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# Shorebird Seasonal Abundance and Habitat-use Patterns in Punta Rasa, Samborombón Bay, Argentina

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**Abstract.**—Shorebird assemblage composition and habitat-use patterns were characterized at Punta Rasa during the austral summer, autumn and winter. Compared to other sites within the region, this area showed high species richness, reflected by a total of 22 species recorded within a relatively short time frame. Differences in assemblage structure were driven by the use of estuarine mudflats and oceanic sandy beaches as feeding habitats. During low tide, more species used estuarine environments, achieving the highest total densities. Abundance patterns and assemblage composition also changed seasonally. Maximum total abundance occurred during the austral summer, and minimum total abundance during the austral winter. During the austral summer, the assemblage was dominated by Nearctic migrants such as American Golden-Plover (*Pluvialis dominica*), Hudsonian Godwit (*Limosa haemastica*) and White-rumped Sandpiper (*Calidris fuscicollis*). In addition, Two-banded Plover (*Charadrius falklandicus*) and American Oystercatcher (*Haematopus palliatus*) were abundant during the austral autumn. The Red Knot (*Calidris canutus*), a shorebird that dominated the austral autumn assemblage 25 years ago, was recorded in relatively small numbers during this study, probably reflecting the global population trend of a subspecies of the Red Knot (*C. c. rufa*) in the past two decades. During the austral winter, resident birds largely dominated the assemblage. However, it is noteworthy that some individuals of nine Nearctic migrant species remained in the area. In the case of the endangered Red Knot, Punta Rasa is, along with Lagoa do Peixe in Brazil, one of the sites in South America with the highest known abundances during the austral winter. *Received 15 July 2014, accepted 18 October 2014.*

**Key words.**—Argentina, habitat-use, migration, Samborombón Bay, shorebirds, South America.

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The itinerant use of different sites by migratory shorebirds enables them to exploit resources cyclically in places unsuitable for continuous use, but this strategy makes them dependent upon a specific sequence of sites essential for completing their annual cycles (Myers 1983). For migrant shorebirds in southeastern South America, one of these key areas is Samborombón Bay and particularly its southern end, Punta Rasa, which has been recognized as a critical coastal wetland for shorebirds in South America (Morrison and Ross 1989; Vila *et al.* 1994; Blanco *et al.* 2006), as well as a site of international importance within the Western Hemisphere Shorebird Reserve Network (2012).

Samborombón Bay is situated in temperate latitudes on the coast of South America, where migratory species from North America (Pan New World migration system *sensu* Joseph 1997) and southern South America (South American Cool Temperate migration system *sensu* Joseph 1997), as well as resident species, occur. Nearctic migrant species are more frequent in Buenos Aires province during the austral spring-summer, while Neotropical migrant species arrive at the end of the austral spring or early in the austral summer and are more frequent during the austral autumn-winter (Myers and Myers 1979).

In spite of the large advance in studies about shorebird ecology around the world (Colwell 2010; Piersma and van Gils 2011), relatively little information has been produced in South America compared to sites in North America. Even the basic details of important non-breeding areas and stopover sites are largely unknown. Published studies on coastal shorebirds in Samborombón Bay have focused on topics such as habitat-use patterns for a restricted number of species during short time frames (Blanco 1998; Ribeiro *et al.* 2004), trophic ecology of some species (Iribarne and Martínez 1999; Ribeiro *et al.* 2003; Ieno *et al.* 2004), and the effect of shorebird predation on the benthic fauna (Botto *et al.* 1998). In addition, published information on general abundance patterns throughout the year is limited to a few species (Blanco *et al.* 1992, 1995), while much valuable information remains in the gray literature (e.g., Blanco *et al.* 1988), which is difficult for the international scientific community to access. Our aims were to characterize shorebird assemblages and habitat-use patterns of migratory and resident species and to describe temporal shorebird abundance patterns at Punta Rasa during three different seasons.

