Wader counts along the Saudi Arabian coast suggests the Gulf harbours millions of waders

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Wader counts were made in the intertidal zone of the Saudi Arabian Gulf coast in January/February 1986. By extrapolation of density counts, covering 5.3% of the intertidal area (200 km²), the total number of waders wintering along the Saudi Arabian Gulf coast is estimated at a quarter of a million waders. Dunlin *Calidris alpina* is the most common species. Since the total surface area of the intertidal flats in the entire Gulf amounts to 3,000 km², we estimate that perhaps four million waders winter in the Gulf, and that a similar number use the area as a stopover site during migration.

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INTRODUCTION

Little information is available on the numbers of wintering waders depending on coastal wetlands in western Asia. Even less is known about numbers migrating in spring and autumn, although it is evident that the many waders wintering in southern and eastern Africa must use wetlands in western Asia as refuelling stations en route (Summers *et al.* 1987).

The Arabian (Persian) Gulf might harbour large numbers of waders since extensive tidal flats are present in the region (Figure 1). However, apart from counts performed 20 years ago in Iran (Summers *et al.* 1987) and, recently, by Uttley *et al.* (1988) in the United Arab Emirates, quantitative data are lacking. We were able to survey the entire Saudi-Arabian Gulf coast in January/February 1986. Our wader counts aim to provide a preliminary estimate of the number of wintering waders in this part of the Gulf. Since few data are available, we speculate about the size of the winter wader population present in the entire Gulf, as well as during the migration periods. We conclude from this that the Gulf must be one of the most important wader areas in the world.

DESCRIPTION OF THE AREA

The Gulf is a semi-enclosed sea, 850 km long and 250 km wide, connected to the Indian Ocean via the Strait of Hormuz. It is a shallow sea with an average depth of only 35 m. The salinity is high (40‰) due mainly to high rates of evaporation. Salinities rise to 50-70‰ in the Gulf of Salwah, the embayment between Saudi Arabia, Qatar and Bahrain. The waders feeding there clearly face a salt stress which is rarely encountered elsewhere in the world. Sea water temperatures in the Gulf vary between 15° and 35°C. Waders arriving in the Gulf in July/August regularly encounter air temperatures which exceed 50°C, a situation which must cause heat stress. Tidal range varies from 3-4 m in the north to 1-3 m, or less, in other parts of the Gulf. Tides along the coasts are diurnal, semi-diurnal and mixed.

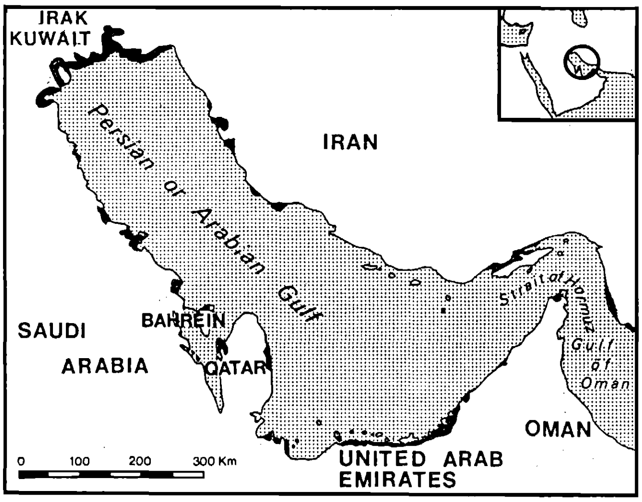

Figure 1. The main intertidal areas in the Arabian/Persian Gulf.

Extensive intertidal areas are indicated on the outline maps of the Gulf (British Admiralty and U.S. Government Charts, 1:350,000 and 1:750,000). Using these charts, we estimate a total intertidal surface area of *ca.* 3,000 km². As shown in Figure 1, the largest flats are found in the Bay of Kuwait (*ca.* 350 km² mudflats); and, adjacent to this, around the Tigris-Euphrates delta (Shatt al Arab) on the border of Iraq and Iran and further east (total *ca.*1,300 km² mudflat). Vast tidal flats also occur near Busbehr and near Qeshm island in Iran and along the coast of the United Arab Emirates, western Abu Dhabi, the east coast of Qatar, and the area around the Hawar archipelago, Bahrain (Figure 1). The large intertidal areas in Saudi Arabia are found around the former island of Tarut and NW of the former island of Abu Ali (Figure 2).

