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Shorebirds in the State of Sergipe, northeast Brazil: potential tourism impacts

Glen T. Hvenegaard[1] and Edison Barbieri[2]

[1] University of Alberta, Augustana Campus, 4901-46 Avenue, Camrose, Alberta T4V 2R3 Canada. E-mail: glen.hvenegaard@ualberta.ca.
[2] Instituto de Pesca da Secretaria da Agricultura e Abastecimento do Estado de São Paulo. Caixa Postal 61, Avenida Professor Besnard, s/nº, CEP 11990-000, Cananéia, São Paulo, Brasil. E-mail: edisonbarbieri@yahoo.com.br.

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RESUMO: Aves limícolas do Estado de Sergipe, nordeste do Brasil: impactos potencias do turismo. Muitas aves limícolas neárticas migram para a América do Sul logo após a estação reprodutiva, utilizando vários pontos de parada e sítios de invernada ao longo da costa Atlântica. Entretanto, há poucas informações sobre as aves que utilizam a costa nordeste brasileira, especialmente em locais onde está ocorrendo o aumento do turismo. Este estudo examina o potencial de impacto do turismo sobre as aves limícolas neárticas na Praia de Atalaia Nova, na Barra dos Coqueiros, Sergipe, Brasil. Num transecto de 5 km, fez-se um total de 67 censos em 2004. Houve uma correlação negativa significativa entre o número de pessoas e o de aves limícolas (r = -0,25), principalmente para as espécies: *Arenaria interpres* (r = -0,24), *Charadrius collaris* (r = -0,31), *Calidris pusilla* (r = -0,64), and *Calidris canutus* (r = -0,71). Conclui-se que o crescimento do turismo na paria de Atalaia Nova tem um potencial de impacto negativo sobre as aves. Antes de fomentar o turismo, mais pesquisas devem ser feitas para examinar os efeitos sobre as aves limícolas que utilizam a área.

PALAVRAS-CHAVE: aves limícolas, migração, Brasil, impacto do turismo, Sergipe, Praia de Atalaia Nova.

ABSTRACT: Many Neartic shorebirds migrate to South America for the non-breeding season, using several key stopover and wintering sites along the Atlantic coast. However, there is little information about shorebird use of the northeast coast of Brazil, especially at those sites experiencing increasing levels of tourism. This study examines the potential impacts of tourism on shorebirds at Atalaia Nova beach in Sergipe State, Brazil. On a 5 km stretch of beach, we conducted censuses on 67 days throughout 2004. There was a significant negative correlation between numbers of people and numbers of all shorebirds (r = -0.25), and especially for *Arenaria interpres* (Ruddy Turnstone; r = -0.24), *Charadrius collaris* (Collared Plover; r = -0.31), *Calidris pusilla* (Semipalmated Sandpiper; r = -0.64), and *Calidris canutus* (Red Knot; r = -0.71). We conclude that the growth of tourism at Atalaia Nova beach (particularly recreation and development) has the potential to negatively impact shorebird use of the beach. Before tourism developments are initiated, more research should examine their potential effects on shorebird use of the area.

KEY-WORDS: shorebirds, migration, wintering, Brazil, tourism impacts, Sergipe, Atalaia Nova Beach.

Shorebirds migrate long distances and have specialized habitat preferences (Myers *et al.* 1979, Burger and Gochfeld 1991). Important winter destinations in South America include Lagoa do Peixe in the State of Rio Grande do Sul (Brazil), Tierra del Fuego, and the coasts of Peru and Chile (Myers *et al.* 1990). Many shorebirds use sandy beaches that occur along most of the Atlantic coast of tropical and subtropical America (Sick 1997). In coastal Brazil, there is little known about the migration routes, stopover points, provisioning of shorebirds using sandy beaches, or impacts from tourism.

One important known wintering site for shorebirds in Brazil is the Atalaia Nova beach in the Satate of Sergipe (Barbieri 2007), which has been designated as an 'Environmental Protection Area' (Almeida and Barbieri 2008). However, there are few studies on its use by shorebirds, species numbers and composition, seasonal changes, and impacts from tourists. The latter is a concern because this region has become a popular destination for tourists who compete for space with shorebirds throughout the year.

