

# REPUBLIC OF KOREA

## INTRODUCTION

Based on information provided by Prof. Won Pyong-Oh

**Area:** 99,143 sq.km.

**Population:** 41,600,000 (1986).

The Republic of Korea comprises the southern half of the Korean Peninsula and its numerous offshore islands. About two-thirds of the country are hilly or mountainous, and 81% of the land is over 100m above sea level. In general, the western and southern slopes of the peninsula are gentle, with well developed river basins, relatively broad coastal plains, extensive estuarine systems, and many offshore islands, while the eastern slope is very steep, with no significant river basins or coastal plains and no islands. Low-lying areas ideally suited to human habitation and cultivation constitute only 3,801 sq.km (3.8%) of the national territory.

The Korean Peninsula has a humid, East Asian monsoonal climate. The winters are generally cold and dry, with northwesterly winds bringing cold, dry air from eastern Siberia. Mean January temperatures in most of the country are just below freezing. Summers are warm and wet, with mean temperatures exceeding 20°C. The summer monsoon brings abundant moisture from the ocean and produces heavy rainfall. Most parts of the country receive between 1,000 and 1,500 mm of rain per year, about 70% falling in the period June to September. Typhoons are frequent along the south coast in summer and early autumn, and often bring heavy floods.

The predominant natural vegetation over most of the country is temperate, broad-leaved deciduous forest and mixed forest, but large areas have been cleared for agriculture and urban development. On the south coast and offshore islands of Cheju and Ullung, the warm, wet climate supports a warm-temperate, broad-leaved evergreen forest, while on the higher mountains in the central and eastern parts of the country, there are coniferous and mixed forests typical of a cold-temperate climate.

With a population density of 419.3 persons per sq.km, the Republic of Korea has one of the highest population densities in the world. The population continues to grow rapidly, although the annual rate of increase has fallen from 2.7% during the early 1960s to 1.25% during 1980-85. In recent decades, there has been a great expansion in urban and industrial areas, often at the expense of agricultural land. During the period 1970-1983, urban and industrial areas expanded by 80.6 sq.km., while farmland was reduced by 109 [sq.km.](#) As a consequence, the degree to which the country was self sufficient in food fell from 80.5% to 48.7% during the same period, and food imports rose from 21 million to 72 million tons per year.

In an effort to solve these problems, the Government is pursuing a major programme of land reclamation at estuaries and shallow bays on the south and west coasts.

Reclamation has a long history in Korea, the first projects dating from about the 13th Century. By 1941, approximately 41,000 ha had been reclaimed, and by 1983, this had risen to 91,000 ha. In recent years, the national land area has been increasing by an average of 11,000 ha per year, and between 1983 and the year 2001, the Government plans to increase the land area by a total of 197,900 ha. In a pre-feasibility study carried out by the Government in 1984, 155 estuaries and bays with a total area of 418,368 ha were identified as being suitable for land reclamation projects. Seventy-three of these sites (390,350 ha) are on the west coast and the remainder (28,018 ha) are on the south. It is anticipated that all 155 sites will eventually be reclaimed, resulting in the loss of 66.5% of the coastal wetlands in the south and west of the Republic.

The Republic of Korea has emerged as one of the world's leading fishing nations, with fleets engaged in all major oceans. However, the inland fisheries catch is rather small, e.g. 50,000 metric tonnes in 1984. The species taken are mainly carp, eel, bach and trout. Aquaculture is growing in importance and the production of molluscs, particularly oysters, and sea-weeds has increased substantially. The Government has been pursuing a long term aquaculture development programme through the expansion of oyster and clam cultivation areas and the intensified development of both profitable and unexploited species. Already certain tidal areas in the southern provinces have been designated for shellfish culture. However, there is a growing concern that pollution might affect these aquaculture areas as a result of the reclamation works and industrial development in adjacent areas.

### **Summary of Wetland Situation**

Despite the ruggedness of much of its terrain, the Republic of Korea possesses a number of very important wetlands, particularly in the larger river basins in the northwest, and at the major estuaries on *the* west and south coasts. The Republic has 13,200 km of coastline (including 8,577 km around offshore islands), and about 630,000 ha of estuarine systems and shallow sea bays on the west and south coasts. The northwest coast has one of the highest tidal ranges in the world, with neap tides of 5.5m and spring tides of 9.3m. In the southeast, the tidal range is much lower; about 0.3m at neap tides and 1.5m at spring tides. Extensive areas of mudflats are exposed at low tide, particularly on the west coast in estuaries such as the Han, Kum and Tangjin, and in tidal basins and bays such as the Asan, Cheon Su and Haenam. The country possesses 3,952 km of rivers and streams, and some 18,620 small lakes and ponds. The great majority of the latter are in the four southernmost provinces, North and South Cholla, and North and South Kyongsang.

Only a few of the wetlands have been studied in detail, and there is an urgent need for more survey work. Four of the most important sites for waterfowl have been designated as Natural Monuments under the Cultural Property Preservation Law, but no major wetland has as yet been protected in a National Park. There are, however, three large marine national parks and a coastal national park which include some wetland habitat.

The wetlands of the Republic of Korea support a remarkably rich variety of waterfowl, including a number of endangered species. Of the total avifauna of about

383 species, over 140 species are waterfowl and a further 40 or so are birds of prey, near-passerines or passerines often or always associated with wetlands. Thus almost 50% of the country's avifauna are dependent on wetland habitats. The Republic is particularly important for wintering ducks, geese and swans (40 species), wintering cranes (three species), and passage shorebirds (52 species). Threatened species include one breeding species, *Egretta eulophotes*, four regular winter visitors *Anas formosa*, *Grus japonensis*, *G. vipio* and *G. monacha*, two scarce winter visitors, *Ciconia (ciconia) boyciana* and *Larus saundersi*, and four uncommon to rare passage migrants, *Platalea minor*, *Mergus squamatus*, *Tringa guttifer* and *Eurynorhynchus pygmeus*. The Japanese Crested This *Nipponia nippon* formerly occurred as a rare winter visitor in the north, but was last recorded in 1977/78, and there are two old records (1913-14 and 1916) of the Crested Shelduck *Tadorna cristata*, a species which is now believed to be extinct.

Sixteen species of waterfowl have been designated as Natural Monuments under the Cultural Property Preservation Law, namely *Egretta eulophotes*, *Ciconia (ciconia) boyciana*, *C. nigra*, *Platalea leucorodia*, *P. minor*, *Nipponia nippon*, *Cygnus olor*, *C. cygnus*, *C. columbianus*, *Anser cygnoides*, *Branta bernicla*, *Aix galericulata*, *Grus japonensis*, *G. vipio*, *G. monacha* and *Haematopus ostralegus*. The wintering grounds for swans on Chindo Island, the wintering area for divers *Gavia* spp around Kojedo Island, the wintering area for cranes in the Han River estuary, and the Nakdong Estuary have also been designated as Natural Monuments. Other Natural Monuments include eight breeding colonies of herons and egrets, and five sites for the freshwater fishes *Anguilla marmorata*, *Siniperca scherzeri*, *Gonoprokopterus mylodon* and *Brachymystax lenok* (two sites).

Most ducks and geese, the Watercock *Gallicrex cinerea* and 12 species of shorebirds have been designated as game birds which may be hunted during specified open seasons. However, in 1972, the Government proclaimed a ban on all hunting throughout the Republic except in a few special hunting areas such as those on Cheju Island.

On the whole, the Government of the Republic of Korea and the general public have reacted favourably to appeals from conservation bodies for increased protection of wetland habitats, but as yet no positive measures have been taken, and the wetlands continue to be destroyed at an alarming rate. The major causes of loss or degradation of wetland habitat are direct human threats such as: (a) reclamation for agriculture, industry and urban development; (b) construction of dikes, dams, levees and sea-walls for flood control and water supply; (c) diversion of sediments by dams, deep channels or other structures; (d) discharge of domestic sewage, solid waste, pesticides and other chemical pollutants into rivers and other water bodies.

In the Republic of Korea, as elsewhere, wetland loss and degradation cannot be neglected or tolerated any longer. Every effort should now be made to conduct a nation-wide campaign for the protection and management of the remaining wetlands, both inland and on the coast. Such a campaign should include: (a) a campaign through the mass media to improve public awareness of the importance of wetlands and necessity for wetland conservation; (b) a campaign to promote the protection and management of those wetlands of international importance for migratory waterfowl;

(c) the completion of a detailed national inventory of wetlands which can then serve as the basis for a continuing monitoring programme; (d) a research programme on the ecology of the wetlands and their wildlife to augment existing information on wetland values, and to discover effective means for their protection and management.

### **Wetland Research**

Prior to 1986, no systematic study of the wetlands of the Republic of Korea had been attempted. Fisheries research has been undertaken by the Government Fisheries Research and Development Agency based in Pusan, but most of this has concerned the marine fisheries and aquaculture. A considerable amount of attention has been given to coastal wetlands with a view to the possibilities for land reclamation, and a great deal of wetland research has been undertaken in the Nakdong Estuary since 1980, to determine the ecological impact of the Nakdong Barrage and to provide baseline data for future monitoring. Most other studies on the wetlands and their wildlife have been carried out by university staff and students, and have focused on threatened species such as the swans and cranes. In April-June 1988, however, extensive shorebird surveys were carried out at wetlands along the west and south coasts in a joint project between the University of East Anglia, U.K., and Kyung Hee University in Seoul (Long et al., 1988; Won et al., 1988).

In 1985, the Environment Administration initiated a National Survey of Natural Ecosystems. Work began on a survey of the wetland ecosystems in 1986, and is expected to be completed by 1990. The wetland survey is being carried out by the Environment Administration and involves several research institutes and many university personnel.

### **Wetland Area Legislation**

There is no legislation which specifically relates to wetland protection. The coastal and marine areas are covered by the national park legislation which began with the Natural Parks Law enacted in 1967. In 1981, miscellaneous laws and decrees relating to national parks were integrated into the Natural Parks Law, ensuring a more favourable and more powerful national parks administration. Natural Monuments, which may include both sites and species, are designated under the Cultural Property Preservation Law. Areas can also be designated as National Environmental Preservation Areas (NEPA) under the National Land Use and Management Law of December 1982, and as National Ecological Systems Preservation Areas (NESPA) under Article 9 of the Environmental Preservation Law of December 1981. These confer greater protection on an area than a Natural Monument. Restrictions in National Environmental Preservation Areas include the prohibition of house building, cutting of trees, reclamation of land, changes in land use, livestock grazing and the capture of wild animals. A NESPA is an area within a National Environment Protection Area which requires special protection. No NEPAs or NESPAs have as yet been designated to protect areas for nature conservation. However, part of the Nakdong Estuary has been proposed as a NEPA and is scheduled for designation in late 1988.

### **Wetland Area Administration**

There is no ministry or office within the Government which is exclusively assigned to the administrative work for nature conservation, and there is no organization specifically concerned with wetlands. Four ministries are involved in nature conservation. The Ministry of Construction was appointed as the National Park Administration Authority, and its Division of Parks has designated 12 National Parks since 1967. The Bureau of Cultural Property Preservation in the Ministry of Culture and Information designates Natural Monuments. A Division of Nature Conservation was set up within the Bureau of Local Administration in the Ministry of Home Affairs in 1978, to handle all matters relating to nature conservation in that Ministry. An Environment Administration was established in 1980, to deal with matters relating to the natural environment. The Division of Environmental Ecology within this Administration is responsible for matters relating to natural ecosystems.

### **Organizations involved with Wetlands**

#### a) Governmental Organizations

- Environment Administration

The agency is sponsoring a major survey of ecosystems of Korea.

