

Migrant birds present on Ilha Comprida, southern coast of the State of São Paulo

Edison Barbieri^{1,*}, Karina Anahi Ávila Esparza²

¹ Instituto de Pesca - Agência Paulista de Tecnologia dos Agronegócios (APTA) - Governo do Estado de São Paulo (Av. Professor Besnard s/n. Cananéia - 11990-000 - SP - Brazil)

² Universidade Estadual Paulista "Júlio de Mesquita Filho" - Instituto de Biociências - PPG Biodiversidade Aquática - Campus Litoral Paulista (Praça Infante Dom Henrique s/n^o - Parque Bitaru - 11.330-900 - São Vicente - Caixa Postal 73601 - SP - Brazil)

* Corresponding author: edisonbarbieri@yahoo.com.br

ABSTRACT

The present study sought to provide information on the variations in abundance of migratory bird populations in relation to seasonality, reinforcing the significance of Ilha Comprida on the migration route, as a stopping point for this fauna group's resting and feeding. The Ilha Comprida beach was travelled by car during low tide, at an average speed of 40 km/h, following a 70-km by 200-meter predetermined transection. During the study period between January and December 2016, a total of 9134 individuals from 26 species of migratory birds were registered. This environment receives migrant species from both the Northern and Southern Hemispheres, increasing species richness primarily in September and October. The lowest wealth of birds and smallest number of individuals was recorded on the beach during June, July, and August. This study shows that many birds leave Ilha Comprida in late May and return in September.

Descriptors: Abundance, Migratory, Bird, Populations, Seasonality.

INTRODUCTION

Migratory birds have an extraordinary ability to travel long distances (Hayman et al., 1986; Antas, 1989; Morrison et al., 1989; Sick, 1997; Azevedo Jr. et al., 2002; Alerstan et al., 2003; Barbieri et al., 2007; Nunes and Tomas, 2008, Somenzari et al., 2018, Jahn et al., 2020). During the winter, the low supply of food resources combined with endogenous factors induce the migration of several species from the Northern and Southern Hemispheres to feeding sites or wintering areas in neighboring countries or other continents. They then return to their breeding sites at the beginning of spring

(Hayman et al., 1986; Antas, 1989; Antas, 1994; Azevedo Jr. et al., 2002; Nunes and Tomas, 2008, Somenzari et al., 2018, Jahn et al., 2020).

The Cananéia-Iguape-Ilha Comprida estuary region is visited by thousands of birds making seasonal movements from North America to South America and *vice-versa* (Barbieri and Paes, 2008). Among these, those that migrate with the near the boreal winter stand out (Barbieri et al., 2013). Seeking wintering places and rest stops, migrants come to the Lagamar region, with its wide variety of environments to find abundant food (Numao and Barbieri, 2011), providing continuity of their life cycle.

The migratory birds that arrive at the Cananéia-Iguape-Ilha Comprida Estuary can be subdivided into two groups: Nearctic and Neotropical. Nearctic birds are considered the great migrants,

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as they perform trans-equatorial migration and fly over 20,000 kilometers from breeding points in the Arctic to Brazil, along the Atlantic coast and through central Brazil, crossing the Pantanal until reaching the south of the continent towards Patagonia (Argentina and Chile), the main point of concentration of these birds (Sick, 1997, Somenzari et al., 2018).

Migrating birds of species from the Northern Hemisphere (United States, Canada, and Mexico), countries in Central America, the south of the continent (Argentina, Chile and Uruguay), and even Antarctica arrive in Brazil (Sick, 1997, Jahn et al., 2020). The group from the Northern Hemisphere is concentrated in several points in Brazil, mainly in two regions in the North commonly known as Salgado Paraense, Pará and the Reentrâncias Maranhenses, Maranhão (Nunes and Tomas et al., 2008, Somenzari et al., 2018). The third point of largest concentration is the Lagoa do Peixe National Park, Rio Grande do Sul (Sick, 1997, Somenzari et al., 2018). Species making regional displacements between the Cananéia-Iguape-Ilha Comprida Estuary and the central (Pantanal) and south regions, such as Cormorans (*Nannopterum brasilianus*) and Spoonbills (*Platalea ajaja*) (Numao and Barbieri, 2011), migrate according to seasonality. According to Delchiaro et al. (2020), they come from the South, are represented by a few species of migrants, and are mostly water birds.

