# ABUNDANCE OF WADERS IN THE NAKDONG ESTUARY, SOUTH KOREA, IN SEPTEMBER 1984

by Theunis Piersma

## INTRODUCTION

From 14-18 September 1984 I visited Nakdong Estuary near Pusan in the south-eastern corner of South Korea, to study waders for the Environmental Programme of the Nakdong Estuary Barrage and Reclamation Project. Tidal barrages will be constructed on the last two remaining branches of Nakdong river (the first was closed-off in 1934 by the Noksan Dam, Figure 1a), while about 200 ha of intertidal flats will either be reclaimed or excavated by dredging. These works will obviously affect the environmental features of the estuary. The Environmental Programme aims to monitor the changes and to provide advice during the construction of the works.

This paper presents the results of two high-tide wader counts and low-tide counts over sample areas, in September 1985 (for other details, see Piersma 1985). Few studies on waders have higherto been carried out in South Korea. Doorbos (1984) and ISWACO (1984) report on the occurrence of waders in Nakdong Estuary while Won (1976) summarized the status of waders in his 'Checklist of the Birds of the Republic of Korea'. In view of the limited availability of this checklist, the information on waders found therein is reproduced in the Appendix.

## STUDY AREA AND METHODS

The Nakdong Estuary (35°15'N; 129°10'E) measures 14 km by 7 km and comprises 3030 ha of intertidal land. During the study period, the easternmost branch of Nakdong river was closed off by the building pit for the tidal barrage, and therefore all discharge water flowed via the western branch. The tidal range varied from 30 cm at neap to 150 cm at spring tides. Salinities in the estuary decreased from 25-30% seaward of the barrier islands to 2-5% at the level off Hadan (ISWACO 1984).

The western intertidal flats of the estuary (Figure 1a) are surrounded by the steep hills of mainland Korea and the large island Gadeog Do. The eastern intertidal flats are protected from the open sea by a row of low sandy barrier-islands. The barrier-islands Galmaegi Deung, Namusit Deung and an unnamed sand spit in the eastern branch of Nakdong river are uninhabited low, sandy, beach-like islands without any vegetation. In contrast, Jinuh Do is a rather higher inhabited sandy island with patches of dunes and cultivation (mainly onions). The other estuarine islands (Daema Deung, Ogryu Deung and Baeghab Deung) are covered by reedbeds and patches of dunes and are partly cultivated, but not inhabited. The southeastern point of Eulsuk Do consists of extensive reedbeds while the remainder of the island is cultivated with onions and rice. Near Noksan Dam, part of an extensive refuse dump which had been covered with clay, made a marshy wetland suitable for waders.

High tide counts were made on 15 and 17 September and on 26 September using A 15X-60X zoom telescope, 10 X 40 binoculars and a hand counter. During a counting trip, the southern tip of Eulsuk Do was visited first, followed on foot by three of the barrier islands (Namusit Deung (partly), Galmaegi Deung (completely) and Jinuh Do (partly)); the remaining area was covered from the boat, with occasional landings. In addition, trips by car were made along the northern shores of the estuary during which the Pusan City-refuse dump was also visited. Coverage of the tidal area was probably fairly complete, though I was unable to visit the western branch of Nakdong river during the second count. This was due to stormy weather.

The long and narrow island Galmaegi Deung where most waders roosted (see below), was counted on foot from east to west. Any flocks that were encountered were carefully examined (in a