Much marine ecological research has been undertaken by Universities in the region, environmental departments of governments and oil companies, although the greater part of this information is hardly accessible; but see Coles & McCain (1990), John *et al.* (1990) and Price (1990) and references found in these papers. Basson *et al.* (1977) give a useful description of the different habitats and species inhabiting them. The field guide of Jones (1986) is also valuable to scientists visiting the area.

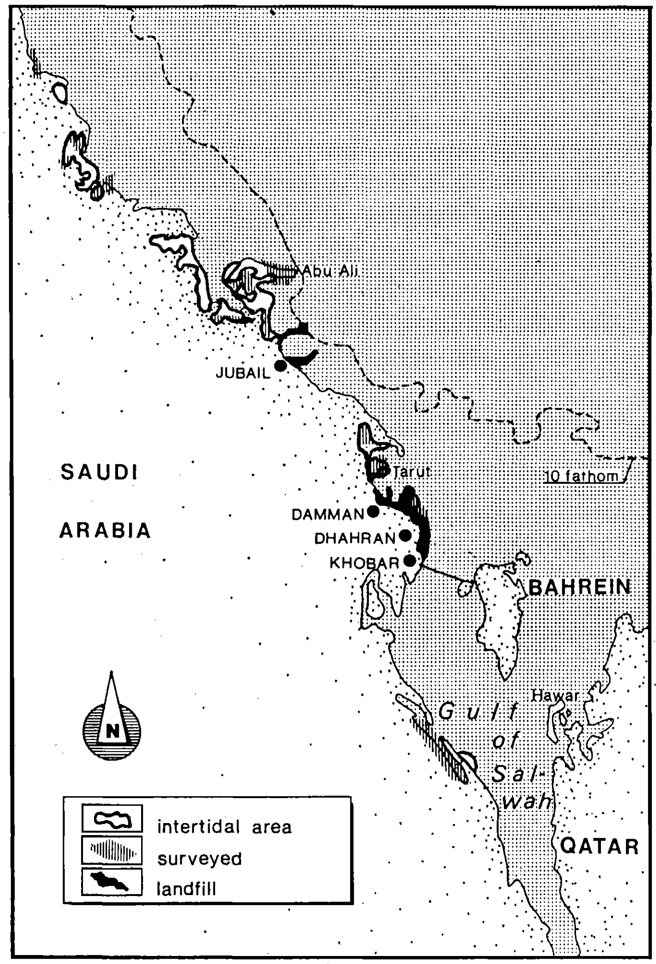

Figure 2. The main intertidal areas along the Saudi Arabian Gulf coast. Also indicated is the area lost by coastal landfill (according to IUCN 1987) and the sites where waders were counted in winter 1986.

METHODS

Since our field work was limited to a short period of 11 days (26 January - 6 February 1986), it was not possible to make counts along the whole coastline, *i.e.* 500 km between Kuwait in the north and Qatar in the south as the crow flies, or 1,070 km if one follows the high tide mark. Bird counts were made in 55 areas, covering a distance of 180 km (Figure 2). All major areas were visited, but only the southern part of the extensive tidal flats west of Abu Ali could be surveyed.

A tripod mounted telescope (15-45 x 60) and binoculars (10 x 40) were used to make a complete count of the cormorants, herons, ducks, waders, terns and gulls in the study sites. Waders were usually counted at low water when they were widely scattered over the intertidal zone. Observations were made from a vehicle and on foot.