Barbieri and Paes (2008) identified 52 species of birds that frequent the beach of Ilha Comprida based on the inventories and collections already carried out in this area. Although there are few studies, it is essential to emphasize the importance of the lagoon Estuary complex of Cananéia-Iguape-Ilha Comprida for birds, mainly because it supports an extraordinary abundance of water birds (Barbieri et al., 2013) and acts as an important migration route for visitors seasonally leaving the South of the continent or Northern Hemisphere (Delchiaro et al., 2020). However, little is known about the species that use Ilha Comprida as a stopping and wintering site during migratory movements, be they large-scale or regional migrants.

Due to the long stretch of beach, Ilha Comprida is more favorable to urbanization for tourism than the municipalities of Cananéia and Iguape. Major

activities in Ilha Comprida beach are boating, fishing, surfing, kayaking, parasailing, windsurfing, and other water sports. As the island is 70 km long, it is also used as a transportation route for vehicles between the South and North. In addition to the beach, the tidal range, substrate composition, and high productivity of the lagoon Estuarine complex, Ilha Comprida can be considered the most important stopping point in southeastern Brazil for species of the Charadriidae and Scolopacidae families (Barbieri and Pinna, 2007). Moreover, it is part of the Cananéia-Iguape-Paranaguá Estuarine-lagoon complex, considered by IUCN (1992) as one of the most productive environments in the South Atlantic and still well conserved.

Given the importance of the region, the present study sought to provide better information on the monthly variations in abundance of migratory bird populations, reinforcing the significance of Ilha Comprida on the migration route as a stopping point for the resting and feeding for this fauna group. In addition to the importance of the region, noting the monthly variation in richness and abundance of migratory birds has important management implications.

STUDY AREA

The studied area is located in the extreme south of the State of São Paulo where the Serra do Mar ridge recedes, forming the hydrographic basin of the Ribeira de Iguape river, whose mouth marks the northern limit of the Cananéia-Iguape Estuarine-lagoon Complex –Paranaguá, with Ilha Comprida in the central region. This island is approximately 70 km long and 3 km wide on average. It is intersected by small streams, making it attractive to birds and other animals (Figure 1). Ilha Comprida beach consists of a long sandy strip with fine-grained, homogeneous sediment and a low slope, characterized as a dissipative beach type. Ilha Comprida is a quaternary barrier island of recent sedimentation, predominantly marine, formed by the accumulation of sandy materials (Barbieri et al., 2013). It results in a sweeping zone approximately 20 meters long, with high invertebrate densities in this zone (Burger et al., 2004). Astronomical tides have a height of approximately 1.50 meters, with a strong influence of winds.

