SOUTH KOREA'S SHOREBIRDS: A REVIEW OF ABUNDANCE, DISTRIBUTION, THREATS AND CONSERVATION STATUS.

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INTRODUCTION

South Korea is increasingly recognized for its importance to long-range migrant shorebirds of the East Asian–Australasian Flyway, supporting an official estimate of 12.7% of the Flyway's shorebirds on northward migration and 8.7% on southward migration. This understanding has developed gradually over the past three decades, with most shorebird research conducted to the background of (or even as part of) tidal flat reclamation projects and the construction in the mid-1980s of estuarine barrages across three of the nation's largest rivers: The Geum, the Yeongsan and the Nakdong. While the historical tidal flat area in South Korea exceeded 450,000 ha, one recent estimate suggests that this area will be reduced to a little over 110,000 ha within a decade. Lacking an extensive historical record of shorebird numbers, either nationally or at the Flyway level, it is difficult to suggest with any confidence what the impacts of such massive habitat loss and habitat degradation (not only in South Korea but in many other parts of the Yellow Sea) have been up to now, and what they will be in the future. Already, there has been a near-collapse of inshore fisheries in South Korea, an obvious and precipitous decline of the Endangered Spoon-billed Sandpiper, and several other tidal flat dependent species closely associated with the Yellow Sea have a very poor conservation status, including Nordmann's Greenshank (Endangered), Black-faced Spoonbill *Platelea minor* (Endangered), Chinese Egret *Egretta eulophotes* (Vulnerable) and Saunders's Gull *Larus saundersi* (Vulnerable). Concern over the anticipated impacts of the largest of the reclamation projects to date, the ongoing 40,100 ha reclamation of the Mangyeung and Dongjin estuaries (collectively known as "Saemangeum"), has generated sufficient national and international concern to lead to the development of the three-year Saemangeum Shorebird Monitoring Program (2006–2008). This Program will monitor impacts of the reclamation on shorebirds at both the local and the population level, and over time help to improve conservation possibilities in Korea. What is clear already is that the present conservation initiatives in South Korea, while often good on paper, still lack the political will or authority to stem the present tidal-wave of habitat loss.

This paper aims to provide sufficient information to enable a fuller understanding of the status of shorebirds in South Korea, and to help facilitate discussions and actions leading to their better conservation. It is divided into five sections:

- a review of shorebird research;
- shorebird habitats, and threats to them;
- a list of internationally important shorebird sites;
- estimates of contemporary shorebird populations in South Korea;
- background to shorebird conservation.

A REVIEW OF SHOREBIRD RESEARCH

Before 1950

In attempting to describe the abundance, trends, and conservation status of shorebirds at the national level, it is usually necessary to have a historical base for comparison. There is, however, very little useful information on most shorebird species and their habitats in South Korea before 1980, with the first national review of Korea's avifauna (Austin 1948) assessing the status of species like the Great Knot as a "rare transient", based on a Korean-peninsula record of only five specimens (compared to 14 specimens of Spoon-billed Sandpiper already collected by that time). The apparent rarity of species like the Great Knot and other tidal flat dependent shorebirds was most likely due to their "habit of staying on the outer beaches and offshore islands instead of coming into the paddies, where (they) could have been observed and collected more frequently" (Austin 1948). Of the 48 shorebird species accepted by Austin's review, only 22 were assessed as "common" or at least "not uncommon" in Korea, with the majority either distinctive or freshwater associated species: Eastern Oystercatcher, Grey Plover, Pacific Golden Plover, Little Ringed Plover, Kentish Plover, Long-billed Plover, Lesser Sand Plover, Whimbrel, Eurasian Curlew, Far Eastern Curlew ("commonest of the curlews, a fairly common spring and autumn transient"), Bar-tailed Godwit, Spotted Redshank (in the rice fields "flocks of several hundred individuals were not uncommon"), Common Greenshank, Green Sandpiper, Wood Sandpiper, Common Sandpiper, Ruddy Turnstone, Pintail Snipe, Common Snipe, Long-toed Stint, Sharp-tailed Sandpiper and Dunlin. Austin accepted only two of these, the Eastern Oystercatcher and Little Ringed Plover, as breeding species, although the Common Sandpiper had also been found breeding in the previous century (Taczanowski 1888).

The 1960s and 1970s

With a limited amount of ornithological activity in South Korea, and access to much of the coastal zone restricted by the military from at least the 1940s through almost to the present (Long *et al.* 1988; pers. obs.), only limited research was conducted in estuarine habitats in the 1960s and 1970s. Fennel & King (1964) revealed new national high counts of Broad-billed Sandpiper (including a single flock of 500 on 2 September 1962 in Gyeonggi province), a total of 39 Nordmann's Greenshank over two autumns near Incheon, and added Great Ringed Plover *Charadrius hiaticula* and Curlew Sandpiper to the national list. In the late 1960s and early 1970s, more intensive surveys, especially by South Korea's pre-eminent ornithologist Won Pyong-Oh at the Nakdong Estuary in the south-east, provided improved data for the revised species assessments given by Gore & Won (1971), the last published comprehensive review of South Korea's avifauna in English. Their review included 51 species of shorebird, and significantly a count of "several hundred Spoon-billed Sandpiper on the mudflats in the Naktong delta on 18–20 September, 1970" (with this count then re-presented as a more modest 200 by Long *et al.* 1988). Gore & Won (1971) largely agreed with Austin's shorebird species' assessments from two decades before, but considered Eastern Oystercatcher, Ruddy Turnstone, Pintail Snipe and Long-toed Stint (as well as Spoon-billed Sandpiper) to be only "uncommon passage migrant(s)", and added four more coastal species to the list of species considered to be relatively common: Black-tailed Godwit, Terek Sandpiper, Sanderling, and Red-necked Stint (the last, "Abundant"). Considering the species' distinctiveness (and its present rather local status), the description of Spotted Redshank at that time as "the most common wader in the flooded rice fields in spring from March-early May" (Gore & Won 1970) seems suggestive of significant declines at the national level of that species in recent decades, with only one unverified report (in Moores & Moores 2004) of up to 2,500 in spring 2004, somewhere in the north-west, at all comparable in recent years.

The 1980s

According to the account in Long *et al.* (1988), survey work at the Nakdong Estuary by Piersma in 1984 and by Won in 1987, at the Geum River by Ham and Lee (1985), and in the north-west in the late 1980s by Won (unpubl.) produced several significant improvements in knowledge. These were often achieved through research conducted in connection with major development plans, including the barraging of both the Nakdong and the Geum rivers at their estuaries in the mid-1980s. New national high counts from this period included 850 Eastern Oystercatcher at the Geum Estuary on the west coast in December 1984, and of Kentish Plover (2,561 in September 1984), Great Knot (1,240 in September 1984), Red-necked Stint (2,320 in May 1987, 10,880 in September 1984), Dunlin (9,012 in October 1983), Far Eastern Curlew (635 in September 1984), Grey-tailed Tattler (309 in September 1987), and Terek Sandpiper (790 in September 1987) at the Nakdong Estuary. It also returned Eastern Oystercatcher and added Kentish Plover to the list of South Korean breeding shorebird species.

