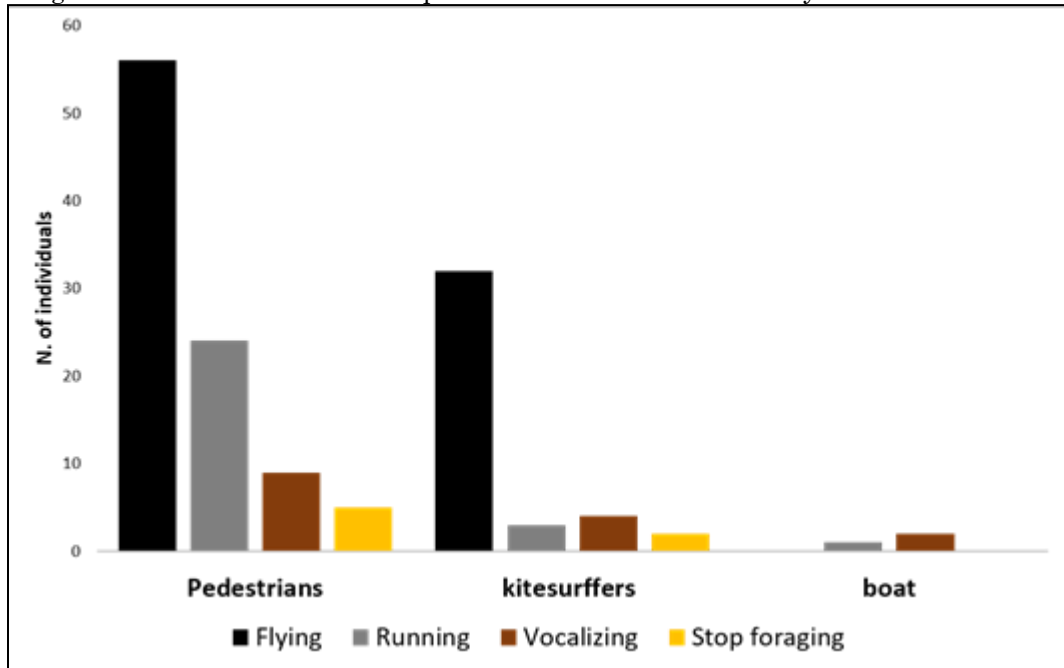


Source: Elaborated by the authors (2023).

If one takes into account birds' behavior at disturbance times, it is possible to observe that 64% of these registers were recorded at foraging time, and other disturbances took place at birds' resting time. The highest disturbances (66%) were posed to birds gathered in flocks, whereas 34% of them were

recorded for individuals, alone. Birds' main fleeing behavior in response to the approach of walking tourists lied on scaping the location by fleeing away (60%), and the same happened because of tourists who were kitesurfing (78%) (Figure 4).

Figure 4 – Birds' behavior in response to disturbances caused by touristic activities.

