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SEASONAL ABUNDANCE AND BEHAVIOUR OF COASTAL BIRDS ON CASSINO BEACH, BRAZIL

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Abstract. Fifty-one bird censuses were carried out along 60 km of beach to the south of Cassino, 32°12'S, 52°10'W, from May 1982 to December 1986. Mean monthly bird density was highest (80 to 100 birds/km) from February to April, and lowest (20 birds/km) in August and September. Thirty-three species were recorded, of which 7 terns, 3 gulls, 13 waders and 10 others (skua, jaegers, skimmer, sheathbill, cormorant, herons and hawks). Thirteen species were Permanent Users (including local breeders), 9 were Southern Hemisphere Migrants, and 11 were Northern Hemisphere Migrants. Waders reached peak numbers in austral spring and autumn due to passage of Northern Migrants: *Calidris fuscicollis*, *Calidris alba*, *Calidris canutus*, *Pluvialis dominica* and *Pluvialis squatarola*, some of these remaining in lesser numbers through summer. Winter waders were mainly the Permanent Users *Charadrius collaris*, *Haematopus palliatus* and *Himantopus himantopus melanurus*, and the Southern Migrant *Charadrius falklandicus*. Terns showed peak numbers in autumn (northbound *Sterna sandvicensis eurygnatha* and *Sterna hirundo*), winter (*Sterna maxima*, *Sterna trudeaui*, *Sterna superciliaris* and *Sterna hirundinacea*, all wintering) and late spring (southbound *Sterna sandvicensis eurygnatha*). *Rynchops niger* migrated southward from May to July. Numbers of gulls (*Larus dominicanus* and *Larus maculipennis*) were lowest in spring due to breeding outside the study area. The shore of Rio Grande do Sul as a whole is an important staging area in the northward migration of the *Calidris* species, the birds moving through the entire area, feeding as they go. The waders and gulls feed in or near the swash zone, the different species coexisting through the use of different foods and feeding methods. The terns and the Black Skimmer use the beach for resting. For all birds, human presence on the beach creates disturbance and interferes with feeding and/or resting, which is specially critical for migrating waders. This needs to be considered in the management of the environment in the area. *Accepted 6 January 1990.*

Key words: Birds, ecology, sea shore, Brazil.

INTRODUCTION

The present study started with the observation in 1980, that birds were diverse and abundant on the beach to the south of the seaside resort Cassino, at lat. 32°12'S, long. 52°10'W. *Calidris canutus*, *Calidris fuscicollis*, *Calidris alba* and *Sterna hirundo* were seen in great numbers during summer and autumn, and *Charadrius falklandicus* was common during winter. Thus, it was thought that this beach might be an important feeding and resting area for migratory coastal birds from both hemispheres. Recent studies by Resende & Leeuwenberg (1987) and Resende (1988) show that such is the case 145 km further north at Lagoa do Peixe (Lat. 31°22'S).

The beach offers good conditions for motorized vehicles and constitutes in fact a major traffic route. Recreation on the beach is typically by car, and other human activities include the use of heavy transport, such as sand extraction from dunes, shore-based fishing and the servicing of lighthouses. Recent proposals of industrial development include discharge of factory waste in nearshore waters. Thus arises the question of the impact of these factors on the coastal birds. Quantitative information on seasonal abundance of birds in the area was thought to be needed, to provide a background for further studies and a base for comparison with future situations. Therefore it was decided to carry out a series of censuses along the beach.

MATERIAL AND METHODS

The coast of the state of Rio Grande do Sul is a sandy beach, stretching over 700 km from lat. 28°40'S to 33°45'S, in the direction of 215° T, interrupted by several major lagoon mouths and by creeks which drain the marshes behind the dunes and form small lagoons on the upper beach. Lunar tides have an amplitude of about 50 cm, with high tide around noon and midnight, but wind exerts overriding influence on

the sea level, which is lowered by the prevailing northeasterly wind, and rises with southerly weather. The beach has a gentle slope (i/30 to i/50) and as a result the swash zone is wide, generally about 10 m. In this zone, invertebrates occur at high density. Dominant species are the clams *Mesodesma mactroides* and *Donax hanleyanus*, the crustaceans *Emerita brasiliensis* and *Excirolana armata* and the polychaetes *Euzonus furciferus* and *Spio gaucha* (Gianuca 1983).

From 4 May 1982 to 10 December 1986, bird censuses were carried out along the stretch of 60 km of beach from the seaside resort Cassino southward to Sarita Lighthouse (Fig. 1). Coastal birds were counted on the southward journey

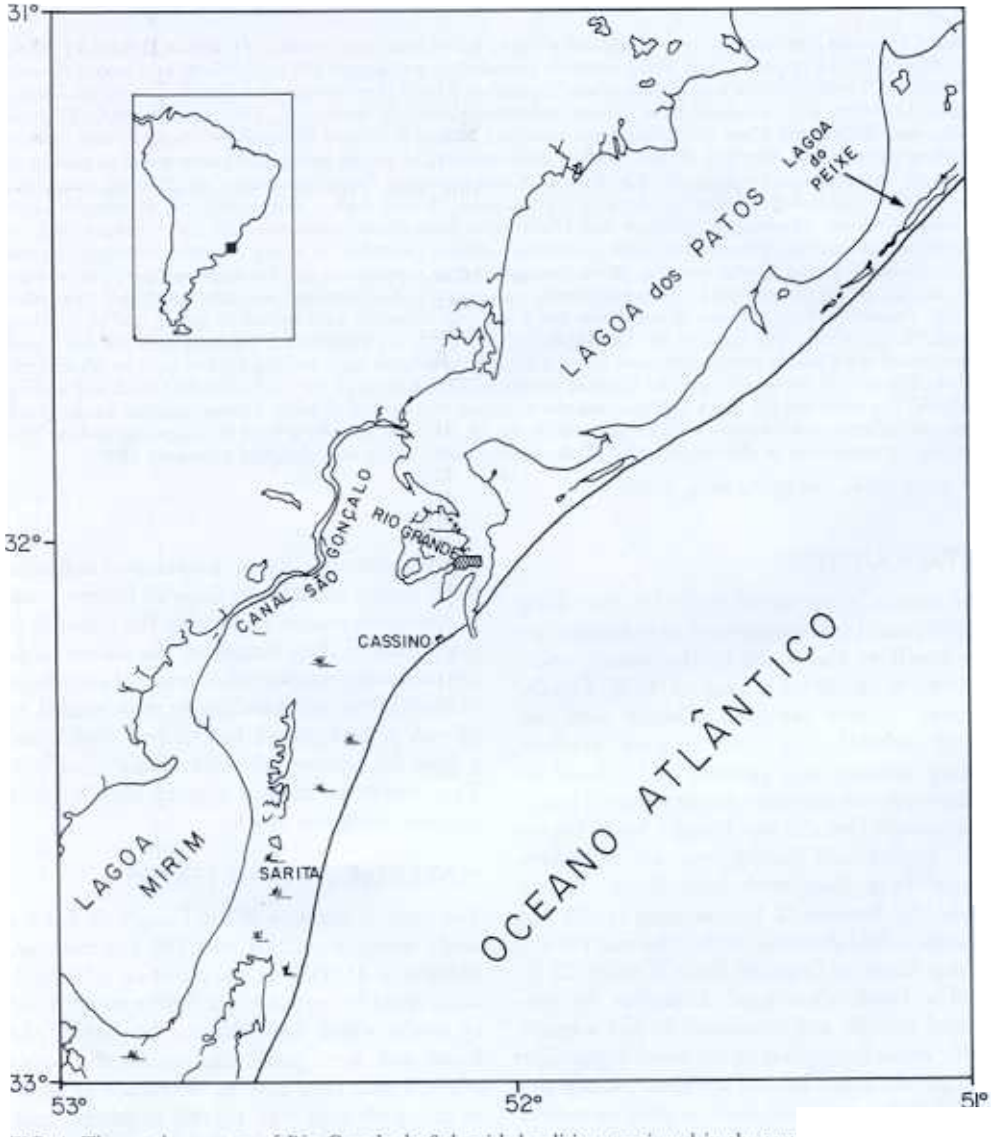

FIG. 1. The southern coast of Rio Grande do Sul, with localities mentioned in the text