The potential for human-induced disturbance of shorebirds is increasing (Burger and Gochfeld 1991) because of growing tourism and habitat conversion in areas preferred by shorebirds. A human-induced disturbance refers to a human activity which causes 'a bird to behave differently from the behaviour it would exhibit without the presence of that activity' (Oranjewoud 1982 *in* Smit and Visser 1993, p. 6). More specifically, such a disturbance is 'any relatively discrete event in time that disrupts ecosystems, communities or populations, where disruption refers to a change in behaviour, physiology, numbers or survival' (Cayford 1993, p. 3). There is an increasing demand for research on human-induced disturbance of birds (Hill *et al.* 1997, Yasué 2005).

Three main sources of human-induced disturbance, according to Hill *et al.* (1997) are recreation (the focus of this paper), development and construction, and hunting. Human-induced disturbance varies 'in its magnitude, frequency, predictability, spatial distribution and duration' (Cayford 1993, p. 3). Species also vary in their susceptibility to disturbance, which is affected by age, season, weather, and degree of previous exposure (Cayford 1993). Other factors to consider are the availability of alternative habitats, relative scarcity of the species in question, pre-disturbance behaviour, flushing distance, and disturbance thresholds (de Boer and Longamane 1996, Hill *et al.* 1997, Monz *et al.* 2005, Goss-Custard *et al.* 2006). Key behavioural responses to disturbance include displacement from optimal foraging habitats (Burger and Gochfeld 1991, Burger 1993), temporary stops to feeding or reduced feeding rates (Burger and Gochfeld 1991, Yasué 2005, 2006), timing of feeding (Burger and Gochfeld 1991), and habituation (Goss-Custard and Verboven 1993, Smit and Visser 1993). Among the growing literature on the dynamics of human-induced recreational disturbance on shorebirds, most has found that different types of human activities have different effects on bird presence and disturbance (Burger 1981, Kirby *et al.* 1993). Several studies found that shorebirds were relatively less common on sites that contain more people and related human activities (Pfister *et al.* 1992, Burger 1994, Thomas *et al.* 2003).

FIGURE 1: Location of Atalaia Nova Beach on the coast of the State of Sergipe, northeast Brazil.

The coast of the State of Sergipe is important for shorebirds, especially as a migration stopover site and a wintering site because of abundant food resources (Almeida and Barbieri 2008). The coastal shorebird densities at Atalaia Nova Beach are lower than sites in north-central or southern Brazil (Morrison and Ross 1989), similar to sites at Cassino Beach in Rio Grande do Sul (Belton 1984, Vooren and Chiaradia 1990) and Coroa do Avião in Pernambuco (Sick 1997, Telino-Junior *et al.* 2003, Lyra-Neves *et al.* 2004), and higher than other sites in northeastern Brazil (Telino-Junior *et al.* 2003, Cabral *et al.* 2006, Barbieri 2007). Of the 13 shorebird species recorded at Atalaia Nova Beach, the most abundant are *Charadrius semipalmatus* (Semipalmated Plovers), *Calidris pusilla* (Semipalmated Sandpipers), and *Calidris alba* (Sanderling) (Barbieri and Hvenegaard 2008). For most species, the highest numbers occur between September and March, and the lowest numbers occur between April and August, although some species are present throughout the year. The purpose of this paper is to evaluate, in general terms, the impact of tourist numbers on shorebird abundance at this site. We hypothesize that the number of tourists is negatively correlated with the number of shorebirds.

STUDY SITE AND METHODS

Coastal Sergipe is a prominent landscape located in northeast Brazil (Figure 1). About 163 km long, coastal Sergipe is formed by the accumulation of sandy sediments and is very fragile to intensive human activities. The primary habitats adjacent to this beach are swamps, dunes, restinga forests, and mangroves. The wide sandy beach is interrupted by only a few small streams and five estuaries. The tidal range is about 2.5 m. Winds exert an overriding influence on sea level, lowering it with the prevailing northeasterly winds, and raising it with southerly winds. With a very gentle beach slope (i/40 to i/60), the swash zone is very wide, generally about 250 m. In this zone, invertebrates occur in high densities.

Coastal Sergipe is attracting a growing number of residents and tourists. The coast contains some secondary residences (with little coordinated planning) and a few traditional fishing communities. A bridge is currently

TABLE 1: Linear regression results and correlation results between shorebird numbers and tourist numbers at Atalaia Nova Beach, Sergipe, Brazil.