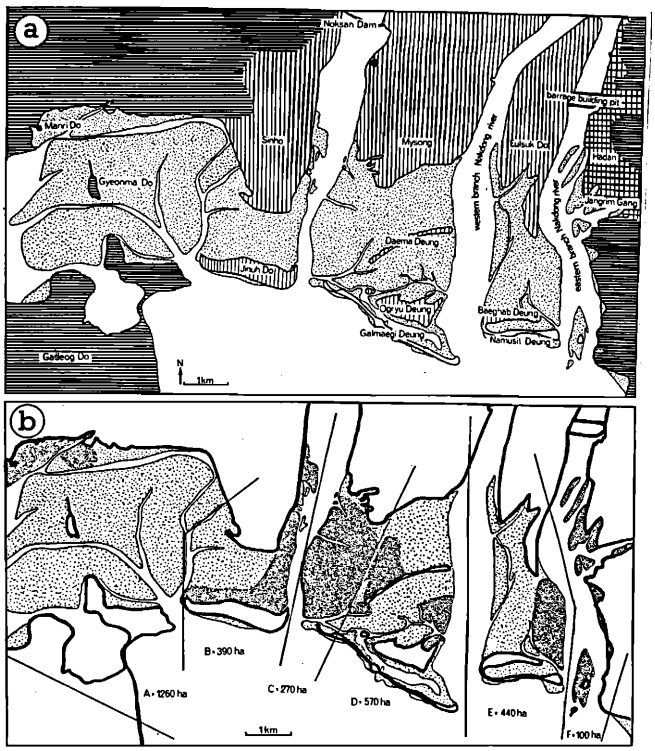


Figure 1. Map of the Nakdong Estuary (A) and division of the intertidal area in six compartments (B).
A. horizontally hatched: steep (mainly wooded) hillsides; vertically hatched: agricultural land and reedbeds; cross-hatched: industrial and built-up areas; dotted: intertidal areas; unhatched (within thick lines): beach-like sandy islands; unhatched (rest): open water; thick dot: refuse dump of the City of Pusan.
B. heavily dotted parts are areas counted once or twice during low tide periods between 17 and 25 September 1984.

westerly direction) to quantify common species composition and to look for the rarer species. I then disturbed the flock such that the birds passed me eastwards in flight, permitting a total count. This method of 'systematic disturbance' worked very well on Galmaegi Deung.

Some wader counts were made on parts of the intertidal flats during low tide periods (from three hours before to three hours after predicted time of low tide according to local tide tables). After counting a certain area, the intertidal area which had been counted was delimited by eye and indicated on a map. This was done with the help of a compass, landmarks such as islands and gullies and a proper map. Surfaces of sample area were either 'stepped out' (1 step = 1 m) and/or estimated from the map with a 1 mm grid transparent overlay. Results of all sample area-counts per intertidal compartment (Figure 1b) were assembled to extrapolate the total numbers per species per compartment.

The nomenclature in this paper follows Voous (1973), except in the case of the Lesser Golden Plover *Pluvialis fulva* where Connors (1983) is followed.

## RESULTS

The results of the two high tide wader counts are presented in Table 1. In mid-September a total of 19 000 waders was found, while at the end of September 14 000 waders were counted. During the first and the second count respectively 79% and 99% of all the waders roosted on Galmaegi Deung. During the first count, an important wader roost (450 Black-tailed Godwits *Limosa limosa*, 100 Bar-tailed Godwits *Limosa lapponica* and 1800 Red-necked Stints *Calidris ruficollis*) also occurred on the southernmost tip of Eulsuk Do. During the second count this site was submerged by the high spring tides. The less common wader species were encountered mainly at the refilled Pusan refuse-dump. The Black-winged Stilt *Himantopus himantopus*, one of the two Eastern Collared Pratincoles *Glareola maldivarum* and the Red-necked Phalarope *Phalaropus lobatus*, all seen for the first time in the vicinity of Nakdong Estuary (Kwon pers. comm.), were found at this marshy site.

The results of the low tide counts are presented in Table 2. For most species the extrapolation of the low tide counts comes close to the results of the high tide counts. For Kentish Plovers *Charadrius alexandrinus* and Sanderlings *Calidris alba* however, the extrapolation yielded much smaller numbers than the total numbers at high tide, while many more Greenshanks *Tringa nebularia* and Terek Sandpipers *Xenus cinereus* were estimated to be present in the estuary than was apparent from the results of the high tide counts. The possible reasons for these differences will be discussed below.