## Methods

### Study Area

This study was conducted at the southern tip of Samborombón Bay, Buenos Aires, Argentina, more precisely between Punta Rasa Natural Reserve and San Clemente port (Fig. 1). The Punta Rasa area is located in the temperate region (Peel *et al.* 2007) between two ecosystems: the estuarine coasts of the La Plata River to the west and the Atlantic Ocean to the east (Fig. 1). It is affected by low-amplitude (< 1.5 m), semidiurnal tides with brackish mesohaline waters. The estuarine coasts are characterized by a gentle slope where large muddy intertidal flats are exposed during low tide (Isacch *et al.* 2006). Oceanic beaches are characterized by a small intertidal zone composed of fine sand sediments (Bértola and Morosi 1997).

We conducted 12 shorebird counts from December 2011 to July 2012, covering 7.2 km of coastline, which was selected based on accessibility (most of the bay's coastline is inaccessible by land) and historical importance for migratory shorebirds (Blanco *et al.* 1988, 1992; Blanco 1998); 2.7 km of this coastline was oceanic and 4.5 was estuarine (Fig. 1). All surveys were conducted by the same two observers, who moved parallel to the coastline. Surveys started 1.5 hr before and ended approximately 1.5 hr after low tide. A high-definition spotting scope (20-60x) was used to identify species and count individuals.

### Surveys

For analysis, counts were classified into three categories according to different periods of the migration schedule of Nearctic migrants. Our classification was

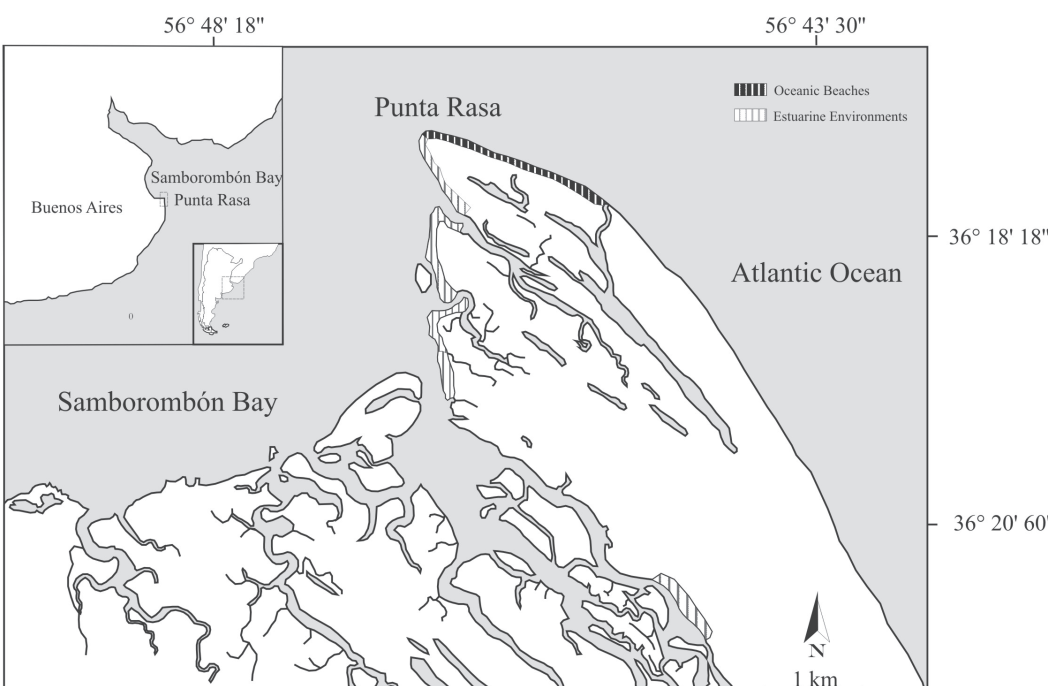


**Figure 1. Study area and locations of the estuarine environments and oceanic beaches where counts were conducted. The inset maps show the location of Punta Rasa and Samborombón Bay in Buenos Aires province and southern South America.**

based on Nearctic migrants because they dominated local shorebird assemblages during most times of the year. We used information compiled in Birds of North America (Poole 2005) to establish migration time frames (seasons refer to the southern hemisphere's schedule): 1) austral summer: Nearctic migrants use southern sites as non-breeding areas (counts from 5-26 December 2011); 2) austral autumn: Nearctic migrants engage in northbound migration (counts from 31 March 2012 through 19 April 2012) and; 3) austral winter: most Nearctic migrants reach their breeding grounds but some remain in the southern hemisphere (counts from 11 May 2012 through 28 July 2012). We conducted four counts during each of the three migration phases. Data obtained were expressed as densities (individuals/km) for habitat use analysis and showed as abundance (individuals/survey) in the graphs. We also recorded other shorebird species detected in the area outside the systematic surveys.