from a vehicle moving at about 40 km/h along the lower beach. The censuses were done in the morning from about 08:30 h to 11:00 h, with low rising tide, and only when weather and traffic conditions were good, i.e., no rain and no strong southerly weather. The term "coastal birds" indicates all birds which used the area for feeding and/or resting. All such birds present on the beach and those flying or swimming inshore were counted. Not included were seabirds (albatrosses, petrels and the penguin *Spheniscus magellanicus*) which were frequently cast ashore dead or exhausted. An interval of two weeks between censuses was aimed at but weather and logistics did not always permit this. The series as a whole includes censuses in all months of the year: 2 in January, 1 in February, 5 in March, 9 in April, 6 in May, 5 in June, 6 in July, 1 in August, 3 in September, 6 in October, 2 in November and 2 in December, a total of 48 censuses. In addition, waders only were counted in three censuses, in January, April and August. General notes were taken on the behaviour of the birds, and specimens were collected and deposited in the collection of the University. Occasional observations made from 1987 onwards are also cited in this paper. The species were identified according to Voous (1955), Alexander (1959), Peterson *et al.* (1960), Chapman (1966), Olrog (1968), Escalante (1970a), Prater *et al.* (1977), Tuck & Heinzel (1978), Harrison (1983), Sick (1985) and Hayman *et al.* (1986).

Frequency of occurrence of a species was calculated expressing the number of censuses

TABLE 1. Rank numbers of density of birds observed on Cassino Beach, Brazil. For each month, from left to right, the values for 1982 to 1986. — indicates absence of data. For explanations of rank numbers, see text.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PERMANENT USERS												
Larus dominicanus	-2-3-	-2-	-332-	-33-3	23-	333-	22322	-2--	2---1	3-022	3-	-2 -2-3
Larus maculipennis	-2-2-	-3-	-332-	-34-3	23-	332-	23222	-2--	3---2	2-222	2-	-2 -2-3
Sterna maxima	-1-1-	-1-	-211-	-11-1	12-	212-	11212	-2-	1---1	1-110	1-	-1 -1-1
Sterna trudeaui	-1-1-	-2-	-221-	-11-2	21-	232-	22222	-2-	2---2	1-121	1-	-1 -1-1
Phaetusa simplex	-0-0-	-1-	-101-	-10-1	00-	011-	01110	-0-	1---0	1-011	1-	-1 -0-1
Sterna superciliaris	-1-1-	-1-	-101-	-11-1	11-	212-	31211	-1-	1---1	1-111	1-	-1 -1-1
Haematopus palliatus	-2-2-	-2-	-323-	-32-3	23-	223-	22222	-22-	2---2	2-222	2-	-2 -2-2
Charadrius collaris	-1-0-	-1-	-101-	-11-1	21-	121-	21111	-11-	1---0	1-111	0-	-0 -0-0
Himantopus himantopus	-0-0-	-0-	-101-	-10-1	22-	320-	21110	-1--	1---0	1-110	1-	-0 -0-0
Milvago chimango	-1-1-	-1-	-111-	-11-1	11-	121-	11111	-1-	1---1	1-111	1-	-1 -1-1
Polyborus plancus	-0-0-	-0-	-101-	-00-1	11-	011-	01110	-1-	0---0	0-101	1-	-0 -0-1
Ardea cocoi	-1-1-	-1-	-111-	-11-1	11-	111-	01111	-1-	1---1	1-111	1-	-1 -1-1
Egretta thula	-1-0-	-1-	-112-	-11-1	11-	111-	11111	-1-	1---1	1-121	1-	-1
SOUTHERN MIGRANTS												
Sterna sandvicensis	-1-1-	-1-	-211-	-22-0	01-	000-	01001	-0-	0---1	0-000	2---1	-0-0
Sterna hirundinacea	-0-0-	-0-	-000-	-00-0	00-	021-	12210	-2-	1---1	0-000	0---0	-0-0
Rynchops niger	-0-0-	-0-	-100-	-11-1	11-	011-	11112	-1-	0---0	1-010	0---1	-1-0
Catharacta sp.	-0-0-	-0-	-000-	-00-0	10-	000-	00010	-0-	1---0	--000	0---0	-0-0
Charadrius falklandicus	-0-0-	-0-	-001-	-12-1	11-	111-	21111	-11-	0---0	0-000	0---0	-0-0
Charadrius modestus	-0-0-	-0-	-000-	-10-0	11-	011-	00000	-0-	0---0	0-000	0---0	-0-0
Phalacrocorax olivaceus	-1-1-	-1-	-111-	-10-1	00-	000-	00010	-0-	1---0	1-111	1---1	-1-1
NORTHERN MIGRANTS												
Sterna hirundo	-1-2-	-1-	-300-	-13-2	01-	000-	00000	-0--	0---0	1-101	1-	-1 -1-0
Stercorarius sp.	-1-1-	-0-	-010-	-11-1	01-	000-	00000	-0--	0---1	0-010	1-	-0 -2-0
Pluvialis dominica	-2-2-	-2-	-010-	-00-0	00-	000-	00100	-0--	0---0	2-212	2-	-2 -2-1
Pluvialis squatarola	-1-1-	-0-	-201-	-22-2	11-	011-	00111	-0--	0---2	0-112	0-	-1 -0-0
Calidris alba	-2-2-	-3-	-232-	-3234	01-	011-	00110	-01-	0---0	1-201	1-	-1 -1-1
Calidris canutus	-0-0-	-0-	-333-	-4312	23-	011-	20222	-01-	1---1	0-121	2-	-2 -0-0
Calidris fuscicollis	-2-1-	-3-	-332-	-4222	12-	000-	00000	-00-	0---1	2-021	3-	-3 -1-2
Arenaria interpres	-0-0-	-0-	-101-	-11-0	11-	000-	00000	-0--	0---0	0-101	0-	-1 -0-0
Tringa sp.	-1-0-	-1-	-001-	-00-1	10-	001-	00000	-0--	0---0	0-110	1-	-1 -0-1

with presence as a percent of the total number of censuses in a given period. Density of a species at a given census was calculated dividing the total number counted, by the distance covered, expressed as number of birds per km, abreviated as b/km. The monthly means of the density were ranked according to the following scale: 0 is absence; 1 is presence up to 1.0 b/km; 2 is from 1.1 to 10.0 b/km; 3 is from 10.1 to 50.0 b/km; 4 is more than 50.0 b/km. For given periods of the year, the mean was also calculated of all censuses with presence of the species. This parameter gives a more direct idea of the densities at which the birds actually occurred, and is named "density when present", abreviated as DP and stated in b/km.

The seasons of the year are cited according to the southern hemisphere. Feeding methods of terns are classified according to Ashmole & Ashmole (1967), and those of waders according to Burton (1974).

RESULTS AND DISCUSSION

Permanent users

This category includes 13 species which were present during all or most of the year, either without a seasonal pattern, or with definite presence during the months of lesser abundance.

