

Red Knots *Calidris canutus rufa* and other shorebirds on the north-central coast of Brazil in April and May 1997.

James R. Wilson, Augusto A.F. Rodrigues & Doris M. Graham

Wilson, J.R., Rodrigues, A.A.F. & Graham, D.M. 1998. Red Knots *Calidris canutus rufa* and other shorebirds on the north-central coast of Brazil in April and May 1997. *Wader Study Group Bull.* 85: 41-45.

Shorebird counts were made on part of the north-central coast of Brazil between 23 April and 6 May 1997. Special attention was paid to Red Knots *Calidris canutus rufa*. One Red Knot colour flagged in USA, and one in Tierra del Fuego were seen among 355 Red Knots on 30 April at Maiaú island. Most of these birds were in breeding plumage and were very fat. They were probably ready to migrate. In contrast 18 Red Knots caught on 5 May on Panaquatira Beach had a mean weight of 140.1 g, (s.d. 10.05, range 114-154 g) and were not thought to be ready to migrate. The spring migration strategy of Red Knots in South America is discussed by comparing flight distances to the east coast of USA, and fat requirements of birds leaving Lagoa do Peixe in southern Brazil with birds leaving the north-central coast of Brazil. It is proposed that it would be logical for Red Knots to use the north-central coast of Brazil as an additional staging area on northward migration after Lagoa do Peixe. To what extent they do this is unknown as the coast is considered difficult to access and has been little explored.

J.R. Wilson, 13/27 Giles St., Kingston, ACT 2604, Australia. A.A.F. Rodrigues, Departamento de Biologia, Universidade Federal do Maranhão, Av. dos Portugueses, S/N., Campus Universitário do Bacanga, 65080-040 São Luís, Maranhão, Brazil. D.M. Graham, 14 Falconer St., North Fitzroy, 3068 Victoria, Australia.

INTRODUCTION

In the northern winter (northern seasons are used throughout this paper) the north-central coast of Brazil, lying to the east of the mouths of the Amazon River, between Belém and São Luís, held about 330,000 shorebirds between 13 and 21 January 1986 (Figure 1), consisting of 9% of all small shorebirds on the South American coasts, 21% of the medium sized shorebirds, 62% of the Black-bellied Plovers *Pluvialis squatarola*, 76% of the Ruddy Turnstones *Arenaria interpres*, 49% of the Willets *Catoptrophorus semipalmatus*, 44% of the Whimbrels *Numenius phaeopus* and the only significant population of Red Knot *Calidris canutus rufa* (about 8,000 birds) north of the main wintering area in Tierra del Fuego and Patagonia (Morrison & Ross 1989).

Apart from the 1986 winter shorebird counts, a helicopter survey of the coast was made in May 1987 (Morrison, pers. comm.). A further census was made by Rodrigues (1993), on Panaquatira Beach from October 1991 to April 1992, which confirmed the occurrence of small numbers of Red Knots on this sector of the coast (maximum 500 in April). A Brazilian shorebird expedition made by the Centro de Pesquisas Para a Conservação das Aves Silvestres (CEMAVE) to the island of Maiaú (in which AAFR took part) from 28 April to 12 May 1992 banded at least 50 Red Knots, all of which were in breeding plumage. In spring 1993, shorebirds on the island of Campechá were studied by CEMAVE. As far as we are aware, apart from the winter counts and the census on Panaquatira Beach in 1991/92, the results of these expeditions have not been published. A small wintering flock of Red Knots on Panaquatira Beach and its surroundings is currently the subject of a PhD study by the second author.

It is possible that Red Knot wintering further south use the north-central coast of Brazil as the last staging area in South

America before migrating 4,800 km or more to the east coasts of North America. (Morrison & Harrington 1992). The last currently known major staging area for Red Knots is at Lagoa do Peixe in southern Brazil. This lies 8,300 km from Delaware Bay, the only known large spring staging area in North America. If Knots flew this distance without stopping, it would be the longest non-stop flight of any land bird in the world. It seemed to us that the strategy of stopping on the north-central coast of Brazil, even if for a short time, as suggested by Morrison & Harrington (1992), would be more likely.