### Statistical Analysis

Shorebird assemblage structure was analyzed with PRIMER (Clarke and Gorley 2002). Differences among habitat types (factors: estuarine and oceanic environments) and seasons (factors: austral summer, autumn and winter) were evaluated with a two-way crossed analysis of similarity (ANOSIM; Clarke and Gorley 2002). We tested the following hypotheses: 1) no habitat effects; and 2) no season effects in terms of assemblage composition. We used the ANOSIM pair-wise comparisons to determine differences among seasons and the SIMPER (similarity percentages; Clarke and Gorley 2002) routine to identify species that accounted for the observed differences.

We also used an Indicator Species Analysis (ISA; Dufrêne and Legendre 1997) to identify characteristic species of each habitat type and a Relative Importance Index (IRI; Bucher and Herrera 1981) to assess the relative weight of each species within each migration phase. The ISA calculates an indicator value for each species based on its relative frequency and relative abundance in all treatment categories (i.e., habitat types). Indicator values can range from 0 to 100. The latter means a perfect indication for a given habitat, implying that the species was recorded exclusively in all samples within that habitat. The ISA was conducted with PC-ORD (McCune and Mefford 1999), and significance (significant at $P \leq 0.01$ and Indicator Values > 25%) was assessed with a Monte Carlo randomization procedure. The IRI was calculated as $(N_i/N_t) \times (S_i/S_t) \times 100$, where $N_i$ is the number of individuals of the species $i$ and $N_t$ is the total number of individuals observed in the season under consideration; $S_i$ is the number of surveys in which the species $i$ was observed and $S_t$ is the total number of surveys. This index can range from values of 0 (a species is absent from all counts) to 100 (a species is the only one recorded during all surveys).

## RESULTS

We recorded 18 shorebird species belonging to the families Charadriidae ($n = 5$), Haematopodidae ($n = 1$), Recurvirostridae ($n = 1$) and Scolopacidae ($n = 11$) throughout the surveys (Table 1). Fourteen species were Nearctic migrants, two Neotropical migrants and two residents, and accounted for 66%, 7.4% and 26.6% of total shorebird numbers, respectively. We observed four additional species of the families Charadriidae ($n = 2$), Chionidae ($n = 1$) and Scolopacidae ($n = 1$) within the area during the same period, but outside the systematic surveys. These represent one Nearctic and two Neotropical migrants and one resident species. Bird species reported are listed in Table 1, with their English and scientific names.

Total shorebird density ranged from 60.7 to 404.9 individuals/km in estuaries and from 1.1 to 73.3 individuals/km on oceanic beaches (Table 1). The ANOSIM test showed overall significant differences in shorebird assemblage structure driven by the use of estuarine or oceanic environments (Table 2). Fourteen species were recorded in both habitat types, while the Short-billed Dowitcher, Spotted Sandpiper, Solitary Sandpiper and Willet were seen only on estuarine beaches. The indicator species analysis identified 11 species with significant indicator values; all of them were associated with estuaries. No indicator species for oceanic beaches were identified (Table 1).

We also found seasonal global differences in assemblage structure. Pair-wise tests showed differences among the three periods (Table 2). The highest total shorebird density was recorded during the austral summer and decreased toward the austral winter (Fig. 2). In all three seasons, the assemblage was largely dominated by a few species (Fig. 3): American Golden-Plover, Hudsonian Godwit and White-rumped Sandpiper during the austral summer; the latter two species together with Two-banded Plover and American Oystercatcher dominated the assemblage during the austral autumn; and the latter species along with Black-necked Stilt were dominant during the austral winter (Table 3; Fig. 3). These six species also explained much of the differences (≥ 84%) in between-season assemblage structure, which suggests that the differences are mainly due