Spring 1988 saw the first attempt at coverage of shorebird habitats along all of the west and parts of the south coast, where most of South Korea's tidal flats are concentrated. A joint initiative of East Anglia (UK) and Kyung-Hee Universities (South Korea), this pioneering survey "completely changed the state of knowledge of distribution and numbers of shorebirds in the country" (Long *et al.* 1988). Surveying 23 coastal sites over two months (early April to early June), coverage was very limited for much of the coastline away from the north-west close to Seoul, and (only) five sites that were considered "internationally important to migratory shorebirds" were identified: the Nakdong Estuary (based on previous surveys), and the four main north-western sites, i.e. Ganghwa, Yeongjong, Namyang Bay and Asan Bay, for which "No previous counts exist" (Long *et al.* 1988). Eight further sites were identified as of national importance, including the Dongjin River Estuary, in present-day Saemangeum (Long *et al.* 1988). The survey recorded between 136,157 and 167,823 shorebirds of 35 species in total, including 98–135 Nordmann's Greenshank. The most numerous shorebirds recorded were Dunlin (64,500–74, 785), Great Knot (20,000–35,000), Black-tailed Godwit (16,345–17,370) and Bar-tailed Godwit (13,220–15,720), accounting for 84 percent of the total numbers of shorebirds seen (Long *et al.* 1988). It is critical to note when comparing these results with other counts or national estimates that the survey did not include the Nakdong Estuary (as it had already been covered by previous survey effort) and did not cover most of the south-western sand- and sand-mudflats at all well. The survey also covered the Geum Estuary very poorly (counting Yubu Island only once, on either 26 or 27 May, when "there were few birds present and saltpan workers said the birds had left in early May", and did not even visit mainland tidal flats to the north of the river-mouth). The survey team also visited the Mangyeung Estuary only once (on 27 May, when "poor coverage" and when "no birds were seen"), and the Dongjin Estuary twice: once on 28 April during a neap tide, and again on 26 May (by which time most shorebirds would have migrated [Moores *et al.* 2006]). The very small numbers of shorebirds seen in this vast area in spring 1988 should not and cannot be used to infer in any way that later counts at Saemangeum were due (largely) to shorebirds displaced from elsewhere. Counts attempted post-1998 also found almost no birds at neap tides and/or at the end of May (pers. obs.).

In addition to establishing South Korea's importance to species such as the Great Knot and Nordmann's Greenshank, Long *et al.* (1988) also provided perhaps the first detailed account in English of numerous coastal reclamation plans being considered by the South Korean military government as part of The National Masterplan, 1984–2001. This masterplan simplistically identified almost precisely two-thirds (66.5%) of remaining coastal wetlands along the west and south coasts as fit for reclamation by 2001, listing 150 potential projects, involving 155 estuaries and bays and covering 480,000 ha (Long *et al.* 1988). As noted at the time: "There is no doubt that future land reclamation of coastal wetlands is going to take a significant percentage of the present total … If the large-scale reclamation projects in the four key sites (Ganghwa, Yeongjong, Namyang and Asan Bays) were executed, this would severely jeopardize the staging areas for a very important percentage of shorebirds in the East Asian-Western Pacific Flyway … Theoretical studies on the possible effect of reclamation of mudflat areas on populations of migratory shorebirds have been carried out on data from the Wash (UK) … But nothing is known about the real effects that intertidal reclamation, on the scale that is proposed in South Korea, could have on such populations." (Long *et al.* 1988).

The 1990s to the present

The year 1991 saw the start of construction of the Saemangeum sea-wall and the 1990s saw the completion of a series of coastal reclamations, significantly reducing shorebird habitat at Yeongjong, along the Incheon coastline and, Shihwa, in Asan Bay, as well as many bays and estuaries on the south coast. The next significant paper on shorebirds (Kim *et al.* 1997) contained the results of shorebird survey work conducted on a total of 75 days during the northward and southward migrations between September 1993 and October 1996. Survey work again concentrated on the north-western sites, three of which (Yeongjong south, Namyang and Asan) were already undergoing partial or near-complete reclamation. It improved on earlier coverage of the 40, 000 ha Saemangeum estuarine system, with counts on eight dates there during the three-year period (in May, September and October), and also included two counts at the Geum Estuary (11 May and 24 September, 1996). Even with such limited coverage, the survey team found internationally important concentrations at Saemangeum of Great Knot (12,700) and Nordmann's Greenshank (52 on 19 October 1994). They also recorded high counts of at least two other species at the north-west sites: Kentish Plover (3,048 at Yeongjong Island on 17 October 1993) and Eurasian Curlew (1,516 at Namyang Bay on 16 September 1993), clearly indicating the importance of these sites on southward as well as northward migration.

An intensive survey of shorebirds and their coastal habitats between April 1998 and February 1999 (Moores 1999a, 1999b) then covered 56 coastal wetlands, identifying (dependent on delineation) at least 20 internationally shorebird sites, and suggesting that probably 20 species of shorebird were supported in internationally important concentrations in South Korea (based on waterbird population estimates found in Rose and Scott [1997], and unpublished estimates by Watkins [1999]). The main survey was conducted in (more or less) one-day per site circuits along the whole length of the south and west coasts, followed by repeat surveying in other months. During spring (13 April-27 May), a largely similar period to that covered by Long *et al.* (1988) a decade before, three circuits were made, finding a minimum total of 225,847 shorebirds (based on a simple totalling of maximum counts for each of the species during the spring period). Much of the increase in total numbers counted, when compared to the survey a decade before, can be considered likely due to improved site access and improved coverage of sites away from the north-west. This assumption is based largely on the similarity of total counts made at the same four main north-western sites (Ganghwa, Yeongjong South, Namyang and Asan Bays), with a minimum of 111,316 shorebirds there in 1988 (Long *et al.* 1988) and a minimum at the same sites of 108,044 in 1998 (Moores 1998a). Most numerous species over the three spring circuits along the entire west and south coastline in 1998 included Great Knot (80,404 between 29 April and 11 May), Dunlin (73,659 between 13 April and 25 April), Black-tailed Godwit (24,715 between 29 April and 11 May) and Bar-tailed Godwit (17,138 between 13 April and 25 April). While the counts by Moores (1999a, 1999b) included the Geum Estuary and Saemangeum, coverage was very restricted in time and scope, with only 3 full days at Saemangeum during northward migration, and no coverage of Yubu Island in the Geum Estuary. Subsequent counting at Saemangeum and the Geum Estuary by the same surveyor, that year and later, indicate that all counts during northward and southward migration in 1998 were likely to have been significant underestimates (Moores 1999b).