- National Land Development Institute

The Institute has conducted a study of coastal wetlands suitable for reclamation.

- Forest Research Institute, Ministry of Agriculture, Forestry and Fishery

The Wildlife Division in the Office of Forestry administers the laws concerning the protection and hunting of wildlife.

- Bureau of Cultural Property Preservation, Ministry of Culture and Information

Responsible for preserving threatened species and communities, and for designating Natural Monuments.

- Division of Nature Conservation, Ministry of Home Affairs -Ministry of Construction

The Bureau of Land Planning is responsible for planning reclamation projects, while the Institute for Human Settlements administers the actual development. The Division of Parks within the Bureau of Land Planning designates and administers National Parks.

#### b) Non-governmental Organizations

- Korea Central Council for Nature Preservation -National Parks Association of Korea

The Association was created in 1971 to "ensure the sound development of attractive natural scenic areas", including national, municipal and provincial parks, natural parks and tourist sites. It publishes a quarterly bulletin entitled "National Parks". - Korea Society for the Protection of Wild Animals The Society established a Wetlands Research Group in 1986, and is involved in the survey of ecosystems being coordinated by the Environment Administration.

- Korean Association for the Conservation of Nature

Established as the Korean Commission for Conservation of Nature in 1965, and renamed in 1974. - Institute of Ornithology The Institute is an association of ornithologists in academic institutions, many of whom are involved in research

on wetlands and waterfowl. - Industrial Sites and Water Development Corporation (ISWACO) In charge of the Nakdong Estuary Barrage and Reclamation Project. - ICBP National Section c) Universities

- Dong A University, Pusan

Particularly the Department of Biology which is conducting studies on the Nakdong Estuary.

- Kyeong-Nam University, Kyeongsangnam-do

- Kyung Hee University, Seoul

Particularly the Department of Zoology and Natural History Museum.

- Seoul National University, Seoul

Particularly the Commission for Conservation of Nature and Natural Resources in the Department of Zoology.

## WETLANDS

Site descriptions based on a report prepared for this Directory by Professor Won Pyong-Oh of Kyung Hee University, wetland data sheets provided by Mr Hwang Hong-Suk of the Environment Administration and Mr Theunis Piersma, and a report entitled "A Survey of South Korean Wetlands and Staging Shorebirds: Spring 1988" by Long et al. (1988).

**Wetland name:** Hwajinp'o, Song'chi, Ch'ongch'o and Kyongp'o Lakes

**Country:** Republic of Korea

**Coordinates:** Hwajinp'o 38°28'N, 128°26'E; Song'chi 38°20'N, 128°31'E; Ch'ongch'o 38°12'N, 128°35'E; Kyongp'o 37°47'N, 128°54'E;

**Location:** on the coast of the East Sea, 17-107 km south of the North Korean border, Kangwon Province. The southernmost lake, Kyongp'o, is five km north of Kangnung.

**Area:** Hwajinp'o 230 ha; Song'chi 63 ha; Ch'ongch'o 135 ha; Kyongp'o 117 ha.

**Altitude:** 0-10m.

**Biogeographical Province:** 2.15.5.

**Wetland type:** 08 & 17.

**Description of site:** A series of small brackish lakes, ponds and marshes along a 100 km stretch of the narrow coastal plain in the extreme northeast of the Republic. The largest lake, Hwajinp'o, is a reservoir built for agricultural water supply; Song'chi, Ch'ongch'o and Kyongp'o Lakes were formed by the natural damming of small estuaries. Other less important sites include Bongp'o Pond (10 ha), Yeongnang Pond (101 ha), Maeho Pond (19 ha) and Hyangho Pond (104 ha). The lakes are about 1.5-2.0m deep, and all are brackish to saline (maximum salinity 34 p.p.t.).

**Climatic conditions:** Humid, temperate, monsoonal climate with cold dry winters and warm wet summers. The average annual rainfall varies from 1,287 mm at Hwajinp'o to 1,305 mm at Kyongp'o, and the mean annual temperature from 11.8°C to 12.1°C.

**Principal vegetation:** Marshes dominated by *Typha orientalis* and *Phragmites communis*, with *Zizania latifolia*, *Najas minor*, *Potamogeton berchtoldii* and *Ruppia rostellata*. Rice paddies and forested hills in adjacent areas.

**Land tenure:** The lakes are state owned; adjacent areas are privately owned.

**Conservation measures taken:** No habitat protection. The wintering swans were designated as a Natural Monument (No.201) in 1968.

**Conservation measures proposed:** It is recommended that the four main lakes and adjacent seashores be designated as Natural Monuments for the wintering swans.

**Land use:** Sport fishing and other forms of outdoor recreation; cultivation of rice in adjacent areas.

**Disturbances and threats:** Dredging at Kyongp'o Lake by the Kangnung City Authorities.

**Economic and social values:** No information.

**Fauna:** An important wintering area for the swans *Cygnus cygnus*, *C. columbianus* and *C. olor*; some 250-350 swans visit the lakes between late October and early March, including about 50 *C. olor* (maximum of 145 in January 1980). This is the only regular wintering area for *C. olor* in the Republic. Fishes include *Carassius auratus*, *Tridentiger obscurus*, *Oncorhynchus masou*, *Moroco lagowskii*, *Lefua costata*, *Rhinogobius brunneus*, *Chaenogobius castaneus*, *C. annularis*, *Plecoglossus altivelis*, *Misgurnus anguillicaudatus* and *Ctenogobius gymnauchen*.

**Special floral values:** No information.

**References:** Won (1981a & 1981b).

**Criteria for inclusion:** 1b, 3b.

**Source:** Won Pyong-Oh.

**Wetland name:** Ch'olwon Basin

**Country:** Republic of Korea

**Coordinates:** 38°15'N, 127°13'E;

**Location:** on the edge of the Demilitarized Zone, 18 km north of Tongduch'on and 75 km NNE of Seoul, Kangwon Province.

**Area:** 500 ha.

**Altitude:** 190m.

**Biogeographical Province:** 2.15.5.

**Wetland type:** 11, 15 & 19.

**Description of site:** An area of rice paddies with scattered dry fields, uncultivated gravelly lands and fallow lands overgrown with weeds; in a basin amongst low hills in the upper drainage of the Imjin River. The basin is crossed by four or five streams fed by abundant spring water and with a rich growth of aquatic vegetation. The area includes two small reservoirs, Hak in the south and T'ogyo in the northeast, and a small lake, Sammyong, in the west.

**Climatic conditions:** Humid, temperate, monsoonal climate with cold dry winters and warm wet summers. The average annual rainfall is 1,307 mm, and the mean annual temperature 10.5°C.

**Principal vegetation:** Spring-fed marshes with *Cyperus exallatus*, *Carex* spp and *Miscanthus sinensis*, and rice paddies.

**Land tenure:** Mainly privately owned.

**Conservation measures taken:** No habitat protection. The Red-crowned Cranes were designated as a Natural Monument (No.202) in 1968, and an artificial feeding programme was carried out for the cranes from 1978-1980.

**Conservation measures proposed:** It is recommended that the basin be designated as a Natural Monument for the wintering cranes.

**Land use:** Cultivation of rice and other crops.

**Disturbances and threats:** None known.

**Economic and social values:** No information.

**Fauna:** A regular wintering area for Red-crowned Cranes *Grus japonensis*; the cranes were first discovered in the late 1970s and since then there have usually been between 60 and 80 birds present each winter, although 100 were recorded in February 1987. White-naped Cranes *Grus vipio* have also begun to winter in the area. Six were found in the winter of 1977/78; between seven and 35 occurred annually until 1984/85, 69 appeared in 1986/87 and 61 were present in mid-January 1988. Other waterfowl present in mid-January 1988 included 60 *Anser fabalis* and three *Anas poecilorhyncha*. Fishes include *Zacco platypus*, *Z. temmincki*, *Coreoleuciscus splendidus*, *Coreoperca herzi*, *Cobitis koreensis* and *Microphysogobio longidorsalis*.

**Special floral values:** No information.

**Research and facilities:** Several studies have been carried out on the wintering cranes.

**References:** Archibald (1981); Won (1981c & 1986b).

**Criteria for inclusion:** 2a.

**Source:** Won Pyong-Oh.

**Wetland name:** Taesong'dong and Panmunch'om Marshes

**Country:** Republic of Korea

**Coordinates:** 37°57'N, 126°42'E;

**Location:** in the Demilitarized Zone 40 km northwest of Seoul, Kyonggi Province.

**Area:** 1,700 ha.

**Altitude:** 32m.

**Biogeographical Province:** 2.15.5.

**Wetland type:** 11, 17 & 19.

**Description of site:** A complex of rice paddies and riverine marshes with two small water storage reservoirs (of 400 ha and 200 ha respectively), on the plains north of the Imjin River in the Demilitarized Zone. There are several springs and streams which remain unfrozen throughout the winter, and some areas of undisturbed marsh along the North Korean border.

**Climatic conditions:** Humid, temperate, monsoonal climate with cold dry winters and warm wet summers.

**Principal vegetation:** Riverine marshes and rice paddies.

**Land tenure:** Mainly privately owned.

**Conservation measures taken:** No habitat protection. The Red-crowned Cranes and White-naped Cranes were designated as Natural Monuments in 1968 (Nos.202 and 203 respectively), and some artificial feeding was carried out for the cranes between 1974 and 1978.

**Land use:** Cultivation of rice.

**Disturbances and threats:** None known.

**Economic and social values:** No information.

**Fauna:** A very important staging and wintering area for 5,000-10,000 ducks and geese, and a wintering area for about 120 White-naped Cranes *Grus vipio* (maximum 172 in January 1988) and small numbers of Red-crowned Cranes *Grus japonensis*. Counts of Anatidae in the autumn and winter of 1986 included:

26 *Cygnus* sp

2,650 *Anser fabalis*

1,500 *A. albifrons*

100 *Aix galericulata*

100 *Anas crecca*

1,000 *A. platyrhynchos*

2,000 *A. poecilorhyncha*

*The wintering Red-crowned Cranes were first discovered in 1974 (36 birds). About 40 wintered in the area until 1981, but numbers have since declined; only ten were present in the winter of 1986/87, and no birds were seen in January 1988. Many birds of prey have been recorded on passage and in winter, including *Pandion haliaetus*, *Haliaeetus albicilla*, *Buteo lagopus*, *Circus cyaneus*, *Falco columbarius* and *F. peregrinus*. The endangered Japanese Crested This *Nipponia nippon* formerly wintered in the area; three were observed near Panmunch'om in 1966, four were present in the same area in the winter of 1973/74, and two were found in the winter of 1977/78, but none has been seen since then, and this small population is now thought to be extinct.*

**Special floral values:** No information.

**Research and facilities:** Several studies have been carried out on the wintering cranes.

**References:** Archibald (1981); Won (1981c & 1986b).

**Criteria for inclusion:** 1b, 2a, 3b.

**Source:** Won Pyong-Oh.

**Wetland name:** Han River Estuary

**Country:** Republic of Korea

**Coordinates:** 37°42'-37°46'N, 126°39'-126°42'E;

**Location:** in Paju and Gimpo Counties, 30 km northwest of Seoul, Kyonggi Province.

**Area:** 2,620 ha.

**Altitude:** 0-10m.

**Biogeographical Province:** 2.15.5.

**Wetland type:** 02, 06, 08 & 19.

**Description of site:** The estuarine system of the Han River from about 25 km downstream of Seoul to its confluence with the Imjin River. The river is 2-3 km wide and rather shallow; there are extensive salt marshes on both banks, and large areas of mudflat are exposed at low tide. The adjacent alluvial plain and reclaimed land are largely under cultivation for rice. Salinities range from 6.9-22 p.p.t., and the pH values from 6.7-7.0. The tidal range is one of the highest in the world.