In total, 29,947 waders were counted in the 55 areas. Wader counts, together with surface area estimates, were available for 29 areas and these were used to calculate low water feeding densities. Intertidal surface areas were determined from charts (British Admiralty and U.S. Government Charts, 1:80,000 and 1:150,000), aerial photographs (1:150,000), the vehicle's distance counter, or from foot-steps. The surface area of these counting sites varied from 9 to 150 ha. Altogether, 1,063 ha were surveyed in this way and 14,047 waders were counted in, what are subsequently termed, the density counts. The counts in 26 other areas, where a total of 15,900 waders were noted, could not be converted into low water feeding densities, principally because these sites were not visited at low tide. In other cases, the tidal flats were incompletely covered, so that the extent of the feeding area used by the counted birds was unknown. These counts are referred to as 'non-density counts'.

IUCN (1987) and Price *et al.* (1987) estimated the total intertidal surface of the Saudi Arabian Gulf coast at 200 km², of which 15% is rockflat or rockflat with sand or mud, 3.5% is beach, 17% is sandflat, 18% is mudflat and 42% is mud/sandflat (mixed substrate). Mangroves cover 2.1% of the intertidal zone. This estimate of the total surface of tidal land is lower than the 500-1,000 km² estimated by Basson *et al.* (1977). In recent years, however, a substantial part of the coastal zone of the Saudi Arabian Gulf has been lost due to landfill, for instance by construction of causeways, creation of harbours and development of residential properties (IUCN 1987; see also Figure 2).

WADER DENSITIES

Table 1 gives the average wader densities, separately for the three habitat types distinguished: rockflats (7 sites covering 192 ha), sandflats, including beach (8 sites - 452 ha) and mudflats (14 sites - 419 ha). Lowest wader densities were found on rockflat sites. However, since these all occurred in the hypersaline Gulf of Salwah, it is possible that waders rejected these sites also because of the very high salinity (see above).

The average density for the three habitat types combined is 13 waders per ha. This figure is close to the average wader density in the 21 main wintering areas along the East-Atlantic coast (Zwarts 1988). The overall mean for these 21 areas is 11 waders per ha or, excluding temperate sites, 15 waders per ha. There is, however, a large variation between sites. As in Saudi Arabia, more waders feed on mudflats than on sandflats in Europe and western Africa.

Dunlins dominated in all habitat types in Saudi Arabia. relatively high numbers of Greater Sand Plover *Charadrius leschenaultii* and Mongolian (or Lesser Sand) Plover *C. mongolus* fed on the rockflats. All species, except the Kentish Plover *C. alexandrius*, were more common on mudflats than on sandflats. Palfrey (1988) also noted higher densities of Greater Sand and Mongolian Plover on mud and muddy sand than on sandflats and beaches. Black-tailed Godwit *Limosa limosa* and Broad-billed Sandpipers *Calidris falcinellus* did not occur on sandflats. In fact, all Broad-billed Sandpipers and most of the Black-tailed Godwits were observed in only two sites which were exceptionally muddy (probably due to recent silting up). One site was situated in the shelter of the new causeway to the (former) island Tarut and the other in the shelter of the new harbour of Dammam.

ESTIMATION OF WINTERING NUMBERS IN SAUDI ARABIA

Assuming that counting sites are a representative sample of the total intertidal zone, we can estimate total numbers. Since only 5.3% of the area was counted, this estimate can only be preliminary. Estimated total numbers, given in the last column of Table 1, are obtained by adding numbers counted at sites of known surface area and multiplying this by 100/5.3. The choice has thus been made to use surface area of counting sites as a weighting factor.

One way to check whether density counts are a representative sample of the entire area, is to compare species composition of the 29 density counts with those of the 26 non-density counts (Figure 3). There appears to be a close relationship between the relative abundance of 16 wader species in both types of counts, although 44% of waders were Dunlins in density counts, but this species accounted for only 26% in the other counts. A similar difference was found in Little Stint: 19 versus 10%. The opposite trend was found in the less common species. These deviations underline the fact that the estimated total numbers per species, which are only based on density counts, are tentative.