While the data in Moores (1999a, 1999b) should be considered as only partial counts for many of the larger sites, they identified an increased number of sites as internationally important for shorebirds, and helped confirm the importance of several of these sites on southward migration too. They also provide a limited opportunity to compare abundance in shorebird numbers at a few specific sites. A preliminary analysis of peak waterbird counts, comparing published shorebird numbers at the Nakdong Estuary pre-barrage closure, and again during counts on six dates in 1998, suggested declines in at least 13 shorebird species, little change in two species, and an increase in two species (Whimbrel and Grey-tailed Tattler). Species suggesting the most significant declines at the Nakdong included Red-necked Stint (10,900 to 1,425), Far Eastern Curlew (635 to 40), Spotted Redshank (150 to 1) and Ruddy Turnstone (637 to 13) (Moores 1999b); subsequent survey work (pers. obs.) further confirmed the trend. In addition, the surveys in 1998 at the Nakdong Estuary failed to find any Spoon-billed Sandpiper, a species previously present there "in the hundreds" (Gore & Won 1971), and found only in very small numbers in recent years (Zöckler *et al.* in prep. [2006]). At a larger scale, significantly lower nationwide counts in 1998 than in 1988 of Nordmann's Greenshank (9) and Red-necked Stint (3,797 compared to between 5, 225 and 5,578 recorded by Long *et al.* 1988, at far fewer sites), and lower counts of Dunlin at specific sites suggested that those species were less numerous in spring 1998 than in 1988, while one species, Terek Sandpiper, "appeared to be genuinely more numerous" (Moores 1999b).

The 1998–1999 survey (Moores 1999a) coincided with government-led shorebird surveying that continues, more or less, to the present. These counts, for a period supported by banding and flagging (mostly at one major shorebird roost in the Mangyeung Estuary), have been conducted largely by the National Institute for Environmental Research (the NIER, formerly known as the Forestry Research Institute, and now under the auspices of the Ministry of Environment). The NIER is responsible for official shorebird estimates and counts (e.g. Ministry of Environment [MoE] 1998; and unpublished data used by Barter 2002), and forms the focal point for a very broad range of national and international shorebird (and other species) conservation initiatives, including coordinating flag-sightings data, identifying sites for inclusion in Site Networks, and bilateral bird conservation agreements. Regrettably, rather few NIER shorebird data appear to have been formally published or made widely available in more recent years. However, once-a-month shorebird counts have also been conducted in the Saemangeum area by a research unit (KARICO) of the Ministry of Agriculture and Forestry, with this data published in annual environmental assessment reports. The MoE and KARICO (2003, 2004, 2005) surveys improved greatly upon the counts within the Saemangeum area especially, finding between 180 and 280 Spoon-billed Sandpiper there in 1999 (Barter 2002), and a peak of 123,000 Great Knot on southward migration in 2004 (KARICO 2004). The combination of NIER data provided by Yi & Kim (in prep.) and Moores (1999) led Barter (2002) to identify 16 South Korean sites as internationally important for shorebirds (Barter 2002), with the two sites of the Mangyeung and Dongjin Estuaries combined (as Saemangeum) considered the most important known shorebird in the Yellow Sea at that time.

More recently, Lee (2004) provided useful data from Yubu Island in the Geum Estuary (especially on Eastern Oystercatcher), while Moores *et al.* (2006) and Rogers *et al.* (2006), provided the most recent assessment of shorebird numbers within the massively important Saemangeum estuarine system, which supported a minimum 192,872 shorebirds on northward migration in 2006, with 15 species in internationally important concentrations, and the adjacent Geum Estuary, 80,000 shorebirds with 13 species in internationally important concentrations. These counts, conducted as part of the Birds Korea-Australasian Wader Studies Group Saemangeum Shorebird Monitoring Program, were made by a large team of experienced counters over two months, during which time the 33 km Saemangeum seawall was completed, and the tidal regime there significantly altered. While the spring survey reinforced the findings of previous (1998–2005) surveys, basic counting and habitat assessment within the Saemangeum area in September and October 2006 suggested that numbers of shorebirds there were much reduced when compared to previous autumns, with Great Knot almost entirely absent (pers. obs.).

Contemporary Perspective

Following several decades of massive degradation and loss of shorebird habitats, improving coverage of coastal habitats has gradually increased understanding of the extreme importance of South Korea for migratory shorebirds, with the nation's wetlands now recognised as supporting both high shorebird diversity and internationally important concentrations of a number of species, including some of the highest counts known anywhere of both the Endangered Nordmann's Greenshank and the Endangered Spoon-billed Sandpiper. The NIER concluded that eight major staging sites supported 84% of shorebirds on northward migration, and 87% on southward migration nationwide, with South Korean tidal flats holding 12.7% and 8.7% respectively of the East Asian–Australasian Flyway's migratory shorebirds. They recognized 11 sites as holding more than 10,000 shorebirds in a season, and 19 sites holding internationally important concentrations (Yi 2004).

The checklist of the conservation organization Birds Korea, as of November 2006, listed 59 species of shorebird as documented with photographs or specimens in South Korea, with a further four species considered inadequately documented. A further two species, Wandering Tattler *Tringa incanus* and Western Sandpiper *Calidris maura* are listed for North Korea by Tomek (1999) on the basis of specimens. Of the total, only eight species have been proven to breed in South Korea: Common Sandpiper, Greater Painted Snipe, Pheasant-tailed Jacana (first in 2006: documented with photographs on the internet), Eastern Oystercatcher, Black-winged Stilt (first in 1998: Park, 2002), Long-billed Plover, Little Ringed Plover, and Kentish Plover. In addition, the Oriental Pratincole is strongly suspected of having bred once, in 2004 (Moores & Moores 2004).

At least 28 species of shorebird have also been reliably recorded in the northern mid-winter period in Korea (mid-December to mid-February), with 13 or 14 species over-wintering regularly (see below), and the remainder doing so only rarely or irregularly. Claims of over-wintering flocks of Far Eastern Curlew, Little Ringed Plover and Red-necked Stint, for example, which have on occasion been reported in national winter waterbird surveys (e.g. Ministry of Environment 2004), usually by inexperienced observers, are best considered to be in error, unless full supporting details can be provided.

SHOREBIRD HABITATS IN SOUTH KOREA AND THREATS TO THEM

Moores *et al.* (2006) concluded that out of the 56 or so species of shorebirds now recorded more or less annually in South Korea, 35 of these are dependent on tidal flats (23 of these being found in internationally important concentrations), with the majority of the remainder occupying a narrow range of freshwater habitats, most especially rice fields and small rivers. While tidal flats are used by the majority of shorebirds (individuals and species) during migration, they also support the largest number between October and March. Over 31,000 shorebirds were counted along the west and south coasts in January and February 1999, with Dunlin (20,442), Grey Plover (4,493), Eurasian Curlew (2,671), Eastern Oystercatcher (2,987) and Kentish Plover (458) the most numerous species (Moores 1999a).