## DISCUSSION

The great majority of waders in Nakdong Estuary roosted on one island, the Galmaegi Deung, while virtually none roosted on the nearby, and very similar Namusit Deung. The intertidal area north of Namusit Deung contained higher densities of waders than the intertidal flats north of Galmaegi Deung (Table 2). It is therefore not the absence of nearby suitable feeding areas that could possibly prevent waders from roosting on Namusit Deung. However, Namusit Deung is directly connected to the vegetated and higher island Baeghab Deung by a 5-10 m wide landbridge on which mammalian bird-eating predators such as rats and foxes may have lived. These animals could easily have reached roosting waders on Namusit Deung. Galmaegi Deung is not connected by a land bridge to any vegetated island and is therefore difficult for mammalian predators to reach during high tide. This may make Galmaegi Deung relatively 'safe' and therefore much preferred by the waders.

Numbers of Kentish Plovers and Sanderlings were apparently under-estimated and numbers of Greenshanks and Terek Sandpiper over-estimated during the low tide counts compared to the high tide count-results (Table 2). The first two species are known to prefer foraging on dry sandy areas and sandy beaches respectively (Cramp & Simmons 1983). Such areas were not covered during the low tide counts and the numbers of Kentish Plovers and Sanderlings were therefore probably under-estimated by the low tide counts-extrapolation. Kentish Plovers may have fed on top of the barrier islands during low tide. Here, large densities of their prey, the small crab *Scopimera globosa*, occurred. The Sanderlings probably fed mainly on the seaward beaches of the barrier islands. Greenshanks and Terek Sandpipers both had the peculiar habit of roosting on 'inland' sites where I was able to locate them by chance only (Figure 2). Greebshanks tended to roost even more 'inland' than Terek Sandpipers, in small creeks and wet fields inside the polder-dikes. Greenshank numbers, estimated from low tide counts, were correspondingly higher than the high tide numbers, compared to those of Terek Sandpipers. Real numbers of both species are most probably much closer to 400 and 300 birds respectively, than to the figures resulting from the high tide counts.

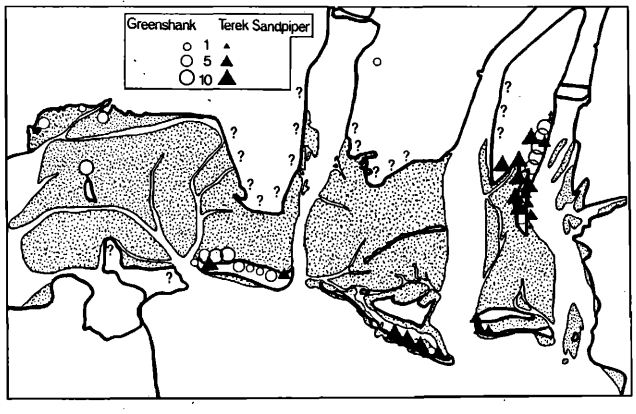


Figure 2. High tide distribution in Nakdong Estuary of 125 Greenshanks *Tringa nebularia* and 186 Terek Sandpipers *Xenus cinereus* during two counts in September 1984.

Some interesting patterns emerge from a comparison of the counts from this study and those by Doornbos (1984) in October and November 1983. Kentish Plover, Great Knot *Calidris tenuirostris*, Sanderling, Red-necked Stint and Far Eastern Curlew *Numenius madagascariensis* apparently migrate through Nakdong Estuary in September, while Dunlin

Table 1. Results of two high tide counts of waders in the Nakdong Estuary in September 1984.