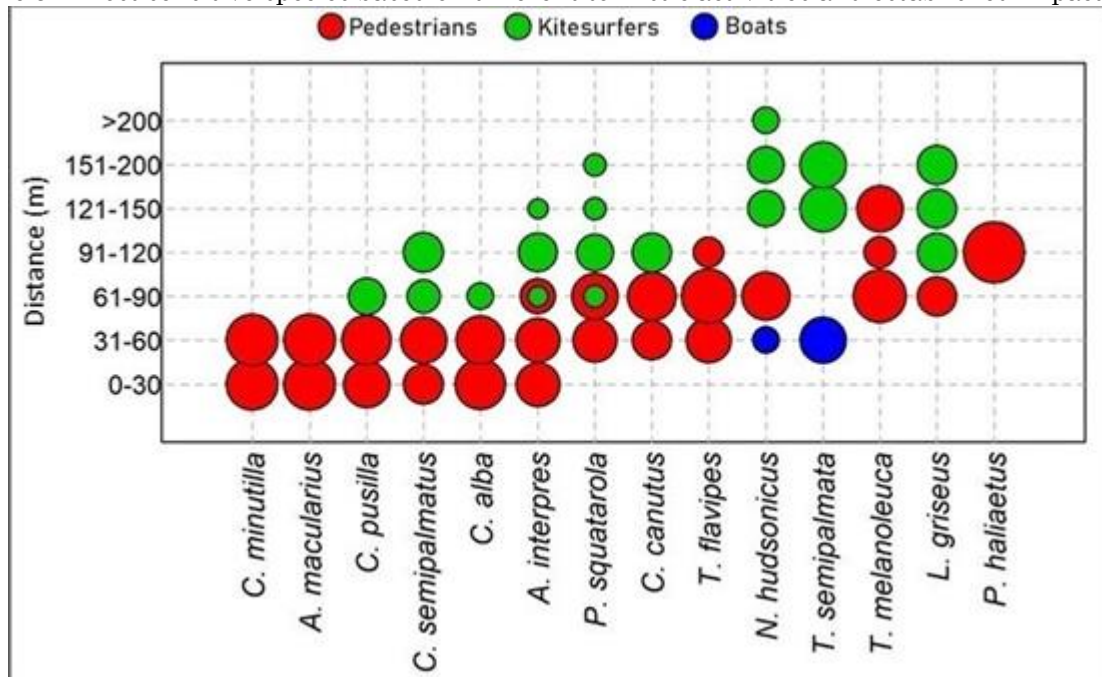


Source: Elaborated by the authors (2023).

C. minutilla, *C. pusilla*, *C. alba*, *A. macularius* and *C. semipalmatus* were the species least sensitive to disturbances caused by bathers if one takes into consideration the different impact zones. These species were also the ones recording higher response frequency between impact zones $Z = 0-30m$ and $Z = 31-60m$, whereas species *P. squatarola*, *N. hudsonicus*, *T. melanoleuca*, *C. canutus*, *L. griseus* and *P. haliaetus* were the most sensitive to disturbances, since their response

to disturbances was always longer than 31m in distance. Birds have shown more sensitivity to kitesurf practitioners, because this sports modality necessarily needs to get practitioners closer to birds and it makes them fly away, although bathers' approach to them have led to the highest disturbance rates. On the other hand, disturbances caused by kitesurf practitioners have made birds flee to distances longer than 60 m – some disturbances led to distancing longer than 200 m (Figure 5).

Figure 5 – Most sensitive species based on different touristic activities and established impact zones



Source: Elaborated by the authors (2023).

DISCUSSION

Some touristic activities caused disturbance over Nearctic migratory shorebirds that winter in the estuaries of Cardoso and Camurupim rivers, and it interfered with their foraging and resting processes, besides stressing these species. These disturbances can have a negative impact on migratory birds' populations because unnecessary anthropic disturbances increase these animals' energy expenditure due to their sudden flights (Vooren; Chiaradia, 1990).

Disturbance increases in coastal zones in combination to birds' short foraging time during the low tide can have a negative effect on species' energy accumulation, since prey intake becomes insufficient (Burger *et al.*, 2004; Navedo *et al.*, 2019). Yasué (2005) reports that birds can reduce foraging rates rather than moving out to different habitats when there are only a few alternative feeding habitats available, and it makes the problem even worse.

Disturbance-distancing reaction changed between species, but smaller birds like *C. pusilla*, *C. minutilla*, *A. macularius*, *C. semipalmatus* and *C. alba* were less sensitive to the approach by walking tourists – they allowed approximation by 15 m. Similar results were observed by Koch and Paton (2014),

according to whom, small-sized birds were more tolerant to the presence of pedestrians, and it allowed people to approach up to 20 m before birds had any disturbance reaction. They also stated that big-sized species like *P. squatarolla* often react with distances longer than 50m. The same behavior was herein observed, mainly by species *C. canutus*, *L. griseus*, *T. flavipes*, *T. melanoleuca*, *T. semipalmata*, *N. hudsonicus* and *P. haliaetus*.