Southern Black-backed Gull *Larus dominicanus*

Present all year round, with overall frequency of 96 %. DP was greatest (mean 13.51 b/km, range 1.44 to 27.30) in March to June, then decreased to 5.78 b/km (range 1.30 to 11.56) in July and 3.83 b/km (range 0.73 to 10.80) in August to November, then increased to 11.23 b/km (range 3.30 to 16.80) in December to February. Thus, the general pattern shows greatest values in autumn and early winter, and a minimum in early spring (Table 1). Belton (1984) also observed the species all year round in the area and characterizes the bird as resident. However, breeding of the species has not been recorded in Rio Grande do Sul, but takes place in spring on islands off the Uruguayan Coast (Escalante 1970a). It is concluded that the species migrates to the study area in search of food, which is abundant in the form of discards of the shore fishery and dense populations of invertebrate prey in the swash zone (Gianuca 1983). The decrease in numbers in August to November reflects migration to the breeding areas further south. The birds were mostly seen resting on the beach in flocks of up to 150 individuals. Such flocks were wary and fled when approached within less than 50 m. Fish discards attracted large flocks, but the birds were also seen singly or in groups of up to 10 individuals searching for natural food on the lower beach.

Brown-hooded Gull *Larus maculipennis*

The species was present in all but two censuses. DP was high from February to September (mean 12.95 b/km, range 1.00 to 53.00) and moderate from October to January (mean 5.07 b/km, range 1.68 to 13.12). Monthly values were highest in April (mean 18.56 b/km, maximum 53.00) and June (mean 18.51 b/km, maximum 33.11), and lowest in January (3.30 and 2.64 b/km). Belton (1984) recorded nuptial plumage as sporadic in late June and common in late July. The present data confirm the latter: 54 out of 111 birds had the brown hood on 17 July 1986. Belton (1984) cites breeding of the species in marshes near the study area in October and November. Thus, the decrease in numbers after September reflects migration to those areas, and the birds return to the shore in February. From April to October, density varied 6- to 10-fold within 5 out of those 7 months. This indicates that at those times, massive short-term migration takes place between Cassino Beach and neighbouring areas. The birds foraged along the lower beach, diffusely scattered along the entire area, and rested in flocks of up to 60 individuals near lagoons. In addition to the scavenging and aerial insect-catching also mentioned by Belton (1984), the birds fished at creek mouths.

Royal Tern *Sterna maxima*

Present all year round, with overall frequency of 85 %. The general pattern was of higher density in autumn and winter, and lower density in spring and summer (Table 1). From October to February, DP was 0.27 b/km, with range from 0.02 to 0.73, the lowest values occurring from December to February. From March to September, DP ranged from 0.10 to 5.00 about the mean of 0.98 b/km, the highest value occuring in July.

Adults in non-breeding plumage were collected on 2 April 1983 and seen on 2 May 1985, and adults in breeding plumage were seen on 29 July 1989 and collected on 4 August 1985. These data agree with the seasonality of such plumages as cited for Uruguay and Argentina by Escalante (1968), who concludes that the species breeds in spring in unknown places in these countries. As there is no record of breeding along the coast of Rio Grande do Sul, it is concluded that the birds which occur in the study area belong to populations which breed in spring further south and migrate to Cassino Beach in winter. The birds rested on the beach in groups of up to about 50 individuals, often together with *Larus dominicanus*. The resting groups were shy, not permitting approach within less than 50 m. The birds were seen fishing beyond the surf and several times accompanied beach seines, taking escaping or discarded small fish in the surf or on the lower beach.

Trudeau's Tern *Sterna trudeaui*

The species was present all year round, with higher density in autumn and winter, and lower density in spring and summer (Table 1), as also observed on the coast of Uruguay (Escalante 1970a). Overall frequency was 92 %. In June and July, DP was 6.6 b/km with range from 1.30 to 18.40. In August and September, DP decreased to 2.90 b/km with range from 0.70 to 4.90. During the rest of the year, DP ranged from 0.10 to 1.50 about the mean of 0.60 b/km. The species breeds in spring in coastal and inland marshes and lagoons in Brazil, Uruguay, Argentina and Chile (Escalante 1970a, Belton 1984). It is concluded that birds from such areas in southern Brazil migrate to the coast after breeding and stay there during winter. The birds were seen fishing in the inner surf zone by air- and contact-dipping, and rested in groups up to 10 birds, often together with other terns.

Amazon Tern *Sterna superciliaris*

Present all year round with overall frequency of 90 %, high density in winter, and low density during the rest of the year (Table 1). Values for June and July ranged between 0.04 and 14.1 about the DP of 2.63 b/km, and during the other months, between 0.02 and 0.80 about the DP of 0.17 b/km. The species breeds mainly on the shores of lakes and rivers (Sick 1985), and the authors observed breeding at Lagoa Mirim in January 1990. A specimen in first summer plumage was collected at Cassino in March 1983, which indicates breeding in or near the study area. It is concluded that birds from outside this area, possibly from the interior of southern Brazil, concentrate on Cassino Beach in June and July. The birds present at low density in other months may be residents in the study area. The species was associated with fresh water, being typically seen at creek mouths and lagoons, fishing by dipping and plunge diving. The birds rested in groups which in June and July contained up to 30 individuals.

Large-billed Tern *Phaetusa simplex*

Observed sporadically all year around at density of less than 1 b/km (Table 1). Sick (1985) characterizes this bird as a species of freshwater. In Rio Grande do Sul the species was found breeding during summer 1986/87 by Resende & Leeuwenberg (1987) at Lagoa do Peixe, and by the authors on the shore of Lagoa Mirim. In Uruguay the species is a resident and occurs on the beach in the same manner as in the study area (Escalante 1962). The presence of the birds on Cassino Beach probably reflects movements of dispersal or migration. The birds were seen singly or in pairs, flying steadily as if migrating, or resting and fishing by bill-dipping at lagoons on the upper beach.

Collared Plover *Charadrius collaris*

Density was highest from May to July, the species was not seen in November and December, and density was low in the remaining months (Table 1). From January to April frequency was 65 %, and DP was 0.08 b/km ranging from 0.02 to 0.13. From May to July, frequency was 100 %, mean density 0.72 b/km with range from 0.10 to 2.00; from August to October, frequency was 90 %, and DP was 0.19 b/km ranging from 0.02 to 0.42. Belton (1984) also found the species to be more common on the beach in winter than in summer. The density from May to July is similar to the value of 1.0 b/km observed by Harrington *et al.* (1986) on the beach at Lagoa do Peixe. Resende & Leeuwenberg (1987) found the spe-

cies breeding in the seaward dunes at Lagoa do Peixe from November to January and observed that the birds forage mostly in the dunes during the breeding period, and on the beach during winter, which results in seasonal variation in numbers on the beach. The pattern observed in the study area is consistent with the hypothesis that the species breeds there and that the winter peak in abundance represents the local breeders and their offspring.

Black-winged Stilt *Himantopus himantopus melanurus*

The birds were absent from December to February, reached peak numbers in May and June and were present at mostly less than 1 b/km, in the remaining months (Table 1). In March and April frequency was 57 %, DP was 0.15 b/km with range from 0.01 to 0.47; in May and June, frequency was 82 %, DP was 4.32 b/km with range from 0.42 to 8.70; in July to November, frequency was 72 %, DP was 0.36 b/km with range from 0.08 to 0.63. Belton (1984) characterizes the bird as an abundant resident breeding in freshwater marshes in spring, and cites peak numbers on the beach in May and June, the latter being also observed at Lagoa do Peixe (Harrington *et al.* 1986). It is concluded that the birds in the study area belong to a population which breeds in nearby marshes and migrates to the shore in early winter. The birds occurred in the swash zone in loose groups of up to 8 individuals, scattered along the entire lower beach, and in flocks of up to 50 birds at lagoons on the upper beach. The birds foraged visually on submerged substrate by wading and pecking at prey near the surface of the water, and also on moist exposed substrate.