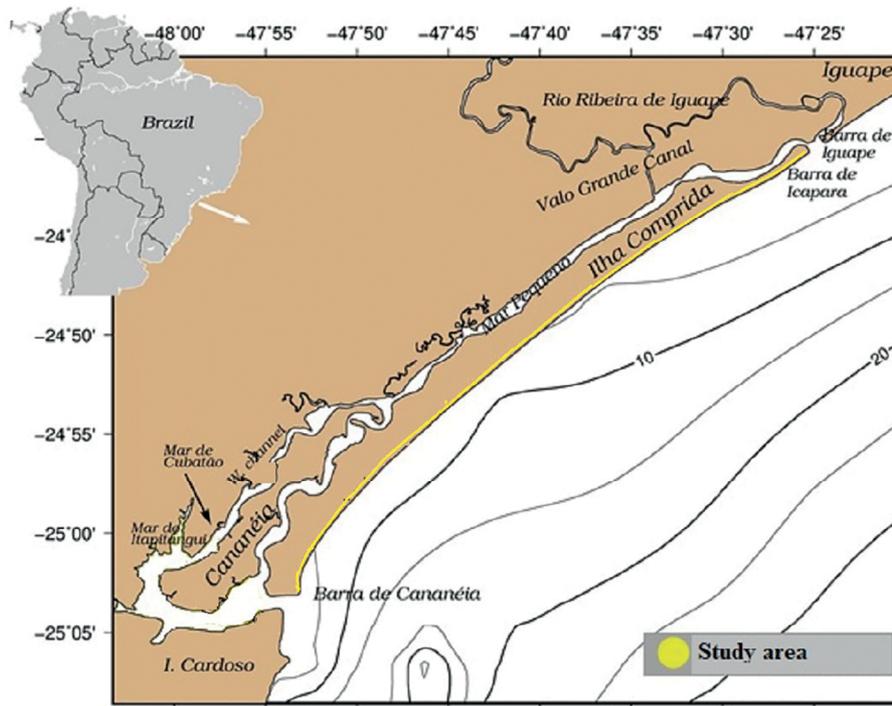


Figure 1. Map of the study area with the location of Ilha Comprida. Itinerary in yellow.

The side facing the continent consists of mangroves with intermareal plains, for an ideal environment for migrants to feed, rest, and recover (Barbieri and Paes, 2008).

METHODS

The records and counts of migratory birds were carried out using the fixed itinerary method, performed weekly in the morning with a minimum observation duration of 2:30 hours and a maximum of 4:00 hours, totaling 610 hours ($2:30 \pm 0:31$ hours/visit) and 43 samples during the study between January and December 2016. The morning period was used for sampling due to the low incidence of southeast wind in the region and lower tides, facilitating traffic of vehicles around the island.

The Ilha Comprida beach was travelled by car during low tide at an average speed of 40 km/h and following a 70-km by 200-meter predetermined transection (Vooren & Chiaradia, 1990; Bibby et al., 1992; Barbieri and Mendonça, 2005). The route traveled always began in the southern part of the island (Boqueirão Sul), proceeding to the north (Canal de Icapara). The birds sighted

were identified using 7X50 and 20X60 binoculars and were counted and photographed.

To estimate the relative abundance (percentage of individuals of a taxon in relation to the total of individuals), the following formula was used: $(n/N) \times 100$, where n is the number of individuals of the species and N the total number of individuals (Dajoz, 1978). The frequency of occurrence of the species was calculated using the formula: $C = p \times 100 / P$ (Dajoz, 1978), where p corresponds to the number of samples of the sighted species and P corresponds to the total number of samples. Depending on the values obtained, the taxa were classified as Constant (present in $> 50\%$ of visits), Accessory (present in 25-50% of visits), Uncommon (present in $< 25\%$ of visits), and Rare (present in $< 1\%$ of visits).

RESULTS

A total of 9134 individuals of 26 species of migratory birds were sighted on the beach of Ilha Comprida. The collected data reinforces that the island receives migratory species from the Northern and Southern Hemisphere, thus

increasing species richness in this environment as it is used for resting and feeding. During the months of June, July, and August, there were fewer species of birds and individuals on the beach, resulting in a decrease in richness of migratory birds (Figure 2).

Thirteen species of migratory birds were found to be rare and one to be uncommon, with the majority being migrants from the Northern Hemisphere (23) and only three species from the Southern Hemisphere (Table 1). The highest abundances were recorded between September and October, suggesting that many birds leave Ilha Comprida in late May and return in September (Table 2).

DISCUSSION

During the spring (August-September), the Nearctic coastal birds of the Charadriidae and Scolopacidae families migrate to wintering areas such as Lagoa do Peixe, Rio Grande do Sul and Tierra del Fuego, Argentina, and then return to breeding areas in the northern hemisphere during the fall (April-May) (Castro and Myers, 1987; Finch, 1991; Holmes and Sherry, 1992; Pereira et al., 1997; Vooren and Brusque, 1999; Azevedo Jr. et al., 2001a,

b, 2002; Nunes and Tomas, 2008, Somenzari et al., 2018, Jahn et al, 2020). According to Sick (1997), Nearctic birds may choose different migratory routes, thus appearing in different regions for each leg of the journey. Moreover, they stop less frequently during northbound migrations (Antas, 1983; Castro and Myers, 1987; Myers et al., 1985a, b; Stotz et al. 1992, Sick, 1997; Nunes and Tomas, 2008).