Some individuals belonging to species *A. interpres*, *C. semipalmatus* and *C. alba* made short flies and landed a few meters from the initial disturbance point; they would return to the same place after the disturbance was over. This finding can provide signs of these animals' adjustment to human presence (Cestari, 2008). Such a behavior can be a potential issue, since it makes birds more vulnerable to hunting, which is one of the anthropic practices most often affecting birds during their migration process (Gallo-Cajiao *et al.*, 2020).

Although most disturbances were caused by tourists who walked by birds' feeding and resting grounds, the assessed species have shown more sensitivity to kitesurf practitioners, because the fleeing reaction to them was always longer than 60m in distance. Kitesurf is a nautical sports modality linked to the adventure-tourism segment. Kitesurf practitioners make maneuvers with their boards while they slide on the water and in the air, with the aid of a kite (Abeta, 2022). The

kite's folio-shaped structure and moves in the air can be confused with the hunting behaviors of preying birds that are considered potential migratory bird predators (Menq, 2013; Cresswell; Whitfield, 1994).

According to Voorem and Chiaradia (1990), the area used by coastal birds turns inadequate when human presence in it exceeds a given disturbance level. However, based on the herein presented data, these conditions cannot be enough to scare birds from these locations, although touristic activities and kitesurfing can cause disturbance over migratory birds visiting the estuaries of Cardoso and Camurupim rivers. It is so, because several species still use estuaries as pit-stop points. However, it is important to highlight that it is necessary to implement mitigating measures to reduce negative impacts on local birdlife, since the study site accounts for high potential for tourism development.

It is worth highlighting sports modalities, such as kitesurf, among recorded touristic activities, since this modality has been growing in Brazil. It is broadly outspread in Northeastern Brazil from August to December, due to this region's geomorphological and climatic features, which provide strong winds at this time of the year (Pereira; Dantas, 2019). This is such a worrisome fact, if one has in mind that this time meets the wintering period of several Nearctic migratory bird species on the coast of Piauí State and in Northeastern Brazil, as a whole, where one also finds several wintering grounds (Cardoso *et al.*, 2023; Oliveira *et al.*, 2016; Telino-Júnior *et al.*, 2003). Krüger (2016) concluded that kitesurf practice can generate strong disturbance stimulus over birds, even if only one single practitioner is found on the site. These authors also highlight that kitesurf practicing only loses positions to speedboat sailing and jet skiing when it comes to activities related to the aquatic environment like windsurfing, sailboats, rowing boats, canoes and kayaks.

However, adopting mitigating measures can help reduce disturbances over birds. According to Burger *et al.* (2004), installing information plates, regulations and inspections, in association with environmental education, can be actions taken to reduce anthropic disturbances in birds' feeding and resting grounds, as well as create protection zones in locations where one finds intense pedestrian traffic, mainly at migration-time peak. Thus, based on Koch and Paton (2014), setting protection zones within a 185m radius would be

a proper protection measure to prevent disturbances over the most sensitive species.

FINAL CONSIDERATIONS

Results in the current study have shown that touristic activities in the estuaries of Cardoso and Camurupim rivers were a threat to migratory birds that winter in this region. It is so, because these birds suffer from disturbances mainly caused by bathers' circulation and by kitesurf practitioners, since these activities interfere with species' feeding and resting periods in this ground. Accordingly, implementing protection zones to reduce disturbances resulting from these activities is essential to mitigate such impacts.

Thus, it is recommended to create appropriate protection zones to minimize disturbances caused by pedestrians' approach distances shorter than 160m (200m protection zones are recommended to mitigate disturbances caused by kitesurf practitioners). In addition, the installation of information plates, inspection and environmental education are also actions capable of helping mitigate these impacts on this region. These measures still can be adopted in management plans applied to Área de Proteção Ambiental Delta do Parnaíba in order to make tourism development and migratory birds' conservation in this Conservation Unit feasible.

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AUTHOR CONTRIBUTION

Airton Janes da Silva Siqueira and Anderson Guzzi conceived the study, collected and analyzed the data and wrote the text. Muryllo dos Santos Nascimento collected data, wrote and revised the final text. Suely Silva Santos and Solano de Souza Braga wrote, reviewed and edited the final text.



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