**Table 1. Species registered in Punta Rasa during austral summer, autumn and winter; † indicates species observed outside the systematic surveys. Data for estuarine environments (E) and oceanic beaches (O) are given as minimum-maximum densities (individuals/km), as well as species richness (number of species) within each season. The Indicator Species Analysis (Dufrêne and Legendre 1997) exhibits the Indicator Values (I.V.) expressed as a percentage of perfect indication for a given habitat type (H.T.); *= significant at $P \leq 0.01$.**

| | Estuarine Environments | | | Oceanic Beaches | | | Indicator Species Analysis | | |
|---|---|---|---|---|---|---|---|---|---|
| | Summer | Autumn | Winter | Summer | Autumn | Winter | I.V. | H.T. | *P* |
| Nearctic Migrants | | | | | | | | | |
| American Golden-Plover (*Pluvialis dominica*) | 34.9-53.8 | 0.2-0.4 | 0 | 0.0-0.4 | 0 | | 54.5 | E | 0.044 |
| Black-bellied Plover (*Pluvialis squatarola*) | 6.2-1.8 | 3.3-6.9 | 0.2-5.3 | 0 | 0.0-1.5 | 0 | 95.0 | E* | < 0.001 |
| *Pluvialis sp.* | 0.0-1.8 | 0.2-4.0 | 0.0-1.8 | 0 | 0 | 0 | | | |
| Semipalmated Plover (*Charadrius semipalmatus*) | 0.2-9.3 | 0.0-3.1 | 0 | 0 | 0 | 0 | 51.8 | E | 0.030 |
| Hudsonian Godwit (*Limosa haemastica*) | 32.4-82.2 | 13.1-66.7 | 5.6-12.9 | 1.5-3.0 | 0.4-1.5 | 0.0-0.7 | 96.8 | E* | < 0.001 |
| Ruddy Turnstone (*Arenaria interpres*) | 6.9-29.1 | 5.1-6.7 | 0.2-0.9 | 0 | 0.0-6.0 | 0 | 86.5 | E* | < 0.001 |
| Red Knot (*Calidris canutus*) | 0.0-0.4 | 2.4-10.0 | 1.1-4.4 | 0 | 0.0-5.2 | 0 | 75.4 | E* | < 0.001 |
| Sanderling (*Calidris alba*) | 0.0-0.4 | 0.0-0.2 | 0.0-1.3 | 0.4-1.5 | 0.0-1.5 | 0.0-0.4 | 44.0 | O | 0.062 |
| Semipalmated Sandpiper (*Calidris pusilla*)† | | | | | | | | | |
| White-rumped Sandpiper (*Calidris fuscicollis*) | 167.1-184.0 | 34.4-64.4 | 0.0-0.2 | 0 | 0.7-1.9 | 0.0-0.4 | 77.7 | E* | 0.006 |
| Short-billed Dowitcher (*Limnodromus griseus*) | 0.0-0.2 | 0 | 0 | 0 | 0 | 0 | 7.1 | E | 1.000 |
| Spotted Sandpiper (*Actitis macularius*) | 0.2-3.3 | 0.2-0.7 | 0 | 0 | 0 | 0 | 57.1 | E* | 0.002 |
| Solitary Sandpiper (*Tringa solitaria*) | 0.0-0.2 | 0 | 0 | 0 | 0 | 0 | 7.1 | E | 1 |
| Greater Yellowlegs (*Tringa melanoleuca*) | 1.3-11.3 | 0.0-0.67 | 0.0-0.2 | 0 | 0.0-0.4 | 0 | 53.1 | E | 0.048 |
| Willet (*Tringa semipalmata*) | 0.2-0.4 | 0.0-0.2 | 0.0-0.4 | 0 | 0 | 0 | 57.1 | E* | 0.002 |
| Lesser Yellowlegs (*Tringa flavipes*) | 7.3-49.6 | 0.2-6.4 | 0 | 0 | 0.0-0.4 | 0 | 63.9 | E* | 0.003 |
| Neotropical Migrants | | | | | | | | | |
| Tawny-throated Dotterel (*Oreopholus ruficollis*)† | | | | | | | | | |
| Two-banded Plover (*Charadrius falklandicus*) | 0.0-13.1 | 13.8-47.3 | 5.6-13.6 | 0 | 0.7-46.7 | 0.0-0.7 | 64.6E | 0.040 | |
| Ruffous-chested Dotterel (*Charadrius modestus*) | 0 | 0.0-0.9 | 0.2-2.0 | 0 | 0 | 0.0-0.4 | 59.9 | E* | 0.004 |
| Snowy Sheathbill (*Chionis albus*)† | | | | | | | | | |
| Residents | | | | | | | | | |
| Southern Lapwing (*Vanellus chilensis*)† | | | | | | | | | |
| American Oystercatcher (*Haematopus palliatus*) | 13.4-19.3 | 4.9-72.9 | 7.11-172 | 3.0-8.9 | 1.5-8.9 | 0.4-5.6 | 88.7 | E* | < 0.001 |
| Black-necked Stilt (*Himantopus mexicanus*) | 1.3-11.1 | 5.8-18.7 | 19.3-42.9 | 0.0-2.6 | 1.1-3.3 | 0.0-0.7 | 94.1 | E* | < 0.001 |
| Total Shorebirds | 306.0-404.9 | 110.4-250.2 | 60.7-238.9 | 8.9-25.6 | 7.4-73.3 | 1.1-7.0 | | | |
| Species Richness | 12-16 | 12-15 | 9-11 | 7-9 | 6-9 | 2-5 | | | |