Shorebird species	Linear regression results			Correlation results		
	A	E_y	B	E_x	r	*P*
Calidris alba	119.83	20.45	-0.100	0.08	-0.15	0.24
Arenaria interpres	41.18	4.81	-0.050	0.01	-0.43	< 0.01
Charadrius collaris	3.48	0.65	-0.002	< 0.01	-0.24	0.05
Calidris canutus	22.95	3.73	-0.030	< 0.01	-0.37	< 0.01
Calidris pusilla	262.82	39.92	-0.310	0.09	-0.39	< 0.01
Charadrius semipalmatus	148.05	16.31	-0.070	0.04	-0.25	0.04
All shorebirds	250.81	124.23	-0.090	0.05	-0.25	0.04

A = y-intercept of linear regression model
E_y = standard error of y-intercept
B = slope of linear regression model
E_x = standard error of x-intercept
r = Pearson correlation coefficient
P = significance of correlation (one-tailed)

TABLE 2: Linear regression results and correlation results of $\log_{10}$ of number of shorebirds and $\log_{10}$ of number of tourists at Atalaia Nova Beach, Sergipe, Brazil.

Shorebird species	Linear regression results			Correlation results		
	A	E_y	B	E_x	r	P
Calidris alba	2.76	0.57	-0.46	0.25	-0.22	0.07
Arenaria interpres	2.27	0.51	-0.44	0.21	-0.24	0.05
Charadrius collaris	0.99	0.26	-0.29	0.11	-0.31	< 0.01
Calidris canutus	3.10	0.30	-1.13	0.13	-0.71	< 0.01
Calidris pusilla	5.64	0.65	-1.90	0.28	-0.64	< 0.01
Charadrius semipalmatus	1.96	0.27	-0.08	0.11	-0.08	0.51
All shorebirds	2.51	0.12	-0.11	0.05	-0.26	0.04

A = y-intercept of linear regression model
E_y = standard error of y-intercept
B = slope of linear regression model
E_x = standard error of x-intercept
r = Pearson correlation coefficient
P = significance of correlation (one-tailed)

being considered which, when complete, will further increase access for tourism. The most popular months for tourism are December-January and July (which coincide with school and job vacations). Most tourism occurs on weekends. Typical human activities on the beach include sun-tanning, walking, running, and fishing.

We followed the observation methodology proposed by Bibby *et al.* (1992) and adapted by Yasué (2006). On four weeks per month (Monday to Friday during each week and weeks chosen randomly), from 4 January to 28 December 2004, we conducted bird censuses along a 5 km stretch of Atalaia Nova beach (Figure 1). An additional 19 censuses were carried out on random weekend days, for a total of 67 samples. The counts occurred during the morning and lasted for 1-2 h. The direction of travel was from south to north (from Canal do Rio Sergipe to Praia da Costa). Binoculars (7 × 50 mm; 20 × 60 mm) and spotting scopes (20-80 × 160 mm) were used for observations. Sighted birds were identified, counted, and, whenever possible, photographed. We recorded the number of people along the same stretch of beach at the same time.

To examine the relationship between the numbers of people and numbers of shorebirds, we conducted two analyses. First, for each species and a total for all species combined, we calculated a linear regression with the 'Y' as number of shorebirds on the beach (dependent variable) and 'X' as the number of people on the beach (independent variable; see Yalden 1992). Second, we calculated a Pearson's product-moment correlation coefficient between the same variables (Barbieri and Pinna 2005). We also conducted the same two analyses on the $\log_{10}$ of the number of shorebirds (total and by species; see Pfister *et al.* 1992) and $\log_{10}$ of the number of people. We set the degree of statistical significance at $p < 0.05$. Values are presented as means ± 1 SD.

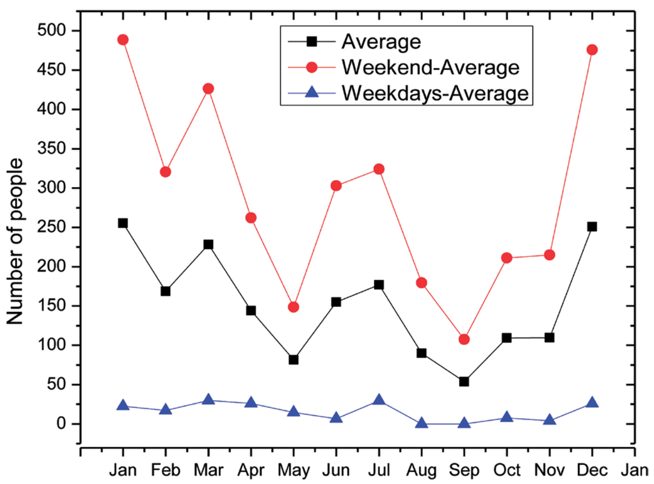

FIGURE 2: The average number of people per census by month at Atalaia Nova Beach, Sergipe, northeast Brazil.