Table 1. The average feeding density at low water of 18 wader species in the counting sites along the Saudi Arabian Gulf coast in January/ February 1986, shown separately for three habitat types. Also given: the species code used in Figure 3, the occurrence, *i.e.* the percentage of the sites in which the species occurred, and total number of waders observed in the 55 (density and non-density) counts (see text); not included are 2,150 undetermined waders. The last column gives, as an extrapolation from the density counts, the estimated total numbers on the 200 km^2 intertidal flat. The species are ordered according to their estimated total abundance. Beside the 18 wader species mentioned, we saw 13 Ruff *Philomachus pugnax*, 1 Whimbrel *Numenius phaeopus* and 1 Spotted Redshank *Tringa erythropus.*

Species	Code	Occurrence %	Density(waders/ha) rocky	sandy	muddy	Number counted	Number estimated
Dunlin *Calidris alpina*	Du	79	1.81	2.19	6.19	9,792	116,000
Little Stint *Calidris minuta*	LS	35	0	0.24	2.59	4,128	51,000
Mongolian Plover *Charadrius mongolus*	MP	75	0.22	0.81	0.87	3,123	28,000
Redshank *Tringa totanus*	Re	56	0.01	0.22	1.04	2,298	9,000
Ringed Plover *Charadrius hiaticula*	RP	40	0.01	0.01	0.77	764	8,000
Greater Sand Plover *Charadrius leschenaultii*	GS	69	0.13	0.11	0.80	1,033	8,000
Grey Plover *Pluvialis squatarola*	GP	67	0.01	0.10	0.76	1,912	7,000
Broad-billed Sandpiper *Calidris falcinellus*		4	0	0	0.48	320	6,000
Curlew *Numenius arquata*	Cu	75	0.04	0.28	0.68	1,132	6,000
Bar-tailed Godwit *Limosa lapponica*	BG	46	0	0.12	0.62	1,717	6,000
Black-tailed Godwit *Limosa limosa*		6	0	0	0.41	263	5,000
Curlew Sandpiper *Calidris ferruginea*	CS	31	0	0.08	0.43	295	4,000
Terek Sandpiper *Xenus cinereus*	TS	50	0	0.05	0.25	435	4,000
Turnstone *Arenaria interpres*	Tu	49	0.05	0.09	0.12	175	3,000
Oystercatcher *Haematopus ostralegus*	Oy	27	0	0.01	0.02	187	1,000
Kentish Plover *Charadrius alexandrinus*	KP	44	0.03	0.06	0.02	72	800
Greenshank *Tringa nebularia*	Gr	27	0.02	0.03	0	97	500
Sanderling *Calidris alba*	Sa	15	0.04	0.00	0	9	200
TOTAL			**2.51**	**4.42**	**27.48**	**27,783**	**260,000**

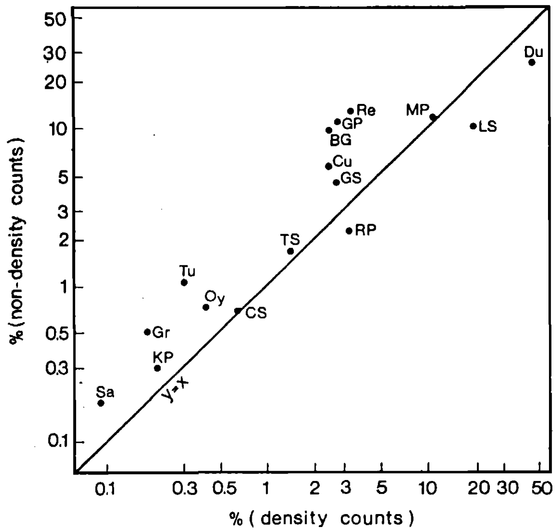

Figure 3. The relative abundance of 16 wader species in the 29 density counts and the 26 non-density counts. The plotted percentages refer to total number of a species counted relative to the summated total numbers of all wader species. Two-letter codes indicate the species (see Table 1). The correlation is highly significant ($r = 0.86$). Broad-billed Sandpiper and Black-tailed Godwit were omitted since they were only observed during the density counts and not in the non-density counts.