During a three-week break in a shorebird banding expedition to Argentina, Brazil and Delaware Bay, USA., led by Professor Allan Baker and Patricia Gonzales (in which we participated), we attempted to confirm if this area could be the last spring staging area for Red Knots. We visited the region of São Luís and sailed westward along part of the coast in a catamaran between 23 April and 6 May 1997. We also looked for 10 Red Knots which had been tagged with radio transmitters at Punta Rasa, north-east Argentina, at the end of March and 10 tagged at Lagoa do Peixe in early April by Theunis Piersma and members of the above mentioned expedition. The guaranteed life-span of the Holohil 1.5-1.8 g transmitters was 6 weeks (and the empirical lifespan usually 8-9 weeks) so they should still have been active when the shorebird survey was carried out.

THE COAST

The coast is heavily indented, consisting of drowned river valleys, bordered by huge expanses of mangroves. Sand beaches have formed at the headlands to the valleys. The substrate in the very extensive intertidal areas ranges from very soft mud under and near the mangroves, to hard sand on the outer coasts. The coast is not affected by the outflow of fresh



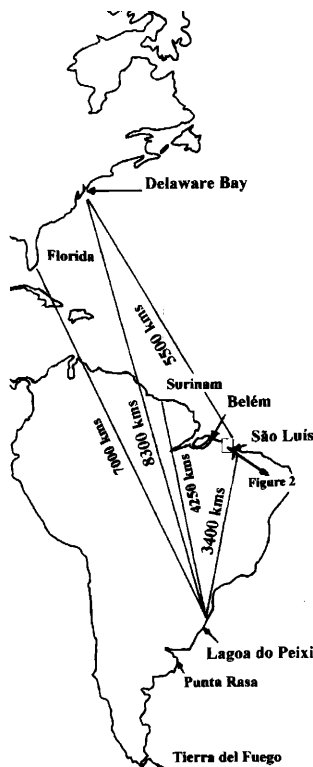


Figure 1. Great circle distances on the potential migration routes of Red Knots between Brazil and the east coast of USA.

water or sediments from the Amazon, as the ocean currents sweep these to the west where huge deposits of very soft mud have built up in Surinam and French Guiana forming very important shorebird sites. The north coast of Brazil to the west of the Amazon mouths is heavily eroded and is not important to shorebirds, probably because of the instability of the deposits and of variability in the salinity caused by variations in the outflow of fresh water from the Amazon. A detailed description of the coasts is given in Morrison & Ross (1989).

ITINERARY

Maps of the coast were not readily available but, after our return, maps were obtained for us from the Brazilian navy. However, we found a publication, *Guia de Praias 1997* (Guide to the Beaches), in bookstores in Belém. This is a book of satellite photographs of the whole of the Brazilian coastline with tourist information about the beaches. As there was little road access and few towns on the coast, the only feasible means of access was by boat and/or helicopter.

We spent 23 - 28 April in the São Luís area where we visited the second author's study sites at Panaquatira Beach and Curupu Island, 30 km north-east of São Luís, and counted shorebirds on a city beach, Pta. da Areia. We also hired a basic catamaran with a crew of three fishermen. We arranged for them to sail westward round the headlands from São Luís to meet us at Cururupu, a small village near the Baía Cabelo do Velha. We sailed on 29 April and returned to São Luís on 3 May. We spent 4-6 May at Panaquatira Beach counting and