Two regular wintering tidal flat species, the Eastern Oystercatcher and the Kentish Plover, also breed in Korea, with the former typically egg-laying in rock crevices on small rocky islets, and the latter preferring sandy islands and spits, often nesting in loose colonies. Some species such as Northern Lapwing, a winter visitor to Korea, are found equally in rice fields and on tidal flats, with a further dozen species very largely dependent on freshwater habitats (including three species of snipe and Long-toed Stint) during migration, and in a few cases during the breeding season too. Both Greater Painted Snipe and Black-winged Stilt, for example, have been found breeding very locally in wet rice fields, while the much more widespread Little Ringed Plover nests on drier ground next to rice fields, and also in river beds, in many areas sharing shingle-bed habitat with breeding Long-billed Plover. One other species, the Solitary Snipe, a very uncommon and localized winter visitor, is also almost entirely confined to small rivers. Other habitats used by shorebirds in Korea include woodland (Eurasian Woodcock) and open sea areas (Red-necked Phalarope and Grey Phalarope *Phalaropus fulicarius*). None of the shorebird species dependent on freshwater habitat in South Korea are considered to be either globally threatened or found in internationally important concentrations, although Black-tailed Godwit uses both estuaries and rice fields in internationally significant numbers during migration. The Red-necked Phalarope likely occurs in internationally important concentrations on occasion in sea areas, although it is perhaps less numerous now than in the recent past. There is convincing anecdotal evidence of very significant decline in recent decades in the region (Rubega *et al.* 2000).

Tidal flats: Reclamation, Over-exploitation and Degradation

Estuaries and tidal flats are the most important shorebird habitats in South Korea. Due to rapid changes in wetland type and land use (primarily due to reclamation, urbanization, and changes in agricultural practice), in combination with the complex and different methods used by different ministries and administrative authorities to calculate such changes, there are perhaps no fully reliable figures either for area of tidal flat (lost or remaining) or for remaining areas of other significant shorebird habitat at the national level. There is also very limited information available on changes in the quality of feeding and roosting at those sites that do remain. The most urgent conservation concern, however, is undoubtedly loss of habitat due to coastal reclamation, though a range of other threats exist for all wetlands and for most species of waterbirds, not only shorebirds (e.g. Moores 2002).

The Yellow Sea is one of the most extensive tidal flat and shallow sea areas in the world (e.g. Hong and Miller in prep.), with the tidal range reaching 9.3 m in Gyeongii Bay (north-western South Korea), a major landform containing the internationally important shorebird sites of Ganghwa Island, Yeongjong Island, Song Do (and Sorae) tidal flats, Namyang Bay and Asan Bay. Tidal-range is progressively less extreme southward along the west and south coasts, falling to 7 m at the Geum Estuary, 5 m in the south-west of the peninsula, and only 2.4 m at maximum at the Nakdong Estuary in the far south-east (Koh 1999).

Based on the present area remaining and the area of tidal flat believed reclaimed, it can be assumed that South Korea had at least 460,000 ha of tidal flat historically. Recognising that tidal flat reclamation "has a long history" in Korea, Long *et al.* (1988) stated that the first reclamation projects dated from the thirteenth century and that about 41,000 ha had been reclaimed in total by 1941. The pace of reclamation remained comparatively slow until the 1960s when, according to the Ministry of Agriculture and Forestry (1996) in Moores *et al.* (2001), 17,215 ha were reclaimed; increasing to 18,072 ha reclaimed in the 1970s; and a further 34,000 ha reclaimed between 1980 and the mid-1990s. These figures vary somewhat from the 97,000 ha reclaimed in total by 1983 suggested by Long *et al.* (1988), presumably based on different data from the Ministry of Construction and Transport provided to NEDECO (1985).

According to Koh (1999) there were an estimated 390,500 ha of tidal flats in South Korea in 1964, which had been reduced to an estimated 285,000 ha by the beginning of the 1990s (a loss averaging 1% per annum over the same period), with 83% of remaining tidal flats along the west coast and 17% along the south coast. By 1998, the year after South Korea acceded to the Ramsar Convention and the year before the passing of the national Wetlands Conservation Act (1999) which divided responsibility for wetland and wetland species conservation between the MoE and Ministry of Maritime Affairs and Fisheries (MOMAF), significant efforts were made to calculate the remaining area of tidal flat, and consequently area of authority for each ministry. Koh (1999) stated that 62,000 ha had already been dyked between 1985 and 1994, with a further 76,000 ha undergoing reclamation, including the 40,100 ha Saemangeum reclamation project. This might well be an underestimate, however, as it likely excludes from the total those tidal areas lost in rivers due to dams and barrages (with tidal influence formerly extending 70 km up the Geum River, and 42.4 km up the Nakdong: Moores *et al.* 2001); tidal-areas illegally reclaimed by private users (for salt pans, fish farms or other uses); and areas of lower tidal flat lost due to changes in tidal-regimes (including local sea-level rise due to embankments). In some areas by contrast, new tidal flats will likely have formed, and existing tidal flats changed in type and quality, due to barrage or dyke construction (e.g. Kim *et al.* 2006).

A very recent study by MOMAF, reported in the national Hankyoreh Newspaper (6 November, 2006), confirmed that tidal flat area had declined almost 20% in the past 20 years, to only 225,000 ha. In addition, with 267 reclamation projects now ongoing, and with ongoing and future plans targeting a further 113,600 ha, the Ministry anticipated a further loss of 44.5% of remaining tidal flat within the next 5 years: i.e. leading to an approximate 75% decline in tidal flat area from a historic total of *c.* 460,000 ha to less than 112,000 ha, with most of this loss occurring in only 50 years.

Due to this massive reclamation, in combination with pollution of inshore waters and over-fishing, South Korea's fishing industry has had to increase fishing effort enormously in recent decades to maintain catches in national waters, inevitably leading to increased pressure on remaining shallow sea and tidal flat natural resources. Many extant tidal flat areas are also very heavily exploited by people, with bird scarers employed on the tidal flats in some areas (e.g. at the Suncheon Bay Ramsar site) to reduce competition between people and foraging shorebirds, and many tidal flats are lined with crab traps and fish nets. Almost all are significantly disturbed.

In addition, following the construction of the Geum, Yeongsan and Nakdong Estuary barrages, and the loss of the Saemangeum system, there are now only two major estuaries that are open to the sea: the Han-Imjin complex in the north-west, and the Seomjin River on the south coast. The former maintains very large shorebird populations, while the latter flows into Gwangyang Bay, now very extensively developed for heavy industry, with almost all tidal flat areas already reclaimed or targeted for reclamation. The loss of this brackish zone throughout much of coastal South Korea seems likely to have impacted fish populations, benthic communities and shorebird populations – and might be partly responsible for the massive decline at the Nakdong Estuary of some species following barrage closure.

While feeding areas for many shorebirds have been degraded by pollution or lost through reclamation and barrages, roost opportunities in many areas have also been reduced. The majority of salt-marsh and upper tidal flat areas (used for roosting by a broad range of species) have been lost to reclamation, while alternative artificial roost sites such as salt-pans have also become increasingly lost to recent changes in land use, with the pans either becoming overgrown or converted to other uses. Much of the hinterland of tidal flat areas (largely composed of agricultural land) has also become increasingly intensively developed following road construction programs initiated at the end of the 1990s, with a now well developed infrastructure along most of the coastline including higher dikes, roads, bridges, electric wires and in many areas restaurants or motels – elements potentially reducing attractiveness of such areas to roosting tidal flat shorebirds or even feeding freshwater dependent shorebirds. Changes over recent decades in agricultural practice also mean that most rice fields are either dry in April or May (during northward migration) or densely vegetated with rice crop from July until harvesting in October (the period of southward migration).