**Climatic conditions:** Humid, temperate, monsoonal climate with cold dry winters and warm wet summers. The average annual rainfall is 1,250 mm, and the mean annual temperature 11.2°C.

**Principal vegetation:** The marshes bordering the mudflats are dominated by *Suaeda japonica*, *Salsola komarovi*, *Scirpus (maritimus) fluviatilis* and *Imperata cylindrica* var. *koenigii*; the central parts of the marshes are dominated by *Phragmites (communis) longivalvis*, *Aster tripolium*, *Scirpus (maritimus) fluviatilis* and *Calamagrostis epigeios*. Rice paddies in adjacent areas.

**Land tenure:** The estuary is state owned; adjacent rice paddies are privately owned.

**Conservation measures taken:** That part of the Han River Estuary in Gyoha-myeon, Paju County, was designated as a Natural Monument (No.250) for White-naped Cranes in 1975. The protected area was extended to include Haseong-myeon in Gimpo County on the west side of the Estuary in 1977. The Bureau of Cultural Property Preservation provided funds for artificial feeding for the cranes at Gyoha-myeon and Haseong-myeon in 1976.

**Land use:** Fishing; cultivation of rice in adjacent areas.

**Disturbances and threats:** The principal threat is reclamation of more salt marsh and mudflat for agricultural land. The construction of a multi-purpose dam in the 1970s at Paldang, 82 km upstream, and the filling and draining of parts of the marshes have caused changes in the tidal channels and salt concentrations in the soil. This has resulted in a great increase in the extent of *Phragmites*, *Aster*, *Imperata* and *Calamagrostis*, and decrease in the extent of *Scirpus*, *Salsola* and *Suaeda*.

**Economic and social values:** No information.

**Fauna:** The estuary was once a very important staging and wintering area for geese, ten species of ducks and White-naped Cranes *Grus vipio*, but the numbers of waterfowl using the area have decreased markedly in recent years. In the 1970s, several thousand geese (*Anser fabalis*, *A. albifrons*) and ducks (mainly *Anas platyrhynchos*, *A. poecilorhyncha*) used the area in autumn, but maximum counts in recent years have been only:

220 *A. fabalis*

200 *A. albifrons*  
570 *A. platyrhynchos*  
160 *A. poecilorhyncha*

In the early 1970s, as many as 2,300 *G. vipio* used the estuary as a staging area in late October and early November before moving on to their wintering grounds in Kyushu, Japan. However, numbers have fallen rapidly since then. Some 1,740 were recorded in November 1976 and 1,500 in November 1978, but only a few hundred birds occurred in the early 1980s, and only 30-40 in 1985 and 1986. A few cranes normally remain in the area throughout the winter. The estuary remains important as a staging area for migratory shorebirds, e.g. 300 *Tringa erythropus* in April 1986. Fishes includes *Pseudogobio esocinus*, *Carassius auratus*, *Lefua costata*, *Misgurnus mizolepis* and *Macropodus chinensis*.

**Special floral values:** No information.

**Research and facilities:** Several studies have been carried out on the White-naped Cranes and their habitat.

**References:** Archibald (1981); Cha (1986); Karpowicz (1985); Kim (1986); Kim & Oesting (1981); Koo (1986); Koo & Won (1986); Lee (1986); Won (1980, 1981c, 1984 & 1986b).

**Criteria for inclusion:** 1b, 2a, 3b.

**Source:** Won Pyong-Oh.

**Wetland name:** Shin Islet

**Country:** Republic of Korea

**Coordinates:** 37°32'N, 126°05'E;

**Location:** in the Yellow Sea off the mouth of the Imjin Estuary, 54 km west of Inch'on, Kyonggi Province.

**Area:** 2.2 ha.

**Altitude:** Sea level to 40m.

**Biogeographical Province:** 2.15.5.

**Wetland type:** 03.

**Description of site:** A small, flat-topped, rocky islet in the Yellow Sea, about 28 km off the southwest coast of Kanghwa Island.

**Climatic conditions:** Humid, temperate, monsoonal climate with cold dry winters and warm wet summers.

**Principal vegetation:** The flat top of the island is covered in a low growth of *Chenopodium album* var. *centrorubrum* and *Artemisia scoparia*.

**Land tenure:** State owned.

**Conservation measures taken:** No habitat protection. The Chinese Egret *Egretta eulophotes* has recently been designated as a Natural Monument.

**Conservation measures proposed:** Won Pyong-Oh has recommended that the island be given official protection, and the Government has agreed to designate the island as a Natural Monument.

**Land use:** None. There is one automatic beacon on the island. **Disturbances and threats:** None known.

**Economic and social values:** None known.

**Fauna:** The island supports the largest breeding colony of the endangered Chinese Egret *Egretta eulophotes* hitherto discovered. In June 1988, Won Pyong-Oh counted 429 nests with eggs or young. Many of the egrets feed on the extensive intertidal mudflats at the south end of Kangwha Island and around Yongjong Island (sites 6 &

7), about 30 km to the east. The only other birds breeding on Shin Islet are some 5,000 pairs of Black-tailed Gulls *Larus crassirostris*.

**Special floral values:** None known.

**Research and facilities:** Avifaunal surveys were carried out by Won Pyong-Oh in August 1987 and June 1988.

**References:** Won (1988).

**Criteria for inclusion:** 2a.

**Source:** Won Pyong-Oh.

**Wetland name:** South Kanghwa and North Yongjong Mudflats

**Country:** Republic of Korea

**Coordinates:** 37°31'-37°37'N, 126°18'-126°35'E;

**Location:** 30-55 km west of Seoul, Kyonggi Province. Area: South Kanghwa mudflats 7,662 ha; north Yongjong mudflats 3,555 ha.

**Altitude:** Sea level.

**Biogeographical Province:** 2.15.5.

**Wetland type:** 02, 03, 06, 10 & 19.

**Description of site:** The extensive intertidal mudflats along the south coast of Kanghwa Island and north coast of Yongjong Island. At low tide, the two areas of mudflats are separated by a channel about one kilometer wide. The south Kanghwa mudflats include Yocha-ri, Sondu-ri and the shore east to Tongdom islet, which is connected to the southeast corner of Kanghwa by a causeway. Approximately 10 km of the coast are embanked with a stone sea-wall, backed by rice paddies and one fish pond. The north Yongjong mudflats stretch out for up to eight kilometers from the north coast of the island. There are small rocky outcrops on the mudflats and some small areas of sand. The tidal range is very great, varying from 5.0m at neap tides to 9.2m at spring tides. These mudflats are two of the few remaining patches of the formerly very extensive mudflats to the south of the Han Estuary; most other areas have been reclaimed for agricultural and industrial development.

**Climatic conditions:** Humid, temperate, monsoonal climate with cold dry winters and warm wet summers. The average annual rainfall is 1,122 mm, and the mean annual temperature 11.2°C.

**Principal vegetation:** No information.

**Land tenure:** The mudflats are state owned; adjacent rice paddies and fish ponds are privately owned.

**Conservation measures taken:** None.

**Conservation measures proposed:** Long *et al.* (1988) have recommended that the mudflats and shorebird roosting areas be fully protected and designated as a Natural Monument or preferably as a National Environmental Preservation Area. If the area is given adequate protection, the shorebird roosting site at Yocha-ri could be developed as a nature reserve with observation hides and information centre.

**Land use:** Harvesting of shellfish on the mudflats; cultivation of rice and aquaculture in adjacent areas. There is some industrial development on the mainland immediately to the east.

**Possible changes in land use:** The south Kanghwa and north Yongjong mudflats are part of a proposed area for seashore reclamation (Projects Sindo A3 and Sindo P84), which would involve joining Kanghwa, Yongjong, Sammock and Yongju Islands.

**Disturbances and threats:** A stone embankment has recently been constructed around reclaimed land at Sondu-ri, and this has destroyed some areas suitable as high

tide roosts for cranes and shorebirds. In May 1988, an important shorebird roost at Yocha-ri was developed into a fish pond. People collecting shellfish on the mudflats cause a considerable amount of disturbance to shorebirds. There is some evidence that contamination with poisons and/or pesticides is a problem in the south Kanghwa area. If the proposed reclamation schemes (Projects Sindo A3 and Sindo P84) are implemented, all intertidal mudflats will be lost.

**Economic and social values:** No information.

**Fauna:**The tidal mudflats of south Hanghwa and north Yongjong are a very important staging area for migratory shorebirds, especially *Numenius madagascariensis* and *Calidris alpina*. Three large shorebird roosts were located in April and May 1988; two on reclaimed land behind the sea-wall at Yocha-ri, south Kanghwa, and one on the muddy foreshore off Unpuk-ri, north Yongjong. Over 20,000 shorebirds of 26 species were recorded at the three roosts (16,200 at the Yocha-ri roosts and 4,000 at Unpuk-ri). These included:

750 *Pluvialis squatarola*

75 *Charadrius alexandrinus*

920 *C. mongolus*

1,760 *Limosa lapponica*

135 *Numenius phaeopus*

695 *N. madagascariensis*

575 *Tringa nebularia*

200 *Xenus cinereus*

370 *Calidris tenuirostris*

40 *C. canutus*

250 *C. ruficollis*

14,200 *C. alpina*

At least five Nordmann's Greenshanks *Tringa guttifer* were recorded at one of the roosts at Yocha-ri. The mudflats are also a very important feeding area for Chinese Egrets *Egretta eulophotes* from the breeding colony at Shin Islet (site 5) to the west. The maximum counts in May and June 1988 were 92 at Yocha-ri, 30 at Sondu-ri and 10 at Unpuk-ri. Other rare species present at this time included one Black-faced Spoonbill *Platalea minor* at Sondu-ri and four Saunders' Gulls *Larus saundersi* at Unpuk-ri. The site is also a wintering area for several hundred ducks and geese, and up to 28 Red-crowned Cranes *Grus japonensis*. Waterfowl recorded during a census at Sondu-ri in late January 1988 included:

40 *Anser fabalis*

68 *Tadorna ferruginea*

23 *Grus japonensis*

1 *G. monacha*

Up to ten *G. japonensis* were present at Yocha-ri in early 1988, but these may have come from the Sondu-ri group. The area seems to have increased in importance for waterfowl since the vast mudflats at North-ku near Inch'on and at Kilsang-myon on Kanghwa Island were reclaimed for agriculture.

**Special floral values:** None known.

**Research and facilities:** Regular waterfowl censuses have been carried out at Sondu-ri, and shorebird surveys were made throughout the area in April, May and June 1988.

**References:** Long *et al.* (1988); Won *et al.* (1988).

**Criteria for inclusion:** 1b, 2a, 2c, 3a.

**Source:** Won Pyong-Oh and references.

**Wetland name:** Mudflats of south Yongjong and adjacent islands

**Country:** Republic of Korea

**Coordinates:** 37°23'-37°29'N, 126°23'-126°35'E;

**Location:** 2-20 km west of Inch'on and 40 km WSW of Seoul, Kyonggi Province.

**Area:** 9,446 ha.

**Altitude:** Sea level.

**Biogeographical Province:** 2.15.5.

**Wetland type:** 02, 03, 06, 08, 09 & 19.

**Description of site:** A large area of intertidal mudflats along the south coast of Yongjong Island and around the nearby islands of Sammok, Sin Pul, Yongju and Mui. The main area of mudflats extends from south Yongjong around Sammok and Sin Pul to Yongju, the westernmost of the group. The mudflats along the eastern and western sides of Mui Island, to the south, are separated from the main area of mudflats by a narrow channel. The tidal range varies from 5.0m at neap tides to 9.5m at spring tides. There are stone sea-walls backed by reclaimed land along the southeastern coast of Yongjong and along much of the southern coast of Sammok. Sin Pul is connected to the southwest corner of Yongjong by reclaimed land used for salt pans (350 ha). Sammok and Yongjong are linked by a road causeway with fringing salt marshes. A 3.5 km causeway is now being constructed between Sammok and Yongju.