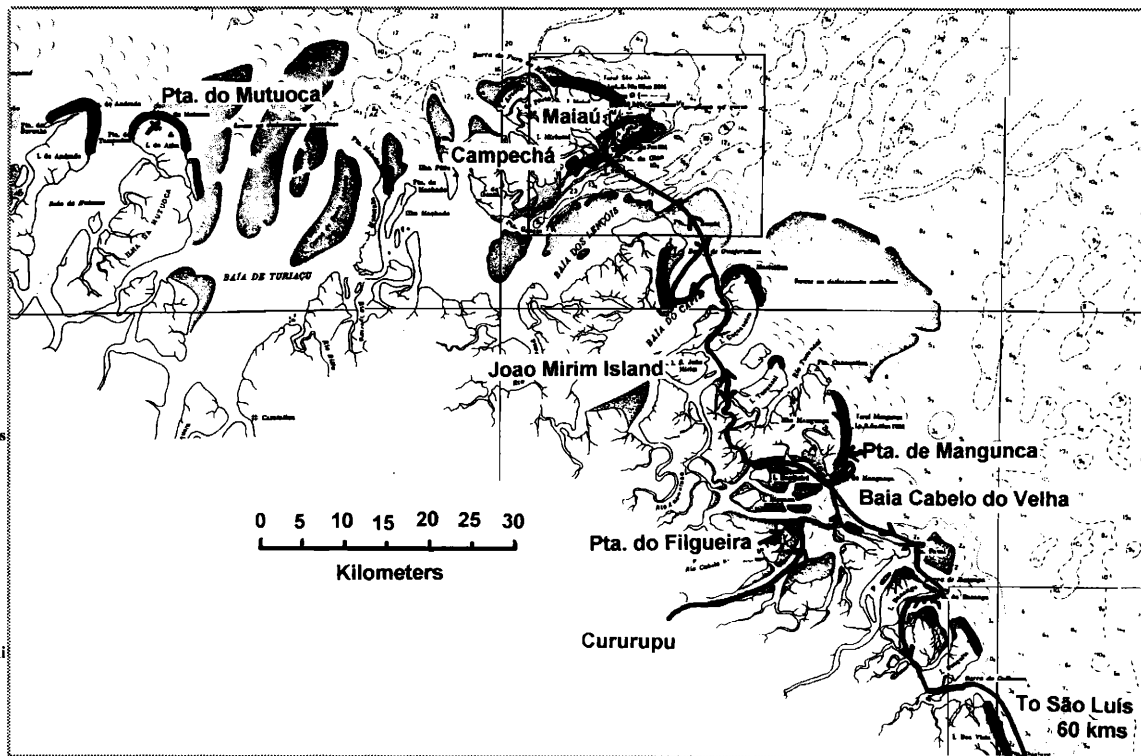


Figure 2. Route sailed by the catamaran to the west of São Luís with sites mentioned in the text and Table 1. Thick black lines depict sand beaches shown on the satellite photographs. Mudflats and sandbanks shown on the Brazilian naval charts are also depicted. Channels and inner bays are also lined with extensive mudflats, but these are not shown on the naval charts.

mist-netting shorebirds. The route we took in the catamaran and counting sites are shown in Figure 2.

RESULTS.

Shorebird counts and the corresponding coast sector allocated by Morrison & Ross (1989) are shown in Table 1.

Red Knots

Five hundred were seen on Panaquatira Beach on 27 April. These were not fat and about 40% were classified as sub-adults based on plumage characteristics. Eighteen birds from a flock of 200 caught here 8 days later on 5 May had a mean weight of 140.1 g, (s.d. 10.05, range 114-154 g), well below an expected departure weight of around 200 g (see Discussion). One bird was two years old, having been banded as a juvenile there in April 1996, one was aged as a sub-adult, weight 114 g, and many of the others were probably second year birds. None were in full breeding plumage. It is probable that these birds were part of the small population which spend the winter at this site (Rodrigues unpubl.) and were going to spend their first or second summer there. This is substantiated by the sighting by the second author of 44 Red Knots on this beach on 24 May 1997.

In contrast, many of the 355 Red Knots seen on 30 April on Maiaú Island were very fat and in advanced breeding plumage. About 10% were adjudged to be juvenile or second-year birds. Some birds (60+) from this flock were later found feeding throughout the high tide in the dunes near to the low tide mudflat feeding areas. They were picking prey (probably sandflies) off the surface of the sand. One bird had a green flag on the left tibia indicating that it had been banded in the