| | | 15 & 17 September | | | 26 September | | |
|---|---|---|---|---|---|---|---|
| | | Galmaegi Deung | elsewhere | total | Galmaegi Deung | elsewhere | total |
| Black-winged Stilt | *Himantopus himantopus* | 0 | 1 | 1 | 0 | 0 | 0 |
| Eastern Collared Pratincole | *Glareola maldivarum* | 0 | 1 | 1 | 1 | 0 | 1 |
| Little Ringed Plover | *Charadrius dubius* | 0 | 0 | 0 | 0 | 12 | 12 |
| Kentish Plover | *Charadrius alexandrinus* | 2 500 | 61 | 2 561 | 2 125 | 38 | 2 163 |
| Lesser Sand Plover | *Charadrius mongolus* | 60 | 16 | 76 | 440 | 3 | 443 |
| Lesser Golden Plover | *Pluvialis fulva* | 6 | 0 | 6 | 0 | 4 | 4 |
| Grey Plover | *Pluvialis squatarola* | 126 | 2 | 128 | 153 | 4 | 157 |
| Great Knot | *Calidris tenuirostris* | 1 000 | 240 | 1 240 | 450 | 0 | 450 |
| Sanderling | *Calidris alba* | 1 300 | 0 | 1 300 | 575 | 12 | 587 |
| Red-necked Stint | *Calidris ruficollis* | 9 000 | 1 880 | 10 880 | 6 960 | 8 | 6 968 |
| Dunlin | *Calidris alpina* | 800 | 0 | 800 | 2 150 | 0 | 2 150 |
| Spoon-billed Sandpiper | *Eurynorhynchus pygmeus* | 4 | 0 | 4 | 4 | 0 | 4 |
| Broad-billed Sandpiper | *Limicola falcinellus* | 3 | 0 | 3 | 11 | 0 | 11 |
| Common Snipe | *Gallinago gallinago* | 0 | 0 | 0 | 0 | 10 | 10 |
| Black-tailed Godwit | *Limosa limosa* | 0 | 450 | 450 | 0 | 0 | 0 |
| Bar-tailed Godwit | *Limosa lapponica* | 170 | 450 | 620 | 320 | 0 | 320 |
| Whimbrel | *Numenius phaeopus* | 16 | 8 | 24 | 0 | 2 | 2 |
| Eurasian Curlew | *Numenius arquata* | 0 | 4 | 4 | 50 | 0 | 50 |
| Far Eastern Curlew | *Numenius madagascariensis* | 15 | 582 | 597 | 630 | 5 | 635 |
| Spotted Redshank | *Tringa erythropus* | 0 | 2 | 2 | 0 | 1 | 1 |
| Greenshank | *Tringa nebularia* | 1 | 86 | 87 | 0 | 38 | 38 |
| Green Sandpiper | *Tringa ochropus* | 0 | 0 | 0 | 0 | 1 | 1 |
| Wood Sandpiper | *Tringa glareola* | 0 | 9 | 9 | 0 | 0 | 0 |
| Terek Sandpiper | *Xenus cinereus* | 36 | 107 | 143 | 3 | 40 | 43 |
| Common Sandpiper | *Actitis hypoleucos* | 0 | 4 | 4 | 0 | 0 | 0 |
| Polynesian Tattler | *Heteroscelus brevipes* | 0 | 48 | 48 | 0 | 2 | 2 |
| Turnstone | *Arenaria interpres* | 6 | 0 | 6 | 0 | 0 | 0 |
| Red-necked Phalarope | *Phalaropus lobatus* | 0 | 1 | 1 | 0 | 0 | 0 |
| Totals | | 15 043 | 3 952 | 18 995 | 13 872 | 180 | 14 052 |

Table 2. Numbers of waders counted during low tide on different compartments of the intertidal area (Figure 1b) of the Nakdong Estuary, 17-25 September 1984, compared with the total numbers found during two high tide counts (Table 1). Low tide is defined as the period between three hours before and three hours after predicted time of low tide.