Housing, industrial estates, commercial properties, and especially rice fields (a suboptimal wetland type for a broad range of floodplain-associated species) now occupy almost all the remaining floodplain area, as well as reclaimed coastal flat-lands, with rice covering almost 1,000,000 ha nationwide in 1998. Despite the legal conditions of the Public Water Reclamation Act (requiring agriculture to be the primary purpose of any reclamation of public waters), the area of rice field is decreasing annually due to urban sprawl and other changes in land use, related largely to the growth in the national economy. Although there has been no national survey of shorebirds in rice fields, this habitat appears to be used by a rather small number of birds (both species and individuals), probably due to a combination of crop cycle outlined above, intensive use, well-developed infrastructure, disturbance, very high levels of pesticide and fertiliser use, and low levels of winter precipitation, when most fields often appear barren and frozen. As a result, perhaps only the Black-tailed Godwit is found in internationally important concentrations regularly in rice fields (as well as in adjacent coastal areas) with several thousand staging at Seosan and near Namyang Bay on northward migration. In addition, probably only *c.* 100 Northern Lapwing winter nationwide in rice fields. Grey-headed Lapwing, a fairly representative bird of rice fields in parts of central Japan, occurs only as a rare migrant. Breeding shorebirds like Black-winged Stilt has been found nesting in only two small discrete areas of rice field nationwide (both in very extensive areas reclaimed in the 1980s and 1990s, still lacking a well-developed infrastructure). The Greater Painted Snipe also seems to be of very local occurrence, breeding in rice fields interlaced with fallow fields or near-permanent shallow wetland.

There are even fewer data on area, length and quality of river used regularly by shorebirds. The Solitary Snipe is known regularly from only one stretch of river nationwide (less than 1 km in length) with records from probably the same area dating back over almost a century (e.g. Austin 1948, Fennell & King 1964, Moores & Moores 2004); yet this area is unprotected and suffering from increasing alteration of the river bank and catchment. The Long-billed Plover, a largely resident river-specialist, appears to be a reasonably widespread breeding species, tolerant to some degree, but apparently unable to use areas that suffer repeated dike-building and dredging.

Research priorities

While most coastal areas have now been surveyed, the following areas need attention.

- Gathering and analysing existing data on shorebirds, to detect statistically significant changes in species' number and abundance.
- In addition to counts conducted as part of the Saemangeum Shorebird Monitoring Program, regular counts are needed at other control sites, especially those not experiencing significant development pressures (if any exist), to help better understand the dynamics of shorebird migration in Korea, and the ecological requirements of staging shorebirds in the Yellow Sea.
- Coordination of counts targeting species of highest conservation value, such as Nordmann's Greenshank and Spoon-billed Sandpiper, is needed to establish an accurate national estimate and to identify more clearly these species' ecological needs.
- Shorebird research needs to be conducted in rice field areas to determine abundance, trends, and limiting factors for shorebirds. Ideally, such research should extend to investigate ways to modify farming practice, to enhance such areas for shorebirds.
- Counts need to be coordinated within river systems, to develop a more reasonable estimate of the numbers of shorebirds using such areas, especially for breeding. As with rice field research, this should extend to investigate ways to modify river-management methods, to maintain populations, or enable them to increase

INTERNATIONALLY IMPORTANT SHOREBIRD SITES

Based on the research described above and on other information received or reviewed, and dependent upon delineation, probably 17 discrete intertidal areas in South Korea used to support or still do support internationally important concentrations of shorebirds, though none are comprehensively protected or managed (Table 1). It is worth noting that while there is much overlap, these sites do not correspond exactly with those identified by Moores (1999a), Barter (2002), or Yi (2004) due to changes in shorebird population estimates, different datasets, and different delineation (the NIER for example, followed by Barter (2002), recognised the Mangyeung and Dongjin Estuaries as separate sites, despite shorebirds moving between both estuaries during tide-cycles, as well as listing Yubu Island as separate from the Geum Estuary [Yi 2004]). Several potentially internationally important sites have probably already been lost (e.g. Gwangyang Bay), while several others so-identified have been significantly degraded, even since 2000; eleven have been partially reclaimed; and three

Table 1. Internationally important wetlands for shorebirds in South Korea. In Threat column: 1 = Urbanization; 2 = Degradation; 3 = Over-exploitation/disturbance; 4 = Part-reclamation; 5 = Major Reclamation or development ongoing; 6 = Complete Reclamation ongoing; 7 = Threatened with further major reclamation. Table based on Moores *et al.* (2006).

Name	Coordinates	Threats
Han-Imjin Estuary	37º 45'N, 126º 48'E	1
Ganghwa Island	37º 35'N, 126º 27'E	1,2,3,4
Yeongjong Island (south)	37º 35'N, 126º 32'E	1,2,3,5
Song Do	37º 25'N, 126º 39'E	1,3,6
Daebu Island	37º 20'N, 126º 35'E	2,3,4
Namyang Bay	37º 10'N, 126º 44'E	5/6
Asan Bay	36º 55'N, 126º 53'E	1,2,4,7
Cheonsu Bay	36º 37'N, 126º 25'E	2
Geum Estuary	36º 01'N, 126º 35'E	1, 2, 3, 4, 7
Saemangeum Area	35º 50'N, 126º 45'E	6
Paeksu Tidal flat	35º 20'N, 126º 21'E	3,4
Hampyeong Bay	35º 07'N, 126º 25'E	2,4
Muan-Gun tidal flats	35º 04'N, 126º 16'E	2,4
Aphae Island	34º 50'N, 126º 20'E	2,4,5
Haenam Tidal flats	34º 25'N, 126º 30'E	2, 4
Suncheon Bay	34º 50'N, 127º 30'E	1,2,3,4
Nakdong Estuary	35º 05'N, 128º 50'E	1,2,3,4,5

or four have been or are being completely reclaimed. These include Saemangeum.

ESTIMATES OF CONTEMPORARY SHOREBIRD POPULATIONS IN SOUTH KOREA

The combination of the relative paucity of historical (and even contemporary) data on shorebird numbers outlined above, the very extensive and rapid degradation and loss of shorebird habitats, the anticipated annual fluctuations in population, and the lack of research on measuring or estimating population turnover rates within the region require that any national estimate of contemporary shorebird numbers in South Korea cannot be exact and needs to have a very significant margin of error built in. This is expressed in Table 2 through inclusion of a coarse measurement of level of confidence in the estimate, with greatest confidence (1) in estimates based on shorebirds that occur at only a few well known intertidal sites, and lowest confidence (3) for estimates of species usually found in very poorly researched habitats.

Table 2 is based on the following major sources of information:

- shorebird data gathered through nationwide survey effort, especially in 1998–1999 (Moores 1999a, 1999b) but also in subsequent years (pers. obs.);
- unpublished NIER data given in presentation (Yi in litt. 2003) and also national estimates provided for key sites (Yi 2004);
- Saemangeum and Geum Estuary data published in a number of sources, including that presented in Moores *et al.* (2006);
- Published and unpublished information, most especially in Gore and Won (1971), Long *et al.* (1988), Park (2002), and Barter (2002);
- Records in the Birds Korea archives, either submitted or gathered through internet and other searches.