Table 1. Shorebird counts along the north-central coast of Brazil

Sites counted		A*	A	B	C	C	D	E	F	G	H
Date of count		Apr.23	May 3	Apr.25	Apr.27	May 5	Apr.29	Apr.29	Apr.30-May 1	May 1	May 2
Wilson's Plover	<i>Charadrius wilsonia</i>		10							8	
Collared Plover	<i>Charadrius collaris</i>		150		50					40	
Semipalmated Plover	<i>Charadrius semipalmatus</i>		87		15					20	
Small Plovers		100				80			300		200
Black-bellied Plover	<i>Pluvialis squatarola</i>	164	120		100	30	450	150	100	75	100
Whimbrel	<i>Numerius phaeopus</i>	1	7				100			50	40
Willet	<i>Catoptrophorus semipalmatus</i>						200			5	20
Greater Yellowlegs	<i>Tringa melanoleuca</i>						8		8	1	
Short-billed Dowitcher	<i>Limnodromus griseus</i>	2							30	12	
Sanderling	<i>Calidris alba</i>		50			30		25	10		
Semipalmated Sandpiper	<i>Calidris pusilla</i>		20		10	100			4000	20	1000
Red Knot	<i>Calidris canutus rufa</i>	13	4	20	500	200	1		355	120	
Turnstone	<i>Arenaria interpres</i>	62	160		40	400	150			400	20
TOTAL		342	608	20	715	840	909	175	4803	751	1380
Coast Section (Morrison & Ross 1989)		59	59	59	59	59	50	50	48	48	50

* A. Pta. da Areia, São Luís. B. Curupu Island. C. Panaquatira Beach. D. Pta. do Filgueira. E. Pta. de Mangunça. F. Maiaú Island. G. Campechá Island. H. Channel north of Joao Mirim Island.

USA, and one had an orange flag on the left tibia and a yellow ring on the left tarsus showing that it had been banded in Tierra del Fuego in February 1995 (Baker *et al.* 1995). Morrison (pers. comm.) also recorded birds marked at Lagoa do Peixe in a flock of 5,000 knots at Pta. do Mutuoca, 60 km west of Maiaú Island, in the second week of May 1987. These sightings indicate that at least some Red Knots use the north-central coast of Brazil as a staging area on their migration from wintering areas further south.

Radio scans were carried out daily, whether or not Red Knots were seen. A total of about 1,200 birds was known to be scanned, of which at least 70% were adults. None of the 20 Red Knots marked with radio transmitters were detected.

Other shorebirds

The species composition of all other flocks (Table 1) reflects what is already known about the wintering populations on this coast, with especially high numbers of Black-bellied Plovers, Semipalmated Sandpipers *Calidris pusilla* and Turnstones (Morrison & Ross 1989). Many of the Black-bellied Plovers and Turnstones were in full breeding plumage.

Ten of 12 Turnstones caught on Panaquatira Beach on 5 May were adults in breeding plumage with a mean weight of 123.9 g, (s.d.9.9, range 113-144 g) while two juveniles weighed 84 g and 87 g respectively. The apparent increase in numbers of Turnstones from 62 to 160 at Pta. da Areia between 23 April and 3 May, and from 40 to 400 at Panaquatira Beach between 27 April and 5 May (Table 1) may have been due to the spring tides forcing birds to concentrate more on to the available roosting sites. Alternatively, there may have been passage from further south, although Morrison & Ross (1989) did not record large numbers of Turnstones south of the north-central coast of Brazil in winter.

DISCUSSION

The first aim of our explorations was to find large numbers of Red Knots, since the question as to whether they use the north-central coast of Brazil is crucial to understanding their spring

Table 2. Flight range in kilometres based on Davidson (1984).

Wt at start of flight gms	Wt at finish of flight gms	Ground Speed km/hr			
		50	60	70	80
		Distance kms			
240	100	5803	6964	8124	9285
230	100	5484	6581	7678	8774
220	100	5155	6186	7217	8248
210	100	4816	5779	6742	7705
200	100	4465	5358	6251	7144
240	110	5243	6292	7340	8389
230	110	4924	5909	6894	7879
220	110	4595	5514	6433	7352
210	110	4256	5107	5958	6809
200	110	3905	4686	5467	6248
240	120	4718	5661	6605	7548
230	120	4399	5278	6158	7038
220	120	4070	4884	5698	6512
210	120	3730	4477	5223	5969
200	120	3380	4055	4731	5407

migration strategy. This coast is about 500 km in length in a straight line but, because of the indentations and channels, the total shoreline is several thousand kilometres long. It was estimated that it would take about 32 hours flying time to census the whole coast from the air (Inês de Lima S. do Nascimento, pers. comm.). We sailed 130 km measured in a straight line from São Luís, and our coverage was therefore minimal (Figure 2).