**Table 2. Global and pairwise ANOSIM test and SIMPER analysis (Clarke and Gorley 2002) for differences in species composition driven by the effects of habitat type (oceanic or estuarine environments) and season (austral summer, autumn and winter).**

| | R | *P* | % Average Dissimilarity |
|---|---|---|---|
| Habitat Type | | | |
| Global Test | 0.924 | 0.001 | 89.4 |
| Season | | | |
| Global Test | 0.530 | 0.001 | |
| Pairwise Test | | | |
| Summer-Autumn | 0.609 | 0.005 | 73.6 |
| Autumn-Winter | 0.430 | 0.009 | 76.4 |
| Summer-Winter | 0.661 | 0.001 | 82.9 |

to variations in the relative abundances of the dominant species rather than to changes in species composition (Table 3).

In terms of abundance, Nearctic migrants were the largest group of species during the austral summer and autumn (Fig. 1). They also were the largest group in terms of species richness in the three seasons. We recorded 14 Nearctic migrant species during the austral summer and 12 during the austral autumn. Solitary Sandpiper and Short-billed Dowitcher, absent from the latter, were only represented by single individuals in the former. Both the abundance and species richness of Nearctic migrants reached minimum values in austral winter (Fig. 1). We observed eight species during our austral winter surveys (Table 1) and one additional species, the Lesser Yellowlegs, outside the austral winter surveys. Black-bellied Plovers, Hudsonian Godwits and Red Knots were the most abundant Nearctic shorebirds recorded during this season (Fig. 3). However, the largest flocks of the latter two species observed during austral winter were recorded outside the systematic counts: 300 Hudsonian Godwits and 150 Red Knots.

Residents were the largest group of species in terms of abundance during the austral winter. Within this group, the American Oystercatcher was the most abundant species (Fig. 2). Its abundance increased toward the austral winter, exhibiting a maximum count of 787 individuals during this period (Fig. 3).

Neotropical migrants did not dominate the shorebird assemblage in any of the three seasons under consideration (Fig. 2). The most abundant species was the Two-banded Plover, which was present in all the surveys, while the Rufous-chested Dotterel was only recorded in low numbers during the austral winter (Table 1). Our data showed a peak in density of Neotropical migrants during the austral autumn, which suggests that some of them remained in Punta Rasa throughout the non-breeding season while others seemed to use Punta Rasa only as a migratory stopover site.