**Climatic conditions:** Humid, temperate, monsoonal climate with cold dry winters and warm wet summers.

**Principal vegetation:** No information.

**Land tenure:** The mudflats are state owned; the salt pans are privately owned.

**Conservation measures taken:** None.

**Conservation measures proposed:** Long et al. (1988) have recommended that the area be fully protected and designated as a Natural Monument or preferably as a National Environmental Preservation Area. Pollution studies should be carried out, in view of the close proximity of the site to Inch'on city and port.

**Land use:** Fishing for shellfish; salt production on Yongjong and Sammok, and cultivation of rice and a little wheat on Yongjong. Inch'on port lies immediately to the east of the site.

**Possible changes in land use:** Four reclamation schemes have been proposed by the Government:

1. Sindo P84 and Sindo A3. A large project which would involve the joining of many of the islands in the area, and loss of large areas of mudflat.
2. Eulwang A4. A small project on the south side of one of the islands.
3. Mueui A5. A small agricultural project on the south side of Mui Island.
4. Yongjong Ui. An urban development project at two areas on the south coast of Yongjong Island.

**Disturbances and threats:** There is heavy shipping traffic along the south side of the mudflats, to and from Inch'on port and other industrial areas to the east. Large areas of mudflat will be lost if the various proposed reclamation schemes are implemented.

**Economic and social values:** No information.

**Fauna:** The mudflats are a very important staging area for migratory shorebirds, particularly *Calidris alpina*. Three high tide roosts were located in May 1988; one on the muddy foreshore at Nunam-ri on Yongjong Island, one on the northwestern shore of Sin Pul Island, and one at a lagoon on reclaimed land on Sammok Island. Over

22,000 shorebirds of 15 species were using the three roosts (16,500 at Nunam-ri, 3,150 at Sin Pul and 2,600 at Sammok). These included:

420 *Pluvialis squatarola*

750 *Limosa lapponica*

590 *Numenius phaeopus*

20 *N. madagascariensis*

115 *Tringa nebularia*

220 *Xenus cinereus*

70 *Arenaria interpres*

50 *Calidris ruficollis*

20,000 *C. alpina*

A group of 28 Nordmann's Greenshanks *Tringa guttifer* at the Nunam-ri roost was particularly noteworthy. Other waterfowl present in May 1988 included some 35-50 Chinese Egrets *Egretta eulophotes*, presumably feeding birds from the breeding colony on Shin Islet (site 5).

**Special floral values:** None known.

**Research and facilities:** Shorebird surveys were carried out by Long *et al.* in May 1988.

**References:** Long *et al.* (1988); Won *et al.* (1988).

**Criteria for inclusion:** lb. 2a, 2c, 3a.

**Source:** See references.

**Wetland name:** The Han River in Seoul

**Country:** Republic of Korea

**Coordinates:** 37°31'N, 126°48'-127°07'E;

**Location:** in Seoul City, Kyonggi Province.

**Area:** 2,020 ha.

**Altitude:** 0-10m.

**Biogeographical Province:** 2.15.5.

**Wetland type:** 11 & 13.

**Description of site:** A stretch of about 35 km of the lower Han River with several small islands and some riverine marshes, within the city of Seoul and its suburbs. The river has a maximum depth of 4m, and pH values in the range 6.9-7.2.

**Climatic conditions:** Humid, temperate, monsoonal climate with cold dry winters and warm wet summers. The average annual rainfall is 1,301 mm, and the mean annual temperature 11.6°C.

**Principal vegetation:** *Ceratophyllum demersum*.

**Land tenure:** State owned.

**Conservation measures taken:** None.

**Land use:** Transportation and fishing.

**Disturbances and threats:** Dredging, construction of concrete embankments, and pollution from Seoul City.

**Economic and social values:** No information.

**Fauna:** The river is a very important wintering area for Anatidae. Almost 38,000 ducks were present in late February 1987, including 27,000 *Aythya ferina*, 4,150 *Aythya fuligula* and 1,900 *Anas platyrhynchos*. About 10,000 ducks were recorded in late January 1988, including:

2,500 *Anas platyrhynchos*

700 *A. poecilorhyncha*

1,100 *A. acuta*  
1,100 *Aythya fuligula*  
3,000 *Mergus merganser*  
260 *M. albellus*

Other waterfowl recorded at this time included 46 *Tachybaptus ruficollis*, 105 *Ardea cinerea* and over 700 gulls (*Larus* spp) of four species.

Fishes include *Anguilla japonica*, *Zacco platypus*, *Pseudogobio esocinus*, *Cyprinus carpio*, *Hemibarbus labeo*, *Carassius auratus* and *Pelteobagrus fulvidraco*.

**Special floral values:** No information.

**Research and facilities:** Regular mid-winter waterfowl censuses have been carried out.

**References:** Won *et al.* (1986).

**Criteria for inclusion:** 3a.

**Source:** Won Pyong-Oh.

**Wetland name:** Yangsu-ri Reservoir

**Country:** Republic of Korea

**Coordinates:** 37°32'N, 127°18'E;

**Location:** in Yangp'yong County 25 km east of Seoul, Kyonggi Province. **Area:** 487 ha.

**Altitude:** 10m.

**Biogeographical Province:** 2.15.5.

**Wetland type:** 17.

**Description of site:** The reservoir behind the P'altang Dam on the Han River at its confluence with the Bughan River. There are some fringing marshes in the upper reaches of the reservoir along the Han and Bughan Rivers. The pH value is **7.4**.

**Climatic conditions:** Humid, temperate, monsoonal climate with cold dry winters and warm wet summers. The average annual rainfall is 1,253 mm, and the mean annual temperature 10.9°C.

**Principal vegetation:** Marshes dominated by *Typha orientalis*, *Phragmites communis*, *Zizania latifolia* and *Trapa japonica*.

**Land tenure:** The reservoir is state owned.

**Conservation measures taken:** None.

**Land use:** Fishing.

**Disturbances and threats:** None known.

**Economic and social values:** No information.

**Fauna:** The marshes support breeding populations of *Tachybaptus ruficollis*, *Ixobrychus sinensis* and *Gallinula chioropus*. Fishes include *Pseudogobio esocinus*, *Pseudorasbora parva*, *Hemibarbus labeo*, *Rhodeus ocellatus*, *Acheilognathus yamatsutae*, *Acanthorhodeus asmussi*, *Paracheilognathus rhombea* and *Misgurnus anguillicaudatus*.

**Special floral values:** No information.

**Criteria for inclusion:** 2b.

**Source:** Won Pyong-Oh.

**Wetland name:** Namyang Bay

**Country:** Republic of Korea

**Coordinates:** 37°02'-37°11'N, 126°42'-126°51'E;

**Location:** Hwasong-gun, 45 km SSW of Seoul, Kyonggi Province.

**Area:** c.10,000 ha (including 6,675 ha of mudflats).

**Altitude:** Sea level.

**Biogeographical Province:** 2.15.5.

**Wetland type:** 02, 06, 09, 17 & 19.

**Description of site:** A large bay, about 13 km long and 10 km wide at its mouth, aligned along a northeast-southwest axis. At Yihwa-ri, in the south, a small river has been dammed with a coastal barrage to form Namyang Lake. There are large areas of tidal mudflats, especially along the south side of the bay. Much of the south shore has been embanked with a stone sea-wall, which is backed by salt pans and rice paddies. The tidal range varies from about 5.2m at neap tides to 8.5m at spring tides.

**Climatic conditions:** Humid, temperate, monsoonal climate with cold dry winters and warm wet summers.

**Principal vegetation:** No information.

**Land tenure:** The mudflats are state owned; adjacent rice paddies and salt pans are privately owned.

**Conservation measures taken:** None.

**Conservation measures proposed:** Long *et al.* (1988) have recommended that the entire bay be protected and designated as a Natural Monument or preferably as a National Environmental

Preservation Area. If the bay is given adequate protection, the area around Yihwa-ri would be particularly suitable for environmental education.

**Land use:** Fishing for shellfish, finfish, prawns and crabs. There is an oil terminal and electric power plant adjacent to the causeway that forms Namyang Lake. Namyang Lake is a popular recreation area for sailing, sport fishing, swimming etc. There is a military base southeast of the bay.

**Possible changes in land use:** The entire bay is proposed for reclamation in the National Development Plan. The reclaimed land would be developed for a variety of uses (Compound Project Woojeong C3).

**Disturbances and threats:** Small islets within two km of the coast are used as targets by American bombers and other war planes from the military base east of Maehyang-ri. Saltpan workers at Unp'yong-ri use poisons to control crabs which burrow in the mudbanks around the ponds, and some birds have been poisoned as a result. A KIA car factory is being constructed on a 300 ha plot of mainly reclaimed land near the shorebird roost at Yihwa-ri. Coolants from the power plant near Namyang Lake are released onto the mudflats near Yihwa-ri. There is a potential threat from off-loading of petroleum products at the nearby oil terminal. All the mudflats will be lost if the proposed reclamation scheme is implemented.

**Economic and social values:** No information.

**Fauna:** An extremely important staging area for migratory shorebirds, particularly *Limosa limosa*, *L. lapponica*, *Tringa guttifer*, *Calidris tenuirostris* and *C. alpina*. Six main high-tide roosts were located in April and May 1988: at Hokok-ri, Wonan-ri, Unp'yong-ri (two sites), Maehyang-ri and Yihwa-ri. It was estimated that about 52,000 shorebirds of 23 species were using the roosts in early May 1988. These included an estimated:

2,100 *Pluvialis squatarola*

70 *Charadrius alexandrinus*

3,500 *C. mongolus*

10,500 *Limosa limosa*

8,000 *L. lapponica*

320 *Numenius phaeopus*  
75 *N. madagascariensis*  
90 *Tringa erythropus*  
170 *T. nebularia*  
480 *Xenus cinereus*  
100 *Heteroscelus brevipes*  
7,700 *Calidris tenuirostris*  
110 *C. canutus*  
2,400 *C. ruficollis*  
16,400 *C. alpina*  
32 *Limicola falcinellus*

At least 60 and possibly as many as 79 Nordmann's Greenshanks *Tringa guttifer* were recorded, the largest concentration of this threatened species observed in recent years. Other rare shorebirds included five Spoon-billed Sandpipers *Eurynorhynchus pygmeus*.