The extrapolation reliability will probably vary from species to species, depending on how widely each is distributed. Dunlins were observed in 78% of 48 counting sites where waders were seen, but Broad-billed Sandpipers were encountered in only 4%. In general, common species were counted in more sites than less numerous species, as revealed by the significant rank correlation between estimated total number of the percentage of the counting sites in which the species was observed ($r_s = 0.58$, $p < 0.01$); but there remains some variation (Table 1). For instance, the extrapolated total number of Curlews *Numenius arquata*, Bar-tailed Godwits *Limosa lapponica* and Broad-billed Sandpipers were similar (viz. 6,000 birds). However, their occurrence was very different since the three species were observed in 75, 33 and 4% of sites, respectively. Thus the estimate of Curlew numbers will, for statistical reasons, be more accurate than that of the two other species. The estimated 6,000 Broad-billed Sandpiper might be too low if some major sites for this species were not sampled. On the other hand, it is possible that the 320 birds counted were the only ones present in the entire area.

That numbers given cannot be more than tentative, can be shown by reference to counts made in Guinea-Bissau. When 5.2% of the intertidal flats were counted, 1.1 million waders were estimated to be present (Poorter & Zwarts 1984); but when a new estimate could be made, based on 23% of the total area counted, the extrapolated total decreased by 13% (Zwarts 1988). However, differences were much larger for individual species: extrapolated totals for Little Stint became 2.6 times lower and for Knot 3.7 times higher. The explanation of these deviations was that the sampled areas in the initial counts were particularly muddy and probably not representative, as the sandy bars in the main channels were not visited (Zwarts 1988). Sampling bias might also have occurred during counts in Saudi Arabia, because all counts were made from the shore. Counts at the small sites are representative, since the counted areas extended from high to low water mark. However, the flats further offshore were not surveyed in the extensive tidal areas. If these flats are more sandy (which is quite possibly due to the more exposed position), the estimated total numbers might be too high.

NUMBERS OF WADERS WINTERING IN THE GULF

The total surface area of all intertidal flats in the Gulf (Figure 1) has been determined from marine charts, and amounts to *ca.* 3,000 km², of which *ca.*7% occurs in the Saudi Arabian portion of the Gulf. Assuming that the wader density in the Gulf as a whole is not substantially different from the calculated average density in Saudi Arabia, one arrives at the remarkable number of nearly four million wintering waders! The presence of large numbers was already apparent from the midwinter counts made in Iran: 200,000 waders were counted along the Iranian Gulf-coast (Summers *et al.* 1987). This figure must be considered as an absolute minimum, however, since only 5% of the waders were recorded in the north of the Gulf, where 2/3 of the total surface of the Iranian intertidal flats is found. The presence of large numbers of waders along shores of the other side of the Iran-Iraq border was recorded by Scott & Carp (1982). Although no extensive tidal flats occur in the northern part of the United Arab Emirates (Figure 1), Uttley *et al.* (1989) found 40,000 waders along this part of the coast in autumn. Combining these few sources of information, a total of several million waders is a tentative but plausible estimate.

There are three reasons for suggesting that the figure of about four million wintering waders might be an

The extrapolation reliability will probably vary from species to species, depending on how widely each is distributed. Dunlins were observed in 79% of 48 counting sites where waders were seen, but Broad-made at spring tide, the under-estimate of surface area and thus over-estimate of the feeding density, is probably not serious.

Second, the wader densities might be lower in areas where the tidal cycle is diurnal rather than semi-diurnal. But since the occurrence of a diurnal tidal cycle is restricted to the northern part of Saudi Arabia and the western part of the United Arab Emirates, this effect may be of little significance. The tidal cycle is semi-diurnal in all important tidal areas in the Gulf (see Figure 1).

Third, as discussed in the previous section, mudflats may have been over-represented in the counted surface area. Since waders feed on mudflats in higher densities than on sandflats (Table 1), the extrapolated number may be too high. On the other hand, it is clear from the marine charts that the most important tidal area in the Gulf - the Bay of Kuwait and the extensive tidal zone around the border of Iran and Iraq - consists of muddy sediments. If waders feed there in densities similar to those associated with the mudflats in Saudi Arabia, millions of waders may be present only in this part of the Gulf.