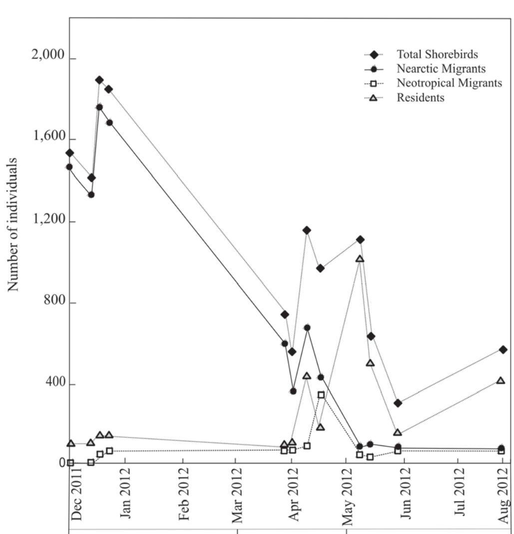


**Figure 2. Abundance of total shorebirds, Nearctic migrants, Neotropical migrants and resident species recorded in each of the austral summer, autumn and winter surveys.**

## DISCUSSION

We updated the information on shorebird abundance and habitat-use patterns in Punta Rasa. Despite the site's recognized regional (Blanco *et al.* 1992, 2006) and hemispheric (Morrison and Ross 1989) importance, little information on these topics has been produced since the late 1980s and early 1990s. Within the region (i.e., southern South America), Punta Rasa exhibits high shorebird richness: 22 species observed dur-

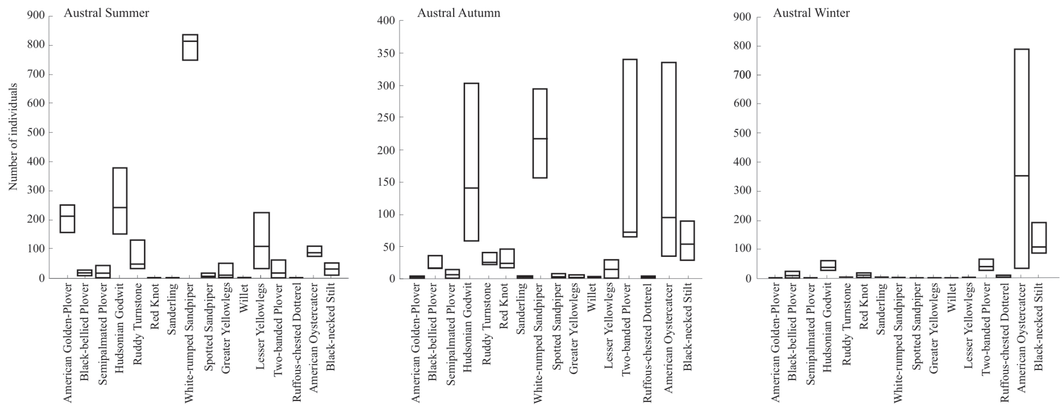


**Figure 3. Minimum, maximum and median abundances of the shorebird species observed in the austral summer, autumn and winter surveys. Only the species registered in more than one survey are shown.**

ing the 8-month study. This is noteworthy when compared to the number of species recorded in other studies conducted with similar time scales in nearby Western Hemisphere Shorebird Reserve Network sites: 15 species in Laguna de Rocha, Uruguay (Alfaro and Clara 2007) and eight in San Antonio Oeste, Argentina (González 1996) in about 1-year surveys each; 17 in Lagoa do Peixe, Brazil (Scherer and Petry 2012) in 2 years; and 13 in Rio Gallegos, Argentina (Ferrari *et al.* 2002) in 2.5 years. In addition, Jaramillo (2000) hypothesized that Punta Rasa may function as a vagrant trap for birds moving in southeastern South America. This may explain several unusual records of Snowy Plover (*Charadrius alexandrinus*; Olrog 1979 in Chebez 2009), Lesser Sand Plover (*Charadrius mongolus*; Le Nevé and Manzione 2011), Semipalmated Sandpiper (*Calidris pusilla*; Jaramillo 2000) and Terek Sandpiper (*Xenus cinereus*; Blanco *et al.* 1988). We also added observations of other unusual species: a Short-billed Dowitcher and a Semipalmated Sandpiper, both species with few records in the country (Narosky and Di Giacomo 1993; Chebez 2009).