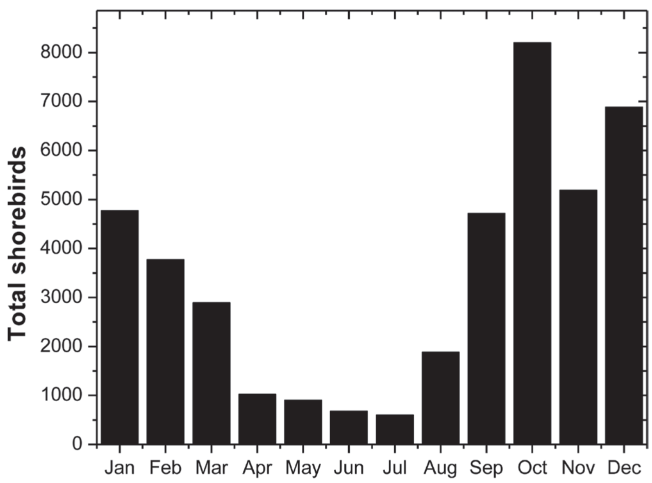

FIGURE 3: Total count of shorebirds (all species) by month in 2004 at Atalaia Nova Beach, Sergipe, northeast Brazil.

RESULTS

The mean number of people on the beach per census was 151.9 ± 67.0 (Figure 2). On weekend days, the mean was 288.5 ± 125.4, while on week days; the mean was 15.3 ± 11.4. The months which had the highest average number of people per census were December, January, and March, and the lowest were May, August, and