According to Barbieri and Paes (2008), there were also records of several migratory species from the northern hemisphere along the beach of Ilha Comprida between January 1999 and December 2001. Fifteen species were in common with those of this study: *Charadrius semipalmatus*, *C. modestus*, *Pluvialis squatarola*, *P. dominica*, *Numenius phaeopus*, *Actitis macularia*, *Arenaria interpres*, *Calidris alba*, *C. fuscicollis*, *C. canutus*, *C. melanotos*, *Tringa flavipes*, *T. melanoleuca*, *Sterna hirundo* and *T. maximus*. However, eleven new species were recorded in the present study: *Stercorarius parasiticus*, *S. pomarinus*, *Leucophaeus pipixcan*, *Chroicocephalus cirrocephalus*, *Charadrius falklandicus*, *Charadrius modestus*, *Limosa haemastica*, *Bartramia longicauda*, *Calidris pusilla*, *Phalaropus tricolor*, *Pandion haliaetus*.

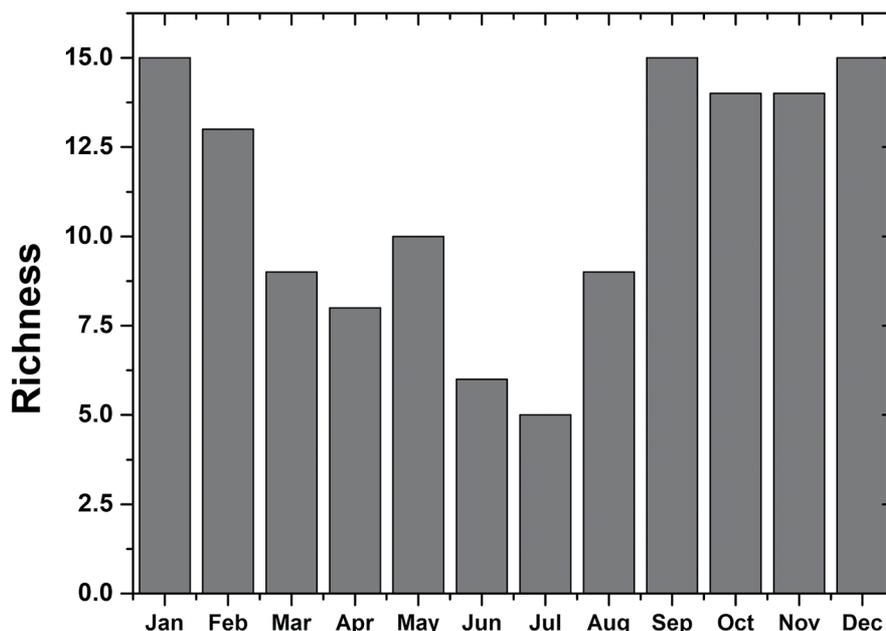


Figure 2. Monthly richness of migratory birds recorded on the Ilha Comprida beach between January and December 2016.

Table 1. Bird species observed in the Ilha Comprida beach environment during the study period. Ecological Categories (EC) are NM (Northern Migrant) and SM (Southern Migrant). N is the total number of individuals, A is the annual average, and AB is the total relative abundance.

Family/Species	EC	Constancy	N	A	AB
Stercorariidae	-	-	-	-	-
<i>Stercorarius parasiticus</i>	NM	Rare	2	0.16	0.02
<i>Stercorarius pomarinus</i>	NM	Rare	2	0.16	0.02
Sternidae	-	-	-	-	-
<i>Sterna hirundo</i>	NM		56	4.66	0.61
<i>Talasseus maximus</i>	NM/SM		230	19.16	2.51
Laridae				-	-
<i>Leucophaeus pipixcan</i>	NM	Rare	1	0.08	0.01
<i>Chroicocephalus cirrocephalus</i>	SM		2	0.16	0.02
Charadriidae		-	-	-	-
<i>Pluvialis dominica</i>	NM	Constant	229	19.08	2.50
<i>Pluvialis squatarola</i>	NM	Constant	53	4.41	0.58
<i>Charadrius semipalmatus</i>	NM	Constant	6606	550	72.32
<i>Charadrius falklandicus</i>	SM	Rare	2	0.16	0.02
<i>Charadrius modestus</i>	SM	Rare	2	0.16	0.02
Scolopacidae					
<i>Limosa haemastica</i>	NM	Rare	3	0.25	0.02
<i>Numenius phaeopus</i>	NM	Uncommon	9	0.75	0.03
<i>Actitis macularius</i>	NM	Rare	2	0.16	0.02
<i>Tringa melanolenca</i>	NM	Rare	2	0.16	0.02
<i>Tringa flavipes</i>	NM	Constant	145	12.08	1.58
<i>Arenaria interpres</i>	NM	Accessory	30	2.5	0.32
<i>Bartramia longicauda</i>	NM	Rare	2	0.16	0.02
<i>Calidris canutus</i>	NM	Accessory	218	18.16	2.38
<i>Calidris alba</i>	NM	Constant	687	57.25	7.52
<i>Calidris pusilla</i>	NM	Accessory	190	15.83	2.08
<i>Calidris fuscicollis</i>	NM	Constant	647	53.91	7.08
<i>Calidris melanotus</i>	NM	Rare	4	0.33	0.04
<i>Tryngites subruficollis</i>	NM	Rare	4	0.33	0.04
<i>Phalaropus tricolor</i>	NM	Rare	4	0.33	0.04
Pandionidae	-	-	-	-	-
<i>Pandion haliaetus</i>	NM	Rare	2	0.16	0.02