| | area A | | area B | | area C | | area D | |
|---|---|---|---|---|---|---|---|---|
| | sample 98ha | estim. total 1260ha | sample 176ha | estim. total 390ha | sample 260ha | estim. total 270ha | sample 122ha | estim. total 570ha |
| Kentish Plover | 0 | 0 | 16 | 35 | 7 | 7 | 30 | 140 |
| Lesser Sand Plover | 0 | 0 | 11 | 24 | 21 | 22 | 27 | 126 |
| Grey Plover | 0 | 0 | 3 | 7 | 18 | 19 | 11 | 51 |
| Great Knot | 0 | 0 | 0 | 0 | 511 | 531 | 0 | 0 |
| Sanderling | 0 | 0 | 2 | 4 | 30 | 31 | 24 | 112 |
| Red-necked Stint | 0 | 0 | 22 | 48 | 47 | 49 | 176 | 882 |
| Dunlin | 0 | 0 | 0 | 0 | 141 | 147 | 137 | 640 |
| Bar-tailed Godwit | 0 | 0 | 0 | 0 | 172 | 179 | 0 | 0 |
| Whimbrel | 2 | 26 | 4 | 9 | 0 | 0 | 1 | 5 |
| Eurasian Curlew | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 0 |
| Far Eastern Curlew | 1 | 13 | 11 | 24 | 545 | 567 | 16 | 75 |
| Greenshank | 21 | 271 | 50 | 110 | 7 | 7 | 4 | 19 |
| Terek Sandpiper | 0 | 0 | 42 | 92 | 12 | 12 | 25 | 117 |
| Common Sandpiper | 1 | 13 | 0 | 0 | 0 | 0 | 0 | 0 |
| Polynesian Tattler | 0 | 0 | 9 | 20 | 0 | 0 | 3 | 14 |

| | area E | | area F | | estimated grand totals 3030ha | grand totals high tide counts |
|---|---|---|---|---|---|---|
| | sample 111ha | estim. total 440ha | sample 100ha | estim. total 100ha | | |
| Kentish Plover | 34 | 135 | 41 | 41 | 328 | 2 163 - 2 561 |
| Lesser Sand Plover | 0 | 0 | 0 | 0 | 172 | 76 - 443 |
| Grey Plover | 0 | 0 | 0 | 0 | 77 | 128 - 157 |
| Great Knot | 5 | 20 | 72 | 72 | 623 | 450 - 1 240 |
| Sanderling | 0 | 0 | 17 | 17 | 164 | 587 - 1 300 |
| Red-necked Stint | 1 337 | 5 295 | 1 090 | 1 090 | 7 304 | 6 968 - 10 880 |
| Dunlin | 3 | 12 | 0 | 0 | 799 | 800 - 2 150 |
| Bar-tailed Godwit | 54 | 214 | 2 | 2 | 395 | 320 - 620 |
| Whimbrel | 0 | 0 | 1 | 1 | 41 | 2 - 24 |
| Eurasian Curlew | 0 | 0 | 2 | 2 | 4 | 4 - 50 |
| Far Eastern Curlew | 3 | 12 | 27 | 27 | 718 | 597 - 635 |
| Greenshank | 1 | 4 | 4 | 4 | 415 | 37 - 88 |
| Terek Sandpiper | 9 | 36 | 45 | 45 | 302 | 43 - 143 |
| Common Sandpiper | 0 | 0 | 0 | 0 | 13 | 0 - 4 |
| Polynesian Tattler | 0 | 0 | 2 | 2 | 36 | 2 - 48 |

*Calidris alpina* and Eurasian Curlew *Numenius arquata* arrive in great numbers only in October. In the middle of October, Doorbos (1984) counted 9102 Dunlins, numbers of which declined later in the month, and a maximum of 436 Eurasian Curlews in early November. Apparently, the Dunlin is a late migrant and the Eurasian Curlew a wintering species.

Despite frequent observations, no waders of any species were observed with flight feather (primary) moult in the Nakdong Estuary, even though wing-moult is fairly easy to observe in the field (van Dijk 1980). The absence of wing-moulting waders at this migratory-staging site fits with the observations of Minton (1981) who states that most Palearctic waders begin primary moult only after arriving in September-October on their wintering grounds in Australia.

Counts of 20 000 waders indicate that the Nakdong Estuary is without doubt a major staging area for waders on the Korean peninsula. However, its importance cannot be evaluated on a national level as there are no data for the other tidal areas in South Korea. The completion of the barrage and reclamation-works will lead to some losses of wader feeding grounds in Nakdong Estuary, although the remaining tidal area is probably to be managed as a protected nature reserve. However, according to Schultz (1984), a total area of 345 500 ha of intertidal land along the west and south Korean coastline should be reclaimed in the near future (Figure 3). Even if wader densities on these sites only equal the lowest densities measured in Nakdong Estuary (0.3 birds/ha in area A, calculated from Table 2), this could still result in the loss of feeding sites for 100 000 waders in autumn (and, reasoning from the highest density in Nakdong Estuary, a maximum of 4 500 000!). The loss of such extensive intertidal areas may therefore have a severe effect on migrant wader populations. Environmental impact studies are therefore strongly recommended *in advance* of reclamation projects in view of the important role that South Korean wetlands may fulfil in the very heart of the West Pacific wader flyway.