American Oystercatcher *Haematopus palliatus*

The species occurred in all censuses. Greatest densities were observed from March to June with mean of 6.88 b/km and range from 0.30 to 11.10. Mean density during the remaining months was 3.42 b/km. Belton (1984) states that this bird is a coastal species, and found evidence of breeding near Cassino in November. This was confirmed during the study period, chicks being collected in November, and first-summer juveniles from January to March, which indicates breeding in spring. As no birds were seen in the dunes, it is concluded that breeding takes place on the upper beach. The results indicate that on Cassino Beach there is a sedentary population of local breeders. From the magnitude of the difference in density betweeen autumn and the rest of the year it is concluded that the autumn peak reflects the growth of this population during the breeding season. The birds were observed feeding on the white clam *Mesodesma mactroides* in the swash zone and rested on the upper beach. The birds occurred throughout the year in pairs and small groups, but also formed flocks of up to 80 individuals in autumn and winter.

Chimango *Milvago chimango*

This hawk occurred at low density throughout the year (Table 1), with frequency of 92 %, DP of 0.3 b/km, and maximum of 1.5 b/km in June 1983. The species is common further inland in dry open country (Belton 1984) and thus is not strictly a coastal bird, but its presence was a constant feature of the beach. The birds were solitary and scavenged fishes (often discards from the shore fishery) and petrels and albatrosses washed ashore, never touching the carcasses of the penguin *Spheniscus magellanicus* which were abundant during winter.

Crested Caracara *Polyborus plancus*

This hawk occurred with frequency of 38 %, being absent in January and February and present at DP of 0.06 b/km during the remainder of the year. The species is common further inland, specially near the coast, and hunts in open dry country (Belton 1984). The bird was more frequent on the beach in autumn and winter, which may reflect dispersal during the non-breeding period. The birds occurred mostly in pairs and were not seen feeding.

Snowy Egret *Egretta thula*

Present all the year round without a seasonal pattern (Table 1), with overall frequency of 90 % and DP of 0.26 b/km, with range from 0.02 to 1.03. The species is abundant near the study area in marshes, where it breeds in spring (Belton 1984). The birds present on the beach may be non-breeding members of the populations in that region. The birds were observed singly or in

groups of up to 6 individuals, always at the mouths of freshwater creeks, feeding on small fishes which were caught through active search and pursuit.

White-Necked Heron *Ardea cocoi*

Present all year round without a seasonal pattern, with overall frequency of 85 % and DP of 0.11 b/km with range from 0.02 to 0.40. The species is common in marshes and breeds in spring (Belton 1984), and the conclusion stated for *Egretta thula* may also apply to the present species. The birds were solitary, resting on the tops of the dunes or standing in the surf where they preyed on fishes, the sciaenid *Menticirrhus littoralis* being among the species taken. The birds did not fish in creeks and lagoons and were shy, not permitting approach within about 50 m.

Southern migrants

This category includes 9 species which are known or presumed to breed in southern regions of the continent and which stayed in on passed through the study area during definite seasons, being scarce or absent at other times. Two scarce winter visitors are also included.

Bigua Cormorant *Phalacrocorax olivaceus*

The species occurred sporadically from April to August, and regularly in other months (Table 1). From September to March, frequency was 86 %, and DP was 0.26 b/km with range from 0.07 to 0.53. From April to August, a single bird was seen in 3 out of 28 censuses. In Rio Grande do Sul, the species breeds in inland marshes and flooded areas in spring and is scarce in winter (Belton 1984), although Sick (1985) mentions observation of large concentrations in the Lagoa dos Patos in August which included birds banded in Argentina. The birds which occur frequently in small numbers in the study area in spring and summer may be immature members of the populations which breed in southern Brazil. The birds rested on the lower beach or near lagoons on the upper beach, singly or in groups of up to 8 birds, and fished in the surf and in lagoons.

Great Skua *Catharacta skua*

Sick (1985) cites the Northern Great Skua as a rare visitor to northern Brazil, and the Southern Great Skua as occurring from northeastern Brazil southwards, regularly off Rio de Janeiro in May and June. Three birds were observed during the present study from May to September. One of these, found dead, belonged to the southern subspecies *chilensis*. The two live specimens were not identified as to race but in view of the above literature, it is likely that they also belonged to southern forms. The present data characterize the Southern Great Skua as an occasional visitor on Cassino Beach in autumn and winter. This agrees with its seasonality in Uruguay, where the species is regularly observed in small numbers from March to September (Escalante 1970a).

Belcher's Gull *Larus belcheri*

The species was not identified during the censuses but one juvenile specimen was photographed on 3 June 1989. The bird foraged through wading in the swash zone and was easily approached to a distance of 15 m, being much less shy than *L. dominicanus*. The only other record is by Gianuca (*in* Belton, 1984) who states that a specimen was captured in winter of 1971 near Rio Grande. The species breeds in Argentina and is a regular winter visitor on the coast of Uruguay (Escalante 1970a) but few birds stray into southern Brazil.

Cayenne Tern *Sterna sandvicensis eurygnatha*

The birds occurred at high density in autumn (March—April) and spring (November) and were scarce or absent during the remainder of the year (Table 1). In March and April, frequency was 50 %, DP was 2.14 b/km with range from 0.02 to 7.40; in November, the species occurred in both censuses with 0.05 and 2.30 b/km; in the remaining months, frequency was 22 % and DP was 0.20 b/km with range from 0.02 to 0.60 b/km. An adult in breeding plumage was collected in August 1984, and 11 adults collected from February to April (1981 to 1983) were in non-breeding plumage and in the early stages of wing moult. These data agree with the seasonality of such plumages in Uruguay and are consistent with the hypothesis that the birds belonged to populations which breed further south in early summer and migrate northwards into Brazil during the non-breeding season, as proposed by Escalante (1970b). From the present data it is

concluded that the birds pass through the study area during their northward migration in autumn, and again in spring during their return to the south. However, high densities occurred in March 1983, April 1983 and 1984, and November 1982, but not in March 1984 and 1985, and April and November 1986. This may mean that the migrating population passes rapidly through the study area, so that the phenomenon may not always be detected by censusing at two-weekly intervals. The birds rested in groups of up to 30 individuals, usually together with other terns and gulls, and were not seen fishing close to shore.

South American Tern *Sterna hirundinacea*

This species and the Common Tern *Sterna hirundo* both occur in Southern Brazil (Belton 1984). During the present study, criteria for distinguishing between the two species in the field were not achieved, Harrison (1983, p. 369) also stating that such criteria are "still evolving", and all terns which might be one or the other were recorded as *Sterna* sp. The density of this category was high in autumn, intermediate in winter, and low at other times (Table 1).

Specimens were identified from plumage and measurements (Table 2). Of 16 specimens collected from June to September, 14 were *Sterna hirundinacea* and 2 were *Sterna hirundo*, whereas of 18 specimens from November to April, 1 was *Sterna hirundinacea* and 17 were *Sterna hirundo*. It is concluded that the census data for summer and autumn refer basically to *hirundo*, and those for winter, to *hirundinacea*. Thus, the latter species occurred from June to August with frequency of 75 % and DP of 1.94 b/km with range from 0.30 to 7.30.

Of the 14 winter specimens, 10 were adults in non-breeding plumage, and 4 were 1st-year-juveniles. The species breeds in July off Rio de Janeiro (Sick 1985) and from October to December in Chile and Argentina as stated by Escalante (1970a). It is concluded that in the study area the species is a non-breeding winter visitor from the south, occurring in moderate numbers from June to August.

In the adult specimens of those months, wing moult is in the final stage, most specimens having the outer primary missing or growing, and several are moulting the outer tail feathers. The latter means that during winter the birds do not always have the long, deeply forked tail, which is stated as one of the main field characters (Tuck & Heinzel 1978, Harrison 1983). The birds rested on the beach in flocks of up to 32 birds.