There is little information on migratory routes and stopping points along the coast of Brazil (Barbieri et al., 2013). Some authors suggest that coastal Nearctic birds use the Amazonian-central route for migration towards the south and do not mention the Atlantic route (Sick, 1997; Myers et al., 1990; Nunes and Tomas, 2008), but several

works have demonstrated the significance of this migratory route, such as: Lyra-Neves et al. (2004), Cabral et al. (2006), Barbieri (2008), Barbieri and Havenegaard (2008), Barbieri and Paes (2008), Lunardi et al. (2012) and Cestari et al., (2019).

The increase in number of individuals and species of Charadriidae and Scolopacidae in Ilha

Table 2. Monthly number of individuals of migratory birds recorded on the Ilha Comprida beach between January and December 2016.

Family/Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Stercorariidae												
<i>Stercorarius parasiticus</i>	-	-	-	-	-	-	-	-	-	2	-	-
<i>Stercorarius pomarinus</i>	2	-	-	-	-	-	-	-	-	-	-	-
Sternidae												
<i>Sterna hirundo</i>	6	4	-	-	-	-	-	-	6	10	20	10
<i>Talasseus maximus</i>	20	15	20	14	10	20	12	34	25	26	20	14
Laridae												
<i>Leucophaeus pipixcan</i>	-	-	-	-	-	-	-	-	1	-	-	-
<i>Chroicocephalus cirrocephalus</i>	-	-	-	1	1	-	-	-	-	-	-	-
Charadriidae												
<i>Pluvialis dominica</i>	32	24	15	12	-	-	-	16	45	40	25	20
<i>Pluvialis squatarola</i>	4	4	5	-	-	3	-	14	16	4	2	1
<i>Charadrius semipalmatus</i>	750	610	600	400	320	246	250	150	950	850	730	750
<i>Charadrius falklandicus</i>	-	-	-	-	-	-	1	1	-	-	-	-
<i>Charadrius modestus</i>	-	-	-	-	-	-	1	2	-	-	-	-
Scolopacidae												
<i>Limosa haemastica</i>	-	-	-	-	-	-	-	-	-	-	-	4
<i>Numenius phaeopus</i>	2	1	-	-	2	-	-	-	-	-	2	2
<i>Actitis macularius</i>	-	1	-	-	-	-	-	-	-	-	1	-
<i>Tringa flavipes</i>	10	10	10	5	25	10	4	5	19	18	17	10
<i>Tringa melanolenca</i>	-	-	-	-	2	-	-	-	-	-	-	-
<i>Arenaria interpres</i>	-	-	5	-	-	-	-	-	10	10	3	2
<i>Bartramia longicauda</i>	1	-	-	-	-	-	-	-	-	-	-	1
<i>Calidris canutus</i>	10	5	-	-	35	-	-	-	80	50	28	10
<i>Calidris alba</i>	60	40	30	25	35	22	-	50	200	100	80	45
<i>Calidris pusilla</i>	30	25	5	5	20	-	-	-	45	40	10	10
<i>Calidris fuscicollis</i>	60	40	30	35	25	22	-	45	190	80	70	50
<i>Calidris melanotos</i>	-	-	-	-	-	-	-	-	2	2	-	-
<i>Tryngites subruficollis</i>	-	-	-	-	-	-	-	-	2	2	-	-
<i>Phalaropus tricolor</i>	1	-	-	-	-	-	-	-	1	-	1	1
Pandionidae												
<i>Pandion haliaetus</i>	1	1	-	-	-	-	-	-	-	-	-	-
Total of individuals	989	780	720	497	475	323	268	317	1592	1234	1009	930