In order to assess if Red Knots could overfly this coast on their route to Delaware Bay, USA, we compared the great circle distances from Lagoa do Peixe and São Luís to the eastern coast of the USA (Figure 1) and the flight ranges of Red Knots for given departure and arrival weights and flight speeds (Table 2), based on the flight formula given by Davidson (1984).

Maximum recorded weights of Red Knots at Lagoa do Peixe were of two birds at about 244 g and one about 272 g, as interpolated from the graph published by Antas & Nascimento (1996). Morrison & Harrington (1992) also reported four birds over 250 g. Maximum weights of over 240 g and up to 246 g have also been recorded for a few *C.c. canutus*, which are similar in size to *C.c. rufa*, before departure from the Wadden Sea in spring (Prokosch 1988). The weight of 272 g at Lagoa do Peixe must surely be a mistake.



However, the average spring departure weights from the Wadden Sea in north-west Europe for *C. c. canutus* bound 4,500 kms or more for Siberia are about 210 g. (Prokosch 1988). For *C.c. islandica* in Iceland and north Norway, bound for Greenland and Canada, average departure weights are about 200-210 g (Wilson & Morrison 1992; Davidson & Wilson 1992). These birds probably carry excess fat on to the breeding grounds. *C.c. canutus* on intermediate stages of their migration depart from South Africa at a weight of about 200 g, but only at 165 g for the 4,600 km flight from Mauritania, West Africa, to the Wadden Sea (Piersma *et al.* 1992). Based on these data, it seems unlikely that Red Knots would leave Lagoa do Peixe with masses greater than an average of 220 g.

A bird departing with a mass of 220 g would theoretically only be able to cover the 8,300 km to Delaware Bay by flying at high average ground speeds (80 km/hr) and it would arrive with no reserves (weight 100g) (Table 2).

A regular direct flight from Lagoa do Peixe to Delaware Bay is theoretically possible, but birds must leave at very high mass, have wind assistance for a great part of their journey in order to achieve very high ground speeds, and on arrival have no reserves left. Winds need to be investigated further by studying weather charts over northern South America and the Caribbean to see if this flight is possible. Davidson's (1984) flight formula could also be underestimating flight ranges.

If birds were exhausted, they could land on the north coast of South America, or the south coast of USA. However, only small numbers have been seen in early May on spring migration in Surinam, about 4,000 km from Lagoa do Peixe, (Spaans 1978). As Surinam lies on a direct line between Lagoa do Peixe and the eastern USA, the absence of large numbers of Red Knots at this important shorebird site seems remarkable. However, they may be deterred by the very soft 'sling' mud occurring there as all the Red Knots seen were on less productive tough clay banks emerging from the eroding coastline, or in shallow lagoons. Red Knots are not common on spring migration on the coasts of Florida, 7,000 km from Lagoa do Peixe (Figure 1). However, large numbers have been recorded on the coasts of Georgia and North Carolina in some years (Morrison & Harrington 1992); these could be a fall-out from the main migration.

The safest strategy would seem to be to use the north-central coast of Brazil, 3,300 km north of Lagoa do Peixe, as an additional staging post. Here, there is a range of suitable habitats for Red Knots. Indeed, this study and Morrison's helicopter survey in 1987, indicate that some birds are stopping there. However, about 67,500 Red Knots have been recorded in winter in Patagonia and Tierra del Fuego (Morrison & Ross 1989) and very large numbers have not yet been found on the north-central coast of Brazil, although Morrison (pers. comm.) found one flock of 5,000. Our survey was very limited in time and coverage and was possibly too early in the northward

migration cycle. Since the main Red Knot arrivals in Delaware Bay are not until after mid-May (Clark *et al.* 1993), one would expect the peak numbers on the north-central Brazil coast to occur in the second week of May. The coast has been so little investigated that the extent of its use by Red Knots is unknown.