Black Skimmer *Rynchops niger*

The species was not seen in January, February and September, and occurred during the remaining months at DP of 0.14 b/km with range from 0.02 to 1.58. Frequency was highest from April to July (52 %), in August and September one

TABLE 2. Measurements of *Sterna hirundinacea* and *Sterna hirundo* from Cassino Beach, Brazil, 1982–1986. MT+C is middle toe with claw, MT–C middle toe without claw, WT total body mass in g, linear dimensions in mm, n indicates sample size, — lack of data. Incomplete wings and tails are not included. WT is of healthy *Sterna hirundinacea* in June, *Sterna hirundo* in March and April.

	Sterna hirundinacea						*Sterna hirundo*					
	1st-year juvenile			Adult			Immature			Adult		
	n	mean	range	n	mean	range	n	mean	range	n	mean	range
Culmen	3	36.2	34.5–37.0	10	38.6	36.3–42.0	14	35.5	33.0–38.0	4	37.2	
Tarsus	5	20.9	19.5–23.2	10	21.4	20.0–22.8	14	20.7	18.5–23.3	4	22.4	
MT + C	5	26.8	26.0–27.0	10	26.9	26.0–28.4	14	24.2	23.0–26.0	4	26.2	
MT – C	5	20.6	19.0–23.0	10	19.9	18.0–21.4	14	17.7	16.0–20.0	4	18.0	
Wing	5	275.8	270–280	3	303.7	286–320	12	253.6	235–268	3	271.0	
Tail	5	143.2	130–158	7	192.3	187–204	12	122.5	113–147	3	139.0	
WT	0	—	—	3	202.7	195–210	11	127.4	114–145	3	148.0	

bird was seen in one out of five censuses, and in October frequency was 40 %. However, Belton (1984) observed large roosting flocks up to 500 birds in Lagoa do Peixe and Lagoa Mirim in January and February, and such flocks were also observed by the authors on 7 February 1987 on a sand bar in the mouth of the Lagoa dos Patos, where windrows of primary feathers indicated wing moult at that time. A juvenile in 1st-summer plumage was collected in April 1983 and adults in breeding plumage were collected in May 1983 and photographed on 2 June 1989. Data on reproduction of the species are scanty, Escalante (1970a) citing reports about breeding along the Paraguay river from July to September. The scarcity of birds on the beach in August and September, and the observation of breeding plumage in May and early June (present study) and from July to August in Uruguay (Escalante 1970a), are consistent with this. It is proposed that the birds in the study area belong to populations which breed in late winter in inland situations in or near Rio Grande do Sul and which spend the summer months at coastal lagoons such as those mentioned above. The frequent occurrence in the study area from April to July may be evidence of migration along the shore. In the study area, the birds were seen groups of up to 30 individuals, mostly resting or fishing at a permanent creek mouth with a lagoon, 16 km to the south of Cassino. They also fished in the surf, flying parallel to shore and skipping sideways over breaking waves.

Two-banded Plover *Charadrius falklandicus*

The species was present from March to August, with DP of 0.60 b/km and range from 0.04 to 7.11, and with frequency of 72 %, the birds occurring in all censuses from June to August. The values are similar to those observed by Harrington *et al.* (1986) in early May on beaches near Lagoa do Peixe. The species breeds in southern Argentina, being a winter migrant and occasional breeder in coastal Buenos Aires Province (Myers & Myers 1979). The same was recently observed at Lagoa do Peixe, where about one-third of the population present during winter remains during summer and breeds (Resende & Leeuwenberg 1987). The present data indicate that the latter does not occur in the study area, and that the birds on Cassino Beach are non-breeding winter visitors from the south. A specimen in full breeding plumage was collected in August 1983 which indicates that the pre-nuptial moult takes place in the area. The birds occurred as single individuals, spaced out over the entire area, foraging along the upper edge of the swash zone.

Rufous-chested Dotterel *Charadrius modestus*

The species occurred in 30 % of the censuses from April to June, with a maximum of 2 individuals per census. The species breeds in the south of the continent (Sick 1985) and is classified as a non-breeding winter visitor in the study area, as also stated by Belton (1984) who observed the species from April to August, and by Myers & Myers (1978) who cite presence from late March to September in coastal Buenos Aires Province. The cited authors state that grasslands and marshes are its typical habitat at that time. This is consistent with the fact that in the study area the birds were only seen at margins of creeks and lagoons.

Snowy Sheatbill *Chionis alba*

A single bird was observed on the lower beach on 11 April and 18 May 1983, and a dead bird was found on 30 April 1984. Belton (1984) cites two records in the area, in May 1973 and June 1975. The bird is a regular winter visitor on the islands off Uruguay (Escalante 1970a). Apparently, birds from this area stray into southern Brazil.

Northern Migrants

This category includes 11 (or 12, see *Tringa* spp.) species which breed in temperate or higher latitudes in the northern hemisphere and which were seasonally present or abundant in the study area.

Long-tailed Jaeger *Stercorarius longicaudus* and Parasitic Jaeger *Stercorarius parasiticus*

Due to the difficulty of distinguishing between the species *parasiticus* and *longicaudus* in non-breeding plumage in the field, small jaegers were recorded as *Stercorarius* sp. Such birds were seen with frequency of 33 % from September to May,

up to 2 specimens being observed per census. The seasonality of jaegers on Cassino Beach is in agreement with the dates of occurrence of *longicaudus* and *parasiticus* in other areas of Brazil (Sick 1985) and in Uruguay (Escalante 1985). Belton (1984) cites only *S. parasiticus* for the area, in May and August. However, an adult of *S. longicaudus*, pursuing *Sterna trudeaui* over the surf, was identified on 20 September 1986 by the presence of the long central tail feathers. Six specimens were collected and identified according to criteria stated by Lambert (1981), Escalante (1985) and Melville (1985). Five were *longicaudus* (forearm 98 to 104 mm), and one was *parasiticus* (forearm 116 mm). Both species are characterized as scarce visitors in the study area from spring to autumn. The birds were mostly seen resting on the beach. An unusual situation (not included in the census data) occurred on 28 December 1984, when over 18 km of shoreline 18 live and 12 recently dead birds were counted, 4 of the latter being collected and identified as *longicaudus*. The birds were starving, the body mass of 2 specimens (218 and 236 g) being at the low end of the range cited for the species by Roselaar (1983). The surviving birds were eating the carcasses of their dead conspecifics which, however, did not show signs of attacks and evidently has not been killed for food but had died of starvation. This form of cannibalism, which represents the last resort for survival among carnivores facing lack of food, has not been recorded previously for jaegers.

Common Tern *Sterna hirundo*

Under *Sterna hirundinacea* it is shown that *Sterna hirundo* was scarce in summer, abundant in autumn, and almost absent at other times. From December to February, frequency was 80 % and DP was 0.07 b/km with range from 0.02 to 0.10. In March and April, frequency was 57 % and DP was 10.33 b/km with range from 0.02 to 36.11. Peak numbers ranged from 1100 to 2200 birds. Of the 18 specimens, 4 were adults and 14 were immatures with the dark carpal bar. Photographs taken in March and April 1984 confirm that the birds present during those months were mostly such immatures. Harrington (1984, *in* Resende & Leeuwenberg 1987) saw 4000 of such birds on the beach at Lagoa do Peixe in early May 1984. Resende & Leeuwenberg (1987) found there in the 1986—1987 season that numbers of the species were maximal in the mouth of the lagoon in December and January (up to 14000 birds, mostly adults) and that after February, lesser numbers (up to 2000 birds, age not stated) remained on the beach in March and April. These authors cite Bremer (pers. comm.) as stating that large numbers of the species occur on the coast of Buenos Aires Province in January and February. It is inferred that immatures of *Sterna hirundo* spend southern summer in Argentina and then migrate northwards, stopping over in southern Brazil from March to early May. The birds rested near lagoons and on the lower beach in flocks of up to 200 individuals and were not observed fishing. The scarcity of *Sterna hirundo* in the study area during summer contrasts with the great numbers recorded at Lagoa do Peixe at that time. Possibly, the disturbance due to tourist traffic makes Cassino Beach unsuitable for the terns during summer. Thus, the present results stress the importance of Lagoa do Peixe as a summer habitat for *Sterna hirundo*.