Comprida during the spring reinforces that this environment is an important stopping point in southeastern Brazil. This record confirming the use of the Atlantic route for several species during the migration to the south (September-October), and is a point for resting and feeding, especially for *Calidris alba* (Barbieri et al., 2013) and *Phalaropus tricolor*

(Barbieri et al., 2010) during their displacement to the south of South America (Barbieri et al., 2003).

Other studies have identified the occurrence of species of the Charadriidae family along the entire Brazilian coast (Vooren and Chiaradia, 1990; Sick, 1997; Branco et al., 2011, Somenzari et al., 2018, Jan et al, 2020), but have not precisely quantified

individuals nor preferred areas throughout the year. Our knowledge is thus sparse with respect to resting and foraging area preferences along the southeastern coast of Brazil for this family. The data from our study provide monthly information about richness and abundances of migratory birds at Ilha Comprida, which is very valuable to island administrators for tourism management, helping avoid impacting these migratory birds.

According to our results, *Pluvialis squatarola* and *P. dominica* are frequent during spring and summer, with migrations in autumn towards the north of the continent. Similar behavior was recorded for *P. dominica* on the Saco da Fazenda, Santa Catarina (Branco et al., 2007), on Cassino beach and on Lagoa do Peixe, Rio Grande do Sul (Vooren & Chiaradia, 1990), in Santa Catarina (Manoel et al., 2011a, b), and in Patagonia, Argentina (Belton, 1984). The energy collected at these sites is essential for their return to the Northern Hemisphere in mid-April (Sick, 1997). In this scenario, Ilha Comprida acts as a stopping point for food and rest, as the energy drawn from feeding enables the continued migration and increases the necessary reserves for reproductive success in breeding areas (Davison and Evans, 1988; Hvenegaard and Barbieri et al., 2010).

It was found that few individuals of *Charadrius semipalmatus*, *Pluvialis dominica*, *Calidris alba*, and *Tringa flavipes* were recorded throughout the year of study on the beach of Ilha Comprida. Most individuals of these species migrate to Praia do Cassino, Lagoa do Peixe (Belton, 1984), and Terra do Fogo (De La Peña, 1986) during the summer. According to Sick (1997), these species return to the Northern Hemisphere for reproduction during our winter, so the flocks observed during this period are likely immature birds that do not return (Belton, 1984; Vooren and Chiaradia 1990; Barbieri and Mendonça, 2005).

Calidris canutus occurred in low abundance on Ilha Comprida and was more common in April and from September to December, similar to the results of Barbieri (2007), Belton (1984), and Telino-Júnior et al. (2003) for other regions of the country. In addition, Vooren and Chiaradia (1990), who studied coastal birds in Rio Grande (RS), and Rodrigues (2000) in the Gulf of Maranhão, registered peaks

between March and May. Our results indicate an increase in individuals in September and October and then in April, thus supporting the hypothesis that Ilha Comprida is used as a stopping point when traveling to wintering locations further south in the country and in Argentina (Morrison et al., 1989). This also applies to *Charadrius semipalmatus*, *Pluvialis dominica*, *P. squatarola*, *Calidris alba*, and *C. fuscicollis* during the return to the Northern Hemisphere (April) and to the foraging areas of the Southern Hemisphere (September). Ilha Comprida can also be considered a wintering site for *C. semipalmatus*, as they were recorded year round on the beach, with an increase in abundance in the spring and summer months.

Phalaropus tricolor is recorded from southwestern Canada to the northeastern United States, migrating to Peru, Bolivia, Chile, and Argentina (Canevari et al., 2001). Its migration passes through Central America in March/April and September/October (Herrera et al., 2006). This bird has been observed on the Brazilian coast, coming from the northern hemisphere to spend the summer in the southern hemisphere (Sick, 1997). On Ilha Comprida, *Phalaropus tricolor* can be seen in Lagoa da Ilha between September and April (Barbieri et al., 2010). Although quite common, the population of this bird has been declining in some areas due to the loss of habitat such as prairie swamps (Warnock et al., 2002). Some areas for food stops during migration to the south, as well as the lowlands of the Cananéia-Iguape and Ilha Comprida Estuaries, may be of critical importance for the species.