**Special floral values:** None known.

**Research and facilities:** Long *et al.* carried out eight shorebird surveys in April and May 1988.

**References:** Long *et al.* (1988); Won *et al.* (1988).

**Criteria for inclusion:** lb. 2a, 2c, 3a.

**Source:** See references.

**Wetland name:** Asan Bay

**Country:** Republic of Korea

**Coordinates:** 36°53'-37°00'N, 126°41'-126°55'E;

**Location:** 70 km SSW of Seoul, on the border of Kyonggi and South Ch'ungch'ong Provinces.

**Area:** Over 15,000 ha (including: Asan Lake, 1,900 ha; Sakpyo Lake, 1,600 ha; and 7,200 ha of mudflats).

**Altitude:** Sea level.

**Biogeographical Province:** 2.15.5.

**Wetland type:** 02, 06, 17 & 19.

**Description of site:** A large bay, about 15 km long and up to 15 km wide, adjoining Namyang Bay (site 10) to the north. Two rivers have been dammed with barrages at the head of the bay to form large freshwater lakes (Asan Lake in the east and Sakpyo Lake in the south). The barrages also facilitated reclamation of surrounding areas, mostly for agriculture. There are large areas of intertidal mudflats in the head of the bay off Kwonkwan-ri, and in the southeastern corner between Soma and Cha Ka-ri. The tidal range varies from 5.2m at neap tides to 8.5m at spring tides.

**Climatic conditions:** Humid, temperate, monsoonal climate with cold dry winters and warm wet summers.

**Principal vegetation:** No information.

**Land tenure:** No information.

**Conservation measures taken:** None.

**Conservation measures proposed:** Long *et al.* (1988) have recommended that the entire bay be protected and designated as a Natural Monument or preferably as a National Environmental Preservation Area. They also recommend the establishment of an environmental education centre with facilities both for students and for the general public.

**Land use:** Fishing, especially for prawns, but also for shellfish, crabs and octopus. Asan Bay is a popular tourist resort; there are tourist villages at the northwestern corner of Asan Lake and at the western end of the Sakpyo Lake causeway. Asan Lake is used for sailing, power-boating and pleasure cruising.

**Possible changes in land use:** It is proposed that the head of the bay be closed off with a barrage to create a freshwater reservoir and reclamation area. This would be used for industry and a power plant.

**Disturbances and threats:** The intertidal mudflats between Soma and Cha Ko-ri are currently being reclaimed for agriculture (Project Sugmum A7 and A8). This reclamation involves the construction of a stone sea-wall, 8.5 km in length, which will enclose 3,100 ha of mudflats and cut off the mouth of the Dae Bang Mui River. Work had already commenced on the sea-wall in May 1988. All other important mudflats will be lost if the proposed barrage scheme is implemented.

**Economic and social values:** Situated close to a popular tourist resort and with good access, the area has very high potential for environmental education.

**Fauna:** An extremely important staging area for migratory shorebirds, particularly *Numenius madagascariensis*, *Tringa guttifer*, *Calidris tenuirostris* and *C. alpina*. Five large high-tide roosts were located in April and May 1988: at Kwon Kwan-ri, Kulmae-ri (two sites), Cha Ko-ri and Soma. These held between 38,000 and 47,000 shorebirds of 22 species in mid-May, including about:

900 *Pluvialis squatarola*

50 *Charadrius alexandrinus*

150 *C. mongolus*

5,500 *Limosa limosa*

2,900 *L. lapponica*

200-300 *Numenius phaeopus*

200-400 *N. madagascariensis*

250 *Xenus cinereus*

215 *Heteroscelus brevipes*

100 *Arenaria interpres*

400-500 *Calidris canutus*

15,000-20,000 *C. tenuirostris*

1,450 *C. ruficollis*

11,000-13,000 *C. alpina*

At least 17 Nordmann's Greenshanks *Tringa guttifer* were recorded.

**Special floral values:** None known.

**Research and facilities:** Long *et al.* carried out six shorebird surveys in April and May 1988.

**References:** Long *et al.* (1988); Won *et al.* (1988).

**Criteria for inclusion:** 1b, 2a, 2c, 3a.

**Source:** See references.

**Wetland name:** Cheon Su Bay

**Country:** Republic of Korea

**Coordinates:** 36°24'-36°38'N, 126°20'-126°30'E;

**Location:** Sosan-gun and Honggsong-gun, 110 km SSW of Seoul, South Ch'ungch'ong Province.

**Area:** Over 15,000 ha, including over 2,500 ha of mudflats.

**Altitude:** Sea level.

**Biogeographical Province:** 2.15.5.

**Wetland type:** 01, 04, 06, 09 & 17.

**Description of site:** A large sea bay, about 22 km long and up to eight km wide, running north-south between the mainland and Amyon Island off the Sosan Peninsula. The substrate includes sandy, muddy and rocky areas. The head of the bay splits into two arms, both of which have been cut off by barrages and reclaimed in recent years. In the eastern arm, there is a freshwater reservoir of about 1,000 ha with agricultural land behind. Reclaimed land within the western arm is still being improved.

**Climatic conditions:** Humid, temperate, monsoonal climate with cold dry winters and warm wet summers.

**Principal vegetation:** No information.

**Land tenure:** State owned.

**Conservation measures taken:** The bay has been designated as a Sea Resources Conservation Area in the Second National Comprehensive Development Plan (1992-1991).

**Land use:** Fishing. There is a rice-processing plant nearby.

**Possible changes in land use:** A small reclamation project has been proposed at the mouth of the bay on the east side of Amyon Island.

**Disturbances and threats:** There is relatively little disturbance in the area at present. Some of the mudflats will be lost if the proposed reclamation project on Amyon Island is implemented.

**Economic and social values:** No information.

**Fauna:** The bay is an important staging area for migratory shorebirds. Two high-tide roosts were located in April and May 1988: one on salt pans at Chang Ki-ri, Nam-myon, and the other on a sand and shingle beach at Osa-ri, Mongsong-gun. These held a maximum of 1,300

shorebirds of 14 species, including about:

60 *Pluvialis squatarola*

75 *Numenius phaeopus*

260 *Xenus cinereus*

50 *Heteroscelus brevipes*

120 *Arenaria interpres*

200 *Calidris ruficollis*

500 *C. alpina*

One Spoon-billed Sandpiper *Eurynorhynchus pygmeus* was located amongst the *C. ruficollis*. The reservoir at the head of the bay may be a very important wintering area for Anatidae. Local people reported the presence of large numbers of ducks, geese and swans during the winter of 1987/88, and over 3,000 *Aythya fuligula* were still present in mid-April 1988.

**Special floral values:** None known.

**Research and facilities:** Long *et al.* carried out preliminary shorebird surveys in April and May 1988.

**References:** Long *et al.* (1988).

**Criteria for inclusion:** 1b, 3b.

**Source:** See references.

**Wetland name:** Upper Kum River Estuary

**Country:** Republic of Korea

**Coordinates:** 36°08'N, 126°54'-127°00'E;

**Location:** 20-35 km upstream from the mouth of the Kum River, 15 km WSW of Nonsan, on the boundary between South Ch'ungch'ong and North Cholla Provinces.

**Area:** 500 ha.

**Altitude:** 0-10m.

**Biogeographical Province:** 2.15.5.

**Wetland type:** 02, 08, 11 & 13.

**Description of site:** The upper estuary of the Kum River, with tidal brackish marshes in the lower reaches (near Kunsan), and freshwater revering marshes in the upper reaches (near Kangkyung). Salinities range from 15-33.6 p.p.t. in the Kunsan area, and from 0-5.1 in the Kangkyung area. The river is 2-4m deep, the tidal variation in the Kunsan area is 3m, and the pH values range from 6.7-6.9.

**Climatic conditions:** Humid, temperate, monsoonal climate with cold dry winters and warm wet summers. The average annual rainfall is 1,353 mm, and the mean annual temperature 12.4°C.

**Principal vegetation:** Fresh and brackish marshes with *Phragmites communis*, *Typha orientalis*, *Posamogeton distinctus*, *Arundinella hirta*, *Miscanthus sinensis* and *Cyperus amuricus*. Rice paddies and other agricultural land on the adjacent plains.

**Land tenure:** The river and estuary are state owned.

**Conservation measures taken:** None.

**Land use:** No information.

**Disturbances and threats:** A barrage has recently been constructed in the estuary.

**Economic and social values:** No information.

**Fauna:** A very important wintering area for Anatidae, with regular wintering populations of 420 *Cygnus cygnus*, *C. columbianus*, 3,000 *Anser fabalis*, 700 *A. albifrons*, and 7,000 dabbling ducks *Anas spp.*

A male Crested Shelduck *Tadorna cristata* was collected at the Kum River Estuary in the winter of 1913-14.

**Special floral values:** No information.

**References:** Ham & Lee (1985).

**Criteria for inclusion:** 1b, 3b.

**Source:** Won Pyong-Oh.

**Wetland name:** Kum, Mankyung and Tangjin Estuaries

**Country:** Republic of Korea

**Coordinates:** 35°45'-35°59'N, 126°32'-126°48'E;

**Location:** Kunsan-shi and Kimje-gun, west and south of Kunsan, North Cholla Province.

**Area:** c.20,000 ha.

**Altitude:** Sea level.

**Biogeographical Province:** 2.15.5.

**Wetland type:** 02, 06, 09, 10 & 19.

**Description of site:** The extensive intertidal mudflats in the estuaries of the Kum, Mankyung and Tangjin Rivers. There are approximately 3,000 ha of intertidal mudflats in the outer estuary of the Kum River. The main area lies to the south of the river mouth, between the mainland and Oshig Island, and is adjacent to a large area of reclaimed land which is now the outer port and industrial area for Kunsan City. The small island of Yabu lies in the centre of the river mouth, and is surrounded by mudflats and salt pans. The combined estuarine system of the Mankyung and Tangjin

Rivers lies about 10 km to the southeast. The main area of mudflats is on the north shore of the Tangjin Estuary. Much of the coast in this region has been embanked, with rice paddies and other agricultural land behind the sea-wall. There is a large area of salt pans (2,700 ha) on the north shore of the Mankyung Estuary. River flow has been constricted by canalization at the head of the two estuaries. The tidal range in all three estuaries is about 2.8-5.7m.

**Climatic conditions:** Humid, temperate, monsoonal climate with cold dry winters and warm wet summers. The average annual rainfall is 1,120 mm, and the mean annual temperature 12.4°C.

**Principal vegetation:** No information.

**Land tenure:** The mudflats are state owned.

**Conservation measures taken:** No habitat protection. The Oystercatcher *Haematopus ostralegus* was designated as a Natural Monument (No.326) in 1982.

**Conservation measures proposed:** Long et al. (1988) have recommended that further studies be carried out as soon as possible, in view of the imminent threats to the mudflats in all three estuaries.

**Land use:** Fishing for finfish, shrimps, crabs and lobsters. Kunsan City is a major fishing port, and there are several fishing villages on the Mankyung and Tangjin Estuaries. There is a large industrial complex on the south side of the Kum Estuary, between the outer port and city of Kunsan.

**Possible changes in land use:** Large-scale reclamation projects have been proposed for both the south and the north sides of the Kum Estuary. The Oshikoo Project 1H12 will extend the outer harbour industrial area by a further eight km, and will result in the loss of all mudflats on the south side of the estuary. The project involves the construction of sea dykes from the outer harbour to Oshik Island, and from Oshik Island south to Shin Nansan. Work had already commenced on the first sea dyke in early 1988. The proposed Jangjang Compound Project C4 is a large, multi-purpose reclamation project covering 13,722 ha on the north side of the Kum River, and including all the mudflats around Yabu Island. This project is not, however, being given high priority. Both the Mankyung and Tangjin Estuaries are threatened with closure in a proposed agricultural reclamation scheme. The project involves the construction of a sea dyke across the combined mouths of the two tidal basins, and would create a 5,350 ha freshwater reservoir and 6,940 ha of agricultural land. The project is being given high priority, and is likely to go ahead in the near future.