The specimens provide data on moult and body proportions (Table 2). Of the adults, 1 was in breeding plumage on April 13th, and three in non-breeding plumage from January 3rd to April 13th. Two immatures of November had all primaries old and worn, 1 adult in January moulted the inner primaries, and 15 birds of March and April had wing molt in the final stage or just completed. The comparison of the moult cycles of *Sterna hirundo* and *Sterna hirundinacea* indicates that in areas where both species occur in non-breeding plumage, observing the state of the primaries may aid in identification of the species.

American Golden Plover *Pluvialis dominica*

The species was abundant from October to February, and one individual was seen in March and July 1984. From October to February, frequency was 85 %, and DP was 3.91 b/km with range from 0.30 to 6.40, the species being present in all censuses from November to February. The months of abundance in the study area agree with patterns observed in Lagoa do Peixe (Resende & Leeuwenberg 1987) and in Buenos Aires Province (Myers & Myers 1979), but these

authors cite first arrival respectively in late August and September. The observation of one bird in July is consistent with the statement by Belton (1984) that small numbers stay in southern Brazil during winter. The present results coincide with the observation by Resende & Leeuwenberg (1987) that in Lagoa do Peixe, *Pluvialis dominica* arrives one month later and leaves two months earlier than *Pluvialis squatarola*. Although the typical habitat of *dominica* is cited as short-grass pasture and wetlands (Myers & Myers 1979), in the study area the birds foraged along the swash zone, spaced out regularly as single individuals or in loose groups of up to 30 birds.

Grey Plover *Pluvialis squatarola*

The species was present throughout the year, with high densities in spring and autumn, and was fairly common during winter (Table 1). In September and October, frequency was 56 % and DP was 2.37 b/km with range from 0.02 to 5.27. In March and April, frequency was 80 % and DP was 1.59 b/km with range from 0.10 to 5.90. From May to July, frequency was 41 % and DP was 0.23 b/km with range from 0.04 to 0.38. The species was sporadically seen in other months with a maximum of 4 birds per census, being absent in December and February. It is concluded that on Cassino Beach, migrants pass through in spring on the southward migration, and again in autumn on the return journey. Some of the autumn birds stay through winter, but join the southward moving birds in the next spring. This pattern is different from that at Lagoa do Peixe, where in 1986—1987 numbers increased from August onwards to peak values in December to February and then declined to virtual absence after May (Resende & Leeuwenberg 1987). There, the birds fed during summer in the salt marshes inside the lagoon mouth, and only occurred on the beach from late April onwards. In the study area, the abundant spring and autumn birds were mostly seen in small groups (up to 6 birds) on the upper beach in the low vegetation among the primary dunes, and to a lesser extent on the lower beach where they foraged in the manner of *Pluvialis dominica*. The data for Lagoa do Peixe indicate that the birds stay through summer where suitable feeding habitat is available. The migrating birds were shy and could not be approached within less than about 60 m. Possibly, the degree of human activity on Cassino Beach makes the area unsuitable for the species during summer.

Sanderling *Calidris alba*

The species was abundant from February to April and occurred in small numbers during the rest of the year (Table 1). From January to April, frequency was 100 % and DP was 19.65 b/km with range from 1.02 to 58.40, but density was low in January (1.02 to 6.90 b/km). From May to December, frequency was 42 % and DP was 0.32 b/km with range from 0.03 to 0.57. From January to early March and from May to December the birds were in non-breeding plumage. Prenuptial molt took place during March and April, as evidenced by adult specimens collected in 1983: two in non-breeding plumage on 9 March, and two in breeding plumage on 29 April. The results confirm the observations by Belton (1984) and Resende (1988) that *Calidris alba* spends austral summer on the shores of southern Brazil, and that small numbers stay there during winter. However, in Lagoa do Peixe, abundance was high from November to February, decreased in March and increased again in April (Resende 1988). In the study area, the birds occurred in compact flocks of up to 200 individuals which foraged exclusively in the submerged part of the swash zone, continuously running back and forth with the movement of the waves and pecking at prey on the surface. In Lagoa do Peixe the birds foraged from October to February within the lagoon but occurred on the beach in March and April (Harrington *et al.* 1986; Resende 1988). In the study area the greatest density was also recorded in April. The results indicate that the summering birds prefer the lagoon habitat and that the beach is used during the northward migration in March and April. Myers & Myers (1979) state that the species is common from spring to autumn in Coastal Buenos Aires Province and occurs as far south as Valdez Peninsula in Patagonia. The increase in numbers at Lagoa do Peixe and in the study area in April may indicate that northbound migrants from Argentina use the beaches of southern Brazil for stopovers. That such stopovers may be short is

indicated by the great variation (8.82 to 58.40 b/km) of the densities recorded in three censuses in April 1986.

Red Knot *Calidris canutus*

The species was absent in summer, abundant in autumn, and present in small numbers during winter and spring (Table 1). In March to May the species occurred in all censuses. Density was moderate in March, with mean of 12.17 b/km and range from 4.00 to 19.80 b/km, rose sharply in April to a mean of 22.13 b/km with range from 0.78 to 148.90, then decreased in May to a mean of 8.48 b/km with range from 0.10 to 40.20. From June to November, frequency was 58 % and DP was 1.48 b/km with range from 0.20 to 3.70. The pattern is similar to that observed at Lagoa do Peixe by Resende & Leeuwenberg (1987). The peak value of 8900 birds observed in the study area on 17 April 1983 is similar to the peaks of 7000 and 11000 birds cited for Lagoa do Peixe in April 1984 and 1987 by Harrington *et al.* (1986) and Resende & Leeuwenberg (1987) respectively. The birds were moderately tame, being approachable to about 20 m. The birds occurred in dense flocks of up to 200 individuals which fed in the swash zone, but slightly further upshore and in a less mobile manner than flocks of *Calidris alba*. The birds probed the substrate for food in the stitching manner. Harrington *et al.* (1986) saw the birds feeding on the clam *Donax* sp. and the crustacean *Emerita* sp., and the gizzard contents of 24 specimens collected from 9 April to 4 May 1983 in the study area confirmed this. The gizzards were packed with newly broken shells of *Donax hanleyanus* (fragments up to 11 mm in length) which indicates that these clams are crushed by muscular contraction of the organ. The pre-nuptial molt took place during March and was completed by mid-April, and the birds gained body mass rapidly during the following two to three weeks (Table 3), attaining values similar to those observed by Harrington *et al.* (1986) at Lagoa do Peixe in late April 1984. The March values were similar to the fat-free body mass of the species cited by Harrington *et al.* (1986) as 120 g. The data confirm that after completing the pre-nuptial moult, the birds accumulate in about two weeks a lipid reserve amounting to approximately 50 % of their initial body mass. At that time the birds occur at high density, for instance 1 bird per 6.7 m of shoreline on 17 April 1983. As the birds feed exclusively in a narrow strip of the swash zone, it seems beyond doubt that intensive feeding at such a density causes a considerable impact on the food resource in a short time. This implies that the birds must keep moving through the habitat. That this in fact happens can be seen from the data for April 1983: 580 birds present on the 11th, 8900 on the 17th, and 590 on the 26th. This, and the fact that the peak numbers in the study area and Lagoa do Peixe are so similar and only occur in April, lead to the conclusion that the major part of the adult population of *Calidris canutus* which overwinters in Argentina (Myers & Myers 1979) moves during April as one body along the coast of southern Brazil, cropping the food resources as it goes. Gianuca (1983) states that the abundance of juvenile *Donax haleyanus* and *Emerita brasiliensis* in the area reaches a peak in late summer. Thus, the mi-

TABLE 3. Data on specimens of *Calidris canutus* from Cassino Beach, Brazil, March to May 1983. N indicates sample size, S standard deviation. "Moult" refers to pre-nuptial moult.