While the estimates in Table 2 are similar in many cases to those presented by Yi (in litt. 2003), for others, e.g. Great Knot, they are very significantly lower (150,000 compared to 250,000 on northward migration), helping in turn to produce a rather more modest estimate of total numbers of shorebird present during migration (*c.* 470,000 of all species at all sites during northward migration, compared to 535,000 of a more limited range of species at the 8 major sites alone [Yi 2004]). These differences probably derive largely from the different method of calculation. The present estimates aim to be contemporary and aim to allow for the apparent decline of some species in recent years (e.g. Dunlin). More significantly, the NIER data is apparently based on adding maximum counts of a given species made over a period of years at different sites (with for example the Mangyeung and Dongjin, Geum Estuary and Yubu Island described as four sites), perhaps inadvertently increasing the possibility of double-counting. For Great Knot, although data remain insufficient to confirm the hypothesis, this paper instead recognizes two different main areas used in South Korea on northward migration especially – one centred on Saemangeum and the Geum (central west coast) and the other centred on Gyeonggi Bay (north-west coast), with Great Knot assumed to move frequently between contiguous key sites within these two discrete areas. Long *et al.* (1988) for example noted some movement of Great Knot between Namyang Bay and neighbouring Asan Bay, while survey effort in 1998 also recorded flocks of birds moving overland between the two sites. A count of 34,000 Great Knot at Asan Bay on 23 and 24 April 1998, with only 1,033 counted at

Table 2. National population estimates for the fifty-three most numerous shorebird species in South Korea. In all columns: r = recorded; CL = Confidence level (1: +/- 30%; 2: +/- 50% 3: +/- 75% or more); NM = Northward Migration (late March-late May); SM = Southward Migration (late July-late October); Br = Breeding species, with estimate expressed in pairs (late March-June); Non-Br = Non-breeding species, present in the northern mid-winter period (mid-December to mid-February); Trend: Inc. = Increasing; Dec. = Declining.

Species	CL	NM	SM	Br Prs	Non-Br	Trend
Eastern Oystercatcher *Haematopus (ostralegus) osculans*	1	r	r	300	5,000	
Black-winged Stilt *Himantopus himantopus*	2	100	<100	5-10	r	Inc.
Pied Avocet *Recurvirostra avosetta*	1	<5	<10	-	<5	-
Northern Lapwing *Vanellus vanellus*	2	r	r	-	250	-
Grey-headed Lapwing *Vanellus cinereus*	1	<10	<10	-	-	-
Pacific Golden Plover *Pluvialis fulva*	2	300	300	-	-	-
Grey Plover *Pluvialis squatarola*	1	15,000	20,000	-	6,000	-
Long-billed Plover *Charadrius placidus*	3	r	r	300	<1,000	-
Little Ringed Plover *Charadrius dubius*	3	2,000	3,000	500	-	-
Kentish Plover *Charadrius alexandrinus*	2	3,000	30,000	300	<1,000	-
Lesser Sand Plover *Charadrius mongolus*	2	12,000	10,000	-	<10	-
Greater Sand Plover *Charadrius leschenaultii*	2	<10	50	-	-	-
Greater Painted Snipe *Rostratula benghalensis*	3	r	r	10	<20	-
Pheasant-tailed Jacana *Hydrophasanius chirurgus*	1	<10	<5	(1)	-	Inc.
Eurasian Woodcock *Scolopax rusticola*	3	1,000?	1,000?	-	?	-
Solitary Snipe *Gallinago solitaria*	3		<20	-	10	-
Latham's Snipe *Gallinago hardwickii*	3	100	100	-	-	-
Pintail Snipe *Gallinago stenura*	3	100	500	-	r	-
Swinhoe's Snipe *Gallinago megala*	3	<100	<100	-	-	-
Common Snipe *Gallinago gallinago*	3	1,000?	10,000	-	<500	-
Long-billed Dowitcher *Limnodromus scolopaceus*	2	<10	<10	-	r	-
Asian Dowitcher *Limnodromus semipalmatus*	2	<5	5-10	-	-	-
Black-tailed Godwit *Limosa (limosa) melanuroides*	2	30,000	15,000	-	r	-
Bar-tailed Godwit *Limosa lapponica*	2	35,000	10,000	-	r	-
Little Curlew *Numenius minutus*	2	<50	r	-	-	-
Whimbrel *Numenius phaeopus*	2	6,000	3,000	-	r	-
Eurasian Curlew *Numenius arquata*	2	3,000	10,000	-	3,000	-
Far Eastern Curlew *Numenius madagascariensis*	2	10,000	7,500	-	r	-
Spotted Redshank *Tringa erythropus*	2	1,000?	200	-	<100	Dec.
Common Redshank *Tringa totanus*	2	100	250	-	10	-
Marsh Sandpiper *Tringa stagnatilis*	2	300	750	-	-	Inc.
Common Greenshank *Tringa nebularia*	2	4,000	10,000	-	25	-
Nordmann's Greenshank *Tringa guttifer*	2	100	150	-	-	-
Grey-tailed Tattler *Tringa brevipes*	2	8,000	2,000	-	-	-
Green Sandpiper *Tringa ochropus*	2	500	1,000	-	>250	-
Wood Sandpiper *Tringa glareola*	3	5,000	5,000	-	-	-
Terek Sandpiper *Xenus cinereus*	2	10,000	15,000	-	-	Inc.
Common Sandpiper *Actitis hypoleucos*	3	1,000	2,000	50	100	-
Ruddy Turnstone *Arenaria interpres*	2	1,200	2,000	-	r	Dec.
Great Knot *Calidris tenuirostris*	2	150,000	160,000	-	-	-
Red Knot *Calidris canutus*	3	5,000	1,000	-	-	-
Sanderling *Calidris alba*	2	500	1,000	-	300	-
Red-necked Stint *Calidris ruficollis*	2	10,000	7,500	-	<5	Dec.
Temminck's Stint *Calidris temminckii*	2	100	50	-	-	-
Long-toed Stint *Calidris subminuta*	3	500	500	-	-	-
Sharp-tailed Sandpiper *Calidris acuminata*	2	3,000	250	-	-	-
Curlew Sandpiper *Calidris ferruginea*	2	<100	<50	-	-	-
Dunlin *Calidris alpina*	2	150,000	70,000	-	30,000	Dec.
Spoon-billed Sandpiper *Eurynorhynchus pygmeus*	2	<50	<250	-	-	Dec.
Broad-billed Sandpiper *Limicola falcinellus*	2	<1,000	1,000	-	-	Dec.
Ruff *Philomachus pugnax*	2	<25	<25	-	-	
Red-necked Phalarope *Phalaropus lobatus*	3	1,000-10,000	1,000-10,000	-	-	Dec?
Oriental Pratincole *Glareola maldivarum*	1	<50	<25	(1)	-	Inc.