**Disturbances and threats:** There is heavy port traffic in the Kunsan Estuary. Kunsan City is being developed for the expected increase in trade with China, and pollution in the Kum Estuary is likely to become a problem as more heavy industry is developed in the area. The Mankyung Estuary is heavily contaminated with pollutants entering the river upstream. Fish catches have been deteriorating, and this has been attributed to the high levels of pollution.

The mudflats in all three estuaries will be lost if the proposed reclamation schemes are implemented.

**Economic and social values:** No information

**Fauna:** The estuaries are a very important staging and wintering area for migratory ducks and shorebirds, particularly *Haematopus ostralegus*. Counts at the Kum Estuary in recent years have included up to 1,000 ducks, 850 *Haematopus ostralegus* and 4,000 other shorebirds. Over 2,500 shorebirds were present in early May 1988, including 160 *Limicola falcinellus*. A high-tide roost of over 3,300 shorebirds of ten species was located at Geochun-ri in the Tangjin Estuary in late April 1988. The roost contained:

100 *Pluvialis squatarola*

250 *Limosa lapponica*

100 *Numenius phaeopus*

60 *N. arquata*

150 *Xenus cinereus*

600 *Calidris tenuirostris*

2,000 *C. alpina*

**Special floral values:** None known.

**Research and facilities:** Regular waterfowl censuses have been carried out in the Kum Estuary, and preliminary shorebird surveys were made in all three estuaries in April and May 1988.

**References:** Ham & Lee (1985); Long *et al.* (1988).

**Criteria for inclusion:** 1b, 3b.

**Source:** Won Pyong-Oh and references.

**Wetland name:** West Taegu and Talsong Wetlands

**Country:** Republic of Korea

**Coordinates:** 35°49'N, 128°28'E;

**Location:** by the Nakdong River 10 km WSW of Taegu, West Taegu and Koryong Counties, North Kyongsang Province.

**Area:** 5,000 ha.

**Altitude:** 20m.

**Biogeographical Province:** 2.15.5.

**Wetland type:** 11, 13 & 19.

**Description of site:** An alluvial plain with extensive rice paddies, patches of dry farmland, and some revering marshes, on a wide bend of the Nakdong River near Taegu City. The river has a maximum depth of three metres. The plain includes the villages of P'yongni-dong and Hoch'on-dong in Koryong County, and P'aho-dong in West Taegu.

**Climatic conditions:** Humid, temperate, monsoonal climate with cold dry winters and warm wet summers. The average annual rainfall is 993 mm, and the mean annual temperature 12.7°C.

**Principal vegetation:** Rice paddies and wheat fields.

**Land tenure:** Mainly privately owned.

**Conservation measures taken:** The area is fully protected by the County Authorities as a wintering area for Hooded Cranes, and the cranes were designated as a Natural Monument (No.228) in 1970.

**Land use:** Cultivation of rice, wheat and other crops.

**Disturbances and threats:** None known.

**Economic and social values:** No information.

**Fauna:** The main wintering area for Hooded Cranes *Grus monacha* in Korea; between 200 and 350 individuals have wintered in the area since 1984 (210 were present in January 1988). Several dozen White-naped Cranes *Grus vipio* occur during the migration seasons.

**Special floral values:** No information.

**Research and facilities:** Several studies have been carried out on the wintering Hooded Cranes.

**References:** Won (1986b).

**Criteria for inclusion:** 2a.

**Source:** Won Pyong-Oh.

**Wetland name:** Upo Marsh

**Country:** Republic of Korea

**Coordinates:** 35°33'N, 128°25'E;

**Location:** at Ibang-myon, Changnyong County, 35 km SSW of Taegu, South Kyongsang Province.

Area: 170 ha.

**Altitude:** 10m.

**Biogeographical Province:** 2.15.5.

**Wetland type:** 17.

**Description of site:** A small water storage reservoir and associated marshes on the plains on the east bank of the Nakdong River. The reservoir retains water throughout the dry season, and extensive flooding occurs in surrounding areas during the rainy season. The maximum depth of water is five meters, and the pH value 7.8.

**Climatic conditions:** Humid, temperate, monsoonal climate with cold dry winters and warm wet summers.

**Principal vegetation:** Marshes with *Phragmites communis*, *Isachne nipponensis* and *Persicaria blumei*; cultivated land and an *Isachne nipponensis* community in surrounding areas.

**Land tenure:** The reservoir is state owned; surrounding areas are privately owned.

**Conservation measures taken:** None.

**Conservation measures proposed:** Some recommendations have been made concerning the protection of the wetland.

**Land use:** Fishing; agriculture in surrounding areas.

**Disturbances and threats:** Uncontrolled cutting of aquatic vegetation.

**Economic and social values:** The reservoir is an important source of irrigation water for adjacent agricultural land.

**Fauna:** A wintering area for Anatidae, notably *Cygnus cygnus*, *Tadorna ferruginea* and several *Anas* species, a breeding area for *Egretta alba* and *Ardea cinerea*, and a staging area for shorebirds, notably *Vanellus vanellus*. Waterfowl recorded during a census in mid-January 1988 included:

19 *Egretta alba*

81 *Cygnus cygnus*

800 *Anser fabalis*

200 *Anas strepera*

100 *A. platyrhynchos*

480 *A. acuta*

The fishes include *Culter brevicauda* and *Rhodeus uyekii*, and the invertebrates include *Annana gammarus* and *Sphaerium sp.*

**Special floral values:** None known.

**Research and facilities:** Preliminary surveys were carried out by the Environment Administration during its National Survey of Natural Ecosystems in 1986, and by the Local Authorities in 1987.

**References:** Environment Administration (1987).

**Criteria for inclusion:** 3b.

**Source:** Hwang Hong-Suk and Won Pyong-Oh.

**Wetland name:** Daepyeong, Jilnal and Yujeon Marshes

**Country:** Republic of Korea

**Coordinates:** 35°18'N, 128°20'E;

**Location:** near Popsu-myon and Kunbuk-myon, Haman County, 25 km WNW of Masan, South Kyongsang Province.

**Area:** Daepyeong 14 ha; Jilnal 28.7 ha; Yujeon 36.7 ha.

**Altitude:** 10m.

**Biogeographical Province:** 2.2.2.

**Wetland type:** 15.

**Description of site:** A complex of permanent and seasonal freshwater marshes on the plains south of the Nam River, a tributary of the Nakdong River. The three main marshes are Daepyeong in the north, Jilnal about two km to the south, and Yujeon a further two km beyond that. The marshes are fed by local run-off and subterranean sources. The maximum depths and pH values are as follows: Daepyeong, 1.24m and 6.8-7.1; Jilnal, 1.24m and 7.0-7.1; Yujeon 0.87m and 7.0-7.1.

**Climatic conditions:** Humid, temperate, monsoonal climate with cold dry winters and warm wet summers. The average annual rainfall is 1,279 mm, the average relative humidity 75%, the maximum temperature 38.0°C, and the minimum temperature -13.4°C.

**Principal vegetation:** The aquatic vegetation is dominated by *Trapa japonica*, *Ceratophyllum demersum* and *Hydrilla verticillata*; *Nelumbo nucifera* is grown commercially at Daepyeong Marsh. The marshes are surrounded by rice paddies, other agricultural land and woodland with *Pinus densiflora* and *Smilax china*.

**Land tenure:** Daepyeong Marsh is privately owned; Jilnal and Yujeon Marshes are owned by Haman County. Surrounding areas are partly private and partly owned by the County.

**Conservation measures taken:** All of the wetland in Daepyeong and Jilnal Marshes were designated as a Natural Monument (No.346) in 1984.

**Conservation measures proposed:** The Government has proposed that the wetlands be given some protection, but the land owners have opposed this because of their desire to drain the marshes for agricultural purposes.

**Land use:** Fishing, reed-cutting and cultivation of aquatic plants (particularly *Nelumbo nucifera*). Agriculture and forestry in surrounding areas.

**Disturbances and threats:** Drainage and land-fill for conversion into agricultural land.

**Economic and social values:** The marshes serve a valuable function as natural water storage reservoirs for irrigation; they have high value for scientific research and provide excellent opportunities for conservation education.

**Fauna:** The marshes and surrounding rice paddies are an important feeding area for wintering Baikal Teal *Anas formosa*, which roost at the Ch'unsan and Tongp'an Reservoirs some 30 km to the east (site 18). At least 17,000 *A. formosa* were using the area in late January 1988 (Won Pyong-Oh, pers. comm.). The marshes support a very rich fish and invertebrate fauna. Fishes include *Pseudorasbora parva*, *Carassius auratus*, *Misgurnus anguillicaudatus*, *M. mizolepis*, *Channa argus*, *Oryzias latipes*, *Macropodus chinensis* and *Rhinogobius brunneus*. Aquatic insects include *Epeorus uenoi*, *Sympyeon paedisca*, *Anax part henope*, *Epophthalmia elegans*, *Microvelia horvathi*, *Gerris amembo*, *Aphelochirus vittatus* and *Diplonychus japonicus*.

**Special floral values:** The marshes support a fine growth of *Euryale ferox*.

**Research and facilities:** The Environment Administration carried out a preliminary survey of the marshes and their fauna and flora between May and September 1984.

**References:** Environment Administration (1984).

**Criteria for inclusion:** 1b, 2a, 2b.

**Source:** Hwang Hong-Suk.

**Wetland name:** Sannam, Ch'unsan (Junam) and Tongp'an Reservoirs

**Country:** Republic of Korea

**Coordinates:** 35°18'N, 128°41'E;

**Location:** 11 km north of Ch'angwon and 14 km NNE of Masan, Uichang County, South Kyongsang Province.

**Area:** Sannam 75 ha; Ch'unsan (Junam) 307 ha; Tongp'an 50 ha.

**Altitude:** c.10m.

**Biogeographical Province:** 2.2.2.

**Wetland type:** 17.

**Description of site:** Three small water storage reservoirs and associated marshes in close proximity to one another, on cultivated plains south of the Nakdong River. Sannam was constructed in 1922, Ch'unsan in 1944, and Tongp'an in the 1970s. The reservoirs receive inflow from the Nakdong River, and the water levels remain almost stable throughout the year. The middle and largest reservoir (Ch'unsan or Junam) has a maximum depth of four meters and a pH value of 7.3.

**Climatic conditions:** Humid, temperate, monsoonal climate with cold dry winters and very warm wet summers. The average annual rainfall is 1,426 mm, and the mean annual temperature 14.3°C.

**Principal vegetation:** Marshes dominated by *Typha orientalis* with some *Phragmites communis*, and an abundant growth of submergent and floating vegetation including *Salvinia natans*, *Potamogeton malainus*, *P. distinctus*, *Vallisneria asiatica*, *Hydrilla verticillata*, *Hydrocharis dubia*, *Spirodela polyrhiza*, *Lemna paucicostata*, *Nuphar japonicum*, *Euryale ferox*, *Ceratophyllum demersum*, *Trapa japonica*, *Myriophyllum spicatum*, *Nymphoides indica* and *N. peltata*. Rice paddies, barley fields and pine forests with *Pinus densiflora* in surrounding areas.

**Land tenure:** The reservoirs are owned by the County Farmland Improvement Trust; surrounding areas are privately owned.

**Conservation measures taken:** Ch'unsan Reservoir has been designated as a Game Sanctuary. Many of the wintering waterfowl are protected by the Cultural Properties Protection Law of 1962 and other laws.

**Conservation measures proposed:** A proposal has been made for the establishment of a permanent game refuge (bird sanctuary), but this has met with opposition from the local farmers who fear that the birds may cause damage to crops.

**Land use:** Fishing, pearl culture, and water supply for irrigation and industry; cultivation of rice, barley and other crops in surrounding areas.