Date	Moult frequency		Body mass (g)			
	in progress	completed	mean	range	S	N
9 March	4	0	115.8	110.7—126.3	7.4	4
22 March	9	1	123.6	115.0—135.0	7.5	7
11 April	7	3	120.4	117.0—130.0	5.6	11
29 April			198.5	177.0—220.0	—	2
4 May		6	182.6	164.0—191.0	11.8	9

gration of *Calidris canutus* through the area is timed so as to coincide with optimal availability of food of suitable size. It is concluded that not only Lagoa do Peixe but the shore of Rio Grande do Sul as a whole is a staging area in the migration of *Calidris canutus* to its breeding grounds, and that the ecological conditions in this entire area are of crucial importance in the life cycle of the population involved. The fact that many birds moult and attain peak body mass not only at Lagoa do Peixe but also in the study area, is further evidence of this.

Skins of two birds in non-breeding plumage dated 06/04/82 and 23/10/1984 show the brownish tinge on the upper parts mentioned by Hayman *et al.* (1986) as characteristic of juveniles. The dark markings on the marginal underwing coverts, the axillaries and the upper tail coverts are less bold than in the adult, of a brownish grey colour. The lower tail coverts are wholly white, and do not have the distinct black submarginal marks observed in all adult specimens.

White-rumped Sandpiper *Calidris fuscicollis*

The species was abundant in spring and autumn, occurred in lesser numbers during summer, and was absent during winter (Table 1). The species occurred in all censuses from November to April, and in 10 out of 12 in October and May. Mean (and range) of density was: 8.92 b/km (zero to 30.13 in October—November); 2.91 b/km (0.29 to 7.65) in December—January; 18.45 b/km (0.39 to 107.6) from February to April; and 0.38 b/km (zero to 0.70) in May and September. The birds were tame, being approachable to about 5 m, as also observed by Wetmore (1926, *in* Bent 1962) in Argentina. The birds occurred in diffuse concentrations of up to 300 individuals along the entire area, foraged on the moist sand at the upper margin of the swash zone, and searched for prey by visual means, as also observed by Harrington *et al.* (1986). At Lagoa do Peixe the birds were abundant in spring and autumn but reached peak numbers in November to January, during which months they fed mostly inside the lagoon, being only abundant on the beach in October and April-May (Resende & Leeuwenberg 1986). The species is from September to April the most common northern shorebird in coastal Buenos Aires Province, where numbers increase during March through migration from the south and decrease sharply after mid-April (Wetmore 1926 *in* Bent 1962, Myers & Myers 1979, Harrington *et al.* 1986). The results show that, unlike *Calidris canutus*, the present species stops over in southern Brazil in October and November during the southward migration and stays there in large numbers through summer where lagoon feeding habitat is available, as also observed in *Pluvialis squatarola*. In March and April, northbound migrants from Argentina stop over in the study area. Harrington *et al.* (1986) and Resende (1988) show that during those months the birds complete the pre-nuptial molt and fatten up, and then migrate to staging areas in the northern hemisphere. Three very high densities, of 1 bird per 9.3 to 32.5 m of shoreline, were recorded from 9 March to 17 April. These results lead to conclusions similar to those stated for *Calidris canutus* regarding the manner in which the birds use the coast of southern Brazil as a staging area during the northward migration. However, in *Calidris fuscicollis* high densities were observed both in March and April, so that the migration seems to occur in successive waves.

Baird's Sandpiper *Calidris bairdii*

The species was not recognized in the field, but three skins collected in November 1981 were thus identified from measurements and plumage. The primaries were new, contrary to what occurs in *Calidris fuscicollis* in November (Resende 1988). Belton (1986) saw this species on Cassino Beach in January. The species is classified as a scarce summer visitor.

Ruddy Turnstone *Arenaria interpres*

The species was seen in 41 % of the censuses in March to May, October and November, with numbers of up to 3 birds per census. The species is a common summer resident in coastal Buenos Aires Province (Myers & Myers 1979). It is concluded that small numbers stop over in the study area during the migrations between the breeding and wintering areas. Harrington *et al.* (1986) and Resende & Leeuwenberg (1987) also observed this at Lagoa do Peixe.

Tringa sp.

Birds of this genus were not identified as to species. The birds occurred with numbers of up to 4 birds per census, most frequently in spring and summer (50 % from October to February), less in autumn (15 % from March to June), and were absent from July to September. The birds occurred at the margins of small lagoons on the upper beach but where also seen wading in the swash zone. *Tringa melanoleuca* and *Tringa flavipes* are common throughout the year in inland and coastal areas in southern Brazil (Belton 1984, Resende & Leeuwenberg 1987), so the present data refer to either or both of these species.

GENERAL COMMENTS

Overall bird density, obtained by totalling the overall monthly means of all species, was lowest in July through October (17 to 30 b/km), and highest (85 to 98 b/km) in February through April (Fig. 2a). The latter peak was mainly composed of waders (47 to 69 b/km). This category decreased after April to a minimum of 3 b/km in September, then increased to a minor peak of 22 b/km in November. Both peaks of waders reflect the passage of Northern Migrants, mainly *Calidris fuscicollis* in spring, and the latter species and *Calidris canutus* in autumn (Fig. 2b). During the latter period, the birds moulted and acquired the fat reserve for migration. These results stress the importance of the shores of southern Brazil as a staging area in the migration of Northern waders, and the role of these birds in the ecosystem of the swash zone as predators and as producers of manure which enters the system through digestion of their food.

The Permanent Species of waders reached a peak in autumn and early winter. This reflects mostly the seasonal migration of *Himantopus himantopus melanurus* to the beach, and the breeding success of the local population of *Haematopus palliatus*. The Southern waders (mainly *Charadrius falklandicus*) were a typical feature of the beach in autumn and winter but occurred at low density, monthly means ranging from 0.1 to 0.9 b/km. The highest values occurred in April, which indicates the passage of northbound migrants at that time. Further research may decide whether the low density of

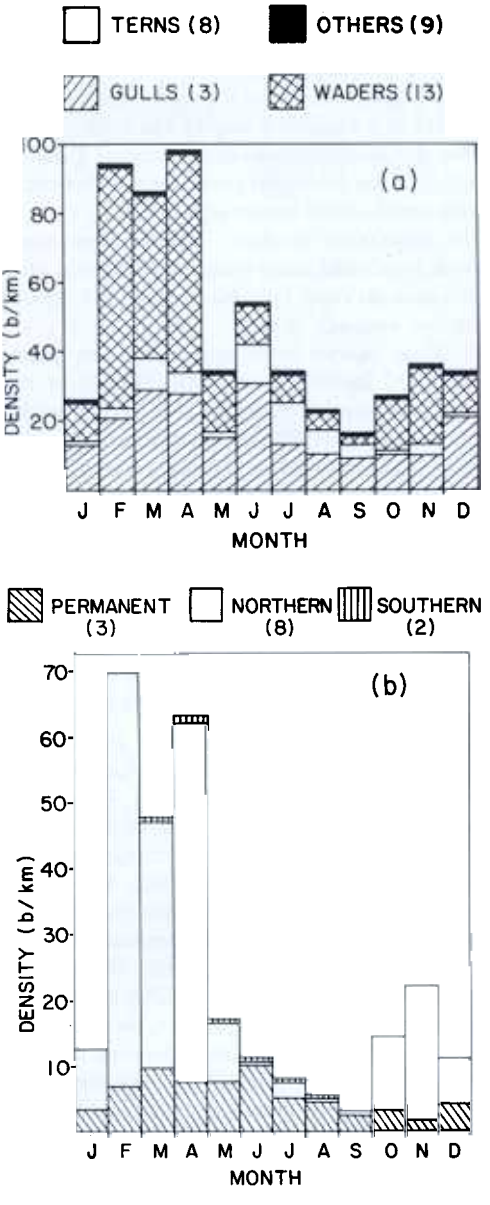

FIG. 2. Monthly mean density of coastal birds, in number of birds per km of shoreline (b/km), on Cassino Beach from May 1982 to December 1986. The figure in brackets is the number of species. (a) Total birds: "gulls" are Larinae, "terns" are Sterninae and *Rynchops niger* "waders" are Charadrii (not including *Chionis alba*), for "others" see Table 1. (b) Waders: categories indicate Permanent Users, Northern Migrants and Southern Migrants as defined in the text.

these birds is a response to reduced availability of food in winter, or reflects a smaller size of their populations in comparison with Northern waders of similar feeding habits.