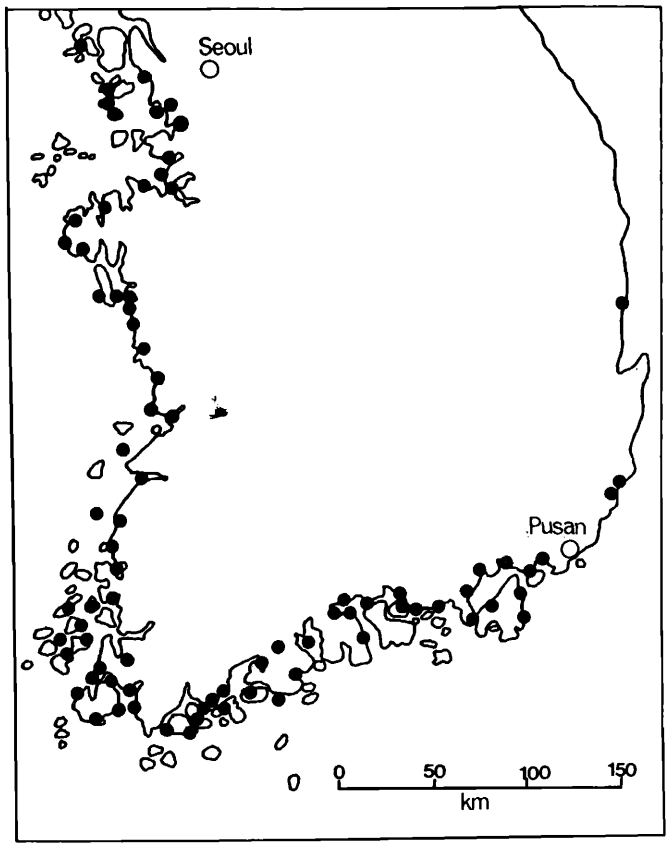


Figure 3. Overview of reclamation projects (dots) scheduled in 1984 in South Korea. After Schultz (1984).

ACKNOWLEDGEMENTS

The invitation to do this study came from Drs Jankees Post of Euro-consult. I am grateful to him for giving me this opportunity and for his enthusiastic guidance. The team of NEDECO (Netherlands Engineering Consultants) at Pusan (Adri van Ieperen and his family, Anda & Olaf van Duin, Rien van Harmelen, Myeong Hee Lee, Wout de Leeuw, Rens Sneep, Wiek Visser and Ad van der Waals) provided a most helpful and very pleasant "home-environment" when I was not outdoors. I thank Kyung Seok Bai and fisherman Phan Young Lee for their help in the field. I am grateful to Dr Ki-Chung Kwon, zoologist at the Dong-A University of Pusan, for kindly sharing his knowledge of the birds of Nakdong Estuary and immediately lending me his telescope when mine "drowned". Leo Zwarts, Jan Veen and Jouke Prop lent me scientific equipment while Kees Swennen made some helpful remarks about the results. I thank Prof Pyong-Oh Won for permitting me to reproduce parts of his checklist.

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APPENDIX. THE STATUS OF WADERS IN SOUTH KOREA

The following list was taken, with permission from and with minor changes by the author, from the *'Checklist of the Birds of the Republic of Korea'* by P.O.Won (Institute of Ornithology, Kyung Hee University, Seoul, April 1976). The sequence of species and English and Latin names follow Voous (1973).