**Disturbances and threats:** There is some pollution from nearby industries, and considerable disturbance from illegal hunting, fishing activities, the culture of freshwater pearls, and the cultivation of herbs for oriental medicines.

**Economic and social values:** The reservoirs are an important water supply and support a significant fishery. They also provide excellent opportunities for scientific research and conservation education.

**Fauna:** An extremely important wintering area for Anatidae, particularly Baikal Teal *Anas formosa*, a species now threatened throughout much of its range. Some 5,000 *A. formosa* were reported in February 1984 at Ch'unsan; in January 1987, no less than 20,000 were found roosting on the ice at Ch'unsan, and in January 1988, about 20,000

were again present, mostly on Tongp'an Reservoir. The birds roost on the reservoirs and flight out to feed in rice paddies around Daepyeong, Jimal and Yujeon Marshes (site 17), some 30 km to the west. The majority of birds depart in early March; only 100 were present by 19th March 1988. It seems likely that this wintering concentration of *A. formosa* is a recent phenomenon, as the species has for many years been recorded only as a scarce passage migrant in the Republic of Korea. Huge flocks have been recorded on migration in the past, but the last such flock was one of at least 10,000 birds flying over Suwon in March 1946 (Gore & Won, 1971).

Counts of other waterfowl in recent years have included 350-550 swans (mainly *Cygnus Cygnus* with some *C. columbianus*) and:

1,000-3,500 *Anser fabalis*

500-1,270 *A. albifrons*

up to 12,000 *Anas penelope*

1,250 *A. falcata*

2,460 *A. crecca*

5,300 *A. platyrhynchos*

950 *A. poecilorhyncha*

2,100 *A. acuta*

5,400 *Aythya ferina*

480 *A. mania*

Other species occurring in smaller numbers include *Tachybaptus ruficollis*, *Podiceps cristatus*, *Egretta garzetta*, *E. alba*, *Ardea cinerea*, *Aix galeniculata* (in summer), *Anas quenquedula* (on passage), *Mergus aibelius* and 11 species of shorebirds (on passage). Twelve White-naped Cranes *Grus vipio* were present in the winter of 1986/87, and nine in the winter of 1987/88. The Hooded Crane *G. monacha* has also been reported. Fishes known to occur in the reservoirs include *Plecoglossus altivelis* and *Culter brevicauda*. The invertebrates include *Radix auriculana* and *Annano gammarus*.

**Special floral values:** None known.

**Research and facilities:** Mid-winter waterfowl censuses have been carried out on a regular basis. Yoon and Won made a botanical survey of Ch'unsan Reservoir in 1984 and 1985, and the Environment Administration conducted a study there in 1986.

**References:** Environment Administration (1987); Gore & Won (1971); Won (1983 & 1986a); Yoon & Won (1985).

**Criteria for inclusion:** 2a, 3a.

**Source:** Hwang Hong-Suk and Won Pyong-Oh.

**Wetland name:** The Nakdong Estuary

**Country:** Republic of Korea

**Coordinates:** 35°03'-35°13'N, 128°48'-129°00'E;

**Location:** west of the city of Pusan, South Kyongsang Province.

**Area:** 9,560 ha of wetlands, including 4,560 ha in the main Nakdong channels, 500 ha in the Jukrim channel, and 4,500 ha in the Yeongwonri area to the west.

**Altitude:** 0-3m.

**Biogeographical Province:** 2.2.2.

**Wetland type:** 02, 03, 05, 06 & 08.

**Description of site:** The delta and estuarine system of the Nakdong River, with its numerous tidal channels, low-lying islands and sand bars, about 3,000 ha of intertidal mudflats, and extensive brackish to saline marshes. Large areas of former marsh and

mudflat have been reclaimed for agriculture, and many of these diked areas are subject to seasonal flooding. The western marshes and mudflats (4,500 ha) are almost surrounded by the steep hills of the mainland and the large island of Gadeog-do. The eastern marshes and mudflats (4,560 ha) are protected from the open sea by a chain of low sandy barrier islands, including Galmaegi Deung, Namusit Deung and Jinuh Do. Other small estuarine islands such as Daema Deung, Ogryu Deung and Baeghab are covered with reed-beds, patches of dunes and cultivation. The largest island, Eulsuk Do, lies between the two main branches of the Nakdong; most of the island is cultivated for onions and rice, but there are extensive reed-beds at the south end. The Jukrim channel, a western branch of the Nakdong, was closed off by the Noksan Dam, six km upstream from its mouth, in 1934. The channel above the dam has since become a shallow freshwater lake of 500 ha, with abundant aquatic vegetation. In 1984-86, a barrage was constructed across the two main channels of the Nakdong at Eulsuk Do Island, converting these channels into multi-purpose freshwater reservoirs with the water level about one metre above sea level.

The output of the Nakdong River reaches its maximum in July, and minimum in January. Prior to the construction of the barrage, salt water influence extended for up to 30 km upstream, and tidal influence for about 60 km. Salinities range from two to five p.p.t. in the upper reaches of the estuary, and from 25 to 30 p.p.t. along the coast. The tidal range varies from 0.3m at neap tides to 1.5m at spring tides.

**Climatic conditions:** Humid, temperate, monsoonal climate with cold dry winters and very warm wet summers. The average annual rainfall is 1,520 mm, 70% of which falls during the four months from June to September. The mean annual temperature is 14.2°C; the mean in the coldest month, January, is 2.2°C, and the mean in the hottest, September, is 22.2°C.

**Principal vegetation:** The main plant communities are as follows: (1) fresh to brackish riverine marshes along the upper stretches of the Nakdong dominated by *Phragmites communis* and *Carex scabrifolia*, with patches of *Potamogeton malainus*, *Trapa japonica* and *Vallisneria asiatica* in shallow water; (2) halophytic vegetation nearer the coast with *Aster tripolium*, *Limonium tetragonum*, *Suaeda maritima* and *S. asparagoides*; (3) open vegetation on the barrier islands with *Carex pumila*, *Cynodon dactylon*, *Imperata cylindrica* var. *koenigii*, *Zoysia sinica* and *Salsola komarovi*; (4) sparsely vegetated mudflats with *Scirpus triquetus*, mats of *Enteromorpha* sp, and some patches of *Zostera noltii*, particularly south of the Noksan Dam; (5) freshwater lake vegetation in Jukrim Reservoir dominated by *Potamogeton malainus*, *Trapa japonica* and *Vallisneria asiatica* in association with *Salvinia natans*, *Spirodela polyrhiza*, *Najas minor* and *Hydrilla verticillata*, and with a dense fringe of *Phragmites* reeds. Reclaimed land inside the sea-walls is largely under cultivation for onions, rice and other crops. A botanical survey of the Nakdong Estuary in April 1984 recorded 297 taxa of vascular plants, including 25 taxa of aquatic plants, and 53 species of diatoms.

**Land tenure:** State owned; under the jurisdiction of Pusan City.

**Conservation measures taken:** The Office of Forestry prohibited hunting in the estuary in 1962, and the Bureau of Cultural Property Preservation designated the entire estuary as a Natural Monument (No.179) for migratory birds in 1966.

**Conservation measures proposed:** The loan agreement for the Nakdong Barrage Project, signed between the World Bank and the Korean Government in 1983, included a requirement that the Government establish a National Environmental Preservation Area (NEPA) or similar protected area incorporating all those parts of the estuary not destroyed by the construction of the barrage. The Government

commissioned NEDECO (Netherlands Engineering Consultants) to study the estuary, and they proposed that an area of 5,000 ha be set aside as a NEPA. However, no further action was taken, and in 1986, with the barrage project almost completed, the Korean Government requested a release from the conservation obligation of the loan. In the meantime, the Ministry of Construction had drawn up plans to polderize nearly the entire undeveloped area of the estuary. Several alternative poldering schemes were proposed, one of these involving about 6,400 ha of the estuary. Having already handed over 99% of the loan, the World Bank found itself in a poor position to enforce the conservation stipulation in the agreement. In discussions with the World Bank in 1986, the Korean Government agreed to establish a Preservation Area of about 4,000 ha, and to reduce the planned reclamation area to 2,000 ha. The World Bank accepted the compromise, provided that strong protection be given to the Preservation Area and specific compensation measures be implemented by the Government. In February 1988, after further discussions with the World Bank, an inter-ministerial agreement approved the reduction of the planned reclamation area from 2,000 ha to 1,170 ha. The proposed NEPA has been expanded accordingly, and the Government is expected to establish the reserve before the end of 1988.

**Land use:** Fishing, mainly for eels (*Anguilla japonica* and *Astroconger myriaster*) with fixed nets, and for freshwater fish in the Jukrim branch; harvesting of the abundant molluscs for human consumption; culture of the algae *Porphyra* sp and *Undaria* sp, particularly along the southern shores of the barrier islands; and transportation. Agriculture and industrial development in adjacent areas. The city of Pusan, with a population of about four million, lies immediately to the east of the estuary.

**Possible changes in land use:** There are plans to polderize a further 1,170 ha of the estuary for agricultural and industrial development.

**Disturbances and threats:** Prior to the construction of the Nakdong Barrage, the principal threats were pollution from industrial waste and from pesticides widely used on adjacent agricultural land. Several dams and river "improvement" schemes upstream on the Nakdong have had an effect on the delta by altering the water regime. Reed-beds along the river banks and on Ulsuk Island are illegally cleared for agriculture, and there is a problem with the disposal of domestic sewage on Ulsuk Island. Local people regularly collect the eggs of *Charadrius alexandrinus*, *Sterna albifrons* and other species for food, although this is illegal.

The recently completed Nakdong Barrage Project has involved the construction of a barrage across both branches of the Nakdong River, the construction of a sluice for shipping in the eastern channel, the dredging of an approach channel through the southeastern part of Eulsuk Do Island and adjacent mudflats, and the dredging or reclamation of all mudflats on the eastern shore of the estuary. These activities have resulted in the immediate loss of 300 ha of mudflats and marshes, and the conversion of the two river channels into freshwater lakes. The barrage has, however, also brought about changes in the sedimentation, erosion and resuspension processes, and has affected salinity fluctuations throughout the estuarine system. The main stream of the river has been shifted, and thus the load of fresh water and nutrients has also changed. These changes are likely to have significant long-term effects on the macrobenthos of the mudflats and hence on the fish and waterfowl populations. The possible impact of the barrage on bird populations has been discussed by Doornbos (1983), Doornbos *et al.* (1986) and Piersma (1985a).

A recent proposal to reclaim 6,400 ha of the remaining marshes and mudflats for agricultural and industrial purposes met with considerable opposition from

conservationists. In February 1988, an inter-ministerial agreement, approved by the President of Korea, limited the proposed area for reclamation to 1,170 ha. This includes 170 ha of the important Myongji-do mudflats.

**Economic and social values:** The estuary and adjacent mudflats provide important breeding and nursery grounds for many fishes and invertebrates of commercial importance, support a major fishery for both finfish and shellfish, and serve a valuable role in water purification. Because of their proximity to the city of Pusan, the wetlands provide excellent opportunities for scientific research, conservation education and nature-oriented outdoor recreation.