Namyang Bay over the same two days, was followed two weeks later by a count of 18,000 at Asan and 12,500 at Namyang Bay on 8 and 9 May 1998 (Moores 1999a), also strongly suggesting birds were moving between the two sites. In addition, within the Saemangeum area, Great Knot and other shorebirds (including Spoon-billed Sandpiper) have been observed regularly moving from the Dongjin Estuary to the Mangyeung, especially on incoming spring tides, with movement between the contiguous sites inevitable even at low tide, as many birds used the tidal flat lying between the two main river channels for feeding. In 1998 at least, large numbers of Great Knot were also watched moving between the northern part of Saemangeum (an area identified as part of the Geum estuary by Long *et al.* [1988], before reclamation of part of the site) and the Geum Estuary proper, while in 2006, some shorebirds feeding on the outer tidal flats of the Geum Estuary were also watched moving towards the Saemangeum reclamation area during the highest tides, returning soon on falling tides (pers. obs.). Apparently no simultaneous counts have recorded 150,000 Great Knot in Korea, and there was no obvious evidence of a high turnover of Great Knot through Saemangeum, the most important site for the species in Korea, at least in 2006. Instead, numbers built gradually through April and May, until most individuals departed towards the end of the month (with nearly all shorebirds gone by 20 May). Based on repeat counts and on the pattern of flag-sightings, it was deduced that Great Knot from eastern Australia arrived at Saemangeum in early April, and remained there for a long period, with their numbers augmented by birds, presumably from north-western Australia, which had first staged in eastern China (Moores *et al.* 2006). Moreover, counts of Great Knot on southward migration at Saemangeum showed extreme variation in the years 2003–2005, with maximum counts of 26,680, 123,745 and 66,380 respectively (KARICO 2003, 2004, 2005). As no mass mortality has been suggested by counts on northward migration during the same period, and unless there was double-counting at that time, it can be assumed that some of these birds were simply staging in different sites in different years, with almost all Great Knot in Korea staging at Saemangeum in 2004. In conclusion, it is considered that totalling maxima from adjacent sites greatly increases the potential for exaggerating the numbers at the national level of the species concerned.

BACKGROUND TO SHOREBIRD CONSERVATION

"Shorebird conservation status is best measured by the actual extent to which shorebirds and their habitats are being effectively protected by legislation, policies and plans, and the Protected Area system" (Barter 2002).

Fortunately, there is very little, if any, impact on shorebirds by hunting in South Korea, with the major threat to populations being the degradation and loss of habitat. This has been widely recognised. For example:

- there have been repeated calls for the conservation of key intertidal areas since at least 1988 (Long *et al.* 1988);
- South Korea has acceded to the Convention on Biodiversity Conservation and the Ramsar Convention, and intends to host the 10th Convention of the Parties in 2008;
- South Korea has enacted eight laws that charge four ministries with making policies for coastal and marine protected areas, designating 422 different Marine Protected Areas, including five Ecosystem Conservation Areas, 7 Wetlands Conservation Areas, 86 Wild Birds and Mammals Protected Areas, four Environmental Conservation Areas and 153 National Natural Monuments (Hong and Miller in prep.);
- it has also established a bilateral agreement with Russia for the protection of migratory birds, and has recently finalised a similar agreement with Australia;
- South Korea has also initiated a UNDP-GEF Wetlands Biodiversity project and a Yellow Sea project with China.

Despite these initiatives, there is still not a single comprehensively protected area of tidal flat in South Korea, and still almost 50% of remaining tidal flats are threatened by reclamation (Hangyoreh Newspaper, 6 November 2006). The Nakdong Estuary, on paper, is probably the most protected level of wetland nationwide, but is presently being part-reclaimed, with, in addition, a major expressway also being constructed through a recently restored wetland area there; and, even the Dongjin Estuary, the only South Korean coastal Protected Area identified by Barter (2002), has, as of April 2006, already been reclaimed.

The present failure of wetland conservation in South Korea has many underlying causes. An analysis in 2004, undertaken under the auspices of the MoE as part of the UNDP-GEF Wetlands Biodiversity project, identified approximately 23 major root causes of wetland loss and degradation in South Korea, which were then grouped under the following 5 overlapping headings.

- Lack of economic incentives to conserve, and provision of perverse incentives by local and national governments, to reclaim and degrade wetlands.
- Administrative and structural weaknesses.
- Legal framework loopholes and legal complexity.
- Lack of adequate information (and accessible models).
- Lack of capacity and support, especially for local key players and stakeholders, to develop local community-based initiatives.

Plans for reclamation, damming and conversion of rivers suffer from a combination of these elements, themselves deriving largely from the socio-economic conditions created by several decades of extremely rapid economic and industrial growth. Although certain sections of government (e.g. MoE and MoMAF) are required under the provisions of the Wetland Conservation Act (1999) to oversee wetland conservation, they apparently lack adequate funding and capacity to do so. Between the ministries there are few effective mechanisms to allow for exchange of information and even some of the ministries with responsibility for wetland conservation lack detailed information on wetland conservation and how best to achieve it. The Wetland Conservation Act itself appears to be deeply flawed in structure, with the MoE now responsible for species, for freshwater and for international conventions (such as Ramsar), while MoMAF is responsible for intertidal areas. Estuaries and brackish waters therefore fall under either both or neither ministry's authority. At the same time, other sections of government (most especially the Ministry of Construction and Transport and the Ministry of Agriculture and Forestry) have created an extremely strong political and financial power base, appropriating massive national funds, many of which are then used in converting, degrading or even destroying wetlands. The problems of achieving wetland and shorebird conservation are further confounded by the near-absence of a specialist non-government organisation (NGO) community (and a largely uninterested urban population). The environmental NGO community originated only in the 1970s and 1980s in response to the policies of a military government; it has less than 1% popular membership at the national level and it largely lacks adequate capacity to cooperate fully with existing specialist international NGOs, like Birdlife International and Wetlands International, neither of which has established national offices or formal partnerships with organizations in Korea.

Beyond the need within South Korea to improve existing structures to enable more communication and coordination between ministries and to increase awareness of the need and benefits of good conservation practice, there is also an urgent need for established NGOs and specialist institutions outside of Korea to find ways to involve further in and support wetland conservation initiatives in Korea and the Yellow Sea as a whole. While South Korea is one of the most economically powerful nations in the world, it has one of the poorest conservation records and still very limited capacity (and time) to modify existing policies on intertidal areas. Ramsar Resolution 7: 21, endorsed in 1999, calls for Contracting Parties, "to review and modify existing policies that adversely affect intertidal wetlands, to seek to introduce measures for the long-term conservation of these areas, and to provide advice on the success, or otherwise, of these actions in their National Reports" and "to identify and designate as Wetlands of International Importance a greater number and area of intertidal wetlands, especially tidal flats, giving priority to those sites which are important to indigenous people and local communities, and those holding globally threatened wetland species" (http://www.ramsar.org /res/key_res_vii.21e.htm). With only one tidal flat area to date designated a Ramsar site, and with almost all remaining internationally important areas threatened, it now appears especially ironic that this key Resolution was first proposed to the Ramsar Convention conference by South Korea's own government delegation.