| English name | Latin name | Status |
|---|---|---|
| Painted Snipe | *Rostratula benghalensis* | vagrant |
| Oystercatcher | *Haematopus ostralegus* | uncommon winter visitor in south, uncommon summer visitor |
| Black-winged Stilt | *Himantopus himantopus* | vagrant |
| Avocet | *Recurvirostra avosetta* | vagrant |
| Eastern Collared Pratincole | *Glareola maldivarum* | rare passage migrant |
| Little Ringed Plover | *Charadrius dubius* | common summer visitor |
| Long-billed Ringed Plover | *Charadrius placidus* | scarce passage migrant, scarce winter visitor |
| Kentish Plover | *Charadrius alexandrinus* | common passage migrant, common winter visitor, common summer visitor |
| Lesser Sand Plover | *Charadrius mongolus* | uncommon passage migrant |
| Greater Sand Plover | *Charadrius leschenaultii* | vagrant |
| Caspian Plover | *Charadrius asiaticus* | rare passage migrant |
| Lesser Golden Plover | *Pluvialis fulva* | common passage migrant |
| Grey Plover | *Pluvialis squatarola* | common passage migrant |
| Grey-headed Lapwing | *Hoplopterus cinereus* | rare passage migrant |
| Lapwing | *Vanellus vanellus* | uncommon passage migrant, common winter visitor |
| Great Knot | *Calidris tenuirostris* | uncommon passage migrant |
| Knot | *Calidris canutus* | rare passage migrant |
| Sanderling | *Calidris alba* | common passage migrant, common winter visitor |
| Red-necked Stint | *Calidris ruficollis* | abundant passage migrant |
| Temminck's Stint | *Calidris temminckii* | uncommon passage migrant |
| Long-toed Stint | *Calidris subminuta* | scarce passage migrant |
| Pectoral Sandpiper | *Calidris melanotos* | vagrant |
| Sharp-tailed Sandpiper | *Calidris acuminata* | uncommon passage migrant |
| Curlew Sandpiper | *Calidris ferruginea* | uncommon passage migrant |
| Dunlin | *Calidris alpina* | common passage migrant, abundant winter visitor in south and west |
| Spoon-billed Sandpiper | *Eurynorhynchus pygmeus* | scarce passage migrant |
| Broad-billed Sandpiper | *Limicola falcinellus* | uncommon passage migrant |
| Ruff | *Philomachus pugnax* | vagrant |
| Jack Snipe | *Lymnocryptes minimus* | vagrant |
| Common Snipe | *Gallinago gallinago* | common passage migrant, common winter visitor |
| Pintail Snipe | *Gallinago stenura* | scarce passage migrant |
| Swinhoe's Snipe | *Gallinago megala* | rare passage migrant |
| Solitary Snipe | *Gallinago solitaria* | scarce winter visitor |
| Woodcock | *Scolopax rusticola* | uncommon passage migrant |
| Black-tailed Godwit | *Limosa limosa* | uncommon passage migrant |
| Bar-tailed Godwit | *Limosa lapponica* | uncommon passage migrant |
| Little Whimbrel | *Numenius minutus* | rare passage migrant |
| Whimbrel | *Numenius phaeopus* | common passage migrant |
| Eurasian Curlew | *Numenius arquata* | common passage migrant, common winter visitor |
| Far Eastern Curlew | *Numenius madagascariensis* | common passage migrant |
| Spotted Redshank | *Tringa erythropus* | common passage migrant |
| Redshank | *Tringa totanus* | uncommon passage migrant |
| Marsh Sandpiper | *Tringa stagnatilis* | vagrant |
| Greenshank | *Tringa nebularia* | common passage migrant |
| Spotted Greenshank | *Tringa guttifer* | rare passage migrant |
| Green Sandpiper | *Tringa ochropus* | common passage migrant uncommon winter visitor |
| Wood Sandpiper | *Tringa glareola* | uncommon passage migrant |
| Terek Sandpiper | *Xenus cinereus* | common passage migrant |
| Common Sandpiper | *Actitis hypoleucos* | common passage migrant, uncommon summer visitor |
| Polynesian Tattler | *Heteroscelus brevipes* | common passage migrant |
| Turnstone | *Arenaria interpres* | uncommon passage migrant |
| Red-necked Phalarope | *Phalaropus lobatus* | uncommon passage migrant |