Our second aim was to see if it would be possible to mount a cannon-netting expedition to catch Red Knots on this coast. In our opinion this should indeed be possible, by using a spotter plane, a catamaran and a small, experienced team. The coast would take many weeks to explore by boat alone, but as Red Knots tend to roost on the outer beaches (see Figure 2), it would be possible to fly along most of these on one high tide to locate roosting flocks, which then could be reached fairly rapidly by boat. The island of Maiaú, although 130 km from São Luís, can be reached in 12 hours by catamaran. Further west on the coast, in areas not visited by us, there are fishing villages where one could hire boats, and many of the beaches are not more than a few hours sailing from them. Based on information in *Guia de Praias*, many of the beaches are easy to land on. We had no problems in landing on those we visited, although our captain refused to sail our frail craft along some of the outer beaches which are pounded by surf.

A study in spring could collect valuable and interesting data, particularly on departure weights of other shorebird species. It is likely that Turnstones and Sanderlings *Calidris alba*, as well as Red Knots, fly the 5,500 km directly into Delaware Bay. Furthermore, after Professor Allan Baker's expedition to Delaware Bay in May 1997, in which two of us took part (JW/DG), shorebird studies there will probably increase markedly in the future.

ACKNOWLEDGEMENTS.

We would like to thank Professor Allan Baker for inviting us to join his expedition to South and North America, Professor Maria Paula Schneider and her staff at the University of Belém for invaluable help in Belém and for obtaining maps, Inês de Lima S. do Nascimento and Paulo de Tarso Zuquim for advice on where to go and how to get there, Theunis Piersma for lending us his radio tracking equipment, and to Capella, captain of our catamaran, for navigating us safely along the coasts and through the mangrove waterways and channels.

REFERENCES.

- Antas, T.Z.P. & Nascimento, I.L.S. 1996. Analysis of Red Knot *Calidris canutus rufa* banding data in Brazil. *International Wader Studies*. 8: 63-70.
- Baker, A.J., Manriquez, R.E., Benegas, L.G., Blanco, D.E., Borowik, O., Ferrando, E., de Goeij, P., Gonzalez, P.M., Gonzalez, J., Minton, C.D.T., Peck, M., Piersma, T., Ramirez, M.S. 1995. Red Knot *Calidris canutus* at their furthest south: an international expedition to Tierra del Fuego, Argentina, in February 1995. *Wader Study Group Bull.* 79: 103-108.
- Clark, F.E., Niles, L.J. & Burger, J. 1993. Abundance and distribution of migrant shorebirds in Delaware Bay. *The Condor* 95: 694-705.
- Davidson, N.C. 1984. How valid are flight range estimates for waders? *Ring. & Migr.* 5: 49-64.



Davidson, N.C. & Wilson, J.R. 1992. The migration system of European-wintering Knots *Calidris canutus islandica*. *Wader Study Group Bull.* 64, *Suppl.*: 39-51.

Morrison, R.I.G. & Ross, R.K. 1989. *Atlas of Nearctic shorebirds on the coast of South America*, 2 Volumes. Canadian Wildlife Service. Ottawa.

Morrison, R.I.G. & Harrington, B.A. 1992. The migration system of the Red Knot *Calidris canutus rufa* in the New World. *Wader Study Group Bull.* 64, *Suppl.*: 71-84.

Piersma, T., Prokosch, P., & Bredin, D. 1992. The migration system of Afro-Siberian Knots *Calidris canutus canutus*. *Wader Study Group Bull.* 64, *Suppl.*: 52-63.

Prokosch, P. 1988. Arktische Watvögel im Wattenmeer. *Corax* 12: 273-442.