We therefore conclude that as many as four million waders may winter in the Gulf. The Gulf, together with Australia, NW Africa, NW Europe and the northern coast of South America, therefore represents one of the world's major wintering sites for waders.

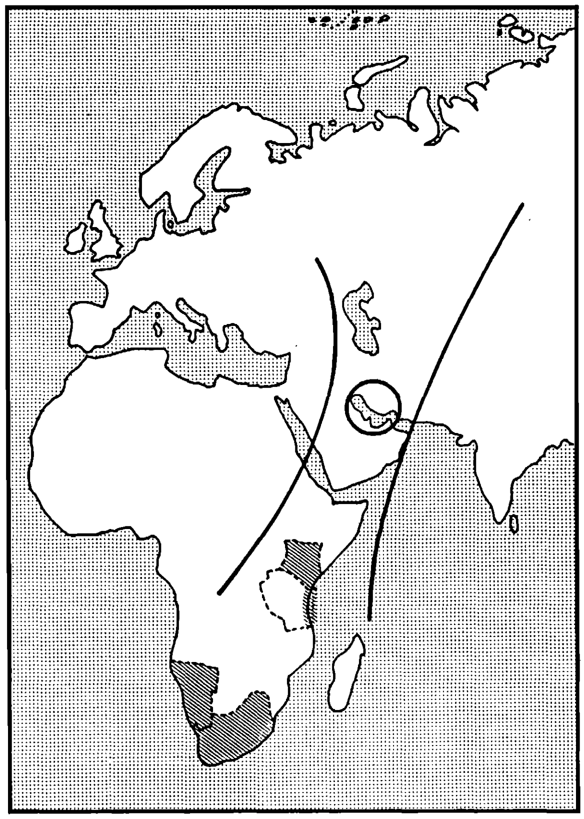

Figure 4. The location of the Gulf in the migration system of waders breeding in northern Eurasia and wintering in eastern and southern Africa. The huge gaps in our knowledge are shown: the numbers of wintering waders involved have been quantified in only four countries (shaded): Namibia, South Africa, Tanzania (coast only) and Kenya.

NUMBER OF WADERS PASSING THE GULF

Unfortunately, it was not possible to repeat this series of winter counts some months later in April/May. During this period even larger numbers of waders would be expected, due to the presence of many migrant waders (Courtenay-Thompson 1972; Gallagher & Woodcock 1980; Hill & Jenkins 1981; Nightingale 1984). Table 2, based upon Jenkins (1981), shows which wader species are more common during migration periods than in winter. This agrees with the seasonal variation in the abundance of waders as described for Oman (Gallagher & Woodcock 1980), Dubai, United Arab Emirates (Smart *et al.* 1983) and Bahrain (Hill & Nightingale 1984).

The counts of Uttley *et al.* (1988) in Dubai substantiates the trends summarized in Table 2. These authors counted in their study site, for instance, 2,300 Curlew Sandpipers *Calidris ferruginea* in late August and early September, while less than 100 remained until winter. Broad-billed Sandpipers reached their autumn peak in the middle of October with 4,000 birds, while only 200 were still present in November. The peak numbers of the Little Stint in September/October were not much higher than in November (1,100 versus 800), but the early captured birds were heavy and thus (nearly) ready to continue migration. It is thus likely that during the migration period there was a turnover in the population. Common wintering waders in Dubai were Dunlin, Little Stint, Bar-tailed Godwit, Redshank *Tringa totanus* and the five plover species. The series of counts of Uttley *et al.* (1988) suggest that, taking the different species together, as many waders pass through the Gulf as

Table 2. The abundance of wader species in the Saudi Arabian Gulf (after Jennings 1981). * = small numbers; ** = large numbers.

Kentish Plovers are residents.