**Fauna:** The Nakdong Estuary is one of the most important staging and wintering areas for migratory Anatidae and shorebirds in the Korean Peninsula, regularly supporting over 50,000 birds. Winter censuses between 1975 and 1984 produced peak counts of 1,500 swans (*Cygnus columbianus* and *C. cygnus*) and:

130 *Podiceps nigricollis*  
260 *Phalacrocorax carbo*  
2,000 *Anser fabalis*  
1,100 *A. albifrons*  
700 *Branta bernicla*  
2,500 *Tadorna tadorna*  
6,770 *Anas penelope*  
1,280 *A. falcata*  
1,430 *A. strepera*  
2,200 *A. crecca*  
8,500 *A. platyrhynchos*  
2,690 *A. poecilorhyncha*  
2,580 *A. acuta*  
4,000 *A. clypeata*  
7,100 *Aythya ferina*  
5,080 *A. fuligula*  
2,700 *A. mania*  
150 *Melanitta nigra*  
260 *M. fusca*  
3,300 *Bucephala clangula*  
170 *Mergus aibellus*  
300 *M. serrator*  
1,760 *Fulica atra*  
2,700 *Calidris alpina*  
3,200 *Larus ridibundus*  
200 *L. canus*  
2,970 *L. crassirostris*  
1,620 *L. argentatus*

In one census in November 1983, some 670 swans, 540 geese, 21,400 dabbling ducks and 6,100 diving ducks were recorded.

Over 100,000 waterfowl were recorded in February 1987 including 1,800 grebes (mainly *Podiceps cristatus* and *P. nigricollis*), 3,000 grey geese (*Anser fabalis* and *A. albifrons*) and:

1,120 *Phalacrocorax carbo*  
644 *Cygnus cygnus*  
13 *C. columbianus*  
134 *Branta bernicla*

6,020 *Tadorna tadorna*  
almost 20,000 *Anas platyrhynchos*  
10,000 *Aythya ferina*  
15,900 *A. fuligula*  
40,000 gulls (*Larus spp*)  
10,000 other waterfowl

Over 39,000 waterfowl were present in mid-January 1988. These included:

250 *Podiceps cristatus*  
610 *Phalacrocorax carbo*  
340 *Cygnus cygnus*  
540 *C. columbianus*  
215 unidentified swans  
2,480 *Anser fabalis*  
2,260 *Tadorna ferruginea*  
2,900 *Anas platyrhynchos*  
9,200 *Aythya ferina*  
11,900 *A. fuligula*  
1,470 *Melanitta fusca*

The estuary is located in the middle of the East Asian shorebird flyway, and is of great importance as a staging area for migratory shorebirds in both spring and autumn. Doornbos (1983) recorded 10,600 shorebirds in October 1983, and Piersma (1985b) recorded 19,000 in mid September 1984. Thirty-seven species of shorebirds have been observed, including:

up to 160 *Pluvialis squatarola*  
2,560 *Charadrius alexandrinus*  
440 *C. mongolus*  
450 *Limosa limosa*  
620 *L. lapponica*  
90 *Numenius phaeop*  
440 *N. arquata*  
635 *N. madagascariensis*  
150 *Tringa erythropus*  
400 *T. nebularia*  
790 *Xenus cinereus*  
200 *Heteroscelus brevipes*  
1,240 *Calidris tenuirostris*  
1,300 *C. alba*  
10,900 *C. ruficollis*  
9,100 *C. alpina*

The estuary and adjacent coastal waters also provide a rich feeding area for migrating Common Terns *Sterna hirundo*; up to 600 have been recorded in the estuary, and over 10,000 were observed at sea south of the estuary in September 1984. The marshes and barrier islands support significant breeding populations of a variety of waterfowl including *Tachybaptus ruficollis*, *Ixobrychus sinensis*, *Anas poecilorhyncha*, *Gallinula chloropus*, *Fulica atra*, *Haematopus ostralegus*, *Charadrius dubius*, *C. alexandrinus* (c.130 pairs), *Sterna albifrons* (c.100 pairs) and *Acrocephalus orientalis*. The marshes also provide feeding areas for many herons and egrets, notably *Egretta garzetta*, *E. alba* (up to 500) and *Ardea cinerea*. In total, over 140 species of birds have been observed in the delta, including 96 species of waterfowl and most of the Anatidae and shorebirds known to occur in Korea. Many rarities have been recorded, such as *Egretta eulophotes*, *Aythya valisneria*, *Bucephala islandica*, *Grus vipio*, *Recurvirostra avosetta*, *Eurynorhynchus pygmeus* (up to 11 in recent years) and *Larus saundersi*. A female Crested Shelduck *Tadorna cristata* was shot on the lower reaches of the Nakdong River near Pusan in December 1916. The estuary is unusually rich in birds of prey, particularly in winter; species recorded include *Pandion haliaetus*, *Haliaeetus pelagicus*, *H. albicilla*, *Circus aeruginosus*, *C. cyaneus*, *C. melanoleucos* and *Falco peregrinus*. The invertebrate fauna and fishes have been described in some detail in a report sponsored by the Industrial Sites and Water Resources Development Corporation (1984). This lists 46 species of Crustacea, 40 species of Mollusca and 82 species of fishes. Doornbos (1984) recorded 40 species of macrozoobenthos (10 polychaetes, 11 molluscs and 19 crustaceans) in the intertidal mudflats, and calculated the average biomass at 14.6 gm ADW/sq.m (molluscs 9.5 gm, crustaceans 2.9 gm, and polychaetes 2.2 gm). The most important species were the polychaetes *Tylorriynchos heterochaetus*, *Neanthes japonica*; the bivalves *Corbicula japonica*, *Macoma contabulata*, *Laternula limicola*, *Sinonovacula constricta*, *Nuttallia olivacea*; the gastropods *Batillaria multiformis*, *Assiminea japonica*, and the crabs *Ilyoplax pusilla*, *Macrophthalmus japonicus*, *M. dilatatus* and *Scopimera globosa*. The most abundant small crustacean was the isopod *Cyathura sp.* The fishes include 40 marine species, 15 estuarine species, and 27 species which are primarily freshwater. Fourteen species are anadromous, including two species of great economic importance, *Plecoglossus altivelis* and *Anguilla japonica*. These species and the salmon *Onchorhynchus keta* (raised at a hatchery on the upper Nakdong River) will be seriously

affected by the barrage. Other commercially important species include *Astroconger myriaster*, *Cyprinus carpio*, *Carassius auratus*, *Misgurnus anguillicaudatus*, *Parasilurus asotus*, *Channa argus*, *Mugil cephalus* and *Gasterosteus aculeatus*.

**Special floral values:** None known.

**Research and facilities:** Numerous studies have been carried out on the estuarine ecosystem, its fisheries, and its fauna and flora, especially by biologists from the Fisheries University and Dong A University in Pusan. A great deal of this research has been undertaken as part of the environmental impact assessment for the Nakdong Barrage and to provide baseline information for the monitoring programme following the completion of the barrage. Much of the research carried out by Korean biologists is summarized in a report sponsored by the Industrial Sites and Water Resources Corporation (1984). Extensive environmental studies have also been carried out by NEDECO and the Delta Institute for Hydro biological Research in the Netherlands (Doornbos, 1983, 1984 & 1985; Doornbos et al., 1986; Eysink, 1983; Groenendijk & Yoon, 1985; NEDECO, 1981; Piersma, 1985a; Post, 1983). Special attention has been given to the waterfowl populations, macrozoobenthos of the mudflats, and biomass of food plants for waterfowl.

**References:** Doornbos (1983, 1984 & 1985); Doornbos et al. (1986); Eysink (1983); Groenendijk & Yoon (1985); Industrial Sites and Water Resources Corporation (1984); Karpowicz (1985); Kim & van Houweninge (1983); Korean Society for the Protection of Wild Animals (1982, 1983 & 1984); Long et al. (1988); NEDECO (1981); Piersma (1985a, 1985b, 1985c, 1985d, 1986a & 1986b); Post (1983); Won (1981b, 1983 & 1986a); Yoon & Won (1985).

**Criteria for inclusion:** 1b, 2a, 2c, 3a.

**Source:** Theunis Piersma and Won Pyong-Oh.

**Wetland name:** Hakdong Bay

**Country:** Republic of Korea

**Coordinates:** 34°46'N, 128°39'E;

**Location:** between Kujora and Haegumgang, on the southeast coast of Koje Island, South Kyongsang Province.

**Area:** 3,000 ha.

**Altitude:** Sea level.

**Biogeographical Province:** 2.2.2.

**Wetland type:** 01, 03 & 04.

**Description of site:** A small sea bay with rocky shores and several offshore islets, on the hilly southeast coast of Koje Island in the Korea Straits. The bay stretches from Kujora Headland in the northeast to Haegumgang Headland in the south.

**Climatic conditions:** Humid, temperate, monsoonal climate with cold dry winters and very warm wet summers. The average annual rainfall is 1,368 mm, and the mean annual temperature 14.1°C.

**Principal vegetation:** No information.

**Land tenure:** State owned.

**Conservation measures taken:** The bay was designated as a Natural Monument (No.227) for wintering divers (*Gavia* spp) in 1971.

**Land use:** No information.

**Disturbances and threats:** None known.

**Economic and social values:** No information.

**Fauna:** An important wintering area for Black-throated Divers *Gavia arctica viridogularis*, Pacific Divers *G. (arctica) pacificus*, Black-necked Grebes *Podiceps nigricollis* and sea-ducks. Counts in recent years have included:

up to 540 *G. arctica/pacificus*

272 *P. nigricollis*

137 *P. cristatus*

150 *Melanitta fusca*

23 *Histrionicus histrionicus*

210 *Mergus serrator*

along with large numbers of gulls, mainly *Larus crassirostris*. *Egretta sacra* occurs on the rocky shores, and the raptors *Haliaeetus pelagicus*, *H. albicilla* and *Falco peregrinus* have been recorded in winter.

**Special floral values:** No information.

**Research and facilities:** Mid-winter waterfowl censuses have been carried out in recent years.

**References:** Won & Yoon (1974)

**Criteria for inclusion:** lb. 3b.

**Source:** Won Pyong-Oh.

**Wetland name:** Songsanp'o Lake

**Country:** Republic of Korea

**Coordinates:** 33°27'N, 126°55'E;

**Location:** at the eastern end of Cheju Island, 35 km east of Cheju City, Cheju Province.

**Area:** 30 ha.

**Altitude:** Sea level.

**Biogeographical Province:** 2.2.2.

**Wetland type:** 08.

**Description of site:** A shallow saline lagoon and associated marshes, formed by the damming of a small sea bay at the extreme eastern tip of Cheju Island. The salinity is 34.25 p.p.t.

**Climatic conditions:** Humid, temperate, monsoonal climate with cold dry winters and very warm wet summers. The average annual rainfall is 1,763 mm, and the mean annual temperature 14.7°C.

**Principal vegetation:** Brackish marshes dominated by *Phragmites communis*.

**Land tenure:** State owned.

**Conservation measures taken:** None.

**Land use:** Fish culture.

**Disturbances and threats:** None known.

**Economic and social values:** No information.

**Fauna:** An important wintering area for waterfowl, notably Anatidae. Censuses in the winters of 1979/80, 1980/81 and 1987/88 included:

up to 1,700 *Anas penelope*

400 *A. strepera*

150 *A. crecca*

140 *A. platyrhynchos*

110 *A. poecilorhyncha*

100 *A. acuta*

600 *Aythya fuligula*

along with smaller numbers of *Tachybaptus ruficollis*, *Egretta garzetta*, *Ardea cinerea*, *Anas falcata*, *A. clypeata*, *Aythya ferina* and *Fulica atra*.

**Special floral values:** No information.

**Research and facilities:** Several waterfowl censuses were carried out by Park and Kim between December 1979 and February 1981, and a mid-winter count was conducted in January 1988.

**References:** Park & Kim (1981).

**Criteria for inclusion:** lb. 3b.

**Source:** Won Pyong-Oh.

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