Similar to the pattern found for the whole Buenos Aires province (Blanco *et al.* 2006), this study showed that in Punta Rasa the estuarine mudflats are the most important feeding habitats for shorebirds. The higher densities found there could be related to the higher densities of macrobenthos communities (Botto *et al.* 1998), as opposed to the lower invertebrate densities of marine intertidal communities of soft bottoms (Ieno and Bastida 1998). Despite the importance of the estuarine intertidal flats as feeding areas, it should be noted that some of the species that use this habitat type during low tide move to marine environments during high tide, when intertidal mudflats are flooded (Blanco 1998), and therefore depend on both environments to meet their daily requirements.

The general lack of historical information in our region limited detailed comparisons of abundance or assemblage composition over long periods of time. This kind of information is particularly valuable because it may define long-term population trends. A study conducted 25 years ago in Punta Rasa (Blanco *et al.* 1988), which covered two of the same seasons as our study (austral summer and austral autumn), provides some basis for comparison. The current austral summer shorebird assemblage seems to be dominated by the same species as in the past. However, although the Hudsonian Godwit and the White-rumped Sandpiper were among the most abundant species during austral autumn in both studies, the Nearctic migrant assemblage showed some differences. The Red Knot, which was also one of the dominant species 25 years ago, with peak numbers during April (Blanco *et al.* 1988), is currently represented by relatively

**Table 3. Contribution of each species to the average by—season dissimilarity given by SIMPER analysis (Clarke and Gorley 2002) and Index of Relative Importance (Bucher and Herrera 1981) by season (austral summer, autumn and winter). Only values for species that account for the 90% of the cumulative dissimilarity and Index of Relative Importance > 0.5 are reported. Scientific names are in Table 1.**

| | % Contribution to Average Dissimilarity | | | Index of Relative Importance | | |
|---|---|---|---|---|---|---|
| | Summer-Autumn | Autumn-Winter | Summer-Winter | Summer | Autumn | Winter |
| Nearctic Migrants | | | | | | |
| American Golden-Plover | 9.35 | — | 9.87 | 12.52 | — | — |
| Black-bellied Plover | — | — | — | 1.09 | 2.54 | 2.02 |
| Semipalmated Plover | — | — | — | 1.09 | 0.63 | — |
| Hudsonian Godwit | 14.05 | 12.04 | 12.76 | 15.23 | 19.22 | 6.55 |
| Ruddy Turnstone | 3.38 | 2.66 | — | 3.77 | 3.47 | — |
| Red Knot | — | 2.40 | — | — | 3.26 | 1.98 |
| White-rumped Sandpiper | 34.69 | 17.98 | 27.53 | 48.23 | 26.50 | — |
| Greater Yellowlegs | — | — | — | 1.22 | — | — |
| Lesser Yellowlegs | 4.29 | — | 3.69 | 7.07 | 1.82 | — |
| Neotropical Migrants | | | | | | |
| Two-banded Plover | 12.46 | 15.27 | 3.99 | 0.07 | 16.47 | 7.00 |
| Ruffous-chested Dotterel | — | — | — | — | — | 0.75 |
| Residents | | | | | | |
| American Oystercatcher | 9.32 | 28.90 | 23.56 | 5.41 | 16.73 | 60.45 |
| Black-necked Stilt | 4.23 | 12.28 | 8.76 | 1.81 | 6.82 | 19.80 |

small numbers. This change in the assemblage structure probably reflects the trend of populations of the Red Knot subspecies (*C. c. rufa*), which has undergone a major decline in recent decades (Niles *et al.* 2008).

Finally, we provide the first systematic data set of austral winter species composition, highlighting the dominance of resident species, particularly of the American Oystercatcher. We also observed that several Nearctic migrants remain in the area during this season. This phenomenon was also observed in the past (Blanco *et al.* 1992, 1995): for example, a flock of 600 Red Knots was recorded from July to August 1987 (Blanco *et al.* 1992). One-year-old juvenile Red Knots remain south of their breeding grounds during the reproductive season. The locations where they stay, however, are not well known (Baker *et al.* 2013). Our results, including observations of 150 individuals, indicate that Punta Rasa is currently one of the South American sites that holds higher abundances during austral winter, along with Lagoa do Peixe in Brazil (Scherer and Petry 2012). More information on the health and molt status of these individuals is needed to have a better assessment of the current importance of Punta Rasa for this threatened species.

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