Species	winter	autumn/spring
Oystercatcher	*	
Sanderling, Black-tailed Godwit, Whimbrel, Spotted Redshank, Greenshank, Terek Sandpiper	*	*
Lesser & Greater Sand Plover, Grey Plover Dunlin, Curlew, Redshank	**	**
Ringed Plover, Little Stint, Ruff, Bar-tailed Godwit, Common Sandpiper, Turnstone	*	**
Crab Plover, Broad-billed Sandpiper		*
Curlew Sandpiper		**

remain to overwinter. This estimate of passing numbers is based upon a comparison of the peak numbers in autumn with the winter numbers of the different species. However, the estimate is probably too low, as it does not take into account a population turnover during the migration period.

From this, we conclude that, if several million waders winter in the Gulf, a similar number may use the area as a temporary staging area en route. This raises the question of where such a large population might overwinter. The migration studies summarized by Summers *et al.* (1987) clearly show that all waders in eastern Africa and the majority of the waders in southern Africa pass through western Asia. Uttley *et al.* (1988) give two recoveries: one of a Little Stint and one of a Curlew Sandpiper, showing the link between the Gulf as staging area and southern Africa as wintering site. Moreover, it is possible that part of the wader populations wintering along shores further east of the Gulf (*i.e.* Pakistan and NW India), use the Gulf as a stopover site. This is a known migration route for the Broad-billed Sandpiper which breeds in Scandinavia and NW Russia and winters in western Asia (Cramp & Simmons 1983).

The review of Summers *et al.* (1987) shows that 360,000 waders winter in South Africa and 200,000 in Kenya. Recent counts along the coast of Tanzania suggest that another 300,000 waders may winter there (Bregneballe *et al.* 1989). Quantitative data are still lacking for important parts of the east coast of Africa (Figure 4). The muddy shores of Malagasy (Madagascar) and Mozambique might harbour large numbers, and the same might apply for the 3,000 km coastline of Somalia. From this we conclude that several million waders may winter in eastern and southern Africa and use not only the Gulf, but also the Red Sea and the Caspian Sea as migratory stopover sites. Further research needs to be undertaken to confirm whether the wader migration system between eastern Africa and Siberia is used by as many waders as are known to use the East-Atlantic Flyway.

ACKNOWLEDGEMENTS

We are grateful to Blaise Humbert-Droz (IUCN) for managing the project and to Peter Meininger for sending photocopies of some papers.

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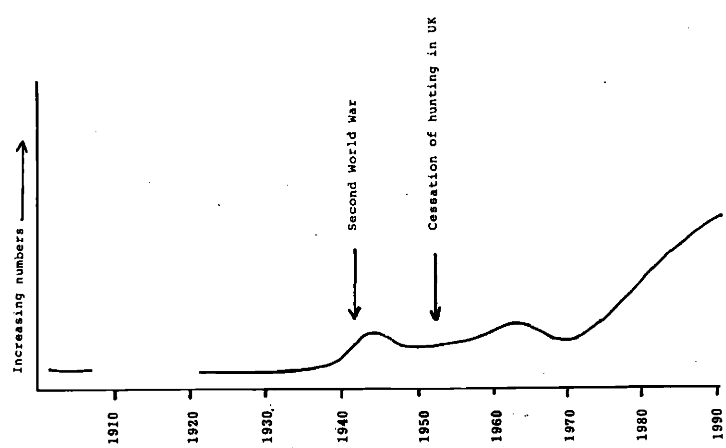
Erratum to *Bulletin* 61

The population history of Grey Plovers *Pluvialis sqatrarola* in the Solent, Southern England
by Colin R Tubbs

Figure 6 was missing from page 20

Figure 6. A possible population history of Grey Plovers *Pluvialis sqatarola* in The Solent (and elswhere?)



Erratum to *Bulletin* 62

The Northern Dunlin Puzzle by Hans Meltofte

page 16 - 3rd paragraph should read;

2. Dunlins, *whose core wintering area is in France,* move to the Dutch Wadden Sea around 1 April and then further into the northern part of the Wadden Sea and the Danish coasts in late April and early May. From here they fly to the breeding grounds in mid or late May. This breeding area is east to around the Ob river in northwestern Siberia, whilst the western boundary with the previous sub-population is unknown.