Rodrigues, A.A.F. 1993. Migração, abundância sazonal e alguns aspectos sobre a ecologia de aves limícolas na baía de São Marcos, Golfão Maranhense, Brasil. Dissertação de Mestrado. UFPA/MPEG.

Spaans, A.L. 1978. Status and numerical fluctuations of some North American waders along the Surinam coast. *Wilson Bull.* 90: 60-83.

Wilson, J.R. & Morrison, R.I.G. 1992. Staging studies of Knots *Calidris canutus islandica* in Iceland in the early 1970s: body mass patterns. *Wader Study Group Bull.* 64, *Suppl.*: 129-136.

Migration pattern of waders at the Salobrar de Campos, Mallorca, in autumn 1996 and spring 1997

Matthias Kestenholz & Dieter Peter

Kestenholz, M. & Peter, D. 1998. Migration pattern of waders at the Salobrar de Campos, Mallorca, in autumn 1996 and spring 1997. *Wader Study Group Bull.* 85: 45-50.

In autumn 1996 and spring 1997, the salinas in south-eastern Mallorca were used as a stop-over site by 30 wader species, among them four breeding species. Phenological patterns of the most abundant species are presented. In most species, spring numbers outweighed autumn numbers. For several species, the migration patterns on Mallorca correspond with those known from the central European inland flyway.

M. Kestenholz & D. Peter, Swiss Ornithological Institute, CH-6204 Sempach, Switzerland. E-mail: kestenhm@orninst.ch, peterd@orninst.ch

INTRODUCTION

Waders are among the most outstanding migrants, travelling between continents and crossing oceans and deserts. On their journeys, they rely on an extensive network of major and minor staging sites. Although waders have been studied intensively on the East Atlantic Flyway (Piersma *et al.* 1987), there is a lack of data for the Mediterranean (Gromadzka 1987). As Smit (1986) has shown, this region is more important for waders than has so far been supposed.

Wintering populations of waders have been counted annually for many years in Spain (Velasco & Alberto 1993) and on Mallorca (Ramis *et al.* 1996). However, for Mallorca, information on numbers and phenology in spring and autumn is very poor. We report on the first systematic wader counts in spring and autumn in the Salobrar de Campos. We describe phenology patterns and give peak numbers which also provide valuable information for assessing the importance of this wetland and protecting it. Given the geographical position of Mallorca (Figure 1), 300 km from the mainland, the data presented could also contribute to a better understanding of flight strategies of waders crossing the western Mediterranean.

STUDY AREA

The salinas of Salobrar de Campos are situated in south-east Mallorca, Spain (39°19' N, 03°05' E), 2 km north-east of the nearest coastline. They are part of a protected area designated in 1984 (Area Natural de Especial Interés = site of special scientific interest). The salinas comprise a complex of salt

pans with a total area of about 400 ha (Figure 1). The older salt pans have water all year round; those exploited commercially (evaporation beds, 100 ha) are flooded periodically. Therefore, the salinas provide a pattern of shallow waters of varying salinity, whose depth varies from a few to 50 cm. It also comprises small emergent mudflats, vegetated banks and causeways. The vegetation is halophilous consisting mainly of *Salicornia spp.*, *Salsola spp.* and *Tamarix spp.*. The salt-tolerant maxillipod crayfish *Artemia salina* and non-biting midges *Chironomus spp.* are the major food resources for waders.

METHODS

Our camp was situated on the eastern edge of the Salobrar de Campos where we carried out radar studies on bird migration in autumn 1996 and spring 1997 (see Bruderer *et al.* 1996). We observed and censused waders on a daily basis from 10 August to 22 October 1996 and from 19 March to 22 May 1997. The surveyed area (Figure 1) covered about 50% of the salinas and the range of vision depended on the vegetation height on the causeways. We recorded all passage migrant species but excluded the four breeding species Black-winged Stilt *Himantopus himantopus*, Kentish Plover *Charadrius alexandrinus*, Redshank *Tringa totanus*, and Stone-curlew *Burhinus oedipnemus* (Avellà *et al.* 1997). Numbers were assessed by means of visual counts using telescopes 25 x 60 and 20 x 80.

The first and last day of observations are given as well as the