Stercorarius pomarinus is a sea bird that migrates to practically all oceans after reproduction and can be observed with some frequency in the South Atlantic (Olsen and Larsson, 1997). However, there is little information about the occurrence of this bird along the coast of the State of São Paulo (Olmos, 2000); a single publication mentions its in the Iguape, Cananéia, Ilha Comprida Estuary (Barbieri and Bete, 2013). *S. parasiticus* and *Stercorarius pomarinus* are trans-equatorial migrants who winter on the South American coast (Sick, 1997; Olmos 2000). According to Sick (1997), the species is a regular visitor to the Brazilian coast. Based on the BTO

files, Olmos (2002) cites reports of *S. parasiticus* in the state of Espírito Santo and Barbieri et al. (2008) on Ilha Comprida.

Pandion haliaetus is considered a rare visitor from the southern coast of São Paulo, with a single reference from Barbieri and Gonçalves (2009) for the Iguape - Ilha Comprida Estuary area. Records of *P. haliaetus* also exist for the city of São Vicente (Silva and Olmos, 2002) and for other regions such as the city of Santos (Luederwaldt (1919)) and the city of Cubatão (Olmos (1989)).

Chroicocephalus cirrocephalus breeds in South America and Africa (Harrison, 1989). Though not considered a truly migratory species, during its post-reproductive dispersion some individuals may visit very distant areas (Canevari et al., 1991). For example, wandering specimens *C. cirrocephalus* have been recorded in North America and Europe (Malling-Olsen and Larsson, 2003). The first recorded individual in São Paulo was on the beach of Ilha Comprida (Boqueirão Sul) on April 28, 2009 (Barbieri et al., 2010). The franklin gull *Leucophaeus pipixcan* is a visiting seabird occurring in the interior of the United States, which migrates after breeding towards South America (Smith, 2002). The first occurrence on Ilha Comprida was recorded by Barbieri et al. (2016) in September 2015, when two individuals were photographed.

According to Moore and Simons (1992), migration in autumn and spring is important in terms of potential mortality for coastal birds. During long migrations, birds need to stop to feed and rest. In addition to the accumulation of fat reserves during wintering periods, the food acquired at stop areas provide energy to continue the migratory flight (Barbieri et al., 2000). Many species interrupt their movement for the energy-demanding process of changing their feathers and select appropriate stopping sites according to the quality, productivity, and risk of predation (Alerstan et al., 2003; Fedrizzi et al., 2004).

Furthermore, studies have linked the declining population of migratory birds to several factors, such as habitat fragmentation, deforestation, expansion of agricultural activities, pesticide contamination, nest predation, and the cumulative effects

of changes in habitat along migration routes (Goldstein et al., 2003). Thus, the preservation of these birds is directly related to the conservation of feeding, resting, and reproduction sites. The loss of these environments can cause a decrease in population and even local extinction of species (Cordeiro et al., 1996) due to the difficulty in reaching the next stopping point or finding a new foraging area, which causes unnecessary energy expenditure (Havenegaard and Barbieri, 2010).

Hvenegaard and Barbieri (2010) point out that human alterations on the beach of Ilha Comprida can negatively affect migratory bird species that pass through the region and depend on their resources during displacement. Increasing real estate development on Ilha Comprida has been replacing natural habitats with subdivisions (Hvenegaard and Barbieri, 2010), which may significantly impact migrant species in the region, especially for the Charadriidae and Scolopacidae families which are dependent on the beach. As such, the preservation of the Cananéia-Iguape-Ilha Comprida Estuary is crucial for the conservation of various species that pass through the region, be they northern, southern, or regional migrants; mitigation measures for the preservation of this important ecosystem are necessary.

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AUTHOR CONTRIBUTIONS

E.B.: Conceptualization, Investigation, Supervision; Writing - original draft; Writing - review and editing.

K.A.A.E.: Investigation, Data curation; Writing - review and editing.

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