SUMMARY

While information and datasets are hard to compare, the following can be suggested:

- Before1970, there was very limited shorebird research in South Korea. Between 1970 and 1988, this research was more or less confined to the north-west sites of Ganghwa Island, Yeongjong Island, Namyang Bay, Asan Bay and the Nakdong Estuary in the south-east. Between 1993 and 1998, survey effort began to include other sites along the west and south coasts. Between 1998 and the present, the Saemangeum area became recognized as the most important site for shorebirds in South Korea and the Yellow Sea.
- Estuaries and tidal flats are the most important habitat for shorebirds in South Korea, supporting several hundred thousand shorebirds on both northward and southward migration.
- While South Korea historically had an estimated 460,000 ha of tidal flat, over 50% of this area has already been lost, and a recent estimate suggested that only 110,000 ha will remain within the coming decade. In addition, remaining areas are typically heavily exploited, and most rivers are now dammed at their estuary.
- In addition to the decline of fisheries, some shorebird species appear to have shown significant declines in recent decades; these include Spotted Redshank, Red-necked Stint, Dunlin, Spoon-billed Sandpiper and perhaps Broad-billed Sandpiper. Other species have at least shown declines at known sites, due to either local changes or also to a decline in population, notably Nordmann's Greenshank. Some species have appeared to increase, likely due almost entirely to improved observer coverage; these include Grey Plover, Black-tailed Godwit and Great Knot; others, such as Terek Sandpiper, have apparently become genuinely more numerous in recent decades.
- More research is required to fill remaining information gaps.
- Much greater national effort and international cooperation and support is required if the present period is to result in genuinely improved conservation possibilities for Korea's and the Flyway's shorebirds.

REFERENCES

Austin, O.L., Jr. 1948. The birds of Korea. Bulletin of the Museum of Comparative Zoology, Harvard University 101: 1–301.

Barter, M.A. 2002. Shorebirds of the Yellow Sea: Importance, threats and conservation status. Wetlands International Global Series 9, International Wader Studies 12, Canberra, Australia.

Fennell, C. & B. King. 1964. New Occurrences and Recent Distributional Records of Korean Birds. The Condor, Volume 66, May-June 1964, Number 3, pp.239–246.

Gore, M.E.J. & P-O Won. 1971. Birds of Korea. Seoul: Royal Asiatic Society Korea Branch in conjunction with Taewon Publishing company.

Hong, J-S & M. Miller. In prep. Toward an Integrated Environmental Philosophy: Practical Zoning and Participatory Ecology Strategies for tidal Flat Management in Korea. Submitted to Ecology and Society, March 2006.

KARICO. 2003. Habitats and Shelters for Migratory Birds. Rural Development Corporation Research Institute 383 pages (In Korean)

KARICO. 2004. Habitats and Shelters for Migratory Birds. Rural Development Corporation Research Institute. 112 pages (In Korean)

KARICO. 2005. Habitats and Shelters for Migratory Birds. Rural Development Corporation Research Institute. 152 pages (In Korean)

Kim, J-H, J-Y Park & J-Y Yi. 1997. Spring and autumn avifauna of western coastal mudflat in Korea. Journal of Korean biota 2: 183–205. (In Korean with English abstract)

Kim T-I, B-H Choi & S-W Lee. 2006. Hydronamics and sedimentation induced by large-scale coastal developments in the Keum River Estuary, Korea. Estuarine Coastal and Shelf Science 68 (2006): 515–528.

Lee, H-S. 2004. The Breeding and Wintering Population of Eurasian Oystercatcher *Haematopus ostralegus osculans* at Yubu Island. Pp. 153–159. The Proceedings of the 2004 International Symposium on Migratory Birds, Gunsan, Korea. Published by the Ornithological Society of Korea.

Long, A.J., C.M. Poole, M.I. Eldridge, P-O Won & K-S Lee. 1988. A Survey of Coastal wetlands and Shorebirds in South Korea, Spring 1988. Asian Wetland Bureau, Kuala Lumpur.

Ministry of Environment. 1998. Spring and Fall Counts of waterbirds migrating to the major wetlands on the west coast of Korea. Ministry of Environment, Seoul, Korea.

Ministry of Environment. 2004. '99-'04 Winter Bird Census Report. Ministry of Environment, National Institute of Environmental Research. Report Number 11-1480083-00248-14. (In Korean.)

Moores, N. 1999a. A survey of the distribution and abundance of shorebirds in South Korea during 1998–1999. Stilt 34: 18–29.

Moores, N. 1999b. Korean Wetlands Alliance National NGO Wetlands Report: Ramsar 1999. 142 pages. Published by Yullinmaul, Seoul.

Moores, N. 2002. Wetlands: Korea's most-threatened habitat. OBC Bull. Number 36: 55–60.

Moores, N., P. Battley, D. Rogers, M-N Park, H-C Sung, J. van de Kam & K. Gosbell. 2006. Birds Korea-AWSG Saemangeum Shorebird Monitoring Program Report, 2006. Birds Korea publication, Busan.

Moores, N., S-K Kim, S-B Park & T. Sadayoshi (eds). 2001. Yellow Sea Ecoregion: Reconnaissance Report on Identification of Important Wetland and Marine Areas for Biodiversity. Volume 2: South Korea. Published by WBK and WWF-Japan, Busan. 142 pages (published in Korean and English-language versions).

Moores, N. & C. Moores. 2004. The Birds Korea review of 2004. Published on internet at: http://www.birdskorea.org/birdskorea_review2004.asp

Park J-Y. 2002. Current status and distribution of birds in Korea. Department of Biology, Kyung Hee University, Seoul (unpublished thesis). (In Korean.)

Rogers, D.I., N. Moores & P.F. Battley. 2006. Northwards migration of shorebirds through Saemangeum, the Geum Estuary and Gomso Bay, South Korea in 2006. Stilt 50: 73–89.

Rubega, M., D. Schamel & D. Tracy. 2000. Red-necked Phalarope in The Birds of North America, Eds A. Poole and F. Gill. No. 538, 2000. pp 1–27

Syroechkovski, E. 2005 The Spoon-billed Sandpiper on The Edge. A Review of Breeding Distribution, Population Estimates and Plans for Future Research in Russia. Pages.169–174 in P. Straw, editor. Status and Conservation of Shorebirds in the East Asian–Australasian Flyway; Proceedings of the Australasian Shorebirds Conference 13–15 December 2003, Canberra, Australia. Wetlands International Global Series 18, International Wader Studies 17, Sydney, Australia

Taczanowski, L. 1888 Liste supplémentaire des oiseaux recueillis en Corée par M. Jean Kalinowski. Proceedings of the Zoological Society of London 1888: 450–468.

Tomek, T. 1999. The birds of North Korea. Non-Passeriformes. Acta Zoologica Cracoviensia 42: 1–217.

Yi J-D. 2004. Status and Habitat Characteristics of Migratory Shorebirds in Korea. pp. 87–103. The Proceedings of the 2004 International Symposium on Migratory Birds, Gunsan, Korea. Published by the Ornithological Society of Korea.

Zöckler, C. C., E.E. Syroechkovski Jr. & G. Bunting. In prep. International Single species Action Plan for the Conservation of the Spoon-billed Sandpiper Eurhynorhynchus pygmeus on behalf of BirdLife International and the CMS.