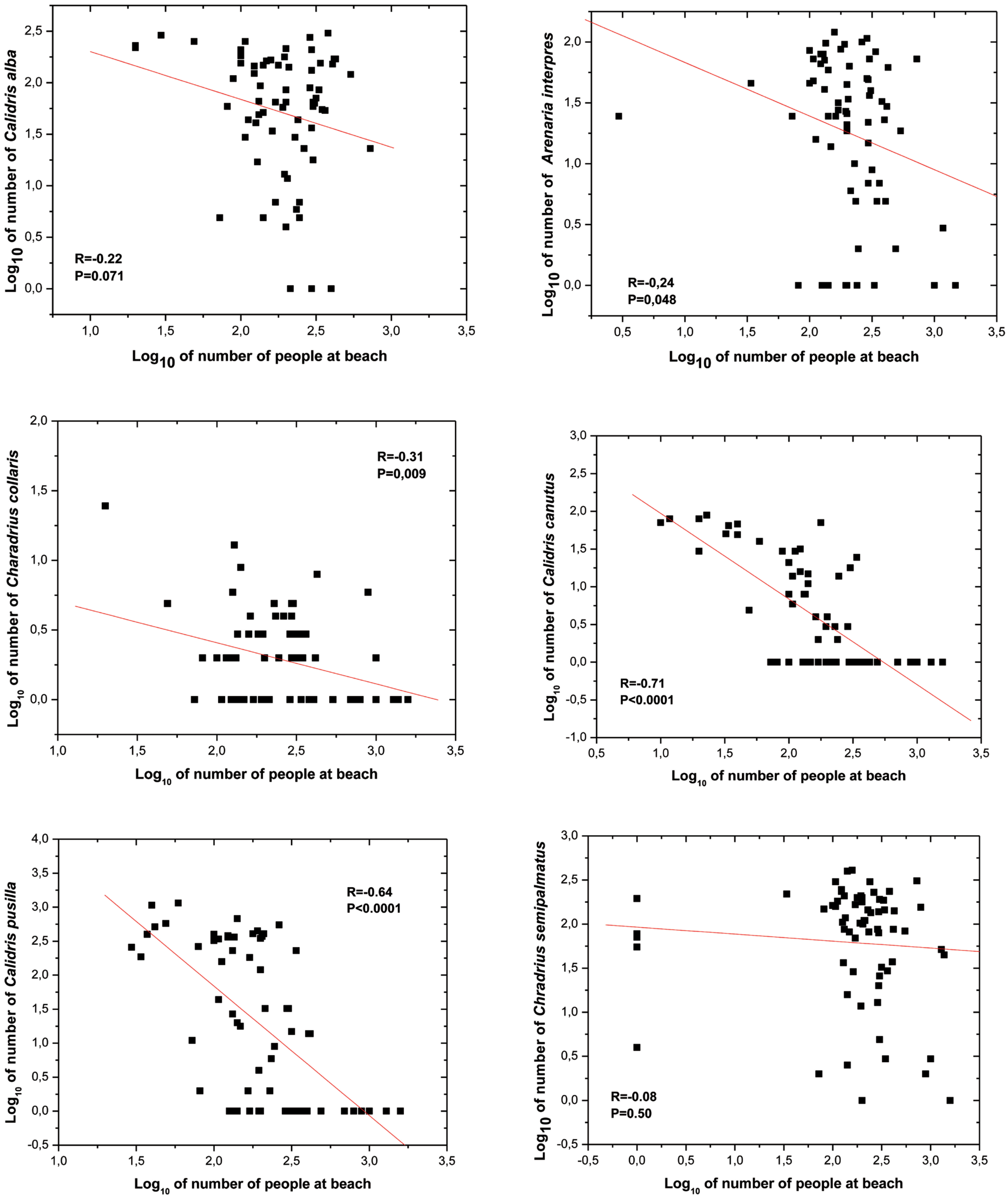

FIGURE 4: Correlation between $\log_{10}$ number of *Calidris alba, Arenaria interpres, Charadrius collaris, Calidris canutus, Calidris pusilla, Charadrius semipalmatus* and $\log_{10}$ number of people along Atalaia Nova Beach.

September. From April to August, we recorded about 1,000-2,000 shorebirds per month (Figure 3). From September to March, we recorded 3,000-8,000 shorebirds per month.

We had sufficient results to analyze tourism interactions with only the six most common shorebirds (Table 1). Using raw numbers for linear regression analyses, the slopes were negative (from steepest to shallowest in Column B from Table 1) for *Calidris pusilla, Calidris alba, Charadrius semipalmatus,* all shorebirds combined, *Arenaria interpres* (Ruddy Turnstone), *Calidris canutus* (Red Knot), and *Charadrius collaris* (Collared Plover). Using raw numbers for correlation analyses, there was a significant negative relationship (from largest to smallest) for *Arenaria interpres, Calidris pusilla, Calidris canutus, Charadrius semipalmatus,* all shorebirds combined, and *Charadrius collaris* (Table 1).

Based on $\log_{10}$ of both shorebird numbers and tourist numbers, the slopes of the linear regression lines were negative (from steepest to shallowest) for *Calidris pusilla, Calidris canutus, Calidris alba, Arenaria interpres, Charadrius collaris,* all shorebirds combined, and *Charadrius semipalmatus* (Table 2). Based on correlation analyses, there was a significant negative correlation (from largest to smallest) for *Calidris canutus, Calidris pusilla, Charadrius collaris,* all shorebirds combined, and *Arenaria interpres* (Table 2, Figure 4).

DISCUSSION

Atalaia Nova Beach is a relatively important site for shorebirds in this region (especially for food and rest during migrations; Barbieri and Hvenegaard 2008). Overall, current human use of Atalaia Nova Beach is concentrated

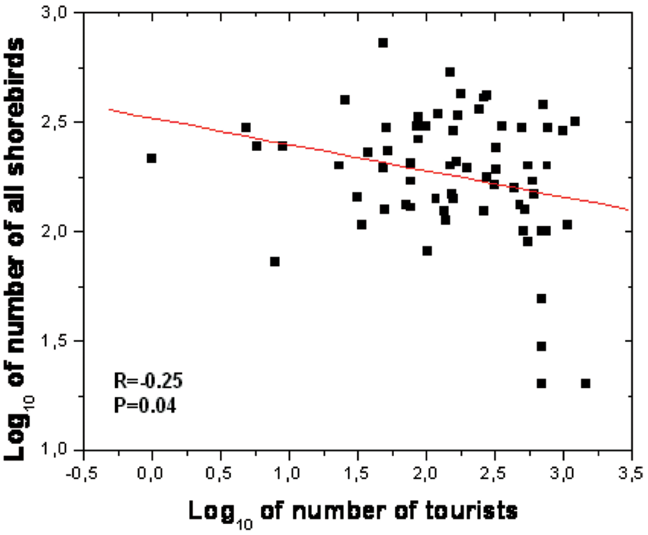

FIGURE 5: Correlation between $\log_{10}$ number of all shorebirds and $\log_{10}$ number of tourists along Atalaia Nova Beach.