The terns and skimmers (Fig. 2a) showed three peaks, in autumn (March—April), winter (June—August) and late spring (November) respectively. The autumn peak reflects the northbound passage of *Sterna sandvicensis eurygnatha* and of juveniles of *Sterna hirundo*. The June-to-August peak is composed of *Sterna maxima*, *Sterna trudeaui*, *Sterna superciliaris* and *Sterna hirundinacea* which winter in the area, while *Rynchops niger* migrates through to the south from May to July. The November peak reflects the southbound passage of *Sterna sandvicensis eurygnatha*. The numbers of gulls (*Larus dominicanus* and *Larus maculipennis*) varied but were lowest in spring (Fig. 2a), which reflects breeding in distant places at that time.

Terns and skimmers use the beach for resting and preening, contributing to the latter ecosystem through the production of manure from prey obtained at sea and in lagoons. *Rynchops niger* and *Sterna trudeaui* fish in the surf and in beach lagoons, *Sterna superciliaris* mostly in creek mouths. The other terns fish offshore. Thus, the assembly of tern species shows an ecological division by feeding range as also observed among tropical Sterninae by Ashmole & Ashmole (1967). The waders feed on invertebrates in the swash zone, each species employing a distinct feeding strategy and occupying a certain part of the habitat, ranging from submerged substrate (*Calidris alba* and *Himantopus himantopus*) to moist sand (*Calidris fuscicollis*). Certain species (*Pluvialis squatarola*) also use the upper beach, and *Charadrius modestus* is only seen at the margins of freshwater creeks and lagoons. The gulls use a variety of feeding methods, including scavenging of invertebrates and fishes. The hawk *Milvago chimango* scavenges dead birds, which are not eaten by the gulls. Among herons, *Egretta thula* fishes in creek mouths, while *Ardea cocoi* is unique in fishing in the surf. Thus, the coastal bird species coexist through ecological division by the feeding niches available in the area at different times of the year.

Natural mortality of coastal birds appears to be low, dead birds being rarely found. Thus, disturbance and the availability of food are the main limiting factors. Disturbance by human activity, through passage of vehicles and presence of people in the habitat, means loss of feeding and/or resting time and of energy spent in flight and in searching for better places. This is critical when birds are moulting and forming fat reserves for a long migratory flight according to a tight schedule. Therefore the habitat becomes unsuitable for the birds if human activity exceeds a certain level. Also, traffic along the lower beach is detrimental to the invertebrate fauna, thus affecting the food supply of the birds (Gianuca 1983). These factors need to be considered in the ecological management of the shores of southern Brazil.

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REFERENCES

Alexander, W. B. 1959. Die Vögel der Meere (translation by G. Niethammer). Hamburg.

Ashmole, N. P., & M. J. Ashmole. 1967. Comparative feeding ecology of sea birds of a tropical oceanic island. Peabody Museum of Natural History, Yale University, Bull. 24: 1—131.

Belton, W. 1984. Birds of Rio Grande do Sul, Brazil. Part 1. Rheidae through Furnariidae. Bull. Am. Mus. Nat. Hist. 174: 369—636.

Bent, A. C. 1962. Life histories of North American shore birds. New York.

Burton, P. J. K. 1974. Feeding and the feeding apparatus in waders: a study of anatomy and adaptations in the Charadrii. British Museum (Natural History), London.

Chapman, F. M. 1966. Handbook of the birds of eastern North America. New York.

Escalante, R. 1962. Frequency of occurrence of some seabirds in Uruguay. Condor 64: 510—512.

Escalante, R. 1968. Notes on the Royal Tern in Uruguay. Condor 70: 243—247.

Escalante, R. 1970a. Aves Marinas del Rio de la Plata y aguas vecinas del Oceano Atlantico. Montevideo.

Escalante, R. 1970b. Notes on the Cayenne Tern in Uruguay. Condor 72: 89—94.

Escalante, R. 1985. Los salteadores menores *Stercorarius parasiticus* y *S. longicaudus* en el Uruguay. Comunicaciones Zoologicas del Museo de Historia Natural de Montevideo XI (154): 1—8.

Gianuca, N. M. 1983. A preliminary account of the ecology of sandy beaches in southern Brazil. Pag. 413—419 *in* McLachlan, A., & T. Erasmus (eds.): Sandy beaches as ecosystems. The Hague.

Gianuca, N. M. 1985. The ecology of a sandy beach in southern Brazil. Ph. D. thesis, University of Southampton.

Harrington, B. A., Antas, P. de T. Z., & F. Silva. 1986. Northward shorebird migration on the Atlantic coast of southern Brazil. Vida Silvestre Neotropical 1: 45—54.

Harrison, P. 1985. Seabirds, an identification guide. Beckenham.

Hayman, P., Marchant, J., & T. Prater. 1986. Shorebirds. Boston.

Lambert, K. 1981. Hinweise zur feldornithologischen Bestimmung der Raubmöwen. Falke 28: 42—51.

Melville, D. S. 1985. Long-tailed skuas *Stercorarius longicaudus* in New Zealand. Notornis 32: 51—73.

Myers, J. P., & L. P. Myers. 1979. Shorebirds of coastal Buenos Aires Province, Argentina. Ibis 121: 186—200.

Olrog, C. C. 1968. Las aves sudamericanas, una guia de campo, tomo primeiro (Pinguinos — Pajaros Carpinteros). Tucumán: Fudación Instituto "Miguel Lillo", Universidad Nacional de Tucumán.

Peterson, R. T., Mountfort, G., & P. A. D. Hollom. 1960. Vogelgids (translation by J. Kist). Amsterdam.

Prater, A. J., Marchant, J. H., & J. Vuorinen. 1977. Guide to identification and ageing of Holarctic waders. Tring.

Resende, S. de M. L. 1988. Nonbreeding strategies of migratory birds at Lagoa do Peixe, Rio Grande do Sul, Brazil. Master thesis, Cornell University.

Resende, S. L., & F. Leeuwenberg. 1987. Ecological studies of Lagoa do Peixe. Report of Project "Lagoa do Peixe", World Wildlife Fund (mimeo).

Roselaar, C. S. 1983. Family Stercorariidae. *In* Cramp, S., & K. E. L. Simmons (eds.): Handbook of the birds of Europe, the Middle East and West Africa, Vol. III: 652—697. Oxford.

Sick, H. 1985. Ornitologia Brasileira, 2a edição. Brasília: Editora Universidade de Brasília.

Tuck, G., & H. Heinzel. 1978. A field guide to the seabirds of Britain and the world. London.

Voous, K. H. 1955. De vogels van de Nederlandse Antillen. Curaçao: Natuurwetenschappelijke Werkgroep Nederlandse Antillen.