on weekends. There is potential for increased human use in the near future. Whether using linear regression or correlation analyses, and whether using raw or $\log_{10}$ numbers, there was a significant negative relationship between the number of tourists and the number of shorebirds, most consistently for *Charadrius collaris, Arenaria interpres, Calidris canutus,* and *Calidris pusilla.*

Atalaia Nova Beach supports shorebirds for food and rest, and supports tourists for recreation, which leads to potential conflict. First, human-induced disturbances can force shorebirds to fly from place to place successively, leading to an unnecessary loss of energy (Burger 1986). The loss of energy can be critical for birds that migrate long distances (Dunn *et al.* 1988). The increase in tourism in coastal Sergipe will increase these disturbances. Second, since the mid-1990s, the Atalaia Nova Beach has become increasingly urbanized, resulting in considerable habitat change. Human disturbance at Atalaia Nova Beach is altering the beach landscape, mainly due to the real estate speculation associated with tourism activities.

The negative relationship between the number of people on the beach and the abundance of most shorebirds, while requiring more research, is of concern for a few reasons. First, human proximity to shorebirds affects the amount of foraging activity. Burger and Gochfeld (1991) found that when people were within 10 and 100 m, shorebirds devoted less time to feeding and flew or ran away from those beach habitats. Second, the distribution pattern of shorebirds on a beach may change due to human disturbance (Pfister *et al.* 1992), perhaps forcing birds to use more marginal habitats. Third, shorebird abundance declines with other intensive activities, as found for Sanderlings and the number of vehicles on a beach (Klein 1993, Klein *et al.* 1995, Barbieri and Pinna 2005). Fourth, all of these human activities indicate demand for other support facilities (*e.g.,* roads, hotels) which lead to further habitat loss and a decline in shorebird populations.

These results are important to policy-makers and conservationists for several reasons. First, managers need to place the importance of this site in context with other shorebird stopover and wintering sites along the Brazilian coast. In this way, managers can give an appropriate level of priority to each site. Second, given some indicators of the negative correlation between tourist numbers and shorebird numbers, managers should conduct more detailed research to examine the impacts of tourist activities on the behaviors, site use, and long-term population trends of shorebirds. If those results also indicate tourist impact on shorebird activities and distributions, managers should implement protective measures (Burger *et al.* 2004, Gill 2007), especially during the peak migration times, to reduce human impact and increase nesting success for shorebirds. For example, managers can erect educational signs (*e.g.,* to discourage human behavior that disrupts shorebirds), restrict access to areas with high shorebird use during sensitive times, build viewing platforms so that human use is concentrated in one place, and regulate illegal human behavior on the beach with regular patrols and fines.

There are a few limitations to this study. First, we measured, and conducted analyses of, the number of shorebirds and tourists along the entire beach length. We did not measure or analyze interactions between shorebirds and people at particular times or along specific segments of the beach; this approach to consider scale effects was useful for studies by Yasué (2006). Second, even though we kept track of birds as much as possible as they moved up and down the beach, we realize that some double-counting of birds may have occurred. Third, even when the data showed no significant correlation between shorebird numbers and tourist numbers, it is possible that human activity disturbed shorebirds. For example, shorebirds might have move to less preferred habitats, increased their vigilance behaviours, or become habituated, even as they remained on the beach (Burger 1993, Fitzpatrick and Bouchez 1998, Yasué 2006). As well, we did not consider potential long-term effects, as suggested by West *et al.* (2002). Fourth, our conclusions were based on a multi-month study of one site. We did not have an experimental control or comparison between sites, as preferred for more robust studies (see Klein 1993, Hill *et al.* 1997).

Future research on the impact of tourism on shorebirds should consider the dynamics of tourist activity type (*e.g.,* proximity to birds, use of motor vehicles, timing of impact, and time for birds to return to previous behaviours). Other research should examine the effects of environmental planning and management efforts in reducing the effects of tourism on shorebird populations. Future research on the importance of coastal Sergipe for shorebirds should examine habitat preferences, prey availability, and other potential threats. It would also be helpful to consider the role of coastal Sergipe in the context of shorebird migratory stopover points northward and southward.

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